Cash Flow, Investment, and Hedging

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This version: September 2000

[1]We would like to thank Tim Adam, Christa Bouwman, Susan Chaplinsky, N.K. Chidambaran, Alan Eberhardt, Rob Hansen, Bob Harris, Charles Himmelberg, Narayan Jayaraman, Kose John, Greg Kadlec, Raman Kumar, Michael Pagano, N.R. Prabhala, Dan Rogers, Vijay Singal, and James Weston for valuable comments. We have also benefited from comments by seminar participants at Virginia Tech, Georgetown University, the New Horizons Seminar at the Darden School, University of Virginia, the ninth annual Financial Economics and Accounting Conference at NYU, the fifth International Finance Conference at Georgia Tech, and the 1999 EFA Conference in Helsinki. We also wish to thank the Darden School Foundation and a summer research grant from Virginia Tech for financial support.

Abstract

Using a sample of S&P 500 non-financial firms between 1993 and 1995, we examine whether the use of foreign currency derivatives by firms with significant exposure to exchange-rate risk enables them to reduce their dependence on internal cash flow for making investments, as predicted by Froot, Scharfstein, and Stein's (1993) model of optimal hedging. Consistent with our hypothesis, we find that while hedgers and non-hedgers have similar sensitivities of investment to net cash flow, sensitivity to unhedged cash flow is significantly lower for hedgers than non-hedgers. This result is robust to the use of alternative specifications of cash flow, investment, and Q; to further controls for leverage, size, and diversification; and to controls for the endogeneity of the hedging decision. Finally, we find additional evidence supporting the effectiveness of hedging as indicated in the above model: hedgers reduce the volatility of net cash flow significantly more than non-hedgers.

Introduction

What do firms seek to achieve by hedging? According to Lewent and Kearney (1990) who describe Merck's risk management philosophy, hedging is critical given the "potential effect of cash flow volatility on our ability to execute our strategic plan −particularly, to make the investments in R&D that furnish the basis for future growth". This argument is formalized by Froot, Scharfstein, and Stein (1993) (hereafter FSS), who postulate that hedging adds value to the extent that it allows firms to stabilize their internally generated funds and undertake necessary investment, which might have otherwise been bypassed in the face of costly external financing.[1] Recently, Geczy, Minton, and Schrand (1997) have examined the use of foreign currency derivatives in a sample of Fortune 500 firms and found that firms with large investment/growth opportunities and tight liquidity constraints are more likely to use currency derivatives than firms with less attractive investment opportunities and less severe liquidity constraints.[2]

While Geczy, Minton, and Schrand (1997) provide evidence that is consistent with the FSS (1993) hypothesis, their question is posed in *ex ante* terms, i.e., they test if firms that the FSS model predicts as having incentives to hedge, actually do so. No study so far has examined if firms that use derivatives are indeed able to reduce the *ex post* dependence of their investments on internal cash flow, and thus mitigate the underinvestment problem.[3] In this paper we directly examine whether firms that face significant exchange-rate risk and

[1] A similar argument was earlier articulated by Lessard (1990), Smith, Smithson and Wilford (1990) and Stulz (1990). Other theories of corporate hedging include, for example, Stulz (1984), which suggests that corporate hedging is due to managers' risk aversion and Smith and Stulz (1985), which suggests that the structure of taxes or the costs of financial distress may prompt firms to undertake hedging activities.

[2] Other related empirical studies have found evidence consistent with Smith and Stulz's (1985) theory [e.g., Nance, Smith and Smithson (1993), Haushalter (2000)], consistent with Stulz's (1984) managerial risk aversion theory [e.g., Tufano (1996)], and consistent with an argument of high fixed costs of hedging [e.g., Mian (1996)].

[3] An exception is Petersen and Thiagarajan (1996) who examine the differences in the use of gold derivatives between two firms in the gold mining industry. In this paper, in contrast, we examine this hypothesis for the use of currency derivatives in a large cross-section of firms.

use foreign currency derivatives (FCDs) smooth their cash flows, and thus their investments, more than firms that also face exchange-rate risk but do not use derivatives. We focus on currency derivatives because we want to isolate a common source of risk (i.e., currency) for the two groups of firms (hedgers and non-hedgers) that we examine. Since currency risk is important for both hedgers and non-hedgers in this sample, any observed differences in cash flow and investment between the two groups may be attributed more convincingly to currency hedging.[4]

More specifically, to examine whether cash flow affects investment differently for hedgers than for non-hedgers, we examine the difference in the relation between the level of investment and the level of operating cash flow (i.e., the difference in the investment-operating cash flow sensitivity) between the two groups. Our prediction is that if hedging is effective and as prescribed by FSS, hedgers should have a lower sensitivity of investment to pre-hedging cash flow than non-hedgers, controlling for differences in access to external capital and investment opportunities between the two groups.

Our test requires the use of pre-hedging or *unhedged* cash flows, since we want to examine whether cash flow from financial hedges counteracts the volatility of cash flow from operations, and thus stabilizes the total internal cash available for investing. Given the currently non-harmonized reporting practices in derivatives, identifying unhedged cash flows from operations requires careful examination of firms' annual reports. Therefore, we examine the annual reports of every derivative user in our sample to determine where hedge cash flows are reported for each of them. We classify firms into three categories in the following manner: (1) a firm includes all cash flow from hedges in operating income; (2) a firm includes all cash flow from hedges in nonoperating income (e.g., "Other income", "Interest income") or in

[4] Clearly, one needs to control for firm characteristics that reflect differences in access to external capital and investment opportunities between the two groups that may also explain differences in cash flow and investment.

both operating and nonoperating income; and (3) a firm does not report, or it is not clear from the annual report, where cash flows from hedges are included. For firms in category (2), for which at least part of the cash flows from hedges is included in nonoperating income, *operating* cash flow is a reasonable, though admittedly, imperfect, proxy for unhedged cash flow (a list of all firms classified in category (2) along with the derivatives-related statements from their annual reports is available upon request from the authors). Specifically, we use Net Operating Profit (NOP) plus Depreciation and Amortization (DA) minus change in working capital (ΔWC), and alternatively, Net Operating Profit Less Adjusted Taxes (NOPLAT) plus DA (as taxes paid represent a non-discretionary cash flow that is exposed to FX risk) minus change in working capital (ΔWC) as measures of unhedged cash flow.

The paper links two seemingly disparate literatures — one on hedging, and the other on financing constraints and investment — in an empirical setting.[5] The FSS model establishes the theoretical connection between them by showing that through hedging, firms can reduce the volatility of their cash flow, and thus reduce the volatility of their investment, without relying on costly external financing. We test this hypothesis using a sample of S&P 500 nonfinancial firms between 1993 and 1995 that face substantial exchange-rate risk. We use a specification similar to the one used in the investment-cash flow sensitivity literature: investment is regressed on unhedged cash flow (NOPLAT plus DA minus ΔWC), an FX derivative dummy, an interaction term between unhedged cash flow and the FX derivative use dummy, and controls for growth opportunities (Tobin's Q, estimated as in Perfect and Wiles (1994)), and fixed firm and year effects. Both investment and cash flow are scaled by capital stock at the beginning of the year.

Consistent with our hypothesis, we find that the investment-cash flow sensitivity of the

[5]See, for example, Fazzari, Hubbard, and Petersen (1988), Hoshi, Kashyap, and Scharfstein (1991), Kaplan and Zingales (1997), Lamont (1997), Shin and Park (1998), and Whited (1992) for references in the financing constraints and investment literature.

sample of hedgers is significantly lower than that of the sample of non-hedgers, as indicated by the negative and significant coefficient on the interaction term. This evidence supports our hypothesis that firms that hedge tend to stabilize their investment programs and make investment less dependent on current cash flow. Alternative measures of unhedged cash flow (e.g., NOP plus DA minus ΔWC) also yield significantly lower estimates of investment-cash flow sensitivity for hedgers than for non-hedgers. However, the estimated investment sensitivity to net (post-hedging) internal cash flow, which is determined by the ease of access to external financing, is not significantly different for the two groups suggesting that the observed difference in investment sensitivity to unhedged cash flow is not driven by differences in dividend policy and/or unequal access to external financing.

Next, we examine whether our results are robust to a variety of alternative specifications of the regression equation and the dependent/independent variables. In these tests, we follow closely the literature on investment-cash flow sensitivity and financing constraints [see, e.g., Fazzari, Hubbard, and Petersen (1988) and Kaplan and Zingales(1997)]. Specifically, our results are robust to the use of lagged cash, lagged Q, lagged investment, and Q^2 as additional controls; to an alternative measure of investment (capital expenditures plus R&D and advertisement expenditures); to the use of Market-to-Book ratio instead of Tobin's Q; and to the use of R&D and advertising expenditures in addition to, or instead of, Q as a proxy for growth opportunities.

We also estimate a model of changes in investment in response to cash flow changes. Such a model allows us to quantify the effect on investment of a 1 percent change in cash flow, and provides a check against possible autocorrelation in the data. Again, we find evidence consistent with our hypothesis that as cash flow changes, investment changes by a significantly smaller proportion for hedgers than for non-hedgers. Further, in line with the theoretical prediction of FSS, these differences are more pronounced in the case of negative cash flow changes. In this case, a decline in investment in response to a 1% decline in cash flow is lower for hedgers by 0.254% than for non-hedgers.

