A Cross-sectional Analysis of Firm Growth Options

Michael S. Long, John K. Wald, and Jingfeng Zhang*

Department of Finance and Economics
Rutgers Business School – Newark and New Brunswick
Newark, NJ 07102-1820

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Abstract

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JEL Classification: D24, G31

Keywords: real options, empirical valuation

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*Emails: mikessam@aol.com, wald@rbs.rutgers.edu, jingfeng@andromeda.rutgers.edu. Tel: (973) 353-5163, Fax: (973) 353-1233. We wish to thank Young-Hye Cho, Palani-Rajan Kadapakkam, Itzhak Venezia, and seminar participants at the 2002 Financial Management Association Conference for helpful comments on earlier drafts.

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I) Introduction

Growth in the economy results from both savings and improvements in production efficiency. While the former is relatively simple to measure, the latter is hard to measure *a priori*, but one estimate of gains in production efficiency is provided by the stock market. Specifically, high growth firms, those which will undergo gains in production or demand, can be identified by high price/earnings ratios. However a measure of future growth which relies only on price/earnings ratios includes the effect of different risk levels as well as different forecasted efficiency improvements. In more modern financial economics the value of the firm can be separated into the value of its earnings from assets-in-place plus the value of projected future growth, including new products and improved production of current ones. This second portion of a firm's value is the present value of future investment options, commonly referred to as the present value of growth options (PVGO).

Knowing what factors affect growth options gives a better understanding of the economy's mechanics and how economic policy should be set. For instance, do product markets affect the portion of growth options? If they do, policies which control market structure may impact growth. Or do firm specific undertakings such as R&D or advertising primarily increase growth? In this case, tax policy could be directed to stimulate these activities. Improvements in understanding how these factors impact a firm's real options could help in setting policies which would encourage growth. We therefore examine how the market's perception of a firm's growth options varies depending on firm specific and product market characteristics.

Recently, these growth options have been the focus of a great deal of academic attention (see, for instance, Dixit and Pindyck, 1994; Abel and Eberly, 1994; Abel, Dixit, Eberly, and Pindyck, 1996), and modern text books often discuss how maximizing these options is an important component of the modern manager's training (see, for instance, Damadaran, 1997, Brealey and Myers, 2000). However, relatively little empirical work has been done on measuring what types of firms have growth options and how these options are related to market structure.

We hypothesize that growth options may be related to a variety of individual firm characteristics. Firms with higher R&D and higher advertising expenses may be more likely to generate new products, and their brands may generate larger income after production; thus we hypothesize that these firms may have higher PVGO. We also hypothesize that firms with higher growth options may have lower leverage, as lower current earnings will support less debt, and also because the PVGO may be reduced by higher bankruptcy risk. Alternatively, higher leverage may be associated with a higher PVGO for the firm's equity, as all the residual value, and thus all the options associated with the underlying assets, accrue to equity while the currently held assets may be financed largely with debt. We also test whether higher variance of earnings is associated with a positive option value, and thus with a larger PVGO (see, for example, Pindyck, 1988). Additionally, we examine the relationship between the firm's investment policy and its PVGO. We include controls for the firm's average Q, and show that the results are robust to a variety of specifications.

A firm's PVGO may instead be more closely related to its product market than to its individual characteristics. For instance, small firms may have trouble competing with larger firms in their market, and thus the value of their growth options may be lower. Alternatively, small firms may be more nimble in finding new opportunities, and thus may have larger growth options. We include both the firm's size and it's size relative to its product market to measure these effects. Firms in more concentrated markets may also have higher growth options, as new products will face lower competition, and so we include the market's Herfindahl-Hirschman index to test for the impact of market concentration. The level of product diversification may also be related to the amount of the firm's growth options, and so we include a variable which measures the degree of the firm's diversification.

In order to test our hypotheses, we construct no-growth estimates of the equity value of a set of manufacturing firms and subtract them from the firms' equity market values. The additional portion of the firm's equity value is an estimate of the firm's PVGO. We examine the relationship between the firm's PVGO and its individual and market characteristics using both raw correlations and a variety of regressions.

As expected, we find that firms with higher R&D have significantly higher PVGO, and that larger firms, and those that operate in more concentrated industries have higher PVGO. We find mixed evidence of the relationship between debt and PVGO, with some indication that the relationship may be positive. Our results also suggest that market structure impacts a firm's PVGO. This result contrasts with Hirschey (1985) who does not find a significant relationship between market value and firm concentration but agrees with the findings of Thomadakis (1977).

