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Return predictability and the real option value of segments

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Abstract Theory suggests that firm value should include the value of real options; that is, firms have the option to expand more profitable businesses and liquidate less profitable businesses. In a diversified firm, each segment has its own real options. Applying real options theory to a diversified firm at the firm level neglects the value of segment-level options. If investors overlook segment-level options, mispricing will occur. Using data from 1981 to 2013, we find that a hedge portfolio buying diversified firms in the highest decile of the estimated real option value of segments (RVS) and selling those in the lowest RVS decile earns a significant 0.79% size-adjusted monthly return. The hedge returns are more significant for firms whose growth opportunities mainly lie in the more profitable segments. We also find that the predictive power of RVS is stronger for firms with high growth, lower analyst coverage, and stronger corporate governance. Further investigation links improved operating performance to the exercise of segment-level real options.

Keywords Real option value · Return predictability · Abnormal returns · Segment

JEL classification G12 · M41

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1 Introduction

Shareholders have real options in a firm. Operations with high profitability can be expanded and those with low profitability can be adapted to an alternative use or liquidated. The former can be considered as a call option whose value increases with profitability, and the latter as a put option whose value increases when profitability decreases. Real option value is an important component of firm value. (Brennan and Schwartz 1985; Zhang 2000) The implications of real options on firm value have been examined, and the empirical evidence is consistent with the theoretical predictions. For example, Burgstahler and Dichev (1997) show that equity valuation is a convex function of a firm's book value and earnings, suggesting that stock prices reflect the value of a liquidation option. Hao et al. (2011a) systematically test the implications of real options-based valuation models and provide evidence that the relation between equity value, earnings, and equity book value depends on investment decisions. Chen et al. (2015) further provide evidence that the real option value exists worldwide. Hwang and Sohn (2010) suggest that real option value is not fully reflected in the current stock prices and predicts future abnormal returns.

Most studies examine real option value at the firm level. However, as Chen and Zhang (2003) suggest, the concept of real options can also be applied to the segment level. Each of the multiple segments of a firm can have its own real options, and the firm value should include the combination of the real option value of all the segments. The valuation function is convex on profitability, so the combination of the segment-level real option value is greater than the value estimated at the firm level. We argue that neglecting the real option value at the segment level leads to mispricing as well as to predictable future returns when the mispricing is corrected.

We examine whether the real option value of segments has predictable power for future stock returns. Following the theoretical work of Chen and Zhang (2003), we construct a variable (RVS) based on segmental information to measure the importance of the real option value of segments in a diversified firm. RVS is defined as the asset-weighted divergence of segment profitability deflated by the market value of equity, calculated at the end of June every year. We then examine the returns in the following 12 months starting from July. RVS is found to significantly predict future abnormal returns. In a large sample of diversified firms in the period of 1981 to 2013, we find that the monthly sized-adjusted returns of firms with a high decile of RVS exceed those with a low-RVS decile by 0.791%, which translates into an annualized abnormal return of 9.49%. The annual returns for the hedging strategy that longs firms with a top decile of RVS and shorts those with a bottom decile of RVS are positive in 26 out of 33 years. The usefulness of RVS for return prediction is robust after controlling for risk factors, such as firm size, book-to-market ratio, momentum, accruals, and E/P ratio. The evidence suggests that the real option value of segments is an important component of firm value and is reflected in stock prices with a lag.

Following the theoretical prediction in Chen and Zhang (2003), we further test whether the predicative power of RVS is affected by the distribution of growth opportunities within the firm. As profitable segments are more capable in using growth opportunities to generate value, real option segment value is higher when the growth opportunities mainly lie in more profitable segments. We divide our sample into two groups based on a variable that measures the distribution of growth opportunities within the firm and find that the predicative power of RVS is stronger when the profitable segments also have high growth opportunities.

We conduct further empirical tests to corroborate the implications of real option segment value. First, firm growth has a multiplier effect on real option segment value—that is, the value is greater when firm growth is higher. We therefore expect the return predictability of RVS to be stronger for growth firms. We divide our sample into two groups based on the firms' forecasted long-term growth and find that the monthly size-adjusted returns of the hedge portfolio are higher in the high-growth group than in the low-growth group. Second, we find that analysts help the market incorporate such value. For firms with a low level of analyst coverage, RVS predictability is stronger, while for firms with a high level of analyst coverage, predictability is weaker. Third, firms must expand successfully and contract unsuccessful segments to realize real option segment value. However, agency problems often lead to inefficient internal markets, and managers move funds in an opposite direction if exercising the real option s of segments. Therefore real option segment value is difficult to realize in firms with severe agency problems, which then weakens the return RVS predictability. We combine our sample with a measurement of corporate governance (i.e., the G-Index developed by Gompers et al. 2003) and examine the RVS-based trading strategy conditional on corporate governance. The hedge portfolio is found to earn a significant size-adjusted return in the good corporate governance group and an insignificant return in the poor corporate governance group.

We further show that firms exercise the real options of segments. We find that, when RVS is high, the firm is more likely to expand profitable segments and contract unprofitable segments. We also find that RVS in the current year is negatively associated with the change of RVS in the subsequent year, suggesting that managers realize real option segment value, which reduces the RVS. We then examine the implication of RVS for future earnings performance and find it relates positively to future earnings changes, suggesting that current real option segment values can lead to an earnings increase in future years. The change of RVS also relates negatively to future earnings changes, suggesting that the exercise of real option segment value (i.e., the reduction of RVS) leads to an increase in future performance. Together, these results provide evidence for a channel in which the market incorporates the real option value of segments; that is, the market can absorb information regarding real option segment value by observing its effect on earnings performance.

Lastly, we examine the abnormal returns around earnings announcements, which we find to be significant and larger than the proportion of annual abnormal returns, suggesting that part of the mispricing is corrected through earnings announcements.

Our study makes several contributions to the literature. First, we add to the research on the relation between capital markets and financial statements information and, in particular, to efficiency tests of the market's response to specific accounting information. Researchers have documented that accounting information is value-relevant and that the market cannot fully price publicly available accounting information.[1] However, most of these studies are disconnected from formal valuation models. In contrast, our study draws insights from valuation theory and designs empirical tests that are centered

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

on a valuation construct predicted by theory. (See theoretical works by Chen and Zhang 2003 and Zhang 2014.)

Second, our study contributes to the understanding of the usefulness of segment information. Practitioners and academics agree that segment information matters for valuation. For example, the Association for Investment Management and Research (AIMR 1993) 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." However, no consensus exists on how to extract economic implications from segment data. Our study examines real option segment value as a predictor of future returns, which complements the work of Chen and Zhang (2003) and provides direct empirical evidence for the usefulness of segment information. Segment information does not appear to be immediately understood by the market, and real option segment value is partially incorporated into the market price with a lag.

Third, our study presents evidence that a real options analysis can be extended to the segment level. The literature has examined the implications of real option value, and the evidence indicates that it affects market value and also predicts future returns (e.g., Burgstahler and Dichev 1997; Hao et al. 2011a; Hwang and Sohn 2010). However, most analyses are at the firm level.[2] We apply a real options analysis to the segment level and find that real option segment values can predict future abnormal returns. We also provide empirical evidence that firms exercise the real options of segments, which lead to higher future earnings changes. Our study sheds additional light on the importance of real options at the segment level.

Our paper closely relates to the work of Chen and Zhang (2003), who analytically prove that a real options analysis can be applied to the segment level and empirically examine the value-relevance of the real option value of segments. Our paper builds on their theoretical model. However, we also examine the effect of real option segment values on mispricing and anomalies, whereas they assume market efficiency and examine whether the current market prices reflect real option segment values. Our study thus supplements their empirical evidence by identifying the usefulness of a real options analysis at the segment level in return prediction. We also provide cross-sectional evidence and illustrate that return prediction is conditional on heterogeneous investment opportunities, firm-level growth, corporate governance, and analyst following. We further extend their study by examining the exercise of real options of segments. Our paper also relates a study by Hwang and Sohn (2010), who examine the role of real option value in predicting future returns. However, our paper examines real option value at the segment level, while they examine real option value at firm level.

The remainder of the paper is organized as follows. Section 2 reviews related literature, 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 real option value on firms' future stock returns and examines conditional variables that affect the predictive power. Section 5 carries out several further tests to investigate the effect of analysts'

[2] An exception is Chen and Zhang (2003), which we discuss below in more detail.

following and corporate governance on return predictability, the exercise of real options, and the market reactions around earnings announcements. Section 6 concludes.