It is however possible that the differences in the investment-cash flow sensitivities between the two groups are driven by differences in factors other than hedging. For example, the two groups may have different capital structure or size, which will affect both investment and cash flow and therefore the relationship between investment and cash flow. To control for such possibilities, we perform additional tests where we interact cash flow with debt-to-equity, size, and diversification. We find that none of these variables affects our result that the investment-cash flow sensitivity is lower for hedgers than for non-hedgers.

There are two related concerns that arise from our partitioning the sample into two groups on the basis of the observed decision by a firm to hedge/not hedge. First, this represents an endogenous decision by the firm which may introduce a selectivity bias in the coefficient estimates [see Heckman (1979), Maddala (1983)]. We use Heckman's (1979) two-step procedure to address this issue. Second, it is possible that the hedging and investment decisions of the firm are made simultaneously based on a common information set, thus introducing a simultaneous equations bias which may again render the estimates biased. We use a Two-Stage-Least-Squares procedure to address this problem, using the determinants of hedging identified by prior research as explanatory factors in the first stage.

Our final test of the effect of hedging on cash flow and investment examines the volatilities of cash flows before and after incorporating the effect of cash flows from hedging. This represents another way to determine if the lower investment-cash flow sensitivity for hedgers is indeed related to the volatility-reducing effect of cash flows from financial hedges, or to better access to external capital markets. Regressing hedged cash flow on unhedged cash flow yields a significantly lower coefficient for hedgers than non-hedgers, reinforcing our inference from the previous tests that hedging attenuates the impact of operating fluctuations on net internal cash available for investing.

In general, our findings suggest that firms use derivatives as a risk management tool that allows them to execute their strategic plan and maintain investment, similar to what was described as Merck's primary purpose of derivative use. Our finding is also consistent with Allayannis and Weston's (2000) finding that firms that use derivatives increase their value. The investigation of the magnitude of the value benefit due to the reduction of underinvestment as a result of the use of derivatives is an important question for further research.

The remainder of the paper is organized as follows. Section 1 describes our sample and develops our hypothesis. Section 2 presents our main tests on the differences in the investment-cash flow sensitivity between hedgers and non-hedgers. Section 3 considers alternative explanations of our results and provides additional evidence on the effectiveness of hedging in smoothing investment. Section 4 concludes.

1. Hypothesis development and sample description

1.1 The impact of hedging on investment-cash flow sensitivity

There are two main directions that the literature on hedging has followed. One direction is the examination of which theory of hedging best describes what we observe in the data. There are several papers that examine the use of alternative types of derivatives (exchange-rate, interest-rate, and commodity) and their determinants [see, e.g., Tufano (1996), Geczy, Minton, and Schrand (1997), Mian (1996), Nance, Smith, and Smithson (1993), Haushalter (2000), Guay (1998), Viswanathan (1998), and Graham and Rogers (2000)].[6] An alternative

[6] See, also earlier studies by Booth, Smith and Stolz (1984), Block and Gallagher (1986), and Wall and Pringle (1989) on the use of interest-rate derivatives and more recent studies by Jalilvand, Switzer, and Tang

route has been to examine the impact of hedging on a firm. For example, He and Ng (1998), Allayannis and Ofek (2000), and Simkins and Laux (1997) examine the effect of the use of currency derivatives on a firm's exchange-rate risk and find that on average, firms reduce their exchange-rate risk through the use of derivatives. In a more general context, examining the use of currency, interest-rate, and commodity derivatives, Guay (1999) finds that firms reduce risk following the initiation of a hedging program. More recently, Allayannis and Weston (2000) examine the use of currency derivatives and its effect on firm value, and find that hedging increases firm value.

This paper augments the latter literature by examining the impact of currency hedging on a firm's cash flow and investment. In the FSS framework, a firm hedges to mitigate underinvestment, which would otherwise arise due to volatility in internally generated cash flows and costly external financing. If firms hedge for such a purpose, then for a sample of firms with exposure to currency risk, one should observe less volatile investment for those that hedge currency risk than for those that do not. To the extent possible, hedgers would want to make investment independent of current unhedged cash flow and thus ensure that investment is undertaken regardless of the level of internally generated cash. This should therefore lead to a lower sensitivity of investment to unhedged cash flow for hedgers than for non-hedgers.

This paper links the hedging literature with the one on financing constraints and investment cash-flow sensitivity. When a firm is financially constrained, it is more likely to be unable to invest, i.e., if cash flow falls, investment falls. On the other hand, a firm that is less financially constrained should be better able to undertake investment by tapping into external capital markets. However, as Kaplan and Zingales (1997) point out, external fi-

(1998) on the use of derivatives by Canadian firms and Abimbola and Baker (1998) for U.K firms. See also Bodnar and Gebhardt (1999) for a comparison of derivative use between U.S. and German firms.

nancing is costlier than internal funds for every firm and the distinction between constrained and unconstrained firms essentially lies in the degree of this cost differential. Consequently, even for large and mature firms (as in our sample of S&P 500 firms) insufficient internal cash generation will result in investment cutbacks and financial hedging could provide a solution to it. Given the large fraction of foreign sales for the firms in our sample, currency hedging could play an important role in insulating firms from problems of insufficient internal cash caused by adverse exchange rate movements.

1.2 Identifying hedgers and non-hedgers

We obtain information on the use of currency forwards, futures, swaps, and options for all S&P 500 nonfinancial firms (as of 1995) from the footnotes to their annual reports. We trace their use of derivatives over the period 1993-95. A firm that used currency forwards, futures, swaps, or options in a year is categorized as a hedger for that year, while a firm that did not indicate any use of such derivatives is considered to be a non-hedger. Note that there is evidence by Guay (1999), and Allayannis and Ofek (2000), which suggests that currency derivative users are on average reducing their exchange-rate risk (i.e., they are hedging). We excluded S&P 500 financial firms from our sample because most of them are also market-makers in foreign currency derivatives and therefore their motivation in using derivatives may be very different from that of nonfinancial firms. We also excluded public utilities because they are heavily regulated.

At first glance, some amount of noise may seem unavoidable in identifying hedgers and non-hedgers. This is due to the fact that while we concentrate on currency hedging alone, actual corporate hedging programs may include other forms of hedging (e.g., interest rate, commodity) as well. Consequently, we may erroneously classify some hedgers as non-hedgers. Closer inspection of the data, however, indicates that the impact of such errors is likely to be small. There is earlier evidence (Geczy, Minton, and Schrand (1995), Working Paper version), confirmed in our sample, that most firms that use non-currency derivatives also use currency derivatives. The actual divergence between the two, and therefore the misclassification error, is small. Further, any noise in classifying firms as hedgers and non-hedgers will blur the true distinction, if any, between the two groups, and will introduce some bias against our hypothesis of lower investment-cash flow sensitivity for hedgers.

1.3 Measuring unhedged cash flow: The use of NOPLAT plus DA minus ΔWC as a proxy

A certain amount of caution is necessary when choosing the appropriate measure of cash flow (See Figure 1). In the financing constraints literature, it has been customary to use net cash flow, i.e., net income plus depreciation and amortization. This is appropriate, since the point of that literature is to examine whether external financing is used to smoothen out fluctuations in internal funds (net cash flow) in making investments. Our objective, however, is to examine if the use of financial derivatives reduces the firm's internal cash flow volatility. Given that the firm's operations are exposed to foreign exchange risk, we want to test if FX volatility-induced fluctuations in unhedged cash flows are neutralized by derivative cash flows, so that net cash flow, and consequently investment, are stabilized. Our goal therefore is to estimate the sensitivity of the firm's investments to its *unhedged* cash flows from operations, and test if using financial derivatives enables the firm to reduce this sensitivity.

Consider the following numerical example for illustration. Firms A and B are identical in every respect other than hedging — A hedges while B does not. They have identical levels of operating risk: assume that operating cash flow volatility is 50% for both firms, of which half, i.e., 25% volatility, is due to FX risk. They also face identical levels of financing constraints so that for both firms, investments have to be cut by 50 cents for every dollar reduction in net internal cash flow. For A, the 50% volatility of unhedged operating cash flow results in 25% volatility of net cash flow (since the 25% volatility component due to FX risk is hedged away) resulting in 12.5% volatility of investments. For B, however, the 50% volatility of operating cash flow translates into 50% volatility of net cash flow and 25% volatility of investment. If investment-cash flow sensitivity is measured on the basis of net cash flow, it will yield the same coefficient of 0.5 for both firms, reflecting the identical extent of financial constraints faced by them, while if it is measured on the basis of operating cash flow, it will yield a lower coefficient (0.25) for A than for B (0.5), reflecting the impact of hedging for A.

Unfortunately, direct observation of unhedged cash flows from operations is made difficult by the lack of uniformity in hedge accounting and reporting practices. We therefore examine statements in the annual reports for all currency derivative users in our sample to determine where (in which item in the income statement) each firm includes cash flow from currency hedges. We classifiy the hedgers in three categories in the following manner: (1) a firm includes all cashflow from hedges in operating income; (2) a firm includes all cashflow from hedges in nonoperating income (e.g., "Other income", "Interest income") or in both operating and nonoperating income; and (3) a firm does not report, or it is not clear from the annual report, where cash flows from hedges are included.