Additionally, we find that PVGO is negatively correlated with current investment. This suggests that on average firms with more growth options delay investment; as with regular options, the value of these real options may be increased by delaying exercise (see Dixit and Pindyck, 1994).

Section II briefly addresses the literature on growth options and how our empirical findings relate to the theory. Section III discusses the data and methodology, whereas section IV presents our findings and discusses some robustness checks. Section V concludes.

II) The Literature on Growth Options

In the economics literature, the value of a firm's growth options is part of the literature on investment. Reversible investment decisions with quadratic adjustment costs lead to the Q-model of investment (Hayashi, 1982). Irreversible investment allows future growth opportunities to be valued as options (see, for instance, Pindyck, 1988). Moreover, the stockholders of the firm can also put the firm's assets if their value drops below the value of debt (Venezia and Brenner, 1977; McDonald and Siegel, 1985; Pindyck, 1988; Abel et al, 1994).

Berger, Ofek, and Swary (1996) confirm that a firm's value increases in its exit value. Thus, more generalizable assets produce a higher put option value, and this has a measurable positive impact on the value of the firm. In this study, we instead focus on the growth (call) options, rather than the put option empirically analyzed by Berger et al (1996).

Thomadakis (1977), Lindenberg and Ross (1981), Hirschey (1985), and Lustgarten and Thomadakis (1987) test whether firm concentration in the product market impacts the market value of a firm using somewhat different ratios. Thomadakis (1977) and Hirschey (1985) use the difference between market value and book value of the firm scaled by the firm's sales, whereas Lindenberg and Ross (1981) use Tobin's Q. Thomadakis (1977) finds a significant relation between firm concentration and market value, whereas Lindenberg and Ross (1981) and Hirschey (1985) find no significant relationship. Our findings are consistent with Thomadakis' (1977) results; they suggest that market concentration does impact the value of a firm's growth options.

Lustgarten and Thomadakis (1987) also consider that the Q ratio's relationship with market structure variables should change across time with market conditions. Of course the traditional Q ratio incorporates both the firms ability to earn excess returns on existing assets and the value of its future growth opportunities. They find that industry concentration was positively related to Q in the mid-1960's during a long bull market, but was negatively related in the mid-1970's after the start of what would turn out to be a lengthy bear market. They interpret these findings as implying that product market structural features must be interpreted as indices of resource flexibility rather than as sources of stable positive rents. However, their results could result from two opposite explanations for concentrated industries. The traditional industrial organization argument was that more concentrated industries can extract monopoly rates of return, hence firms in these industries would have higher Q ratios (the soft drink industry may be an example of a sector with such market power). Another possible argument is that higher concentration represents mature industries in which firms have consolidated for economies of scale reasons to create high concentration levels. These firms have low future growth options and no competitive advantage giving them low Q ratios (the paper industry may be a sector with this type of concentration). Using interactions between our measure of market power and Q, we specifically attempt to test between these alternatives.

III) Data and Methodology

We examine what variables are associated with PVGO using a sample of manufacturing firms available in the COMPUSTAT database for 1992, then again for 1997. We consider only these two years as the census bureau only provides HHI information for manufacturing firms on five-year intervals. We additionally extract CRSP return data in order to calculate firm-specific betas. Whereas the initial sample is quite large, at 5,048 firms in 1992, most firms are dropped due to missing data. We find 619 manufacturing firms in 1992 and 871 firms in 1997 that have all the variables we need. When calculating variables requiring longer historical time series, such as the standard deviations of sales, an even smaller sample is obtained. For every analysis, we report the results using the largest sample available, although using only the smaller samples does not significantly impact the results.

In order to estimate the portion of the firm's value that results from the present value of growth options (PVGO), we estimate the firm's projected earnings from assets in place, capitalize those earnings, and then subtract the value of the-assets-in-place from the firm's market value of equity.[1] The resulting PVGO estimate is then scaled by the firm's market value of equity to obtain the portion of equity value due to growth options.

[1] Notice that following Brealey and Myers (2000), we define PVGO as the option value of *equity*, not of the firm as a whole.

