'GROWTH OPTIONS AND THE VALUE-SIZE PUZZLE'*

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ABSTRACT

This study presents an intuitive explanation, based on insights of real options theory, for the value size puzzle. Growth firms are not overvalued, but priced for their upward potential. Small growth firms are especially characterized by an asymmetric risk-return relation. Therefore, the value-size premium comprises two parts: a distress premium and a growth discount. Beta underestimates the risk of distressed firms and overestimates the risk of growth firms caused by asymmetries in stock returns. We examine the impact of growth options on equity returns within a panel of 7,167 listed U.S. firms (1981– 2000).

JEL: G10, G19, G39

Key words: anomalies, investment strategies, size, value, growth opportunities, and growth options.

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I. INTRODUCTION

It is puzzling that CAPM beta fails to explain the variation in equity returns for portfolios sorted along firm specific variables. With insights derived from real options theory, we analyze the risk return characteristics of stocks with varying values of embedded growth options. The differences in growth options value across firms induce asymmetry in equity returns, but beta ignores this asymmetry. We find high risk and upward potential characterize small growth firms. This finding helps our understanding of the explanatory power of book/market and size.

There is an extensive literature investment strategies, elsewhere referred to as anomalies. Many empirical studies show that a portfolio strategy based on specific firm characteristics, such as size, earnings, or book/market ratios, can earn high returns. Fama and French, (1992 and 1993) find that small value stocks tend to outperform stocks of large growth firms, independent of their betas.

There are different explanations for the value-size puzzle: data snooping, under/overpricing due to behavioral biases, distress risk, and asymmetric return distributions. Empirical studies report skewness and thick right tails in the return distribution over the cross-section of firms (e.g., Knez and Ready, 1997). Our study relates to asymmetric return distributions, and introduces an explanation based on real options for the empirical observations.

Option Pricing Theory (OPT) has greatly influenced the field of economic thought. The influence of OPT has not been limited to financial options, but also affects investment decisions made by firms (Merton, 1998). Firms can be considered as portfolios of real options in which growth opportunities of a firm involve discretionary decisions or rights, with no obligation, to acquire an asset for a specified alternative price (e.g., Kester, 1984, and Myers 1977). The scope of real options applicability can further be expanded when we consider the distinctive characteristics that real options have on stock returns (e.g., Berk, Green, and Naik, 1999; Pope and Stark, 2001). We propose that growth options help explain the Fama and French factors when firms have different levels of growth prospects.

The contribution of our paper is to provide a real options explanation for the value size puzzle. Small firms with growth options have distinctive return distributions compared to large asset based firms. This observed asymmetry in equity returns of small growth firms can be explained by the sequential or compound option character of growth opportunities. The sequential exercise of growth options enables a few firms to fully utilize their upside potential, while many growth options expire worthless. In our view, growth firms are not overpriced but instead are rewarded for the upside potential they offer through their growth options. Thus, in addition to the distress premium there is also a growth discount.

The paper proceeds as follows. In section II we discuss two sets of literature: the investment strategy and the growth options literature. In section III we empirically investigate the performance of stocks based on embedded growth options in a panel study (1981-2000). We rank portfolios of stocks two-dimensionally by their proportion of growth options and control for beta and size. Section IV concludes.

II. GROWTH OPTIONS AND EQUITY RETURNS

A. Framework

Our starting point for this study is an option view of the firm. Figure 1 is a roadmap, which gives an overview of the literature and relates real options insights to the Fama and French factors. We start at the top of the figure and consider that the equity value of a firm consists of the value of assets that are in place and the value of future growth opportunities.

To address this growth options value separately, several authors suggest splitting the equity value into a cash-flow component and in a growth options component (e.g., see Kester, 1984, and Myers, 1987). The general growth parameter in the standard valuation methodology (Gordon and

Shapiro, 1956) is suitable for valuation of assets in place, but growth options need to be addressed with real option valuation.

The risk-return profile of growth options differs, by nature, from the risk return profile of assets in place (e.g., Smit, 1999; Chung and Charoengwong, 1991, who empirically test the effect of firm's growth opportunities on beta and report a positive relation). For example, an increase in demand uncertainty (c.p.) will lead to asset value destruction, but at the same time it may increase the growth option value. The future is uncertain and investment decisions, as options, need to be appropriately exercised throughout the business process, thereby embodying a dynamic rather than a static character (e.g., Baldwin, 1982; Berk, Green, and Naik, 1999; Mauer and Triantis, 1994; Pope and Stark, 2001; and Dixit and Pindyck, 1995). Berk, Green, and Naik show that during the process of exploiting growth opportunities, the systematic risk of the firm changes. This is particularly true for firms with low book/market ratios. We expect that the growth option component of firm value should be reflected in the equity return profile in an efficient market.

Insert Figure 1 about here

B. Value-Size puzzle

Empirical studies find a relatively poor performance of CAPM beta. In a series of empirical papers, Fama and French (e.g. 1992, 1993, and 1996) present their three-factor-model (TFM) and include additional factors besides beta. They add size and book/market more for their explanatory power than for their economic meaning. The rejection of empirical CAPM is puzzling and continues to trigger research on this subject.

There are several alternative explanations for the value-size puzzle: (1) data snooping and sample selection biases, (2) over/under pricing, (3) distress risk, and (4) asymmetric return distributions. The first explanation is based on coincidence: the influence of data snooping, data mining and various biases in the data might explain the observed phenomena (e.g., Ball and Wats, 1979; and Kothari, Shanken, and Sloan, 1995; Campbell, Lo, and Mackinlay, 1997).

