Are Corporations Reducing or Taking Risks with Derivatives?

Ludger Hentschel[a] and S.P. Kothari[b]

[a]Simon School, University of Rochester, Rochester, NY 14627.
[b]Sloan School, Massachusetts Institute of Technology, Cambridge, MA 02142.

February 17, 2001
First Draft: August 1994

Forthcoming in *Journal of Financial and Quantitative Analysis*, March 2001
Comments Welcome

Abstract: Public discussion about corporate use of derivatives focuses on whether firms use derivatives to reduce or increase firm risk. In contrast, empirical, academic studies of corporate derivatives-use take it for granted that firms hedge with derivatives. Using data from financial statements of 425 large u.s. corporations, we investigate whether firms systematically reduce or increase their riskiness with derivatives. We find that many firms manage their exposures with large derivatives positions. Nonetheless, compared to firms that do not use financial derivatives, firms that use derivatives display few, if any, measurable differences in risk that are associated with the use of derivatives.

Keywords: Derivatives, futures, forwards, hedging, options, risk management, speculation, swaps.

JEL Classifications: G32, M41

We thank the following for helpful comments: an anonymous referee, Paul Gompers, Stacey Kole, John Long, Bill Schwert, Jay Shanken, Cliff Smith and seminar participants at the Berkeley Program in Finance, the cepr Summer Symposium in Finance, the Chicago Board of Trade, the inquire Conference, and the London School of Economics. Anjali Arora and Eric Kim (under an Olin Fellowship) provided excellent research assistance. We gratefully acknowledge financial support from the Bradley Policy Research Center and the John M. Olin Foundation.

Contents

1 Introduction

The primary objective of this study is to empirically investigate whether corporations' use of derivatives is significantly related to their overall stock-return risk. Risk management that reduces return volatility is frequently termed hedging, and risk management that increases return volatility is called speculation. While there is survey evidence and some empirical evidence that firms engage in hedging activities using derivatives (e.g., Bodnar and Marston 1996, and Tufano 1996a), research examining the net consequence of derivatives-use on firms' return volatility is surprisingly absent. Such research is important because the possibility that firms use derivatives to increase their risk exposures recently has been a principal concern guiding regulatory agencies in their considerations of derivatives regulation.

Derivatives users have consistently argued that regulators' concerns about the dangers of derivatives-use (i.e., speculation) are misplaced. They contend that the direct and indirect costs of "excessive" regulation will reduce derivatives' usefulness. Most recently, a *Wall Street Journal* editorial echoes concerns that FASB's latest proposal to expand required derivatives disclosure is counterproductive.[1] The intense debate about the appropriate level of derivatives disclosure among regulators, analysts, derivatives users, and dealers has largely occurred in the absence of systematic empirical evidence about the effects of derivatives-use on firms' stock-return or cash-flow volatility. Much of the evidence cited by regulators and referred to in the financial press is anecdotal. Large-sample, systematic empirical evidence is important in ascertaining whether current derivatives-use is consistent with widespread speculation.

In a panel of 425 large, U.S. firms, we cannot detect an economically or statistically significant relation between firms' risk characteristics and the extent of their participation in derivatives markets. We focus not only on the average firm, but also on intensive users of derivatives. Even for firms that hold large derivatives positions relative to overall firm size we cannot detect an economically significant link between derivatives and increased volatility. Our results are inconsistent with the hypothesis that firms use derivatives to speculate on a large scale. In fairness, somewhat surprisingly, our results also say that we do not detect significant exposure or risk reductions due to derivatives.

Our results for non-financial firms complement Koski and Pontiff's (1999) findings for mutual funds. Their finding "contradicts the popular association of derivatives-use with increased risk exposure" (p. 813). Koski and Pontiff compare risk measures and higher moments of the return distributions of mutual funds that do or don't use derivatives. They classify mutual funds as users and non-users of derivatives since they do not have data on the funds' intensity of derivatives-use.

The absence of a significant relation between derivatives-use and return volatility is not attributable to a lack of statistical power of the tests we employ. The estimated standard errors are small enough to rule out positive and negative

[1] *Wall Street Journal,* March 14, 1997, p. A16.

net effects of economic significance. Our estimates of the effects of derivatives on firm risk are simply close to zero in both economic and statistical terms. These findings cast doubt on the seriousness of the frequently voiced concern that corporations use financial and commodity derivatives to speculate and thus place shareholders' wealth at undue risk.

The absence of an economically or statistically significant association between firms' risks and their derivatives-use also does not appear to be due to the endogenous choice of derivatives-use. That is, the firms' use of derivatives themselves is influenced by the exposures (volatilities) facing the firms and their choice of financial leverage. Endogenous use of derivatives can make it difficult to unmask the marginal effect of derivatives-use on return volatility using simple regression procedures. We therefore also estimate instrumental-variables regressions (which are equivalent to two-stage least squares estimation). This analysis also leads us to conclude that firms' derivatives-use does not measurably increase or decrease their return volatility.

Our findings are consistent with Stulz's (1996) argument that firms primarily use derivatives to reduce the risks associated with short-term contracts. Since the cash flows associated with these contracts typically represent a small fraction of firm value, risk reduction for these contracts is unlikely to have material effects on overall firm volatility. This argument is quite different from established theories of corporate risk management, however.

Stulz (1984), Smith and Stulz (1985), DeMarzo and Duffie (1992), and Froot, Scharfstein, and Stein (1993), among others, construct models of corporate hedging. These models predict that firms attempt to reduce the risks they face if they have poorly diversified and risk averse owners, face progressive taxes, suffer large costs from potential bankruptcy, or have funding needs for future investment projects in the face of strongly asymmetric information. In many instances, such risk reduction can be achieved with derivatives.

There also are, however, theories that predict that firm owners might use derivatives to take on additional risks. These theories build on the Black and Scholes (1973) analogy between options and corporate claims. The analogy suggests that higher volatility is beneficial to equity owners—holders of call options—at the expense of debt owners—writers of put options. Jensen and Meckling (1976) and Myers (1977), for example, point out that the owners of leveraged firms can have incentives to increase the firms' riskiness in order to transfer wealth from bond holders to stock holders. Derivatives can produce these increases in risk.

Thus far, limited empirical evidence has been brought to bear on the implications that these theories have for the corporate use of derivatives. In large part, this lack of evidence can be attributed to poor data availability. Financial institutions form a notable exception to this lack of data and evidence (see Booth, Smith and Stolz 1984; Eccher, Ramesh and Thiagarajan 1997; Scott and Peterson 1986; Schrand 1993; Veit and Reiff 1983; or Gorton and Rosen 1995, for example) since they have had to file more detailed reports on derivative holdings to their supervisory agencies.

For non-financial firms, however, the existing evidence on corporate derivatives activity typically takes the form of categorical data—whether firms hold any derivatives or not. Moreover, most studies try to determine *why* firms use derivatives to reduce risks, not *whether* they use derivatives to reduce risk. Nance, Smith and Smithson (1993) present survey data for a sample of 169 firms, while Mian (1996) collects data for 1,636 firms from annual reports for 1991; Geczy, Minton, and Schrand (1997) analyze data on 411 *Fortune* 500 firms for 1990 and 1991.

With two exceptions, relatively little is known about the derivative activity of non-financial firms beyond these categorical data. Tufano (1996a) conducts a detailed study of risk management in the gold-mining industry. Tufano's findings support the hypothesis that firms in the gold-mining industry use derivatives to reduce risks. The primary motivation for this hedging seems to be managerial and owner risk aversion. Unfortunately, it is not clear whether these results extend to other industries, where the sources of risk and ownership are not as concentrated. Bodnar and Marston (1996) provide extensive survey evidence on corporate derivatives-use. Their evidence suggests that firms typically hedge with derivatives but do so imperfectly. Some firms in the survey seem to take speculative positions occasionally. Unfortunately, the voluntary and unmonitored reporting in such surveys makes it difficult to ascertain what roles selective or dishonest survey responses play in the data.

The remainder of the paper provides the details of our analysis. Section 2 describes the sample and provides descriptive statistics on the sample firms' derivative holdings and financial characteristics. Section 3 investigates how derivative holdings relate to firms' risk characteristics such as volatility or exposures to exchange and interest rates. Section 4 concludes.

2 Derivative Holdings and Firm Characteristics

This section describes the nature of the disclosures in the annual financial statements, how the sample was constructed, and the basic sample properties of the data.

2.1 Disclosure of Derivative Activity in Financial Reports

The Financial Accounting Standard Board's Statement of Financial Accounting Standards (SFAS) No. 105, "Disclosure of Information about Financial Instruments with Off-Balance-Sheet Risk and Financial Instruments with Concentration of Credit Risk" mandates, among other things, footnote disclosure of the face, contract, notional, or principal amount of derivative contracts in financial statements issued for fiscal years ending after June 15, 1992. SFAS No. 105 requires that the information is reported separately for option, futures, and forward contracts. Subsequently, more detailed disclosure requirements for derivatives have been introduced. The revised standards mandate disclosure of fair market values of financial instruments with off-balance-sheet risk and whether these instruments are being issued or held for trading purposes or for other purposes. The more recent standards impose higher disclosure requirements on trading positions in derivatives. Unfortunately, they do not provide more precise information for our purposes. As for SFAS No. 105, comparable data have to be furnished for the previous year. Therefore, notional principal values of derivative holdings are available from 1991.