Specifically, we calculate the projected earnings from assets in place by multiplying the value of common equity by the return on equity (ROE).[2] We estimate ROE by the operating cash flow (COMPUSTAT number 308) divided by the beginning period book value of long-term liabilities not including debt (COMPUSTAT data 6 – 5 –19).[3] We tried several different definitions for ROE;[4] however, we believe that operating cash flow divided by non-debt long-term liabilities best captures the actual economic returns to equity rather than accounting definitions.

We then weigh the estimated ROE from the four prior years prior so as to give greater weight to more recent observations. We estimate:

$$\text{Average ROE} = .4\text{ROE}_{-1} + .3\text{ROE}_{-2} + .2\text{ROE}_{-3} + .1\text{ROE}_{-4} \quad (1)$$

We use this weighted average as more recent observations should provide a better indication of the true ROE. Moreover, using an equal average of the past four years provides very similar results. Those firms with a negative average ROE are excluded from the results, as we are not able to project cash flows for them (this amounted to 12% and 15% of our sample for 1992 and 1997 respectively).

We then multiply this estimated average ROE by the end-of-period non-debt long-term liabilities in order to generate projected cash flows. We discount these cash flows

[2] Note that we use historical returns on assets in place rather than forecasts from analysts (as used by Berger et al, 1996) because analyst forecasts would include a portion of the realized growth options.
[3] This includes the net shareholders' equity plus long-term liabilities such as deferred taxes.
[4] The other measures of ROE we use include alternative definitions for the numerator, such as net income minus preferred dividends (COMPUSTAT data 172 – 19), net income minus preferred dividends and extra ordinary items (COMPUSTAT data 172 – 19 – 192), and net income minus preferred dividends and discontinued items (COMPUSTAT data 172 – 19 – 48). We also test changing the denominator to the beginning period book value of common equity. The results are similar across these methods.

using a firm-specific discount rate to calculate the value of assets in place. We calculate these discount rates using adjusted betas (as suggested by Blume, 1975) where a one-factor historical beta is weighted equally with one.[5] Our historical betas are calculated using a 60-month covariance of the firm's equity returns with the returns on the S&P500 index. We calculate discount rates by using CAPM and a thirty-year treasury bond rate as our risk-free rate with a 7% risk premium over the long-term risk free rate. We adjust this discount rate for inflation using an estimated 4% inflation rate per year.[6] The PVGO is then set equal to the total market value of equity less the value of assets in place (associated with equity) divided by the total market value of equity.

We consider a number of other variables that we believe may explain cross-sectional differences in growth opportunities. These variables include capitalized R&D and advertising over total firm market value,[7] where R&D is capitalized using straight-line amortization over five years, and advertising expenses are capitalized over three years (these calculations follow Long and Malitz, 1985). We also consider whether leverage affects growth. For our leverage variable, we use total debt as a fraction of firm market value. As an estimate of the firm's past growth, we use the firm's sales growth over the past five years. To measure the level of firm investment, we consider the level of capital expenditures as a fraction of firm value. We also examine whether exchange listing affects PVGO with a dummy equal to one if the firm's stock is listed on the New York Stock Exchange (NYSE). To measure the risk of the firm's assets, we include the

[5]We tested a number of alternative definitions for beta, and find they have little impact on the results. For instance, we used just the historical betas, the Value Line estimates of betas equal to 2/3*1 + 1/3*historical beta (Brigham, Gapenski, and Ehrhardt, 1999, p. 450), or just using a beta equal to one for all firms. The overall results are largely insensitive to the definition of beta..

[6] We also try a number of possible inflation rates from 2.5% to 5%, with little impact on the results.

[7] We also scale all our variables by the firm's book value and find similar results.

standard deviation of first differences of the firm's sales divided by firm value.[8] Lastly, we control for average Q, defined as the market value of equity minus the book value of equity plus the book value of total assets all divided by the book value of total assets (see Smith and Watts, 1992, and Shin and Stulz, 1998). As average Q is the most widely used measure of firm value, we include regressions with and without this variable to demonstrate that the correlations we find for PVGO are not due to correlations between Q and the other variables.

We also consider the relationship between PVGO and a number of variables that we believe describe the firm's position in its product market. These include, as a measure of diversification, a dummy equal to one if the last digit of the firm's four digit SIC code is equal to zero meaning the firm operates and produces in more than one 4 digit industry. In order to test our hypothesis about market structure and firm growth options, we include a variable equal to the square root of the firm's Herfindahl-Hirschman Index (HHI) if the firm has above average Q, and zero if the firm has below average Q. Additionally, we include the logarithm of the firm's total market value as a measure of firm size, and to measure size relative to the market, the sales of the firm divided by the total sales in the firm's SIC code.

