Derivative Instruments and Their Use For Hedging by U.S. Non-Financial Firms: A Review of Theories and Empirical Evidence

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The purpose of this paper is to review the literature on the use of financial instruments known as derivatives. Derivatives use is a relatively recent phenomenon, dating back to around the 1970s. In the past 15 years a significant theoretical and empirical literature has emerged that examines why non-financial firms use derivatives. This review weaves a common thread through the literature on the use of derivatives that covers economics, accounting, and finance. We present empirical evidence from extant research that shows the use of derivatives by U.S. non-financial firms has increased over time. We review the basic theory of hedging based on costly external finance that provides a basis for organizing and detailing the empirical evidence on derivatives use. The econometric evidence indicates the importance of costly external finance in determining derivatives use and provides support for the view that non-financial firms use derivatives for hedging. Our review also touches on some macroeconomic implications of derivatives use, suggesting that the use of derivative instruments may moderate the impact of monetary policy shocks.

INTRODUCTION

Derivatives can be defined as financial instruments whose values are derived from some underlying asset or rate/price (such as a rate of interest or the price of gold). The development of the option pricing models by Black and Scholes (1973) and by Merton (1973) has made it possible for derivatives markets to develop and for these financial instruments to become a potentially important tool in risk management. Derivatives are now an important part of the world economy, with a notional value of more than $200 trillion of these derivatives traded on organized and OTC markets in 2004 (Bank for International Settlements, 2005). The theory of risk management through hedging can be seen in the model of Froot, Scharfstein, and Stein

(1993), which characterizes the problem as one of coordinating firms' investment and financing activities. Applying theories linking the role of finance to imperfect information (e.g., Myers and Majluf 1984; and Myers 1977) or the role of taxes to firm valuation (Smith and Stulz 1985), an empirical literature has developed to try to test the various implications of these theories with respect to the use of derivatives for hedging.

Despite these developments over the last thirty years, derivatives seem to remain a rather exotic area that often baffles the public, who has come to know about these derivatives largely through the reporting in the news media of cases involving large losses. These cases include Enron (Partnoy 2002), Barings PLC (Kuprianov 1995), and Procter & Gamble (Miller 1997). Barings (loss of $1.3 billion), no longer operating, was a financial firm; Enron (loss of billions of dollars), currently in bankruptcy proceedings, started out as a natural gas pipeline operator; and Procter & Gamble (loss of $137 million), a profitable firm, is a producer of consumer products. That derivatives as a financial instrument present in the mind of the public a specter over financial stability is what a well-known authority in the area of derivatives wanted to address in a recent paper, "Should We Fear Derivatives?" (Stulz 2004). The complexity of derivatives and the need for transparency in their reporting have led to a debate in the accounting profession that culminated in the reporting requirements as set forth by the Financial Accounting Standards Board (FASB) in SFAS No. 133, *Accounting for Derivative Instruments and Hedging Activities* (1998).

The purpose of this paper is to review the theoretical and empirical literature on the use of derivatives for hedging by U.S. non-financial firms. We also provide and discuss some of our own evidence on derivatives use. Currently there is no review that provides coherence and breadth to the empirical literature on the use of derivatives by non-financial firms for hedging. For example, the recent brief survey by Stulz (2004), while useful, does not provide an adequate discussion of the empirical evidence on the use of derivatives by non-financial firms. A recent working paper by Bartram et al. (2006) provides extensive international data and econometric evidence on the use of derivatives, but does not provide the level of detail and organization that would help one understand the different results as obtained in various studies. For example, we find a pattern of difference in results between qualitative and quantitative studies of derivatives use. It does not provide an analysis of the reporting environment that has a bearing on the data, nor does it discuss potentially important macroeconomic implications of derivatives use. Our review, in addition to updating the empirical literature reviewed to the present time, covers the above points that were also not expressly in an earlier review by Bartram (2000). The basic theory of hedging and the empirical evidence that we review in this paper suggest that derivatives perform an important function in the economy in allowing non-financial firms, as part of their risk management strategy, to hedge against risks related to fluctuations in foreign exchange rates, in interest rates, or in commodity prices. Such exposures impact firms' cash flows or the values of their assets and liabilities, and may result in less investment due to the higher cost of external finance.

Our review is organized as follows. In the next section we explain what these derivative instruments are and provide some evidence on their use. We first explain disclosure requirements that have implications for the availability of data and for interpreting empirical results on derivatives use. The basic theories of hedging and macroeconomic implications of derivatives use are then reviewed. The econometric evidence is reviewed next; and we conclude in the last section with some thoughts on further research that would fill in some current gaps in our knowledge of derivatives use by non-financial firms.

DERIVATIVE INSTRUMENTS: WHAT THEY ARE AND EVIDENCE ON THEIR USE

Firms face uncertainty when planning their production and capital investment. Specifically, the risks arising out of this uncertainty are those connected with the firms' exposures to fluctuations in interest rates, in foreign exchange rates, and in commodity prices. Smoothing cash flows or the market values of its assets or liabilities by hedging against these exposures may benefit the firm in a number of ways. For example, large exposures to foreign exchange rate changes are part of the environment for a firm such as Merck, a multinational pharmaceutical company, in that the firm is uncertain as to what it would get in the future when it converts its foreign currency earnings from the sale of its products into the home currency. The potential risk from such exposures may limit the firm's capital investment, including its research and development projects. The firm could choose to hedge against this risk by entering into a derivative contract, such as a forward foreign currency contract, to deliver the anticipated amount of foreign currency in return for the home currency at some exchange rate fixed ahead of the sale of the products (see, e.g., Lewent and Kearney 1990). In a perfect hedge, the change in the value of the underlying exposure (such as foreign currency earnings) would be exactly offset by the change in the value of the derivative contract, leaving the hedger's cash flow or asset value position unchanged.

The data in Table 1 indicate that the derivatives usage rate is more than 50 percent and that non-financial firms use derivatives for hedging. The mean notional amount is more than $1 billion. Larger firms tend to use derivatives more. The evidence presented in the table suggests that derivatives use has become an integral part of American firms' risk management landscape (international data provided by Bartram et al. (2006) show U.S. usage rate is similar to that in European countries). One should, however, note that the evidence does not rule out the potential multi-purpose use of derivatives, for managing earnings, as evidenced in Barton (2001), or for reducing the cost of borrowing, as shown in a survey-based study by Bodnar et al. (1998) and as discussed in Faulkender (2005).

