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Hedging, Financing, and Investment Decisions:
A Simultaneous Equations Framework

Chen-Miao Lin and Stephen D. Smith

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Abstract: The purpose of this paper is to empirically investigate the interaction between hedging, financing, and investment decisions. This work is relevant in that theoretical predictions are not necessarily identical to those in the case where only two decisions are being made. We argue that the way in which hedging affects the firms' financing and investing decisions differs for firms with different growth opportunities. We empirically find that high-growth firms increase their investment, but not their leverage, by hedging. However, we also find that firms with few investment opportunities use derivatives to increase their leverage.

JEL classification: G31, G32

Key words: investment, financing, hedging

The views expressed here are the authors' and not necessarily those of the Federal Reserve Bank of Atlanta or the Federal Reserve System. Any remaining errors are the authors' responsibility.

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I. Introduction

According to the theory of Modigliani and Miller (1958, 1963), in a perfect capital market neither hedging nor financing decisions add value to shareholders since companies can always obtain external funds at the same costs as internal funds to finance their investment opportunities. Thus, in order for investors to care about these decisions by corporations, some market imperfections must exist.

Most existing theories discuss either investment and financing, investment and hedging or financing and hedging. They show that various imperfections affect hedging and financing, hedging and investment, or investment and financing decisions. Underinvestment theories raised by Bessembinder (1991) and Froot, Scharfstein, and Stein (1993) argue that firms with greater growth opportunities should hedge more because of capital market imperfections. Tax shields associated with debt financing lead Stulz (1996), Ross (1996), and Leland (1998) to posit that hedging causes an increase in firm value by enabling firms to increase leverage. The debt capacity argument thus predicts a positive relationship between hedging and leverage. When looking at financing and investment, Myers (1977) demonstrates that firms with good investment opportunities should carry less debt since a high level of debt induces managers to forgo positive NPV projects.

However, the theoretical relationship between hedging, financing, and investment decisions can be different than when we consider just two of three decisions in isolation. For example, by considering the relation among hedging, leverage, and investment, Ross (1996) argues that hedging to increase leverage may not mitigate the underinvestment problem, since if firms increase debt capacity after hedging then this higher leverage increases the agency cost of debt that in turn leads to the incentive for underinvestment. Ross' argument implies that firms

with high growth opportunities are more likely to hedge to mitigate the underinvestment problem and are less likely to increase debt capacity. For firms with few growth opportunities, Stulz (1996) suggests that a manager with interests that are aligned with those of shareholders would be more likely to hedge to increase leverage in order to maximize shareholder wealth.

Given these often conflicting theories, the purpose of this paper is to empirically investigate the interaction between hedging, financing, and investment decisions for firms with different growth opportunities. We argue that a three equation system is more consistent with the idea that all three decisions are made at the same time. Therefore, we investigate these decisions within a simultaneous framework in order to avoid the standard problem of endogeneity. In particular, we use derivative usage to measure the extent of risk management. While we recognize that derivatives can be used for speculation purposes, due to the data constraints we assume that derivatives are used as hedging instruments.

By conducting cross-sectional regressions as well as tests for new users of derivatives, we find empirical evidence to support Ross' hypothesis (1996) that firms with high investment opportunities are more likely to mitigate the underinvestment problem by hedging. Moreover, we do not find that those firms increase their leverage by hedging. However, we find that, consistent with Stulz (1996), firms with poor investment opportunities increase their leverage by hedging.

The remainder of the paper proceeds as follows: Section II reviews the current literature and develops the hypotheses. Section III provides the methodology. Section IV describes our data and Section V provides empirical results. We conclude in Section VI.

II. Literature Review and Hypotheses

II.1 Literature Review

Most of hedging and financing theories attempt to explain why investors concern themselves with these decisions by introducing some market imperfection(s) into the classic Modigliani and Miller (1958) paradigm. The following summarizes some of the imperfections that induce firms to make investment, financial or risk management decisions that influence firm value.

II.1.1 Hedging and Financing

The likelihood of incurring bankruptcy costs is a disadvantage to the use of debt financing. In the case of financial distress, the value of the firm is reduced because payments must be made to third parties other than bond- or shareholders. Mayers and Smith (1982) and Smith and Stulz (1985) demonstrate that if financial distress is costly, hedging lowers the probability of encountering financial distress by reducing cash flow variability and, thus, increases firm value. By using leverage to proxy for the possibility of incurring financial distress, Dolde (1995), Berkman and Bradbury (1996), Haushalter (2000), Gay and Nam (1998), and Graham and Rodgers (2002) find a positive relation between hedging and leverage. However, using the same proxy but a different sample and control variables, Nance, Smith, and Smithson (1993), Geczy, Minton, and Schrand (1997), and Allayannis and Ofek (2001) find no support for this hypothesis.

