PEPPERDINE UNIVERSITY

The Journal of Entrepreneurial Finance

Volume 3
Issue 3 *Fall 1994*

Article 4

December 1994

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Rick H. Mull
Fort Lewis College

Recommended Citation
Mull, Rick H. (1994) "Venture Capital, Private Firms, and the Capital Acquisition Process," *Journal of Small Business Finance*: Vol. 3: Iss. 3, pp. 229-248.
DOI: https://doi.org/10.57229/2373-1761.1157
Available at: https://digitalcommons.pepperdine.edu/jef/vol3/iss3/4

Venture Capital, Private Firms, and the Capital Acquisition Process

Rick H. Mull

This paper presents an empirical examination of the incentives motivating venture capitalists and sample of growth option intensive private firms with acute capital requirements to interact, the gains each group achieves through this association, the types of private firms successfully attracting venture capital, and mechanisms used in this funding process. Results show that venture capital backed firms achieve growth rates (1) greater than expected, and (2) greater than a matched sample of non-venture capital backed firms. This paper also finds that low collateral asset values, low profitability, and younger firm age to be significant determinants in which firms obtain venture capital funding. Finally, this paper shows that the use of the convertible preferred stock to be positively related to increasing firm risk, and that venture capital backed firms use convertible preferred stock more frequently than do non-venture capital backed firms.

I. INTRODUCTION

Recent venture capital research provides insight into the certification role of venture capitalists, their contract structures, risk/return characteristics, and investment decision processes[1]. Yet no empirical analysis currently exists examining how venture capitalists benefit by providing funds to private firms, nor the mechanisms they use in providing funds to private firms[2]. Additionally, there is limited empirical literature focusing on private firms with acute capital requirements, the specific mechanisms used by such firms in overcoming barriers to capital formation, and how these firms benefit by the use of venture capital. This paper integrates these ideas, examining the incentives motivating venture capitalists and private firms to interact, the gains each group achieves through this association, the types of private firms successfully attracting venture capital, and mechanisms used in this funding process.

Rick H. Mull • College of Business Administration, Fort Lewis College, Durango, CO 81301.

The Journal of Small Business Finance, 3(3):229–248
ISSN: 1057-2287

To explore this process, a matched sample of venture capital backed and non-venture capital backed private firms in high growth potential industries is identified. These private firms are confronted by the limited capital resources of private equity markets, as well as the informational (Myers & Majluf, 1984), incentive (Jensen & Meckling, 1976), and reputational (Diamond, 1984) difficulties associated with capital formation. Funding difficulties are further intensified by low historical profitability and an urgent need to finance high levels of non-collateralizable assets. As Whited (1992) shows, financial constraints significantly limit investment spending for even relatively large, publicly-traded firms. Capital limitations will surely be even more binding for small, private firms that need to finance very rapid growth.

This paper examines three basic predictions regarding the use of venture capital by private firms.

1. Venture capital involvement contributes to firm informational asymmetry reductions and provides reputational capital to certify firm value to outsiders (Barry, Muscarella, Peavey III, & Vetsuypens, 1990), and Megginson and Wiess (1991). Such benefits should stimulate capital access and allow venture capital (VC) backed firms to achieve greater growth than similar non-venture capital (non-VC) backed firms.
2. The high marginal capital costs associated with venture capital funding (Gartner, 1988, Morris, 1987, & Sahlman, 1988) suggests that firms with fewer alternative capital sources, higher capital requirements, lower collateral asset values, and expected returns potentially high enough to cover these costs may successfully obtain venture capital funding.
3. This paper predicts that venture capitalists are particularly adept at using convertible preferred stock, a specialized financial vehicle, as a mechanism to align management incentives, reduce investment risk, and provide valuable options on firms assets.

These predictions are examined using a matched sample of venture and non-VC backed firms. Initial comparisons find VC backed firms to have lower sustainable growth rates (a priori) than the matched set of non-VC backed firms. In spite of this, results show VC backed firms' actual growth rates to be far greater than the a priori expectations implied by sustainable growth rates. Further, VC backed firms realize greater positive spreads between sustainable (expected) and actual (subsequent) growth than non-VC backed firms. Here, evidence shows that both venture capitalists and the firms they back benefit by the gains reaped through higher growth. Regarding VC backed firm-specific

characteristics, results show that firms with lower collateral asset values, lower profitability, and younger age are associated with the use of venture capital. Finally, convertible preferred stock is found to be a significant funding mechanism associated with venture capital backing, and that its use is positively related to increasing firm risk as proxied by earnings per share, collateral asset value, and firm age.