The disclosure of notional contract values limits the information that can be extracted from the data. In particular, there is no strict relation between the size of a contract and the sensitivity of its value to the underlying price. Nonetheless, except for options and leveraged swaps, it is not unreasonable to assume a general proportionality between contract size and exposure. Unless firms hold offsetting positions, this proportionality should hold approximately for the firms' total derivatives position. One would expect that many financial firms, who are market makers in derivatives, hold such offsetting positions to run a "balanced book." Non-financial firms that are trying to take net positions with derivatives, however, have no obvious reason to hold offsetting derivatives positions.

Firms are also required to mark their derivatives positions to market and report the changes in market values of the derivatives held for trading purposes in their income statement. Although this information can be used to estimate the exposure of the derivatives positions, it is confounded by acquisitions and sales during the year. Moreover, firms apply "hedge accounting" to some derivatives, thereby keeping the changes in market value out of the income statement. Consequently, we do not attempt to estimate derivatives exposures from the income-statement data.

Data on the firms' derivative activity are obtained from notes to the firms' financial statements. For each firm year, data are separately recorded for interest rate, foreign currency and commodity derivatives. The derivatives are separated into forwards, swaps, options and futures. Firms disclose their activities at various levels of aggregation and frequently only subtotals are available for larger categories. When firms only make categorical disclosure of their derivative activities this also is recorded.

Concomitant with disclosure requirements, we find a large increase in the number of firms reporting derivative holdings after 1990. For 1990, we find 83 firms that disclose derivatives activity—often as part of their statement of comparable figures for prior years. For 1991, 170 firms in our sample disclose derivatives holdings. For 1992 and '93, the numbers are 157 and 176, respectively.

2.2 Sample Construction

In order to focus on non-financial corporations with derivatives, we select large U.S. corporations from the April 25, 1988 issue of *Fortune* magazine. The initial list of firms includes the 200 largest industrial firms, the 25 largest retailers, the 25 largest transportation companies, the 25 largest utilities, the 50 largest diversified service companies, the 50 largest diversified financial firms excluding insurance companies, and the 50 largest commercial banks.[2] These are the largest firms in their respective categories ranked according to sales in 1987. These firms can be grouped into 325 non-financial firms and 100 financial firms. The sample is unbalanced by design, since we are primarily interested in the non-financial firms. The financial firms are included to provide comparisons to previous studies. Most of the interesting differences between financial and non-financial firms are so large that they cannot be attributed to noisy sampling in the smaller financial sample.

For each firm, we search the annual reports in Standard and Poor's Compact Disclosure database for 1992 and 1993 for keywords that indicate derivative activity. Since firms disclosing derivatives activity in 1992 must also report comparative information for 1991, we are also able to gather information on derivatives positions for 1991. The potential sample size is 1,275 firm year observations using the initial sample of 425 firms.[3] Of these, we are able to obtain usable data for 297 firm-year observations in 1991, 260 in 1992, and 283 in 1993. Eighty-nine firms disclosed comparative information for 1990 and we include their information as well. We drop firms from the initial sample of 425 as they cease to exist due to mergers, acquisitions, bankruptcy, or other reasons, if their annual reports are not included in the Compact Disclosure database, or if additional data could not be constructed from the equity files of Compustat and the Center for Research in Securities Prices (CRSP). This selection process possibly introduces a slight, but unavoidable, survivor bias. Nonetheless, firms are not required to have a complete four-year history to be included in our sample. The total sample comprises 929 firm years.

Furthermore, we use Compustat data to obtain firms' book values of assets and long-term debt. Finally, we compute annual returns, market-model betas, and return variances using CRSP daily return data.

2.3 Derivatives Held by Sample Firms

Table 1 summarizes the basic characteristics of the sample firms' derivative positions. For 586 out of 929 firm years, we find some derivative activity. The remaining 343 annual reports give no indication that the firms use derivatives, and hence no separate data are reported in this table. While almost two thirds of all firms participate in derivative markets, fully three quarters of the financial firms are active in derivative markets. Only about half of the non-financial firms disclose any derivative activity.

---

[2] Insurance companies are excluded because industry regulation is likely to affect returns and because the wide range of financial activities by insurance companies makes it difficult to separate them into financial and non-financial corporations. We retain other financial institutions since they have been a focus of the corporate derivatives literature.

[3] Although our sample includes only 425 large U.S. firms, the sample covers a large share of the total value of outstanding derivatives. The United States General Accounting Office (GAO) estimates that the notional principal of all outstanding derivatives was roughly $20 trillion at the end of 1992. During 1992, firms in our sample report an aggregate notional principal of $10 trillion. (Neither number is corrected for double-counting.)

Table 1

Derivative Holdings

	All Firms		Non-Financial Firms		Financial Firms	
	All	With Derivatives	All	With Derivatives	All	With Derivatives
Panel A: Total derivative activity						
	41,043	65,066	973	1,704	156,724	195,089
Grand Total	143	1,091	100	558	6,607	10,139
	201,175	250,271	3,207	4,097	373,740	408,081
Firm Years	929	586	767	394	257	192
Panel B: Derivative activity by underlying asset						
	16,844	26,683	395	661	64,335	80,083
Currency	0	191	0	143	97	755
	88,086	109,754	1,353	1,686	164,924	180,624
	21,118	33,415	406	617	80,913	100,719
Interest Rate	0	375	0	118	3,964	6,989
	106,139	132,130	1,845	1,575	197,693	216,089
	443	703	21	37	1,663	2,070
Commodity	0	0	0	0	0	0
	4,773	5,997	249	329	9,308	10,350
Panel C: Derivative activity by instrument						
	21,394	33,916	246	431	82,447	102,630
Forwards	0	130	0	0	1,267	3,743
	112,439	140,107	1,139	1,482	210,362	230,346
	11,687	18,539	347	607	44,563	55,529
Swaps	0	373	0	150	1,913	3,542
	58,003	72,202	1,169	1,496	108,147	118,223
	6,557	10,401	41	71	25,449	31,711
Options	0	0	0	0	327	1,072
	38,624	48,249	214	279	73,163	83,482

The table shows the mean, median and standard deviation of the notional principal in each derivative category across firm years. The notional principals are measured in millions of dollars. Separate data are provided for all firms as well as only firms that disclosed derivative holdings. The same split of all firms and firms without derivatives is also shown for subsamples of non-financial and financial firms. The grand total includes the notional value of all disclosed derivative contracts. If foreign exchange derivatives were separately reported, they are included in the currency category. Similarly, separately reported interest rate and commodity derivatives are included in their respective categories.

The individual categories do not add up to the grand total since not all firms disclosed their derivative positions at this level of detail.

The sample consists of 929 firm-years from 1990 to 1993. These firms are selected from the 425 largest U.S. firms ranked according to sales and listed in the April 25, 1988 issue of *Fortune* magazine. These 425 firms include the 200 largest industrial firms, the 25 largest retailers, the 25 largest transportation companies, the 25 largest utilities, the 50 largest diversified service companies, the 50 largest diversified financial firms excluding insurance companies, and the 50 largest commercial banks. Any firm with an annual report in the *Compact Disclosure* database for the years 1992 and 1993 and financial and stock-return data on Compustat and CRSP is included in the sample. Financial firms are those with Compustat SIC codes between 6000 and 7000.

The first row in panel A of table 1 shows that financial institutions' average notional principals are orders of magnitude larger than those held by typical non-financial firms. For both financial and non-financial firms, the median holdings of notional principal of derivatives are far smaller than average holdings. Non-financial firms with derivatives average notional principals of $1.7 billion.

For financial firms, a comparison of the mean and median shows that average derivative holdings are influenced by a few very active firms. These firms are typically dealers for one or more derivative products, and have large holdings. Presumably, these large holdings are carefully balanced, so that they do not expose the dealer to large price risks. In our sample, Chemical Banking Corporation is the most active among the financial institutions, and discloses aggregate notional principal of $2.47 trillion for 1993. By comparison, the most active non-financial user, General Electric Company only shows $45 billion in notional principal for 1992. The uncommonly large derivatives holdings of General Electric are attributable to General Electric's consolidated financial subsidiary, General Electric Capital Services, which used to own Kidder, Peabody & Co.

The next block of rows in table 1, panel B, shows derivatives-use by underlying asset. Firms that separately report their derivative holdings according to type roughly split their derivative positions between interest rate and foreign exchange derivatives. (The figures for the sub-categories do not add up to the grand total since not all firms itemize their holdings for all sub-categories.) Commodity derivatives rank a distant third. For example, in 1992, Caterpillar Incorporated held $37 million in commodity derivatives, but more than $2 billion in interest rate swaps and forward rate agreements.

Panel C of table 1 shows derivatives-use by instrument. Non-financial firms use swaps most intensively. Forwards are second with about $^2/_3$ as much in notional principal, while options are a distant third with about $^1/_{10}$ of the notional principal of swaps.

By all measures in the table, financial firms are vastly more active in the derivatives markets than their non-financial counterparts. Since many of the financial firms act as market makers, this discrepancy is to be expected. These enormous differences graphically illustrate the fact that one cannot extrapolate the behavior of non-financial firms in the derivative markets from the better-documented behavior of financial firms. We therefore analyze the financial and non-financial firm samples separately. Due to the fact that many of the financial institutions make markets in derivatives, the net exposure of their positions is a minuscule fraction of the reported notional principal. Although many market makers attempt to run balanced books with small or zero exposures, the disclosed values for notional principal do not allow us to compute net exposures. Nonetheless, the next section presents evidence that supports this balanced-book hypothesis.

