The Real Option Value of Segments and Future Abnormal Returns[*]

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Abstract

The real option theory suggests that firm value should include the value of real options, i.e. a firm has the option to expand a profitable business and the option to liquidate assets of a less profitable business. For a diversified firm, each segment has similar options. Applying the option-based valuation to a multi-segment firm at only the firm level neglects the real option value of its segments and could lead to mispricing and subsequent abnormal returns. Using data from 1981 to 2009, we find that a hedge portfolio buying diversified firms with the highest decile of real option value of segments (RVS) and selling those with the lowest decile of RVS earns a significant 11.7% size-adjusted abnormal returns in the next year. The hedge returns are positive in 22 of 26 total sample years. We also find that the hedge returns are more significant in firms with high growth or with good corporate governance. Further investigations indicate that firms exercise their segment-level real options to improve operating income and that abnormal returns concentrate around subsequent earnings announcements. Lastly, our finding provides an alternative explanation for the well-documented diversification discount.

1. Introduction

Shareholders have real options in the firm, i.e. operations with high profitability can be expanded and operations with low profitability can be adapted to alternative use or liquidated (Myers 1977). The former can be considered as a call option whose value increases when the profitability increases, and the latter can be considered as a put option whose value increases when the profitability decreases. Valuation of a firm should reflect these real options therefore should be a convex function of profitability. The literature has examined the implication of real options and, the evidence indicates that real option value is an important component of firm value. Burgstahler and Dichev (1997), for example, show that the equity valuation is a convex function of a firm's profitability, suggesting that stock prices reflect the real option value.[1]

Most of prior studies examine real option values only at the firm level.[2] However, as Chen and Zhang (2003) suggest, the concept of real options can be applied to the segment level as well. For a firm with multiple segments, each segment has its own real options, and the firm value should include the combination of the real option value of all segments. Because the valuation function is convex on profitability, the combination of the real option value of segments is greater than the real option value estimated at the firm level. Neglecting the real option value of segments could lead to mispricing and predictable future returns.

In this paper we examine whether the real option value of segments predict future returns. Following the theoretic work of Chen and Zhang (2003), we construct a variable RVS based on segment information to measure the importance of real option value of segments in a diversified firm. RVS is defined as the asset-weighted divergence of segment profitability deflated by the

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[1] See also Hayn (1995); Berger, Ofek and Swary (1996); Collins, Pincus and Xie (1999); Zhang (2000); Biddle, Chen and Zhang (2001); etc.

[2] Two exceptions are Chen and Zhang (2003; 2007). We will discuss these two papers in more details later.

market value of equity. We form 10 portfolios based on the most recent RVS at the end of June in each year and accumulate returns from July. In a sample of 15,410 observations in the period of 1981 to 2009, we find that a hedge portfolio buying firms with the highest decile of RVS and selling those with the lowest decile of RVS earns a significant 11.7% size-adjusted abnormal return in the year following portfolio formation. The hedge returns are positive in 22 out of 26 years. The abnormal returns do not reverse in the second or the third years. The usefulness of real option value of segments in return prediction is robust after controlling for pricing factors such as firm size, book to market ratio, momentum, and E/P ratio. The evidence suggests that stock prices do not fully reflect the real option value of segments.

Two scenarios might affect the effectiveness of the RVS-based trading strategy. First, firms with different growth rates might experience different valuation effects of the real options. The theoretical work of Chen and Zhang (2003) suggests that firm growth has a multiplying effect on the real option value of segments. The real option value of segments is greater when a firm has a higher growth rate. We divide our sample into two groups based on firms' market-to-book ratio and find that the size-adjusted abnormal returns of the hedge portfolio are 16.2% in the high growth group, significantly greater than the abnormal returns of 6.2% in the low growth group. Second, firms need to expand successful segments and retract unsuccessful segments in order to realize the real option value of segments.[3] However, Rajan, Servaes, and Zingales (2000) suggest that agency problems often lead to inefficient internal markets such that managers compensate unsuccessful segments using the resources from successful segments. Therefore, the real option value of segments is difficult to realize in firms with severe agency problems. We combine our sample with the measurement of corporate governance (G-Index) developed by Gompers et al.

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[3] Consistent with this scenario, Hwang and Sohn (2010) find that the superior return predictability of the real options model is pronounced in the set of firms with a high probability of exercising liquidation options.

(2003) and examine the RVS-based trading strategy conditional on corporate governance. The evidence shows that the hedge portfolio earns a significant size-adjusted return of 16.5% in the good corporate governance group and an insignificant 0.1% in the poor corporate governance group. The evidence indicates that good corporate governance reduces agency problem and increases the possibility to realize the real option value of segments.

We conduct further empirical tests to provide corroborative evidence on the implication of real option value of segments. First, we present evidence that firms exercise the real option value of segments. We find that RVS is negatively associated with the change of number of segments and the change of RVS in the next year, suggesting that firms exercise the real options. We also find that RVS is positively related to future earnings changes, and the change of RVS is negatively related to future earnings changes, suggesting that the exercise of the real options of segments leads to future earnings increase. The market absorbs the information about real option value of segments by observing its effect on earnings performance. Second, we examine the abnormal returns around quarterly earnings announcements in the future year. We accumulate returns within (-1,1) trading days around four earnings announcements in the year following the portfolio formation and find that the size-adjusted abnormal return for the hedge portfolio is 1.7%, which is about 13.5% of the total hedge return. The proportion of the abnormal return around earnings announcements in total hedge return is much higher than the proportion of the announcement period in the whole trading days (12 trading days/250=4.8%). The evidence is consistent with the notion that the market neglects the real option value of segments and is surprised by the earnings performance of firms with high real option value of segments.

Third, we examine whether the real option value of segments provides an explanation for the well-known diversification discount. Studies by Lang and Stulz (1994), Berger and Ofek

(1995), and Servaes (1996) show that diversified firms trade at a discount relative to comparable single-segment firms. The result seems to be robust in different time periods and different countries (Lins and Servaes 1999). Our evidence suggests that diversified firms have real option value of segments and this real option value of segments is not fully reflected in the market value, which could lead to a valuation discount relative to focused firms. We calculate diversification discount following Berger and Ofek (1995) and regress the diversification discount on RVS and other controlling variables. We find that RVS is significantly associated with diversification discount, suggesting that the failure to incorporate the real option value of segments could be an explanation of diversification discount.

Our paper makes several contributions to the literature. First, it adds to the research that examines the relation between capital markets and financial. Researchers have documented that accounting information is value-relevant and that the market does not fully price publicly available accounting information, such as accruals (Sloan, 1996), discretionary accruals (Xie, 2001), seasonal earnings changes (Bernard and Thomas, 1990), analysts' earnings forecasts (Elgers et al., 2001), special items (Burgstahler et al., 2002), and net operating assets (Hirshleifer et al., 2004).[4] Focusing on the impact of segment-level financial information, this paper finds that stock prices do not fully reflect segment-level accounting information in cross-section. Subsequently, a trading strategy based on the segment-level real option value yields significant abnormal returns. To our best knowledge, our paper is the first one that designs a trading strategy based on segment-level information.

Second, our paper contributes to the understanding of the usefulness of segment information.

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[4] See Richardson et al. (2010) for a review of accounting based anomalies.

Practitioners and academics agree that segment information matters for valuation.[5] However, no consensus exists about how to extract the economic implications from segment data. Many researchers—for example Givoly et al. (1999), Wysocki (1999), Basu et al. (2000)—treat segment information as an alternative to firm-level information. Tse (1989) shows that segment information is useful but does not show how to use segment information. Chen and Zhang (2003) explicitly analyze the equity value of a multi-segment firm as the combination of (1) the part explained by aggregate firm level accounting data and (2) an incremental component attributed to real options value of segments. In their empirical study, however, the incremental explanation power from segment data is very small. Our paper is an extension of Chen and Zhang (2003) and examines the real option value of segments as a predictor of future returns. We provide direct empirical evidence that the real option value of segments predicts future abnormal returns and that the hedge return is greater for growth firms. Our finding of market inefficiency regarding segment accounting information also provides an explanation for why Chen and Zhang (2003) find only small incremental explanation power from segment data.

Third, our paper presents evidence that real option analysis on firm valuation can be extended to the segment level. The literature has examined the implications of the real option value, and the evidence indicates that the real option value affects market value and also predicts future returns. However, most of the analysis is on the firm level. Chen and Zhang (2003) suggest that the concept of real option value can be easily extended to the segment level. We apply the real option value analysis to segment level and find the real option value of segments can predict future abnormal returns. We also provide empirical evidence that firms exercise the

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[5] For example, Association for Investment Management and Research (AIMR) states that segment information is "vital, essential, indispensable and integral to the investment analysis process. Analysts need to know and understand how the various components of a multifaceted enterprise behave economically. …There is little dispute over the analytic usefulness of disaggregated financial data."

real options of segments, which leads to higher future earnings change.

Our paper also adds to a growing list of studies that provide explanations to the empirically well-documented diversification discount (Berger and Ofek, 1995), including the inefficient internal capital market (Rajan, Servaes, and Zingales, 2000; Scharfstein and Stein, 2000), the data problem (Villalonga 2004), the endogeneity problem (Graham et al., 2002; Campa and Kedia 2002), and uncertainty about the profitability (Hund et al., 2010). Distinct from all these studies, our paper suggests that the diversification discount could exist because of the real option value of segments. Due to the convexity of the valuation function on profitability, the combination of the real option value of segments is greater than the real option value estimated at the firm level. If diversified firms are priced using only firm level information and the real option value at the segment level is ignored, diversified firms will show a discount relative to their single-segment counterparts. Our empirical evidence strongly supports our arguments.