Although some patterns emerged as to where companies include different types of cash flow from hedges, we found several counter-examples for many of them: for example, although cash flow from hedges associated with anticipated transactions are reported by some firms as nonoperating expense/income (e.g., Atlantic Richfield, ARC), other firms (e.g., Chevron, CHV) report it as operating income. Cash flows that are tied to specific operations are usually netted at the revenue/cost level and hence the impact of such hedges is included in operating income. Such firms were classified in category (1). If in addition, they had other types of hedges for which cash flows were included in nonoperating income, they were included in category (2). For example, Silicon Graphics, (SGI) has both "gains and losses on foreign exchange forward contracts for which a firm commitment related to a customer transaction has been attained", which is included in revenue (operating income), as well as "gains and losses on foreign currency forward contracts that are designated and effective as hedging of existing assets and liabilities", which are recognized in interest and other income. Therefore, SGI is included in category (2). Also, cash flows from debt-related derivatives (e.g., cross-currency swaps) and those that are financing-related are almost always recognized under interest expense/income along with the underlying debt transaction.[7] For example, IBM states in its 1995 annual report "Interest and currency rate differentials accruing under interest rate and currency contracts related to the customer financing business are recognized over the life of the contracts in interest expense, and the effects of contracts related to intracompany funding are recognized over the life of the contract in interest income". Finally, we encountered some instances of ambiguity between 'income', 'net income', and 'operating income'. In such cases, we conservatively assumed 'net income' and 'income' to be the same, except, in a few cases, when it was clear from the context that the cash flow pertained to nonoperating income.

Out of 181 currency derivative users in our sample, 54 include cash flow from hedges in operating income only (category 1), 45 include them in nonoperating income only or both in operating and nonoperating income (category 2), while 82 did not report any specific information regarding the cash flow from hedges, or if they did report, it was not sufficient to allow classification in any of the previous categories (category 3). To be conservative, we only included firms in category (2), for which we were quite certain that at least part of the

[7]Also, cash flows from interest-rate hedges are almost always recognized under interest expense/income.

cash flows from hedges were included in nonoperating income. We included several firms in category (3), even though we suspected that they could be classified in category (2), but did not have explicit evidence in the annual reports to confirm our suspicion (A list of all firm classified in category 2 along with related derivatives statements that led us to classify them in those categories is available upon request from the authors).

For firms in category 2, therefore, Net Operating Profit plus Depreciation and Amortization[8] minus change in Working Capital (NOP+DA-ΔWC) represents a measure of operating cash flow that is not affected by these derivative cash flows. Note that for the purposes of our paper, since we are interested in cash flow available for investment, we would not want to account for changes in working capital related to cash/marketable securities and short-term investment or related to financing activities, such as debt in current liabilities. Therefore, we define working capital as receivables plus inventories minus accounts payable.[9] Further, taxes paid represent a non-discretionary cash outflow that is exposed to FX risk. Consequently, we use Net Operating Profit Less Adjusted Taxes plus Depreciation and Amortization[10] minus changes in working capital (NOPLAT+DA-ΔWC) as our measure of unhedged cash flow from operations. However, in our robustness tests, we also use NOP+DA-ΔWC and NOP+DA-ΔWC-Income Tax Expense as alternative measures of cash flow.[11] In our tests, we require cash flow to be positive, as negative cash flow may be indicative of financial distress (see Hubbard (1998)).

[8] Operating profit before depreciation, Annual COMPUSTAT data item number 13.
[9] Annual COMPUSTAT item number 2 plus item number 3 minus item number 70.
[10] Annual COMPUSTAT data item number 13 minus item number 317.
[11] We prefer the use of taxes paid (COMPUSTAT item number 317) over income tax expense (COMPUSTAT item number 16) since the former is a cash item while the latter is an accrual item.

1.4 Other regression variables — Investment and Tobin's Q

Following the investment-cash flow literature, we use capital expenditure as a measure of investment. We scale investment and cash flow using capital stock at the beginning of the year, as measured by net property, plant and equipment. We use Tobin's Q as a proxy for a firm's investment opportunity set. Tobin's Q is defined as the ratio of market value of the firm to replacement cost of assets. Our methodology for constructing the market value and replacement cost of assets follows Perfect and Wiles (1994).[12] The market value of the firm is constructed by adding the market value of debt and the market value of equity. The market value of common stock is taken directly from COMPUSTAT. We estimate the market value of preferred stock using the year-end redemption value as suggested by Lang and Stulz (1994). The market value of debt is constructed by using a recursive methodology that estimates the maturity structure of the firm's long-term debt and accounts for changes in the yield on A-rated industrial bonds. We assume that other liabilities (short-term debt) have market value equal to book value. The replacement cost of assets is calculated as the replacement cost of fixed assets plus inventories. We estimate replacement cost using a recursive methodology that accounts for real depreciation, inflation, new capital expenditures, and the method of inventory accounting used by each firm, as described in Perfect and Wiles (1994). Further, we also use alternatively a simple measure of Q, defined as the ratio of market value of assets to book value of assets, as well as R&D and advertising expenditure, either alone or in addition to Q.

[12] This methodology has also been employed by Lang and Stulz (1994), Yermack (1996), and Servaes (1996), among others.

1.5 Sample characteristics

Our initial sample consists of 944 firm-year observations between 1993 and 1995. For all the firms in this sample, we obtained data from the geographical segment of the COMPUSTAT database on year-end foreign sales from operations abroad. FASB 14 requires firms to report geographical-segment information for fiscal years ending after December 15, 1977 for segments whose sales, assets, or profits exceed 10% of consolidated totals. Approximately 71% (670) of the firm-year observations in our sample have foreign sales from operations abroad. Earlier empirical studies [e.g., Jorion (1990)] show that the percentage of foreign sales is positively and significantly related to a firm's exchange-rate risk. Therefore, for such firms the use of currency derivatives may be vital. Approximately 75.2% (504) out of the sample observations with foreign sales have currency derivatives. We were able to definitively classify 127 sample observations as belonging to firms which report at least part of the cash flows from hedges to nonoperating income (category 2).

Table 1 presents summary statistics separately for the samples of currency derivative users (classified in category 2) and non-users. As also found in Geczy, Minton, and Schrand (1997), users are much larger than nonusers (e.g., mean sales for users of 18871.92 compared to 5790.67 for nonusers) and have larger ratio of R&D to capital stock on average (0.181 versus 0.065). As also found in Allayannis and Weston (2000), FCD users have higher Tobin's Qs and market to book ratios (e.g., mean Tobin's Q of 2.109 for users compared with 1.617 for nonusers). Also, FCD users have similar dividend ratios (0.357 for users versus 0.331 for non-users; difference not statistically significant) suggesting that the two groups do not differ significantly with respect to their ease of access to external capital. Finally, although investment is larger for FCD users than nonusers reflecting possibly their larger size, investment normalized by capital stock is similar for the two groups (0.243 for users versus 0.203 for nonusers).

2. Cash Flow, Investment, and Hedging

2.1 Regression Specification and Results

In this section, we present the tests of our hypothesis and the results. Our hypothesis is that firms that are significantly exposed to exchange-rate risk will benefit from hedging by having a smaller investment-cash flow sensitivity than firms that do not hedge. To compare the investment-cash flow sensitivity among the two groups, we estimate the following cross-sectional model, which is similar to the one that has often been used in the financing constraints and investment literature:[13]

$$\frac{I_t}{K_{t-1}} = \alpha + \beta Q_t + \gamma \frac{CF_t}{K_{t-1}} + \alpha^* FCDDUM + \gamma^* \frac{CF_t}{K_{t-1}} FCDDUM + YEARDUM + FIRMDUM + \epsilon_t \quad (1)$$

where $\frac{I_t}{K_{t-1}}$ is investment during year t, scaled by capital stock at the beginning of the year; $\frac{CF_t}{K_{t-1}}$ is cash flow during year t, scaled by capital stock at the beginning of the year; Q_t is Tobin's Q at the beginning of the year, used as a measure of a firm's investment opportunities; $FCDDUM$ is a dummy variable that equals 1 if the firm is a hedger and 0 otherwise and $YEARDUM$ and $FIRMDUM$ are dummies to control for year and firm effects. In the above regression, the coefficient γ^* for the interaction term $\frac{CF_t}{K_{t-1}} * FCDDUM$ reflects the difference in the investment-cash flow sensitivity between hedgers and nonhedgers. Our hypothesis suggests that $\gamma^* < 0$ (hedgers have a smaller investment-cash flow sensitivity than nonhedgers) and $\gamma > 0$ (indicating that higher cash flow leads to higher investment for

[13] See, e.g., Fazzari, Hubbard and Petersen (1988), Kaplan and Zingales (1997), and Lamont (1997).

both groups).[14]

