AN EMPIRICAL STUDY OF THE IMPACT OF FINANCE ON PRODUCTION AND GROWTH

Hong V. Nguyen and Michael O. Mensah, University of Scranton
Kania School of Management, University of Scranton, Scranton, Pennsylvania 18510

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I. Introduction

Derivatives, such as swaps, forwards, futures, calls, floors, collars and puts, are financial instruments that derive their values from some underlying asset. These financial instruments have become an important tool for firms to manage their risks, including financial price risks related to changes in interest rates, foreign exchanges, or commodity prices. The explosion in the use of derivatives beginning in the 1980s and the 1990s has resulted in a series of new reporting requirements issued by the Financial Accounting Standard Boards (FASB) in the 1990s, including SFAS 119 (Disclosure about Derivative Financial Instruments and Fair Values of Financial Instruments, 1994) and SFAS 133 (Accounting for Derivative Instruments and Hedging Activities). A recent study shows that such disclosure requirements are informative (Seow and Tam, 2002). This importance of derivatives use over the past decade is shown in a recent survey of non-financial firms (Bodnar, Hayt, and Marston, 1998). This survey reveals that, while the percentage of firms using derivatives may not have changed between the mid- and late 1990s, there is clear evidence that usage intensity by firms has increased. It is, therefore, not surprising that a number of studies have been done to examine the use of derivatives. However, due to the lack of reported data on firms' use of derivatives, especially on non-financial firms (a focus of this paper), empirical research in this area has been limited to survey data. This paper takes advantage of the greater availability of reported data on derivatives use to explore a number of issues related to the use of derivatives. A larger research agenda is to explore the role of finance in firm's production and investment decisions, an issue discussed more recently by Rajan and Zingales (1998, 2001a, and 2001b). Substitution among financial instruments is discussed in Barton (2001).

II. Background

Derivatives allow firms to reduce certain costs arising out of market imperfections. One imperfection is attributed to contracting costs associated with the conflict between stockholders and bondholders that prevent a firm from making an investment with a positive net present value (Mayers and Smith, 1987; Myers, 1977). Another imperfection is the greater cost of obtaining external financing of investment projects (Froot et al., 1993). A third type of imperfection is the transactions costs firms may incur when they experience financial distress (Smith and Stulz, 1985). By allowing firms to lower these costs, derivatives confer benefits on society by encouraging greater investment and growth in the economy. In addition, firms may have an incentive to hedge to take advantage of the convexity of the tax structure where there is a tax advantage in smoothing out earnings (Mayers and Smith, 1982; Smith and Stulz, 1985). The variables can be grouped into dependent and explanatory variables, where in most studies the dependent variable is derivatives use, measured either as a 0-1 variable or as notional dollar value, and where the explanatory variables reflect either tax or market imperfections as discussed above. In some studies, a risk variable, such as the standard deviation of a firm's earnings, is used as the dependent variable, with the main explanatory variable being derivatives use. The market imperfection variables are grouped under "growth variable" to capture a firm's investment opportunities; "external financing" to capture the firm's potential need for external borrowing; and "financial distress" to reflect the probability of this experience.

In the Appendix, we provide a summary of the relevant literature dealing with the use of derivatives by non-financial firms. This literature seems to suggest the following: (1) firms with greater risk exposures use derivatives relatively more, confirming derivatives as an instrument in firms' hedging strategies; (2) many of past studies have used survey data, where continuous measures of derivatives use were not available; (3) firms have a greater chance of using derivatives if they have more growth opportunities; and (4) no evidence that firms use derivatives for speculative purposes.

The purpose of this paper is to extend the earlier research by focusing on firms' derivatives use and its interaction with external financing dependence in affecting certain variables related to the firm's growth. Dependence on external financing is measured by the difference between capital expenditures and cash flow, scaled by capital expenditures. In a paper in which derivatives use is the dependent variable, Gay and Nam (1998) allowed for an interaction between cash flows and growth variables in determining derivatives use. Similarly, Geczy et al. (1997) allowed for the impact of growth opportunities on derivatives use to depend on financial distress probability as measured by the long-term debt ratio. Guay (1999) used a methodology for sample selection that attempted to avoid the endogeneity bias in his regression model relating total risk of the firm to derivatives use. This bias arises in cross-sectional studies because derivatives use is determined simultaneously as part of the firm's risk-management strategy (Anne Beatty, 1999).