Non-financial firms are more likely to take net positions in derivatives. Indeed, using derivatives to take on exposures is the objective for derivatives users—as opposed to dealers—regardless of whether the derivatives are used for hedging or speculation. The only difference between hedging and speculation with derivatives is the relation between the firm's inherent exposures and the exposures of the derivatives. A firm that hedges with derivatives employs derivatives to offset the firm's inherent exposures, while a firm that speculates with derivatives employs derivatives to increase the firm's inherent exposures.

Unfortunately, the notional principal of the derivatives positions only gives a rough indication of the size of the exposures. For example, if two call options are identical, except that one is deep out of the money, while the other one is deep in the money, the deep-in-the-money option provides a much higher exposure to the underlying asset at the same notional principal (contract size). Similarly, swaps with longer maturities have higher exposures than similar swaps with shorter maturities but identical notional principals. Consequently, the reported notional principal values have to be interpreted with care. Even so, unless firms employ vastly different principals in order to construct a given exposure, notional principals are still a rough measure of the size of the exposure.

Overall, table 1 shows that large U.S. corporations are active users of derivatives. Our data also suggest that derivatives-use is growing. There are 249 firms in our sample for which data are available for 1991 and 1993. The average notional principal of all derivatives held by these firms grew from $31 billion to $46 billion, a growth of 48.4% over two years.

2.4 Financial Characteristics of Sample Firms

Table 2 provides basic financial statistics for the financial and non-financial firms in our sample. In many instances, the aggregate statistics for the combined sample are not informative since there is large systematic variation across the financial and non-financial categories.

Panel A shows that financial firms in our sample have substantially higher book values of assets than their non-financial counterparts. This is true largely because financial firms are an order of magnitude more highly leveraged than non-financial firms. When compared on the basis of their equity market capitalization, the non-financial firms in our sample are larger. This comparison does not depend on derivative activity either.

Even a casual comparison of the asset and equity values for firms with and without derivatives suggests that firms with derivatives are substantially larger, on average, than those without. To provide some measure of derivative holdings relative to firm size, we show the grand total derivative position normalized by the market value of assets. The market value of assets is computed as the sum of the market value of equity and the book value of liabilities. Non-financial firms hold derivatives with an average notional principal equal to 7% of their assets; conditional on holding derivatives, this figure rises to 12%.

Financial firms average 185% of their assets in notional principal. Conditional on holding derivatives, the aggregate notional principal of derivatives held by financial firms averages 230% of assets. The median derivative holdings is only 25%, however. Obviously, a few financial firms have very large derivative holdings, which is consistent with the notion that those financial firms are market makers in derivatives.

TABLE 2
Firm Characteristics

	Non-Financial Firms			Financial Firms		
	All	With Derivatives	Without Derivatives	All	With Derivatives	Without Derivatives
Firm Years	690	394	296	239	192	47
Panel A: Financial information						
	11,603	14,676	7,514	42,485	48,225	19,035
BV of Assets	5,581	6,596	4,076	30,728	33,562	12,268
	21,126	25,491	12,340	40,296	41,082	26,342
	7,746	9,866	4,925	3,553	3,788	2,593
MV of Equity	3,885	4,608	3,146	2,455	2,633	1,136
	11,305	13,696	5,885	3,619	3,720	3,026
	0.07	0.12	0	1.85	2.30	0
Derivatives/	0.01	0.05	0	0.25	0.39	0
MV of Assets	0.28	0.36	0	3.70	4.00	0
Panel B: Risk measures						
	1.81	1.85	1.77	2.05	2.04	2.13
σ	1.67	1.69	1.62	1.87	1.87	1.86
	0.82	0.78	0.85	0.89	0.75	1.32
	2.91	2.96	2.84	3.01	2.97	3.17
σ/σ_m	2.68	2.69	2.66	2.90	2.91	2.88
	1.47	1.57	1.32	1.10	0.89	1.71
	1.02	1.07	0.95	1.22	1.29	0.92
β	1.03	1.07	0.96	1.23	1.29	0.82
	0.41	0.40	0.40	0.46	0.40	0.55
	1.72	1.75	1.68	15.97	16.69	13.03
Leverage	1.08	1.09	1.08	12.02	12.71	7.14
	3.03	2.25	3.82	12.76	12.47	13.62

The table shows the mean, median and standard deviation of several firm characteristic across firm years. Separate data are provided for financial and non-financial firms, and each of these categories is also split according to whether or not the firms disclosed any derivatives positions during the year.

The book value of assets and market value of equity are measured at the beginning of the year for which derivative data are collected for each firm; they are measured in millions of dollars. Derivatives divided by the market value of assets is the aggregate notional value of all reported derivative contracts deflated by the market value of assets measured at the beginning of the year for which derivative information is collected. The market value of assets is computed as the sum of the market value of equity plus the book value of liabilities. The standard deviation of returns, σ, is measured in percentage points and is calculated from the daily equity returns during the calendar year for which derivative information is reported. The standardized standard deviation of returns, σ/σ_m, is the standard deviation measure normalized by the standard deviation of the daily CRSP value-weighted index returns for the same year. The CAPM β is estimated by regressing daily returns on the daily CRSP value-weighted index return. Leverage is the book value of liabilities divided by the market value of equity, where all values are measured at the beginning of the year for which derivative information is reported.

The sample consists of 929 firm-years from 1990 to 1993. These firms are selected from the 425 largest U.S. firms ranked according to sales and listed in the April 25, 1988 issue of *Fortune* magazine. These 425 firms include the 200 largest industrial firms, the 25 largest retailers, the 25 largest transportation companies, the 25 largest utilities, the 50 largest diversified service companies, the 50 largest diversified financial firms excluding insurance companies, and the 50 largest commercial banks. Any firm with an annual report in the *Compact Disclosure* database for the years 1992 and 1993 and financial and stock-return data on Compustat and CRSP is included in the sample. Financial firms are those with Compustat SIC codes between 6000 and 7000.

Panel B of table 2 provides several risk measures for the firms in the sample: the standard deviation of daily returns, σ, measured during the fiscal year for which the annual report provides data; the standard deviation of daily returns normalized by the standard deviation of the CRSP value-weighted index, σ_m; and the market beta, β, estimated by regressing daily returns on the CRSP value-weighted index. Statistics for the normalized standard deviation, σ/σ_m, are presented to avoid possible biases from a spurious correlation between derivative reporting in our sample and market volatility. The volatility of daily market returns was 0.90% in 1990, 0.81% in 1991, 0.55% in 1992, and 0.49% in 1993.

Although the point estimates of the standard deviation and normalized standard deviation are slightly higher for non-financial firms with derivatives than those without, the hypothesis that their means are equal across firms with and without derivatives cannot be rejected at the 10% confidence level. For non-financial firms with derivative holdings, the standard deviation of daily stock returns is 1.85% compared to 1.77% for firms without derivative holdings. When the standard deviations are annualized, the differences are on the order of two percentage points. For financial firms, the difference between the average standard deviations of daily returns are economically small and statistically insignificant at the 10% level.

Based on the leverage ratios for non-financial firms, we conclude that these firms have limited motivation to take additional risks with derivatives. When interpreted as an option, equity in these firms is so deep in the money that increases in volatility produce small increases in equity values. For plausible values of interest rates and debt maturities, the leverage ratios in table 1 indicate that a typical non-financial firm would have to raise its annual volatility by at least 15 percentage points to realize a 1 percent equity gain.[4]

Like non-financial firms, financial firms with derivatives have significantly higher average β and leverage than those without derivatives. For financial firms with derivatives, the mean β is 1.29. For financial firms without derivatives, the mean β is only 0.92.

Overall, firms with derivatives have higher market betas and leverage than firms without derivatives, but they have similar volatility. Based on the differences in market betas, firms with derivatives appear to have higher market risk, but lower idiosyncratic risk, since their total standard deviation is not different from that of firms with derivatives. We will make a more convincing case later that a large part of this incremental market risk is due to differences in firm size and leverage, measured as the ratio of a firm's liabilities to its market equity.

3 Derivative Holdings, Risk, and Exposure

This section provides detailed evidence on the relation between firms' derivative holdings and firms' risk characteristics. If firms held derivatives primarily to speculate, one would expect—all else equal—higher-than-average derivative holdings to be associated with greater-than-average exposures and consequently

[4] This calculation assumes a debt maturity of 10 years and a risk-free rate of 5 percent.

above-average risk. This increase in risk follows unambiguously from the definition of speculation. Conversely, if firms use derivatives primarily to hedge, one would expect—all else equal—higher-than-average derivative holdings to be associated with lower-than-average exposures and consequently below-average risk. Unlike in the speculation case, however, there is an important exception to this association. If firms frequently attained the variance-minimizing hedge position, then we would expect little or no association between derivatives and volatility.[5] Based on the relatively small position sizes we report in table 2, it is unlikely that firms typically attain their variance-minimizing hedge position. This argument is further supported by the survey evidence in Bodnar and Marston (1998), where firms report that they hedge less than half of their foreign currency exposures.

In principle, it is possible that firms speculate but frequently reverse their positions. For example, a firm may bet on interest-rate increases one day and interest-rate decreases the next. Although such a firm could display an average interest-rate exposure close to zero, such speculation still increases the volatility of the cash flows to the firm, which would increase the volatility of the firm's stock price. We first investigate the relation between derivatives and firm volatility, before turning to derivatives and exposures.

3.1 Derivative Holdings and Risk

The sample descriptions of the previous section already allowed some analysis of derivatives and risk. Although the data suggest that firms with derivatives have slightly higher standard deviations and betas, we already alluded to the fact that this higher risk may be related to other factors. Indeed, the data indicate that firms with derivatives are generally larger than those without; they also generally have higher leverage than firms without derivatives. We now present formal tests of the hypothesis that large derivative positions are associated with relatively high risk of the firm's equity, controlling for the effects of other firm characteristics such as leverage, firm size, and book-to-market ratios.