Table 2 presents results of the estimation of model (1) for four alternative measures of cash flow. In the first column, we use NOPLAT+DA-ΔWC as the measure of unhedged cash flow, as explained earlier. Consistent with our hypothesis, we find that the investment-cash flow sensitivity is significantly lower for the hedgers than for the non-hedgers (γ^* equals -0.117), while the common component of investment-cash flow sensitivity γ is positive and significant as expected. The difference in the investment-cash flow sensitivity between hedgers and nonhedgers is significant at the 1 % significance level. The fit of our model is also quite strong as noted by the reported adjusted R^2 (0.77). In column II we use (accrued) income tax expense instead of cash taxes paid to calculate the cash flow measure and again find a significantly lower investment-cash flow sensitivity for hedgers than for non-hedgers (γ^* equals -0.124). In column III we compare the investment-cash flow sensitivity of the hedgers and non-hedgers using NOP+DA-ΔWC as the measure of unhedged cash flow. The only difference is that using the previous definitions of cash flow would also account for differences in taxes (a nondiscretionary cash outflow which is sensitive to FX risk) between the two groups. The results using this measure of cash flow are very similar (γ^* equals -0.121).[15]

Finally, column IV compares the investment-cash flow sensitivity between hedgers and non-hedgers using net cash flow as the measure of cash flow. As we argued in the previous section, this post-hedging measure of cash flow is not likely to reflect the differences in hedging policy between the two groups. We find that the difference in estimated investment-

[14] Note that in this specification, hedgers and nonhedgers differ only in the extent to which cash flow affects investment. We allow the intercept to be different for the two groups in this specification by including the FX dummy independently, as is customary in regressions of this nature (see Greene (1993)). However, we also run regressions in which we force the intercept to be the same for the two groups. We find the results to be qualitatively similar (results not reported).

[15] Given the observed skewness in working capital in our sample, adjusting for it yields some clear outliers in cash flow. We eliminate the top five percent of cash flow observations in these tests to mitigate their impact.

cash flow sensitivity is now much smaller (γ^* equals -0.060) and is statistically insignificant. Investment-cash flow sensitivity at this level is determined solely by the ease of access to external financing, which implies that the differences in investment-cash flow sensitivity at the unhedged cash flow level (columns I, II, and III) are due to differences in hedging behavior between the two groups and not due to differences in access to external financing and/or dividend policy. We present additional evidence supporting this conclusion in subsections 3.1 and 3.3.

2.2 Robustness tests

In this subsection, we examine a variety of alternative specifications of model (1) and alternative measures of investment and Q. The first set of tests examines alternatives related to the measurement of Q and cash flow. We use lagged cash flow (Table 3, Column I) and lagged investment (Table 3, Column III) as additional controls. It is argued by FHP that lagged values of cash flow may have explanatory power for investment in a time-to-build context. We also estimate models in which we use lagged Q (Table 3, Column II) and Q^2 (Table 3, Column IV) as additional control variables. The latter would be appropriate if the adjustment cost function is nonlinear. Finally, the last column presents results when all four control variables (lagged Q, Q^2, lagged cash flow and lagged investment) are used in combination.

The estimated difference in investment-cash flow sensitivity between hedgers and non-hedgers (γ^*) is fairly stable across the alternative models (it ranges from -0.089 to -0.123). In addition, these estimates are very close to the base case estimate presented in Table 2, column I (-0.117). In all specifications, hedgers have a significantly lower investment-cash flow sensitivity than non-hedgers. Our results do not change when we use R&D and advertising expenditures in addition to, or instead of, Q as a measure of growth opportunities, or when we use simple Qs, defined as the ratio of market value of assets to book value of assets, instead of the Qs estimated according to the Perfect and Wiles (1994) methodology (results not reported). Further, FHP argue that "to the extent that the stock market is volatile, Q may not reflect market fundamentals", or may be measured with error. To address this concern, as in FHP, we use lagged Q as an instrument for Q and find that results remain qualitatively unchanged (results not reported).

Next, we examine our hypothesis using an alternative definition of investments. It has been stated in the literature [e.g., Froot, Scharfstein and Stein (1993)] that taking advantage of growth opportunities requires investments not only in fixed capital stock, but also in intangible assets through investment in research and development, and advertising. We examine our hypothesis using this broader definition of investments (investment in fixed capital stock plus R&D plus advertising) and find that our previous results continue to hold (results not reported).

2.3 A model of changes in investment and cash flow

In this subsection, we estimate a model of changes in investment and examine whether they are related to changes in cash flow. This model allows for a better quantification of the effect of cash flow on investment as it estimates the percentage change in investment arising from a 1% change in cash flow. In addition, this model is also a useful check against potential problems of autocorrelation in the data. We expect that if firms hedge effectively, then a change in cash flow should have a smaller effect on hedgers' investment than on non-hedgers'. Hence, we should expect a negative coefficient γ^* on the interaction of the change in cash flow and the hedge dummy. Table 4, column I, presents the results of the tests of the above hypothesis. Consistent with our hypothesis, we find that on average, a 1% change in cash flow changes a hedger's investment by 0.076% less than that of a nonhedger. This is a substantial difference in magnitude, which reinforces our previous results.[16]

Analysis of first-differenced data also lets us examine another implication of the FSS model. It is possible that the effect of a positive cash flow change on investment is not symmetric to the effect of a negative cash flow change. Hedging is particularly beneficial in those states of the world when operating cash flow is low, because those are the states when cash flows from hedges help mitigate the underinvestment problem. The success of a hedging program therefore should be measured by its ability to lower investment-cash flow sensitivity when operating cash flow falls rather than when it rises. The use of nonlinear hedging instruments like options and other option-like derivatives can be explained on this basis. We find that partitioning the sample into positive and negative cash flow changes provides evidence supporting such an asymmetric effect.

Column II (III) reports results for positive (negative) cash flow changes. While during positive cash flow changes, the investment-cash flow sensitivity of hedgers and nonhedgers is similar (γ^* equals 0.000 and statistically insignificant), hedgers have a significantly lower investment-cash flow sensitivity than nonhedgers during negative cash flow changes (γ^* of -0.254) indicating that hedgers are indeed more concerned about reducing investment-cash flow sensitivity when cash flow falls rather than when it rises.

It is possible however, that a firm's investment decision may be affected not so much by the sign of the change in cash flow, but by the absolute level of the resulting cash flow. For example, a firm's investment may decrease if internal cash flow is insufficient relative to its historical average, even if the change relative to the immediately preceding year is positive. To examine this possibility, we calculate the average cash flow over the 1993-95 period for each firm, and separately consider the above- and below-average cash flow observations.

[16]We perform these tests eliminating the top and bottom 1 percent of the distribution of the changes in cash flow, given some extreme observations that occur in the sample.

In the case for which cash flow is insufficient (i.e., below its historical average), we find a large and statistically significant difference in the investment-cash flow sensitivity between hedgers and nonhedgers, as in the case in which negative cash flow changes were considered. Specifically, when internal cash flows are below their historical averages, a 1% change in cash flow leads to a 0.156% smaller (and statistically significant) change in investment for hedgers than for nonhedgers. For the case in which cash flows are above their historical average, we find the difference to be much smaller (γ^* of -0.042 and statistically insignificant), similar to the case for positive cash flow changes (results not reported).

These results are in line with the FSS prediction that a firm may find it optimal to adopt a nonlinear hedging strategy rather than a state-independent, linear one. Specifically, FSS argue that put and straddle-based strategies may be value-maximizing for some firms. The post-hedging sensitivity profile that we observe in the data — very low in low cash flow states and higher in high cash flow states — provides empirical support for the adoption of such put and straddle-like strategies by hedging firms. For non-hedgers, on the other hand, the estimated impact of cash flow fluctuations on investment is more severe for negative cash flow changes.

3. Alternative explanations and additional tests

3.1 Financing constraints, leverage, size, and diversification

The results in the previous section indicate that firms that use foreign currency derivatives are better able to insulate their investments from short-run fluctuations in operating cash flow. It is important to examine however if this reduction in investment-cash flow sensitivity is indeed due to their hedging, or if it is caused by some other firm characteristic that happens to be correlated with the use of foreign currency derivatives. An extensive literature documents that investment-cash flow sensitivity is determined by the degree of financing constraints. We therefore need to check if our partitioning the sample on the basis of the use of currency derivatives induces a systematic difference in financing constraints between the two groups, and thus produces the lower estimated investment-cash flow sensitivity for hedgers.

Fazzari, Hubbard and Petersen (1988) use dividend payout ratio as a proxy for financial liquidity; a firm for which the cost differential between internal and external funds is small would retain a smaller fraction of internally generated cash, and thus have a higher payout ratio. When we divide our sample into currency derivatives users and nonusers, however, we find no evidence to suggest that the difference in their investment-cash flow sensitivities can be explained by differences in their financing constraints. As shown in Table 1, mean dividend payout ratio distributions are not very different for the two groups (0.357 for hedgers versus 0.331 for non-hedgers). Using two procedures to handle potential outliers, we find the difference in mean payout ratios to be economically small and statistically insignificant for both procedures.[17] This is in line with the evidence presented in Table 2, column IV, where we found investment sensitivity to post-hedging cash flow to be insignificantly different for the two groups.