Our paper is closely related to Chen and Zhang (2003). They analytically prove that the real option analysis can be applied to the segment level and empirically examine the value relevance of the real option value of segments. Our paper is based on the theoretical model of Chen and Zhang (2003). However, our paper differs because we examine whether there is market inefficiency to real option value and whether the real option value of segments can predict future returns, while their paper assumes market efficiency and examines whether the current market prices reflect the real option value of segments. Our paper supplements their empirical evidence and provides more evidence on the usefulness of real option analysis at the segment level. In addition, we provide evidence on the exercise of real options of segments and propose that the real option value of segments can explain the diversification discount. Our paper is also related to Hwang and Sohn (2010). They also examine the role of real option value in predicting future

returns. However, our paper examines the real option value at the segment level, while they examine the real option value at the firm level.

The rest of this paper is organized as follows. Section 2 reviews the theoretical framework of real options based analysis at the segment level, develops testable hypotheses, and introduces our empirical design. Section 3 describes the data. Section 4 presents empirical evidence on the predictive power of segment-level data on firms' future stock returns and examines two conditional variables that affect the predictive power. Section 5 investigates the exercise of real options and the usefulness of the real option value of segments in an explanation of the diversification discount. Section 6 concludes.

2. Theoretical framework, testable hypotheses, and empirical design

2.1. Theoretical framework

In this section we review the theoretical framework of the real option value of segments. Our discussion is based on Chen and Zhang (2003) and is descriptive, with the purpose to derive our hypotheses. More rigorous theoretical models can be found in Chen and Zhang (2003).

If a business can neither be expanded nor closed, its valuation is a linear function of its profitability under the conventional dividend discount model (Miller and Modigliani, 1961). This is depicted as the straight line AB in Figure 1a, where the y-axis is the market value deflated by assets and the x-axis is the profitability (ROA). However, in a more realistic setting, shareholders have options to either close the business (a put option), if it has low profitability, or expand it (a call option), if it is highly profitable (Myers 1977; Burgstahler and Dichev, 1997). When shareholders close a business that has zero profitability and sell its assets, the put option is exercised, and the positive value of the put option brings the firm value from zero (point "A") to

some positive number (point "G"). Similarly, a call option can be exercised when the firm is operating at a profitability level higher than its cost of capital (point "F") because shareholders can invest more capital to expand the profitable business. The positive value of the call option brings the firm value from point "B" to point "H." With these real options, the value of a business unit or a single segment firm is a convex function with respect to its profitability. The theory of real option value has been well developed in the literature. (See for example, Berger, Ofek, and Swary 1996 and Zhang 2000.) Burgstahler and Dichev (1997) empirically test an option-style valuation model. [6] They examine empirically the relationship between market value and earnings both scaled by book value, using data from 1976 to 1994, and show there is a convex relationship between the two variables. Their evidence suggests that the market takes into account the real option value at the firm level and the equity value is a convex function of profitability. A more recent study by Billings, Cedergren and Ryan (2011) emphasizes that real option value exists not only when the profitability is negative (abandon option) but also when the profitability is high (continuation option). Firms can make further investments to expand the profitable operations.

(Insert Figure 1a here)

When a multi-segment firm is considered, a simple application of real options analysis based only on its aggregate firm level profitability is not enough. Each segment of the firm has its own real options and should be valued accordingly. The value of a multi-segment firm should be a combination of the real option based valuations of all its segments. The reasoning is illustrated in Figure 1b. Consider a firm with two business segments, each with a distinct profitability, measured by the return on asset (ROA) of the segment. If the segment information

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[6] Burgstahler and Dichev (1997) name the option value of retreating or expanding operations as adaptation value.

is neglected, the firm is valued according to its firm level profitability, or point "D" according to the valuation function discussed above. Note that the valuation at point "D" has already taken account the real option value at the firm level.

If we apply the real option value concept to the segment level, each segment is valued according to the valuation function GH. The valuations of these two segments, taking into account its real options value, are depicted by points "A" and "B" in Figure 1b. The value for the whole firm is therefore the combination of these two business segments indicated by point "C." Because the valuation function is convex on profitability, point "C" is above point "D." The distance between "C" and "D" is the incremental value of real options measured at the segment level.

The existence of real option value of segments can be easily understood using a numerical example. Assume a diversified firm has two equal-sized segments and its cost of capital is 10%. Segment 1 and 2 have ROA of -10% and 30%, respectively, therefore the firm level ROA is 10%. If we only look at the firm level information, this firm is operating at the cost of capital and has little real option value. However, if we look at the segment level information, the firm has a big real option value. The firm can liquidate the loss segment and expand the segment with high profitability. Although our discussion is descriptive and limited only to two segments, the analytic model developed in Chen and Zhang (2003) rigorously proves that the real option value of segments is important to evaluate a diversified firm.

(Insert Figure 1b here)

2.2. Testable hypotheses

The previous discussion suggests that the real option value of segments is an important component of firm value. Chen and Zhang (2003) empirically examine whether firm value

reflects the real option value of segments. Using data from the period of 1986 to 1997, they find that their measure of real option value of segments provides significantly incremental explanation for the market value, consistent with the usefulness of real option value of segment level in market valuation.

However, the incremental explanation power of the real option value of segments, though statistically significant, is not large. Panel B of Table 3 in Chen and Zhang (2003), for example, reports that the regression of firm value on firm-level data and segment data has an adjusted R-square of 0.24, while the regression of firm value on firm-level data alone has an adjusted R-square of 0.23. Other tables also report small increases of R-squares. Although the authors provide a few possibilities for the small increase of explanatory power,[7] an alternative possibility is that the market prices do not fully incorporate the real option value of segments.

The literature provides voluminous evidence that the market prices do not fully incorporate accounting information and that trading strategies based on accounting information can predict future returns. Researchers, for example, have documented that the market does not fully price accruals (Sloan 1996), discretionary accruals (Xie 2001), earnings seasonal changes (Bernard and Thomas 1990), special items (Burgstahler et al. 2002), and net operating assets (Hirshleifer et al. 2004). The accounting information studied in these papers is, in general, simple and straightforward. The accrual, for example, is the core concept in the financial accounting system, a special item is defined to be transitory. By contrast, extracting value relevant information from segmental data is complex. Earlier studies, such as Tse (1989), Givoly et al. (1999), and Basu et al. (2000), present evidence that segmental information is useful in the market valuation.

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[7] The authors suggest that a possible cause for the low incremental explanation power is that reported segment data might contain considerable measurement errors (See also Givoly et al. 1999). Another explanation suggested in their footnote is the costs of operating dissimilar segments in a firm due to communication and coordination, loss of management focus and cross-subsidization which are not accounted for in their model.

However, these studies do not propose a systematic way to integrate segmental information with the firm level information. In contrast, Chen and Zhang (2003) apply the concept of real option to the segment level and offer a systematic way to utilize segment information. Even so, applying the real option value analysis on the segment level remains complex. Given the evidence that the market cannot fully assess even rather straightforward accounting data and given the complexity of segment data, we conjecture that the market cannot efficiently comprehend the real option value of segments. Therefore, there should be predictable patterns in the stock returns of diversified firms when real options value is realized in the future. We propose the following hypothesis:

Hypothesis 1: The market does not fully understand the real option value of segments. Firms with larger real options value of segments will outperform firms with smaller real options value of segments in the future years.

As Chen and Zhang (2003) have shown, the real option value of segments increases with the firm growth.[8] The intuition is simply that, when the firm growth is high, profitability has a larger effect on the firm value[9]. Therefore, the option to cut the loss segment, or expand the profitable segment, has a larger effect on firm valuation. The effect of firm growth can also be illustrated using the graph in Figure 1b. The higher the firm growth, the more convex the valuation function (GH). The incremental value of real option at segments depends on the convexity of the valuation function. With the increase in the convexity, the real option value of segments has a larger effect on firm value. We therefore propose the following hypothesis.

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[8] See their proposition 3 and relevant theoretic deduction.
[9] A simplest model can be thought as $V=E/(r-g)$, where V is firm value, E is the earnings, r is cost of capital, g is firm growth.

Hypothesis 2: A trading strategy based on real option value of segments earns larger abnormal returns in the group of high growth firms than in the group of low growth firms.

To realize the real option value of segments, managers need to exercise these options. In other words, they must make appropriate decisions to cut bad segments and expand good ones. However, the literature suggests that managers may do just the opposite due to agency problems. Rajan, Servaes, and Zingales (2000) find that, because segments in a diversified firm compete for firm level resources, a diversified firm may compensate the loss segment by diverting resources from the profitable segment. Other papers also suggest that the internal capital market could be inefficient. (See Shin and Stulz, 1998; Scharfstein and Stein, 2000; Lamont and Polk, 2002; etc.) Notice that the inefficient internal markets move the funds from successful segment to unsuccessful segment, while if managers exercise the real option of segments, the internal markets should move funds from an unsuccessful segment to a successful segment. The inefficient internal markets move funds in the opposite direction to that if managers exercise the real option value of segments, therefore reduce the possibility that the real option value of segments is realized. Because good corporate governance can alleviate the agency problem and align the interests of managers and shareholders (Gompers et al. 2003 and Dittmar and Mahrt-Smith, 2007), the real option value of segments is more likely to be realized in firms with good corporate governance. Our third hypothesis is stated as follows:

Hypothesis 3: A trading strategy based on real option value of segments earns larger abnormal returns in the group of good corporate governance firms than in the group of bad corporate governance firms.