3.1.1 Volatility regressions

In table 3, the standard deviation of daily equity returns is regressed on several firm characteristics: derivative holdings normalized by the market value of assets, market value of equity, leverage (i.e., debt-to-equity ratio), and book-to-market ratio. Since financial and non-financial firms' intensity and reasons for using derivatives tend to be different, we analyze them separately. However, the results in table 3 are qualitatively unchanged when we run the regressions for pooled samples of financial and non-financial firms. Nor are the basic results affected by using the standard deviation of weekly returns, or firms' beta risk (estimated using daily or weekly returns), instead of the standard deviation of daily returns.

The first column of table 3, panel A reports results of regressing the standard deviation of returns only on non-financial firms' derivatives holdings. Derivative

[5] This exception is a consequence of the zero-gradient property of interior optima.

holdings alone have low explanatory power: only 2.72% in adjusted R^2 terms. However, in statistical terms, the coefficient on derivative holdings, 0.49, has a Student-t statistic of 3.66 (p-value < 0.01). The t-statistics in all regressions are adjusted for heteroscedasticity using White's (1980) method. No adjustments, however, are made for correlation across residuals, or endogeneity. We discuss endogeneity and instrumental-variable regression results later.

Adding market value of equity, leverage, and book-to-market ratio to the derivatives-only model materially increases the explanatory power of the regression. While there is no theoretical basis for expecting the market value of equity to be related to stock-return volatility or beta risk, previous empirical research provides compelling evidence of a negative relation (e.g., Banz 1981). When market value of equity, leverage, and book-to-market are included in the regression, the adjusted R^2 is almost 50%. Although the t-statistics for these variables should also be considered with caution, any standard-error adjustment would leave the R^2 estimates unchanged. The point estimates of the coefficients indicate that larger firms have less volatile returns, and that more highly levered firms have more volatile returns. These results accord with previous findings by Christie (1982), even though Christie's results stem from a time-series analysis of data during a different sample period.

When market value of equity, leverage, and book-to-market ratio are included in the regressions, the point estimate of the coefficient on the standardized derivative holdings is reduced by half. It changes from 0.49 (with a t-statistic of 3.66) in column 1 to 0.27 (with a t-statistic of 2.61) in column 2. The coefficient's economic significance is small. These regressions suggest that a non-financial firm that raises its derivative holdings by 1 percent of total firm assets would—all else equal—raise the *annual* standard deviation of its stock returns by about 0.04 percentage points. Hence, if a firm were to raise its derivatives holdings from zero to the sample average of 12% of assets, one would expect the firm to raise its annual volatility by about one half of one percentage point (for example, from the sample average of 28 percent to 28.5 percent).

The economically unimportant role of derivatives holdings in explaining cross-sectional variation in equity standard deviation is also apparent from the less-than-one-percent reduction in the explanatory power when derivatives holdings are excluded from the regression model 3.

The regression results for the financial firms in panel A also reveal that financial firms' derivatives holdings have little association with the standard deviation of equity returns. The point estimates are negative, but small and statistically insignificant. There is neither an economically nor a statistically discernible relation between derivatives and the volatility of equity returns. The evidence suggests financial firms as derivatives dealers run a balanced book rather than use derivatives to take on exposures that place shareholder wealth at risk.

The qualitative results of the regressions using the entire sample of firms are unchanged upon using only the firms with derivatives. We report these results in panel B of table 3. Comparison of the R^2 statistics of models 2 and 3 for the non-financial firms shows that the inclusion of derivatives beyond other

TABLE 3
Derivatives and Equity Return Volatility

	Non-financial Firms			Financial Firms		
	1	2	3	4	5	6
			Panel A: All Firms			
Intercept	1.78	3.41	3.50	2.06	3.25	3.43
	(56.40)	(10.01)	(10.28)	(30.27)	(4.60)	(5.00)
Derivatives/ MV of assets	0.49	0.27		−0.01	−0.01	
	(3.66)	(2.61)		(−0.46)	(−1.66)	
MV of equity		−0.21	−0.22		−0.23	−0.26
		(−6.22)	(−6.43)		(−3.02)	(−3.45)
Leverage		0.16	0.16		0.03	0.03
		(5.92)	(5.88)		(4.38)	(4.27)
B/M		−0.25	−0.24		0.15	0.16
		(−1.64)	(−1.57)		(0.76)	(0.82)
$\bar{R}^2$ (in %)	2.72	49.47	48.70	−0.37	49.02	48.97
N	690	690	690	239	239	239
			Panel B: Firms with Derivatives			
Intercept	1.79	3.27	3.47	2.04	2.54	2.78
	(44.26)	(7.38)	(8.05)	(32.07)	(5.91)	(6.91)
Derivatives/ MV of assets	0.49	0.23		0.00	−0.01	
	(3.51)	(2.07)		(−0.27)	(−1.69)	
MV of equity		−0.19	−0.21		−0.15	−0.18
		(−4.25)	(−4.76)		(−3.13)	(−4.05)
Leverage		0.21	0.20		0.02	0.02
		(3.40)	(3.34)		(3.75)	(3.61)
B/M		−0.35	−0.32		0.30	0.32
		(−1.35)	(−1.26)		(2.87)	(3.35)
$\bar{R}^2$ (in %)	4.77	45.08	44.17	−0.50	48.43	48.35
N	394	394	394	192	192	192
			Panel C: All Firms Relative to Industry Average			
Intercept	0.98	1.60	1.60	1	1.58	1.67
	(71.64)	(10.05)	(10.21)	(31.75)	(4.90)	(5.30)
Derivatives/ MV of assets	0.02	0.01		0.00	−0.01	
	(4.43)	(1.41)		(−0.42)	(−1.70)	
MV of equity		−0.70	−0.70		−0.88	−0.97
		(−5.25)	(−5.22)		(−3.01)	(−3.45)
Leverage		0.13	0.13		0.23	0.22
		(4.74)	(5.31)		(4.55)	(4.52)
B/M		−0.03	−0.04		0.08	0.08
		(−0.79)	(−0.93)		(0.85)	(0.89)
$\bar{R}^2$ (in %)	2.31	34.45	34.30	−0.37	49.02	48.97
N	690	690	690	239	239	239

The table presents estimates of the coefficients γ_i in the regressions

$$\sigma_{i,t} = \gamma_0 + \gamma_1 \times (\text{Derivatives/MV of assets})_{i,t} + \gamma_2 \times \ln(\text{MV of equity})_{i,t} + \gamma_3 \times (\text{Leverage})_{i,t} + \gamma_4 \times (\text{B/M})_{i,t} + \epsilon_{i,t},$$

where $\sigma_{i,t}$ is the standard deviation of daily stock returns for firm i in year t measured in percentage points.

The numbers in parentheses below the coefficient estimates are t-statistics corrected for heteroscedasticity using White's (1980) method.

Derivatives/MV of assets is defined to be the aggregate notional value of all reported derivative contracts deflated by the sum of the book value of liabilities and the market value of equity, both measured at the beginning of the year for which derivative holdings information is collected;

(continued on next page)

Table 3—*Continued*

MV of equity is the market value of common equity at the beginning of the year for which derivative holdings information is collected;
Leverage is the ratio of the book value of liabilities to the market value of common equity, both measured at the beginning of the year for which derivative holdings information is collected;
The book-to-market ratio, B/M, is the book value of assets divided by the market value of equity plus the book value of debt, where all variables are measured at the beginning of the year.
N is the number of firm years used in each regression.
The sample consists of 929 firm-years from 1990 to 1993. These firms are selected from the 425 largest U.S. firms ranked according to sales and listed in the April 25, 1988 issue of *Fortune* magazine. These 425 firms include the 200 largest industrial firms, the 25 largest retailers, the 25 largest transportation companies, the 25 largest utilities, the 50 largest diversified service companies, the 50 largest diversified financial firms excluding insurance companies, and the 50 largest commercial banks. Any firm with an annual report in the *Compact Disclosure* database for the years 1992 and 1993 and financial and stock-return data on Compustat and CRSP is included in the sample. Financial firms are those with Compustat SIC codes between 6,000 and 7,000.

determinants of stock-return volatility enhances the explanatory power by less than one percent. By themselves, derivatives holdings explain just under 5% of the cross-sectional variation in return volatility. The coefficient on derivatives holdings in model 2 is 0.23 (t-statistic = 2.07), which implies less than 0.5% increase in the annual return volatility of a non-financial firm that increases its derivatives holdings from zero to 12% of the market value of assets, the average level of holdings for non-financial firms with derivatives. For financial firms, there is no evidence to suggest that standardized derivative holdings explain cross-sectional variation in return volatility.

The small standard errors around economically small coefficients on derivatives demonstrate that our findings are not driven by low statistical power. Because the standard errors are small, frequently we can reject the hypothesis that derivatives are not related to firm volatility for non-financial firms. Nonetheless, the economic importance of the statistical rejections is small. Precisely because the standard errors *and* the point estimates are small, the confidence interval around the point estimates only includes small coefficient values. Hence, we can reject the hypothesis that the coefficients are large and economically important, or that derivatives have economically important association with firm volatility.[6]

The regressions so far treat all non-financial firms as a homogeneous group. However, it is possible that the non-financial firms' industry membership is a determinant of their derivatives usage and return volatility as well as other economic variables. To ascertain whether our failure to control for industry effects is masking the association between derivatives holdings and return volatility, we perform the following analysis that attempts to control for industry effects. We deflate all variables in regression models 1 to 3 by their respective 2-digit SIC code industry average values of each variable. If there are fewer than five firms

[6] Nonetheless, table 3 contains some evidence that riskier firms use more derivatives. Controlling for the effects of firm size, leverage, and industry effects on volatility generally reduces the (already low) size and significance of the coefficient on derivatives holdings. This suggests that although riskier firms use more derivatives, the additional risk is primarily related to other factors, not derivatives.

in a 2-digit SIC code industry, then we use 1-digit SIC code classification of the sample firms.

