Real Options and the Diversification Discount

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June 2000

Abstract

Lang and Stulz (1994) and Berger and Ofek (1995) documented that multi-segment diversified firms trade at a discount relative to the sum of the market values of comparable single-segment firms. Bernardo and Chowdhry (1999) offer one possible explanation for the diversification discount: the market value of single-segment firms include the value of real options to diversify and expand in other segments whereas multi-segment diversified firms have perhaps exhausted their options to diversify and expand. In this paper, we document evidence that the diversification discount is increasing in variables that proxy for real options. In particular, we find that the diversification discount is increasing in R&D expenditures of single-segment firms, decreasing in the age of the single-segment firms, and increasing in market volatility.

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1 Introduction

A number of scholars have argued that a firm's investment strategy is determined by leveraging the capabilities, skills and assets (*i.e.*, resources) that are the source of its competitive advantage (Penrose, 1959, Wernerfelt, 1984, Barney, 1991, Collis and Montgomery, 1998). Bernardo and Chowdhry (1999) argue that firms *learn* about the resources they possess by undertaking (and observing the outcomes of) real investments. The realizations of cash flows from these investments provide valuable information about the firm's resources which can be used to guide future investment decisions. Thus, when making investment decisions, firms will optimally consider both the stand-alone cash flows and the value of the information the firm is expected to learn. The value of this information will depend on the current state of information about the firm's resources and on the level and types of real investment opportunities – or real options – that are available to the firm to exploit in the future (Dixit and Pindyck, 1994, and Trigeorgis, 1996).

In this paper, we argue that real options can explain some of the diversification discount - the well-documented empirical result that the market value of diversified firms operating in several business segments appear to be less than the sum of the market values of single segment firms operating in corresponding businesses (Lang and Stulz, 1994, and Berger and Ofek, 1995). This is because the market value of single-segment firms include the value of real options to diversify and expand in other segments whereas multi-segment diversified firms have perhaps exhausted their options to diversify and expand (Bernardo and Chowdhry, 1999). We test this conjecture in three different ways.

First, we argue that if the market value of a single-segment firm includes the value of its real options to diversify and expand into other lines of business, then we should expect a positive relation between a measure of firm's real options and the future number of segments in which it operates. We document evidence consistent with this prediction. Second, we examine the differences between multi-segment diversified firms and firms synthesized by putting together single segment firms that mimic the composition of segments in the diversified firm. We do indeed find that multi-segment firms consist of segments that have smaller real options compared to the corresponding median single-segment firms by showing that diversified firms spend less on R&D, have larger fraction of assets that are tangible, generate larger cash flows and are bigger in size compared to the equivalent synthesized firms. Third, we document evidence that the diversification discount is increasing in variables that proxy for real options. In particular, we find that the diversification discount is increasing in R&D expenditures of single-segment firms, decreasing in the age of the single-segment firms, and increasing in market volatility.[1]

Several theoretical papers have suggested that the diversification discount could be a manifestation of value destruction in diversified firms as a result of agency problems (Montgomery, 1994, Scharfstein and Stein, 1997, Rajan, Servaes and Zingales, 1998). Many empirical papers have related the diversification discount to managerial agency problems.[2] While these papers suggest that the diversification discount is generally explained by managerial agency problems, our paper suggests that part of the diversification discount might be explained by real options. Chevalier (1999) also provides evidence that diversification *per se* may not be associated with destruction in value.

[1]There is some evidence that diversification and firm age are positively related; see Mueller (1972) and Montgomery (1994). Matsusaka (1998) studies a sample of 63 firms that were diversified in 1972 and finds that most of these firms were specialized 10 years earlier and many refocused over the next 10 years.