2.3. Empirical design

To test our hypotheses, we first need to measure the real option value of segments. Our

measure follows Chen and Zhang (2003). Given that the real options valuation approach is

convex in nature, the greater the divergence between segments' profitability, as measured by the

distance between points "A" and "B" in Figure 1b, the larger the real options value of segments,

as measured by the distance between points "C" and "D." Therefore we construct the measure of

the real option value of segments as follows:

$$\text{RVS} = \left(\sum [A_i * | ROA_i - \overline{ROA} |] \right) / MV$$

where ROA_i is the segment profitability of segment I; $\overline{ROA}$ is the aggregate ROA at the firm

level; A_i are the assets reported in segment I; MV is market value of the firm. $|ROA_i - \overline{ROA}|$

measures the deviation of segment i's profitability from the overall firm level profitability, so the

numerator of RVS is assets-weighted deviation of segment profitability from firm level

profitability. RVS captures the intuition that, the larger the profitability divergence within

segments, the higher the real option value of segments. For firms operating in a single industry,

RVS is zero, which means focused firms do not have the real option value of segments. We use

the market value as a deflator so that RVS measures the importance of the real option value of

segments relative to the firm's market value. [10]

To examine whether the real option value of segments can predict future returns, we use a

hedge return method. At the end of June of each year t, all diversified firms in our sample are

assigned into ten portfolios based on the decile breakpoints of RVS. RVS is calculated using the

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[10] Previous studies (for example Berger and Ofek, 1995) indicate that the sum of segmental assets may not equal to firm level assets. To deal with this problem, we (1) delete firms whose firm level asset is not within +/- 25% of the sum of segment assets and (2) adjust the measurement by multiplying the ratio of (sum of segment assets/firm level assets)

most recent financial information, and we allow four months after fiscal year-end for the

financial information to become publicly available[11]. Returns are accumulated from July of year t

and portfolios are rebalanced every year. If the market does not fully understand the value

relevance of segment data, firms with higher (lower) RVS would earn positive (negative) returns.

The hedge-trading rule buys firms with the highest decile of RVS and sells the lowest. We also

use Fama-Macbeth regressions to control for other factors that previous literature has found to

affect stock returns. It should be noted that our tests are joint tests of the notions that (1) RVS

correctly measures the real option value of segments and (2) that the market is efficient with

respect to the real option value of segments.

3. Sample and descriptive statistics

The sample selection begins with all NYSE, AMEX, and NASDAQ firms that are not

financial institutions (SIC 6000~6999) or the utilities (SIC 4900~4999). Any observations with

incomplete firm-level accounting data, such as assets, earnings, book value, or market price, are

also excluded. Segment information is collected from the Compustat Industry Segment (CIS)

annual database. Only firms that report multiple business segments (defined by the 2-digit SIC

codes) are included. We delete firms if one of their segments is in financial industry. Lastly, the

segment-level data is merged with the firm-level COMPUSTAT data. Following Berger and

Ofek (1995), we eliminate a firm-year if the sum of sales across all reported segments is not

within 1% of the firm's total sales and if the sum of assets across all disclosed segments is not

within 25% of the firm's total assets. Stock prices and returns are collected from the CRSP

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[11] That is, to be included in the year t sample, the fiscal year end must end between March of year t-1 and February
of year t.

database. To mitigate the effect of low price stocks, we also restrict the sample to firms with

share prices greater than five dollars at the fiscal year-end.[12]

Our accumulation of returns begins from July of each year, and we examine as long as three

years of returns after the formation of portfolios. The return data cover 29 years from July 1981

to June 2009, and the corresponding accounting data covers 26 years from 1981 to 2006.[13]. The

final sample for our main analyses includes 15,410 firm-years. Table 1 reports descriptive

statistics for the main variables of interest. We have winsorized all variables, except for the

returns and the number of segments, at 1% and 99% in each year.

(Insert Table 1 here)

RVS is our proxy for the real option value of segments and has a mean of 0.322. The

standard deviation of RVS is 0.392, and the interquartile range between Q3 and Q1 is 0.322

(0.405-0.083), indicating that there are significant variations in the real option value of segments.

Size is the natural log of equity market value at the fiscal year-end. The median of firm size of

our sample is \$332.6 million ($=e^{5.807}$), which is higher than the median for all the observations in

the Compustat[14]. The reason is because the diversified firms are usually larger. B/M is the book-

to-market ratio, which has a mean of 0.710 and median of 0.618. The B/M in our sample is on

average smaller that of all Compustat firms, indicating that diversified firms usually are more

mature and have fewer growth opportunities. Tobin's Q is market value of equity plus book

value of debt, divided by book value of the firm, which has a mean of 1.517 and a median of

1.28. E/P is the earnings to price at the fiscal year-end, which has a mean of 0.49 and a median of

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[12] Firms with stock prices less than five dollars are difficult to short (D'Avolio, 2002) and may have skewed stock returns. Our empirical results become even stronger if we include firms with stock prices less than five dollars.

[13] Note the formation of portfolio at year 1981 may need to use financial information as early as of fiscal year 1979. For example, if a firm has the fiscal year end in April, then COMPUSTAT records that the fiscal year of 1980 ends at April 1981, and since we allow 4 months for the data become available, its fiscal year 1980 data cannot be used to form portfolio at June 1981.

[14] The median of equity value for all Compustat firms is around 91 according to Hwang and Sohn (2010).

0.06, suggesting that the market is trading at around 15-20 times of earnings. RAW_1 is the

return over the previous 12 months before the formation of the portfolio, with mean and median

at 0.192 and 0.104. ROA is the return of assets, with mean and median at 0.044 and 0.049.

NSEG is the number of segments. Because our sample firms are diversified firms, NSEG is at

least 2. The average of number of segments in our sample is around 3.

4. Empirical results

4.1 Test of hypothesis 1

Our first hypothesis is that market prices do not fully reflect the real option value of

segments. When the mispricing is remedied, abnormal returns are produced so that firms with

higher real option value of segments have positive abnormal returns. To test this hypothesis, we

use a hedge strategy method. At the end of June of each year t in the sample period, we calculate

RVS as described above and assign all sample firms into ten portfolios based on the decile

breakpoints of RVS. The hedge portfolio buys firms in the decile with the highest RVS and sells

firms in the decile with the lowest RVS. RVS is calculated using the most recent financial

information allowing four months after fiscal year-end for the financial information becoming

publicly available. We accumulated returns from July of year t and rebalance the portfolio every

year. We examine annual returns for three years after the formation of portfolios. The results are

presented in Table 2 and Figure 2.

(Insert Table 2 and Figures 2 here)

The stock returns for each RVS decile are shown in Table 2. We report both raw returns

and size-adjusted abnormal returns according to size deciles of NYSE/AMEX/NASDAQ firms.

The returns are measured in the following way. First, we calculate annual returns for each firm-

year by compounding monthly returns. Then the firm returns are averaged in each portfolio to calculate the equal weighted portfolio return in each year. We present the time-series means and t-statistics of returns in each portfolio. For the size-adjusted returns, we subtract the annualized return on a benchmark portfolio (the AMEX/NYSE/NASDAQ decile provided by CRSP) from the annualized raw return for each firm. When a firm is delisted during the year, we use the delisting returns provided in CRSP. If the delisting return is missing, we set it to -100% following Sloan (1996).[15] Delisted firms are dropped from our portfolios in the following year. Our trading strategy rebalances the portfolios annually and assigns equal weight to those firms that are still in existence.

Table 2 shows that, in general, the portfolio with the lowest RVS has the lowest returns, while the portfolio with the highest RVS has the highest returns. In the first year after the formation of the portfolio, firms in the lowest RVS decile earn on average a size-adjusted return of -4.6%, while firms in the highest RVS decile earn a size-adjusted return of 7.0%. The size-adjusted returns appear to be positively correlated with the level of RVS. Using raw returns instead of size-adjusted returns yields similar results, with the returns of 21.4% for the highest RVS decile and 8.9% for the lowest RVS decile. A long and short hedge portfolio that buys firms in the highest RVS decile and sells firms in the lowest RVS decile could earn a significant 11.7% hedge return in the first year after the formation of portfolios. This strategy consistently earns positive returns through the sample period. Figure 2 shows that the hedge returns are positive in 22 out of 26 years.[16] We also calculate the portfolio returns for year T+2 and T+3.

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[15] The results are robust if we set the missing delisting returns to -35% as in Shumway (1997).

[16] Beginning in 1998, firms started adopting SFAS131 for segment reports. SFAS131 requires firms to report segments according to their internal operating system. The change of accounting rules could potentially affect our analysis. However, our untabulated results indicate that the hedge returns in the post-1998 period is not different than those in the pre-1998 period. We did notice a jump of the number of diversified firms in 1998, consistent with

The results show that the hedge portfolio continues to earn an average return of 3.9% and 1.3% in the second and third year respectively after the formation of the portfolio, but those returns lack statistical significance. In summary, the RVS-based trading strategy earns significantly positive returns in the subsequent year, and the returns do not reverse in the later years. The 10 portfolios in Table 2 are constructed after the segment reporting is made publicly available, and the evidence implies that the market cannot fully understand the economic implication of the real option value of segments.