2 Related literature, hypotheses, and empirical design

2.1 Research on real options

The theory of real options was developed in the finance literature. For example, Myers (1977) suggests that many corporate assets have growth opportunities, which can be seen as call options that firms can exercise in the future. He uses the concept of real options to explain the decision of capital structure. Brennan and Schwartz (1985) develop a model that explicitly allows managers to control the output rate in response to the price changes of output. In other words, managers can increase output when the price increases and decrease output when the price decreases. They suggest that the model is suitable to evaluate natural resource projects and other situations in which future cash flows are determined by future management decisions. Berger et al. (1996) focus on the abandonment option and suggest that firm value should incorporate the exit value.

Zhang (2000) develops a real options-based model (ROM) that introduces accounting rules and links accounting variables and equity valuation. In the model, a firm has the option to adjust operations by making contingent investment decisions in response to the changing external environment. Two accounting variables are important in the model: one is profitability (ROE), which represents the efficiency of operations, and the other is book value, which represents the scale of operations. The model recognizes that accounting information plays a vital role in guiding a firm's investment decisions—that is, the firm adjusts the operation scale according to the efficiency of operation. A salient property of the model is the convexity in the relation between equity value and accounting variables. Chen and Zhang (2003) extend the model to incorporate segment-level information. Hao et al. (2011b) analyze the effect of industry environment on real option value. Zhang (2014) provides a thorough discussion regarding valuation models that adopt a real options-based approach.

In the empirical section, Burgstahler and Dichev (1997) examine whether the adaptation value, one important component of real option value, affects valuation. Using data from 1976 to 1994, they examine the relationship between market value and earnings, both scaled by book value. The evidence suggests that the market seems to take into account the adaptation value of the firm and that equity value is a convex function of profitability. Hao et al. (2011a) consider both adaptation options and growth options and find that the nonlinear relation between equity value, earnings, and equity book value is dependent on investment growth. A more recent study by Chen et al. (2015) examines real option value in a sample of firms from 30 countries in the period from 2000 to 2010 and finds that, at the firm level, real option value is important worldwide. Hwang and Sohn (2010) find that the market reflects real option value with a lag and that the value predicts future abnormal returns.

2.2 Research on accounting anomalies

The literature on accounting anomalies is one of the most active areas of research in accounting and finance. As noted by Lewellen (2010), the goal of the literature is to understand how accounting numbers relate to firm value and how quickly and accurately investors assess the information in financial reports.

Following the seminal publication by Ball and Brown (1968), researchers began to study how efficiently stock prices incorporate accounting information. Bernard and Thomas (1990) find that the market reacts to earnings announcements with a lag, leading to an earnings drift. Sloan (1996) examines the accrual anomaly and finds that the accruals component of earnings is less persistent than the cash flow component. Because investors do not fully understand the different persistence, firms with high (low) accruals earn future negative (positive) abnormal returns. Subsequent studies examine the return predictability of different accounting variables, such as special items (Burgstahler et al. 2002), discretionary accruals (Xie 2001), and net operating assets (Hirshleifer et al. 2004), among others. More recent examples include Hirshleifer et al. (2013), who find evidence that the market is inefficient understanding innovative efficiency, and Li et al. (2014), who report that information on the macroeconomy can predict future stock returns. Richardson et al. (2010) provide an excellent literature review on accounting anomalies.

In general, the research on anomalies finds that the market does not immediately incorporate all of the economic meanings of accounting information. Parts of accounting information are reflected in stock prices with a lag, which leads to predictable patterns of future returns. One critique of these studies is that these empirical studies are mostly disconnected from the formal valuation models and that researchers construct the variables with discretion (Zhang 2014).

2.3 Testable hypotheses

Our paper builds upon the theoretical framework developed by Chen and Zhang (2003). Extending the real options-based framework to multi-segment firms, they show that real options at the segment level have incremental value. We discuss the intuition of their model using figures and then derive our hypotheses.[3]

If a business unit can neither be expanded nor closed, its value is a linear function of its profitability under the conventional dividend discount model (Miller and Modigliani 1961). In Fig. 1a, the straight line AB illustrates this idea in which the y-axis is the market value deflated by assets and the x-axis is the profitability (ROA). However, more realistically, shareholders have the option to either close the business (a put option), if it has low profitability, or expand the business (a call option), if it is highly profitable. The first option is known as the "adaptation option," and the second as the "growth option" (Burgstahler and Dichev 1997; Chen et al. 2015). When shareholders close a business with zero profitability and sell its assets, the adaptation option is exercised, and the positive value of the put option brings the firm value from zero (point A) to a positive number (point G). Similarly, the growth option can be exercised when the firm is operating at a profitability level higher than its cost of capital (point F)

[3] These figures are adapted from Zhang (2014). See Figures 4.1 and 7 for more a thorough discussion.

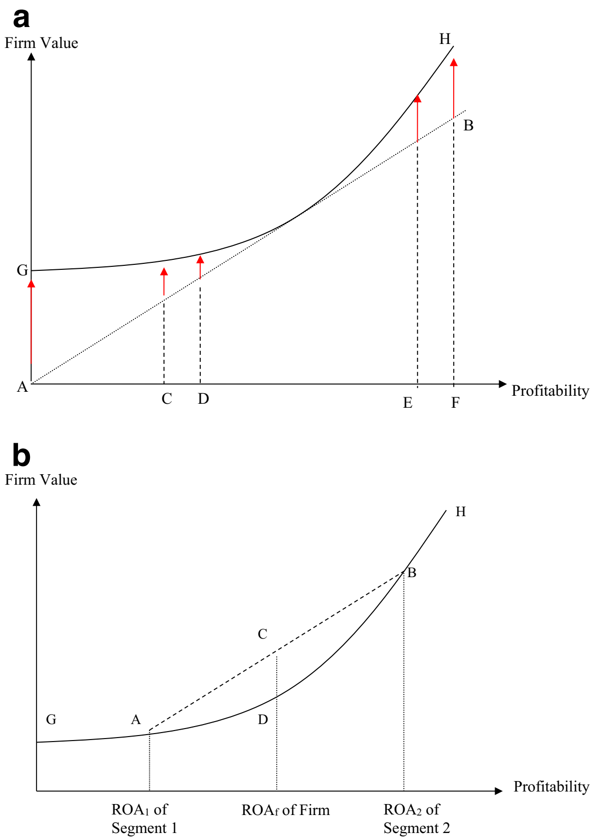

Fig. 1 **a** The real options and firm valuation. Note: There figures are adapted from Zhang (2014), see Fig. 4.1 and 7.1 in the book for more thorough discussions. The vertical axis is the market value normalized by assets and the horizontal axis is profitability (ROA). 1) If a business can neither be expanded nor shut down, then its value is a linear function of its profitability, as depicted by a straight line AB. If a firm operates at a profitability level of zero, its value 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 it is not profitable or expand (a call option) if it is highly profitable. When shareholders close a 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 a 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 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. **b** The real option value of segments and value of a diversified firm. The vertical axis is the market value normalized by assets, and the horizontal axis is profitability (ROA). The GH curve is the valuation function, as shown in (**a**). 1) For a diversified firm with a 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. Points A and 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. Point C is then the valuation of the firm 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 segments 1 and 2 have more divergence in profitability or the valuation curve is more convex, the real option value of the segments becomes larger

as 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.

When considering a multi-segment firm, a simple real options analysis based only on its aggregate firm-level profitability is not sufficient. Each segment of the firm has its own real option value and should be valued accordingly. The value of a multi-segment firm should be a combination of the real options-based valuations of all its segments. The reasoning is illustrated in Fig. 1b. Consider a firm with two business segments, each with distinct levels of profitability, measured by the segment's return on asset (ROA). If the segment information is neglected, the firm is valued according to its firm-level profitability, or point D, according to the valuation function as previously discussed. Note that the valuation at point D has already taken account of the real option value at the firm level.

If we apply the real option-value concept to the segment level, then each segment should be valued according to the valuation function GH. The values of these two segments, taking into account their real option value, are depicted by points A and B in Fig. 1b. Value for the whole firm is therefore the combination of these two business segments, as indicated by point C. The valuation function is convex on profitability, so point C is above point D. The distance between C and D is the incremental value of the real options measured at the segment level.

The existence of the real option segment value can be easily understood using a numerical example. Assume a diversified firm has two equal-sized segments and its cost of capital is 10%. Segments 1 and 2 have an ROA of −10% and 30%, respectively; therefore the firm-level ROA is 10%. If we only consider the firm-level information, the 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 high real option value. Because the firm can cut loss segments and expand those with high profitability, its value should be higher than if it was valued at the firm-level ROA. Although our discussion is simply descriptive and considers only two segments, the analytical model developed by Chen and Zhang (2003) rigorously proves that the real option value of segments is important when evaluating a diversified firm. Their empirical results also show that the real option value of segments has an incremental effect on the contemporary stock prices of diversified firms.