Stulz (1996), Ross (1996) and Leland (1998) suggest that tax shields associated with debt financing provide an incentive for risk management. They argue that by reducing risk, hedging enables the firm to increase debt capacity and to reduce tax liabilities due to increases in leverage. Graham and Rogers (2002) look at derivatives and leverage decisions and find that firms with higher leverage are more likely to hedge and that hedging leads to higher leverage. However,

using a different sample and control variables, Geczy, Minton, and Schrand (1997) find no support for this hypothesis.

II.1.2 Hedging and Investment

The underinvestment problem raised by Myers (1977) provides an incentive for hedging. Myers (1977) suggests that a firm's investment opportunities are options and since shareholders are the residual claimholders of the firm, a firm carrying a high level of debt has an incentive to forgo a positive NPV project if the gain from the project accrues primarily to debtholders rather than the equityholders.

By assuming that a firm simultaneously selects the level of hedging and debt before the selection of investment, Bessembinder (1991) shows that hedging reduces the underinvestment problem because hedging shifts some future states of the world from default to nondefault states and. Therefore, this increases the states where shareholders receive a larger proportion of the incremental benefits from the projects, which in turn reduces the incentives for equityholders to underinvest.

Froot, Scharfstein, and Stein (1993) suggest, based on Myers and Majluf (1984), that costly external funds provide incentives for corporate hedging. With perfect capital markets, internal and external financing are perfect substitutes. However, previous studies find that, other things being equal, the asymmetry of information about investment quality leads to a gap between internal and external financing costs due to information problems. Froot, Scharfstein, and Stein (1993) thus argue that since external funds are more expensive, a stable supply of internal cash flows reduces the underinvestment problem. Therefore, both Bessembinder (1991) and Froot, Scharfstein, and Stein (1993) suggest that firms with more investment opportunities should hedge more.

Empirically, Nance, Smith, and Smithson (1993), Dolde (1995), Gay and Nam (1998), and Graham and Rogers (2002) all find that there is a significant positive relation between R&D expenses, a proxy for growth opportunities, and hedging. Howton and Perfect (1998), however, do not find the same relationship between hedging and R&D expenses. However, using market-to-book to proxy for investment opportunities, Nance, Smith, and Smithson (1993), Mian (1996), Geczy, Minton, and Schrand (1997), Graham and Rogers (2002), and Allayannis and Ofek (2001) find no support for the underinvestment hypothesis.

Instead of investigating whether investment opportunities provide an incentive for hedging, Allayannis and Mozumdar (2000) investigate whether or not hedging can smooth the cash flows of the firm and thus reduce the sensitivity of investment to cash flows. They find results that support the hypothesis of Froot, Scharfstein, and Stein (1993). That is, they find that hedging enables a firm to reduce its dependence on external funds.

II.1.3 Financing and Investment

As mentioned previously, Myers (1977) argues that the agency problem between shareholders and debtholders leads to an underinvestment problem. Since agency costs between shareholders and debtholders are assumed to be higher for firms with higher growth opportunities, firms with good investment opportunities are more likely to have less debt.

Moreover, in the case of an adverse liquidity shock, a firm with a high degree of leverage is more likely to be forced to forgo its investment opportunities when external capital market imperfections restrict the firm's ability to raise capital. Since leverage limits a firm's ability to pursue its investment policy, a firm with good investment opportunities would, other things the same, like to carry less debt in order to have flexibility to grow.

Empirical findings, using R&D expenses, market-to-book ratios, and capital expenditures to proxy for growth opportunities, generally support the negative relation between investment and leverage. Bradley, Jarrell, and Kim (1984), Long and Malitz (1985), and Fama and French (2002) find that firms with higher R&D expenses use less debt. Rajan and Zingales (1995) find that firms with higher market-to-book ratios carry less debt. Lang, Ofek, and Stulz (1996) find a strong negative relation between leverage and capital expenditures. However, Titman and Wessels (1988) find an insignificant relation between leverage and investment opportunities.

II.2 Hypothesis Development

Figure 1 shows that the underinvestment theories predict a positive relation between hedging and investment opportunities, while debt capacity theories argue that hedging allows firms to increase their debt ratios. However, the negative effects of leverage on investment lead Ross (1996) to argue that if a firm hedges and increases its leverage, the effect of hedging on underinvestment is ambiguous. Hedging reduces the probability of underinvestment by providing stable cash flows on one hand but, on the other hand, higher leverage increases the probability of underinvestment since a higher portion of the project benefits go toward bondholders. Based on the arguments of Myers (1977) and Ross (1996), we thus hypothesize that managers with high investment opportunities are more likely to hedge to mitigate the underinvestment problem and are less likely to increase debt capacity by hedging.