It is well documented that stock returns are related to certain risk factors. Fama and French (1995, 1996), for example, show that the market, firm size, and book-to-market ratio are three risk factors associated with stock returns.[17] Other determinants of stock returns include momentum and earnings-to-price ratios (Chan et al., 1996, Basu 1977, and Easton and Harris, 1991). The analysis below aims to control for these risk factors. Panel A of Table 3 presents the correlation between RVS, size (MV), book-to-market ratio (B/M), earning-to-price ratio (E/P), and growth (TobinsQ). The results indicate that the highest correlation among all variables (between RVS and B/M) is 0.397. Although the correlation is significant, the magnitude of the coefficient is not large, which mitigates the concern that RVS might be simply a proxy for factors that are known to cause stock returns. We use firm characteristics like size, book-to-market ratio, and E/P ratio in our regression to control for these previously found risk factors.[18]

(Insert Table 3 here)

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the notion that SFAS131 requires more detailed segment information (see also Botosan and Stanford, 2005; Ettredge et al., 2005).

[17] We did not control for the market in our regressions because the abnormal returns in all regressions have been adjusted according to the NYSE/AMEX/NASDAQ stocks.

[18] Another common way to control risk is to regress monthly returns of each portfolio on monthly returns from three factor-mimicking portfolios (MKT, SMB, HML), as suggested in Fama and French (1993). We obtain the three factors from French's website and replace the firm characteristics with the three factors. The untabulated results confirm that trading strategy based on RVS earns significant returns.

Panel B of Table 3 reports the regression of size-adjusted annual return on RVS and size, book-to-market ratio, E/P ratio, and momentum. We also include the an intercept based upon Jain's (1986) argument that the firm-specific average effect of any additional (missing) factors will be impounded in the intercept. Following Elgers et al. (2001) and Abarbanell and Bushee (1998), we replace each independent variable with its scaled decile value to mitigate the potential impact of extreme values.[19] In each year, we regress size-adjusted annual returns on the rankings of RVS and other factors and then report the time-series means and t-statistics of the coefficients. The results show that after controlling for risk factors' effects (size, book-to-market effect, E/P ratio effect, and momentum) high RVS value still predict high returns, consistent with the hedge portfolio method reported in Table 2. The coefficient estimates for the ranking of RVS in different specification models are all significantly greater than zero. In summary, results in Tables 2 and 3 and Figure 2 consistently suggest that the market does not fully reflect the economic implication of real option value at the segment level.[20]

4.2. Test of hypothesis 2

Our second hypothesis predicts that the real option value of segments is more pronounced for growth firms. To test it, we divide the whole sample into two groups based on the market-to-book ratio. Firms with market-to-book ratio greater (lower) than the annual median are allocated to high (low) growth group. We then take the same methods as in Table 2 and 3 to examine the abnormal returns associated with the real option value of segments in each group. The empirical

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[19] We sort variables in each year and assign the firm-year observations to deciles. Then we replace the value of each variable by its scaled decile rank, varying from 0 to 1. Regression results are qualitatively the same when we use the values of the variables.

[20] This evidence of investors failing to fully comprehend the real option value of segment can be used to reconcile the fact that Chen and Zhang (2003) find segment data to have only small incremental explanatory power conditional on aggregate firm information.

results are presented in Table 4. In Panel A of table 4, we present time-series means and t-statistics for the size-adjusted returns of extreme portfolios and also hedge portfolios formed based on RVS. The evidence indicates that, in the high growth group, the high RVS portfolio earns an 8.9% of size-adjusted return, while the low RVS portfolio earns a -7.3% of size adjusted return. The hedge portfolio in the high growth group earns a 16.2% of size-adjusted return. In the low growth group, the high RVS portfolio earns a 6.6% of size-adjusted return, while the low RVS portfolio earns a 0.4% of size-adjusted return. The hedge portfolio in the low growth group earns a 6.2% of size-adjusted return. Although the hedge return in the low growth group is also significantly positive, it is less than 40% of the hedge return in the high growth group. The difference between the hedge returns in two groups is significant. In Panel B, we run Fama-Macbeth regressions of annual size-adjusted returns on RVS and other risk factors in each of the two groups. The evidence indicates that the coefficient of RVS is 0.108 in the high growth group, significantly greater than the coefficient of RVS (0.058) in the low growth group. The results in Panel A and Panel B of Table 4 indicate that trading strategy based on RVS earns more abnormal returns, which supports our Hypothesis 2.

4.3 Test of Hypothesis 3

Our Hypothesis 3 predicts that the real option value of segments is more important to firms with good corporate governance. The rationale of Hypothesis 3 is that a good system of corporate governance can motivate the managers to act for the shareholders' interests and that firms can therefore realize the real option value of segments and avoid the inefficient allocation of resources. To test this hypothesis, we use the corporate governance index developed by Gompers, Ishii, and Metrick (2003). A higher index indicates higher hurdles to good governance

and thus weaker firm governance. Since governance provisions in any given firm presumably do not change much from year to year, Gompers et al. (2003) do not compute the index for every year. Within our sample period, the corporate governance index is computed for the years 1990, '93, '95, '98, '00, '02, '04, and '06. We interpolate the corporate governance index to cover the period from 1989-2006. For example, the corporate governance in year 1994 is calculated as the average of year 1993 and year 1995. We merge the corporate governance index with our whole sample and get 4,141 firm year observations. We then divide our sample into two groups based on the measure of corporate governance. A firm with a corporate governance index higher (lower) than the annual median is allocated into bad (good) corporate governance group. We then use the same methods as in Table 2 and 3 to examine the abnormal returns associated with the real option value of segments in each group.

The empirical results appear in Table 5. In Panel A of table 5, we present in each group the time-series means and t-statistics for the size-adjusted returns of extreme portfolios and also hedge portfolios formed based on RVS. The evidence indicates that, in the good corporate governance group, the high RVS portfolio earns a 16.2% of size-adjusted return, while the low RVS portfolio earns a -0.3% of size adjusted return. The hedge portfolio in the high growth group earns a 16.5% of size-adjusted return. In the contrast, in the bad corporate governance group, the high RVS portfolio earns a 0.6% of size-adjusted return, while the low RVS portfolio earns a -0.5% of size adjusted return. The hedge portfolio in the low growth group earns a 1.0% of size-adjusted return. The hedge return in the bad corporate governance is not significant and is much less than that in the good corporate governance firm. The difference between the hedge returns in two groups is significant. In Panel B, we run Fama-Macbeth regressions of annual size-adjusted returns on RVS and other risk factors in each of the two groups. The evidence

indicates that the coefficient of RVS is a significant of 0.078 in the high growth group, much greater than the coefficient of RVS (insignificance of 0.017) in the low growth group. The results in Panel A and Panel B of Table 5 indicate that a trading strategy based on RVS earns more abnormal returns in good corporate governance group, which supports our Hypothesis 3 that good corporate governance motivates managers to exercise the real option value of segments and leads to predictable returns.

5. Further Analyses

5.1 The exercise of real option value of segments

We have shown that the real option value of segments is not fully incorporated in the current market price but reflected in the future returns. It is then interesting to examine whether the real options are exercised and how their exercise affects the firm.

In the appendix we offer a typical case of Martha Stewart Living Omni Media, Inc. (MSO), to illustrate how a company can exercise its real option and cut its unprofitable segments while expanding its profitable segments. The financial information is collected from 10-Ks of MSO. The measurement unit is thousand dollars. At the beginning of the period (year 2001), the merchandising segment had assets of $8,265, which was far less than the assets of the internet segment ($32,039). However, the merchandising segment produced far more operating income than the internet segment ($29,861 vs -24,030). In the following years, the assets of merchandising segments kept increasing (to $29,267 at year 2005), and the assets of internet segments kept decreasing (to $3,819 at year 2005). The pattern suggests that managers reallocate the assets in the internet segment to the merchandising segment. As a result, the operating

income from the merchandising segment increased, and the loss from the internet segment decreased.

Chen and Zhang (2007) provide empirical evidence that firms exercise the real option value of segments, i.e. diversified firms can divest its segments. They find that the real option value of segments increase before the divestment. Also, the positive market reaction to the divestment is related to the real option value of segments. Their evidence is consistent with the view that the real option value has been exercised through divestment. However, they focus only one channel of exercise of real options and study only a small group of divestment firms.[21]

We present more evidence that diversified firms exercise their real option value of segments. In Panel A of Table 6, we run two regressions. We use the Fama-MacBath method and run regressions for each year and report time-series means and t-statistics. In the first regression, we regress the change of number of segments from year t to year t+1 ($DNSEG_{t+1}$) on RVS at year t and other control variables. The coefficient of RVS_t is significantly negative, suggesting that high real option value of segments leads to decrease in the number of segments in the future. The evidence is consistent with Chen and Zhang (2007) that firms with high real option value of segments may exercise the real options by cut or divest segments.[22] In the second regression, we regress the change of real option value from year t to t+1 ($DRVS_{t+1}$) on RVS at year t and other controlling variables. The coefficient of RVS_t is significantly negative, suggesting that the high real option value of segments tends to decrease in future years. Taken together, the evidence suggests that the real option value of segments will be exercised.

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[21] The sample size in the study is 554 observations.

[22] A more detailed way of testing the exercise of RVS would be to track how the firms increase the assets of good segments and decrease assets of bad segments. However, the segment ID in COMPUSTAT may not be consistent within years, so we can only examine the change of segment numbers.

In Panel B of Table 6, we regress the change of earnings from year t to t+1 on RVS_t or

$DRVS_{t+1}$ and other controlling variables. Following Fama and French (2000), we include in the

regressions size, book-to-market, and change of earnings in current year. The change of earnings

is positively related to RVS_t, suggesting that firms with high real option value of segments are

associated with positive earnings changes. The evidence is consistent with the view that these

firms exercised the real option, which led to higher earnings. The change of earnings is

negatively related to $DRVS_{t+1}$, suggesting that the decrease of real option value of segments or

the exercise of the real option leads to higher earnings.