However, contemporary prices may not fully incorporate the value implications of segment information. Much evidence can be found that market prices reflect accounting information with a lag and that trading strategies based on accounting information can predict future returns. Researchers have, for example, 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), net operating assets (Hirshleifer et al. 2004), innovative efficiency (Hirshleifer et al. 2013), and macro information (Li et al. 2014). The accounting information examined in these papers is, in general, simple and straightforward. Accruals, for example, are core concepts in the financial accounting system, as these special items are, by definition, transitory and reported separately from operating income. By contrast, extracting value-relevant information from segmental data can be more complex. Previous studies, such as those of Tse (1989) and Givoly et al. (1999), present evidence that segmental information is useful in market valuation, but they do not propose a systematic way of integrating it into firm-level information. Investors may put less weight onto information that is harder to process, which leads to mispricing (Hirshleifer et al. 2013). Although Chen and Zhang (2003) show that segment information has incremental power in explaining current stock prices, they also show that the incremental power is small in magnitude, suggesting that the current prices may not fully reflect the value of segment information.

Given the difficulty of processing segment data, we conjecture that contemporary market prices do not efficiently reflect real option segment value. As part of the value is reflected in future-year prices, firms with large real option segment values will earn abnormal returns in the future. Our assumption is that, although the market is inefficient in the short term, it is efficient in the long term. That is, a short-term stock price may ignore some value-relevant information, but the price will converge to the intrinsic value in the long term.

We propose the following hypothesis.

Hypothesis 1: The market prices cannot fully incorporate the real option value of segments. Firms with larger real option segment value will outperform firms with smaller real option segment value in future years.

Another important prediction of Chen and Zhang (2003) is that real option segment value depends on how growth opportunities are distributed within the firm. Intuitively, a more profitable segment can generate more value for a given level of invested capital compared with a less profitable segment. Therefore, when the more profitable segment also has high growth opportunity, the segment expansion can bring in larger value. In contrast, when the less profitable segment has high growth opportunity, the opportunity is wasted, because the best decision for the firm is to contract with the operation of the less profitable segment. The growth opportunity in the less profitable segment may even destroy value if the firm decides to expand this segment. Therefore the real options of segments have larger value if the growth opportunity lies primarily in more profitable segments and, correspondingly, have smaller value if the opposite is true. We expect that the effect of the divergent segment-growth opportunities also affect its predictability.

Our second hypothesis is as follows.

Hypothesis 2: A trading strategy based on real option segment value earns larger abnormal returns when the growth opportunity mainly lies in more profitable segments than when the growth opportunity mainly lies in less profitable segments.

2.4 Empirical design

To test our hypotheses, we need to measure real option segment value. Given that the real options valuation approach is convex in nature, the greater the divergence between segment profitability, as measured by the distance between points A and B in Fig. 1b, the larger the real option value of segments, as measured by the distance between points C and D. We therefore construct the measurement as follows.

$$RVS = \left(\sum\left[A_i{}^{*}\left|ROA_i - \overline{ROA}\right|\right]\right)/MV, \quad (1)$$

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; and MV is the market value of the firm. $\left|ROA_i - \overline{ROA}\right|$ measures the deviation of segment i's profitability from the firm-level profitability, so the numerator of RVS is the 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 segment values. We use the market value as a deflator so that RVS measures the importance of the real option segment value relative to the firm's market value. Note that, for firms operating in a single segment, RVS is zero, as these firms do not have real option value at a segment level. Chen and Zhang (2003) theoretically prove that the real option segment value can be measured using the profitability divergence within segments. Our research design is centered on the valuation construct predicted by their theory.

To examine whether the real option segment value can predict future returns, we use both the portfolio method and Fama-MacBeth regressions. At the end of June of each year t, we first calculate the RVS for each firm, in which we allow four months after the fiscal year-end for the financial information to become publicly available.[4] We then examine the returns from July of year t until June of year t + 1.

For the portfolio tests, all diversified firms in our sample are allocated into 10 portfolios based on the decile breakpoints of RVS. We then examine size-adjusted returns, Fama-French three-factor-adjusted returns, Carhart (1997) four-factor-adjusted returns, and Fama-French five-factor-adjusted returns for the 10 portfolios as well as for a hedge portfolio. To calculate size-adjusted abnormal returns for each portfolio, we subtract the monthly return on a benchmark portfolio (the AMEX/NYSE/NASDAQ decile provided by the CRSP) from the monthly return of each stock. We then take the average of the size-adjusted monthly returns for each portfolio.

For the other two measures of abnormal returns, we perform standard time-series regressions in which the return of the portfolio is regressed on to a factor mimicking portfolio returns (e.g., Fama and French 1992, 1993, 2015; Carhart 1997). That is,

$$Return_t = \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_t, \quad (M1)$$

$$Return_t = \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 MOM_t + \varepsilon_t, \quad (M2)$$

$$Return_t = \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \beta_5 CMA_t + \varepsilon_t. \quad (M3)$$

[4] 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.

Model (M1) is the Fama-French three-factor model that controls three important factors: MKT is the return to the market portfolio (excess of the U.S. one-month T-bill rate) as reported from Ken French's website. SMB is the size factor (small minus big). HML is the value factor (high minus low book-to-market). Both of these are the factor-mimicking portfolio returns from Kenneth French's website. Model (M2) is the Carhart four-factor model, which includes MOM, the momentum factor (high minus low past returns), as the fourth factor. Model (M3) is the Fama-French five-factor model, which adds RMW (robust minus weak) and CMA (conservative minus aggressive) to their three-factor model. Returns of the abovementioned factor-mimicking portfolios have been found to represent returns for risk, and the intercepts in the time-series regression represent abnormal returns after adjustments for risk. If the market does not fully understand the value-relevance of segment data, we would expect that firms with higher (lower) RVS to earn positive (negative) returns and that hedge portfolios buying firms with the highest RVS decile and selling those with the lowest RVS decile will earn abnormal returns.

We also use Fama-MacBeth regressions to control for other factors that have been found to affect stock returns, such as earnings-to-price ratios, accruals, and so forth. For each month during our sample period, we first calculate the size-adjusted return for each firm. We then regress monthly size-adjusted returns on the RVS of year t and other control variables including firm size, book-to-market ratio, momentum, earnings-to-price ratio, and accruals. All variables are constructed using the most recently available information. For financial information, we allow four months after the fiscal year-end for the financial information to become publicly available. Size and momentum are measured at the end of June of year t. Details of control variable definitions are given in Appendix Table 10. We include 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 effect of extreme values[5] (i.e., R_RVS = 1 for firms in the highest RVS decile and = 0 for firms in the lowest decile). The time-series average slopes for RVS and corresponding t-statistics from the series of monthly cross-sectional regressions can test the RVS predictability power.

Our tests are joint tests of the assumptions that (1) RVS correctly measures real option segment values and (2) that the market is efficient with respect to real option segment values.

3 Sample and descriptive statistics

We collect firm-level financial accounting data from Standard and Poor's Compustat North America Fundamental database. Business segment data are from the Compustat Segment database. Stock returns and prices are obtained from the University of Chicago's Center for Research in Security Prices (CRSP). We eliminate firms in the financial services (SIC code: 6000–6999) and utilities (SIC code: 4400–5000) industries.

[5] We sort variables in each year and assign the firm-year observations to deciles. We then 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.