Interest Rate Derivatives

The most commonly used interest rate derivative contracts by non-financial firms are swaps, with somewhat limited use of caps, floors, and collars, as shown in Table 2 (which also provides information on foreign currency and commodity price derivatives). Interest rate swaps are contracts to exchange between floating-rate payments and fixed-rate payments. If a firm wanted to hedge against the risk of an unexpected change in cash flow to be paid (as with a variable-rate debt instrument), it could enter into a contract to receive a series of floating-rate payments in return for making a series of fixed-rate payments, based on some notional amount of the debt instrument. If a firm wanted to hedge against the risk of a change in the fair value of its debt, it could enter into a swap contract that allows it to receive a series of fixed-rate payments in return for making a series of floating-rate payments. There is evidence that swaps of floating-rate payments for fixed-rate payments are more frequently used (Bodnar et al. 1998), suggesting that firms may be more concerned with unexpected cash flow changes than with changes in the values of assets or liabilities, possibly a reflection of firms' debt structures. Additional data as provided in Table 3 on notional amounts indicate that swaps dominate the use of interest rate derivatives while forwards or futures dominate the use of currency derivatives. These data are consistent with those for the U.S. as obtained by Bartram et al. (2006).

TABLE 1
DERIVATIVES USE BY U.S. NON-FINANCIAL FIRMS, 1986-2001: FREQUENCY, USE PURPOSE, AND NOTIONAL AMOUNT (ORGANIZED BY SAMPLE PERIOD)

Author	Users (%)	Sample[1]	Sample Year	Hedging[1] (%)	Notional Amount (Mean)[2]	Notional Amount (Total)[2]
Bartram et al (2006)	65	2,231 firms from Thomson Analytics and Global Reports	2000/ 2001	NA[3]	NA	NA
Bodnar/Hayt/Marston (1998)	50	Wharton survey of 399 Firms	1998	100	NA	NA
Allayannis/Weston (2001)	40	720 large firms	1995	100	279	81,189
Gay/Nam (1998)	67	486 firms	1995	100	NA	131,411
Graham/Rogers (2002)	36	442 randomly selected firms	1995	100	1,143	180,594
Guay/Kothari (2003)	57	413 largest firms	1995	100	651	152,278
Barton (2001)	72	314 Fortune 500 firms	1994-1996	100	2,452	534,536
Guay (1999)	37	254 new users from Compact Disclosure	1994	100	NA	NA
Howton/Perfect (1998)	62	Fortune 500/ S&P 500	1994	100	1,692	468,642
Hentschel/Kothari (2001)	50	325 largest firms	1993	100	1,704	335,688
Geczy/Minton/Schrand (1997)	59	372 Fortune 500 firms	1990	100	NA	NA
Nance/Smith/Smithson (1993)	NA	169 Fortune 500/S&P 400 firms	1986	62	NA	NA

Notes:
[1] The percentage of firms that used derivatives for hedging. Derivatives may be used simultaneously for purposes other than hedging.
[2] Numbers are in millions of dollars
[3] NA indicates data are not available.

TABLE 2.
DERIVATIVES USE BY U.S. NON-FINANCIAL FIRMS: FREQUENCY OF USE ACCORDING TO RISK TYPES AND CONTRACT TYPES (PERCENT)

Author	Guay/ Kothari (2003)	Graham/ Rogers (2002)	Allayannis/ Weston (2001)	Barton (2001)	Guay (1999)	Bodnar/ Hayt/ Marston (1998)	Gay/ Nam (1998)	Howton/Perfect (1998)		Geczy/ Minton Schrand (1997)
Sample	413 largest firms	442 randomly selected firms	720 large firms	314 Fortune 500 firms	254 new users from Compact Disclosure	Wharton survey of 399 Firms	486 firms[2]	451 Fortune 500/S&P 500	461 randomly selected firms	372 Fortune 500 firms
Foreign Currency	61	68	56	51	36	83	53	45	14	41
Swaps	23	NA	NA	NA	NA	NA[1]	28	24	19	12
Forwards/ Futures	87	NA	NA	NA	NA	NA	80	89	86	29
Options	19	NA	NA	NA	NA	44	26	27	7	NA
Interest Rate	61	70	NA	51	37	76	66	45	27	NA
Swaps	96	NA	NA	NA	NA	100	74	96	90	NA
Forwards/ Futures	6	NA	NA	NA	NA	NA	12	11	4	NA
Options	NA	NA	NA	NA	NA	28	33	11	6	NA
Commodity	15	NA	NA	10	32	56	22	NA	NA	NA
Swaps	36	NA	NA	NA	NA	NA	49	NA	NA	NA
Forwards/ Futures	69	NA	NA	NA	NA	NA	39	NA	NA	NA
Options	22	NA	NA	NA	NA	28	29	NA	NA	NA

Notes:

[1] NA indicates data are not available.

[2] Sample contains 325 firms from the Swap Monitor Database and 161 firms from the Business Week 1000 firms

Foreign Currency Derivatives

Foreign currency derivatives commonly involve forwards, futures, options, and swaps. Currency forwards are contracts that call for future delivery of a foreign currency at some predetermined exchange rate. Futures are similar to forwards, except for the fact that futures are traded on organized exchanges. Firms also use foreign currency swaps, which are contracts to exchange a series of interest payments in one currency for a series of payments in some other currency. These swap contracts may also involve a swap of interest rates, exchanging between floating-rate payments and fixed-rate payments. Firms use foreign currency derivatives as frequently as interest rate derivatives, as evidenced in Table 2. In Table 3, forwards and futures are shown to dominate the use of foreign currency derivatives in terms of their notional amounts.