We next check if our result is driven by other important factors, such as leverage, size, or diversification. It is easy to see how differences in these factors can lead to differences in investment and cash flow. For example, firms that use foreign currency derivatives are significantly larger than those that do not. It seems possible that larger firms are more mature and better known, and the information asymmetry associated with them in external

[17] Dividend payout ratios are difficult to interpret when the firm experiences a temporary decline in earnings, but does not cut dividends due to dividend smoothing reasons. This may result in some observations of the payout ratio being extremely large. Further, if earnings are negative, then the observed dividend payout ratio will be negative as well. It would be incorrect to use such outliers while calculating mean dividend payout ratios. We address this problem by (1) excluding all observations $\notin [0,1]$, and (2) winsorizing those observations, i.e., replacing them with the (high) payout ratio of 1.

capital markets is lower, so that they are less constrained financially than smaller firms. To examine this possibility, we examine our hypothesis controlling for these factors. In our empirical specification of model (1), we add a term in which we interact cash flow with the relevant factor (leverage, size or diversification), and also include the factor independently. The rationale is that the factor could affect investment directly, as well as indirectly through cash flow.

Table 5 reports the results of these tests. Column I presents the results of our hypothesis controlling for leverage as measured by debt-to-equity ratio, Column II controlling for size as measured by the log of capital stock, and column III controlling for diversification. In column IV, we control for all three factors together. We find our result to be robust to these additional control variables. In particular, the investment-cash flow sensitivity of hedgers is smaller than that of non-hedgers by 0.117 when we control for size. This is important, given that size is one dimension along which hedgers and nonhedgers clearly differ. Similarly, the investment-cash flow sensitivity of hedgers is significantly lower than that of non-hedgers when we control for leverage or diversification, or for all three factors together. These tests suggest that hedging affects the investment-cash flow sensitivity regardless of leverage, size, or diversification.

3.2 Endogeneity of the hedging decision: Implications for estimation

3.2.1 Control for selectivity bias

Our attempts so far to control for factors (other than hedging) that affect the relationship between cash flow and investment have implicitly assumed that the decision to hedge is exogenous to the model. In reality, however, hedging is endogenous. It is a choice variable that represents the equilibrium outcome of an optimizing problem faced by the firm, which poses a potential problem for the investment-cash flow sensitivity estimation process in the following sense. It is likely that the hedging and investment decisions of the firm are correlated. In that case, the observed samples of hedgers and non-hedgers are nonrandomly selected, which induces a selectivity bias in the estimated coefficients [see, Heckman (1979), Maddala (1983)].

Heckman (1979) provides a two-step procedure to address this problem, under the assumption that the errors are bivariate normally distributed. The first step entails estimating a Probit model for the binary hedging variable H ($H = 1$ for hedgers, $H = 0$ for non-hedgers), $Pr(H = 1) = \Phi(\mathbf{a}'\mathbf{X})$, where $\Phi(.)$ denotes the standard normal cumulative distribution function and $\mathbf{X}$ is the vector of explanatory variables. The estimated coefficients $\mathbf{a}$ are used to construct a new variable λ, with

$$\begin{aligned} \lambda &= \frac{\phi(\mathbf{a}'\mathbf{X})}{\Phi(\mathbf{a}'\mathbf{X})} && \text{if } H = 1 \\ \lambda &= \frac{-\phi(\mathbf{a}'\mathbf{X})}{1 - \Phi(\mathbf{a}'\mathbf{X})} && \text{if } H = 0 \end{aligned} \tag{2}$$

where $\phi(.)$ is the standard normal probability density function, and λ represents the omitted variable due to incidental truncation. Including λ in the second step specification (1) corrects for this bias and yields

$$\frac{I_t}{K_{t-1}} = \alpha + \beta Q_t + \gamma \frac{CF_t}{K_{t-1}} + \alpha^* FCDDUM + \gamma^* \frac{CF_t}{K_{t-1}} FCDDUM + \delta\lambda + YEARDUM + FIRMDUM + \epsilon_t \tag{3}$$

Implementing the first step requires specifying a model to explain the hedging decision of the firm. Following previous research in the area [Mian (1996), Geczy, Minton, and Schrand

(1997)], we use the following model:

$$\begin{aligned} Pr(H=1) = \Phi(a_0 + a_1 DE &+ a_2 BM + a_3 \frac{DE}{BM} + a_4 FORSALE + a_5 TAXLOSS \\ &+ a_6 SIZE + a_7 QUICK + SICDUM) \end{aligned} \quad (4)$$

where DE is debt-to-equity ratio; BM is book-to-market ratio; $FORSALE$ is the ratio of foreign sales to total sales; $TAXLOSS$ is net loss carryforward divided by sales; $SIZE$ is the log of fixed assets; $QUICK$ is quick ratio; and $SICDUM$ are single-digit SIC code industry dummies.[18] Following Geczy, Minton, and Schrand (1997), we also use R&D expenditure (instead of book-to-market ratio) as a proxy for growth opportunities, in the alternative specification:

$$\begin{aligned} Pr(H=1) = \Phi(a_0 + a_1 DE &+ a_2 RD + a_3 RD * DE + a_4 FORSALE + a_5 TAXLOSS \\ &+ a_6 SIZE + a_7 QUICK + SICDUM) \end{aligned} \quad (5)$$

where RD is the Ratio of R&D expenditure to sales, and other variables are as defined above.

Results of the estimation are presented in Table 6. Estimating models (4) and (5) in the first step yields results that are generally in line with findings in earlier studies (panel A). Exposure, as proxied by foreign sales intensity, and size are identified as highly significant determinants of the decision to hedge as in Geczy et al. (1997). Like Geczy et al. (1997), the coefficient on R&D is positive, though it is not statistically significant at conventional levels. The second step estimates show that our earlier results remain valid even after controlling for the endogeneity of the hedging decision (panel B). The estimated investment-cash flow sensitivity is significantly smaller for hedgers than for nonhedgers (γ^* equals -0.229 when growth opportunities are measured by market-to-book ratio in the first step and -0.220 when R&D expenditure is used instead). In both cases, the difference in estimated investment-cash flow sensitivity between hedgers and non-hedgers is statistically significant (t-statistics

[18] Using industry dummies at the 2-digit SIC level does not alter our results.

of 3.58 and 3.49 respectively). This suggests that our result that the estimated investment-cash flow sensitivity of hedgers is lower than that of non-hedgers is not spuriously induced by selectivity bias.

3.2.2 Control for simultaneity of hedging and investment

We also control for the simultaneity of the hedging and investment decisions by using an instrumental variables (iterated two-stage least squares) approach in a simultaneous equations framework [Maddala(1983), Greene(1993)]. As before, we use determinants of hedging identified by earlier studies — R&D, size, quick ratio, and foreign sales — along with investment (normalized by capital stock), leverage, cash flow, and Q as explanatory factors in the first stage.

$$\begin{aligned} FCDDUM = b_0 + b_1 DE &+ b_2 RD + b_3 DE * RD + b_4 FORSALE + b_5 \left(\frac{I_t}{K_{t-1}}\right)^* \\ &+ b_6 SIZE + b_7 QUICK + b_8 Q + b_9 \frac{CF_t}{K_{t-1}} + e \end{aligned} \tag{6}$$

In the second stage, the predicted values $FCDDUM^*$ are used in

$$\begin{aligned} \frac{I_t}{K_{t-1}} &= \alpha + \beta Q_t + \gamma \frac{CF_t}{K_{t-1}} + \alpha^* FCDDUM^* + \gamma^* FCDDUM^* \frac{CF_t}{K_{t-1}} \\ &\quad + YEARDUM + FIRMDUM + \epsilon_t \end{aligned} \tag{7}$$

The results of the estimation are presented in Table 7. Consistent with our hypothesis, the coefficient of the interaction term $FCDDUM^* \frac{CF_t}{K_{t-1}}$ is negative (-0.155) and significantly different from zero, indicating that hedging enables firms to reduce their investment-cash flow sensitivity.

Including fixed firm and year effects in the first stage regression causes qualitative changes in the first stage results but not in the second stage results. The firm dummies emerge as the predominant significant determinants of the hedging decision. Coefficients on almost all other explanatory factors become insignificant at conventional levels. This is expected, given the time-invariance of the hedging decision for most firms. The adjusted R-squared value for the first stage regression increases from 0.25 to 0.94. However, the second stage regression results are similar to the previous case. Specifically, the estimated coefficient on the interaction term is negative (-0.130) and statistically significant, suggesting that the potential simultaneity of the investment and hedging decision does not alter our result that hedgers have a lower investment-cash flow sensitivity than nonhedgers.

3.3 Volatility of Unhedged and Hedged Cash Flows

Financing constraints should affect investment-cash flow sensitivity when the cash flow in question is *net* cash flow, i.e., total internal funds available for reinvestment (See Figure 1). Our finding that the differences in the estimated sensitivities using this measure of cash flow between the two groups is small and statistically insignificant (Table 2, column IV) implies that the two groups face similar levels of financing constraints. On the other hand, when cash flow is measured at *operating* levels (e.g., NOP+DA-ΔWC, NOPLAT+DA-ΔWC) the difference in investment-cash flow sensitivities is large and statistically significant, which is consistent with the hypothesis that firms use currency derivatives to counteract FX risk-induced fluctuations in operating cash flow. This reduces net cash flow volatility so that given a certain level of financing constraints, investments made by the firm are also less volatile.