Which firms should hedge to increase debt capacity? Stulz (1996) argues that managers who try to maximize shareholders' wealth but with few growth opportunities should hedge to increase debt capacity. Stulz (1996) points out that "the substitution of debt for equity leads managers to pay out excess capital- an action that could be a major source of value added in industries with overcapacity and few promising investment opportunities" (page 17).

The above discussion motivates the following hypothesis:

Hypothesis: Managers with high (low) growth opportunities are more likely to increase their levels of investment (leverage) by hedging and less likely to increase leverage (investment) by hedging.

III. Model and Methodology

To test our hypotheses, we will create an interaction variable, $d_1 \times \text{P/E ratio}$. Follow Nance, Smith, and Smithson (1993), Geczy, Minton, and Schrand (1997) and Allayannis and Weston (2001), we use a binary variable, d_1 , to indicate whether a firm hedges or not. The term d_1 is equal to one for derivatives users, and 0 otherwise. We do not use notional amounts of derivatives use because Geczy, Minton, and Schrand (1997) argue that “the annual report disclosures are noisy, often because of aggregation and netting” (page 1334). Graham and Rogers (2002) also state that prior to the issue of SFAS 119 (which came into effect in 1994) “financial statement disclosures were generally inadequate to analyze the extent of derivatives hedging” (page 823). Our sample firms cover fiscal years from 1992 to 1996. During these years the notional amounts of commodity derivatives were not available and many firms in the sample report the use of derivatives but do not report their levels, we feel that a dummy variable is a more appropriate proxy than notional amounts. Finally, Smith (2002) shows that if a regressor is measured with error, then the estimated coefficient will be biased toward zero and there is no way to recover the true coefficient. However, by using the dummy variable approach, not only do we not encounter the above problems but we can obtain the true estimate, provided that the cut off rate is known, as it is in this case (i.e., zero). For our empirical tests we follow McConnell and Servaes (1995) and use the P/E ratio as a proxy for growth opportunities. The P/E ratio is

calculated by dividing the stock price at the end of fiscal year by operating earnings before depreciation per share.

We first investigate hedging, financing, and investment decisions in a fixed-effects model since our data represents a panel data-set. We also provide some tests using a simultaneous equations framework since estimation within a system allows us to avoid false inferences of causality among these decisions that are due to spurious correlations.

III.1 Financing model

To test our hypothesis, we regress leverage on the interaction variable, $d_1 \times P/E$ ratio, and other control variables suggested by Titman and Wessels (1988). The leverage model is specified as follows:

$$(Leverage)_{i,t} = \mathbf{a}_0 + \mathbf{a}_1(d_1) + \mathbf{a}_2(d_1 \times P/E)_{i,t} + \mathbf{a}_3(Capital \text{ expenditure})_{i,t} + \mathbf{a}_4(IPE)_{i,t} \\ + \mathbf{a}_5(Depreciation)_{i,t} + \mathbf{a}_6(Tax)_{i,t} + \mathbf{a}_7(Size)_{i,t} + \mathbf{e}_{i,t}$$

where leverage is measured as long-term debt plus current portion of long-term debt over total assets. The ratio of capital expenditure expenses to total assets is used as a proxy for investment. Inventory, plant & equipment (IPE), a proxy for collateral value, is measured by the ratio of inventory plus plant and equipment to total assets. It is thought that firms with a higher level of IPE should be able to carry higher debt levels. Depreciation, measured by depreciation scaled by total assets, and the ratio of net operating loss carry forwards over total assets (Tax), are proxies for non-debt tax shields. Firm size is measured by the log of total assets. We expect α_2 to be negative if firms with high growth opportunities are less likely to hedge to increase debt capacity.

III.2 Investment model

To investigate the relationship between derivative use and investment, we follow the same procedure as we do in the leverage model. We regress capital expenditure expenses scaled

by total assets on the interaction variable and a set of control variables suggested by Fazzari, Hubbard, and Petersen (1988, 1998) and Lang, Ofek, and Stulz (1996) in order to test our three hypotheses. The investment model is defined as follows:

$$(Capital \text{ exp enditure})_{i,t} = \mathbf{b}_0 + \mathbf{b}_1(d_1)_{i,t} + \mathbf{b}_2(d_1 \times P/E)_{i,t} + \mathbf{b}_3(Leverage)_{i,t} \\ + \mathbf{b}_4(Cash \text{ flow})_{i,t} + \mathbf{b}_5(Size)_{i,t}$$

All dependent and independent variables are the same as those specified in the debt model expect for cash flow. Cash flow is defined as operating income before depreciation less the sum of taxes, interest expenses, common dividends, and preferred dividends scaled by total assets. Cash flow enters into this equation because the literature finds that, other things being equal, investment is highly sensitive to internal funds.¹ We expect β_2 to be positive since firms with good investment opportunities are more likely to hedge to alleviate underinvestment problems.