III. Model Specification

Since there are market imperfections making external financing costly, especially for smaller firms, one would expect that firms that are dependent on external financing would be helped disproportionately more by the use of derivatives. Thus, the use of derivatives would make it less costly for these firms to invest in growth-enhancing assets such as research and development (R&D).

In addition, the market valuation of assets of firms using derivatives would be higher in cases where firms are dependent on external financing if in fact derivatives use is a signal to investors of the managers' ability to address external financing dependence. Thus, the ratio of market value to book value of assets (or alternatively, the ratio of firm market value to firm book value) would be higher in these cases. Since operating-income volatility affects the ability of managers to commit to investment projects whose benefits may go primarily to bondholders (Myers, 1977), this volatility affects the amount of investment in research and development (and possibly the firm's valuation) to the extent that the firm is dependent on external financing. For example, in their study of Merck and the pharmaceutical industry, Lewent and Kearney (1990) made the observation that "cash flow and earnings uncertainty caused by exchange-rate volatility leads to a reduction of growth in research spending." There may also be an interaction between operating-income volatility and derivatives use, that is, the impact of volatility on the firm's investments or its valuation is reduced if it uses derivatives.

Our model can now be tentatively specified as follows:

$$GROWTH_i = b_0 + b_1*EXTERNAL_i + b_2*DERIVATIVE_j*EXTERNAL_i + b_3*SIZE_i*EXTERNAL + e_i,$$

where the subscript *i* refers to firm *i*. For now we do not consider the industry effect in the above model, as well as the volatility in operating earnings or cash flow. GROWTH reflects a firm's growth potential, measured alternatively as the ratio of R&D to the firm's sales revenues and as the ratio of market value to book value of assets. DERIVATIVE refers to a firm's use of derivatives and EXTERNAL is a variable capturing the degree of dependence on external financing. DERIVATIVE is measured as the notional principal amount of derivatives position as a percentage of the value of the firm's total assets. as in Guay, 1999. The error term of the model is expressed as e. The expected values of the coefficients are that b_1 is negative, while b_2 and b_3 are positive.

IV. Data

The data are for a sample of firms from the Fortune 500 list, covering the two years of 1994 and 1999. EDGAR is used in collecting data on derivatives use. For these firms, data are collected for the variables listed below. All dollar values are in millions of dollars. The variable names in parentheses are those used by the database *Simplystocks*.

CFCEXT: Capital expenditures for property, plant, and equipment
SLT: Firm's revenue from the sale of output
MVALUE: A measure of firm size, calculated as year-end book value of assets (TAXBS) minus book value of equity (TAPC) plus market value of equity (MVAL).
TAXBS: Book value of assets.
PBV: Ratio of the book value of common equity to market value of common equity
MB: The ratio of year-end market value to year-end book value of assets (MVALUE/TAXBS)
CFFO: Firm's cash flows from operations
DERIVATIVE: Notional principal amount of derivatives positions.
DER: When firms are classified into users and non-users of derivatives, this value takes on a value of 1 if the firm is a user, and 0 otherwise
DERIVATIVE1: Notional principal amount of derivatives positions divided by market value of assets (DERIVATIVE/MVALUE)
DERIVATIVE2: Notional principal amount of derivatives positions divided by the value of output (DERIVATIVE/SLT)
RDS: Research and Development expenditures
RD1: RDS divided by size (RDS/MVALUE)
RD2: RDS divided by revenues (RDS/SLT)
EXTERNAL: The ratio of the value of capital expenditures minus cash flow, divided by capital expenditures ((CFCEXT-CFFO)/CFCEXT)

Simplystocks variables:

CFCEXT: Capital expenditures
SLT: Sales revenue
RDS: Research and Development expenses
MVAL: Market value of common equity
TAXBS: Book value of total assets
TAPC: Book value of common equity

V. Preliminary Analysis

Some descriptive statistics for our sample are provided in Tables 1 and 2. We found evidence of increasing use of derivatives over the period 1994-1999. In addition, larger firms are more likely to use derivatives than smaller firms.