In the second explanation, behaviorists argue that based on past performance of firms, investors tend to overreact and accordingly overprice past winners and underprice losers (e.g., De Bondt and Thaler, 1985; Chopra, Lakonishok, and Ritter, 1992; Lakonishok, Shleifer, and Vishny, 1994; Haugen, 1995; and Daniel and Titman, 1997). According to this behavioral view, the value and size premia are the result of various sorts of human biases. EMH is rejected for "value strategies exploit sub optimal behavior of the typical investor" (Lakonishok, Shleifer, and Vishny, 1994).

The distress risk explanation argues that small value stocks tend to be firms in distress and this risk is accordingly priced (e.g., Fama and French, 1996). A portfolio of value stocks has higher returns because it is likely to incorporate distressed firms, with high financial leverage, and with substantial earnings uncertainty in the future (Chen and Zhang, 1998).

The fourth explanation, asymmetric return distributions, relates the Fama and French factors with the higher moments found in the *individual* (see Harvey and Siddique, 2000; Dittmar, 2002; Chung, Johnson, and Schill, 2001) and the *cross-sectional* (see Knez and Ready, 1997) return distribution of stocks. Small firms behave differently than large firms. Knez and Ready show that with a trimmed dataset, kurtosis (fat right tail) in the cross-sectional return distribution can explain the size premium. Knez and Ready demonstrate that the size effect disappears and the value effect strengthens when they leave out the 1% extreme observations of the Fama and French database. In cross-sectional regressions, the returns should be symmetrical and trimming should have no effect. Knez and Ready use a sea turtle metaphor to express their view. Small firms can be considered similar to turtle eggs: only a few eggs hatch and few of the hatchlings will make it to the ocean.

In our view, asymmetry in equity return distributions explains the value-size puzzle. Growth options, although highly uncertain, can cause positive skewness in the individual and cross-sectional return distribution of stocks. In addition to distress, analyzed in other studies, we look at growth options as a source of asymmetry. We regard the size factor as a cross-sectional proxy for growth potential. Some 'happy few' firms manage to exercise growth options sequentially. These firms finally grow large and generate considerable high returns.

The consequence of asymmetry is a weaker performance of (ex ante and ex post) beta. Especially for certain groups of stocks, the non-normalities in equity returns challenge the mean-variance framework. We argue that firm characteristics can act as a proxy for asymmetry in equity returns and that they thus provide a better ex ante measure of risk than beta alone. Small growth firms, whose value is mainly in their potential rather than in earnings generated by current operations, will show a typical asymmetric return distribution. Although small growth firms may seem overpriced based on their beta alone, observation of this asymmetry could provide implicit evidence that investors correctly price these small growth firms.

C. Risk and return of growth options

Although the average return can be easily calculated, the accompanying systematic risk cannot be easily measured. When growth options make up a significant part of firm value, historical beta, based on monthly data, could average out the systematic risk. In addition, standard CAPM assumes a concave utility function.[1] The assumption of a concave utility function, with risk averse behavior has been challenged by Kahneman and Tversky (1979). With experiments they show that investors are *loss* averse rather than risk averse, and have suggested an S-shaped utility function.[2] If investors treat risk asymmetrical: with risk seeking behavior for gains (lotteries) and risk averse behavior for losses (insurance), then the implied risk aversion determined by beta will give biased results. The risk of growth options, characterized by upwards potential, could be overestimated if a mean-variance framework is imposed.

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[1] CAPM assumes either a concave utility function or normal distributed portfolio returns.

Investors have a preference to positive skewness and are willing to accept a lower average expected return (Harvey and Siddique, 2000). The pricing of systematic skewness in equity returns, shows that investors treat upwards potential differently from downwards risk. Skewness in equity returns could also explain the results of Coval and Shumway (2001) who have studied financial option returns. They find that considering their levels of systematic risk, both call and put options earn exceedingly low returns.

It seems that a concave utility function, as assumed in CAPM, is not sufficient to explain all variation in equity returns. We therefore favor the cubic utility function suggested by Kraus and Litzenberger (1976), or any future extensions. Skewness, or asymmetry, may be induced by the following factors. First the presence of growth options on future assets induces skewness in the equity return distribution. Second the presence of limited liability in all equity investments, induces option-like asymmetries in returns.

D. Measurement of growth options

To investigate the empirical relation between growth options and stock returns we will sort stocks along a growth options variable. This variable should differentiate between firms with valuable growth options and firms with few opportunities. We discuss three proxies used in the empirical literature: The book/market ratio (BE/ME), Tobin's q, and the present value of the growth options as a proportion of price, (PVGO/P).

The (BE/ME)ratio is widely used as a proxy for the level of growth options. However, this variable is only indirectly linked with the level growth options and is not 'clean' (e.g. Lakonishok, Shleifer, and Vishny (1994) and Berk, Green, and Naik (1999)). Firms with low book/market ratios are usually referred to as growth firms. However, a low book/market ratio could also indicate that the firm has a large proportion of intangibles, or has an outdated book value of assets.

A high proportion of intangibles lowers the book/market ratio. Under current U.S. GAAP, intangibles (such as research and development or marketing) are not capitalized, but expensed. The investments are treated as fixed costs, thereby increasing operating leverage. Intangibles do not appear on the balance sheet and this results in a lower book/market ratio. Intangibles are likely to create growth options, but a firm with many intangibles is not automatically a firm with valuable growth options.