Table 1 Descriptive statistics

Variables	Obs	Mean	Std	Q1	Median	Q3
RVS	23,663	0.110	0.129	0.032	0.070	0.136
DRVS	20,360	−0.002	0.108	−0.030	−0.002	0.025
SIZE	23,663	6.089	1.990	4.580	6.071	7.469
LEV	23,663	0.253	0.167	0.131	0.239	0.351
BM	23,663	0.664	0.448	0.364	0.572	0.867
ROA	23,663	0.139	0.080	0.097	0.138	0.183
EP	23,663	0.207	0.159	0.111	0.175	0.268
LTG	10,986	0.147	0.075	0.100	0.135	0.175
NSEG	23,663	3.316	1.331	2	3	4
DNI	23,036	0.014	0.151	−0.020	0.008	0.033
Accrual	23,663	−0.039	0.073	−0.074	−0.040	−0.004

This table presents firm characteristics for our sample of 23,663 firm-year observations from 1981 to 2013. The sample includes diversified firms from the NYSE, AMEX, and NASDAQ with relevant information and with stock prices at the fiscal year-end of greater than five dollars. RVS is the real option value of a segment, calculated as $\left(\sum\left[A_i{}^*\left|ROA_i-\overline{ROA}\right|\right]\right)/MV$ using the most recent financial information available, where A_i is the total assets for segment i, ROA_i is the return on 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 the fiscal year. We allow four months after the fiscal year-end for the financial information to become publicly available. DRVS is the change of RVS; size is the natural log of equity market value at the fiscal year-end; LEV is the leverage ratio; BM is the book-to-market ratio; LTG is the firm-level growth opportunity proxied by IBES long term growth rate; ROA is the return on assets; EP is the earnings to price ratio; NSEG is the number of segments for the firm; DNI is the change of net income deflated by price; and accruals is total accruals. Detailed definitions are given in Appendix Table 10. All variables are winsorized at 1% and 99% in each year

The initial sample includes 414,110 business segments with segment-level assets and income information reported in the Compustat Segment database for the period 1981–2013. After dropping firms with missing SIC codes or with segments in the financing industry, we have 57,030 firm-year observations that have multiple segments, corresponding to 184,366 segments. Requiring necessary firm-level financial information reduces the sample to 31,854 observations. Following Berger and Ofek (1995), we eliminate a firm-year observation if the sum of sales across all reported segments is not within 1% of the firm's total sales or if the sum of assets across all disclosed segments is not within 25% of the firm's total assets. We also require firms to have share prices greater than five dollars at the fiscal year-end. Our final sample includes 23,663 firm-year observations,[6] covering 33 years from July 1981 to June 2013.[7]

Table 1 reports descriptive statistics for the main variables of interest. To avoid the outlier effect, we winsorize all variables (with the exception of returns and the number of segments) at 1% and 99% of each year. RVS is our proxy for the real option segment value and has a mean of 0.110. The standard deviation of RVS is 0.129, and the interquartile

[6] 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 of less than five dollars.

[7] 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 a fiscal year end in April, then the Compustat records of fiscal year 1980 ends in April 1981, and as we allow four months for the data become available, its fiscal year 1980 data cannot be used to form a portfolio in June 1981.

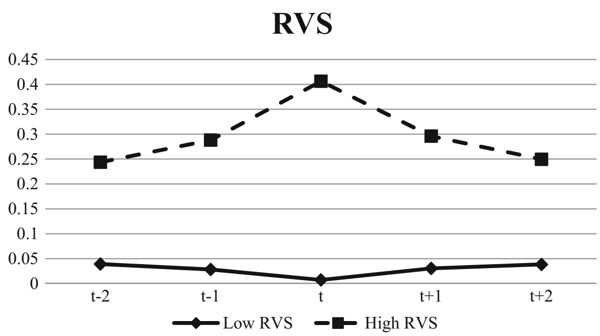

Fig. 2 The time series trend for low RVS- and high-RVS groups. This graph shows the time-series trend of real option segment values (RVS). Between 1981 and 2013, in April of each year (t), we sort diversified firms into ten deciles based on RVS. We then trace the level of RVS of the top and bottom deciles for the two years before and two years after the current year. RVS is calculated as $\left(\sum\left[A_i{}^*\left|ROA_i - \overline{ROA}\right|\right]\right)/MV$, where A_i is total assets for segment i, ROA_i is return on assets in segment i, $\overline{ROA}$ is firm level return on assets, and MV is the market value of the equity. We allow four months after the fiscal year-end for the financial information to become publicly available

range between Q3 and Q1 is 0.104 (0.136–0.032), indicating that significant variations exist in the real option segment value. Size is the natural log of the equity market value at the fiscal year-end. The mean of firm size of our sample is \$440.98 million (=$e^{6.089}$), which is higher than the average for the total observations in Compustat,[8] as we only include diversified firms, which are usually larger. B/M is the book-to-market ratio, which has a mean of 0.664 and median of 0.572. The B/M in our sample is on average smaller than that of Compustat firms, indicating that diversified firms are usually more mature and have fewer growth opportunities. NSEG is the number of business segments. We only include firms with multiple segments, so the minimum is two. The average number of segments in our sample is around three.

To better understand the nature of RVS, we examine its time-series characteristics. We sort the firms into 10 deciles based on RVS and trace the evolution of the variable through time. Figure 2 depicts the time-series trend for groups with the top and bottom RVS. For the group with the top RVS, the mean is 0.406 in year t, which decreases to 0.296 in year t + 1 and further to 0.250 in year t + 2. For the group with the bottom RVS, the mean is 0.007 in year t, which increases to 0.030 in year t + 1, and 0.038 in year t + 2. It is evident that RVS shows mean-reverting characteristics and, more importantly, the change in RVS mainly lies in firms with a high RVS. The results are consistent with the notion that firms exercise real options of segments.

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

[8] For example, the median of equity value for all Compustat firms is around \$91 million in Hwang and Sohn (2010).

firms with higher real option segment value will have positive abnormal returns. To test this hypothesis, we use both the portfolio and regression approaches.

We first use the portfolio approach to examine the predictability of real option segment value. At the end of June of year t, we sort sample firms into 10 portfolios according to RVS. We hold these portfolios over the next 12 months from July of year t until June of year t + 1 and calculate the equal-weighted returns for each. In Table 2, we report the different measures of abnormal returns for each portfolio.

Table 2 The Real Option Value of Segments (RVS) and future returns

Portfolios	Size-adjusted returns (%)	Fama-French 3-factor model adjusted returns (%)	Carhart 4 factor-model adjusted returns (%)	Fama-French 5-factor model adjusted returns (%)
1(Lowest RVS)	−0.322***	−0.074	0.183	−0.001
	(−2.79)	(−0.55)	(1.55)	(−0.01)
2	−0.166*	0.047	0.244**	0.048
	(−1.69)	(0.44)	(2.54)	(0.44)
3	−0.088	0.181*	0.324***	0.061
	(−0.9)	(1.7)	(3.18)	(0.57)
4	0.019	0.248*	0.463***	0.254**
	(0.17)	(1.94)	(3.98)	(1.96)
5	0.11	0.332***	0.46***	0.226**
	(1.15)	(3.43)	(4.97)	(2.32)
6	0.041	0.232**	0.36***	0.166
	(0.38)	(2.25)	(3.62)	(1.58)
7	0.163	0.384***	0.52***	0.324***
	(1.61)	(3.74)	(5.3)	(3.07)
8	0.435***	0.586***	0.737***	0.461***
	(3.77)	(5.27)	(6.96)	(4.10)
9	0.305**	0.436***	0.612***	0.388***
	(2.33)	(3.49)	(5.16)	(3.02)
10(Highest RVS)	0.469***	0.526***	0.732***	0.496***
	(3.15)	(3.64)	(5.37)	(3.33)
Hedge returns	0.791***	0.599***	0.549***	0.498**
	(4.20)	(3.04)	(3.74)	(2.45)

This table presents monthly abnormal returns for portfolios formed on the real option value of segments during the sample of 33 years (1981–2013). At the end of June of each year t, all diversified firms are allocated into 10 portfolios based on the decile breakpoints of RVS. RVS is the real option value of segments, calculated as $\left(\sum\left[A_i^*\left|ROA_i - \overline{ROA}\right|\right]\right)/MV$ using the most recent financial information available, where A_i is the total assets for segment i, ROA_i is the return on 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 the fiscal year. We allow four months after the fiscal year-end for the financial information to become publicly available. The portfolios are held for one year. Size-adjusted returns are estimated according to deciles of NYSE/AMEX/NASDAQ firms supplied by CRSP, the Fama-French three-factor model adjusts for MKT, SMB, and HML; the Carhart four-factor model adjusts for MKT, SMB, HML, and MOM; the Fama-French five-factor model adjusts for MKT, SMB, HML, RMW, CMA. The hedge-trading rule to buy firms with the highest decile of RVS and sells firms with the lowest RVS. T-statistics are in parentheses, calculated using the time-series means divided by time-series standard deviation. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

We report the size-adjusted abnormal return for each portfolio in column (1), the Fama-French three-factor-adjusted return in column (2), the Carhart four-factor-adjusted return in column (3), and the Fama-French five-factor-adjusted return in column (4).