The results in Table 6 indicate that firms with high real option value of segments will

exercise the options in future years and that the exercise of real option leads to higher firm

performance.

(Insert Table 6 here)

5.2. The hedge returns around earnings announcement periods

If firms exercise the real option of segments and improve their earnings, the market can see

the earnings increase and correct the mispricing toward the real option value of segments. We

therefore examine the abnormal returns for RVS-based portfolios around the earnings

announcements. Richardson et al. (2010) suggest that examining the extent to which abnormal

returns are concentrated around earnings announcements is a way to differentiate mispricing and

risk. If the abnormal returns are concentrated around the earnings announcement period, it is

more likely to be mispricing because the risk is hard to change within a few days.

(Insert Table 7 here)

In Table 7 we separately calculate abnormal returns for the RVS-based portfolios during the earnings announcement period and the non-earnings announcement period in the one year following the formation of portfolios. We require that there be four quarterly earnings announcements within the following year.[23] For each earnings announcement, we calculate the size-adjusted returns in (-1, 1) trading days around the reporting dates and then compound the returns for the four earnings announcements. Returns in the non-earnings reporting periods are compounded returns in days other than the earnings reporting period. Results show that the hedge portfolio earns a size-adjusted return of 1.7% during the twelve trading days around the earnings announcements. The total size-adjusted hedge return is 12.6% for one year. The abnormal returns around earnings announcement is 15.7% of the total abnormal returns, while the trading days around earnings announcement is only 4.8% of one year's trading days (assuming a 250 trading days per year). The disproportionate concentration of hedge returns around earnings announcements is consistent with our arguments that the market does not reflect the real option value of segments and that the mispricing is remedied through future earnings announcements.

5.3. The real option value of segments as an explanation for diversification discount

The finance literature has documented that the diversified firms trade at discount compared with their single segment counterparts. (Lang and Stulz 1994, Berger and Ofek 1995) Voluminous studies have examined the diversification discounts and have proposed explanations. One stream of explanations relies on agency theory and regards diversification as a means through which managers can pursue their own interests at the expense of shareholders'. For

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[23] The results are qualitatively the same if we do not impose this restriction.

example, Rajan, Servaes, and Zingales (2000) argue that segments in diversified firms compete for resources, which leads to an inefficient internal capital market and a valuation disadvantage. Jensen (1986) suggests that diversified firms have access to additional capital and therefore have more of an overinvestment problem. Another stream of research on the diversification discount argues that the discount could arise from a data artifact, a sample selection bias, or an endogeneity problem. Villalonga (2004), for example, argues that the diversification discount could be a data artifact because segment data are biased and segments are defined inconsistently across firms. Graham et al. (2002) show that a sample selection bias could occur because business units acquired by diversifying firms were already discounted prior to their acquisition. Campa and Kedia (2002) argue that the diversification discount could arise from an endogeneity problem since firms choose to diversify when the benefits of diversification outweighs the costs and stay focused when they do not.

We offer a new explanation for the diversification discount. Our theoretical discussions show that the real option value of segments is higher than the real option value at the firm level. And our results indicate that the real option value of segments is not fully reflected in the market prices. The diversification discount therefore could due to the neglect of real option value of segments in diversified firms.

To test whether the real option value of segments can explain the diversification discount, we regress the diversification discount (DISC) on RVS, controlling for variables previously used by Campa and Kedia (2002) to explain the diversification discount. The basic control variables include the number of segments, size, capital expenditure and ROA. More expanded set of control variables includes three more variables (size, capital expenditure, ROA) of the previous year, leverage, and the square of firm size. We compute the diversification discount following

the approach in Berger and Ofek (1995). This variable estimates a diversified firm's value had all its segments been evaluated as standalone businesses. First, we calculate the imputed value for each segment of a diversified firm as the product of that segment's industry median Tobin's Q and assets of the segments. The median Tobin's Q is calculated using focused firms in the same industry. And the industry is defined using the finest SIC code level (four-, three- or two- digit) with at least five focused firms. We then add up the imputed values for each segment of a diversified firm to get the firm-level imputed value. Our measure of diversification discounting (DISC) is the logarithm of the market value of the firm divided by the imputed value. Negative DISC indicates a diversification discount relative to single segment firms.

(Insert Table 8 here)

Our results are presented in Table 8. The empirical results in Table 8 confirm that RVS is statistically significant and associated with the diversification discount. The coefficient of RVS is -0.762, with a T-statistic of -13.66, and -0.547, with a T-statistic of -10.73, in Model (2) and Model (4), respectively. This suggests that the greater the real option value of segments, the higher the diversification discount. In addition, the empirical results with regard to the effect of the number of segments, size, capital expenditure to sales, earnings to sales, and leverage are consistent with Campa and Kedia (2002). The R-square improvements from Model (1) to Model (2) and from Model (3) to Model (4) are both significant, which suggests both that the inclusion of RVS improves the empirical model in explaining the diversification discount and that the RVS is a significant driver of the diversification discount. The evidence indicates that the neglect of real option value of segments could be an explanation for the diversification discount.

Our finding is not mutually exclusive to the previous research on the diversification discount. For example, the internal competition of resources may reduce the real option value of

segments, and thus the diversification discount may result from both the internal power struggle and the market failure to correctly price the real option value of segments. While it is impossible to control for all the known factors that could give rise to the diversification discount, our finding adds to the growing body of literature and offers an alternative explanation for the diversification discount.

6. Conclusions

In this paper, we apply the real option analysis to the segment level and examine the usefulness of real option value of segments in predicting future returns. Forming portfolios based on the real option value of segments (RVS) yields an average11.7% size-adjusted annual return by buying firms with the highest RVS decile and selling firms with the lowest RVS decile. The hedge returns are consistently positive in 22 out of the 26 sample years. The abnormal returns are not reversed in the later years and are robust after controlling other risk factors. We also provide evidence the real options of segments have larger values for growth firms and for firms with good corporate governance. Our results indicate that the real option value of segments is an important component of firm value and that the market prices do not fully reflect it. Our paper complements Chen and Zhang (2003) and suggests the importance of segment information.

Further investigation presents evidence that firms exercise the real option of segments. Firms with high RVS tend to decrease their number of segments and real option value in the following year, and their earnings performance increases. We also show that the abnormal hedge returns around earnings announcement periods is high in proportion, suggesting that market prices react to the exercise of real option of segments. Lastly, we offer an alternative explanation

for the diversification discount and suggest that neglect of real option value of segments may lead to the diversification discount.

A limitation of our study is that we cannot directly measure the real option value of segments but use the divergence of profitability in segments as a proxy. Although the proxy has proved to be useful, future research might try to develop a direct measure. Also, our paper does not consider the different growth potential in each segment, which can also affect the value of real option for that segment. Future studies also might address this limitation.

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Figure 1a
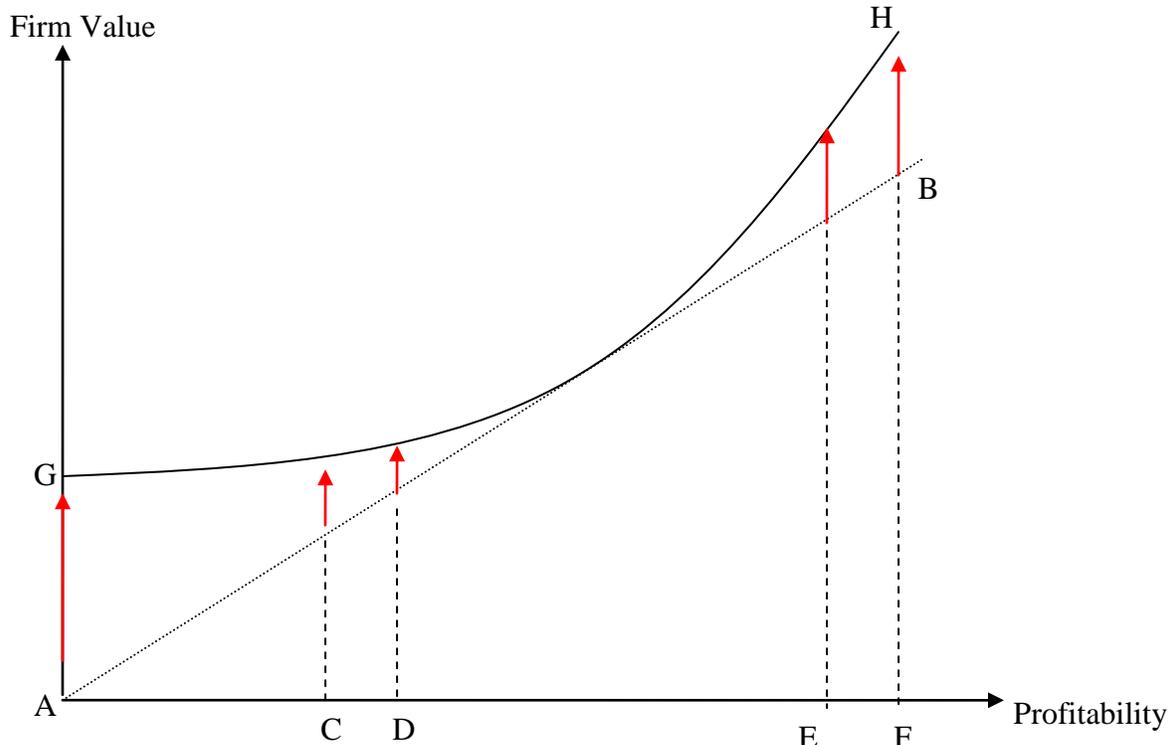**The real option and firm valuation**

Figure 1a illustrates the real option value of a firm. The vertical axis is market value normalized by assets, and horizontal axis is profitability (ROA).