Deflation by industry-average values, by construction, makes the average values of all the variables equal to one and the regression coefficients can be interpreted as the change in the dependent variable for 100% increase in the independent variable relative to its industry average. Panel C of table 3 presents the results of estimating regression models 1 to 3 controlling for industry effects.[7] The tenor of the results is similar to that from the results in panels A and B. For example, if non-financial firms held twice the average derivatives holdings in their respective industries, the expected increase in the return volatility as seen from the derivatives-only regression model 1 is 2% (the coefficient is 0.02 with a t-statistic of 4.43). The corresponding increase implied by the coefficient in a multiple regression is only about 1% with a t-statistic of 1.41. In contrast, coefficients on both market capitalization and leverage suggest that volatility would be affected by economically large magnitudes if there is a 100% change in those variables relative to their industry average values.

In addition to the above, we also repeated the entire analysis in table 3 using time-series averages of each variable whenever multi-year data were available for a firm. The motivation is that the regression variables, like return volatility, derivatives holdings, market values, and leverage are likely to be highly autocorrelated through time. Therefore, successive annual observations on these variables are unlikely to be independent and the regression errors might be autocorrelated. To the extent each annual observation represents a long-term mean value perturbed by unique considerations in a given year and/or random measurement error, the use of firm-specific average values might yield more precise and less biased coefficient estimates.

The results using average values are very similar to those reported in table 3. However, consistent with the measurement error interpretation, the point estimate on derivatives holdings implies larger increases in return volatility as a function of changes in derivatives holdings than we see in table 3. Specifically, using time-series averages of industry-adjusted data, the coefficient on derivatives holdings in regression model 2 suggests a 2.4 percentage point increase in return volatility if a firm increases its derivative holdings from zero to its industry average. The corresponding number for non-financial firms in panel C of table 3 is only 1 percentage point. Notwithstanding the differences in results using the average values of the variables versus firm-year observations, the basic conclusion is the same. Derivative holdings have economically weak association with firms' return volatility.

Finally, corrections for serially correlated residuals do not change the main findings in table 3. Consider the regression model using all non-financial firms, $N = 690$ in column 2 of table 3. Using Cochrane–Orcutt transformed variables,

[7] There are five two-digit SIC codes among the financial services firms in our sample. Hence, standardizing by industry averages according to two-digit SIC codes affects the variables even within the financial services sample of the firm.

the adjusted R^2 drops to 41.02%.[8] The coefficient on derivatives/MV rises slightly to 0.37 with a White-corrected t-statistic of 3.27. Other coefficients are: MV -0.065 (-2.50), Leverage 0.158 (4.95), and BM 0.036 (0.25). Similarly, the regression for non-financial firms with derivatives, $N = 394$ in panel B of table 3, the coefficient on Derivatives/MV becomes 0.35 (3.06). Results for financial firms are similar as well. In column 5 of panel A, the coefficient on derivatives for all financial firms ($N = 239$) is -0.04 (-3.51). For financial firms with derivatives, ($N = 192$) in panel B, the coefficient on derivatives is -0.035 (-3.75). In these regressions, correcting for serial correlation tends to shrink the standard errors on the coefficients slightly, but the general results are not changed.

Clearly, derivatives can be used to manage risk and volatility. In our sample, however, the typical firm does not seem to achieve large changes in risk through derivatives, at least when compared to firms with similar size and leverage. This might be surprising in view of the large dollar values of firms' derivatives positions. Table 2 reveals, however, that these positions are small in relation to firm size. Non-financial firms with derivatives hold positions that represent mean and median fractions of 12% and 5% of assets, respectively. In light of these relatively small positions, it is not as surprising that derivatives don't have large effects on firm volatility.

As we pointed out in the introduction to this section, it is conceptually possible that firms generally attain the minimum-variance hedge and thereby eliminate the association between derivatives and volatility. Based on the small position sizes reported in table 2 and evidence in Bodnar and Marston (1998) we consider this extremely unlikely. Nonetheless, we explore this possibility by replacing the Derivatives/MV of assets variable in the regressions in table 3 with a dummy variable that takes on the value 1 for firms that hold derivatives and 0 for firms that do not hold derivatives. Even if firms come close to the minimum-variance hedge, such a regression should reveal risk differences across firms that use derivatives and firms that don't use derivatives.

For non-financial firms, a regression equivalent to column 2 in panel A of table 3, but using a dummy variable for derivatives-using firms, suggests that the marginal effect of derivatives usage is to increase return variance by a modest 0.19 percentage points (t-statistic = 3.88). The corresponding specification for financial firms (i.e., model 5 in panel A of table 3 estimated using a dummy variable for derivatives-use) yields a point estimate that suggests a 0.02 percent-

[8] To obtain Cochrane–Orcutt transformed variables, we estimate the first-order autoregressive parameter for the residuals in a cross-sectional regression of OLS residuals on lagged residuals. Obviously, this regression only uses observations for the firms with two or more consecutive years of data. Since we estimate the autoregressive parameter using a cross-sectional regression, the parameter is a cross-sectional constant, which is a departure from the standard Cochrane–Orcutt procedure of estimating firm-specific parameters. Lack of a long time series of observations for each firm precludes us from implementing a time-series estimation model. The estimated autoregressive parameter is 0.24. To transform the dependent and independent variables using this parameter, we define each transformed variable as $y_t^* = y_t - \hat{\rho} y_{t-1}$, where $\hat{\rho}$ is the estimated autoregressive parameter. To include the first observation in the time series for each firm, we define $y_1^* = y_1 \sqrt{1 - \hat{\rho}^2}$. (See Maddala 1988, p. 194, for example). As a result, we do not sacrifice any observations in estimating the model when we control for autocorrelated errors.

age point decrease in return volatility (t-statistic = -0.16) as a result of using derivatives. The economic and statistical significance of these results is low and similar to the results reported in table 3.

Although we cannot detect an economically significant relation between firm volatility and firm derivatives, firms may successfully hedge short-term cash flows with derivatives. As long as short-term cash flows represent a small fraction of firm value, they are likely to account for a small fraction of firm volatility. Moreover, any reduction in the volatility of short-term cash flows will have a small impact on overall firm volatility.

3.1.2 Two-stage estimation

The preceding analysis cannot rule out the possibility that derivatives-use is endogenous—that relatively high-risk firms use derivatives to reduce their exposure. Consequently, a cross-sectional analysis of risk and derivatives-use may not be able to unmask the risk-reducing effects of derivatives on firms' return volatility.

This endogeneity issue affects essentially all empirical research in corporate finance and is difficult to resolve completely in the absence of fortuitous exogenous variation. Except for prices, almost all variables associated with firms are, at least partially, under the firms' control and are therefore endogenous. This is also true for derivative holdings. Given that essentially all of the variables that might act as instruments in an instrumental variable or two-stage least squares regression are also endogenous, there is no obvious correction for the endogeneity of derivative holdings. Unfortunately, one cannot definitively sign the possible bias from this complication.

If all firms were using derivatives to hedge, we would expect riskier firms to hold more derivatives than less risky firms—all else equal. Consequently, a simple regression of volatility on derivatives would likely impart an upward bias on the coefficient on derivatives. The regression would erroneously attribute some increases in volatility to the associated higher derivatives holdings instead of the error term. Unfortunately, for firms that use derivatives to speculate, it is not clear whether derivatives holdings would rise or fall with increases in the firms' underlying volatility. The positive bias from firms that hedge with derivatives and the uncertain bias from firms that speculate with derivatives leaves the sign of the overall bias uncertain. Nonetheless, based on the known positive bias from hedging and the uncertain, possibly zero bias from speculation, we believe that a net negative bias in the estimates of the coefficients on derivatives holdings is unlikely.

In an attempt to control for the potentially endogenous use of derivatives in estimating the relation between derivatives-use and volatility, we perform the following instrumental-variables regression analysis, which is equivalent to two-stage least squares regression.

Since volatility, derivatives-use, market value, leverage, and book-to-market ratio are all endogenous, we seek instruments that are highly correlated with the levels of the endogenous variables, but uncorrelated with their variation due to endogenous considerations, for example the change in volatility due to a firm's decision to use derivatives for risk management. Unfortunately, perfect instruments do not exist. We attempt to create instruments that *a priori* substantially meet the criteria.

We rank all sample firms according to their normalized derivatives-use and assign them to three portfolios. Portfolio 0 consists of non-derivatives-users and portfolios 1 and 2 consist of the derivatives-users split at the median level of derivatives as a fraction of market value. We use these portfolio rankings as instruments. The assumption is that the firms' crude portfolio rankings are indicative of the level of derivatives-use, but the partitioning is so crude that it is less likely to pick up the endogenously determined variation in the firms' derivatives-use. We follow a similar procedure in assigning the sample firms to three market-value, leverage, and B/M portfolios—except that the portfolio break points are the 33rd and 67th percentiles of firms ranked on each variable in these cases.

We use the portfolio rankings as instruments in a two-stage least squares regression of volatility on derivatives-use, market value, leverage, and book-to-market ratio. We estimate these regressions separately for financial and non-financial firms. When we try to correct for endogeneity in this way, the tenor of our previous results is unchanged.