[2]For example, Denis, Denis and Sarin (1997) find no evidence that the diversification discount is lower when managerial ownership is higher, but find a U-shape relationship between a firm's reported segments and their managerial ownership levels. Lamont (1997) finds that the exogenous oil price increase of 1986 led diversified oil companies to reduce investment in their non-oil divisions, in contrast to a comparable sample of single-segment, non-oil, stand alone firms. He also finds that this cross-subsidization is inefficient, because prior to the oil shock, the non-oil division of the diversified firm underperformed their stand alone counterparts while they still invested at the same rate. Berger and Ofek (1995) find that unrelated segments of diversified firms overinvesting in low-q industries resulted in a higher diversification discount. Shin and Stulz (1998) find that the investment of the smallest division of the diversified firm is positively related to the cash flow of other segments, in contrast to the investment of the largest division of the diversified firm. They hence suggest that the investment policy of the diversified firm is inefficient because changes in the cash flows of other segments affect investment in low-q divisions and high-q divisions similarly. Scharfstein (1998) finds that diversified firms misallocate capital by overinvesting in divisions with bad investment prospects (as measured by the industry-q of comparable single segment firms) and underinvesting in divisions with good investment prospects, and this "socialistic" investment policy is reduced when managerial ownership levels is higher. Palia (1999) finds that the diversification discount is reduced when the diversified firm has better corporate governance structures (for example, a stronger CEO's pay-performance sensitivity, and a smaller board).

She examines the behavior of merging firms *prior* to the mergers and finds that it is not very different from that after the mergers. Furthermore, she finds evidence that announcement returns for diversifying firms are often positive. She thus attributes the results in the literature about value destruction in diversified firms to selection bias. A stronger claim is made by Campa and Kedia (1999) who suggest that diversification does not necessarily destroy value but rather that firm characteristics that explain firms' decision to diversify are also associated with these firms trading at a discount. They show that once you control for various firm characteristics, the diversification discount becomes much smaller and in some cases disappears. They control for a large number of firm characteristics, chosen in a somewhat *ad hoc* fashion, as they do not have a compelling theory to guide the selection of these control variables. Our approach, on the other hand, is guided by the predictions of the theoretical model of Bernardo and Chowdhry and focuses only on variables that can be considered reasonable proxies for real options.

2 The Data

We begin by using the 1999 business information file from Compustat. In accordance with FASB-SFAS #14 and SEC Regulation K (that requires firms to report segment information), Compustat provides information on segments that represent greater than or equal to 10% of the consolidated firm's sales. This data is provided for firms disaggregated up to 10 different segments. We remove all firms with sales of less than $20 million, to be consistent with Berger and Ofek (1995). As in Berger and Ofek we also remove all firms whose sum of segment sales is off total firm sales by 1%. Diversified firms are defined as all firms with two or more segments. We then calculate Berger and Ofek's excess value measure, defined as the ratio of actual firm value to imputed value. We use their asset multiplier approach, given that they show it is highly correlated with the sales and earning multipliers. The excess value measure is the ratio of the market value of the diversified firm to the segment asset-weighted average of the median single-segment firm in the same industry's market value to book value of assets. In our sample, we find that the excess value measure for the Berger and Ofek's years of 1986 to 1991 to have a mean (median) of -0.133 (-0.202) compared to their mean of -0.162 and median of -0.122. The differences in these results occur because the number of firms in the Compustat database have increased over the years as data for more and more firms have been backfilled.

Using Compustat data limits us to using annual observations and since we have data for only 19 years (1980-1998) this yields only 19 observations for examining time series variation in the diversification discount. Therefore, we append the Compustat data with CRSP data. First, we show in Figure 1, that using annual observations, the excess value measure for the diversification discount is remarkably similar when we use CRSP data to when we use Compustat data, with a correlation coefficient of 0.93. Thus we expand the number of observations from 19 to 76 by calculating the excess value measure on a quarterly basis by using market value of equity on a quarterly basis using CRSP data. For all accounting variables, we use annual data from Compustat and for each quarter in a given year assign the same value that corresponds to the observation for that year.

We construct the following variables for our empirical tests.

- **DD:** Log of the ratio of the market value of the diversified firm to the segment asset-weighted average of the median single-segment firm in the same industry's market value to book value of assets.

- **R&D:** For each segment of a diversified firm we find the median ratio of R&D expenditures to assets for single-segment firms that compete in that segment. The R&D variable is then simply the segment sales-weighted average of these median R&D expenditures to assets ratios.[3]

- **Age:** For each segment of a diversified firm we find the median age for single-segment firms that compete in that segment. The Age variable is then simply the segment sales-weighted average of these median ages.

- **AvDD:** For each quarter, AvDD represents the average over all firms of the variable DD.