1) If a business can neither be expanded nor shut down, then the value of the business is a linear function of its profitability as depicted by a straight line "AB." If a firm operates at a profitability level of zero, the value of the firm is zero (point "A") and its value increases linearly as its profitability increases.

2) However, shareholders have the options to close the business (a put option) if the business is not profitable, or expand the business (a call option) if it is highly profitable. For example, when shareholders close the business with zero profitability and sell its assets, the put option is exercised and the positive value of the put option brings the firm value from zero (point "A") to some positive number (point "G"). Similarly, a call option can be exercised when the firm is operating at a profitability level higher than its cost of capital (point "F") and shareholders raise capital to expand the profitable business. The positive value of the call option brings the firm value from point "B" to point "H". Therefore the valuation curve becomes convex ("GH") due to the real option value.

Figure 1b
The real option of segments and value of a Diversified Firm
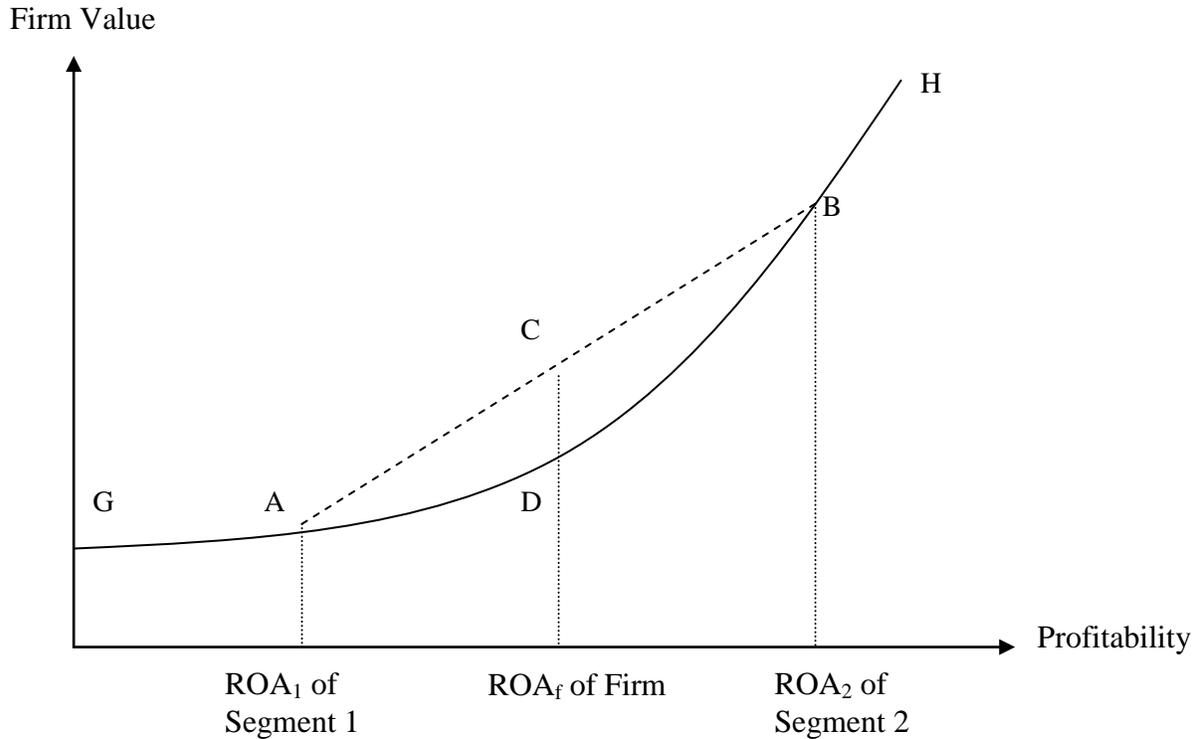

Figure 1b illustrates the valuation of a diversified firm and the real option values of segments. The vertical axis is market value normalized by assets, and horizontal axis is profitability (ROA). Curve GH is the valuation function as discussed in Figure 1a.

1) For a diversified firm with firm level profitability ROA_f, its valuation will be at Point D if its segmental information is not considered. Note that D includes the real option value at the firm level.

2) Assume the firm has two segments with profitability ROA_1 and ROA_2. The Point A and Point B are valuations for segments 1 and 2 respectively, if each segment is valued independently. Note each segment has its own real option value according to its own profitability. Then the Point C is the valuation of the firm by combining the values of two segments.

3) Point C is above D due to the convexity of the curve GH and the distance between C and D is the real option value of segments.

4) When segment 1 and 2 have more divergence in profitability, or the valuation curve is more convex, the real option value of segments becomes larger.

Figure 2
Size-adjusted Hedge Returns Based on the Real Option Value of Segments (RVS)

This graph shows the annual size-adjusted returns of the RVS based hedge portfolio across the 26 years of sample period (1981-2006). At the end of June of each year t, all diversified firms with stock price greater than 5 dollars and necessary information are allocated into ten portfolios based on the decile breakpoints of RVS. The hedge portfolio buys firms in the highest RVS decile and sells firms in the lowest RVS decile. Equal weighted size-adjusted returns are calculated from July of year t to the following June. The portfolios are balanced every year and the delisting returns are set as -100% if missing. Size-adjusted returns are estimated according to deciles of NYSE/AMEX/NASDAQ firms. RVS is calculated as $\left(\sum [A_i * | ROA_i - \overline{ROA} |] \right) / MV$, where A_i is total assets for segment i, ROA_i is return of assets in segment i, $\overline{ROA}$ is firm level aggregate ROA, and MV is the market value of the equity for the firm. We allow 4 months after fiscal year end for the financial information becoming publicly available.
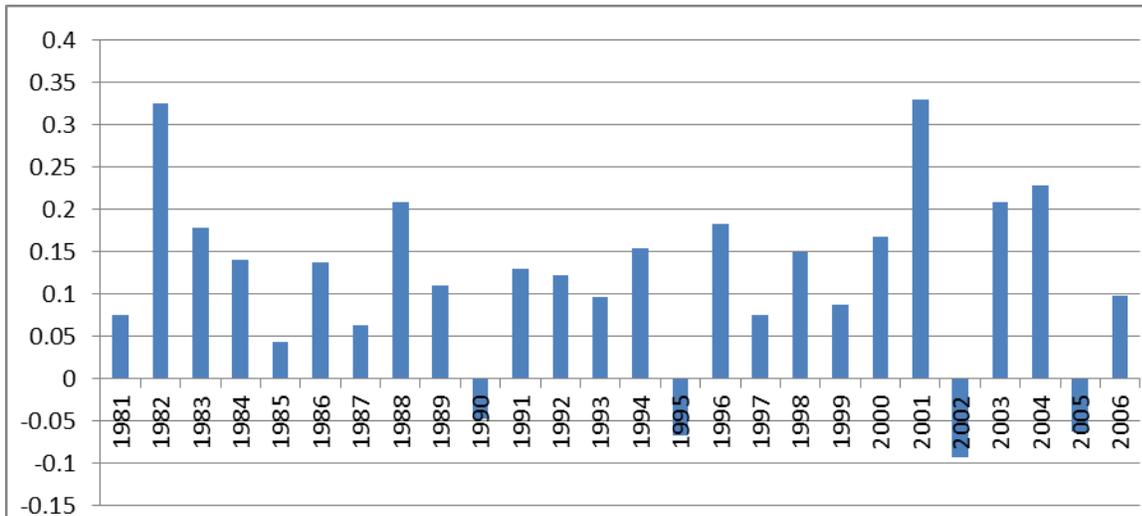
Table 1
Descriptive statistics of sample firms

This table presents firm characteristics for our sample of 15,410 firm-year observations across portfolios formed on RAS from 1981 to 2006. The sample includes diversified firms from the NYSE, AMEX, and NASDAQ with necessary information and with stock price at the fiscal year end greater than 5 dollars. At the end of June of each year t, all diversified firms are allocated into ten portfolios based on the decile breakpoints of RVS. RVS is the real option value of segment, calculated as $\left(\sum[A_i * | ROA_i - \overline{ROA} |]\right)/MV$ using the most recent financial information available, where A_i is the total assets for segment i, ROA_i is the return of assets in segment i, $\overline{ROA}$ is firm-level aggregate ROA, and MV is the market value of the equity for the firm at the end of fiscal year. We allow 4 months after fiscal year end for the financial information becoming publicly available. Other variables are defined as follows: Size is the natural log of equity market value at the fiscal year end; B/M is the book-to-market ratio; Tobin's Q is market value of equity plus book value of debt, divided by book value of the firm; E/P is the earnings to price ratio; RAW_1 is the return over the previous 12 months before the formation of the portfolio; ROA is the return of assets; NSEG is the number of segments for the firm. All variables are winsorized at 1% and 99% in each year.