TABLE 3.
DERIVATIVES USE BY U.S. NON-FINANCIAL FIRMS: NOTIONAL AMOUNTS ACCORDING TO RISK (MILLIONS OF DOLLARS)

Author	Sample	Swaps	Forward/ Futures	Options	Total	Swaps	Forward/ Futures	Options	Total	Swaps	Forward/ Futures	Options	Total
Allayannis/ Weston	720 large firms	-	-	-	-	-	-	-	279	-	-	-	-
Barton	314 Fortune 500 firms	-	-	-	1,758	-	-	-	1,541	-	-	-	220
Gay/Nam	486 firms	320.80	207.81	170.96	-	390.13	348.90	360.05	-	73.45	62.27	57.80	-
Howton/ Perfect	451 Fortune 500/ S&P 500 firms	717.46	247.98	67.79	-	74.44	462.90	108.54	-	-	-	-	-

Commodity Price Derivatives

These derivatives are mostly futures, forwards, and swaps. Forwards and futures work in a similar way to those involving interest rates or foreign currencies. Commodity swaps involve an exchange between floating-price and fixed-price payments where the floating price is based on some price as determined in a futures market and the fixed price is based on the spot price of a commodity, such as gold. These commodity derivatives, unlike those involving interest rates or foreign currencies, are limited mostly to firms that produce or use commodities, such as gold or oil. This is evidenced in Table 2 and Table 3 in terms of a lower frequency of use of commodity derivatives and smaller notional amounts. Not reported in the tables are the derivatives usage rates in gold mining (85 percent; see Tufano 1996) and in oil and gas production (between 44 and 57 percent, which is comparable to that for usage of interest rate derivatives and foreign currency derivatives across firms; see Haushalter 2000).

DERIVATIVE INSTRUMENTS: DISCLOSURE REQUIREMENTS IMPACTING RESEARCH ON DERIVATIVES USE

In the above discussion we have provided evidence showing the relevance of derivatives for U.S. non-financial firms. In order to understand the nature of the data and their availability to researchers in this area, we need to understand the regulatory environment related to accounting disclosure requirements concerning derivatives use. With the disclosure requirements specified in SFAS No. 133 (FASB 1998; effective after June 15, 2000), firms have been required to *recognize* derivatives as assets or liabilities in financial statements, to measure them at fair value in the statements of financial position, and to report fair value gains or losses of derivative instruments. In addition, the purpose for which derivatives were used is also disclosed: cash flow hedging or fair value hedging (including hedging related to fair values of foreign investment, or net investment hedge; see, for example, Munter 2002). While notional amounts (a common

measure of the extent of hedging used in research conducted in the 1990s) were reported under SFAS No. 105 (FASB 1990; effective after June 15, 1990), they are not mandated under SFAS No. 119 (FASB 1994; effective after December 15, 1994) or under SFAS No. 133. The information reported under the newest standard should help external financial statement users understand better a company's risk exposure and its corresponding risk management policy. Positive market evidence along this line has recently been provided for derivatives disclosures by banks under SFAS No. 133 (Ahmed et al. 2006) and under SFAS No. 119 (Seow and Tam 2002). On the other hand, investors may be misled by the *labels* used by firms to report their use of derivative instruments (Koonce et al. 2005).

However, researchers should be aware that there is a lack of uniformity in the parts of the financial statements where derivatives use is reported. Recent research has found that while the vast majority of companies have complied with the qualitative disclosure requirements of SFAS No. 133 such as the reasons for using derivatives, the underlying hedged items, and the risk management policy, many companies did not provide sufficient quantitative disclosures on fair values, changes in fair value over time, or usage effectiveness of the derivative instruments (Bhamornsiri and Schroeder 2004). Also, since firms may use derivatives for purposes other than hedging, such as for earnings management (Barton 2001), the disclosure requirements imposed by SFAS No. 133 may have an impact on the transparency with which firms report their use of derivatives (this sort of possibility is explained and evidenced in Hunton et al. 2006). The continued lack of uniformity in the quantitative disclosures on derivatives use among companies could jeopardize the desired transparency of financial reports and would require some effort in assuring consistency in the data used to study derivatives use.

Reporting requirements on derivatives use may potentially affect firm behavior with respect to production and risk management, and thus our interpretation of empirical results on derivatives use. The model of Kanodia et al. (2000) shows that hedge accounting disclosures, by providing relevant risk information through futures prices, reduce production distortions in an industry. Sapra (2002) demonstrates that it is possible for mandatory disclosures to result in excessive speculation in the derivatives market. DeMarzo and Duffie (1995) explain how managers may not fully hedge if separate, as distinguished from aggregate, disclosures for derivatives were required.

In Table 4 below we report some sample disclosures on derivatives use that we obtained from our own reading of the 10-K reports of 423 non-financial firms selected from a combined non-overlapping list of S&P 500 and Fortune 500 firms. Firms in our sample indicated in their 10-K reports that they used derivatives for risk management. From the same sample and as shown in Table 5, commodity price derivatives are used mainly for hedging against cash flow changes, while interest rate and foreign currency derivatives have been used for both cash flow and fair value hedges (with SFAS No. 133, it is possible to obtain data on hedging purposes)

WHY FIRMS HEDGE: BASIC THEORIES AND MACROECONOMIC IMPLICATIONS

Thus far we have reviewed the various descriptive facts related to derivatives that point to their increasing use by U.S. non-financial firms. We have also explained the disclosure requirements and their potential impact on derivatives use behavior. What motivates firms to use derivatives? We focus on the hedging motive based on costly external finance and review the basic theory behind it. In the Modigliani-Miller (1958) world, a financial strategy such as

hedging would be unnecessary. Therefore, hedging must be based on some type of market imperfection. The key motivation behind hedging often emphasized in the literature is that firms try to avoid costly external finance. In this section we will review the basic theory of hedging and then discuss some macroeconomic implications. We also briefly cover other determinants of hedging: convex tax schedules and managerial incentives related to risk aversion and compensation schemes (Smith and Stulz 1985; and Petersen and Thiagarajan 2000).

Hedging: The Role of Costly External Finance

While there are other motivations for hedging behavior, we want to review the model of Froot, Scharfstein, and Stein (FSS 1993), with its emphasis on costly external finance.