- **AvR&D:** For each year (for all 4 quarters), AvR&D represents the mean over all firms of the variable R&D.

[3]We considered other proxies for real options such as (Assets-Property Plant & Equipment)/Assets which in some sense is a measure of firm's intangible assets. These variables were highly correlated with the R&D variable, so we do not report any results using these alternative measures.

- **AvAge:** For each year (for all 4 quarters), AvAge represents the mean over all firms of the variable Age.

- $\boldsymbol{\sigma}$: For each quarter, the standard deviation of the return on the S&P 500.

- **AvAge**$'$: This variable standardizes the variable **AvAge** by subtracting its mean and dividing by the standard deviation.

- $\boldsymbol{\sigma}'$: This variable standardizes the variable $\boldsymbol{\sigma}$ by subtracting its mean and dividing by the standard deviation.

3 The Evidence

If indeed it is true that the market value of a single-segment firm includes the value of its real options to diversify and expand into other lines of business, then we should expect a positive relation between a measure of firm's real options and the future number of segments in which it operates. To examine this we considered all single segment firms in the year 1980 and grouped them into deciles by their Tobin's q measure which is a reasonable proxy for their real options. We then followed these firms and calculated the number of segments they operated in for each year from 1981 to 1987. Figure 2 plots the average number of segments for firms in the highest and the lowest q-deciles. We observe that high q firms in 1980 were indeed more likely to expand into different lines of business than low q firms. We repeated this procedure for all single-segment firms in the years 1980, 1981, 1982 and so on, and obtained essentially the same result.

We then examine to what extent are multi-segment diversified firms different compared to synthesized firms created by putting together single segment firms that mimic the composition of segments in the diversified firm. We compare four variables, R&D/Assets, Property Plant and Equipment(PPE)/Assets, Cash Flow/Assets and Size, for each diversified firm to its corresponding imputed value for the synthesized firm created by single segment firms. If single-segment firms have greater real options than multi-segment firms we predict that R&D/Assets should be greater for the single-segment firms who will optimally invest more than their multi-segment counterparts. Moreover, single-segment firms are likely to have more intangible assets and thus

PPE/Assets should be smaller. Finally, single-segment firms are likely to be earlier in their life cycle so Cash Flow/Assets and Size should be smaller. As predicted, Table 1 shows that diversified firms have smaller R&D/Assets, and larger PPE/Assets, Cash Flow/Assets and Size, compared to the equivalent synthesized firms. These results are consistent with our conjecture that multi-segment firms consist of segments that have smaller real options compared to the corresponding median single-segment firms.

We then begin by exploring to what extent the cross sectional variation in the diversification discount can be explained by proxies for firm's real options such as firm age[4] and R&D expenditures of the single-segment firms in the industries in which the diversified firms operate. We perform two tests of this intuition. In the first test, we run a panel regression of all firms and all quarters with the diversification discount DD as the dependent variable and R&D, Age and the standard deviation of the market return σ as the independent variables. If the diversification discount is to be related to proxies for real options, we expect the coefficient on R&D to be positive, the coefficient on Age to be negative, and the coefficient on σ to be positive. In the second test, we replaced the market volatility with quarter dummies (one can not include both as they are collinear). The coefficients on the quarter dummies represent the marginal impact on the diversification discount for the year that is not explained by cross-sectional variation in Age and R&D. We will use the coefficients on the quarter dummies later to do robustness checks. Table 2 presents these results (we do not show the coefficients for quarter dummies).

We are not only interested in explaining the cross-sectional variation in diversification discount at the firm level but also the time-series variation in the Average Diversification Discount (AvDD) at the aggregate level. To examine this, we first run OLS regressions of AvDD on Av R&D, AvAge and the standard deviation of the market return σ. We run both univariate as well as multivariate regressions both with and without an interaction term. Table 3 provides the correlation matrix for the independent variables. Notice that the interaction term AvAge*σ is highly correlated with σ. This is because the time series variation in Age is relatively small compared to the variation in σ.

[4] Bernardo and Chowdhry (1999) argue that the diversification discount should be greater when the comparable firms in each segment are younger because these firms have much more valuable real options.