Table IA provides means and standard deviations, while Table IB provides correlations of the data used in the analysis. As expected, the requirement that the data is available for a number of years leaves us with a sample of larger firms. The average ROE is approximately 17% for both periods, and this implies similar PVGOs of 23.8% and 22.4% for 1992 and 1997. Note that we eliminate those firms with negative

[8] Alternatively, we examine the standard deviation of first differences of the firms' earnings before interest and taxes scaled by firm value; again, the results are similar.

estimates for ROE (12% of the sample in 1992 and 15% of the sample in 1997). This selection causes a higher ROE estimate on average; however, our primary interest is in the cross-sectional characteristics of firms' PVGO, which may be less impacted by this selection bias.

Considering the firm specific independent variables, the average leverage equals 18% and 14%, and again these percentages reflect the ratio of total debt to the firm's total market value for 1992 and 1997. The average investment level is lower than both R&D and advertising average values as we use capitalized values for these intangible investments and single year values for other capital expenditures. Finally the sales growth is defined as the sales in the given year divided by the sales five years prior minus one. The values for sales growth of 1.369 and 1.756 translate into annual compound growth rates of 18.8% for the five years prior to 1992 and 22.5% for the years prior to 1997.

In order to explain PVGO, we use ordinary least squares regressions on these independent variables. We test and cannot reject the null hypothesis of homoskedasticity. Additionally, generalized least squares regressions and White heteroskedastic-consistent estimates provide similar results.

One possible concern is that these independent variables are endogenously determined with PVGO. This issue is sometimes addressed using instrumental variable estimation. However, in this case, no obvious exogenous variables exist. Moreover, lagged independent variables cannot be considered exogenous as our dependent variable is constructed from lagged variables. Thus, we do not attempt to interpret these regressions as describing a causal relationship for PVGO; our interest is only in interpreting the conditional correlations between firm and market characteristics and PVGO.

IV) Empirical Results

Table II presents our regressions on PVGO for our two years of interest, 1992 and 1997. Model 1 includes our basic firm characteristic and market characteristic variables. Model 2 includes an average Q variable to show that even though Q and PVGO are closely related, our results are consistent whether or not Q is controlled for. As we use ten years of historical data to calculate our cash flow risk variable (the standard deviation of first differences in sales over firm value) including this variable decreases the sample size by approximately 23% and 41% for 1992 and 1997 respectively. Thus model 3 reports the regression including this risk variable on the smaller data set, whereas model 4 reports the regression with both cash flow risk and average Q. F-tests demonstrate that the regressions are overall significant. The R-squareds vary from 12% for the 1997 regression with the least explanatory variables to 30% for the 1992 regression with the most explanatory variables.

We expect that firms with higher PVGO have more irreversible investment opportunities. Typical investment theory suggests that firms with higher Q will invest more. On the other hand, depending on a particular option's characteristics, option theory suggests that firms with higher PVGO may delay investment to maximize the value of their options (see Dixit and Pindyck, 1994). We find that firms with higher PVGO have a lower investment level in any given year. This negative relationship is significant at the 1% level for all our regressions, and holds whether or not Q is included.

Thus we find evidence that firms with higher PVGO maximize the value of their option by delaying investment, and this significant relationship suggests that PVGO could provide additional power in explaining cross-firm investment differences.

There are several possible relations between leverage and PVGO. On the one hand, a firm with higher PVGO may want to avoid bankruptcy risk in order to avoid the Myers (1977) underinvestment problem. Firms with higher PVGO may also have higher bankruptcy costs, and therefore want to use less debt (Scott, 1973; Kim, 1974). On the other hand, all of the firm's residual claims, and therefore its growth options, accrue to the equity holder. If a firm is financed with more debt, the PVGO may be a larger fraction of the total value of equity. Our results on leverage are mixed, with positive and significant coefficients for 1997 when Q is included, but a negative coefficient for 1992 which is significant in one regression.

We expect a positive relationship between a firm's R&D as a fraction of firm value and the PVGO, and we find exactly that. The relationship is significant in seven out of our eight regressions. We hypothesize a positive relationship between the firm's advertising as a fraction of value and PVGO, but we find no significant positive relationship. Possibly branding does not significantly increase PVGO, but rather increases only the value of the assets in place from higher current profits.