II. SAMPLE DESCRIPTION

To examine the testable hypotheses, a matched sample of VC backed and non-VC backed private growth-option intensive firms is identified. Initially, 390 VC backed initial public offerings issued from January 1983 through September 1987 are identified from the *Venture Capital Journal.* To be included, VC backed firms must be in the IDD database and must also have a prospectus available from Bechtel Information Service. In order to generate as comparable a matched set of VC and non-VC backed firms as possible, each VC backed company is matched with a non-VC backed firm having the same three digit SIC classification. When there is more than one candidate, the non-VC backed company whose offering size is closest to that of the VC backed firm is selected. The final sample consists of 320 VC backed and 320 non-VC backed companies.[3] Financial data is gathered from information provided to the Securities and Exchange Commission by each firm in the prospectus (S-1 or S-18) of its initial public offering (IPO) registration statement.

One possible limitation of the sample is the possibility that these ex-post successful firms are not representative of private firms in general, imparting a selection and survivorship bias. Countering this is the point that this study focuses on the benefits of venture capital backing, not on determining the breadth of venture capital success. The focus on the benefits of venture capital backing necessitates the study of successful firms. Prospectuses are used since they represent the only available comprehensive source of financial information about private firms. Further, the sample is relatively large (320 firms) and taken from a matched strata of successful VC and non-VC backed IPO firms in the same industry. This should reasonably control for selection bias given this paper's focus.

III. PRIVATE FIRMS AND CAPITAL ACQUISITION

Private firms typically face numerous barriers to optimal capital formation. Confined to the limited resources of the non-public capital markets they are

unable to capture the benefits of public market monitoring. The sample firms in this study suffer additional firm-specific traits further limiting capital acquisition. Tables 1 and 2 summarize these characteristics and illustrate the unique nature of the firms identified in this study.

The sample SIC code distributions presented in Table 1 illustrate the high growth potential, high-technology industry concentrations of the sample firms. Fully 31.1 percent of all firms are in computer and electronics related businesses.[4] Table 2 surveys sample financial characteristics and highlights the sample firms' need for external capital to finance subsequent growth. First, low internal funds availability is suggested by low profitability and cash flow measures. Median earnings per share (profitability) for the VC backed sample is –0.045 and for the non-VC backed sample is $0.05. Median gross cash flow to long term debt (cash flow) is 0.069 for VC backed firms and 0.455 for non-VC backed firms. Yet these same firms achieve subsequent median

Table 1

Differences in Population Proportions Using Populations Proportions Tests Between 320 Venture Capital Backed (VCB) IPO's with Offer Amounts of $3 Million or Greater and Prices of at Least $5 Per Share and the Total Remaining Universe of 2324 Non-venture Capital Backed (NVCB) IPO's in Industries with Venture Capital Investment Activity from January 1983 through September 1987 Grouped by Four Digit SIC Code.

		Proportion (percents) for Individual SIC Code Categories		
SIC Code	*Classification*	*VCB*	*NVCB*	*Z**
283	Drugs/Biologics/Pharmaceutical	3.9	1.1	3.93[a]
307	Plastics/Rubber Products	1.8	0.6	2.33[b]
357	Computer Equipment	22.1	0.4	21.01[a]
366	Communication Equipment	2.1	0.5	3.22[a]
367	Semiconductors/Electronic Components	7.1	1.3	6.91[a]
384	Surgical/Medical/Dental Instruments	4.7	1.6	3.72[a]
506	Electronic Parts	1.5	0.2	3.08[a]
737	Prepackaged Software	9.7	4.1	4.46[a]
739	Biotech and Pharmaceutical Engineering	7.7	1.4	7.44[a]
	Totals	60.6	14.8	19.01[a]

Notes: Results are reported only for SIC codes with statistically significant results and venture capital investment greater than 1.5 percent.

*Z is the Z score for differences in two population proportions.

[a]Different from zero at the one percent level of significance.

[b]Different from zero at the five percent level of significance.

Table 2
Selected Descriptive Statistics for the Industry-matched Set of Venture Capital Backed (VCB) and Non-venture Capital Backed (NVCB) Firms Going Public Between January 1983 and September 1987.

Variable	*Fir Type*	*Number of Observations*	*Mean Value*	*Median Value*	*Standard Deviation*
Total asset compound annual	VCB	272	122.4%	53.4%	2.37%
growth rate (% per year)	NVCB	270	211.1%	33.2%	12.87%
Earnings per share	VCB	278	–0.307	–0.045	1.04
	NVCB	279	0.034	0.050	2.35
Earnings per share variance	VCB	268	0.741	0.061	3.47
	NVCB	259	0.745	0.025	9.45
Inventory and gross plant &	VCB	156	1.311	0.478	10.38
equipment / total assets	NVCB	167	0.542	0.518	0.31
Gross cash flow /	VCB	112	–6.473	0.069	105.32
long term debt	NVCB	127	1.605	0.455	5.378
R&D Expenditures /	VCB	309	0.110	0.064	0.257
total assets	NVCB	286	0.135	0.011	0.484
Non-collateralizable expenses /	VCB	288	0.174	0.093	0.225
total assets	NVCB	287	0.192	0.042	0.552
Total debt / total assets	VCB	226	0.281	0.189	0.309
(first financial statement)	NVCB	245	0.318	0.415	0.742
Total debt / total assets	VCB	329	0.611	0.601	0.385
(last financial statement)	NVCB	328	0.755	0.663	0.665
Firm age (in years)	VCB	317	8.58	5.28	13.35
	NVCB	295	12.24	8.01	14.31

Notes: Information was obtained from the firm's prospectus (S-1 or S-18) of its initial public offering (IPO) registration statement.