A necessary implication of this argument is that the volatility of net cash flow, conditional on operating cash flow, should be lower for hedgers than non-hedgers. We test this directly by regressing the post-hedging cash flow (NI+DA, normalized by capital stock) on the pre-hedging cash flow (NOPLAT+DA-ΔWC, normalized by capital stock) and an interaction term between cash flow and hedge dummy and controls for firm and year effects.[19] If hedgers smooth their cash flows effectively, we should expect a negative coefficient on the interaction term, i.e., net cash flow volatility, conditional on operating cash flow volatility, should be lower for hedgers. Consistent with this hypothesis we find that the pre-hedging cash flow coefficient is significantly smaller for the hedgers than for the non-hedgers over the sample period (β^* equals -0.214) (Table 8, column 1). In the by-year regressions, we obtain similarly a negative and significant estimate in all years (columns 2-4). These results complement earlier findings on investment-cash flow sensitivity using net cash flows (Table 2, column 4) and support the hypothesis that foreign currency derivatives enable firms to reduce their net cash flow volatility.

4. Conclusions

Following the seminal study by Fazzari, Hubbard, and Petersen (1988), several papers have shown that when external funds are costlier than internal funds, a firm has to reduce investments when internal cash flow falls. Froot, Scharfstein, and Stein (1993) argue that the need to alleviate this underinvestment problem may explain the use of financial derivatives by firms. Using data on foreign currency exposure and foreign currency derivatives usage by S&P 500 firms during 1993-95, we find evidence that supports their hypothesis; the investment-cash flow sensitivity of firms that use currency derivatives is significantly lower than that of firms that do not. This finding is important as it suggests that firms have used derivatives effectively in smoothing out investment and adds to the evidence that corporate use of derivatives is in fact guided by hedging — and not speculative — motives.

This result is robust to the use of alternative measures of cash flow and investment,

[19] To avoid a possible errors-in-variable problem, we do not adjust post-hedging cash flow for changes in working capital; such inclusion yields a coefficient of close to 1 between post and pre-hedging cash flow, an artifact of both dependent and independent variable containing the same factor (ΔWC).

to the use of lagged control variables, to the use of first-differenced data, and to the use of alternative controls for leverage, size, and diversification. Our result is also robust to controls for the endogeneity of the hedging decision and to potential biases due to our partitioning the sample based on a choice variable. We also find evidence indicating the use of nonlinear put- and straddle-like hedging strategies, in line with predictions of the FSS model. Finally, the examination of cash flows at the operating and net cash flow level indicates significantly greater reduction in net cash flow volatility for firms that use derivatives than for firms that do not.

We conclude with a final remark. It is not our contention that currency risk is the only factor risk affecting cash flows of firms in our sample. Neither do we claim that hedging with currency derivatives completely insulates cash flows of these firms from all factor risks. However, as prior research has shown, firms that use currency derivatives are also more likely to use other types of derivatives. Our results support the hypothesis that these firms are better able to reduce net cash flow volatility, and thus lower their investment-cash flow sensitivity, than firms that do not use derivatives. As more detailed data on firms' complete risk exposures and their derivatives positions become available, it will become possible to examine the effects of these other risk factors and their potential interrelationships in a broad sample similar to what Schrand and Unal (1998) did for a sample of thrift institutions. This is an important direction for future research.

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Table 1
Descriptive Statistics of Sample Partitioned by Foreign Currency Derivatives Use

	Currency Derivatives User				**Currency Derivatives Non-User**			
	No of Obs.	Mean	Std. Dev.	Median	No of Obs.	Mean	Std. Dev.	Median
Total assets	127	23473.78	46960.67	5647.90	166	5535.55	6470.16	3048.58
Total sales	127	18871.92	34019.28	6456.00	166	5790.67	6598.74	3478.10
FCD Dummy[1]	127	1			166	0		
Investment[2]	127	1465.39	2990.14	395.00	163	397.06	597.81	188.03
Investment/Capital	127	0.243	0.149	0.219	159	0.203	0.096	0.194
R&D/Capital Stock	127	0.181	0.294	0.083	162	0.065	0.118	0.003
Capital Stock[3]	127	6985.23	12681.83	1646.60	162	2521.15	3942.41	927.51
Net Working Capital[4]	124	6656.63	19367.47	849.00	151	712.72	803.66	467.64
Tobin's Q (PW)[5]	127	2.109	2.329	1.406	163	1.617	1.145	1.332
Market to Book[6]	127	2.296	2.492	1.556	165	1.767	1.199	1.498
Net Income	127	984.02	1583.62	251.70	166	260.57	428.10	470.95
Operating Cash Flow	116	2859.02	5392.83	728.76	166	835.87	1171.23	470.95
Depr. and Amort.	127	1154.72	2295.78	270.00	166	291.49	460.32	134.30
Income Tax Expense	127	577.71	940.78	150.00	166	147.05	231.17	83.52
Taxes Paid	120	477.65	720.18	135.08	166	139.59	199.14	77.50
Debt to Equity	127	106.00	176.47	60.32	166	80.35	71.21	63.63
Diversif. Dummy	127	0.693	0.463	1	166	0.596	0.492	1
Dividend Ratio[7]	127	0.357	0.343	0.317	166	0.331	0.316	0.299

[1] Equals 1 if the company reports the use of foreign currency forwards, futures, swaps or options.
[2] Capital expenditure.
[3] Net Property, Plant and Equipment.
[4] Inventories plus receivables less accounts payable.
[5] Ratio of market value of assets to replacement costs of assets following the Perfect and Wiles methodology.
[6] Ratio of market value of assets to book value of assets.
[7] Ratio of dividend payout to net income (missing observations are assumed equal to zero).

Table 2
Investment-Cash Flow Sensitivity and Hedging

This table provides coefficient estimates, with standard errors in parentheses, for the investment-cash flow sensitivity model specified below. The two groups (hedgers and non-hedgers) are distinguished by the dummy variable $FCDDUM$, with $FCDDUM = 1$ for hedgers and $FCDDUM = 0$ for non-hedgers. The coefficient γ^* for the interaction term $(CF_t/K_{t-1}) * FCDDUM$ estimates the difference in investment-cash flow sensitivity for hedgers and non-hedgers. The four columns report results for four different measures of cash flow: (I) NOPLAT+DA-ΔWC (Net operating profit less adjusted taxes plus depreciation and amortization less changes in working capital), (II) NOP+DA-ΔWC-tax expense (Net operating profit plus depreciation and amortization less changes in working capital less tax expense), (III) NOP+DA-ΔWC (Net operating profit plus depreciation and amortization less changes in working capital), and (IV) Net income plus depreciation and amortization less changes in working capital.

$$\frac{I_t}{K_{t-1}} = \alpha + \beta Q_t + \gamma \frac{CF_t}{K_{t-1}} + \alpha^* FCDDUM + \gamma^* \frac{CF_t}{K_{t-1}} FCDDUM + YEARDUM + FIRMDUM + \epsilon_t \quad \text{(i)}$$

	(I) NOPLAT +DA-ΔWC	(II) NOP+DA-ΔWC -Tax Expense	(III) NOP+DA -ΔWC	(IV) Net Income +DA-ΔWC
Constant	0.103(0.082)	0.121(0.080)	0.070(0.076)	0.173*(0.074)
Q_t	0.018(0.016)	0.018(0.016)	0.015(0.016)	-0.036*(0.011)
CF_t/K_{t-1}	0.110*(0.037)	0.102*(0.037)	0.129*(0.032)	0.124*(0.044)
$FCDDUM$	0.070(0.041)	0.075(0.041)	0.077(0.040)	-0.048(0.062)
$(CF_t/K_{t-1})*$ $FCDDUM$	-0.117*(0.051)	-0.124*(0.052)	-0.121*(0.043)	-0.060(0.051)
$\overline{R}^2$	0.77	0.77	0.78	0.80
No. of Obs.	257	257	257	270

Table 3
Investment-Cash Flow Sensitivity and Hedging:
Robustness Checks with Additional Control Variables

This table provides coefficient estimates, with standard errors in parentheses, for the investment-cash flow sensitivity model specified below, using several additional control variables. The two groups (hedgers and non-hedgers) are distinguished by the dummy variable $FCDDUM$, with $FCDDUM = 1$ for hedgers and $FCDDUM = 0$ for non-hedgers. The coefficient γ^* for the interaction term $(CF_t/K_{t-1}) * FCDDUM$ estimates the difference in investment-cash flow sensitivity for hedgers and non-hedgers. Columns I-V report results from estimating the model using lagged cash flow (column I), lagged Q (column II), lagged investment (column III), and Q^2 (column IV) as additional controls. The last column (column V) reports the results for the combined model.

$$\frac{I_t}{K_{t-1}} = \alpha + \beta Q_t + \gamma \frac{CF_t}{K_{t-1}} + \alpha^* FCDDUM + \gamma^* \frac{CF_t}{K_{t-1}} FCDDUM + \delta CONTROL_t + YEARDUM + FIRMDUM + \epsilon_t \qquad \text{(ii)}$$