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Table 1. Sample Information

FORTUNE 500 Companies: 396 non-financial companies
S&P 500 Companies: 415 non- financial companies
Sample total: 541 (non-overlapping)
Derivatives Users (percent of total)

FORTUNE 500	Year	1999
S&P 500	73.1	84.0
	70.5	83.3

Table 2. Sample Characteristics with respect to the Use of Derivatives

SIC Code	Sector Description	Derivatives 1993/94	Use (%) 1999	Average Sales Revenue ($mil) Users	Non-Users
1000-1799	Mining	61.1	87.1	3,861	2,220
2000-3999	Manufacturing	83.7	88.5	10,396	2,159
4000-4999	Transportation, Communications, Utilities	63.8	86.8	8,559	3,178
5000-5999	Wholesale and Retail Trade	54.5	70.4	15,544	8,569
6324	Health Care Plans	0	28.6	8,522	8,250
7000-8999	Services	62.1	62.1	4,733	2,722

Appendix: Summary of Past Empirical Research on the Use of Derivatives

	Hertschel and Kothari (2001)	Prevost, Rose, and Miller (2000)	Gay and Nam (1999)	Guay (1999)	Howton and Perfect (1998)
Sample	325 non-financial firn 100 financial firms, 1991-93	Survey of 155 New Zealand firms	Non-financial firms, 325 users and 161 non-users, 1995	6/1990-12/1994; 254 new users , 3,124 non-user observations, 1,597 user observations	Fortune 500/S&P 500 firms (FSP) and a random sample, 1994
Model	Standard regression	Descriptive statistics and charts	Tobit	Logit	Tobit
Dependent Variables	Risk measures	Derivatives use	Derivatives use, continuous	Total risk; derivatives use (1-0 variable)	Derivatives use, continuous
Explanatory Variables	Book value of assets, market value of equity, and ratio of derivatives to market value of assets	Risk management variables	Growth variables	Notional amount and growth/risk variables; interest/exchange exposures; risks	Measures of financial distress, external financing costs, and tax variables
Results	No economically significant result for derivatives use and risk reduction	Most important reason: minimize fluctuations in cash flows	Significant growth variable effects and significant interaction variables	Significant under-investment problems; significant effect of financial distress and external financing costs	For FSP sample, significant results in financial distress, external financing costs, currency risk exposure; but not so for the random sample
Data	Sample based on April 25, 1988 issue of *Fortune* Magazine; Compact Disclosure, Compustat, CRSP; notes to firms' financial statements; 929 firm years	Survey of 334 firms, with final sample of 155; categorical data	Compustat, CRSP, Swap Monitor, *Business Week* 1000 firms, 2-digit SIC classification	Compact Disclosure, Compustat, CRSP	Compustat, 451 firms from Fortune 500/S&P 500 firms; 461 firms in a random sample; notional and fair value of derivatives from annual reports

Appendix (continued): Summary of Past Empirical Research on the Use of Derivatives

	Bodnar, Hayt, and Marston (1998)	Berkman, Bradbury, and Magan (1997)	Mian (1996)	Geczy, Minton, and Schrand (1997)	Nance, Smith, and Smithson (1993)
Sample	Survey, response: 399 non-financial firms, 1998	Survey of New Zealand non-financial firms, 1996	3,022 firms, 1992; 771 hedgers and 2,251 non-hedgers	411 *Fortune* 500 firms, 1991	Survey of 169 firms, 1986
Model Variables	Descriptive statistics and charts	Descriptive statistics and charts	Logit	Logit	Logit
Dependent	Derivatives use	Derivatives use	Currency and interest derivatives use, categorical	Currency derivatives use, categorical	Derivatives use
Explanatory	Risk management: foreign exchange, interest rate, commodity, and equity	Risk management: foreign exchange, interest rate, and commodity	Variables reflecting market imperfections and tax progressivity	Variables reflecting market imperfections, substitution variables, foreign currency risks	Risk management and tax variables
Results	No impact of *FASB 133* on use or risk management strategy; usage rate increases among derivatives users	Use of derivatives by service firms is limited in both U.S. and New Zealand. Derivatives use in U.S.: reducing fluctuations in earnings (49%), cash flow (42%), or market value (8%)	*Negative* effect of contracting costs and market imperfections; no strong evidence on effect of taxes; significant firm size effect	*Significant* effects of R&D, interaction of debt and investment opportunities, and liquidity	*Significant* tax effect; significant R&D effect; substitution between derivatives use and other financial policies
Data	Survey data; randomly selected 2,000 publicly traded firms and 154 non-financial *Fortune* 500 firms	Survey data, categorical; 79 New Zealand firms (non-financial)	Annual reports of 3,022 firms; categorical data; users and non-users	Categorical data; users and non-users	Survey data, categorical; 535 firms from list of *Fortune* 500 and S&P 400; Compustat