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. Firms in the lowest RVS decile earn an average size-adjusted monthly return of −0.322%, and those in the highest RVS decile earn 0.469%. The size-adjusted returns appear to vary monotonically with the level of RVS. A long- and short-hedge portfolio that buys firms in the highest RVS decile and sells in the lowest RVS decile could earn a significant 0.791% monthly return, which, when annualized, equals 9.48%. Similar results are gained from using three-, four-, or five-factor-adjusted returns to measure abnormal returns. Firms with larger (smaller) RVS have higher (lower) abnormal returns. The hedge portfolio can earn abnormal monthly returns of 0.599%, 0.549%, and 0.498%, respectively.[9]

In summary, the RVS-based trading strategy earns significantly positive returns in the subsequent year. The 10 portfolios in Table 2 are constructed after the segment reporting has been made publicly available, and the evidence implies that the market cannot fully understand the economic implications of the real option value of segments.

Second, we examine the ability of RVS to predict returns using monthly Fama and MacBeth (1973) cross-sectional regressions to control for other characteristics that can predict returns. We include other determinants of stock returns such as earnings-to-price ratios and accruals (Basu 1977; Easton and Harris 1991; Sloan 1996).

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 accruals (Accrual). The highest correlation between RVS and other variables is 0.379 (with B/M). 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 influence stock returns. We use firm characteristics such as size, book-to-market ratio, momentum, accruals, and E/P ratio in our regression to control for such previously found risk factors.

Panel B of Table 3 reports the time-series average slopes and corresponding t-statistics from the series of monthly cross-sectional regressions of size-adjusted returns on RVS and other factors. We have a total of 396 monthly regressions. In all specifications, the slopes on the R_RVS measures are positive and highly significant, ranging from 0.387 to 0.592 with t-statistics ranging from 4.13 to 5.88. Other control variables have coefficients generally consistent with those in the literature.

We perform three supplementary tests to provide corroborating evidence. First, we examine whether hedge-trading rules to buy the highest and sell the lowest RVS firms can consistently earn abnormal returns. We calculate the size-adjusted annual returns by compounding the size-adjusted monthly returns for hedge portfolios in each year. We present the hedge-portfolio performances in Fig. 3. The hedge portfolio has earned

[9] Our basic view is that the market is efficient in general but inefficient in some specific aspects. Here our assumption is that the market is generally efficient towards diversified firms, and we do not expect that diversified firms will outperform or underperform relative to focus firms. For this purpose, the market should have priced real option segment value in general but cannot distinguish the level of RVS for each firm. Therefore low RVS firms can serve as a benchmark for high RVS firms.

Table 3 Fama-MacBeth regressions of monthly size-adjusted returns on the Real Option Values of Segments (RVS) and other variables

Panel A: Pearson correlation of variables

	RVS	**SIZE**	**BM**	**EP**	**RAW_1**
SIZE	−0.230				
	(<0.001)				
BM	0.379	−0.382			
	(<0.001)	(<0.001)			
EP	0.346	−0.200	0.501		
	(<0.001)	(<0.001)	(<0.001)		
Accrual	−0.146	−0.117	−0.032	−0.050	
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	
RAW_1	−0.021	−0.021	−0.045	0.006	−0.026
	(0.002)	(0.002)	(<0.001)	(0.381)	(<0.001)

Panel B: Fama-MacBeth regressions of monthly size-adjusted returns on RVS and other variables

	Dependent variables: Size-adjusted returns (%)		
Variables	**(1)**	**(2)**	**(3)**
R_RVS	0.592***	0.546***	0.387***
	(5.88)	(5.60)	(4.13)
R_SIZE	0.258*	0.176	0.056
	(1.79)	(1.20)	(0.38)
R_BM	0.542***	0.525***	0.235*
	(2.98)	(3.05)	(1.73)
RRAW_1		0.057***	0.048**
		(2.62)	(2.27)
R_EP			0.589***
			(2.99)
R_ACC			−0.233**
			(−2.29)
Constant	−0.599***	−0.782***	−0.635***
	(−4.28)	(−4.64)	(−3.34)
Obs	254,663	254,663	254,663
R^2	0.01	0.02	0.03

The sample includes diversified firms and relevant information, and with the stock price at the fiscal year end of greater than five dollars. RVS is the real option segment value, calculated as $\left(\sum\left[A_i{}^*\left|ROA_i - \overline{ROA}\right|\right]\right)/MV$ using the most recent financial information available, where Ai is the total assets for segment i, ROA_i is the return on 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 the fiscal year. We allow four months after the fiscal year end for the financial information to become publicly available. SIZE is the natural logarithm of equity market value; BM is the book-to-market ratio; RAW_1 is the return over the previous 12 months before the formation of the portfolio; EP is the earnings to price ratio; and accruals are total accruals. Detailed definitions are given in Appendix Table 10. In panel A, we present correlations of variables, and in panel B, we regress size-adjusted monthly 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 month and report the time- series means and t-statistics. There are 396 months in total. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

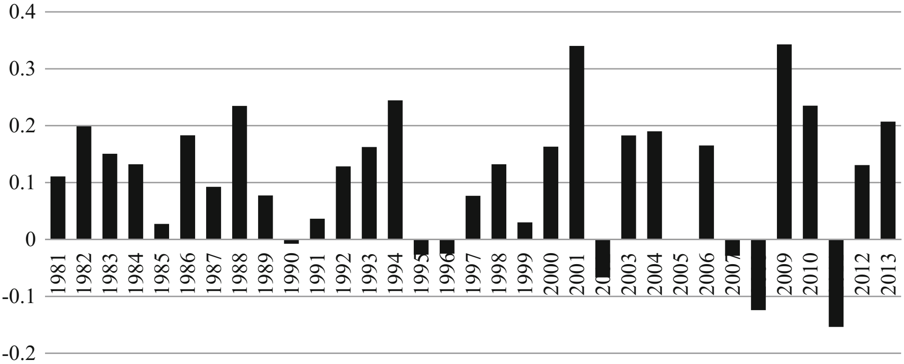

Fig. 3 Size-adjusted hedge returns based on the real option value of segments (RVS). This graph shows the annual size-adjusted returns of the RVS-based hedge portfolio across the 33 years of the sample period (1981–2013). At the end of June of each year t, all diversified firms with stock prices greater than five dollars and necessary information are allocated into 10 portfolios based on the decile breakpoints of RVS. The hedge portfolio buys firms in the highest RVS decile and sells those in the lowest RVS decile. Equal-weighted size-adjusted returns are calculated from July of year t to the following June. Size-adjusted returns are estimated according to deciles of NYSE/AMEX/NASDAQ firms. RVS is calculated as $\left(\sum\left[A_i^*\left|ROA_i - \overline{ROA}\right|\right]\right)/MV$, where A_i is total assets for segment i, ROA_i is return on assets in segment i, $\overline{ROA}$ is firm-level return on assets, and MV is the market value of the equity. We allow four months after the fiscal year-end for the financial information to become publicly available

positive abnormal returns in 26 of the 33 years of the sample period, suggesting that the trading strategy performance is stable and the RVS is more likely to capture a mispricing effect rather than a risk factor.

Second, beginning in 1998, firms began following SFAS131 for segment reports that require segments to be reported according to their internal operating systems. This change of accounting rules could affect our analysis. Segment information under the new rules can better represent the real option value, as information is based on the firm's internal organization. As monitoring is better, the internal market will be more efficient and managers are more likely to realize the real option values (Cho 2015). An increase of return predictability of RVS therefore appears likely, but more transparent disclosure also leads to a better understanding of the real option value of segments, which may reduce the return predictability. We compare the segment information and return predictability from around 1998 and notice a jump in the number of diversified firms in 1998, consistent with the notion that SFAS131 requires more detailed segment information (Botosan and Stanford 2005; Ettredge et al. 2005). However, our untabulated results indicate that the hedge returns in the post-1998 period are not different from pre-1998 returns.

Third, we examine whether the abnormal returns associated with the RVS portfolio can last for more than a year. We check the returns of the hedge portfolio for two and three years and find that abnormal returns are mainly concentrated in the first year, suggesting that the real option segment value is impounded into the price in one year.

In summary, results in Tables 2 and 3 and Fig. 3 consistently suggest that real option segment values can predict future abnormal returns. Our empirical results complement the evidence of Chen and Zhang (2003), who find that contemporary stock prices reflect the real option value at segment levels. Specifically, the authors regress stock prices on divergence of profitability (DOP), their measure of real option value at the segment level, and other variables. They find that, although the coefficient of DOP is significantly positive in all 12 sample years, individually and combined, the incremental explanatory power is low.[10] Combining their results and ours presents a more complete picture. Contemporary stock prices reflect economic implications of the real option value at the segment level to some extent. However, the reflection is not complete. Part of the real option value at the segment level is gradually incorporated into the stock prices, which leads to a predictable pattern in the return.