Outdated book values of assets lower the book/market ratio. To correct for misspecified book values of assets, we could use the Tobin’s q ratio, which measures the market value of a firm's total assets divided by their replacement value. However, for empirical purposes, q is not perfectly suitable. First, since the replacement value is not market priced, the calculation procedure of q is not fully objective. Second, Tobin's q does not fully recognize the replacement value of intangible assets, and thus could give a systematic bias for firms or industries with many intangibles.

Our aim is to find the level of growth options across firms. We have seen that the book/market ratio is not clean and that Tobin’s q not empirically suitable. Therefore, to measure the relative value of growth options, we must identify another proxy that is directly linked to the value of growth options. The variable we use for this purpose is the present value of the growth options as a proportion of price, PVGO/P.

The market value of a firm's equity can be split into two components, the value of assets in place and present value of the growth options. The present value of earnings is the proxy for the assets in place part of equity value, which gives:

$$PVGO_{i,t} = ME_{i,t} - PVE_{i,t} \quad \textbf{(1)}$$

Where $ME_{i,t}$ is the market value of the firm's equity and $PVE_{i,t}$ the present value of the earnings under a zero growth hypothesis:

$$PVE_{i,t} = \frac{Earnings_{i,t}}{\mathrm{E}\left[R_{i,t}\right]} \quad \textbf{(2)}$$

In Equation (2), $Earnings_{i,t}$ is the current earnings stream and $\mathrm{E}[R_i]$ the expectation of the firm-specific discount rate. We note that the mean variance based beta will give biased results in the case of asymmetry in the returns. Nevertheless we use beta to give at least some proxy for the systematic risk. We roughly estimate the discount rate, using the Sharpe Linter Black (CAPM) model, as:

$$E[R_{i,t}] = R_{f,t} + \beta_{i,t} \mathrm{E}[R_m - R_f] \quad \textbf{(3)}$$

where $R_{i,t}$ = ($P_{i,t}$ / $P_{i,t-1}$) -1, with P_i as the dividend and stock split corrected price. We estimate $\beta_{i,t}$, the systematic risk, by using the previous 36 month returns.

The equity premium, E[R_m-R_f], is dynamic in our model. We calculate it as the moving average of the excess return of the market portfolio from 1927 till the year under consideration. For example, in July 1984, the calculated equity premium equals 5.7%, and in July 2000, the equity premium equals 6.8%.

As defined in this paper, PVGO should be able to differentiate between firms with and without growth options. The measure is straightforward and easily interpretable. The current earnings stream, corrected for financial leverage, determines the value of the assets in place. Intangibles are correctly treated: earnings-generating intangibles are recognized as assets in place, where non-earnings-generating intangibles are recognized as growth options.

PVGO/P is related to the E/P factor, which is familiar from other empirical studies. Our results support those of previous studies on the E/P variable, with some difference for the time period under investigation and the treatment of firms with negative earnings. However, the proxy has some shortcomings. We note that PVGO/P is sensitive to earnings, which are volatile and sometimes manipulated. Further, we estimate the firm-specific discount rate, as defined in (3), by using linear CAPM. We recognize these possible shortcomings and for the sake of completeness we include BE/ME as an additional measure of growth options value in our analysis.

E. Individual and portfolio returns

Individual stock returns are not normally distributed, where non-normalities appear both the cross-section and in the time series. Aggregated portfolio returns are often assumed to be normal. However, empirical evidence suggests that portfolio returns are also not normal. In our study, we look at what induces these non-normalities in individual and portfolio returns.

Although portfolio returns are not distributed normally, measuring the variables at a portfolio level does have advantages over measuring at the individual-firm level. In the portfolio approach, the residual variance is lower and will result in portfolio returns that differentiate due to systematic variation in underlying economic causes (Fama & French, 1992). Similar to Fama and MacBeth (1973) we perform a dynamic formation process, which re-ranks the stocks each year and puts each stock into the most likely portfolio.

We create five equal weight portfolios, in which we first sort stocks on the control variable and then sort each control portfolio on the growth options variable. This sorting results in 25 portfolios and controls for other factors than PVGO/P. We note that we minimize the number of portfolios to 25, since it is not the aim of this paper to give another test of CAPM. The portfolio grouping procedure is solely used to control for effects other than PVGO/P.

Most studies in option pricing are performed in continuous time. The value-size puzzle is a problem described in the discrete time investment literature. Therefore, in this study we use discrete returns, thus closely following the investment literature. There are two possible concerns with discrete time returns. The first is that discrete returns are non-additive in time. The second concern is that the discrete return distribution is skewed to the right and becomes more so for an increasing time period. We address the first concern by using the portfolio rebalancing technique, which makes yearly returns additive in time. Although we recognize that discrete performance evaluation automatically introduces asymmetry, because returns vary between –100% and infinity, we show that additional asymmetry is introduced by growth options.[3] To gain a better understanding of this asymmetry, which is present in the returns, we jointly present median values and, to monitor the effect of extreme values, trimmed means.

III. EMPIRICS

A. Data

This study includes all the available U.S. firms found in the Datastream database that satisfy our requirements. We exclude the financial firms, because their accounting figures differ structurally from non-financial firms and thus could give biased results. We recognize that the market for very small stocks is illiquid, which causes returns to occur only on paper and not in real life. Therefore, following Fama and French (1993), we exclude all firms with market values of equity (ME) less than $1 million. We also exclude firms without available income statement figures. After all adjustments in the data, a total of 7,167 firms remain.[4] This number is slightly lower that the number available in the more commonly used CRSP/COMPUSTAT database, but an advantage is that random computational errors are distributed differently for each database.