TABLE 4
SAMPLE DISCLOSURES ON THE USE OF DERIVATIVES FOR HEDGING: CASH FLOW, FAIR VALUE, AND NET INVESTMENT

Cash flow hedge

Interest rate: "We have another agreement expiring January 31, 2003 in the notional amount of $690 million that swaps a variable interest rate for a fixed rate of 6 ¾%, designed to mitigate the interest rate risk related to the portfolio of our proprietary credit card, which is serviced by a third party." From *Home Depot's 2002 10-K report*

Foreign currency: "[W]e enter into forward exchange and swap contracts and purchase options to hedge both firmly committed and anticipated transactions …" From the *Coca-Cola Company's 1995 10-K report*

"The Company partially hedges its forecasted revenues denominated in foreign currencies with purchased local put options." From *Merck's 2000 10-K report*

Commodity: "Alcoa anticipates the continued requirement to purchase aluminum and other commodities such as natural gas, fuel oil and electricity for its operations. Alcoa enters into futures and options contracts to reduce volatility in the price of these commodities." From *Alcoa's 2001 10-K report*

Fair value hedge

Interest rate: "We have one agreement in the notional amount of $300 million that swaps fixed rate interest on $300 of our $500 million 5 3/8% Senior Notes for a variable interest rate equal to LIBOR plus 30 basis points and expires on April 1, 2006." From *Home Depot's 2002 10-K report*

Foreign currency: "Quantum utilized foreign currency forward exchange contracts to manage the effects of foreign currency remeasurement arising from certain assets and liabilities denominated in a foreign currency." From *Quantum's 2000 10-K report*

Net investment hedge

Foreign currency: "[W]e enter into forward exchange and swap contracts and purchase options to hedge … net investments in certain international operations." From *the Coca-Cola Company's 1995 10-K report*

TABLE 5
DERIVATIVES USE BY HEDGE PURPOSES AND CONTRACT TYPES, 2000-2001
(PERCENT)

Instrument Type	2000	2001
Foreign Currency Derivatives		
Purpose		
Cash Flow	52	55
Net Investment	14	15
Fair Value	7	8
Contract Type		
Forwards	52	56
Futures	1	1
Swaps	8	8
Options	16	17
Interest Rate Derivatives		
Purpose		
Cash Flow	36	40
Net Investment	1	1
Fair Value	22	32
Contract Type		
Swaps	46	59
Caps/Collars/Floors	5	4
Commodity Price Derivatives		
Purpose		
Cash Flow	22	26
Net Investment	0	0
Fair Value	2	4
Contract Type		
Swaps	5	5
Futures	7	7

Notes: The numbers indicate the percentages of firms in our sample (423) that use derivatives or that have different purposes. These numbers do not add up to 100 percent since a firm may use more than one instrument type or one contract type, and may have different purposes for these types.

The model is useful for organizing the relevant factors determining derivatives use. Also, it is similar to the basic financial accelerator model of investment of Bernanke, Gertler, and Gilchrist (1996; referred to hereafter as BGG) that we also want to include in this review for thinking about some macroeconomic implications of derivatives use. The BGG model has been applied in the context of the business cycle and, like the FSS model, it focuses on the nexus of investment/production and finance. The importance of this nexus may also be seen in the

liquidity models of investment, such as that of Holmstrom and Tirole (1998), which explain what determines firms' liquidity needs and their influence on investment. A different strand of research views derivatives use as a decision variable that may have a direct impact on the risk profile of the firm (Hentschel and Kothari 2001; and Guay 1999) or on the firm's debt structure (Visvanathan 1998 and Borokhovich et al. 2004); or it may have an indirect impact on the value of the firm (Allayannis and Weston 2001).

In the FSS model of hedging, the firm's hedging motive is linked to the need to coordinate finance and investment in order to avoid costly external finance. As a consequence of these costs, there may be potential underinvestment that firms would address through hedging with the use of derivatives. There are several possible explanations for these costs. They relate to the agency nature of debt necessitating some monitoring costs (Townsend 1979), to the nature of informational asymmetry between managers and outside investors concerning investment opportunities (Myers and Majluf 1984; and Campbell and Kracaw 1987), to potential conflict between equity holders and creditors (Myers 1997; and Bessembinder 1991), to financial distress costs (Smith and Stulz 1985).

The firm selects the level of investment (I) that maximizes the net profit (P) from this investment:

$$P(w) = \max \{f(I) - I - C(e)\}$$

where C(e) is the cost of external finance, e; w refers to internally generated funds (cash flow); and f(I) is the investment technology with diminishing returns. Investment, I, is financed from internally generated funds, w, and from external funds, e

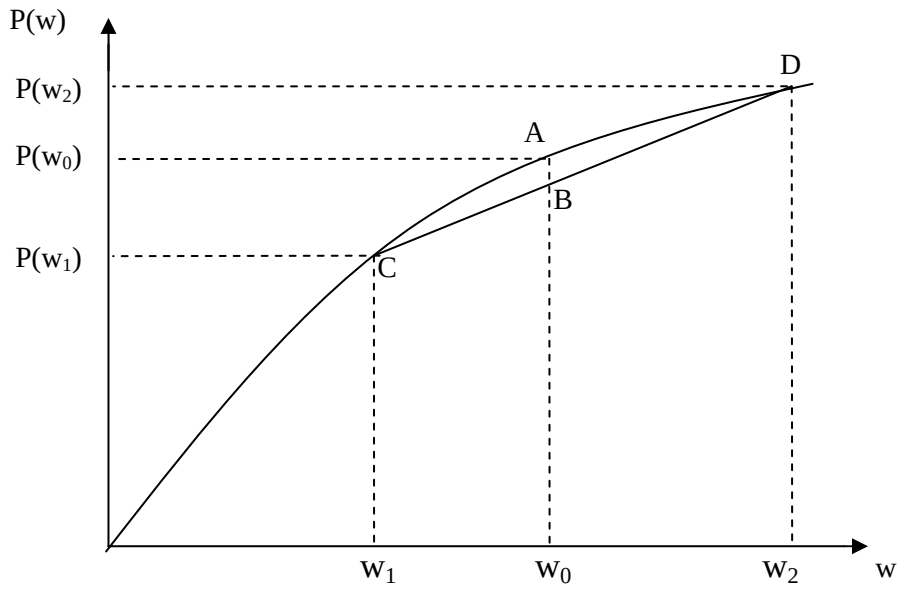
$$I = w + e$$

The cost of a given investment plan would be higher if more of the financing comes from the outside. The firm would invest up to the point where the marginal productivity of investment, f'(I), is equal to a dollar plus the marginal cost of external funds, C'(e):