	(I)	(II)	(III)	(IV)	(V)
	lag(CF/K)	lag(Q)	lag(I/K)	Q^2	Combined
Constant	0.038(0.052)	0.107(0.083)	0.042(0.084)	0.088(0.086)	-0.004(0.063)
Q_t	0.017(0.016)	0.010(0.022)	0.015(0.016)	0.046(0.045)	0.045(0.046)
CF_t/K_{t-1}	0.113*(0.038)	0.112* (0.037)	0.105* (0.036)	0.103* (0.038)	0.094* (0.039)
$FCDDUM$	0.068(0.042)	0.072(0.041)	0.059(0.040)	0.065(0.041)	0.057(0.042)
$(CF_t/K_{t-1})*$ $FCDDUM$	-0.117*(0.051)	-0.123*(0.052)	-0.096*(0.051)	-0.110*(0.052)	-0.089*(0.054)
lag(CF_t/K_{t-1})	0.006(0.027)				-0.013(0.028)
lag(Q_t)		0.008(0.015)			-0.001(0.015)
lag(I_t/K_{t-1})			0.234*(0.087)		0.245*(0.094)
Q^2_{t-1}				-0.003(0.005)	-0.003(0.005)
$\overline{R}^2$	0.77	0.77	0.78	0.77	0.77
No. of Obs.	252	255	255	257	252

Table 4
Investment-Cash Flow Sensitivity and Hedging: Regressions with First-Differenced Data

This table provides coefficient estimates, with standard errors in parentheses, for changes in investment in response to changes in cash flow, as specified by the investment-cash flow sensitivity model below. The two groups (hedgers and non-hedgers) are distinguished by the dummy variable $FCDDUM$, with $FCDDUM = 1$ for hedgers and $FCDDUM = 0$ for non-hedgers. The coefficient γ^* for the interaction term $FCDDUM * \Delta(CF_t/K_{t-1})$ estimates the difference in investment-cash flow sensitivity for hedgers and non-hedgers.

$$\Delta(\frac{I_t}{K_{t-1}}) = \alpha + \beta\Delta Q_t + \gamma\Delta(\frac{CF_t}{K_{t-1}}) + \alpha^* FCDDUM + \gamma^*\Delta(\frac{CF_t}{K_{t-1}})FCDDUM + YEARDUM + \epsilon_t \quad \text{(iii)}$$

Column 2 reports results for the full sample, Column 3 for positive changes in cash flow, and Column 4 for negative changes in cash flow.

	Full Sample	Positive Cash Flow Changes	Negative Cash Flow Changes
Constant	0.029*(0.009)	0.030*(0.015)	0.037*(0.014)
ΔQ_t	-0.012*(0.006)	-0.033*(0.013)	0.008(0.008)
$\Delta CF_t/K_{t-1}$	0.140*(0.031)	0.105*(0.062)	0.206*(0.050)
$FCDDUM$	0.001(0.010)	-0.017(0.013)	-0.025(0.016)
$FCDDUM*$ $\Delta CF_t/K_{t-1}$	-0.076*(0.038)	0.000(0.072)	-0.254*(0.066)
$\overline{R}^2$	0.140	0.225	0.161
No. of Obs.	263	130	133

Table 5
Investment-Cash Flow Sensitivity and Hedging:
Robustness Checks Controlling for Debt/Equity, Size, and Diversification

This table provides coefficient estimates, with standard errors in parentheses, for the investment-cash flow sensitivity model specified below. The two groups (hedgers and non-hedgers) are distinguished by the dummy variable $FCDDUM$, with $FCDDUM = 1$ for hedgers and $FCDDUM = 0$ for non-hedgers. The coefficient γ^* for the interaction term $(CF_t/K_{t-1}) * FCDDUM$ estimates the difference in investment-cash flow sensitivity for hedgers and non-hedgers. Columns I-III report results from estimating the model controlling for Debt-to-Equity ratio, Size (as measured by log of total assets), and Diversification (measured by the diversification dummy, which is set to 1 if the firm reports more than one business segment and 0 otherwise). The last column reports the results for the combined model.

$$\frac{I_t}{K_{t-1}} = \alpha + \beta Q_t + \gamma \frac{CF_t}{K_{t-1}} + \alpha^* FCDDUM + \gamma^* \frac{CF_t}{K_{t-1}} FCDDUM + \delta_1 CONTROL_t + \delta_2 CONTROL_t \frac{CF_t}{K_{t-1}} + YEARDUM + FIRMDUM + \epsilon_t \quad \text{(iv)}$$

	(I)	(II)	(III)	(IV)
	Debt/Equity	Size	Diversification	Combined
Constant	0.178*(0.093)	-1.852*(0.528)	0.044(0.098)	-2.063*(0.545)
Q_t	0.017(0.016)	0.039*(0.016)	0.011(0.017)	0.044*(0.018)
CF_t/K_{t-1}	0.118*(0.039)	0.063(0.167)	0.078(0.050)	-0.108(0.212)
$FCDDUM$	0.062(0.041)	0.079*(0.042)	0.068(0.041)	0.077(0.041)
$(CF_t/K_{t-1})*$ $FCDDUM$	-0.112*(0.051)	-0.117*(0.055)	-0.104*(0.053)	-0.113*(0.056)
D/E	-0.0001(0.0001)			-0.0001(0.0001)
$(D/E) * (CF_t/K_{t-1})$	-0.0002(0.0002)			-0.0003(0.0002)
Size		0.182*(0.049)		0.206*(0.053)
Size*(CF_t/K_{t-1})		0.004(0.021)		0.023(0.026)
Diversification			0.006(0.051)	-0.074(0.052)
Divers.*(CF_t/K_{t-1})			0.052(0.058)	0.075(0.062)
$\overline{R}^2$	0.77	0.79	0.77	0.80
No. of Obs.	257	257	257	257

Table 6
Selectivity Bias Correction for Investment-Cash Flow Sensitivity and Hedging: Two-Step Estimation using Heckman's (1979) Procedure

This table presents results from estimating investment-cash flow sensitivity, correcting for possible selectivity bias, and using two proxies for growth opportunities (Book-to-Market ratio (BM) and R&D-to-Sales ratio (RD)). Panel A presents results of Probit regressions to model the hedging decision described by

$$\begin{aligned} Pr(H=1) = \Phi(a_0 + a_1 DE &+ a_2 BM + a_3 \frac{DE}{BM} + a_4 FORSALE + a_5 TAXLOSS \\ &+ a_6 SIZE + a_7 QUICK + SICDUM) \end{aligned} \quad \text{(v)}$$

in columns 2-4, and described by

$$\begin{aligned} Pr(H=1) = \Phi(a_0 + a_1 DE &+ a_2 RD + a_3 RD * DE + a_4 FORSALE + a_5 TAXLOSS \\ &+ a_6 SIZE + a_7 QUICK + SICDUM) \end{aligned} \quad \text{(vi)}$$

in columns 5-7.

Panel B presents results of the second stage regression

$$\frac{I_t}{K_{t-1}} = \alpha + \beta Q_t + \gamma \frac{CF_t}{K_{t-1}} + \alpha^* FCDDUM + \gamma^* \frac{CF_t}{K_{t-1}} FCDDUM + \delta\lambda + YEARDUM + FIRMDUM + \epsilon_t \quad \text{(vii)}$$

where estimates of λ are obtained from the Probit regressions. The two groups (hedgers and non-hedgers) are distinguished by the dummy variable $FCDDUM$, with $FCDDUM = 1$ for hedgers and $FCDDUM = 0$ for non-hedgers. The coefficient γ^* for the interaction term $(CF_t/K_{t-1}) * FCDDUM$ estimates the difference in investment-cash flow sensitivity for hedgers and non-hedgers. Columns 2 and 3 report results corresponding to the BM and RD proxies for growth opportunities in the Probit regressions, respectively.