The time interval of this panel study encompasses recent data. The period extends from January 1981 to July 2000, a total of 234 months, only the first 36 monthly observations are used for beta estimations. We note that this time period includes the bull market of the nineties, and thus will give higher overall returns than those found in previous empirical studies. For each firm we obtain monthly prices, corrected for dividends and stock-splits (P), market values of equity (ME), the earnings-price ratios (E/P), and book/market ratios (BE/ME). The accounting variables (BE/ME, E/P) are low frequency data and available on a quarterly basis. We sort the stocks and

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[3] The asymmetry depends on the reference period, where yearly returns are more positively skewed than monthly or daily returns. Continuous time returns could eliminate asymmetry in the distribution. However, it fails to translate -100% returns into continuous time.

[4] For a list of all included firms go to: http://www.few.eur.nl/few/people/wvanvliet/research

match the returns with the accounting figures and allocate all firms in their portfolios. Sorting takes place once a year.

The yearly excess returns are matched with the accounting data and market values of equity at the end of June. Yearly excess returns are defined from July to June. The risk-free interest rate, R_f, is defined as the 1-month Treasury bill rate.[5] The market return, R_m, is defined as the S&P 500 index.

B. Cross-sectional returns

By using empirical data we test whether we find option-like characteristics in the return distributions. To test the risk and pay-off relation of growth options across firms, we investigate the performance of portfolio of stocks with varying degrees of option-likeliness. Growth options induce skewness, and non-normality is therefore to be expected in the return distribution of growth firms. We therefore put considerable emphasis on non-normality of portfolio returns instead of the first two moments of the return distribution.

We examine the performance of stocks sorted on PVGO/P, our proxy for the value of growth options. A two-dimensional dynamic portfolio grouping approach isolates the influence of PVGO/P on the variation in stock returns and enables us to control for variation in firm's ex-ante beta and size. Every year, we assign an excess firm return to a quintile portfolio based on the firm's pre-ranking individual control variable, and then subdivide each control quintile into five portfolios ranked along the PVGO/P variable. Doing so we create 25 portfolios. All firm-year excess returns are equally divided between the different quintiles. We calculate the average portfolio returns when rebalancing takes place each year. We use only those firms with available figures for both control variables and PVGO/P values. We provide statistics of the median and standard errors to indicate the robustness of the results.

[5] We obtain this market return and the 1-month T-bill return from the Kenneth R. French data library. The original 1-month T-bill rate comes from Ibbotson Associates.

Insert Table 1 about here

The upper panels of Table 1 show the relation between PVGO/P and return, independent of a firm's ex-ante historical beta. The variation in average equity returns is not explained solely by beta, but also by PVGO/P. The table shows that beta is positively related to average returns and PVGO/P negatively. These findings support earlier research, which reports that growth firms earn lower average returns than asset firms (value stocks). From the second regression we note that the median returns are negatively related to beta and not related to PVGO/P. Overall, we can read from Table 1 that the portfolio of stocks with the highest proportion of growth options tends to have low average and median returns independent of ex-ante beta.

The lower panels of Table 1 show the PVGO/P, the book/market and the beta values for each of our portfolios. Beta is somewhat, but not closely related to PVGO/P. When we compare the PVGO/P (left panel) for each portfolio with its beta (right panel) we observe a positive relation ($\rho_{PVGO/P,\beta}$ = 0.34). This finding strengthens our notion that the implicit leverage of growth options tend to increase market uncertainty as shown by beta. As expected, the PVGO/P values are related with other proxies for growth firms such as book/market values (mid panel) ($\rho_{PVGO/P,B/M}$ = -0.65).

Table 2 presents the statistics for PVGO/P and size portfolios. In the upper left panel, we observe no clear pattern in *average* equity returns in the ME-PVGO/P sorting procedure. However we expect that small growth-based firms would have a distinctive risk return profile. Compared to average returns, the medians, presented in the upper right panel, show a relation. Median returns increase with the size dimension and decrease with the growth dimension. Thus, most firms in the small growth portfolio earn negative returns while most firms in the large asset portfolio earn high positive returns.

Insert Table 2 about here

We can see that the risk-return relation is affected by the higher moments of the distribution, caused by firm's size and implicit value of growth options. If we focus only on averages, we do not see this asymmetry in the cross-sectional stock return distribution. The combination of size and PVGO/P is capable in predicting the asymmetries in the return distribution. The distinctive character of growth options is responsible for this effect.

C. Small growth firms vs. large asset firms

The different nature of small growth versus large asset firms is reflected in the large difference of means and medians of the quintile portfolios in Table 2. We can gain a better understanding of the different risk-return relations by examining the entire equity return distributions. Figure 2 shows the frequency distributions of portfolios (1,5) and (5,1) from Table 2. The frequency distributions of Panel A and B are different in shape and structure. The cross-sectional return distribution of small growth firms is characterized by higher variance, positive skewness, and a fat tail.

Insert Figure 2 about here

Panel C shows the descriptive statistics of the two types of firms. Small growth stocks show higher average returns than large asset firms do (13.3% compared to 9.7%), but when we leave out the 5% extreme observations, we see that small growth firms have lower average returns (6.1% compared to 8.4%). Actually, only 49.7% of the firm year returns in this portfolio are positive. For large asset firms, this number is much higher, 63.2%. This dominant influence of extreme values is further illustrated when we compare the median values (-/-03% compared to 7.6%). In fact, a few small growth firms do extremely well, while most others show negative returns.

Both distributions are characterized by asymmetry, but this asymmetry is most prevalent for small firms with high growth potential. The return characteristics of the two types of firms indicate different risk-return profiles for the firms. This in agreement with our option-based view on the firm. This asymmetrical pattern in expected returns is not captured by standard beta, which ignores investor’s preference for asymmetry.