We expect to find a positive relationship between past sales growth and future growth across firms, and thus we expect and find a positive coefficient on five-year sales growth. The coefficient is positive in seven out of eight regressions, and positive and significant in four of the specifications.

We also control for which exchange the firm is listed on with an NYSE dummy equal to one if the firm is listed on the New York Stock Exchange and equal to zero otherwise. NASDAQ has lower listing costs, and many younger high-tech firms choose to list on NASDAQ initially. We find that the coefficient on the NYSE dummy variable is always negative and significant in seven out of the eight regressions. This suggests that the NASDAQ listed firms had higher PVGO even after correcting for factors such as size and R&D for these years.

Option theory suggests that the value of an option is positively correlated to the asset's volatility. We therefore expect a positive relationship between cash flow volatility and PVGO. We find significant positive relationship for 1992 and a positive but insignificant relationship for 1997.

We next test to see how the firm's position in its market is related to the PVGO. Firms that have products in a number of different areas are often said to suffer from a "diversification discount" (see Berger and Ofek, 1995; Comment and Jarrell, 1995). We test to see whether diversification affects a firm's PVGO with a dummy equal to one if the last digit of the firm's four-digit SIC code equals zero. This zero signifies that the firm produces a substantial portion of its products in more than one four-digit SIC code, and thus has a more diverse product line. We find that more diversified firms have lower PVGO, and this relationship is significant for five out of our eight specifications. This suggests that more diversified firms are less able to take advantage of growth options than firms with a concentrated focus.

Lindenberg and Ross (1981) and Hirschey (1985) find no significant relationship between firm concentration and firm value. They interpret this finding as suggesting that product market efficiency causes firms to reach an equilibrium which does not support excess profit. We test the relation between HHI and PVGO for our sample, and find no significant relationship (these regressions are available upon request). However, this lack of a simple relationship between HHI and PVGO may be because there are two separate types of firms with high market concentrations: firms with true market power and firms in mature industries. As industries mature, they frequently see a merger of firms to obtain operating economies to scale.[9] To separate mature industries, where concentration may be due to cost savings, from those industries where concentration may imply greater market control and higher excess returns, we use a variable equal to the square root of HHI if the firm has Q above the median, and equal to zero if the firm has Q below the median. Firms in mature industries are more likely to have lower values of Q, whereas those in less stagnant industries are likely to have higher values of Q. Thus we believe that this variable captures market concentration, but only for those industries where market power may have a meaningful impact. We find a positive coefficient between this measure of market concentration and PVGO in all our regressions, and this coefficient is significant in six of our eight specifications.

We also test whether the firm's market power is significant by measuring the relative sales of the firm to the firms in its SIC code. In a typical Cournot duopoly model, higher market share would imply larger profits. However, we find no significant relationship between relative size and PVGO. Lastly, we consider the firm's size, as measured by the logarithm of total firm value. A positive coefficient on size could

[9] The mergers in the paper industry in the late 1980s largely fit this description. These mergers include International Paper Company's acquisition of HammerMill in 1986, and Georgia Pacific Corporation's acquisition of U.S. Plywood in 1987, of Brunswick Pulp & Paper Co. in 1988, and of Great Northern Nekoosa Corp. in 1989.

capture additional market power, while a negative coefficient would suggest that larger firms may be more sluggish in taking advantage of growth options. We find significant negative coefficients in two out of the eight regressions, which is consistent with our second hypothesis, but may also be due to correlations between size and our other variables such as risk.

Note that these estimated regression coefficients also largely agree with the raw correlations presented in Table IB, thus providing further evidence of the robustness of these results.

Overall, while firm-specific characteristics such as investment, R&D, and volatility explain a larger proportion of a firm's PVGO, market characteristics such as whether the firm is diversified and market concentration also appear to have some impact on PVGO.

V) Conclusion

We estimate the present value of growth options (PVGO) for a sample of publicly listed firms. We then explain the PVGO using firm and market characteristics. We find that firms with more R&D, higher past sales growth, higher past volatility, and NASDAQ listed firms have higher PVGO. We also find a negative relationship between investment and PVGO, suggesting that firms with more growth options prefer to delay investment.

We also examine the degree to which market structure is related to the firm's PVGO. We find that more diversified firms appear to have lower PVGO, and there is some evidence that firms in more concentrated industries have higher PVGO.