	Mean	Median	Std	Q1	Q3
RVS	0.322	0.196	0.392	0.083	0.405
SIZE	5.907	5.807	1.712	4.512	7.081
B/M	0.710	0.618	0.454	0.399	0.929
TobinsQ	1.517	1.280	0.832	1.034	1.693
E/P	0.049	0.060	0.092	0.031	0.090
RAW_1	0.192	0.104	0.576	-0.125	0.376
ROA	0.044	0.049	0.067	0.022	0.078
NSEG	2.926	3.000	1.110	2.000	3.000

Table 2
Annual returns for portfolios formed on the real option value of segments (RVS)

This table presents annual raw returns and size-adjusted returns for portfolios formed on the real option value of segments. The sample includes diversified firms from the NYSE, AMEX, and NASDAQ with necessary information and with stock price at the fiscal year end greater than 5 dollars. There are 15,410 firm-year observations in the 26 years of sample period (1981-2006). At the end of June of each year t, all diversified firms are allocated into ten portfolios based on the decile breakpoints of RVS. RVS is the real option value of segments, calculated as $\left(\sum [A_i * | ROA_i - \overline{ROA} |]\right)/MV$ using the most recent financial information available, where A_i is the total assets for segment i, ROA_i is the return of assets in segment i, $\overline{ROA}$ is firm-level aggregate ROA, and MV is the market value of the equity for the firm at the end of fiscal year. We allow 4 months after fiscal year end for the financial information becoming publicly available. The return accumulation begins from July of year t and the portfolios are rebalanced every year. Size-adjusted returns are estimated according to deciles of NYSE/AMEX/NASDAQ firms supplied by CRSP. The hedge-trading rule buys firms with the highest decile of RVS and sells the lowest. T-statistics are in parentheses, calculated using the time-series means divided by time-series standard deviation. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

Portfolios	Raw Returns			Size-Adjusted Returns		
	T+1	T+2	T+3	T+1	T+2	T+3
1 (Lowest RVS)	0.089 (2.68)	0.128 (3.67)	0.099 (3.47)	-0.046 (-2.82)	-0.011 (-0.63)	0.001 (0.05)
2	0.112 (2.56)	0.136 (3.63)	0.094 (3.18)	-0.024 (-1.35)	-0.001 (-0.10)	-0.004 (-0.20)
3	0.129 (3.39)	0.132 (3.58)	0.118 (3.81)	-0.012 (-0.70)	-0.011 (-0.59)	0.016 (0.91)
4	0.138 (3.10)	0.137 (3.40)	0.10 (3.45)	-0.004 (-0.17)	0.001 (-0.02)	0.001 (0.04)
5	0.144 (3.51)	0.173 (4.27)	0.124 (3.8)	0.003 (0.15)	0.028 (1.25)	0.023 (1.08)
6	0.144 (3.69)	0.168 (3.96)	0.115 (3.51)	0.001 (0.06)	0.022 (1.26)	0.013 (0.75)
7	0.180 (3.95)	0.160 (3.34)	0.121 (3.46)	0.039 (1.65)	0.017 (0.78)	0.021 (0.96)
8	0.171 (4.25)	0.171 (3.56)	0.117 (3.46)	0.034 (1.73)	0.026 (1.17)	0.013 (0.75)
9	0.183 (4.27)	0.179 (3.60)	0.104 (3.13)	0.041 (1.97)	0.039 (1.52)	0.007 (0.28)
10 (Highest RVS)	0.214 (4.51)	0.170 (3.57)	0.113 (2.77)	0.070 (2.77)	0.029 (1.07)	0.014 (0.46)
Hedge returns	0.125 (5.00)***	0.041 (1.63)	0.014 (0.54)	0.117 (5.58)***	0.039 (1.62)	0.013 (0.45)

Table 3
The real option value of segments (RVS) and future returns, conditional on other risk factors

This table examines the usefulness of RVS in predicting future abnormal returns after controlling for other risk factors. The sample includes diversified firms from the NYSE, AMEX, and NASDAQ with necessary information and with stock price at the fiscal year end greater than 5 dollars. There are 15,410 firm-year observations in the 26 years of sample period (1981-2006). At the end of June of each year t, all diversified firms are allocated into ten portfolios based on the decile breakpoints of RVS. RVS is the real option value of segment, calculated as $\left(\sum [A_i * | ROA_i - \overline{ROA} |]\right)/ MV$ using the most recent financial information available, where A_i is the total assets for segment i, ROA_i is the return of assets in segment i, $\overline{ROA}$ is firm-level aggregate ROA, and MV is the market value of the equity for the firm at the end of fiscal year. We allow 4 months after fiscal year end for the financial information becoming publicly available. The return accumulation begins from July of year t and the portfolios are rebalanced every year. Size-adjusted returns are estimated according to deciles of NYSE/AMEX/NASDAQ firms supplied by CRSP. SIZE is the natural logarithm of equity market value; B/M is the book-to-market ratio; Tobin's Q is the market value of equity plus the book value of debt, divided by the book value of the firm; E/P is the earnings to price ratio; RAW_1 is the return over the previous 12 months before the formation of the portfolio. Panel A presents the correlation of main variables; In Panel B, we regress size adjusted annual returns on annual rankings (Ranking=0 for firms in the lowest decile and =1 for firms in the highest decile) of RVS and other factors in each year during 1981 to 2006, and report the time series means and t-statistics. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

Panel A: Pearson correlation of variables

	SADJRET	RVS	Size	B/M	Tobin's Q	E/P
RVS	0.055					
	(<.001)					
SIZE	-0.021	-0.287				
	(0.010)	(<.001)				
B/M	0.070	0.397	-0.371			
	(<.001)	(<.001)	(<.001)			
Tobin's Q	-0.090	-0.274	0.258	-0.620		
	(<.001)	(<.001)	(<.001)	(<.001)		
E/P	0.058	-0.173	0.006	0.098	-0.115	
	(<.001)	(<.001)	(0.494)	(<.001)	(<.001)	
RAW_1	0.034	0.002	-0.050	-0.027	0.049	0.077
	(<.001)	0.818	(<.001)	(0.001)	(<.001)	(<.001)

Table 3 - continued

Panel B: Regression of size-adjusted stock returns on RVS and other controlling variables

Variables	Model I	Model II	Model III
Intercept	-0.078 (-3.78)***	-0.11 (-4.88)***	-0.135 (-5.60)***
RVS	0.083 (5.77)***	0.082 (5.75)***	0.084 (5.83)***
SIZE	0.018 (0.68)	0.005 (0.20)	0.002 (0.08)
B/M	0.074 (2.22)**	0.075 (2.52)**	0.058 (2.14)**
RAW_1		0.078 (2.82)***	0.067 (2.48)**
E/P			0.079 (3.16)***

Table 4
Hedge returns based on the real option value of segments (RVS), conditional on firm growth

This table presents results that real option value of segments have larger effect on future returns for high growth firms. The whole sample is divided into two groups based on market-to-book ratio of the firm. Firms with high market-to-book ratios larger than the media are defined as high growth firms. In panel A, we present annual size-adjusted returns (from July of year t to June of t+1) for the extreme portfolios and for the hedge portfolios. Portfolios are based on RVS, calculated as $\left(\sum [A_i * | ROA_i - \overline{ROA} |]\right)/ MV$, where A_i is total assets for segment i, ROA_i is the return of assets in segment i, $\overline{ROA}$ is firm-level aggregate ROA, and MV is the market value of the equity for the firm at the end of the fiscal year. The returns are size-adjusted according to deciles of NYSE/AMEX/NASDAQ firms. In Panel B, we regress in each growth group the size adjusted annual returns on annual rankings (Ranking=0 for firms in the lowest decile and =1 for firms in the highest decile) of RVS and other factors in each year, and report the time series means and t-statistics. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

Panel A:Size-adjusted returns for portfolios based on RVS

Portfolios	High growth firms (M/B ratios>median)	Low growth firms (M/B ratios<median)
Lowest RVS	-0.073 (-4.28)***	0.004 (0.12)
Highest RVS	0.089 (2.00)*	0.066 (2.33)**
Hedge returns	0.162 (3.88)***	0.062 (2.83)**

Panel B: Regression of size-adjusted returns on RVS and other risk factors

Intercept	-0.17 (5.12)***	-0.075 (-1.8)*
RVS	0.108 (5.46)***	0.058 (3.34)**
SIZE	0.02 (0.72)	-0.022 (-0.67)
B/M	0.091 (1.80)*	0.031 (0.74)
RAW_1	0.076 (2.06)**	0.052 (2.13)**
E/P	0.093 (2.27)**	0.069 (2.93)**

Table 5
Hedge returns based on the real option value of segments (RVS),
conditional on corporate governance

This table presents results that real option value of segments have larger effect on future returns for firms with good corporate governance. The whole sample is divided into two groups based on the G-index of the firm. Firms with G-index lower than the media are defined as firms with good governance. In panel A, we present annual size-adjusted returns (from July of year t to June of t+1) for the extreme portfolios and for the hedge portfolios. Portfolios are based on RVS, calculated as $\left(\sum [A_i * | ROA_i - \overline{ROA} |]\right)/ MV$, where A_i is total assets for segment i, ROA_i is the return of assets in segment i, $\overline{ROA}$ is firm-level aggregate ROA, and MV is the market value of the equity for the firm at the end of the fiscal year. The returns are size-adjusted according to deciles of NYSE/AMEX/NASDAQ firms. In Panel B, we regress in each growth group the size adjusted annual returns on annual rankings (Ranking=0 for firms in the lowest decile and =1 for firms in the highest decile) of RVS and other factors in each year, and report the time series means and t-statistics. The whole sample has 4,141 firm-year observations. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

Panel A:Size-adjusted returns for portfolios based on RVS

Portfolios	Good CG firms (G-Index<median)	Bad CG firms (G-Index>median)
Lowest RVS	-0.003 (-0.10)	-0.005 (-0.14)
Highest RVS	0.162 (3.38)***	0.006 (0.11)
Hedge returns	0.165 (3.38)***	0.010 (0.21)