$$f'(I) = 1 + C'(e)$$

The firm *underinvests* in this case, relative to the level that would exist if the marginal cost of external funds were zero. The FSS model discusses one possible motivation for costly external finance, which is the potential finance distress imposed by the requirement that the firm earn enough cash to pay its debt. The external cost of finance is positively related to the probability of the firm defaulting on its debt. However, hedging would not enhance the firm's expected profit unless C'(e) increases in e. In Figure 1, we show how hedging would improve the value of the firm. The firm's planned cash flow level (that is, internally generated funds) is w_0. Its cash flow could fluctuate between w_1 and w_2, due to fluctuations in interest rates, for example. If the firm found itself below the planned level of cash flow, then it would need to acquire additional

FIGURE 1
THE BENEFIT OF HEDGING IN REDUCING COSTLY EXTERNAL FINANCE



external funds, equal to (w_0 - w_1), resulting in a reduction in profit equal to {$P(w_0) – P(w_1)$}. If the firm found itself above the planned level of cash flow, its external finance needs would be reduced by ($w_2 – w_0$), resulting in an increase in profit equal to {$P(w_2) – P(w_0)$}. Due to the increasing marginal cost of external finance, {$P(w_0) – P(w_1)$} is higher than {$P(w_2) – P(w_0)$}. By maintaining cash flow at w_0 through hedging, the firm expects to earn $P(w_0)$, which is higher than the profit expected under no hedging (point B in Figure 1, calculated as a weighted average of $P(w_1)$ and $P(w_2)$).

In summary, there are benefits to firms from hedging in that it helps them avoid costly external finance. The extent of these benefits is related to firms' financial and operational conditions as captured in the following: (1) external financing needs measured by such variables as cash flow from operations and the quick ratio; (2) financial distress measured by such variables as the interest coverage ratio, the ratio of long-term debt to short-term debt, and the ratio of debt to total assets; (3) borrowing constraints measured by such variables as tangible assets, net worth, and firm size; (4) investment opportunities measured by such variables as R&D expenditures, capital expenditures, and the ratio of market value to book value of assets; (5) use of substitutes for derivatives such as convertible debt and preferred stock. The FSS model also obtains the following testable implications, which do not seem to have been examined in the empirical literature: Firms where cash flows and investment opportunities are closely correlated would hedge less since hedging would maintain cash flows at a time when they are not needed due to low investment opportunities; firms where cash flows and collateral asset values are closely correlated would hedge more because hedging would allow firms to avoid external finance at those times when it would be very costly due to low collateral asset values.

Hedging: The Role of Taxes

Firms may also benefit from hedging under a progressive income tax system (Smith and Stulz 1985). Figure 1 could be used to illustrate this benefit of hedging if P(w) is now considered as after-tax income. If firms operate currently in the region where taxes are convex, then their expected tax obligations would be smaller at the average income level w_0 (and income after taxes would thus be higher) than what these obligations would be if these firms were to experience increases and decreases in income around w_0. Smoothing income through hedging is thus beneficial to the firm. Under this theory of hedging, firms that have larger tax loss carry-forwards would be more likely to hedge in order to maximize the tax savings.

Hedging: The Role of Managerial Incentives

In addition to costly external finance or tax convexity, decisions on hedging by managers may be affected by their own attitudes on risk (Smith and Stulz 1985), on how they are compensated (Petersen and Thiagarajan 2000), or on the need to communicate reputation (DeMarzo and Duffie 1995). These models suggest that firms would be more like to hedge when managers own a larger fraction of total equity shares or when managers have a greater need to communicate their reputation.

Hedging: Macroeconomic Implications

While the benefits accrue to the hedging firm, it is useful to think about how hedging may have potential macroeconomic implications. In the FSS model discussed above, firms could avoid costly external finance by hedging against unexpected cash flow reductions. The economy-wide benefit of this comes from more efficient risk allocation. Presumably the risks would be distributed to the sector that is more capable of bearing them so that the effect may be one of increasing the average level of investment in the economy. On the other hand, derivatives use may have the effect of reducing the effectiveness of monetary policy. Monetary policy affects capital investment through the credit channel as well as through the interest rate channel. The credit channel refers to the inability of some firms to get credit in times of monetary tightening since some lenders would choose to ration credit rather than to raise interest rates due to market imperfections (such as monitoring costs and adverse selection). The financial accelerator model of BGG is motivated by this type of market imperfection. When interest rates unexpectedly rise, such as when the Fed tightens its policy, hedging would cushion the impact from such a rise, allowing firms, especially smaller ones and those with weaker balance sheets, to continue with their investment plans.

In the BGG model, firms are constrained in the amount they could borrow to finance production. At the beginning of the period, the firm selects an amount of input x (x_1) and an amount of debt d (d_1) to maximize output net of repayment of the debt:

$$\text{Max } P = f(x_1) - (1+r_1)d_1$$

where $f(x_1)$ is the production function with a marginal product of $f'(x)$; d_1 is the current debt used to support current production; and r_1 is the interest rate on current debt. The value of the firm's tangible assets, K_1, limits the amount the firm could borrow to supplement its existing cash flow ($CASHFLOW_0$) in order to finance the purchase of input x. This finance constraint is expressed as:

$$x_1 \leq CASHFLOW_0 + K_1$$

When the constraint is binding, the firm's use of input x would be below the unconstrained optimal amount (where $f'(x) = (1+ r_1)$), with the result that $f'(x_1) > (1+r_1)$. The sum of the values of $CASHFLOW_0$ and K_1 is the firm's net worth, where the valuation of K_1 is negatively correlated with interest rate changes. The FSS model imposes an external cost function on the structure of the firm's investment finance and shows how hedging could improve the firm's performance; while the BGG model imposes an external debt constraint on the structure of the firm's investment finance and shows how monetary policy changes could affect investment through their effect on the firm's asset values. Underpinning these two models are imperfections of an agency nature that result in costly external finance and that limit investment. In the BGG model, $\{f'(x_1) - (1+r_1)\}$ is an implicit measure of the marginal cost of external finance, equivalent to C'(e) in the FSS model. The BGG model suggests that firms' balance sheet strength (measured by such things as net worth and the value of tangible assets) is crucial in determining how costly external finance would be. Firms that are weak financially would be least able to weather any unexpected policy tightening due to costly external finance, resulting in an acceleration of the financial impact of the tightening. The econometric evidence seems to support the financial accelerator model. For example, it has been found that in an economic slowdown, smaller firms, as their cash flows are reduced, tend to reduce inventory investment much more than larger firms (see, for example, Carpenter, Fazzari, and Petersen 1994). This is because agency costs for smaller firms are higher and are thus more constrained in how much they could borrow to finance the cash shortfall. Smaller firms may then be expected to hedge more, other things being equal. While focusing on the financial system (rather than on non-financial firms), Hunter and Marshall (1999) discussed the possibilities that derivative markets may dampen the effects of monetary policy actions on the real economy. Derivatives as a hedging instrument may have other important macroeconomic implications that have not been much studied. For example, it would be interesting to study the possible role played by commodity price derivatives in the rather subdued macroeconomic effect of recent oil price increases in the U.S. economy.

ECONOMETRIC EVIDENCE ON HEDGING WITH DERIVATIVE INSTRUMENTS

The theories we have reviewed above demonstrate the benefits of hedging with derivative instruments as well as their potential macroeconomic impact. These theories also provide us with a framework to review and interpret the econometric evidence on derivatives use. Our presentation of past empirical research follows a somewhat different format from any previous review in that we bring out systematically the nature of the empirics, including whether a study used qualitative or quantitative data, rather than simply stating the results.

As revealed in Table 6 below, most of the econometric work has been conducted in the past 10 years, with data covering the 1990s (before the implementation of SFAS No. 133). Half of the studies used qualitative data of users versus non-users of derivatives, while the other half relied on the availability of quantitative data (notional amounts) made possible by SFAS No. 105. Fourteen of the 17 studies provided an econometric analysis of derivatives use, and about one-third of these studies involved S&P 500/Fortune 500 firms. The data on derivatives use are obtained from annual reports, including those available from EDGAR. We also include a few non-econometric studies (those which used survey data) as well as studies that examined how derivatives use shapes firms' risk profiles or that affects firm value. A number of studies examined total derivatives use, while others examined one or more types of derivatives, such as

those related to interest rate risk exposure. There may be an overlap between these areas in some of the studies reviewed. The variables typically used and how they are measured are provided in Table 7. The organization of Table 7 reflects the three main theories reviewed above: costly external finance, tax convexity, and managerial incentives.

Table 8 below summarizes the results in terms of the significance of the variables used in the studies where derivatives use is the dependent variable (either measured qualitatively or quantitatively). The results for investment opportunities (measured by research and development expenses or by market-to-book value of assets or equity) are not consistent across different studies. On the other hand, there is a strong consistency among quantitative studies (but not so with studies using qualitative data) for the effects of the following variables representing external financing costs: cash flow, leverage, and liquidity. While size is significant in all of the qualitative studies, it is not so in quantitative ones. Why this is so is not clear, but it is possible for this variable to pick up more of the effects of other variables, such as cash flow and leverage, when derivatives use is measured in a more limited way: use or not use. Whether a study is quantitative or not seems to have an effect on finding whether the tax variable is significant. The tax variable is mostly significant with quantitative studies, but not so with the qualitative studies. There does not seem to be any pattern with respect to the effect of different samples used (whether in terms of firms sampled or time period selected) on the results obtained.

The results discussed thus far for Table 8 are from studies where derivatives use is the dependent variable. A limited number of studies have been done where derivatives use is an explanatory variable that could have an effect on the firm's risk profile or on the firm's value. The evidence is weak on derivatives use as having a significant effect on changing firms' risk profiles, while there is some limited evidence to support the effect of derivatives use on firm value.

TABLE 6
SUMMARY OF PAST EMPIRICAL RESEARCH ON THE USE OF DERIVATIVES(ORGANIZED BY SAMPLE PERIOD)
VARIABLES USED IN ECONOMETRIC STUDIES OF DERIVATIVES USE AND THEIR MEASUREMENTS

Author	Sample	Sample period	Model	Dependent Variable	Explanatory Variables	Results	Data
Bartram/ Brown/ Fehle (2006)	6,448 firms - global	2000 and 2001	Probit	Total, currency and interest rate (qualitative)	Variables reflecting financing costs, investment opportunities, tax convexity, and managerial incentives	*Significant*, but wrong sign on investment opportunity; *significant* effects of leverage, interest coverage, and quick ratio; *significant* size effect (positive); *no* tax effect	Data on non-financial firms obtained from Thomson Analytics and Global Reports, including 2,231 U.S. non-financial firms
Bodnar /Hayt/ Marston (1998)	Survey, response: 399 non-financial firms	1998	Descriptive statistics and charts	Derivatives use (qualitative)	Risk management: foreign exchange, interest rate, commodity, and equity	*No* impact of *FASB 133* on use or risk management strategy; usage rate increases among derivatives users	Survey data; randomly selected 2,000 publicly traded firms and 154 non-financial *Fortune* 500 firms
Prevost/ Rose/ Miller (2000)	Survey of 155 firms	1998	Descriptive statistics and charts	Derivatives use (qualitative)	Risk management variables	Most important reason: minimize fluctuations in cash flows	Survey of 334 firms, with final sample of 155; categorical data