Overall, our empirical tests verify the theoretical predictions in the real option model literature about volatility and option value, and about option value and the timing of investment. Additionally, they provide a window into how market characteristics, such as the degree to which the firm specializes or the market concentration, are related to PVGO.

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Table IA: Descriptive Statistics

The variables are defined as:
Average ROE = $.4ROE_{-1} + .3ROE_{-2} + .2ROE_{-3} + .1ROE_{-4}$
Discount Rate = Required rate of rate – expected inflation
VAIP = value of assets in place, computed as average ROE*end-of-period non-debt long-term liabilities / firm-specific discount rate
MV of equity = market value of firm common equity
PVGO = [market value of equity - value-of-assets-in-place] / market value of equity
Q = [market value of equity - book value of equity + total assets]/ total assets
Investment = capital expenditure/ market value of the firm
Leverage = (long term debt + debt in current liabilities)/market value of the firm
R&D = capitalized R&D/ market value of the firm, where R&D is capitalized on a five-year straight-line amortization basis
Advertising = capitalized advertise expense/ market value of the firm, where advertising is capitalized on a three-year straight-line amortization basis
Sales Growth = percent change in firm sales over 5 years
NYSE Dummy = exchange list dummy (NYSE=1, 0 otherwise)
Std Dev. ΔSales = standard deviation of first-difference in firm sales/total assets
SIC Dummy = 1 if the firm's four digit SIC code ends in 0, 0 otherwise
HHI=square root of firm Herfindahl-Hirschman Industry concentration Index
Market Concentration = HHI if the firm's Q value is above the median, zero otherwise
Relative Size = firm sales as a fraction of industry sales
Size = log(market value of the firm).

Variables	1992 number of observations 625	1997 number of observations 871
Average ROE	0.173 (0.117)	0.168 (0.119)
Discount Rate	0.107 (0.02)	0.083 (0.021)
VAIP (in millions)	650.596 (1,415.607)	1,146.142 (2,395.499)
MV of equity (in millions)	853.813 (1,971.142)	1,490.019 (3,581.252)
Total firm value (in millions)	1,034.813 (2,346.136)	1,725.319 (3,969.322)
PVGO	0.238 (0.383)	0.224 (0.396)
Q	1.822 (1.022)	2.055 (1.121)
Investment	0.042 (0.036)	0.040 (0.032)
Leverage	0.179 (0.187)	0.144 (0.155)
R&D	0.090 (0.139)	0.078 (0.116)

Advertising	0.031 (0.078)	0.014 (0.059)
Sales Growth	1.369 (6.697)	1.756 (6.094)
NYSE Dummy	0.425 (0.495)	0.422 (0.494)
Cash flow Volatility	0.181 (0.135)	0.185 (0.123)
SIC Dummy	0.281 (0.45)	0.283 (0.451)
HHI Overall	22.361 (8.649)	22.288 (10.614)
Market Concentration	8.517 (12.078)	10.895 (13.357)
Relative Size	0.013 (0.042)	0.103 (0.627)
Size	5.216 (1.979)	5.876 (1.929)

Table IB: Correlation matrix

Variables defined as above. 1992 and 1997 variables are considered together for the correlation calculations.

Observations: 1490	PVGO	Invest-ment	Leve-rage	R&D	Adverti-sing	Sales Growth	NYSE Dummy	Q	SIC Dummy	Market Concen-tration	Relative Size	Size	Cash Flow Volatility
PVGO	1.000												
Investment	-0.218	1.000											
Leverage	-0.133	0.207	1.000										
R&D	0.094	0.070	-0.089	1.000									
Advertising	0.006	-0.023	0.006	-0.019	1.000								
Sales Growth	0.125	-0.049	-0.019	-0.044	-0.037	1.000							
NYSE Dummy	-0.223	0.031	0.044	-0.180	0.016	-0.101	1.000						
Q	0.301	-0.297	-0.441	-0.164	-0.052	0.123	-0.003	1.000					
SIC Dummy	-0.172	0.059	0.118	-0.232	0.057	-0.055	0.201	-0.070	1.000				
Market Concentration	0.202	-0.254	-0.408	-0.103	0.007	0.079	0.034	0.612	-0.078	1.000			
Relative Size	-0.003	-0.032	-0.008	-0.048	0.069	-0.008	0.117	0.053	-0.004	0.093	1.000		
Size	-0.111	-0.016	-0.046	-0.237	-0.014	0.010	0.609	0.309	0.125	0.283	0.192	1.000	
Cash Flow Volatility	0.129	0.020	0.116	0.025	-0.056	0.041	-0.311	-0.105	-0.096	-0.089	-0.068	-0.411	1.000