III.3 Hedging model

To investigate the incentives for hedging, we specify the model of hedging decisions following Geczy, Minton, and Schrand (1997).² The model is as follows:

$$(h_1)_{i,t} = \mathbf{g}_0 + \mathbf{g}_1(Leverage)_{i,t} + \mathbf{g}_2(Capital \text{ exp enditure})_{i,t} + \mathbf{g}_3(Quick \text{ ratio})_{i,t} + \mathbf{g}_4(Tax)_{i,t} \\ + \mathbf{g}_5(Accuracy)_{i,t} + \mathbf{g}_6(Size)_{i,t}$$

The quick ratio, a proxy for liquidity, is measured as cash and short-term investments over current liabilities. The more liquid firms have less need of hedging. Tax, as defined in the leverage equation, is a proxy for tax function convexity since Smith and Stulz (1985) suggest that firms facing convex tax schedules have greater incentives to hedge. Analyst forecast accuracy (Accuracy) is a proxy for asymmetric information. DeMarzo and Duffie (1991, 1995) argue that if managers have private information, shareholders will be better off if the firm hedges

¹ See Fazzari, Hubbard, and Ptersen (1988), Hoshi, Kashyap, and Scharfstein (1991), and Hubbard (1998).

² All the control variables are suggested by Geczy, Minton, and Schrand (1997), but they also include other control variables in the model, which we ignore.

since hedging can eliminate noise and thus improve the informativeness of corporate earnings as a signal of project quality. Therefore, firms with a high level of asymmetric information are more likely to hedge. Following DaDalt, Gay, and Nam (2002), we construct analyst forecast accuracy for earnings by calculating the absolute value of the difference between the analysts' composite mean earnings per share forecast made in the last I/B/E/S reporting month prior to the release of actual earnings and the actual earnings per share for that year. We then divide this difference by the absolute value of the actual earnings per share. The other control variables are the same as those specified previously.

IV. The Data

We construct our sample of non-financial firms from the Swaps Monitor database, covering fiscal years from 1992 to 1996 (the last year of data reported). Swap Monitor reports derivatives usage information for all Fortune 500 and Business Week 1000 firms, all other industrial firms with revenues greater than \$500 million or assets greater than \$500 million, and other known derivatives users regardless of firm size. Table 1 presents information on the number of interest rate, exchange rate, and/or commodity derivatives users and non-users. The number of users increases from 644 in 1992 to 1035 in 1996 and the number of non-users decreases from 1,108 in 1992 to 717 in 1996. We obtain financial data from the Standard and Poor's Compustat and analysts forecasts from I/B/E/S. Table 2 reports the summary statistics for the explanatory variables used in this study.

V. Empirical Results

In this section, we use multivariate tests to examine hedging, financing, and investment decisions. We conduct fixed-effects models and simultaneous equations specifications for a sample of derivatives users and non-users as well as for a sample of new users of derivatives.

V.1.1 Fixed-effects estimation

Since our data is a panel data-set, we introduce fixed-effects models to control for possible industry and time effects which might affect a firm's financing, hedging, and investment decisions. The industry effects are measured by four-digit SIC dummy variables.

Table 3 reports the results from fixed-effects estimation. The leverage model shows that hedging allows firms to increase its debt capacity. In particular, the coefficient of d_1 is significant at 1% level. Consistent with our hypothesis, high-growth firms do not hedge to increase debt capacity. The coefficient of $d_1 \times P/E$ is negative and significant at 1% level. With respect to the other explanatory variables, we find a significantly negative relation between capital expenditure and leverage, which is consistent with the empirical findings of most of the previous research. We also find a positive relationship between leverage and collateral value (IPE) as well as net operating loss carry forwards (Tax), which is consistent with theory.

From the investment equation, we do not find a positive relation between hedging and investment, but we do find that high-growth firms hedge to increase their investment opportunities. The coefficient of $d_1 \times P/E$ is positive and significant at the 10% level. Consistent with Fazzari, Hubbard, and Petersen (1988, 1998), we also find a positive relation between cash flows and capital expenditure.

In the derivatives use equation, we find that leverage is significantly positively related to derivatives use, which is consistent with the financial distress argument. We also find that firm size is positively correlated with the hedging decision. We do not find a significant relation between hedging and capital expenditure, asymmetric information measure, or tax incentive for hedging.

V.2 Simultaneous equations of hedging, leverage, and investment

Our tests, up until now, implicitly assumed the derivatives use decision is exogenous. However, in reality, hedging, financing, and investment decisions are more likely to be endogenous. Estimation within a system allows us to avoid false inferences of causality among these decisions that are due to least squares bias.