[a]Total asset growth is calculated as the compound annual growth rate of total assets from the first stated to the last year (just prior to the IPO) of financial data. Earnings per share variability is also calculated from the first stated to the last available year of financial data. Inventory and gross plant and equipment/total assets, gross cash flow/long term debt, R&D expenses/total assets, and non-collateralizable (R&D expenses plus selling and marketing expenses) to total assets are calculated using the earliest financial data available. Total debt total assets are calculated for both the initial provided financial statement and the last statement prior to the IPO. Firms age is calculated as the number of years from the incorporation date to the firm's IPO.

compound annual total asset growth rates of 53.4 percent for VC backed and 33.2 percent for non-VC backed firms. To achieve such growth in the face of low profitability and cash flow (liquidity) suggests a heavy reliance on external funding.

The sample firms are also young (even start-up) firms, with median ages of 5.28 years for VC backed firms and 8.01 for non-VC backed firms. Their age suggests a lack of firm reputation and high informational asymmetries. Myers and Majluf (1984) show how informational asymmetries would prompt corporate managers into rationally foregoing positive NPV investment opportunities if the firm's internal cash flow is insufficient to fund these projects. Also, Jensen and Meckling (1976) describe how such agency and incentive problems between insider owners and outside investors would distort investment decisions and reduce external funding availability.

Further exacerbating capital requirements, the sample firms also exhibit the need to fund both research & development (R&D) expenses and selling & marketing expenses to generate and exploit potential growth options. The VC backed sample records a median ratio of 6.4 percent R&D expenses to total assets, with the non-VC backed sample recording a 1.1 percent value. For non-collateralizable assets (research & development plus selling & marketing expenses) to total assets, the VC backed sample has a median 9.3 percent while the non-VC backed sample has a median 4.2 percent. Griliches (1986) documents a high payoff to firms successfully commercializing such projects. Unfortunately, externally funding such growth projects is difficult due to both the non-collateralizeable nature of the asset produced by these expenses and the inherent difficulty involved with credibly conveying information about the value of such projects to outside investors.

A mechanism allowing these firms to overcome binding liquidity and non-collateralizable asset constraints would allow these young, cash poor, growth-option intensive firms to increase capital infusions and expand beyond their ability to generate cash through existing operations. The role of the venture capitalist as just such a mechanism is now examined.

Financial Intermediation and Venture Capital

The points outlined above suggest an economically valuable role for a financial intermediary able to reduce informational asymmetries by gathering relevant inside information about a project's potential, and simultaneously capable of directly funding promising growth options. By directly funding successful growth options, financial intermediaries would benefit

through higher portfolio returns, while firms would benefit through increased investment and firm growth.

Chan (1983) provides a formal model of the venture capitalist as a financial intermediary.[5] Venture capitalists appear to posses the characteristics of intermediaries as outlined in the classic models of Pyle (1971), Benston and Smith (1977), Campbell and Kracaw (1980) and Diamond (1984). Venture capitalists issue claims against themselves, using those funds to purchase other financial assets. They also lower financial transaction costs and capture the benefits of informational intermediation through their role as direct investors. Venture capitalists combine the functions of an intermediary to external capital sources, a direct investor able to exploit revealed profit opportunities, and a corporate insider/director able to effectively monitor and discipline management. This unique combination of roles allows the venture capitalist to develop specialized market niches as described in Fama and Jensen (1985).

This paper predicts that the ability to directly fund growth options, become corporate insiders reducing informational asymmetries, and provide reputational capital certifying firm value to outsiders (Barry, et al., 1990; and Megginson & Weiss (1991)), will reduce capital formation barriers and result in more optimal levels (higher) of firm investment.[6] This is tested in Table 3 by examining VC backed and non-VC backed firm differences in sustainable (a priori or expected) and actual total asset growth rates.

Expected growth rates are measured using the "sustainable growth rate" (SGR) methodology in Higgens (1977). Sustainable growth rates are calculated as a function of a firm's profitability and cash flow from operations, its collateralizable asset base, and its borrowing capacity. It is measured as the achievable growth rate assuming a constant debt ratio, payout ratio and ROE. Note that an analysis of other sample characteristics shows that almost all sample firms pay no dividends (Maquieira & Megginson, 1993) document a similar point). Thus, asset growth differences subsequent to SGR time period calculations may be attributed to access to either external debt and/or equity capital resources.