D. *Time series regressions*

Time series regressions allow us to relate portfolio returns to other factors than beta. In our view the Fama and French (1993) factors are related to characteristics of growth options across firms which cause asymmetry in the return distribution.

We construct a hedge portfolio that invests in PVGO/P quintile 5, which is financed by a short position in PVGO/P quintile 1. The equal weighted return of this portfolio gives the net difference in returns between growth- and asset firms. We call this new portfolio the growth minus assets firms (GMA) portfolio. It is, to a certain extent, comparable with the HML (high minus low book/market) portfolio (Fama and French, 1993). The GMA portfolio reflects the relative returns of growth stocks compared to asset stocks. Thus, growth firms have a positive exposure to GMA, while large asset firms have a negative exposure.

We re-organize our data into monthly portfolio returns and perform time series regressions for the different value-weighted CRSP size quintile portfolios. The excess returns of the size portfolios are regressed on excess returns of the market and on excess returns of our growth options factor. For size portfolio *i*, at time *t*, we conduct the following regression:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{i,m}\left(R_{m,t} - R_{f,t}\right) + \beta_{i,g}\left(GMA_t\right) + \varepsilon_{i,t} \qquad \textbf{(4)}$$

where $R_{i,t}$ is the return on the size portfolio at time *t*, $R_{m,t}$ is the market return at time *t*, $R_{f,t}$ is the risk-free rate, and GMA_t is the net return of growth firms minus asset firms at time *t*. We present the regression results in Table III.

In the standard CAPM estimation, the market beta, $\beta_{t,m}$, of the size quintile portfolios has significant values, explaining between 56% and 96% of the variance in returns. The intercepts, which should be zero, show small deviations from zero. If GMA is added as an extra factor we see an improvement: the market betas remain significant, the growth option beta, $\beta_{t,g}$ shows significant values, and the intercepts become insignificant. The explanatory power of the model increases (between 61% and 97%). Small firms are positively (0.63) related and large firms negatively (-0.15) related to the GMA-factor. The returns of large firms are largely determined by market risk.

Robustness tests indicate that the results are independent of the October 1987 stock market crash. If we use size deciles portfolios instead of size quintiles, the betas also show a steadily increasing pattern. A regression with HML (instead of GMA) is in agreement with the above results, with slightly lower adjusted R^2.

When the value of the portfolio with growth options in the economy increase, small firms tend to benefit from this most. This option factor explains a part of the variation of equity returns of the different size portfolios. Larger firms seem to be negatively related to the value change in growth options. Again, we can see the difference in the behavior of small firms compared to that of large firms. Small firms are exposed to the value change of their growth options; large firms appear to be more asset based.

E. Discussion of results

How are the empirical results related to the value-size puzzle? Based on the results of our study, we argue that (1) small growth firms have different risk-return relations than large asset firms, (2) beta overestimates the systematic risk of growth options; and (3) investors like upward potential, which translates in a growth discount and dislike downwards risk, which translates in a distress premium.

Small growth firms are characterized by an asymmetrical cross-sectional return distribution. Therefore, size and growth potential are good proxies for asymmetry in the cross-sectional return distribution (Figure 2). The time series regressions demonstrate the relation between size and the performance of growth options. But real option intuition can also explain the distinctive character of small high potential firms. Of all firms, only a few small growth firms become new (industry) leaders, but most others will stay behind and will not fully utilize their potential. The happy few exercise their growth options sequentially. They enter a period of extreme growth and rapidly create value. However, most small firms see their growth options expire, worthless, and consequently destroy value. Those firms fail to make the changes that translate their potential into real assets and consequently earnings. Therefore, most small growth firms will show underperformance. The market values growth potential, and only a few of these firms exceed expectations and accordingly show very high returns.

Mean variance analysis may not be sufficient for understanding the value size puzzle. When return distributions are asymmetrical, beta alone cannot completely capture the risk characteristics. Skewness, fat tails, and higher moments are important in understanding the returns of observed portfolio strategies. Traditional beta overestimates the risk of growth options (and financial options) because it ignores the preference for upwards potential. As we can see from the many examples in the investment strategy literature (e.g., size, value, and momentum), grouping by variables other than beta is more effective. Beta cannot predict extreme returns, but these can be predicted by firm specific variables. Large asset firms tend to have more symmetrical risk return relation. For these firms, which have a low possibility of both bankruptcy and extreme growth, beta is a good proxy for risk. However, when the possibility of bankruptcy (distress) becomes relevant, or when the growth potential is high, additional factors have explanatory power.

In our view, the value premium consists of two parts: a premium for distressed firms and a discount for growth firms. Beta fails to price this risk of distressed firms correctly; hence, beta will be too low. Beta overprices the possibility of extreme growth (skewness), and therefore the expected return of the average growth firms is lower than beta would suggest. Both exante betas and expost betas will overestimate of the true risk of growth options, which is characterized by asymmetry. The different expectations for firms with low and high proportions of growth opportunities is not captured by beta and explains why firm-specific factors explain a large part of cross-sectional variation in equity returns.

IV. CONCLUSIONS

This study incorporates insights from real option theory into one of the puzzles of empirical finance. We argue that option leverage is a factor that introduces asymmetry in the equity return distribution, which leads to a wrong estimator of mean-variance-based beta.