Table 4 reports the results of derivatives use, leverage, and investment within a simultaneous equation framework. We have adjusted our estimation methodology to account for the fact that one of the endogenous variables is zero/one. We use a two-stage estimation method discussed in Maddala (1983), (pages 242-247) to provide consistent estimates of the parameters.³ In the first stage, separate OLS regressions are run for the leverage and capital expenditure decisions and probit regression for the derivatives use decision. In the second stage, structural equations are estimated by replacing the explanatory variables with the predicted values from the first-stage regressions.

The leverage equation shows that on average, derivative use (d_1) leads to a significant increase in the level of leverage but the level decreases as a firm's growth opportunities increase. This is consistent with our hypothesis that firms with high growth opportunities are less likely to hedge to increase debt capacity than firms with low growth opportunities.

³ We thank Ping Hu from the SAS institute for providing us with an estimation package. We note that this code will generally be available to the public in the next version of the SAS estimation packages.

The capital expenditure equation indicates that hedgers have a significantly higher level of investment than non-hedgers and the level is enhanced by a firm's growth opportunities. This result supports our hypothesis that high growth firms hedge to increase their investment opportunities.

The derivative use equation shows that bigger firms and firms with a high level of capital expenditure and net operating loss carry forward hedge more. But surprisingly, we find a negative relation between hedging and leverage. Nance, Smith, and Smithson (1993) also find a negative relation between hedging and leverage and their interpretation for this result is that high growth firms tend to hedge more and borrow less.

V.3 New Derivatives Users

In this section, we further investigate the relationship between hedging, financing and investment for new users of derivatives. By looking at new users, we can alleviate the concern that non-users may not be an appropriate control group for users due to different firm characteristics. Following Guay (1999), a firm is defined as a new derivatives user if it reports derivatives use in year t , but does not report a position in derivatives in any years prior to year t during the sample period. Firms that report derivatives use in the year 1992 are not identified as new users since the data on derivatives usage for 1991 is unavailable. The initial sample contains 828 firms that are identified as new users.

Table 5 reports the results from fixed-effects models. Consistent with the cross sectional tests, we find that firms with high growth opportunities are less likely to hedge to increase debt capacity. The coefficient of $d_1 \times P/E$ is significantly negative. However, in the capital expenditure equation, we do not find a significant relation between the interaction variable ($d_1 \times P/E$) and capital expenditure.

Table 6 presents the results that examine the relationship of derivatives use, leverage, and investment for new users within a simultaneous equations framework. The results indicate a positive relation between capital expenditure and $d_1 \times P/E$ but a marginally significant positive relation between leverage and $d_1 \times P/E$. Overall, our results are consistent with those of a using cross-sectional regressions but are somewhat weaker in terms of magnitude.

VI. Conclusions

This paper empirically investigates the interaction between hedging, financing, and investment decisions. Theoretical predictions looking at the three decisions together are different from earlier literature that looks at just two of the three decisions in isolation.

The results of the study, conducted via fixed-effects models and simultaneous equations, strongly support the idea that firms with plentiful growth opportunities manage risk in order to hedge their high growth opportunities, but they do not hedge to increase leverage. The results confirm Ross' hypothesis (1996) that hedging to increase debt capacity would not mitigate the underinvestment problem, which is the goal that a high-growth firm would be more likely to pursue. However, firms with few investment opportunities increase their leverage by hedging. The results support Stulz's argument (1996) that hedging to increase tax shields, resulting from increases in leverage, could be a major source of value added for firms with low growth opportunities.

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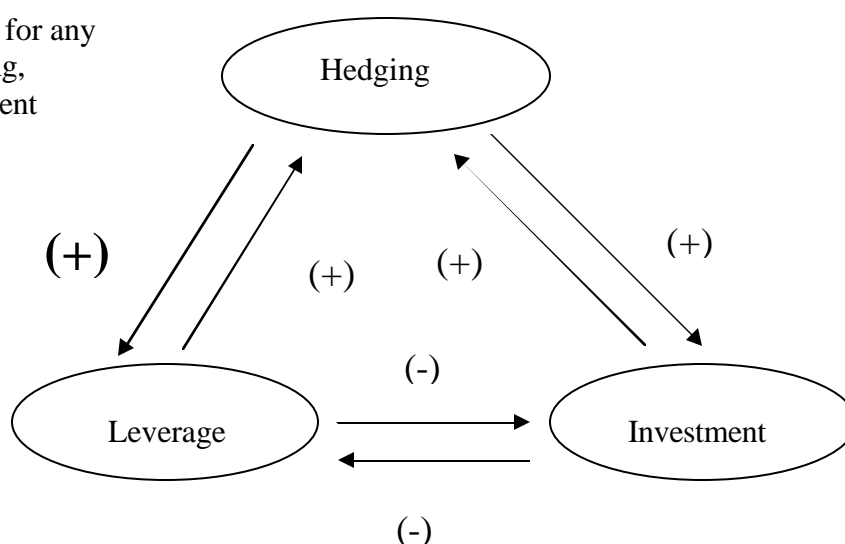
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Figure 1: The relation among hedging, leverage, and investment. The underinvestment theories predict that firms with greater investment opportunities are more likely to hedge and thus hedging allows firms to take on more attractive investment opportunities. The financial distress cost argument predicts that firms with high debt ratios are more likely to hedge and the debt capacity argument posits that firms are all better off hedging in order to increase leverage. The agency costs between shareholders and debtholders suggest a negative relation between investment and leverage. By considering the relation among hedging, leverage, and investment, Ross (1996) argues that hedging to increase leverage may not alleviate underinvestment problems since higher leverage increases the agency costs of debt that would lead to the incentives for underinvestment. Thus, firms with higher growth opportunities are more likely to hedge to increase investment and less likely to increase leverage.