Initially, a comparison of sustainable growth rates examines the relative future growth expectations of the two samples. Table 3, Panel A reports the VC backed sample to have lower sustainable growth rates than the non-VC backed sample. For every year prior to the IPO, the difference between the VC backed and non-VC backed firms' (VCB-NVCB) sustainable growth is negative and significant. This suggests that, a priori, VC backed firms are expected to have lower actual growth rates than non-VC backed firms. However, Table 3, Panel B examines subsequent actual growth rates and reports significant and positive differences for the VC backed subset. VC

Table 3

Descriptive Statistics for Sustainable Growth rates (SGR) in Panel A and Actual Growth Rates (AGR) in Panel B for a Matched Set of 320 Venture Capital Backed and 320 Non-Venture Capital Backed Firms.

Panel A - Sustainable Growth Rates (SGR)[d]

Firm Classification	*SGR T-3(N)*	*SGR T-2 (N)*	*SGR T-1 (N)*	*SGR T0 (N)*
Venture Capital Backed	-.149[b] (170)	-.061[a] (228)	.043[c] (280)	.122[a] (306)
Non-Venture Capital Backed	.239[a] (159)	.222[a] (209)	.345[a] (252)	.230[a] (287)
Difference (VCB - NVCB)	-.272[a] (76)	-.036[a] (138)	-.358[a] (203)	-.102[a] (247)

Panel B - Actual Growth Rates (AGR)[e]

Firm Classification	*AGR T-3 (N)*	*AGR T-2 (N)*	*AGR T-1 (N)*
Venture Capital Backed	.550[a] (194)	.481[a] (236)	.364[a] (272)
Non-Venture Capital Backed	.395[a] (168)	.394[a] (214)	.257[a] (270)
Difference (VCB – NVCB)	.082[c] (90)	-.031 (149)	.122[b] (207)

Panel C - Difference between Actual and Sustainable Growth (DASG = AGR – SGR)

Firm Classification	*DASG T-3 (N)*	*DASG T-2 (N)*	*DASG T-1 (N)*
Venture Capital Backed	.536[a] (154)	.538[a] (195)	.272[a] (240)
Non-Venture Capital Backed	.077[b] (139)	.059[b] (180)	-.092[b] (224)
Difference (VCB – NVCB)	.249[b] (65)	.315[a] (106)	.482[a] (159)

Notes: Panel C contains matched pair non-parametric tests for differences between the actual and sustainable growth rates (AGR-SGR) across the different sets of firms. The period for which variables are calculated include a time identifier (T_{-3} indicates the variable was calculated at three years prior to the IPO). Actual growth rates are calculated as the growth in total assets for the period indicated (AGR T_{-3} indicates a growth rate calculated from year -3 to year -2 prior to the IPO).

[a]Different from zero at the one percent level of significance.

[b]Different from zero at the five percent level of significance.

[c]Different from zero at the ten percent level of significance.

[d]Sustainable growth rate is calculated as:

$$SGR = \frac{p^*(S/A)*(1 + D/e)*R}{1 - p^*(S/A)*(1 + D/E)*R}$$

where p = profit margin, S/A = sales/total assets, D/E = debt/equity ratio, and R = retention ratio.

backed firms have achieved higher growth rates in total assets than their non-VC backed counterparts. Further, Panel C shows significant and positive differences between sustainable and actual growth rates (SGR-AGR) for the VC backed firms relative to the non-VC backed firms (VCB-NVCB). Here, not only are the actual growth rates shown in Panel B higher for VC backed firms, but the spreads between actual and sustainable growth rates are also greater for the VC backed firms.

These results suggest that firms benefit from venture capital backing by attaining growth rates greater than non-VC backed firms, and they achieve this in spite of the VC backed firm's lower sustainable (expected) growth rates. Such results would also explain why firms endure payoff structures that protect the venture capitalist and are also willing to concede to the potential loss of firm control if pre-specified demanding performance standards are not achieved.[7]

Firm characteristics

As illustrated above, firms experience important benefits associated with venture capital backing. In spite of this, few firms (less than 2%) successfully attract venture capital backing (see Gartner (1988, p. 35A-8). Thus, the next focus is to examine which firms are more likely to attract venture capital.

Amit, Golsten, and Muller (1990) present a model predicting several characteristics of firms likely to successfully attract venture capital.

1. With a pool of good projects and either risk averse entrepreneur's or a non-trivial need for new funds, they show that some entrepreneurs will always seek venture capital financing.
2. If only a portion of the entrepreneurs seek venture capital, it will be the less profitable firms.
3. They demonstrate how it may also be worthwhile for some entrepreneurs to expend resources to reduce informational asymmetries in conveying their ability to venture capitalists.