We use an empirical approach to describe the impact of growth options on the performance of stocks. While large asset firms show a more symmetrical return distribution, small growth firms show a typical asymmetrical risk return distribution. While many growth options expire worthless, a few firms will be able to successfully exercise their sequential options, and enter a period of extreme growth. In addition to mean variance trade off, investors seem to prefer firms with upward potential and willing to accept a growth discount on average return. Real options theory can explain why the betas of growth firms are too-high or average returns too-low.

Future research might further explore the causes and consequences of asymmetry in equity returns. Firm-specific characteristics may provide a good ex-ante proxy for the non-normalities in the return distribution. Inclusion of these factors in models that price higher moments will give a better insight into the risk-return relation of stocks. Perhaps an asset-pricing model that distinguishes between upwards potential and downwards risk could rationalize the value-size puzzle.

Figure I

Conceptual framework: corporate finance, asset pricing and empirical finance.

This figure exhibits the underlying economic fundamentals of the explanatory power of the Fama and French risk factors. Starting from this concept we attempt to bring growth options and the empirical literature on the risk of equity together. Corporate finance proposes a firm's equity to be made up of assets in place and growth options. The growth options component of firm value has different risk characteristics than the assets in place component. Asset pricing assumes a utility maximizing investor who makes a trade-off between risk and pay-off. Firm's equity has an expected pay-off and risk, where only the systematic risk is priced. From empirical finance it is known that the historical beta fails to proxy for systematic risk and that stock returns are characterized by non-normality. Higher moments are also priced (M-CAPM) and the existence of growth options within and across firms could explain the non-normality in equity return distributions. Starting from this framework we attempt to investigate why value and size are good proxies for systematic risk.

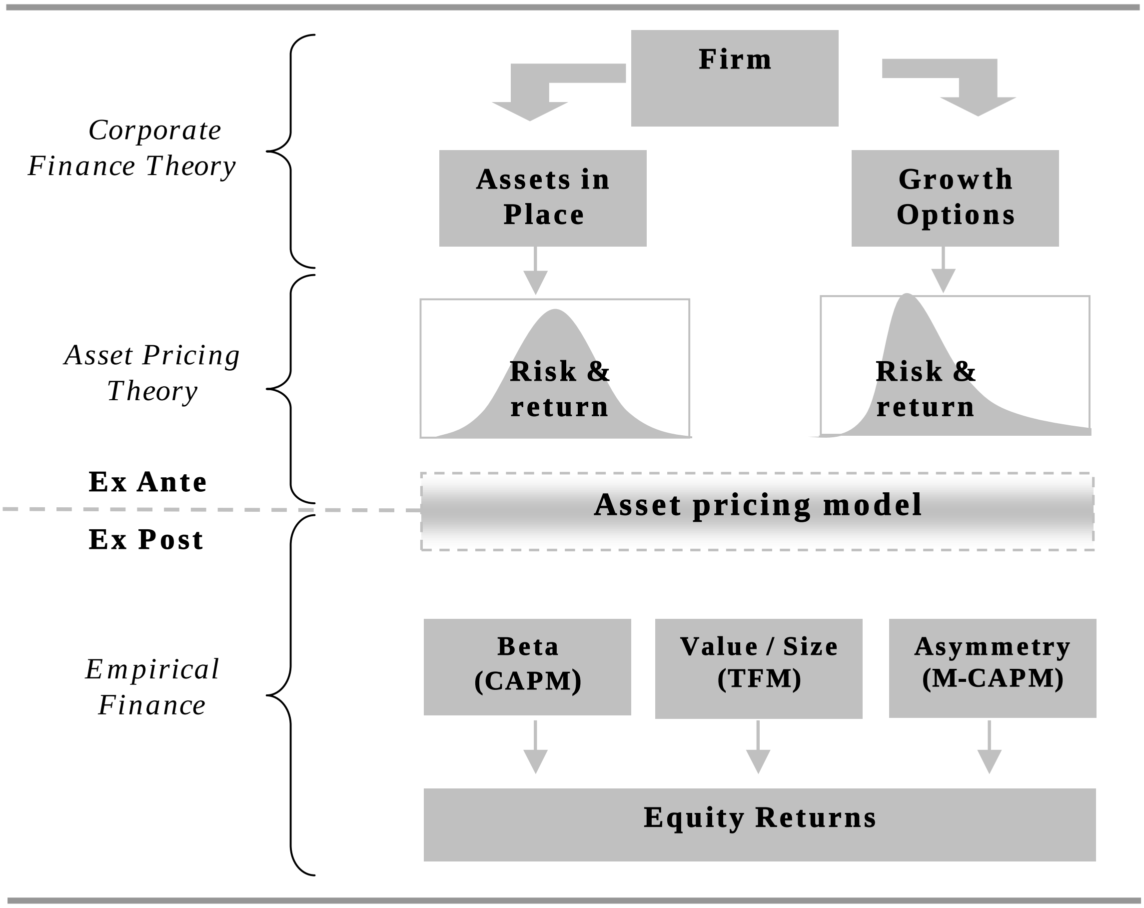


Table I

Average Yearly Returns, median returns, and standard errors, for portfolios formed on Beta and then on PVGO: Stocks sorted on Beta (Down) then on PVGO/P (Across): July 1984 to July 2000.