Table II: OLS Regression on PVGO

Regressions on the present value of growth options for 1992 and 1997. *t*-statistics in parentheses. a, b, and c refer to significance at the 10%, 5%, and 1% significance levels, respectively. The equation in model 1 is give by:

$$1: PVGO = \alpha + \beta_1 Investment + \beta_2 Leverage + \beta_3 R\&D + \beta_4 Advertising + \beta_5 Growth + \beta_6 NYSEdummy + \beta_7 SICdummy + \beta_8 MarketConcentration + \beta_9 RelativeSIZE + \beta_{10} SIZE + \varepsilon$$

Models 2, 3, and 4 add the standard deviation of first differences of sales, Q, or both, respectively.

	Model 1		Model 2		Model 3		Model 4	
	Y92	Y97	Y92	Y97	Y92	Y97	Y92	Y97
Firm Characteristics								
Investment	-2.426^{c}	-1.415^{c}	-2.039^{c}	-0.932^{b}	-2.245^{c}	-2.042^{c}	-1.811^{c}	-1.520^{c}
	(-6.139)	(-3.430)	(-5.269)	(-2.278)	(-5.14)	(-3.601)	(-4.24)	(-2.691)
Leverage	-0.097	0.091	0.046	0.287^{c}	-0.171^{a}	0.018	-0.024	0.222^{a}
	(-1.190)	(0.976)	(0.566)	(3.006)	(-1.797)	(0.142)	(-0.251)	(1.662)
R&D	0.235^{b}	0.261^{b}	0.307^{c}	0.397^{c}	0.135	0.384^{b}	0.187^{a}	0.468^{c}
	(2.267)	(2.136)	(3.040)	(3.280)	(1.178)	(2.297)	(1.688)	(2.842)
Advertising	-0.002	0.086	0.126	0.127	0.043	-0.165	0.192	-0.115
	(-0.012)	(0.369)	(0.739)	(0.558)	(0.165)	(-0.427)	(0.761)	(-0.304)
Sales Growth	0.004^{a}	0.006^{c}	0.003	0.005	0.006	0.004^{b}	-0.003	0.004^{b}
	(1.849)	(2.736)	(1.464)	(2.256)	(1.035)	(1.993)	(-0.563)	(1.852)
NYSE Dummy	-0.074^{b}	-0.177^{c}	-0.036	-0.130^{c}	-0.089^{b}	-0.204^{c}	-0.066^{a}	-0.158^{c}
	(-2.011)	(-5.238)	(-1.013)	(-3.862)	(-2.167)	(-4.740)	(-1.658)	(-3.663)
Cash Flow Volatility					0.354^{c}	0.244	0.348^{c}	0.176
					(2.816)	(1.639)	(2.869)	(1.199)
Q			0.122^{c}	0.105^{c}			0.122^{c}	0.105^{c}
			(6.512)	(6.715)			(6.049)	(4.785)
Market Structure Variables								
SIC Dummy	-0.104^{c}	-0.055^{a}	-0.090^{c}	-0.057^{a}	-0.077^{b}	-0.053	-0.061	-0.053
	(-2.940)	(-1.826)	(-2.631)	(-1.954)	(-1.963)	(-1.350)	(-1.610)	(-1.388)
Market Concentration	0.009^{c}	0.003^{c}	0.004^{c}	0.0002	0.008^{c}	0.003^{a}	0.003^{b}	0.00005
	(6.499)	(2.946)	(2.590)	(0.192)	(5.224)	(1.822)	(2.168)	(0.037)
Relative Size	-0.157	0.015	0.033	0.020	-0.230	0.019	-0.118	0.021
	(-0.388)	(0.701)	(0.083)	(0.977)	(-0.545)	(0.904)	(-0.288)	(1.014)
Size	-0.009	-0.002	-0.026^{b}	-0.021^{b}	0.007	0.009	-0.007	-0.019
	(-0.931)	(-0.262)	(-2.520)	(-2.212)	(0.611)	(0.753)	(-0.644)	(-1.111)
N	619	871	619	871	476	517	476	517
R^2	0.23	0.12	0.28	0.16	0.24	0.15	0.30	0.19