Three models are developed and tested in Table 4 by combining the predications developed in Amit et al. and the predictions of this paper. Model 1 incorporates the first two predictions of Amit et al. It models the likelihood of venture capital backing (VCB) as (1) a positive function of capital needs and (2) a negative function of firm profitability. To proxy for a firm's need for funds, gross cash flow to long term debt, sustainable growth rates, and inventory plus gross plant and equipment to total assets are used. Less gross cash flow (net income plus depreciation) to long term debt suggests a greater

need for funds, since these young firms must at a minimum meet debt service to stay solvent. Lower sustainable growth rates imply higher funding needs, holding firm decisions on the debt ratio, payout ratio, and return on equity constant. Finally, lower inventory plus gross plant and equipment ratios imply lower asset collateral value, suggesting a higher need for alternative capital sources. Profitability is proxied with earnings per share, since lower profitability would suggest greater external funding needs. Model 1 is summarized as follows with the expected signs of the variables indicated:

> *Model 1 : VCB* = f(sustainable growth [–], gross cash flow to long term debt [–], inventory plus gross plant and equipment [-] , earnings per share [–]).

Model 2 adds proxies for informational asymmetries to the model of Amit, et al. If venture capitalist are indeed capable of reducing informational asymmetries through their active role in firm management, such skills should be more valuable to firms with greater informational asymmetries. Firm age is used to proxy for informational asymmetry. Younger firms could be expected to have greater informational asymmetries, since they have developed less market reputation and because they are less technologically and operationally established. While it is true that different industries grow and mature at different rates, ceterus paribus, younger firms will face greater risk and uncertainty than older firms. Venture capital investment should have a greater impact in these young companies than in more established firms.

> *Model 2 : VCB* = f(sustainable growth [–], gross cash flow to long term debt [–], inventory plus gross plant and equipment [–], earnings per share [–], firm age [–]).

The final variable added to the model incorporates the signalling prediction of Amit, et al. Expending resources to signal project quality outsiders would allow firm owners to more credibly convey the value of their project to outside investors. The presence of convertible preferred stock is used to proxy for owner signalling. This option granted by owners to venture capitalists allows entrepreneurs to offer the venture capitalist not only a financial claim superior to their own, but also an instrument that could be used to limit an entrepreneur's freedom of action and even replace the entrepreneur if corporate objectives are not met. Convertible preferred stock also gives the venture capitalist an equity claim on that portion of the gains achieved through increased investment and asset growth. Model 3 is summarized as:

> *Model 3: VCB* = f(sustainable growth [–], gross cash flow to long term debt [–], inventory plus gross plant and equipment [–], earnings per share [–], firm age [–], convertible preferred stock [+]).

Table 4
Logistic Regression Results for Tests of Models Predicting Firms Seeking Venture Capital Backing on the Basis of Specific Firm Characteristics.

Variables[d]	*Model 1*	*Model 2*	*Model 3*
Intercept	–0.26	–2.26[b]	–0.36
Earning per share	0.91	0.37[a]	0.25
Sustainable growth rate	–0.14[c]	–0.12[c]	–0.10
Inventory and gross plant & equipment / total assets	0.19	0.33	0.13
Gross cash flow / long term debt	–0.32[b]	–0.29[b]	–0.34[b]
Firm age in years		–0.64[b]	–0.41[b]
Use of convertible preferred stock			2.52[a]
–2 log likelihood ratio w/intercept only	151.945	151.125	148.129
–2 log likelihood ratio at convergence	32.102	127.237	102.904
Approximate Model R^2	.150	.188	.439
Model Chi-Square	19.846[a]	23.888[a]	45.225[a]
Number of observations	225	221	219

Notes: The dependent variable is a qualitative variable with 1 = the presence of venture capital backing and 0 = no venture capital backing at the firm's IPO.

[a]Different from zero at the one percent level of significance.

[b]Different from zero at the five percent level of significance.

[c]Different from zero at the ten percent level of significance.

[d]All variables remain as calculated in Table 2 and 3. The use of convertible preferred stock is identified with a (1,0) dummy variable, based on the use of convertible preferred stock at any point during the reported operating history of the firm. Sustainable growth is calculated using the earliest available financial data for the firm.

Table 4 presents estimations for the three models. Regression results for Model 1 finds significant negative relationships between the dependent variable of VC backing and the independent variables of sustainable growth rate and gross cash flow to long term debt. This suggests that firms with lower sustainable growth rates and weaker cash flows are more likely to attract venture capital, confirming the first of the Amit, et al. model predictions.

The regression estimation for Model 2 adds the informational asymmetry proxy of age. Recall that younger firms are argued to have less reputation and greater informational asymmetries, and are thus more likely to obtain VC backing. Model 2 estimation finds firm age negatively related to VC backing. This suggests that firms may benefit from the part played by the venture capitalist in reducing informational asymmetries. As before, VC backing is

negatively related to gross cash flow levels. However, VC backing is found positively related to the profitability proxy of earnings per share. This is not consistent with Amit, et al's prediction and suggests instead that venture capitalists finance profitable firms that have weak cash flows and that are unable to internally finance rapid growth.