Panel B: Regression of size-adjusted returns on RVS and other risk factors

Intercept	-0.034 (-0.81)	-0.016 (-0.26)
RVS	0.078 (3.13)**	0.017 (0.68)
SIZE	-0.037 (-0.66)	0.018 (0.4)
B/M	0.032 (0.83)	0.029 (0.87)
RAW_1	0.047 (1.18)	-0.051 (-1.01)
E/P	0.040 (0.79)	0.037 (1.24)

Table 6
The effects of the exercise of real option value of segments (RVS)

This table presents evidence that firms exercise the real option of segments and its effects on future firm performance. In Panel A we present evidence that RVS affects the change of number of segments and the change of RVS from year t to t+1. In panel B we present evidence that RVS predicts earnings changes in the next period. The sample includes diversified firms from the NYSE, AMEX, and NASDAQ with necessary information and with stock price at the fiscal year end greater than 5 dollars. There are 14,100 firm-year observations in the 25 years of sample period (1981-2005). DNSEG is the change of number of segments; RVS is the real option value of segment, calculated as $\left(\sum [A_i * | ROA_i - \overline{ROA} |]\right)/MV$, where A_i is total asset for segment i, ROA_i is the return of assets in segment i, $\overline{ROA}$ is the firm-level aggregate ROA, and MV is the market value of the equity for the firm at the end of fiscal year; DRVS is the change of RVS; DNI is the change of earnings, scaled by the market value at the previous year; Size is the natural logarithm of equity market value; B/M is the book-to-market ratio. We run regressions in each year during 1981 to 2005, and report the time series means and t-statistics. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

Panel A: The effect of real option value of segments (RVS) on the change of number of segments and the change of RVS in the next year

Dependent variable:	$DNSEG_{t+1}$	$DRVS_{t+1}$
Intercept	-0.581 (-6.57)***	0.001 (0.31)
RVS_t	-0.785 (-5.67)***	-0.662 (-25.06)***
$NSEG_t$	-0.306 (-7.89)***	0.006 (7.46)***
DNI_t	0.317 (2.77)**	0.032 (2.99)***
$SIZE_t$	0.109 (9.94)***	-0.001 (-1.90)*
B/M_t	0.162 (7.06)***	0.019 (6.94)***

Table 6 continued

Panel B: The effect of RVS on the earnings changes of next year

Dependent variable DNI_{t+1}	Model I	Model II
Intercept	0.003 (1.22)	0.003 (1.22)
RVS_t	0.037 (3.69)***	
$DRVS_{t+1}$		-0.060 (-6.59)***
$NSEG_t$	0.001 (-0.15)	0.001 (1.11)
DNI_t	-0.067 (-10.24)***	-0.064 (-9.89)***
$SIZE_t$	0.001 (1.14)	0.001 (1.16)
B/M_t	-0.011 (-6.62)***	-0.010 (-5.83)***

Table 7
Hedge returns around the earnings announcements

This table reports size-adjusted returns around earnings announcements within one year after the formation of portfolios. At the end of June of each year t, all diversified firms are allocated into ten portfolios based on the decile breakpoints of RVS. RVS is the real option value of segment, calculated as $\left(\sum[A_i * | ROA_i - \overline{ROA}|]\right)/MV$ using the most recent financial information available, where A_i is the total assets for segment i, ROA_i is the return of assets in segment i, $\overline{ROA}$ is firm-level aggregate ROA, and MV is the market value of the equity for the firm at the end of fiscal year. We allow 4 months after fiscal year end for the financial information becoming publicly available. For a one-year period, beginning from July of year t to June of year t+1, we examine size-adjusted returns for announcement periods, non-earnings announcement period, and the whole year. The announcement periods are (-1, 1) trading days around quarterly earnings announcement dates. Non-announcement periods are days other than earnings announcement period. Size-adjusted returns are estimated according to deciles of NYSE/AMEX/NASDAQ firms supplied by CRSP. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

Portfolios	Annual Returns	Earnings Announcement Period Returns	Non-Earnings Announcement Period Returns
1 (Lowest RVS)	-0.042 (-2.57)	0.005 (1.2)	-0.047 (-2.93)
2	-0.019 (-0.93)	0.012 (2.79)	-0.03 (-1.6)
3	-0.012 (-0.64)	0.009 (2.55)	-0.02 (-1.14)
4	-0.007 (-0.3)	0.004 (1.24)	-0.011 (-0.5)
5	-0.001 (-0.05)	0.012 (3.59)	-0.013 (-0.69)
6	0.004 (0.18)	0.014 (2.94)	-0.01 (-0.57)
7	0.04 (1.59)	0.019 (2.95)	0.021 (1.02)
8	0.032 (1.56)	0.008 (1.96)	0.024 (1.18)
9	0.037 (1.7)	0.012 (2.77)	0.025 (1.25)
10 (Highest RVS)	0.084 (3.13)	0.021 (4.93)	0.063 (2.49)
Hedge Returns	0.126 (5.89)***	0.017 (2.67)**	0.110 (5.44)***

Table 8
The real option value of segment (RVS) and the diversification discount

This table reports the usefulness of real option value of segments in explaining the diversification discount. The dependent variable diversification discount (DISC) defined as the natural logarithm of actual value divided by imputed value, where actual value is total book value of debt plus market value of equity, and imputed value is the sum of the imputed values of the firm's segments, using assets multiples following Berger and Ofek (1995). NSEG is the number of segments for the firm; SIZE is natural logarithm of market value of equity; CAPX is capital expenditure divided by sales; ROA is earnings before extraordinary items divided by assets; LEV is leverage defined as total liability divided by total assets, SIZE2 is square of SIZE. RVS is calculated as $\left(\sum [A_i * \mid ROA_i - \overline{ROA} \mid]\right)/MV$, where A_i is total assets for segment i, ROA_i is the return of assets in segment i, $\overline{ROA}$ is firm-level aggregate ROA, and MV is the market value of the equity at the end of fiscal year. We run regressions in each year during 1981 to 2005, and report the time series means and t-statistics. *, **, *** indicate significance at the 10%, 5% and 1% level respectively.

Variables	Model 1	Model 2	Model 3	Model 4
Intercept	-0.35 (-12.12)***	-0.248 (-8.56)***	-0.625 (-10.7)***	-0.522 (-8.7)***
$NSEG_t$	-0.018 (-4.55)***	0.001 (-0.01)	-0.014 (-4.26)***	-0.003 (-0.73)
$SIZE_t$	0.050 (9.09)***	0.037 (6.92)***	0.302 (12.54)***	0.259 (11.16)***
$CAPX_t$	0.133 (3.81)***	0.100 (2.94)**	0.038 (0.46)	0.03 (0.37)
ROA_t	1.314 (7.87)***	1.033 (6.51)***	0.924 (4.91)***	0.74 (4.06)***
RVS_t		-0.762 (-13.66)***		-0.547 (-10.73)***
$SIZE_{t-1}$			-0.218 (-11.12)***	-0.200 (-11.01)***
$CAPX_{t-1}$			0.095 (1.42)	0.071 (1.08)
ROA_{t-1}			1.198 (7.55)***	1.214 (7.8)***
LEV_t			0.156 (2.83)**	0.197 (3.64)**
SIZE2			-0.003 (-2.36)**	-0.001 (-1.23)

Appendix

This appendix gives an example where a firm exercised the real option value by downsizing its bad segment and expanding its good segment. Martha Stewart Living Omni Media, Inc. (MSO) is a diversified firm. The company operates in four segments: Publishing, Television, Merchandising, and Internet. The following table extracted from 10-Ks summarizes how two segments of MSO evolved during 2001-2005. We can see that MSO has gradually expanded its good segment -- Merchandising and retracted its bad segment -- Internet. The exercise of the real option in this particular case takes more than 5 years.

Martha Stewart Living Omni Media, Inc. (MSO) Extracted Segment Information
(in thousand$)

		2001	2002	2003	2004	2005
Merchandising	Assets	8,265	8,871	22,547	24,014	29,267
	Operating Profit	29,861	32,972	37,716	36,427	39,048
Internet	Assets	32,039	13,695	9,815	5,037	3,819
	Operating Profit	-24,030	-38,944	-16,013	-8,861	-3,537

Note:
1. MSO has been consciously excising the real options of the two segments. In its 2004 10-K, the company stated that "Internet/Direct Commerce revenues decreased…. The decline in commerce sales was largely attributable to our planned lower catalog circulation. …Based on our August 2004 decision to discontinue the Catalog for Living and its online product offerings, we expect to see a reduction in revenue, operating costs and a reduced operating loss in this segment in 2005…The restructuring of the Internet/Direct Commerce segment led to a smaller, more productive merchandising assortment, reduced staffing levels, lower catalog circulation, and generally lower fixed costs. This restructuring led to a decline in revenue and a reduced operating loss…The improvement in the operating profit of the Merchandising …was largely due to our contractual relationship with Kmart which resulted in higher royalty…This business segment operates with a high degree of operating leverage, and therefore, the additional revenue generated from the contractual minimums directly improves operating profit."
2. It is worth noticing that due to the diminishing marginal return, the increase of operating profit is not proportional to the increase of the assets in the Merchandising segment. For example, MSO increased the size of Merchandising segment from $8,871k in 2002 to $22,547k in 2003, almost a 200% increase, whereas the operating profit only increased from $32,972k to $37,716k.