Portfolio rebalancing takes place on an annual basis. All NYSE, AMEX, and NASDAQ stocks that meet the Datastream data requirements are allocated to the 5 beta portfolios. The number of included firms determines the breakpoints, where for each period an equal number of firms are allocated to each portfolio. This procedure results in portfolios which contains each year an equal number of firms. The individual betas are estimated with the prior 36 months of monthly returns ending in July of year (t). PVGO is defined as the difference between market value of equity (ME) and the present value of the earnings (PVE) at the end of June in year (t). The risk free interest rate is defined as the 1-month T-bill rate. The average portfolio returns are the equally weighted excess returns after deduction of the risk free interest rate. The returns are calculated starting in July of year (t) and ending in June of year (t+1). The median returns are calculated using the same procedure. Additionally we report for each portfolio the median PVGO/P, book/market ratio, and market value of equity (size) and their correlations. Average returns and median returns of the 25 portfolios are related with their median betas and PVGO/P values in two simple regressions.

	PVGO Quintile														
	Low	**2**	**3**	**4**	**High**	**Low**	**2**	**3**	**4**	**High**	**Low**	**2**	**3**	**4**	**High**
β	Average Return					Standard error					Median Return				
Low	0.122	0.127	0.099	0.100	0.101	0.023	0.017	0.017	0.016	0.019	0.020	0.059	0.050	0.025	0.013
2	0.123	0.074	0.078	0.098	0.076	0.017	0.014	0.014	0.023	0.016	0.058	0.036	0.040	0.029	0.003
3	0.126	0.112	0.074	0.098	0.081	0.024	0.018	0.014	0.014	0.015	0.040	0.036	0.032	0.055	0.024
4	0.124	0.125	0.079	0.100	0.078	0.021	0.025	0.014	0.018	0.018	0.015	0.031	0.038	0.026	0.010
High	0.140	0.123	0.181	0.163	0.119	0.035	0.021	0.032	0.025	0.025	-0.039	0.011	0.032	0.000	-0.034
β	PVGO/P					BE/ME					Beta				
Low	-4.39	-0.46	0.02	0.35	0.71	0.70	0.78	0.65	0.54	0.34	0.09	0.15	0.20	0.19	0.15
2	-2.40	-0.02	0.27	0.47	0.72	0.69	0.69	0.57	0.45	0.41	0.59	0.58	0.60	0.62	0.61
3	-1.60	0.19	0.42	0.56	0.75	0.64	0.62	0.49	0.40	0.39	0.94	0.94	0.95	0.96	0.96
4	-1.11	0.31	0.51	0.64	0.80	0.57	0.59	0.47	0.40	0.36	1.30	1.29	1.30	1.31	1.33
High	-0.76	0.44	0.63	0.75	0.88	0.52	0.55	0.43	0.34	0.27	1.93	1.92	1.94	1.99	2.20

Regressions

$Ri-Rf = a + b_1 (beta) + b_2 (PVGO/P)$

	a	t (a)	b_1	t (b_1)	b_2	t (b_2)	Adj R2
Average Returns	0.081	9.09	0.027	3.49	-0.010	-2.54	0.337
Median Returns	0.047	5.76	-0.023	-3.24	0.001	0.23	0.281

Correlations

	PVGO/P	BE/ME	Beta
PVGO/P	1.00	-0.65	0.34
BE/ME	-0.65	1.00	-0.51
Beta	0.34	-0.51	1.00

Table II

Average Yearly Returns, median returns, and standard erros for portfolios formed on Size and then on PVGO/P: Stocks sorted on Size (Down) then on PVGO (Across): July 1984 to July 2000.

Portfolio rebalancing takes place on an annual basis. All NYSE, AMEX, and NASDAQ stocks that meet the Datastream data requirements are allocated to the 5 market value of equity (ME) portfolios. The number of included firms determines the breakpoints, where for each period an equal number of firms are allocated to each portfolio. This procedure results in portfolios which contains each year an equal number of firms. At the end of June at year (t) the individual market values of equity are determined as measured by the total number of outstanding shares multiplied by the price. The average portfolio returns are the equally weighted excess returns after deduction of the risk free interest rate. The returns are calculated starting in July of year (t) and ending in June of year (t+1) and the standard errors are given. The median returns are calculated using the same procedure. Additionally we report for each portfolio the median PVGO/P, Book-to-market ratio, and market value of equity (size). Average returns and median returns of the 25 portfolios are related with their median log-scaled sizes and PVGO/P values in two simple regressions.

	PVGO Quintile														
	Low	**2**	**3**	**4**	**High**	**Low**	**2**	**3**	**4**	**High**	**Low**	**2**	**3**	**4**	**High**
	Average Returns					Standard error					Median Returns				
ME-1	0.160	0.188	0.142	0.129	0.133	0.028	0.038	0.024	0.025	0.026	0.006	0.007	-0.006	-0.007	-0.003
ME-2	0.098	0.084	0.105	0.089	0.078	0.021	0.016	0.026	0.021	0.023	0.005	0.008	0.000	-0.032	-0.064
ME-3	0.095	0.087	0.075	0.099	0.118	0.016	0.012	0.017	0.017	0.029	0.033	0.035	0.007	0.020	-0.018
ME-4	0.080	0.088	0.081	0.089	0.134	0.014	0.013	0.011	0.013	0.024	0.033	0.048	0.056	0.035	0.034
ME-5	0.097	0.086	0.103	0.155	0.125	0.011	0.011	0.011	0.022	0.015	0.076	0.058	0.080	0.103	0.054
	PVGO/P					BE/ME					ME				
ME-1	-3.43	-0.32	0.24	0.55	0.81	0.79	0.88	0.77	0.67	0.33	11	14	14	13	12
ME-2	-1.99	-0.01	0.33	0.56	0.81	0.71	0.75	0.67	0.57	0.50	55	54	58	57	55
ME-3	-1.40	0.15	0.41	0.59	0.80	0.63	0.65	0.57	0.50	0.42	180	188	199	194	186
ME-4	-1.15	0.22	0.47	0.62	0.80	0.59	0.57	0.46	0.38	0.31	671	654	694	665	643
ME-5	-1.09	0.24	0.47	0.60	0.78	0.56	0.50	0.37	0.33	0.27	3042	3650	3784	3612	3092