The final regression estimation, Model 3, adds convertible preferred stock as a proxy for signalling. Results show the use of convertible preferred stock positively related to VC backing. As Amit et al. (1990) theorize, some entrepreneurs are willing to expend resources to provide signals of firm value to venture capitalists.

Private firms may be signalling their expectation that the project will be successful enough to overcome the high cost of granting the venture capitalist the valuable conversion options and potentially restrictive control mechanisms associated with convertible preferred stock. Conversely, adding convertible preferred stock as an independent (presumably exogenous) variable may cause a specification problem in the model, since use of this security may be serving as a proxy for VC backing itself. This could happen if venture capitalists choose to use this security for various, endogenous reasons other than simply as a signalling tool. The issue of convertible preferred stock choice is examined in the next section.

Determinants of Convertible Preferred Stock Usage

Since securities are selected to efficiently align incentives, reduce risk, and provide returns, Table 4 (Model 3) results lead to questions regarding specific conditions under which convertible preferred stock is preferred by firms and investors. We now examine (1) the factors motivating the use of convertible preferred stock, and (2) who is more likely to use convertible preferred stock.

Sample firm traits suggest that optimal funding will occur with equity based securities. The technologically sophisticated firms in this study exist to exploit lucrative growth options. Myers (1977) shows that such growth-option assets are difficult to finance externally-particularly with debt capital. Jensen and Meckling (1976) likewise describe serious agency costs associated with the use of debt financing. Smith and Warner (1979) document significant costs associated with enforcing debt contract covenants. Further, the earnings variability of these rapidly-growing firms with unproven technologies argues for less debt financing. This is shown by Bradley, Jarrell, and Kim (1984) who find leverage ratios inversely related to earnings volatility. Also, large research & development expenditures are fixed costs increasing operating leverage. As Dotan and Ravid (1985) make clear, firms with high levels of operating

leverage should use relatively less financial leverage than otherwise equivalent companies. In an empirical study, Titman and Wessels (1988) document a significant negative relationship between leverage ratios and non-collateralizable assets (such as R&D expenditures) in a firm's asset structure. These arguments all suggest that the growth-option-intensive investment opportunity sets of private firms should be funded as much as possible with equity rather than debt capital.

When venture capitalists are involved, convertible preferred stock offers several attractive features.[8] First, while the use of convertible preferred stock allows investors to achieve financial claims senior to the entrepreneur owner, it simultaneously enhances the firm's borrowing capacity by increasing the firm's equity base. Further, this hybrid security allows the venture capitalist to maintain a tight reign over firms by creating a separate security class into which positive and negative covenants can be inserted. This controls management's freedom of action in a way that voting rights alone could not achieve. It also effectively isolates most business risk on the firm, even while claims on superior performance (through the conversion feature) are retained by the venture capitalist. Green's (1984) theoretical analysis of the investment incentives that can be achieved with debt and warrants, shows that such convertible fixed claim securities may beneficially restructure managerial incentives. Such a restructuring of managerial incentives may reduce the agency cost of either equity or debt financing (Jensen & Meckling, 1976), and diminish the incentives of managers to sub-optimally invest (Myers, 1977; Myers & Majluf, 1984).

Convertible preferred stock (CPS) may therefore assist firms and investors by restructuring incentives. Given such a restructuring, firms could be expected to attract greater amounts of capital and achieve higher growth (such as those in Table 3). Based on this, the use of CPS is expected to be directly related to actual, and inversely related to sustainable growth rates. Venture capitalists benefit both by shifting risk to the firm and through greater control over firm actions while using the convertability option to increase investment leverage and potential returns. Accordingly, if convertible preferred stock is indeed a security capable of aligning risk, then its frequency of use should be an increasing function of firm risk. The predictions that convertible preferred stock use is positively related to actual growth rates, firm risk, and negatively related to sustainable growth rates, is tested in Table 5.

Table 5 models the use of convertible preferred stock as a function of four proxies of firm risk and as a function of actual and sustainable growth rates.[9]

1. Earnings per share is used as a measure of firm profitability. Less profitability should imply greater firm risk.

Table 5

Logistic Regression Model Results for Use/Non-use (1,0) of Convertible Preferred Stock by Venture Capitalists Based on Key Variables from a Sample of 320 Venture Capital Backed Firms. Data for this Sample was Gathered from Firm Financial Statements Provided in the Firm's Prospectus (S-1 or S-18) of its Initial Public Offering (IPO) Registration Statement.

Explanatory variable[d]	*Coefficient*	*Chi-Square*
Intercept	–0.127	0.03
Earnings per share	–1.191	8.69[a]
Firm age in years	–0.543	3.19[b]
Gross plant and equipment to total assets	–0.289	3.34[b]
R&D expenses to total assets	0.289	0.21
Asset growth	0.466	2.71[c]
Sustainable growth rates	–0.149	4.47[a]
–2 log likelihood ratio w/intercept only		235.36
–2 log likelihood ratio at convergence		202.84
Approximate Model R^2		.16
Model Chi-Square		19.72[a]

Notes: [a]Different from zero at the one percent significance level.
[b]Different from zero at the five percent significance level.
[c]Different from zero at the ten percent significance level.
[d]All variable are calculated as described in Table 2, 3, and 4. Revenue growth is calculated as the compound annual growth in revenue from the earliest to the latest financial data.