4.2 Test of hypothesis 2

Our second hypothesis predicts that the real option value of segments is more pronounced when more profitable segments also have high growth opportunities. To test this hypothesis, we first need to measure the growth opportunity for each segment. Because analysts do not forecast the growth rate for individual segments, we use the industry-level growth opportunity as a proxy. Specially, for each segment, we identify all focus firms that operate in the same industry and use the median consensus forecasts of the focus firms' long-term growth rate as the measure of the segment's growth opportunity.

Following Chen and Zhang (2003), we then construct a variable, WLTG, to measure the distribution of growth opportunities within the firm. $WLTG = \sum_i w_i(g_i - \overline{g}) + \sum_j w_j\left(\overline{g} - g_j\right)$,where g is the segment-growth opportunity as described above, and $\overline{g}$ is the asset-weighted average of growth opportunity for the diversified firm. Subscription i (j) represents more (less) profitable segments—that is, the segment ROA is higher (lower) than the firm-level ROA. The weight of the segment according to the segment asset is w. Thus WLTG > = 0 (<0) indicates that the growth opportunity mainly lies in the profitable (unprofitable) segments.

We divide the whole sample into two groups based on whether the WLTG is larger than 0. We then use methods similar to those in Tables 2 and 3 to examine the abnormal returns associated with RVS in each group. The empirical results are presented in Table 4. In Panel A of Table 4, we present the time-series means and t-statistics for the size-adjusted monthly returns of extreme portfolios as well as for hedge portfolios, based on RVS. In the group with WLTG > = 0, the high-RVS portfolio earns a 0.678% size-adjusted return, the low-RVS portfolio earns a − 0.318% return, and the hedge portfolio earns a significant 0.996% size-adjusted return. In the group with WLTG <0, the high-RVS portfolio earns a 0.211% size-adjusted return, the low-RVS portfolio a − 0.281% return, and the hedge portfolio earns a 0.492% size-adjusted monthly return. The hedge return is significant but only about 50% of that in the WLTG >0 group. The difference between the hedge returns in the two groups is significant. In Panel B, we run Fama-MacBeth regressions of size-adjusted monthly returns on RVS and other risk factors in each of the two

[10] The incremental explanation power is from 1% to 4% or 23% to 24%, depending on different specifications. The low incremental explanation power suggests that the market may not fully incorporate real option segment value.

Table 4 The Real Option Value of Segments (RVS) and abnormal returns, conditional on divergent segment-growth opportunities

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

Portfolios	**WLTG > =0**	**WLTG < 0**
Lowest RVS	−0.318**	−0.281**
	(−2.12)	(−1.99)
Highest RVS	0.678***	0.211
	(3.55)	(1.19)
Hedge returns	0.996***	0.492**
	(4.11)	(2.17)

Panel B: Fama-MacBeth regression

	Dependent variables	
Variables	**Size-adjusted returns (%)**	**Size-adjusted returns (%)**
	WLTG > =0	**WLTG < 0**
R_RVS	0.474***	0.369**
	(3.70)	(2.35)
R_SIZE	−0.001	0.168
	(−0.00)	(0.78)
R_BM	0.045	0.438**
	(0.26)	(2.27)
R_EP	0.702***	0.493**
	(2.96)	(2.02)
R_ACC	−0.372***	−0.132
	(−2.94)	(−0.77)
RRAW_1	0.036	0.051**
	(1.44)	(2.06)
Constant	−0.447*	−0.832***
	(−1.90)	(−3.21)
Obs	129,383	79,770
R^2	0.04	0.06

The sample is divided into two groups based on the heterogeneity in the segment-growth opportunities (WLTG). $WLTG = \sum w_i(g_i - \overline{g}) + \sum w_j(\overline{g} - g_j)$, where g is the segment-growth opportunity, proxied by the median of long-term earnings growth forecasts for all focus firms in the same industry. $\overline{g}$ is the weighted average of growth opportunity. Subscript i (j) represents more (less) profitable segments—i.e. segment ROA higher (lower) than the firm-level ROA. w is the weight of the segment, according to the segment asset. WLTG > = 0 (<0) indicate that growth opportunities mainly lie in the profitable (unprofitable) segments. 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 returns on rankings (ranking = 0 for firms in the lowest decile and = 1 for firms in the highest decile) of RVS and other factors in each month and report the time-series means and t-statistics. Detailed definitions are given in Appendix Table 10. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

groups. The coefficients of RVS are both significant. The coefficient is 0.474 in the group with WLTG > = 0, greater than that of the other group (0.369).[11]

[11] The difference is not statistically significant.

Panels A and B of Table 4 provide evidence showing that a trading strategy based on RVS earns more abnormal returns when the growth opportunity mainly lies in more profitable segments, which supports our Hypothesis 2.

5 Further analyses

We carry out further tests to enable us to understand the real option segment values and return predictability.

5.1 The effect of firm-level growth

Hao et al. (2011a) find that investment growth increases the firm-level real options value. Chen and Zhang (2003) show in their theoretical model that the real options of segments are more valuable when overall firm growth opportunity is high. The intuition is simply that firm growth opportunity has a multiplier effect on real option segment value.[12] Therefore we expect that a trading strategy based on real option segment value earns larger abnormal returns in the group of high-growth firms than in the group of low-growth firms.

To test this hypothesis, we use analysts' consensus forecasts of long-term growth rates from IBES as a proxy for firms' growth opportunity. That is, at the end of June of each year t, we obtain the most recent consensus forecasts of the long-term growth rate for each diversified firm from IBES. The availability of the data leads to a reduction of our sample observations.[13]

We divide the whole sample into two groups based on the long-term growth rates. Firms with a long-term growth rate greater (lower) than the annual median are allocated to the high- (low-) growth group. We then use methods similar to those in Tables 2 and 3 to examine the abnormal returns associated with RVS in each group. The empirical results are presented in Table 5. In Panel A of Table 5, we present the time-series means and t-statistics for the size-adjusted monthly returns of extreme portfolios as well as for hedge portfolios, based on RVS. In the high-growth group, the high-RVS portfolio earns a 0.720% size-adjusted return, and the low-RVS portfolio −0.159%. The hedge portfolio in the high-growth group earns a 0.879% size-adjusted return. In the low growth group, the high-RVS portfolio earns a 0.461% size-adjusted return, and the low-RVS portfolio earns a 0.197% return. The hedge portfolio in the low-growth group earns a 0.264% size-adjusted monthly return. The hedge return in the low-growth group is insignificant and is about 30% of that in the high-growth group. The difference between the hedge returns in the two groups is significant. In Panel B, we run Fama-MacBeth regressions of size-adjusted monthly returns on RVS and other risk factors in each of the two groups. The coefficient of RVS is 0.351 in the high-growth group, greater than that of the low-growth group (0.095). Panels A and B of Table 5 show that a trading strategy based on RVS earns more abnormal returns in the group of growth firms, consistent with our hypothesis.

[12] The simplest model can be conceived of as V = E/(r-g), where V is firm value, E is the earnings, r is cost of capital, and g is firm growth. See proposition 3 in Chen and Zhang (2003) and the relevant theoretic deduction.
[13] An alternative proxy for growth opportunity is market-to-book ratio (M/B), which does not reduce our sample. We also use M/B as the measure and find that abnormal returns for high M/B firms are much higher than those for low M/B firms, consistent with our hypothesis.

Table 5 The Real Option Value of Segments (RVS) and Abnormal Returns, Conditional on Firm-growth Opportunity

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

Portfolios	High-growth firms (Long-term growth rate > median)	Low-growth firms (Long-term growth rate < median)
Lowest RVS	−0.159	0.197
	(−1.05)	(1.17)
Highest RVS	0.720***	0.461*
	(2.79)	(1.68)
Hedge returns	0.879***	0.264
	(2.94)	(0.82)

Panel B: Fama-MacBeth regression

	Dependent variables	
Variables	**Size-adjusted returns (%)**	**Size-adjusted returns (%)**
	High growth	**Low growth**
R_RVS	0.351*	0.095
	(1.94)	(0.57)
R_SIZE	0.043	0.102
	(0.17)	(0.41)
R_BM	0.249	−0.027
	(0.95)	(−0.13)
R_EP	0.767***	0.412**
	(2.66)	(1.97)
R_ACC	−0.365**	−0.080
	(−2.10)	(−0.50)
RRAW_1	0.021	0.013
	(0.75)	(0.46)
Constant	−0.323	−0.103
	(−1.05)	(−0.32)
Obs	59,331	58,867
R^2	0.06	0.07

The sample is divided into two groups based on the firm-level growth opportunity (LTG). We use the forecasted long-term growth rate from IBES as the firm-level growth opportunity. Firms with LTG higher (lower) than the median are defined as high- (low-) growth firms. In panel A, we present monthly size-adjusted returns for the portfolios with the lowest decile of RVS, the highest decile of RVS, and for the hedge portfolio. 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 returns on rankings (ranking = 0 for firms in the lowest decile and = 1 for firms in the highest decile) of RVS and other factors in each month and report the time series means and t-statistics. Detailed definitions are given in Appendix Table 10. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

5.2 The effect of analyst following

Analyst forecasts have been found to be more accurate than statistical models in predicting earnings, and thus they can provide information to the market (O'Brien 1988; Asquith et al. 2005). Therefore analysts may be able to better understand real option segment value, and firms with more analysts following them are likely to incorporate real option segment value in the current stock prices, leading to lower return predictability. We divide our sample into two groups, based on analyst following, and then use the methods in Tables 2 and 3 to examine the abnormal returns associated with real option segment values in each group.