Therefore we first standardize the two variables and construct the interaction term AvAge′*σ′ which we observe in Table 3 is not highly correlated with other independent variables we include in the regressions. Table 4 summarizes the results of these regressions.[5] We find that AvR&D has a positive and statistically significant impact on the diversification discount and the standard deviation of market return has a positive and significant impact on the diversification discount. Finally, when we include an interaction term and find that the younger the comparable single-segment firms, the greater the impact of market volatility on the diversification discount. This is also consistent with the Bernardo and Chowdhry (1999) hypothesis that younger firms have greater real option opportunities so they benefit more from high market volatility environments. Finally, we perform robustness check by regressing the coefficients on the quarter dummies as the dependent variable to replace AvDD. Recall, the coefficients on the quarter dummies control for *cross-sectional* variation in R&D and Age. This alternative specification does not significantly alter the results (not reported here) which is not surprising as the correlation coefficient between AvDD and quarter dummies is over 0.99. The results in Table 4 help us explain the time-series variation in the Average Diversification Discount net of cross-sectional effects of R&D and Age.

4 Concluding Remarks

Many papers in the literature suggest that the diversification discount reflects inefficiencies in diversified firms caused by agency problems between managers and shareholders. We argue instead that the measured discount may also reflect the fact that the market value of single-segment firms include the value of real options to diversify and expand in other segments whereas multi-segment diversified firms have perhaps exhausted their options to diversify and expand. We provide three pieces of evidence consistent with this prediction. First, we show a positive relation between a measure of firm's real options and the future number of segments in which it operates. Second, we find that multi-segment firms consist of segments that have smaller real options compared to the corresponding median single-segment firms by showing

[5]For brevity, we do not show results when an interaction term for the variables R&D and σ is included as it turns out to be not important.

that diversified firms spend less on R&D, have larger fraction of assets that are tangible, generate larger cash flows and are bigger in size compared to the equivalent synthesized firms. Third, we find that the diversification discount is increasing in R&D expenditures of single-segment firms, decreasing in the age of the single-segment firms, and increasing in market volatility which are all proxies for real options.

While we have analyzed some broad measures of real options in this paper, future research efforts might consider other measures of real options such as those considered in Constantinides and Ye (1998) to further refine the tests.