Guay/ Kothari (2003)	1,000 largest, non-financial firms	1997	Regression	Cash flow and market value sensitivities	Leverage, market-to-book value of assets, size, and others	Among traditional variables, only *size* is significant in total notional principal equation	234 non-financial firms
Berkman/ Bradbury/ Magan (1997)	Survey non-financial firms	1996	Descriptive statistics and charts	Derivatives use (qualitative)	Risk management: foreign exchange, interest rate, and commodity	Use of derivatives by service firms is limited in both U.S. and New Zealand. Derivatives use in U.S.: reducing fluctuations in earnings (49%), cash flow (42%), or market value (8%)	Survey data, categorical; 79 New Zealand firms (non-financial)
Gay/Nam (1998)	Non-financial firms, 325 users and 161 non-users	1995	Tobit	Derivatives use (quantitative)	Growth variables	*Significant* growth variable effects and significant interaction variables	Compustat, CRSP, Swap Monitor, *Business Week* 1000 firms, 2-digit SIC classification
Barton (2001)	Fortune 500 – 314 firms	1994 to 1996	Regression	Derivatives use (quantitative)	Discretionary accruals, leverage, R&D, and bankruptcy probability (distress)	All variables except distress are *significant*	228 derivatives users and 86 non-users
Graham/ Rogers (2002)	442 firms	1994 and 1995	Regression	Derivatives (quantitative)	Tax, debt to assets, R&D, book–to-market value of equity, and others	*No* significant tax effect, but significant in others as listed	158 derivatives users
Borokhovich et al. (2004)	284 S&P 500 non-financial firms	1994	Tobit	Interest rate derivatives (quantitative)	Variables reflecting managerial incentives, leverage, investment opportunities, liquidity, and size	*Significant* effects of leverage and size; *no* effect of liquidity, investment opportunities, or managerial incentives	Corporate Risk Management Handbook (1996), EDGAR, S&P ExecuComp, and Compustat
Howton/ Perfect (1998)	Fortune 500/S&P 500 firms (FSP) and a random sample	1994	Tobit	Derivatives use (quantitative)	Measures of financial distress, external financing costs, and tax variables	For FSP sample, *significant* results for financial distress, external financing costs, and currency risk exposure; but not so for the random sample	Compustat, 451 firms from Fortune 500/S&P 500 firms (FSP); 461 firms in a random sample; notional and fair value of derivatives from annual reports
Saunders (1999)	2,657 non-financial firms; 101 users and 2556 non-users	1991, 1993, and 1995	Logit	Interest rate derivatives (qualitative)	Variables reflecting size, investment opportunities, liquidity, and leverage	*Only size* is significant	Data from SEC through Lexis-Nexis and from Compustat
Visvanathan (1998)	410 S&P non-financial firms	1993	Logit	Interest rate derivatives (qualitative)	Variables reflecting leverage and debt structure	*Significant* effect of leverage	Data from Compustat, CRSP, and Value Line Investment Survey Reports
Mian (1996)	3,022 firms, 771 hedgers and 2,251 non-hedgers	1992	Logit	Currency and interest derivatives use (qualitative)	Variables reflecting market imperfections and tax convexity	*Negative* effect of contracting costs and market imperfections; no strong evidence on effect of taxes; significant firm size effect	Annual reports of 3,022 firms; categorical data; users and non-users

Haushalter (2000)	100 oil and gas producers from a survey	1992-1994	Probit	Commodity derivatives (oil and gas – qualitative)	Variables reflecting contracting costs (debt, liquidity, investment opportunities, liquidity), tax convexity, managerial incentives	*Significant* size effect, tax convexity, and managerial incentives (but wrong sign); no effect from leverage or liquidity	Data in the form of fraction of production hedged, collected from a survey
Geczy /Minton/ Schrand (1997)	411 *Fortune* 500 firms	1991	Logit	Currency derivatives use (qualitative)	Variables reflecting market imperfections, substitution variables, foreign currency risks	*Significant* effects of R&D, interaction of debt and investment opportunities, and liquidity	Categorical data; users and non-users
Allayannis/ Weston (2001)	720 non-financial firms	1990 to 1995	OLS	Firm value (Tobin's Q)	Foreign sales, size, debt to equity, capital spending, R&D, foreign currency derivatives	*No* significance for R&D and capital spending	Sample based on Compustat non-financial firms for 1990-1995
Guay (1999)	254 new users, 3,124 nonuser 1,597 user	1990 to 1994	Logit	Total risk; derivatives use (qualitative)	Notional amount and growth/risk variables; interest/exchange exposures; risks	*Significant* external financing costs resulting from financial distress and others, resulting in under-investment	Compact Disclosure, Compustat, CRSP
Nance/ Smith/ Smithson (1993)	Survey of 169 firms	1986	Logit	Derivatives use (qualitative)	Variables include risk management and tax variables	*Weak* tax effect; *weak* R&D effect; *weak* substitution between derivatives use and other financial policies	Survey data, categorical; 535 firms from list of *Fortune* 500 and S&P 400; Compustat

TABLE 7
VARIABLES USED IN ECONOMETRIC STUDIES OF DERIVATIVES USE AND THEIR MEASUREMENTS

Dependent Variable	**Explanatory Variable**		
Derivatives Use	**External Financing Costs**	**Tax Convexity**	**Managerial Incentives**
Notional value Fair value Zero or one	*Financing Need* Cash Flow (CASHFLOW) Liquidity (LIQUIDITY) *Financial Distress* Leverage (LEVERAGE) Interest Coverage Ratio (INT) *Borrowing Constraints* Tangible Assets (TANGIBLE) Firm Size (SIZE) *Investment Opportunities* R &D (R&D) Market value to book value of assets (MKTBK) *Substitution* Convertible debt (CONVPREF) Preferred stock (CONVPREF)	Operating loss carry forwards (TAX) Tax Progressivity (TAX)	Closely held shares (MGR)