For non-financial firms, the marginal effect of derivative-use continues to be positive, but economically insignificant: Based on the regressions, the annualized return volatility of non-financial firms is expected to increase by about 1 percentage point (with a standard error of 0.35%) when the firm switches from not using any derivatives to using the sample average in proportion to its firm size. This increase is small relative to the average firm's annualized volatility of 29%. For financial firms, we estimate that switching from no derivatives to the sample average proportion of firm size reduces volatility by 1.3 percentage points (with a standard error of 1%). We also repeat the above analysis using all variables deflated by their 2-digit SIC code industry average values. The tenor of the results is unaffected.

3.1.3 Industry effects

As another means of controlling for industry effects, we also investigate the possibility that firm-volatility and derivatives-use have industry-specific components by running the previous regressions industry by industry. The distinction between financial and non-financial firms, which we display in detail, is by far the most important. Most of the qualitative results of the industry regressions are the same as those for the pooled regressions using all non-financial firms. Nonetheless, we separately analyze 13 non-financial industries grouped by their 2-digit SIC codes. In only one industry, gas & electric utilities (SIC code 49), do we find a significant coefficient on derivatives holdings. The estimated coefficient on derivatives holdings is negative in five of the 13 cases. Finally, we also obtain similar results when we restrict the industry-by-industry analysis to firms holding derivatives.

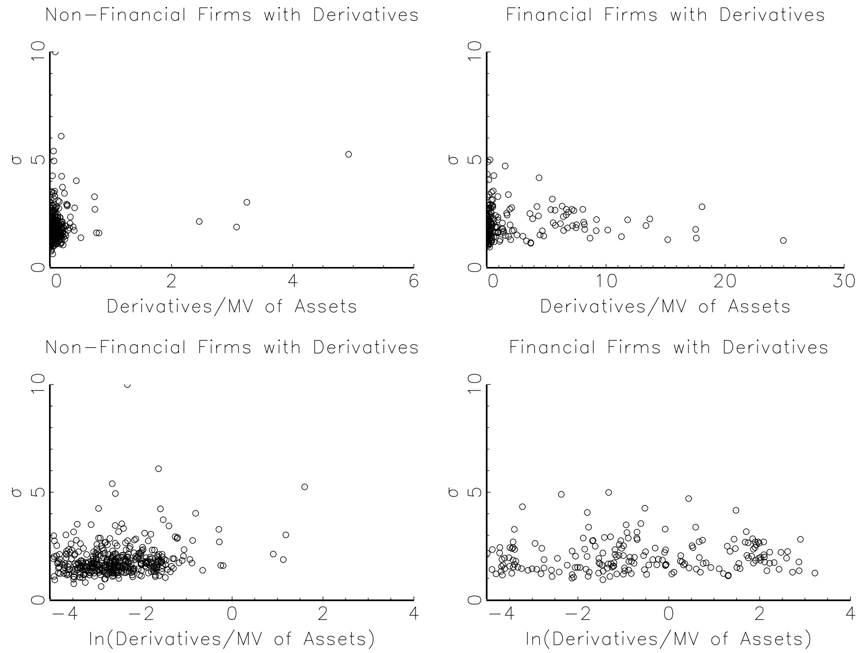

FIGURE 1: DERIVATIVE HOLDINGS AND RISK: FIRMS WITH DERIVATIVES

The figure shows the (absence of) correlation between volatility of firms' daily stock returns and the firms' derivatives holdings relative to the market value of their assets. The two left panels show this relation for 394 annual observations of non-financial firms with derivatives in our sample of large US firms from 1990 to 1993. The two right panels show the same information for 192 financial firms with derivatives. The two top panels use the levels of derivatives holdings relative to assets, while the two bottom panels use the logarithm of the derivative-asset ratio.

Figure 1 graphically illustrates that the volatility of stock returns is uncorrelated with both financial and non-financial firms' derivatives holdings relative to their assets. Furthermore, there is no discernible positive relation—linear or nonlinear—between volatility and derivatives holdings. We graph the relation between volatility and derivatives-use normalized by assets for the financial- and non-financial firms that use derivatives. Derivatives-use is shown in levels and logarithms in the upper and lower panels.[9] Neither logs nor levels of derivatives holdings reveal correlation with stock-return volatility.

3.1.4 Grouping firms by derivatives-use

Table 4 reports results of additional regressions of return volatility on derivatives holdings. These regressions permit a test of whether extreme derivatives-users exhibit higher levels of return volatility consistent with the use of derivatives for speculative purposes. The regression models also control for industry effects.

[9] Taking the logarithm of derivatives relative to assets reduces the influence of a few very large derivatives participants and heteroscedasticity. Unfortunately, the logarithms also require exception handling for firms without derivatives. To avoid such problems with exceptions, we use the levels of the ratio in the regressions.

Table 4

Derivatives and Equity Return Volatility for Firms with Derivatives

Portfolio #	Non-Financial Firms: Derivative Holdings	α_j	(SE)	Financial Firms: Derivative Holdings	α_j	(SE)
0	0.0%	3.364	(0.370)	0.0%	3.198	(0.729)
1	0.6	0.166	(0.067)	0.8	−0.109	(0.141)
2	1.6	0.155	(0.073)	2.6	−0.055	(0.198)
3	2.6	0.114	(0.054)	10.5	−0.168	(0.152)
4	3.6	0.151	(0.094)	20.2	−0.031	(0.177)
5	4.9	0.073	(0.110)	31.9	0.170	(0.176)
6	6.0	0.050	(0.108)	53.8	0.076	(0.207)
7	7.9	0.123	(0.160)	117.3	−0.043	(0.173)
8	11.5	0.008	(0.076)	299.1	0.116	(0.201)
9	16.5	0.088	(0.093)	624.2	−0.209	(0.232)
10	64.2	0.077	(0.117)	1,225.6	−0.177	(0.168)
ln(MV of equity)		−0.197	(0.040)		−0.230	(0.077)
Leverage		0.150	(0.026)		0.029	(0.008)
B/M		−0.171	(0.149)		0.190	(0.222)
$\bar{R}^2$ (in %)		58.62			48.21	
N		690			239	

The table presents estimates of the fixed effects coefficients α_j in the regressions

$$\sigma_{i,t} = \alpha_0 + \sum_{j=1}^{10} \alpha_j P_{i,j} + \gamma_2 \times \ln(\text{MV of equity})_{i,t} + \gamma_3 \times (\text{Leverage})_{i,t} + \gamma_4 \times (\text{B/M})_{i,t} + \sum_{j=1}^{13} \beta_j I_{i,j} + \epsilon_{i,t},$$

where $\sigma_{i,t}$ is the standard deviation of daily stock returns for firm i in year t; the indicator $P_{i,j}$ is one if firm i is in portfolio j and zero otherwise; and the the indicator $I_{i,j}$ is one if firm i is in industry j, as proxied by 13 2-digit SIC codes, and zero otherwise. The dummy coefficient estimates and associated standard errors are not reported in the table for brevity. The regression for financial firms omits industry dummies.

The numbers in parentheses to the right of the coefficient estimates are standard errors corrected for heteroscedasticity using White's (1980) method.

The first portfolio, portfolio 0, contains firms without derivatives. Portfolios 1 through 10 are formed by ranking firms with derivatives according to their derivative holdings normalized by the book value of their assets, and then dividing these firms into ten portfolios containing an equal number of firms.

MV of equity is the market value of common equity at the beginning of the year for which derivative holdings information is collected;

Leverage is the ratio of the book value of liabilities to the market value of common equity, both measured at the beginning of the year for which derivative holdings information is collected;

The book-to-market ratio, B/M, is the book value of assets divided by the market value of equity plus the book value of debt, where all variables are measured at the beginning of the year.

N is the number of firm years used in each regression.

The sample consists of 929 firm-years from 1990 to 1993. These firms are selected from the 425 largest U.S. firms ranked according to sales and listed in the April 25, 1988 issue of *Fortune* magazine. These 425 firms include the 200 largest industrial firms, the 25 largest retailers, the 25 largest transportation companies, the 25 largest utilities, the 50 largest diversified service companies, the 50 largest diversified financial firms excluding insurance companies, and the 50 largest commercial banks. Any firm with an annual report in the *Compact Disclosure* database for the years 1992 and 1993 and financial and stock-return data on Compustat and CRSP is included in the sample. Financial firms are those with Compustat SIC codes between 6000 and 7000.

We briefly describe the important differences between the regressions in table 3 and those in table 4.

First, instead of using derivative holdings normalized by the market value of assets as a continuous variable in the regression, we estimate the marginal impact of derivative holdings on return volatility using portfolio dummy variables (i.e., a fixed-effects model). We form 11 portfolios. The first portfolio, portfolio 0, consists of firms that do not have any derivative holdings. Each of the other portfolios, 1 through 10, consists of 10% of the sample firms ranked according to their total derivative holdings deflated by total assets (defined as the sum of the market value of equity and book value of liabilities). The coefficients on portfolios 1 through 10 provide estimates of the incremental return volatility of the stocks in those portfolios relative to the no-derivatives stock portfolio. The use of portfolio dummies in the model facilitates a test of whether extreme derivatives-users as a group exhibit different levels of return volatility than firms with low or no derivatives positions, controlling for the effects of firm size and leverage on return volatility. Such non-linearity cannot be captured using a continuous variable for derivatives holdings. We emphasize, however, that the tenor of the results is not changed if derivatives holdings are included as a continuous variable, with or without a logarithmic transformation.