The empirical results are shown in Table 6. In Panel A of Table 6, we present for each group the time-series means and t-statistics for the size-adjusted monthly returns of extreme portfolios as well as the hedge portfolios based on RVS. In the low-analyst coverage group, the high-RVS portfolio earns a 0.501% size-adjusted monthly return, and the low-RVS portfolio earns a − 0.518% return. The hedge portfolio earns a 1.019% size-adjusted return. In contrast, in the high-analyst coverage group, the high-RVS portfolio earns a 0.420% size-adjusted monthly return, and the low-RVS portfolio earns a − 0.051% return. The hedge portfolio earns a − 0.471% size-adjusted return. The hedge return in the low group is significantly positive and not significant in the high group. The difference between the hedge returns in the two groups is significant.

In Panel B, we run Fama-MacBeth regressions of size-adjusted monthly returns on RVS and other risk factors in each of the two groups. The RVS coefficient is significant at 0.525 in the low-analyst coverage group while insignificant at 0.162 in the high-analyst coverage group. Table 6 shows that a trading strategy based on RVS earns more abnormal returns in the low- analyst coverage group, suggesting that analysts can mitigate the inefficiency in reflecting the real option segment value.

5.3 The effect of corporate governance

To realize real option segment value, managers must exercise their options. Hwang and Sohn (2010) find that the superior return predictability of the real options model is more significant in a set of firms with a high probability of exercising liquidation options. To realize the real option value at the segment level, managers must make appropriate decisions to cut bad segments and expand good segments. However, the literature suggests that managers may do just the opposite, due to agency problems. Rajan et al. (2000) find that segments in a diversified firm compete for firm-level resources due to the agency problem and a diversified firm may compensate the loss segment by diverting resources from the profitable segment. Other studies suggest that the internal capital market may be inefficient (e.g., Shin and Stulz 1998; Scharfstein and Stein 2000; Lamont and Polk 2002). Although inefficient internal markets move funds from successful to unsuccessful segments, if managers exercise the real options of segments, internal funds should shift from unsuccessful to successful segments. Inefficient internal markets move funds in the opposite direction, therefore reducing the possibility that real option segment values are realized. Also, You (2014) proposes that diversified firms may manipulate earnings across segments, moving them from segments with low price-earnings ratios (PE) to those with high ratios, leading to a fake diversity of profitability among segments and fake real option segment value.

As good corporate governance can alleviate the agency problem and align the interests of managers and shareholders (Gompers et al. 2003), real option segment value is more likely to be realized for firms with good corporate governance. This reasoning suggests that real option segment value has more predictive power for firms with good corporate governance.

Table 6 The Real Option Value of Segments (RVS) and Abnormal Returns, Conditional on Analyst Following

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

Portfolios	Low analyst coverage (number of analysts < median)	High analyst coverage (number of analysts > median)
Lowest RVS	−0.518***	−0.051
	(−3.13)	(−0.39)
Highest RVS	0.501***	0.420
	(3.36)	(1.62)
Hedge returns	1.019***	0.471
	(4.57)	(1.62)

Panel B: Fama-MacBeth regressions

	Dependent variables	
Variables	Size-adjusted returns (%)	Size-adjusted returns (%)
	Low analyst coverage	High analyst coverage
R_RVS	0.525***	0.162
	(4.04)	(1.20)
R_SIZE	0.016	0.039
	(0.09)	(0.20)
R_BM	0.394**	−0.104
	(2.22)	(−0.59)
R_EP	0.593***	0.485
	(2.71)	(1.56)
R_ACC	−0.350***	−0.032
	(−2.66)	(−0.25)
RRAW_1	0.064***	0.023
	(2.99)	(0.83)
Constant	−0.807***	−0.440
	(−3.67)	(−1.54)
Obs	154,746	99,917
R^2	0.04	0.09

The sample is divided into two groups based on the number of analysts following the firm. Those firms with an analyst following higher (lower) than the median are defined as high- (low-) analyst coverage firms. In panel A, we present monthly size-adjusted returns for the portfolios with the lowest decile of RVS, the highest decile of RVS, and for the hedge portfolio. The returns are size-adjusted according to deciles of NYSE/AMEX/NASDAQ firms. In Panel B, we regress in each group the size-adjusted returns on rankings (ranking = 0 for firms in the lowest decile and = 1 for firms in the highest decile) of RVS and other factors in each month and report the time series means and t-statistics. Detailed definitions are given in Appendix Table 10. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

However, good corporate governance may also reduce the predictive power of real option segment value. The literature has documented that corporate governance can affect information asymmetry and information environment; this could enable investors to incorporate real option value more completely, leaving less to be reflected in future returns. Therefore it is an empirical question of whether and how corporate governance can affect the predictability of the real option value of segments.

We use the corporate governance index developed by Gompers et al. (2003) to test the effect. A higher index indicates more obstacles to good governance and weaker firm governance. The provision of governance in a firm is unlikely to change from year to year, and Gompers et al. (2003) do not calculate the index for every year. Within our sample period, the corporate governance index is calculated for the years 1990, 1993, 1995, 1998, 2000, 2002, 2004, and 2006. We interpolate the corporate governance index to cover the period from 1990 to 2006. For example, the corporate governance in year 1994 is calculated as the average of year 1993 and year 1995. We then merge the index with our whole sample. We 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 the bad (good) corporate governance group. We then use methods similar to those in Tables 2 and 3 to examine the abnormal returns associated with real option segment values in each group.

The empirical results appear in Table 7. In Panel A, we show for each group the time-series means and t-statistics for the size-adjusted monthly returns of extreme portfolios as well as the hedge portfolios based on RVS. In the good corporate governance group, the high-RVS portfolio earns a 0.972% size-adjusted monthly return, and the low-RVS portfolio earns a 0.009%. The hedge portfolio earns a 0.963% size-adjusted return. In contrast, in the bad corporate governance group, the high-RVS portfolio earns a 0.074% size-adjusted monthly return, and the low RVS portfolio earns a 0.343%. The hedge portfolio earns a − 0.269% size-adjusted monthly return. The hedge return in the good corporate governance group is significantly positive, while in the bad corporate governance group it is not significant and even negative. The difference between the hedge returns of the two groups is significant.

In Panel B, we run Fama-MacBeth regressions of the size-adjusted monthly returns on RVS and other risk factors in each of the two groups. The coefficient of RVS is a significant 0.760 in the good corporate governance group, while a significant −0.244 in the bad corporate governance group. The results in Panels A and B of Table 7 indicate that a trading strategy based on RVS earns more abnormal returns in the good corporate governance group, suggesting that good corporate governance motivates managers to exercise real option segment values that lead to predictable returns.

5.4 Exercising the real options of segments

Although real option segment values are not fully incorporated into the current market price, they are reflected in the future returns. It is therefore interesting to examine whether real options are exercised and how such actions affect a firm.

In Appendix 2, we offer the real case of Martha Stewart Living Omni Media Inc. (MSO), to illustrate how a company can exercise its real options and cut unprofitable segments while expanding its profitable segments. The financial information is collected from the MSO 10-Ks. The measurement unit is per thousand dollars. At the beginning of the period (2001), the merchandising segment had assets of $8265, far less than those of the internet segment ($32,039). However, far more operating income was produced by merchandising than the internet segment ($29,861 vs −24,030). In the following years, the merchandizing assets of the segment kept increasing (to $29,267 by 2005), and those of the internet segment kept decreasing (to $3819 by 2005). The pattern suggests that managers reallocated the assets in the internet segment to the merchandising segment, so the operating income from the merchandising segment increased and the loss from the internet segment decreased, leading to an overall performance improvement for the firm.