Traditional predictions for any two of the three hedging, financing, and investment decisions



Ross' predictions when considering these three decisions instead of two out of the three.

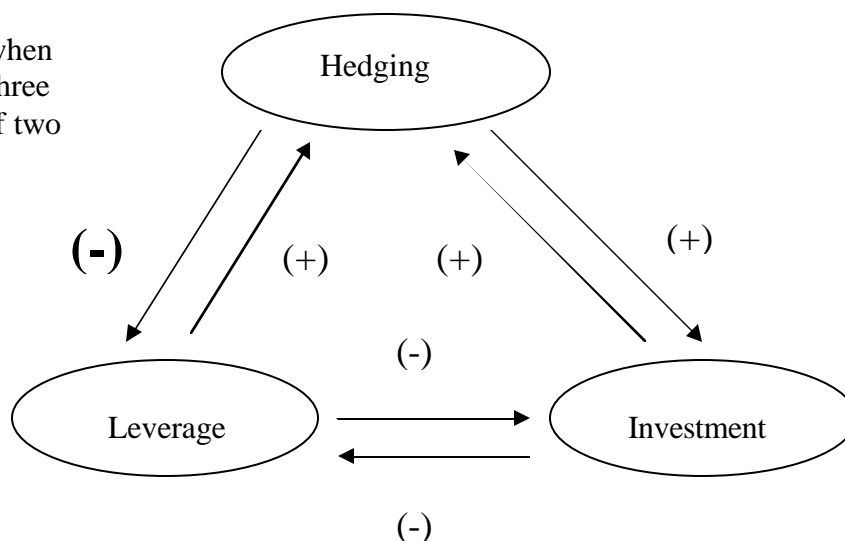


Table 1. Descriptive Information of Derivatives Users and Non-Users

This table provides descriptive statistics of non-financial firms defined as interest rate, and/or exchange rate, and/or commodity derivatives users or non-users from 1992 to 1996 as reported in the Swaps Monitor database.

Year	Interest-Rate Derivatives		Currency Derivatives		Commodity Derivatives		All Firms ^a	
	Users	Non-users	Users	Non-users	Users	Non-users	Users	Non-users
1992	434	1,145	346	1,233	91	338	644	1,108
1993	511	1,068	402	1,177	147	282	761	991
1994	529	1,050	491	1,088	210	219	886	866
1995	529	1,050	414	1,165	224	205	847	905
1996	639	940	480	1,099	264	165	1,035	717

a. The number of users (non-users) in these columns will not equal to the sum of users (non-users) of interest-rate, currency, and commodity derivatives if firms that use multiple derivatives.

Table 2. Explanatory variables-Summary Statistics

This table provides summary information for the independent variables used in this study. The sample contains firm-year observations from the period 1992-1996. d_1 is derivative dummy variable, which is equal to 1 if a firm reports the use of any type of interest rate, foreign currency, or commodity derivatives and zero otherwise. The P/E ratio is calculated by dividing the stock price at the end of fiscal year by operating earnings before depreciation per share. Leverage is measured by (long-term debt + current portion of long-term debt)/total assets. Capital expenditure is capital expenditure expenses/total assets. IPE is the ratio of inventory plus plant and equipment to total assets. Depreciation is depreciation expenses/total assets. The quick ratio is calculated as cash and short-term investments over current liabilities. Cash flow is defined as (operating income before depreciation - taxes - interest expenses - common dividends - preferred dividends)/total assets. Tax is net operating loss carry forwards/total assets. Accuracy is analyst forecast accuracy, computed as the absolute value of average analyst forecast errors of fiscal year end earnings per share scaled by the absolute value of actual earnings per share. Size is the natural logarithm of book value of total assets. P-values are reported in parentheses.