Second, we include 2-digit SIC code industry dummies in the regression using non-financial firms to control for industry-specific components of return volatility. Derivatives usage and return volatilities might systematically vary across industries because of differences in their production, investment, and financing activities. There are 13 two-digit SIC code industries in our sample with a minimum of 20 firms in each industry for which an industry dummy variable is included. We do not report the industry dummy coefficient estimates in table 4 because they do not shed light on any economic hypotheses tested in this paper. The results in table 4, like those in table 3, are not sensitive to the inclusion or exclusion of the industry dummy variables.

The regression results in table 4 bear out the implications of the previous joint analysis. For the non-financial firms, the derivatives portfolio dummies are all positive but none of the coefficients on portfolios 4 through 10 is statistically significant. Interestingly, marginal change in the return volatility of the non-financial firms in portfolios 1 through 3 that is attributable to derivatives-use is significantly positive, but the point estimates indicate economically small magnitudes of volatility increases over those of the firms in the no-derivatives portfolio. More importantly, even for the most intensive users of derivatives (i.e., portfolio 10) the return volatility is indistinguishable from that for the firms without derivatives, after controlling for the effects of firm size and leverage on return volatility. The coefficient on the dummy for the derivatives portfolio 10 is 0.084, which implies an annualized volatility increase of only 1.3%, with a standard error of 1.8%. Thus, the conclusion that there is no reliable increase in return volatility is not due to low power of the tests.

For financial firms, the results in table 4 indicate negative coefficient estimates on the derivative portfolio dummies. As for the non-financial firms, the volatility declines implied by the estimates are neither economically nor statistically significant. Almost all of the explanatory power of the two regressions in table 4 is attributable to leverage and market value.

Collectively, the results reported in tables 3 and 4 and figure 1 produce no evidence that the riskiness of large U.S. non-financial and financial corporations is related to the size of the derivatives positions held by these firms. Therefore, we can rule out wide-spread, economically meaningful speculative use of derivatives among these firms. We also do not find evidence to suggest speculative use among the most intensive derivatives-users in our samples.

3.2 Derivative Holdings and Exposure

In addition to differences in firm risk, the use of derivatives to hedge or speculate also should produce differences in exposures. As we already mentioned, this implication of risk management is less clear. Over the course of a year, firms can have small average exposures even though they consistently speculate. This effect can be achieved by holding long positions for about half of the year and short positions for the other half.

For the large firms in our sample, such trading would involve regular reversals of derivatives positions for hundreds of millions, or even billions, of dollars. This strikes us as unlikely. Consequently, we expect firms that hedge with derivatives to have relatively low or possibly no exposures to the prices underlying the derivatives. Conversely, we expect firms that speculate with derivatives to have large exposures to the underlying prices. Based on the fact that firms primarily hold foreign exchange and interest rate derivatives, we concentrate on the exposures to these variables. In particular, we measure exposures by regressing monthly firm equity returns on the percentage changes in a stock market index, an exchange rate index, and an interest rate.

We use the CRSP value-weighted index as a market measure. Exchange rate exposures are measured relative to the Federal Reserve Board's dollar index. The index is a trade-weighted average of the dollar's exchange rate with the currencies of the remaining G–10 countries.[10] Since we frequently cannot identify which currencies underlie the exchange rate derivatives, an index is preferable to any individual currency. Nonetheless, the index is highly correlated with the major currencies. Monthly percentage changes in the index have correlations of 97%, 84%, and 69% with percentage changes in the dollar exchange rates of the German mark, the British pound, and the Japanese yen, respectively, during the period 1986 to 1995.

Interest rate exposures are measured relative to six-month dollar LIBOR. The six-month maturity was chosen because it is a standard benchmark for short-term and floating-rate instruments such as commercial paper, floating-rate bonds, and interest-rate swaps. During our sample period, term-structure movements seem to be well approximated by proportional shifts. Monthly percentage changes

[10] In addition to the United Sates, the G–10 includes Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, and the United Kingdom.

in the six-month LIBOR rate have correlations of 94%, 81%, and 74% with the percentage changes in one-year, five-year, and ten-year U.S. Treasury bond yields, respectively, during the period 1986 to 1995.

The interest and exchange rate data are obtained from the "International Financial Statistics Selected from the Federal Reserve Bulletin" tape from the Federal Reserve Board.

To assess whether derivative holdings and firms' exposure are positively associated, we separately analyze portfolios of financial and non-financial firms. For each group, we construct eleven portfolios ranked by derivatives-use, as described earlier in the context of table 4.

Table 5 reports the portfolios' currency and interest rate risk exposures. The exposures are estimated by regressing the portfolios' returns on market returns, the return on a trade-weighted dollar exchange rate index, and 6-month LIBOR returns. We estimate the exposure betas using monthly returns to avoid the non-trading biases reported in Scholes and Williams (1977) and Tufano (1996b). The non-financial firms' derivative holdings as a fraction of their assets range from 0.6% for portfolio 1 to 64.2% for portfolio 10. Yet, there is no systematic increase in the portfolios' currency or interest rate risk exposures as a function of derivative holdings. The currency risk beta coefficient of the portfolio of firms without any derivative holdings is 0.09, compared to 0.10 for portfolio 10. Interest rate betas also don't exhibit any clear patterns relative to derivative holdings.

Like non-financial firms, financial firms exhibit no systematic association between their currency and interest rate risks and the level of their derivative activity. Firms with large derivatives positions in portfolios 9 or 10 don't have noticeably higher interest or exchange rate exposures than firms with small derivatives positions in portfolios 1 or 2. Even though the notional values of derivative holdings in portfolio 10 average more than ten times the value of firm assets, even firms in this extreme portfolio have modest exposures. If the exchange rate index increases by 10 percentage points, equity values rise by 2 percentage points; if interest rates rise by 10 percentage points, equity values fall by 3 percentage points.

The standard deviation of the portfolios' daily returns rises slightly with the level of derivative holdings, but, as we showed in table 3, much of this increase is driven by changes in leverage and firm size.[11] Table 5 confirms this finding since portfolios with more derivatives are slightly more volatile, but also have much higher leverage. We also report the portfolios' book-to-market ratios, which have no clear association with either derivatives holdings or firm volatility—as in table 3.

To reduce the effects of industry differences across portfolios, we also average firm characteristics relative to the firms' industry across the firms in each port-

[11] The increase in volatility is not monotonic, but the five portfolios with the lowest derivative holdings have slightly lower average volatility than the five portfolios with the highest derivative holdings.

TABLE 5
Derivatives and Exposures

Portfolio #	Derivative Holdings	Exposures: Market β_m	Currency β_c	Interest rate β_r	Firm Characteristics (Absolute): σ	Leverage	MV of Equity	B/M	(Relative to industry): σ	Leverage	MV of Equity	B/M
Panel A: Non-Financial Firms												
0	0.0%	0.95	0.08	−0.20	1.75%	1.65	4,966	0.68	0.98	0.89	0.98	1.04
1	0.6	1.06	−0.15	−0.22	1.80	1.48	9,603	0.73	1.02	1.02	1.02	0.95
2	1.6	1.00	−0.06	−0.13	1.66	1.33	14,437	0.44	0.97	0.68	1.04	0.82
3	2.6	1.10	−0.00	−0.34	1.61	1.07	15,510	0.54	1.04	0.90	1.02	0.92
4	3.6	1.12	0.04	−0.44	1.84	1.81	9,152	0.50	0.98	0.85	1.02	0.91
5	4.9	1.02	−0.04	−0.15	1.79	1.38	9,739	0.53	0.95	0.83	1.01	0.89
6	6.0	1.03	0.00	−0.12	1.81	1.37	4,973	0.67	1.01	1.31	1.00	1.04
7	7.9	1.06	−0.06	−0.25	2.01	2.01	12,701	0.61	0.98	1.02	1.32	1.05
8	11.5	1.09	0.19	−0.26	1.88	2.25	5,284	0.67	1.02	1.02	1.24	1.08
9	16.5	1.10	0.31	−0.08	1.90	1.82	10,183	0.66	1.10	1.12	1.02	0.91
10	64.2	1.10	0.10	−0.29	2.18	2.88	7,541	0.69	1.07	1.53	1.00	1.15
Panel B: Financial Firms												
0	0.0%	0.90	0.05	−0.15	2.01%	11.99	2,847	1.03	1.12	1.00	0.92	1.03
1	0.8	1.05	0.33	−0.31	1.83	10.09	2,493	0.94	0.98	0.78	0.97	0.95
2	2.6	1.19	0.36	−0.23	1.98	13.72	3,209	1.40	1.06	1.47	0.99	1.43
3	10.5	1.10	0.28	−0.36	1.82	14.46	2,529	0.97	0.98	0.85	0.99	0.89
4	20.2	1.11	0.44	−0.38	2.15	14.99	2,964	0.98	0.92	0.84	1.01	0.91
5	31.9	1.48	0.38	−0.44	2.08	14.60	2,896	0.93	0.96	0.91	0.99	0.90
6	53.8	1.29	0.50	−0.35	2.26	15.78	2,996	0.98	0.96	0.98	0.99	0.95
7	117.3	1.36	0.54	−0.43	2.03	17.31	6,770	0.96	1.01	0.95	1.03	0.96
8	299.1	1.36	0.72	−0.43	2.06	17.35	4,030	0.95	0.95	1.07	1.04	0.94
9	624.2	1.41	0.62	−0.37	2.26	29.78	4,495	1.23	1.05	1.27	1.06	1.19
10	1,225.6	1.54	0.21	−0.28	1.84	19.97	5,896	0.88	0.83	0.88	1.12	0.82

The table shows exposures to market, exchange rate and interest rate risk for portfolios of firms. The exposure coefficients, β, are estimated from

$$r_{j,t} \;=\; \alpha \;+\; \beta_m \times r_{m,t} \;+\; \beta_c \times \frac{\Delta S_t}{S_{t-1}} \;+\; \beta_r \times \frac{\Delta r_{6,t}}{r_{6,t-1}} \;+\; \epsilon_{j,t},$$

TABLE 5—*Continued*

where $r_{j,t}$ is the monthly return on portfolio j, $r_{m,t}$ the monthly return on the CRSP value-weighted index, S_t the Federal Reserve Board trade-weighted dollar index, and $r_{6,t}$ the six-month dollar LIBOR. The difference operator, Δ, indicates monthly changes.