Notations	Variables	How They Have Been Measured in the Literature
CASHFLOW	Cash flow to total assets	3-year average of the ratio of firm's cash flow to total assets (Howton and Perfect 1998)
	Operating cash flow	Operating income minus interest expense minus cash dividends minus net taxes (Howton and Perfect 1998)
CONVPREF	Convertible debt or preferred stock	Ratio of convertible debt (or preferred stock) to market value or ratio of preferred stock to market value (Gay and Nam 1998)
INT	Interest coverage ratio	3-year average of earnings before interest and taxes divided by interest (set earnings equal to 1 if negative and interest is set equal to 1 if no debt, Howton and Perfect, 1998)
LEVERAGE	Leverage	Book value of debt divided by market value of equity (Howton and Perfect 1998); or book value of liabilities divided by market value of common equity (Hentschel and Kothari 2001; Guay, 1999)
LIQUIDITY	Quick ratio	3-year average of current assets minus inventories divided by current liabilities (Howton and Perfect 1998)
MGR	Managerial incentives	Number of closely held shares divided by common shares outstanding (Bartram et al. 2006); total insider ownership as a percentage of total voting rights (Borokhovich et al 2004)
MKTBK	Market value to book value of assets	Market value of equity (Howton and Perfect, 1998); or book value of assets minus book value of equity plus market value of equity (Mian 1996)
R&D	Research and development	3-year average of R&D divided by sales (Howton and Perfect 1998)
SIZE	Firm size	Book value of liabilities plus market value of equity (Guay 1999) divided by book value of assets
TANGIBLE	Tangible assets	Property, plant, and equipment; or total assets minus intangible assets
TAX	NOL/Total assets	Book value of net operating loss carry forwards divided by total assets (Gay and Nam 1998)
	Tax progressivity	Marginal tax rate

TABLE 8
STATISTICAL SIGNIFICANCE OF VARIABLES RELATED TO EXTERNAL FINANCING COSTS,TAX CONVEXITY, AND MANAGERIAL INCENTIVES (CLASSIFIED BY WHETHER STUDIES USED QUANTITATIVE OR QUALITATIVE DERIVATIVES DATA)

Variables	R&D	MKTBK	CASH FLOW	LIQUIDITY	LEVERAGE	INT	TANGIBLE	SIZE	CONV PREF	TAX	MGR
QUANTITATIVE											
Borokhovich et al. (2004)											
Interest rate	NA	–	NA	–**1**	*	NA	NA	*	NA	*	–
Guay/Kothari (2003)											
Total	NA	–	*2	NA	–	NA	NA	*	NA	NA	NA
Graham/Rogers (2002)											
Total	*	*	NA	NA	*	NA	NA	NA	NA	*	NA
Barton (2001)											
Total	–	NA	*3	*4	*	NA	NA	–	NA	NA	NA
Gay/Nam (1998)											
Total	*	*5	NA	NA	*	–	NA	–	–	*	NA
Howton/Perfect (1998)											

Currency**6**	*	NA	*	*	–	–	–	*	–	*	NA
Interest rate	*	NA	*	*	*	–	*	*	–	*	NA
QUALITATIVE											
Bartram/Brown/ Fehle (2006)											
Currency	NA	*__7__	NA	*__8__	*	*	NA	*__9__	NA	–__10__	–
Interest rate	NA	*__7__	NA	*__8__	*	*	NA	*__9__	NA	-__10__	*
Allayannis/ Weston (2001)											
Currency	*	NA	–__11__	*	–	NA	NA	*	NA	–	NA
Haushalter (2000)											
Commodity – Gas and Oil	–__12__	NA	–	NA	_	NA	NA	*	-__13__	*	*__14__
Guay (1999)											
Total	NA	*	NA	NA	*	*__15__	NA	*	NA	NA	NA
Saunders (1999)											
Interest rate (fixed-rate swaps)	NA	_	_	NA	_	NA	NA	*	NA	NA	NA
Visvanathan (1998)											
Interest rate (swaps)	NA	NA	NA	NA	*	NA	NA	NA	NA	NA	NA
Geczy/Minton/ Schrand (1997)											
Currency	*	–	NA	*	–	NA	NA	*	NA	–	–
Mian (1996)											
Currency	NA	–	NA	NA	NA	NA	NA	*	NA	*	NA
Interest rate	NA	*	NA	NA	NA	NA	NA	*	NA	*	NA
Nance/Smith/ Smithson (1993)											
Total	–	–	NA	–	–	–	NA	*	–	–	NA

Notes: (R&D, etc.) are defined in Table 7.
* significant at 10 percent or better
- not significant
1. Quick Ratio
2. Cash plus marketable securities divided by assets
3. Cash dividends
4. Cash cycle, defined as number of days inventory is in stock plus the number of days net receivables are outstanding
5. R&D and MKRBK not included together in same regression
6. When fair contract value (instead of notional contract value) is used, only SIZE, R&D, and INT are significant
7. Coefficient has wrong sign
8. Liquidity variable used is the quick ratio
9. Coefficient is positive
10. Tax variable used is income tax credit
11. Dividend payout is dummy variable
12. Investment expenditures
13. Dividend payout
14. Significant, but wrong sign
15. Interest burden, defined as interest expense in year t-1 divided by operating income before depreciation and interest

CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

In this paper we have presented evidence from extant research that shows the benefits of hedging and the increased use of derivatives by U.S. non-financial firms. We have also explained what these derivatives are and how they may be used for hedging certain risks. In addition, we have reviewed the econometric evidence that suggests the importance of external financing costs in determining derivatives use. There is evidence that studies using qualitative data (on derivatives use) have yielded results that are systematically different from those using quantitative data. Our review has also touched on some macroeconomic implications of derivatives use, suggesting that the use of derivative instruments may moderate the impact of monetary policy shocks.

There are several areas that seem to warrant further research. It would be of importance to go beyond broad numbers for overall derivatives use, common with much of past research, and to find out what different derivative contracts for different risk types suggest about hedging and other purposes for using derivatives. Recent research has moved in this direction, as in Faulkender (2005). The availability of data on hedge classification as between cash flow and fair value, mandated by SFAS No. 133, would provide some valuable information for such research. Another area worth pursuing is whether the price transmission mechanism, from basic commodities to final products, may have changed in sectors that have seen an increase in the use of commodity price derivatives. Similarly and more broadly, it is important to ascertain the impact of hedging with derivative instruments on how firms respond to macroeconomic shocks. Finally, additional research may be necessary to reconcile the consistent evidence supporting the importance of external financing costs with a lack of evidence on derivatives use as an important strategy in improving firms' risk profiles (Guay and Kothari 2003), or with a lack of empirical support for the traditional theoretical framework as presented above (Brown 2001).

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