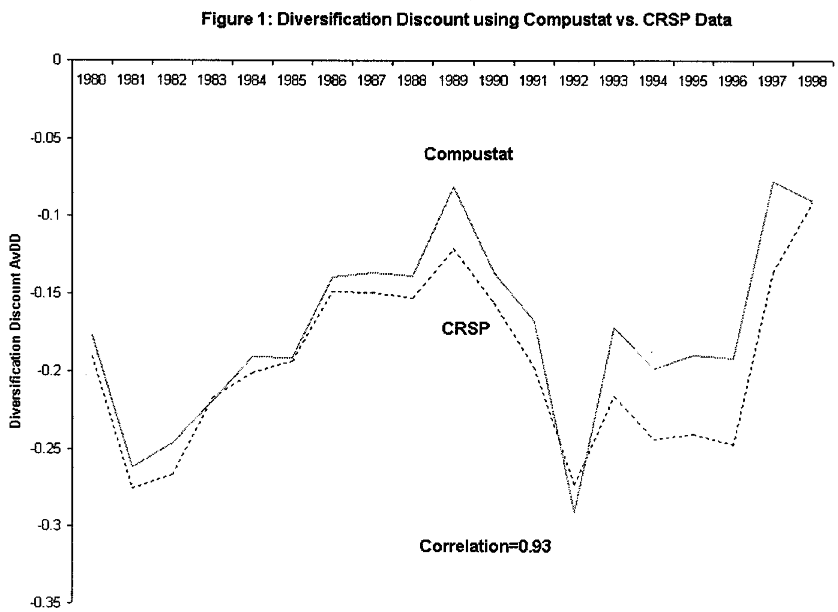

Figure 1: Average Diversification Discount by Year using Compustat vs. CRSP data

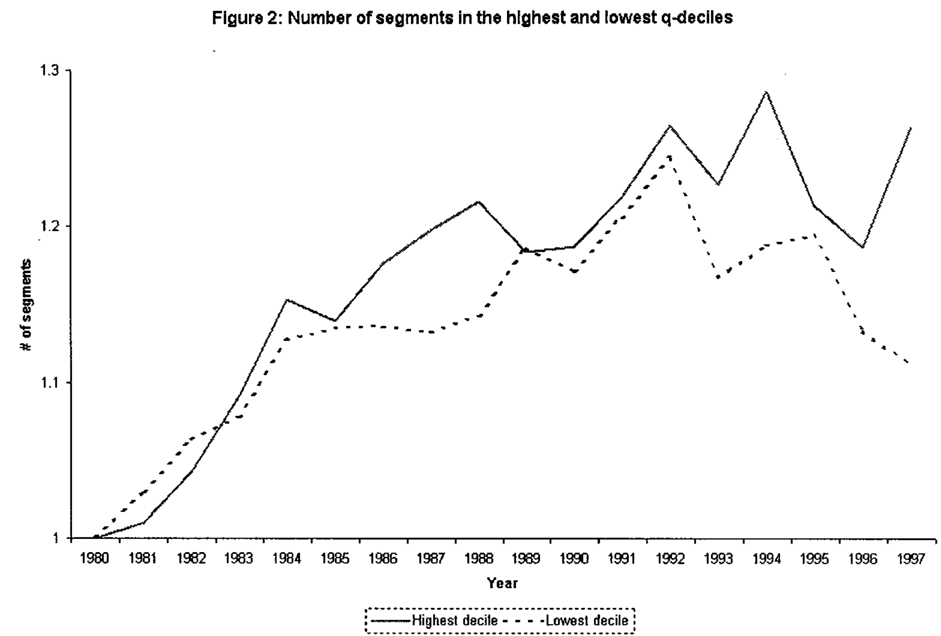

Figure 2: Number of segments over the years for single segment firms in 1980 in the highest and lowest q-deciles

Table 1
Differences between multi-segment diversified firms and synthesized firms

	Diversified Firm Mean	Synthesized Firm Mean	t-statistic for difference
R&D/Assets	0.030	0.033	-6.44
PPE/Assets	0.627	0.558	28.40
Cash Flow/Assets	0.148	0.110	36.03
Size (ln Assets)	5.862	4.156	73.84

Table 2
OLS Panel Regressions of Diversification Discount

	Intercept	R&D	Age	σ	Dummies	N	Adj. R^2
1	-0.167	-0.255	-0.007	0.284		76918	0.31%
	(-22.33)	(-3.43)	(-13.05)	(8.24)			
2	-0.029	-0.374	-0.007		Not	76918	1.10%
	(-1.81)	(-4.99)	(-13.27)		reported		

Numbers in parentheses are t-statistics.

Table 3
Correlation Matrix

	AvR&D	AvAge	σ	AvAge*σ	AvAge′*σ'
AvR&D	1.00				
AvAge	-0.58	1.00			
σ	-0.05	-0.05	1.00		
AvAge*σ	-0.21	0.18	0.97	1.00	
AvAge′*σ'	-0.23	-0.08	-0.26	0.93	1.00

Table 4
OLS Regressions of Average Diversification Discount (1980Q1-1998Q4)

	Intercept	AvR&D	AvAge	σ	AvAge$'$*σ'	N	Adj. R^2
1	-0.32	4.33				76	10%
	(-8.11)	(3.09)					
2	-0.16		-0.0045			76	-0.7%
	(-2.02)		(-0.67)				
3	-0.23			0.27		76	6.8%
	(-15.74)			(2.54)			
4	-0.36	4.54		0.29		76	18.3%
	(-8.97)	(3.38)		(2.88)			
5	-0.16		0.0037	0.27		76	6.1%
	(-2.71)		(0.57)	(2.59)			
6	-0.51	6.15	0.0125	0.30		76	20.3%
	(-5.10)	(3.76)	(1.69)	(3.07)			
7	-0.17		-0.0059	0.16	-0.029	76	20.6%
	(-2.98)		(-0.98)	(1.59)	(-3.81)		
8	-0.41	4.42	0.0064	0.22	-0.021	76	26.5%
	(-3.82)	(2.60)	(0.85)	(2.16)	(-2.66)		

Numbers in parentheses are t-statistics.

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