The first portfolio, portfolio 0, contains firms without derivatives. Portfolios 1 through 10 are formed by ranking firms with derivatives according to their derivative holdings normalized by the book value of their assets, and then dividing these firms into ten portfolios containing an equal number of firms.

Derivative holdings are measured as the aggregate notional value of all reported derivative contracts deflated by the sum of the book value of liabilities and the market value of equity, both measured at the beginning of the year for which derivative holdings information is collected.

Several firm characteristics are shown for comparison. The "absolute" statistics report the sample averages for the firms in each portfolio. The same characteristics are also reported on an industry-adjusted basis. In this case, we average the firm characteristics— relative to each firm's industry average— within the portfolios.

The standard deviation of daily equity returns during the year is given in the column labeled σ; leverage is the ratio of the book value of liabilities to the market value of common equity, both measured at the beginning of the year for which derivative holdings information is collected; MV of equity is the market value of common equity at the beginning of the year for which derivative holdings information is collected. The book-to-market ratio, B/M, is the book value of assets divided by the market value of equity plus the book value of debt, where all variables are measured at the beginning of the year.

The sample consists of 929 firm-years from 1990 to 1993. These firms are selected from the 425 largest U.S. firms ranked according to sales and listed in the April 25, 1988 issue of *Fortune* magazine. These 425 firms include the 200 largest industrial firms, the 25 largest retailers, the 25 largest transportation companies, the 25 largest utilities, the 50 largest diversified service companies, the 50 largest diversified financial firms excluding insurance companies, and the 50 largest commercial banks. Any firm with an annual report in the *Compact Disclosure* database for the years 1992 and 1993 and financial and stock-return data on Compustat and CRSP is included in the sample. Financial firms are those with Compustat SIC codes between 6000 and 7000.

folio. Variation in these industry-adjusted firm characteristics across portfolios is generally similar to the variation in raw firm characteristics.

Neither the currency exposures nor the interest rate exposures of the firms in our sample support the hypothesis that firms' derivative holdings represent economically significant speculation. Speculative positions in currency and interest rate derivatives should result in exposures to currency returns or interest rate changes that are significant in both economic and statistical terms. The absence of such exposures is an indication that derivatives are not used to increase inherent exposures.

4 Conclusion

This paper shows that many of the largest U.S. corporations are active participants in derivatives markets. Firms with derivatives hold similar notional principals of foreign exchange and interest rate derivatives, but they hold almost no commodity derivatives. Non-financial firms hold slightly more foreign exchange derivatives, while financial institutions hold slightly more interest rate derivatives. Apart from these similarities, the holdings of non-financial firms differ significantly from those of financial firms. In particular, financial firms hold much larger notional principals—presumably because they are dealers for some of the instruments. Even among the large non-financial firms in our sample, 40 percent do not hold any derivatives. For the non-financial firms that hold derivatives, the median notional principal equals only 5 percent of the firm's assets.

Our data show the considerable limitations of the derivatives disclosures under current U.S. accounting standards. Firms do not have to disclose the sign or magnitude of their derivatives exposures, only the notional principal of their positions. The mark-to-market information in the income statement is potentially obscured by derivative purchases or sales during the year. The crudeness of the information makes it difficult to determine whether an individual firm is reducing or taking risks with derivatives.

Rather than trying to determine how or why individual firms use derivatives, we try to gauge what effects derivatives have on firms' risk characteristics. Although many of the firms in our sample disclose sizeable derivative positions, these firms display risk characteristics that are similar to the risk characteristics of firms with few or no derivatives. In particular, our sample reveals no association between the volatility of a firm's stock prices and the size of the firm's derivatives position. Moreover, in our sample, a firm's exposures to variations in interest and exchange rates are not directly related to the firm's derivatives position. If firms were using derivatives for speculative purposes, one would expect both, more volatile returns and larger exposures for firms with large derivative positions.

That is not to say that firms cannot take large risks with derivatives. Nor do we argue that no firms alter their exposures or volatilities through derivatives. Our findings show, however, that these effects are currently small for most firms, even those with large derivatives positions. In summary, the answer to the question in the paper's title appears to be "typically not very much of either."

This finding has clear implications for the ongoing regulatory debate. Regulators apparently think that the social value of derivatives in part depends on whether derivatives are used to hedge or to speculate. The empirical absence of higher risk due to derivatives—even among firms with large derivatives positions—shows that concern over widespread speculation with derivatives is unfounded.

References

Banz, Rolf W., 1981, "The relationship between return and market value of common stocks." *Journal of Financial Economics* 9, 3–18.

Black, Fischer and Myron S. Scholes, 1973, "The pricing of options and corporate liabilities." *Journal of Political Economy* 81, 637–54.

Bodnar, Gordon M. and Richard C. Marston, 1996, "Wharton cibc Wood Gundy 1995 survey of derivatives usage by u.s. non-financial firms." Wharton School, University of Pennsylvania, Philadelphia, PA.

Bodnar, Gordon M. and Richard C. Marston, 1998, "Wharton cibc Wood Gundy 1998 survey of derivatives usage by u.s. non-financial firms." Wharton School, University of Pennsylvania, Philadelphia, PA.

Booth, James R., Richard L. Smith and Richard W. Stolz, 1984, "Use of interest rate futures by financial institutions." *Journal of Bank Research* 15, 15–20.

Christie, Andrew A., 1982, "The stochastic behavior of common stock variances: Value, leverage, and interest rate effects." *Journal of Financial Economics* 10, 407–432.

DeMarzo, Peter and Darrell Duffie, 1992, "Corporate incentives for hedging and hedge accounting." Unpublished paper, Northwestern University.

Eccher, Elizabeth A., K. Ramesh and S. Ramu Thiagarajan, 1997, "Fair value disclosures by bank holding companies." *Journal of Accounting and Economics* 22, 79–117.

Financial Accounting Standards Board, 1994, "Statement of financial accounting standard no. 119: Disclosure about derivative financial instruments and fair value of financial instruments." *Financial Accounting Standards Board, Stamford, CT*.

Froot, Kenneth, A., David S. Scharfstein, and Jeremy C. Stein, 1993, "Risk management: Coordinating corporate investment and financing policies." *Journal of Finance* 48, 1629–1658.

Geczy, Christopher, Bernadette A. Minton, and Catherine M. Schrand, 1997, "Why firms hedge: distinguishing among existing theories." *Journal of Finance* 52, 1323–1354.

Gorton, Gary and Richard J. Rosen, 1995, "Banks and derivatives." Unpublished paper, Rodney L. White Center for Financial Research, The Wharton School of the University of Pennsylvania.

Jensen, Michael C. and William H. Meckling, 1976, "Theory of the firm: Managerial behavior, agency costs and capital structure." *Journal of Financial Economics* 3, 305–360.

Koski, Jennifer and Jeffrey Pontiff, 1999, "How are derivatives used? Evidence from the mutual fund industry." *Journal of Finance* 54, 791—816.

Mian, Shezad L., 1996, "Evidence on corporate hedging policy." *Journal of Financial and Quantitative Analysis* 31, 419–439.

Myers, Stewart C., 1977, "Determinants of corporate borrowing." *Journal of Financial Economics* 5, 147–175.

Nance, Deana R., Clifford W. Smith, Jr., and Charles W. Smithson, 1993, "On the determinants of corporate hedging." *Journal of Finance* 48, 267–284.

Scholes, Myron S. and Joseph Williams, 1977, "Estimating betas from nonsynchronous data." *Journal of Financial Economics* 5, 309–327.

Schrand, Catherine M., 1993, "An evaluation of the effects of SFAS no. 80 on interest rate risk management in the savings and loan industry." Unpublished paper, University of Chicago.

Scott, William L. and Richard L. Peterson, 1986, "Interest rate risk and equity values of hedged and unhedged financial intermediaries." *Journal of Financial Research* 9, 325–329.

Smith, Clifford W., Jr. and René M. Stulz, 1985, "The determinants of firms' hedging policies." *Journal of Financial and Quantitative Analysis* 20, 391–405.

Stulz, René M., 1984, "Optimal hedging policies" *Journal of Financial and Quantitative Analysis* 19, 127–140.

———, 1996, "Rethinking risk management." *Journal of Applied Corporate Finance* vol. 9, no. 3, 8–24.

Tufano, Peter, 1996a, "Who manages risk? An empirical examination of risk management practices in the gold mining industry." *Journal of Finance* 51, 1097–1139.

———, 1996b, "The determinants of stock price exposure: Financial engineering and the gold mining industry." Unpublished paper, Harvard Business School, Harvard University, Boston, MA.

Veit, E. Theodore and Wallace W. Reiff, 1983, "Commercial banks and interest rate futures: A hedging survey." *Journal of Futures Markets* 2, 283–293.

White, Halbert, 1980, "A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity." *Econometrica* 48, 817–838.