	No. obs	Mean	Std. Dev.	Median	10 th percentile	90 th percentile
$d_1 \times \text{P/E ratio}$	6,533	3.862	6.197	2.285	0.000	9.937
Leverage	6,512	0.289	0.217	0.273	0.028	0.525
Capital expenditure	6,429	0.077	0.076	0.057	0.018	0.152
IPE	6,436	0.523	0.221	0.534	0.210	0.815
Depreciation	6,532	0.049	0.031	0.044	0.020	0.084
Quick ratio	6,042	0.540	2.170	0.164	0.021	1.233
Cash flow	6,203	0.072	0.096	0.076	0.010	0.149
Tax	4,303	0.055	0.281	0.000	0.000	0.102
Accuracy	5,227	0.296	1.724	0.038	0.004	0.444
Size	6,533	6.389	1.795	6.302	4.123	8.783

Table 3. Fixed-effects Estimation of Derivatives Use, Financing, and Investment Decisions

This table presents results from fixed-effects estimation that relates financing and investment decisions to the use of derivatives. The sample contains firm-year observations from the period 1992-1996. Leverage is measured by (long-term debt + current portion of long-term debt)/total assets. Capital expenditure is capital expenditure expenses/total assets. d_1 is derivative dummy variable, which is equal to 1 if a firm reports the use of any type of interest rate, foreign currency, or commodity derivatives and zero otherwise. The P/E ratio is calculated by dividing the stock price at the end of fiscal year by operating earnings before depreciation per share. IPE is the ratio of inventory plus plant and equipment to total assets. Depreciation is depreciation expenses/total assets. The quick ratio is calculated as cash and short-term investments over current liabilities. Cash flow is defined as (operating income before depreciation - taxes - interest expenses - common dividends - preferred dividends)/total assets. Tax is net operating loss carry forwards/total assets. Accuracy is analyst forecast accuracy, computed as the absolute value of average analyst forecast errors of fiscal year end earnings per share scaled by the absolute value of actual earnings per share. Size is the natural logarithm of book value of total assets. P-values are reported in parentheses. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Leverage	Capital expenditure	d_1
d_1	0.0780*** (0.0000)	0.0016 (0.5448)	
$d_1 \times \text{P/E ratio}$	-0.0063*** (0.0000)	0.0003* (0.0834)	
Leverage		0.0086 (0.1096)	0.2316*** (0.0001)
Capital expenditure	-0.1118** (0.0524)		0.0979 (0.5476)
IPE	0.1132*** (0.0000)		
Depreciation	0.0425 (0.7687)		
Quick ratio			-0.0199* (0.0556)
Cash flow		0.1149*** (0.0000)	
Tax	0.0758*** (0.0000)		-0.0346 (0.5978)
Accuracy			-0.0053 (0.2866)
Size	0.0128*** (0.0000)	-0.0020*** (0.0021)	0.1197*** (0.0000)
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
R-square	0.5369	0.4890	0.5342
Observations	4,178	6,083	3,267

Table 4. Simultaneous Equations Analysis of Hedging, Financing, and Investment Decisions

This table presents results for examining firms' decisions of derivatives use, leverage, and investment within a simultaneous equations framework. The sample contains firm-year observations from the period 1992-1996. Leverage is measured by (long-term debt + current portion of long-term debt)/total assets. Capital expenditure is capital expenditure expenses/total assets. d_1 is derivative dummy variable, which is equal to 1 if a firm reports the use of any type of interest rate, foreign currency, or commodity derivatives and zero otherwise. The P/E ratio is calculated by dividing the stock price at the end of fiscal year by operating earnings before depreciation per share. IPE is the ratio of inventory plus plant and equipment to total assets. Depreciation is depreciation expenses/total assets. The quick ratio is calculated as cash and short-term investments over current liabilities. Cash flow is defined as (operating income before depreciation - taxes - interest expenses - common dividends - preferred dividends)/total assets. Tax is net operating loss carry forwards/total assets. Accuracy is analyst forecast accuracy, computed as the absolute value of average analyst forecast errors of fiscal year end earnings per share scaled by the absolute value of actual earnings per share. Size is the natural logarithm of book value of total assets. P-values are reported in parentheses. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Leverage	Capital expenditure	d_1
Intercept	1.8992*** (0.0000)	0.1566*** (0.0000)	-2.1902*** (0.0000)
d_1	0.8238*** (0.0000)	0.0679*** (0.0000)	
$d_1 \times \text{P/E ratio}$	-0.0046*** (0.0000)	0.0022*** (0.0000)	
Leverage		0.3635*** (0.0000)	-2.4267*** (0.0000)
Capital expenditure	-0.0586*** (0.0000)		5.4634*** (0.0000)
IPE	0.3629*** (0.0000)		
Depreciation	-2.6039*** (0.0000)		
Quick ratio			-0.0964*** (0.0029)
Cash flow		0.2921*** (0.0000)	
Tax	0.0413* (0.0711)		0.3874* (0.0869)
Accuracy			0.0031 (0.7891)
Size	-0.2844*** (0.0000)	-0.0334*** (0.0000)	0.3993*** (0.0000)
Log likelihood	3,441.00		
Observations	3,190		