Panel A: Probit Model for Hedging Decision

	Growth Opportunities: Book-to-Market			Growth Opportunities: R&D/Sales		
	Estimate	Std. Error	p-value	Estimate	Std. Error	p-value
Constant	-3.605*	0.966	0.0002	3.621*	0.903	0.0001
DE	-0.003	0.003	0.254	-0.001	0.002	0.553
BM	-0.109	0.505	0.829			
DE/BM	0.002	0.002	0.285			
RD				2.373	1.614	0.142
$DE * RD$				0.006	0.027	0.821
$FORSALE$	2.450*	0.466	0.0001	2.361*	0.466	0.0001
$TAXLOSS$	-3.174	2.817	0.260	-3.032	2.729	0.267
$SIZE$	0.317*	0.096	0.0001	0.319*	0.095	0.0008
$QUICK$	0.131	0.141	0.351	0.117	0.136	0.390

Panel B: Investment-Cash Flow Sensitivity Estimation		
	Growth Opportunities: BM	Growth Opportunities: RD
Constant	-0.126(0.098)	-0.142(0.102)
Q_t	0.022(0.016)	0.024(0.016)
CF_t/K_{t-1}	0.153*(0.039)	0.156*(0.039)
$FCDDUM$	0.245*(0.098)	0.259*(0.105)
$FCDDUM* CF_t/K_{t-1}$	-0.229*(0.064)	-0.220*(0.063)
λ	-0.055(0.045)	-0.067(0.050)
$\overline{R}^2$	0.789	0.790
No. of Obs.	181	181

Table 7
Simultaneous Equations Bias Correction for Investment-Cash Flow Sensitivity and Hedging: Two-Stage Least Squares Estimation

This table presents results from estimating the impact of hedging on investment-cash flow sensitivity, correcting for possible simultaneous equations bias arising from the simultaneity of the hedging and investment decisions. Panel A presents results of the first-stage regression to model the hedging decision

$$FCDDUM = b_0 + b_1 DE + b_2 RD + b_3 DE * RD + b_4 FORSALE + b_5 \left(\frac{I_t}{K_{t-1}}\right)^* + b_6 SIZE + b_7 QUICK + b_8 Q + b_9 \frac{CF_t}{K_{t-1}} + e \qquad \text{(viii)}$$

in column 2, and

$$FCDDUM = b_0 + b_1 DE + b_2 RD + b_3 DE * RD + b_4 FORSALE + b_5 \left(\frac{I_t}{K_{t-1}}\right)^* + b_6 SIZE + b_7 QUICK + b_8 Q + b_9 \frac{CF_t}{K_{t-1}} + FIRMDUM + YEARDUM + e \qquad \text{(ix)}$$

in column 3, where $FCDDUM = 1$ for hedgers, and $FCDDUM = 0$ for non-hedgers. Panel B presents results of the second-stage regression

$$\frac{I_t}{K_{t-1}} = \alpha + \beta Q_t + \gamma \frac{CF_t}{K_{t-1}} + \alpha^* FCDDUM^* + \gamma^* FCDDUM^* \frac{CF_t}{K_{t-1}} + YEARDUM + FIRMDUM + \epsilon_t \qquad \text{(x)}$$

where $FCDDUM^*$ is the fitted value of $FCDDUM$ obtained from the first-stage regression.

	Without Firm Dummies	With Firm Dummies
Panel A: First-Stage Regression		
Constant	-0.429(0.279)	3.273*(1.172)
DE	-0.001(0.001)	-0.001*(0.0002)
RD	0.039(0.302)	-0.475(0.742)
$DE * RD$	0.010*(0.005)	0.004(0.006)
$FORSALE$	0.591*(0.103)	0.031(0.160)
$(I_t/K_{t-1})^*$	0.290(0.355)	-1.689(1.274)
$SIZE$	0.076*(0.027)	-0.187(0.100)
$QUICK$	-0.044(0.043)	-0.037(0.031)
Q_t	0.036(0.024)	0.010(0.047)
CF_t/K_{t-1}	-0.068(0.128)	0.210(0.131)
$\overline{R}^2$	0.250	0.938
No. of Obs.	236	236

Panel B: Second-Stage Regression		
Constant	-0.002(0.099)	0.031(0.073)
Q_t	-0.017(0.015)	0.014(0.015)
CF_t/K_{t-1}	0.148*(0.047)	0.135*(0.039)
$FCDDUM^*$	0.113(0.099)	0.079(0.070)
$FCDDUM^* * CF_t/K_{t-1}$	-0.155*(0.084)	-0.130*(0.057)
$\overline{R}^2$	0.800	0.802
No. of Obs.	236	236

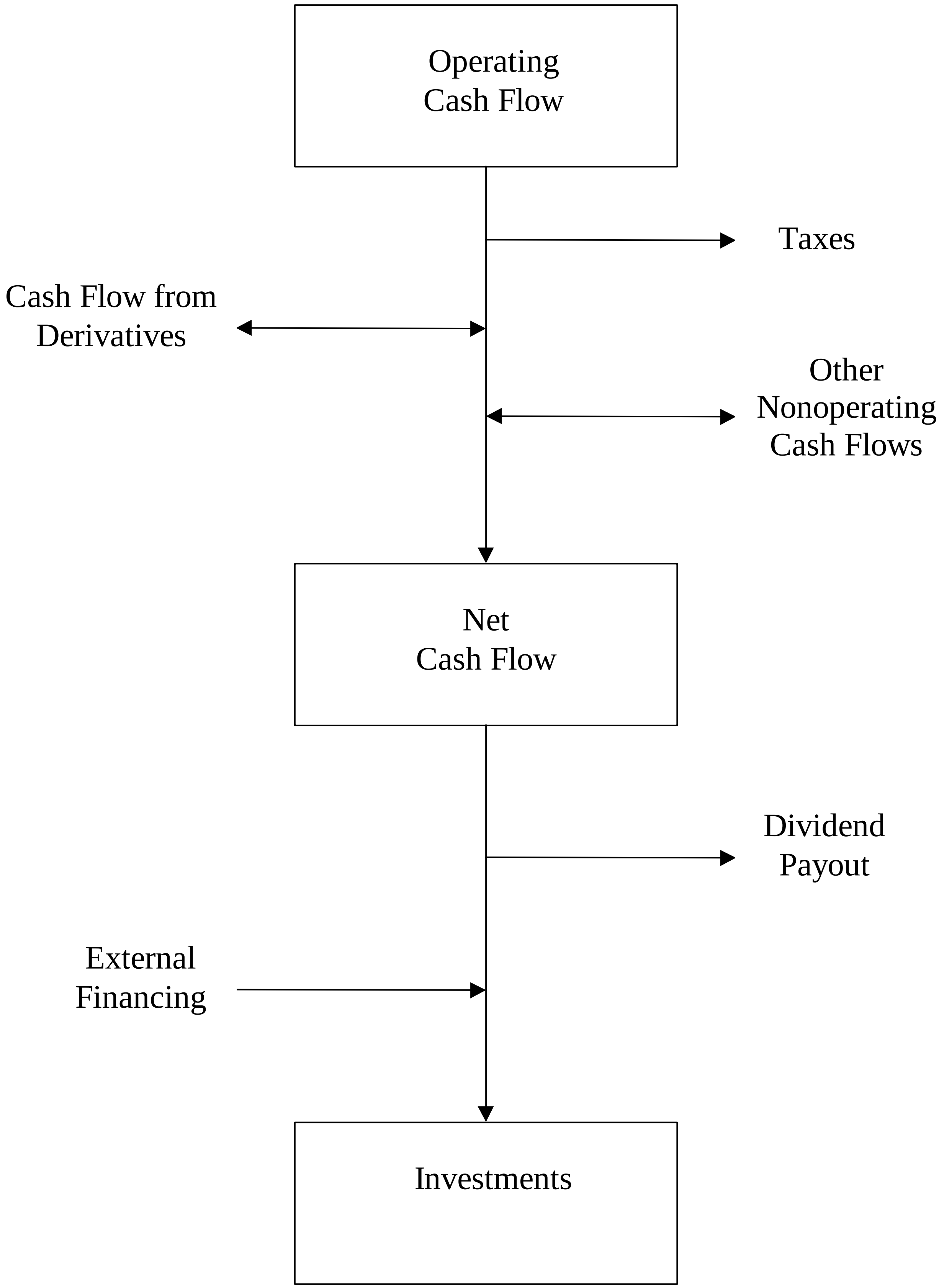
Table 8
Cash Flow Volatility Smoothing: Regression Results

This table presents pooled and by year results for the model specified below. The dependent variable is post-hedging, net cash flow (net income plus depreciation and amortization) normalized by capital stock, and the independent variable (CF_t/K_{t-1}) is unhedged cash flow (NOPLAT+DA-ΔWC) normalized by capital stock. The two groups (hedgers and non-hedgers) are distinguished by the dummy variable $FCDDUM$, with $FCDDUM = 1$ for hedgers and $FCDDUM = 0$ for non-hedgers. The coefficient β^* for the interaction term $(CF_t/K_{t-1}) * FCDDUM$ estimates the difference in sensitivity of post-hedging cash flow to unhedged cash flow for hedgers and non-hedgers. Firm and year dummies are not included in the by-year regressions.

$$\frac{(NI + DEPAM)_t}{K_{t-1}} = \alpha + \beta \frac{CF_t}{K_{t-1}} + \alpha^* FCDDUM + \beta^* \frac{CF_t}{K_{t-1}} FCDDUM + YEARDUM + FIRMDUM + \epsilon_t \quad \text{(xi)}$$

	Full Sample	1993	1994	1995
Constant	0.518*(0.166)	0.081*(0.039)	0.047(0.042)	-0.005(0.030)
CF_t/K_{t-1}	0.164*(0.081)	0.541*(0.061)	0.659*(0.067)	0.826*(0.047)
$FCDDUM$	0.181*(0.093)	0.087(0.056)	0.220*(0.058)	0.096*(0.045)
$(CF_t/K_{t-1})*$ $FCDDUM$	-0.214*(0.095)	-0.172*(0.077)	-0.424*(0.082)	-0.237*(0.064)
$\overline{R}^2$	0.842	0.612	0.582	0.850
No. of Obs.	264	89	87	88

Figure 1



Operating Cash Flow
Taxes
Cash Flow from Derivatives
Other Nonoperating Cash Flows
Net Cash Flow
Dividend Payout
External Financing
Investments