2. Firm age is used as a proxy for informational asymmetry and reputation. Younger firms imply greater informational asymmetries, less firm reputation, and greater investment risk.
3. The ratio of gross plant and equipment to total assets is used as a measure of collateral asset value. Firms with less collateral value should have more difficulty in raising capital.
4. R&D expenses to total assets are used to proxy for the lack of collateral value.

Higher levels of R&D should suggest greater risk, since these expenses are associated with less predictable returns than other investments. Actual growth rate is measured by the observed asset growth, while sustainable growth rate is the same proxy as used previously.

The model estimation in Table 5 shows earnings per share negative and significant at the one percent level, and both firm age and the ratio of gross plant and equipment to total assets negative and significant at the five percent level. R&D expenses to total assets are not significant. This may occur since higher R&D expenses may proxy not only risk, but growth options and potential returns as well, offsetting its ability to accurately measure firm risk. However, finding the use of convertible preferred stock to be a positive function of other firm risk proxies suggests that its use serves to align incentives between the firm and outside investors.

The obvious question that follows is, why is it not more commonly used? As noted earlier, the incentive alignment benefits of convertible preferred stock may be not only a function of firm attributes, but of investor characteristics. To take advantage of the control mechanisms it affords, investors must be capable of making informed decisions. Because of their ability to directly invest in firms and actively participate in firm management as corporate insiders, venture capitalists should be better able to utilize the risk alignment features of convertible preferred stock. They do this while simultaneously benefiting through the leverage of its convertability feature. The prediction that venture capitalists will use convertible preferred stock more frequently than other investors is tested by examining differences in the frequency of convertible preferred stock use by VC backed and non-VC backed firms.

Table 6 presents the results for a comparison of the frequency of convertible preferred stock use by both VC backed and non-VC backed firms. Results show that 41.92 percent of the VC backed firms and 12.58 percent of the matched non-VC backed firms use convertible preferred stock. Sample proportion tests finds this difference significant at the one percent level, showing that convertible preferred stock is far more frequently used by VC backed firms. This provides evidence that venture capitalists and a specific class of firms may reap important benefits through incentive alignment achieved through use of this complex financial security.

IV. CONCLUSIONS

This paper presents an empirical examination of the gains achieved through the interaction of venture capitalists and a sample of growth option intensive private firms with acute capital requirements.

The symbiotic relationship between venture capitalists and the firms they back allow each to capture the benefits of higher growth. Findings show that

Table 6

Population Proportions and Proportion Test for Significant Differences in the Use of Convertible Preferred Stock by Venture Capital Backed and Non-venture Capital Backed Firms. The Sample Consists of 320 Venture Capital Backed Firms and a Matched Set of 320 Non-venture Capital Backed Firms with an Initial Public Offering between January 1983 and September 1987.

	Sample Size	*Proportion with Convertible Preferred Stock*
Venture capital backed firms	$n_1 = 320$	$p_1 = .4192$
Non-venture capital backed firms	$n_2 = 320$	$p_2 = .1258$
Combined (total) sample	$n = 668$	$p = .2720$

Notes: financial statements provided in the firm's prospectus (S-1 or S-18) of its IPO registrations statement were searched for evidence of convertible preferred stock use during the reported operating history.

$Z^* = 8.43$ indicates positive differences significant at the one percent level for the venture capital backed sample relative to the non-venture capital backed sample proportions.

Sample sizes represent the total number of firms in each category for which financial data has been analyzed. The proportions listed represent the proportions of the sample that were found to have used convertible preferred stock at any time during the reported operating history prior to the firm's IPO. Z^* is based on difference in sample proportion statistics.

VC backed firms achieve greater growth than a matched set of non-VC backed firms. They accomplish this in spite of having lower sustainable growth rates than a matched set of non-VC backed firms. Further, VC backed firms experience larger positive differences between sustainable (expected) and actual growth rates. Characteristics of firms likely to successfully attract venture capital are also identified. Evidence shows that firms characterized by younger age and higher earnings per share, but lower gross cash flow and sustainable growth rates are associated with venture capital backing. Finally, this paper shows that the use of convertible preferred stock is associated with incentive alignment and risk reduction. Its use is positively related to increasing firm risk and revenue growth, but inversely related to sustainable growth rates. Tests results also show convertible preferred stock is used far more frequently by venture capital backed firms.