Table 5. Fixed-effects Estimation of Derivatives Use, Financing, and Investment Decisions for New Users of Derivatives

This table presents results from fixed-effects estimation that relates financing and investment decisions to the use of derivatives for new users of derivatives. The sample contains firm-year observations from the period 1992-1996. Leverage is measured by (long-term debt + current portion of long-term debt)/total assets. Capital expenditure is capital expenditure expenses/total assets. d_1 is derivative dummy variable, which is equal to 1 if a firm reports the use of any type of interest rate, foreign currency, or commodity derivatives and zero otherwise. The P/E ratio is calculated by dividing the stock price at the end of fiscal year by operating earnings before depreciation per share. IPE is the ratio of inventory plus plant and equipment to total assets. Depreciation is depreciation expenses/total assets. The quick ratio is calculated as cash and short-term investments over current liabilities. Cash flow is defined as (operating income before depreciation - taxes - interest expenses - common dividends - preferred dividends)/total assets. Tax is net operating loss carry forwards/total assets. Accuracy is analyst forecast accuracy, computed as the absolute value of average analyst forecast errors of fiscal year end earnings per share scaled by the absolute value of actual earnings per share. Size is the natural logarithm of book value of total assets. P-values are reported in parentheses. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Leverage	Capital expenditure	d_1
d_1	0.0562*** (0.0052)	0.0048 (0.4230)	
$d_1 \times \text{P/E ratio}$	-0.0052*** (0.0001)	0.0004 (0.2713)	
Leverage		0.0463*** (0.0002)	0.0579 (0.5450)
Capital expenditure	-0.0453 (0.6365)		0.4462* (0.0559)
IPE	0.1002** (0.0293)		
Depreciation	0.0191 (0.9421)		
Quick ratio			-0.0091 (0.5001)
Cash flow		0.1987*** (0.0000)	
Tax	0.0175 (0.4211)		-0.2981** (0.0331)
Accuracy			0.0144 (0.4277)
Size	0.0186*** (0.0004)	-0.0066*** (0.0000)	0.0545*** (0.0009)
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
R-square	0.6334	0.5728	0.7347
Observations	1,711	2,581	1,241

Table 6. Simultaneous Equations Analysis of Hedging and Financing, and Investment Decisions for New Users of Derivatives

This table presents results for examining firms' decisions of derivatives use, leverage, and investment within a simultaneous equations framework for new users of derivatives. The sample contains firm-year observations from the period 1992-1996. Leverage is measured by (long-term debt + current portion of long-term debt)/total assets. Capital expenditure is capital expenditure expenses/total assets. d_1 is derivative dummy variable, which is equal to 1 if a firm reports the use of any type of interest rate, foreign currency, or commodity derivatives and zero otherwise. The P/E ratio is calculated by dividing the stock price at the end of fiscal year by operating earnings before depreciation per share. IPE is the ratio of inventory plus plant and equipment to total assets. Depreciation is depreciation expenses/total assets. The quick ratio is calculated as cash and short-term investments over current liabilities. Cash flow is defined as (operating income before depreciation - taxes - interest expenses - common dividends - preferred dividends)/total assets. Tax is net operating loss carry forwards/total assets. Accuracy is analyst forecast accuracy, computed as the absolute value of average analyst forecast errors of fiscal year end earnings per share scaled by the absolute value of actual earnings per share. Size is the natural logarithm of book value of total assets. P-values are reported in parentheses. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Leverage	Capital expenditure	d_1
Intercept	0.1375 (0.1685)	-0.0630 (0.1781)	-1.5167*** (0.0000)
d_1	0.1574** (0.0199)	-0.0636* (0.0812)	
$d_1 \times \text{P/E ratio}$	0.0025* (0.0814)	0.0022*** (0.0000)	
Leverage		0.3832*** (0.0000)	-1.6856** (0.0147)
Capital expenditure	-3.9713*** (0.0000)		3.9183*** (0.0000)
IPE	0.8366*** (0.0000)		
Depreciation	3.2048*** (0.0000)		
Quick ratio			-0.0322 (0.4019)
Cash flow		0.2294*** (0.0000)	
Tax	0.2897*** (0.0000)		0.1878 (0.5893)
Accuracy			-0.0408 (0.3907)
Size	-0.0231 (0.1092)	0.0020 (0.8072)	0.2445*** (0.0000)
Log likelihood	893.53		
Observations	1,203		