Regressions

$Ri-Rf = a + b_1 \ln(ME) + b_2 (PVGO/P)$

	a	t (a)	b_1	t (b_1)	b_2	t (b_2)	Adj R2
Average Returns	0.135	7.77	-0.005	-0.34	-0.005	-0.34	0.041
Median Returns	-0.062	-4.79	0.016	6.94	-0.008	-1.84	0.658

Correlations

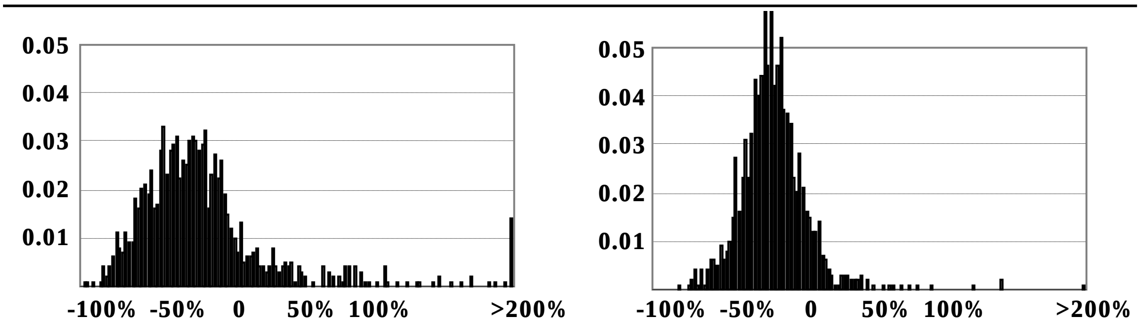
	PVGO/P	BE/ME	ME
PVGO/P	1.00	-0.57	-0.51
BE/ME	-0.57	1.00	0.14
ME	-0.51	0.14	1.00

Figure 2

Frequency distributions of two types of firms: July 1984-July 2000.

Two types of frequency distributions of firm year excess returns are depicted in this figure. Panel A consists of the 20% smallest firms with the 20% highest PVGO/P values and panel B consists of the 20% largest firms with the 20% lowest values of PVGO/P. In each figure 4% of all firm year returns is depicted. Panel A (upper right) and panel B (down left) correspond with the statistics in table 2. The number of all firm year returns is 24732, of which 995 in panel A and 984 in panel B. The frequency distributions are equipped with bin ranges of 3%, where excess returns more than 300% are cumulatively depicted. In panel A 1.4% and in panel B 0.0 % of the excess returns exceed this upper limit of 300%. Panel C provides the statistics for all firms and 5 quintiles. The mean, trimmed mean (5%), median, standard error, skewness and excess kurtosis.

A: Small growth firms | **B: Large asset firms**



C: Descriptive statistics

	Mean	s.e	Med.	% > 0	Trim	Var	Skew	Kurt
A:	13.3%	2.1%	-0.3%	49.6%	6.1%	66.8%	4.79	41.5
B:	9.7%	9.7%	7.6%	63.2%	8.4%	10.9%	2.27	17.1

Table III

Time-series return regressions: Relation Size and PVGO/P

This table contains the results of time-series regressions that test whether the growth options factor is priced for the different size portfolios. The dependent variable is the excess return of one of the value weighted CRSP-size quintile portfolios. The period ranges from July 1984 – December 2000, a total of 198 monthly returns. The intercepts (which should be zero) are expressed in terms of percent per month. The joint Wald test statistic presented below is estimated in a system of equitions applying the seemingly unrelated regression (SUR) estimator. The growth options factor, GMA_t, is a hedge portfolio: long position in PVGO/P 5 financed by a short position in PVGO/P 1. $R_{m,t}$ is the return of the CRSP's value-weighted index and R_f is the short term Treasury bill rate.

$$R_{i,t} - R_f = \alpha_i + \beta_{i,m}(R_{m,t} - R_f) + \varepsilon_{i,t}$$

	α_i	t-stat	$b_{i,m}$	t-stat	Adj. R^2
ME-1	-0.003	-1.18	1.03	15.61	0.56
ME-2	-0.003	-1.55	1.11	24.00	0.75
ME-3	-0.002	-1.15	1.08	32.12	0.84
ME-4	-0.001	-0.49	1.06	46.05	0.92
ME-5	0.001	2.04	0.97	68.60	0.96

Joint Wald test statistic (a_i =0) = 10.53 (p = 0.06)

$$R_{i,t} - R_f = \alpha_i + \beta_{i,m}(R_{m,t} - R_f) + \beta_{i,go}(GMA_t) + \varepsilon_{i,t}$$

	a_i	t-stat	$b_{i,m}$	t-stat	$b_{i,go}$	t-stat	Adj. R^2
ME-1	-0.001	-0.27	0.78	10.23	0.67	5.39	0.61
ME-2	-0.001	-0.50	0.90	17.40	0.56	6.58	0.79
ME-3	0.000	-0.21	0.95	24.47	0.35	5.56	0.86
ME-4	0.000	0.39	0.98	36.31	0.22	5.01	0.93
ME-5	0.001	0.96	1.04	66.18	-0.18	-7.13	0.97

Joint Wald test statistic (a_i =0) = 6.21 (p = 0.29)

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