The findings of this paper suggest that venture capitalists act as financial intermediaries in funding firms, having developed a special niche of high risk, high potential return (but low profitability) firms to fund. They are an efficient source for capital to these firms primarily due to their unique combination of both financial and informational intermediary roles. This combination of roles, along with the use of convertible preferred stock, allows

venture capitalists to reduce informational asymmetries and more closely align firm incentives with their own. The achievement of higher growth rates for VC backed firms illustrates how venture capitalists successfully demand rates of return on their investments far exceeding rates charged by other intermediaries.

Firms also benefit from this relationship. Firms allow venture capitalists (outsiders) to garner important inside information about the value of their projects. They expend resources (signalling) by allowing the use of convertible preferred stock as a funding mechanism. Firm owners also allow the potential of their removal if objectives are not met. Thus, the entrepreneur/owners of VC backed firms are able to effectively convince outsiders of project value, and benefit through faster increases in their asset base than a matched sample of non-VC backed firms.

NOTES

1. For background on the certification role of venture capitalists during a firms Initial Public Offering, see Barry, Muscarella, Peavey, and Vetsuypens (1990), and Megginson and Weiss (1991). For information of the contract structures employed by venture capital limited partnerships, see Sahlman (1988, 1990), Gartner (1988), and Bygrave (1988). See Huntsman and Hoban (1980), Martin and Petty (1983), Brophy and Verga (1988), and Chiampou and Kallett (1989) for literature detailing the risk and return performance of venture capital investments in publicly traded venture capital firms. Aspects of various venture capital investment decisions processes are discussed in Tyebjee and Bruno (1984), Robertson (1987), and Macmillan, Kulow, and Khoylian (1988).
2. Several previously noted studies do theoretically suggest benefits and mechanisms related to venture capital backing. However, the author believes this paper to be the first in depth empirical analysis, outside of individual case analysis, specifically examining the benefits and mechanisms associated with venture capital backing using a large number of venture capital backed firms.
3. This same sample is the same as used in Megginson and Weiss (1991). The author expressly thanks them for generously providing valuable financial data.
4. To construct the matched sample, the universe of 2,644 firm commitment IPOs issued from January 1983 through September 1987 is obtained from Investment Dealers' Digest Corporate Database (IDD). After eliminating financial institutions, S&Ls, and firms whose first day trading price is unavailable from *Standard and Poor's Daily Stock Record: Over-the-Counter*, the remaining sample of firms from which matches are identified consists of 1,845 offers. To formally test whether venture capitalists concentrate their investment in particular industries (i.e., high-tech), the industry distribution of VC backed IPOs is examined for significant differences from the universe of all 2644

IPOs during the study period. The hypothesis that these two groups are drawn from the same population of firms can be rejected at the one percent significance level.

5. There are two other economic roles played by the venture capitalist. First, venture capitalists are expected to perform a certification function during initial public offerings when they, along with auditors and investment bankers, place their reputational capital at risk to certify that the offering price incorporates all relevant private information. Second, venture capitalists who retain their ownership stakes in newly-public firms perform the management monitoring function typically expected of large-block shareholders. See Barry et al. (1990) and Megginson and Weiss (1991).
6. In an analogous fashion, Koshi, Kashyap, and Scharfstein (1989) examine a set of Japanese firms with informational (Myers & Majluf, 1984) and incentive (Jensen and Meckling) problems. They find that those firms which are associated with a "Keiretsu" (industrial group) are less concerned with liquidity than those which are not, and that they are thus able to pursue a more optimal investment strategy.
7. Several authors—including Gartner (1988), Morris (1987) and Sahlman (1988)—have documented that venture capitalists expect compound annual returns on the private-firm investments they make to range from 25 to over 50 percent, depending upon the stage of project development. The payoff structure implied here is the use of convertible preferred stock. The specific arguments for this security are presented later.
8. The use of convertible preferred stock (CPS) has been previously suggested by Sahlman (1988, 1990), Golder (1987), and Testra (1987). However, the author knows of no formal test (1) to determine actual frequency of CPS use by venture capitalists in a sizeable sample, or (2) to examine characteristic differences in CPS usage between venture capital backed and non-venture capital backed firms.
9. Note that it can only be determined if a firm has CPS in its capital structure at the time of (or within three years of) its IPO. If the firm had used CPS early in its history, there may be no evidence of that fact remaining in the financial statements disclosed with its IPO. This measure of CPS usage must therefore be considered a lower bound. Further, firms are not consistent in the method for reporting the use of CPS. Since most firms eliminate CPS from their capital structure prior to the IPO, disclosure requirements are limited. Thus, a majority of firms do not report additional information such as common share equivalents, the size of the block held by any one individual, or voting rights.

ACKNOWLEDGMENTS

I thank Bill Beranek, David Blackwell, Mary Dehner, Steve Jones, Mike Long, William Megginson, Jeff Netter, Annette Poulsen, Clifford Smith, Jim Verbrugge, Kathleen Weiss, and William Wetzel for comments and recommendations. Financial support for this project was provided by The Center for Entrepreneurial Studies at New York University, and by the University of Georgia Research Foundation.

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