Table 7 The Real Option Value of Segments (RVS) and Abnormal Returns, Conditional on Corporate Governance

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	0.009	0.343
	(0.03)	(1.22)
Highest RVS	0.972**	0.074
	(2.48)	(0.19)
Hedge returns	0.963**	−0.269
	(2.01)	(−0.56)

Panel B: Fama-MacBeth Regressions

	Dependent variables	
Variables	**Size-adjusted returns (%)**	**Size-adjusted returns (%)**
	Good CG	**Bad CG**
R_RVS	0.760**	−0.244
	(2.53)	(−1.14)
R_SIZE	−0.268	−0.006
	(−0.55)	(−0.01)
R_BM	0.235	0.095
	(0.55)	(0.28)
R_EP	−0.237	0.392
	(−0.52)	(0.90)
R_ACC	−0.670**	−0.213
	(−2.20)	(−0.77)
RRAW_1	−0.015	−0.076*
	(−0.31)	(−1.66)
Constant	0.477	0.491
	(0.85)	(1.00)
Obs	18,484	19,278
R^2	0.11	0.10

The sample is divided into two groups based on the G-Index of the firm. Firms with a G-Index lower (higher) than the median are defined as good (bad) corporate governance firms. In panel A, we present monthly size-adjusted returns for the portfolios with the lowest decile of RVS, the highest decile of RVS, and for the hedge portfolio. The returns are size-adjusted according to deciles of NYSE/AMEX/NASDAQ firms. In Panel B, we regress in each group the size-adjusted returns on rankings (ranking = 0 for firms in the lowest decile and = 1 for firms in the highest decile) of RVS and other factors in each month and report the time-series means and t-statistics. Detailed definitions are given in Appendix Table 10. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

Chen and Zhang (2007) provide empirical evidence that firms exercise the real options of segments by divesting their segments. Real option segment values increase before divestment, and the positive market reaction to divestment is related to real option segment values. Their evidence is consistent with the view that the real options have been exercised through divestment. Giroud and Mueller (2015) provide evidence that firms reallocate scarce resources, such as capital and labor, to facilities with more investment opportunities.

In Panel A of Table 8, we run two regressions to empirically examine the realization of real option segment values. First, we examine whether high-RVS firms are more likely to expand profitable segments and contract unprofitable segments. For this purpose, we construct a variable (WAG) to measure the distribution of asset growths within the firm. Specifically, $WAG_{t+1} = \sum_i w_i (ag_i - \overline{ag}) + \sum_j w_j (\overline{ag} - ag_j)$, where ag_i is the asset growth of segment i from year t to t + 1; $\overline{ag}$ is the weighted average of segment asset growth for the diversified firm; subscript i (j) represents more (less) profitable segments—that is, segment ROA is higher (lower) than the firm-level ROA. The weight of the segment according to the segment asset is w. WAG indicates whether the firm expands more profitable segments relative to less profitable segments.

We regress WAG on RVS in year t and other control variables. The coefficient of RVS_t is significantly positive, suggesting that firms with high real option segment values expand more profitable segments relative to less profitable segments, consistent with the exercising of the real options of segments.

Second, 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 high real option segment values tend to decrease in future years, which is consistent when the real options of segments are exercised.

We examine whether the exercise of real options of segments leads to better future performance, as shown in Panel B of Table 8. We regress the change of earnings from year t to t + 1 on RVS_t or $DRVS_{t+1}$ and other control variables. Following Fama and French (2000), we include size, book-to-market, and change of earnings in the current year in the regressions. The change of earnings relates positively to RVS_t, suggesting that firms with high real options of segments are associated with positive earnings changes in the next year, consistent with the view that these firms exercised the real options, which led to higher earnings. The change of earnings also relates negatively related to $DRVS_{t+1}$, suggesting that the decrease in real option segment values and the exercise of real options leads to higher earnings.

Taken together, the results in Table 8 indicate that firms with high real option segment value will exercise the options at the segment level, which leads to future firm performance improvement.

5.5 The hedge returns around earnings announcement periods

If firms exercise the real options of segments and improve their earnings, the market can see an earnings increase and correct mispricing toward real option segment values. 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 can differentiate between mispricing and risk. If the abnormal returns are concentrated around the earnings announcement period, it is more likely to be mispriced as the risk will not easily change within a few days.

Table 8 The effects of exercising real options at the segment level

Panel A: The effect of RVS on the distribution of segment asset growths, and the change of RVS in the next year

Variables	Dependent variables	
	WAG_{t+1}	$DRVS_{t+1}$
RVS	0.081***	−0.436***
	(5.91)	(−12.49)
NSEG	−0.003***	0.009***
	(−4.57)	(8.25)
DNI	0.005	0.023***
	(0.66)	(2.99)
SIZE	0.002***	−0.004***
	(2.91)	(−6.08)
BM	−0.003	0.022***
	(−1.29)	(8.18)
LEV	−0.014*	0.036***
	(−1.86)	(7.12)
Constant	0.006	0.039***
	(0.49)	(5.65)
Industry FE	Controlled	Controlled
Year FE	Controlled	Controlled
Obs	20,651	19,849
Adjusted R^2	0.01	0.24

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

Variables	Dependent variables	
	DNI_{t+1}	DNI_{t+1}
RVS	0.139***	
	(4.10)	
DRVS		−0.304***
		(−10.46)
NSEG	−0.001**	0.001***
	(−2.41)	(2.87)
DNI	−0.143***	−0.136***
	(−3.10)	(−3.06)
SIZE	−0.003***	−0.004***
	(−3.84)	(−6.21)
BM	−0.038***	−0.031***
	(−5.53)	(−4.45)
LEV	0.010	0.021**
	(1.26)	(2.27)
Constant	0.040**	0.052**
	(2.23)	(2.49)
Industry FE	Controlled	Controlled

Table 8 (continued)

Year FE	Controlled	Controlled
Obs	19,849	19,849
Adjusted R^2	0.10	0.17

This table presents evidence that firms exercise the real options at the segment level and its effects on future firm performance. In Panel A, we present evidence that RVS affects the change of segment assets 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. WAG measures the distribution of asset growth in segments; RVS is the real option value of segments; 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; BM is the book-to-market ratio; and LEV is the leverage ratio. Detailed definitions are given in Appendix Table 10. Standard errors are clustered by firm and year (Gow et al. 2010). *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

In Table 9, we separately calculate abnormal returns for the RVS-based portfolios during the earnings announcement period and the non-earnings announcement period within one

Table 9 Hedge returns around the earnings announcements

Portfolios	Annual Returns (%)	Earnings Announcement Period Returns (%)	Non-Earnings Announcement Period Returns (%)
1 (Lowest RVS)	−4.864***	0.409	−5.129***
	(−3.93)	(1.64)	(−4.27)
2	−3.168**	0.476	−3.439***
	(−2.57)	(1.37)	(−2.8)
3	−1.701	0.717*	−2.525*
	(−1.19)	(1.81)	(−1.74)
4	−0.831	0.834**	−1.848
	(−0.57)	(2.65)	(−1.18)
5	1.26	1.508***	0.1
	(0.72)	(3.23)	(0.05)
6	0.112	0.735*	−0.643
	(0.07)	(1.92)	(−0.39)
7	2.873**	0.295	2.546*
	(2.1)	(0.84)	(1.85)
8	5.456***	1.034***	3.843**
	(2.92)	(3.03)	(2.01)
9	4.208**	0.98***	3.03
	(2.22)	(3.27)	(1.6)
10 (Highest RVS)	5.879**	1.467***	4.385*
	(2.47)	(3.86)	(1.81)
Hedge Returns	10.743***	1.058**	9.514***
	(4.00)	(2.33)	(3.52)

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 10 portfolios based on the decile breakpoints of RVS. 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 those in the earnings announcement period. Size-adjusted returns are estimated according to deciles of NYSE/AMEX/NASDAQ firms supplied by CRSP. Standard errors are clustered by firm and year. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively year following the portfolio formation. We require four quarterly earnings announcements within the following year.[14] 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 from days other than those in the earnings reporting period. The hedge portfolio earns a size-adjusted return of 1.058% during the three trading days around the earnings announcements. The total size-adjusted hedge return is 10.743% for one year. The abnormal returns around the earnings announcement are 9.84% of the total abnormal returns, while the trading days around the earnings announcement are only 4.8% of one year's trading days (assuming 250 trading days per year). The disproportionate concentration of hedge returns around earnings announcements is consistent with our arguments that the market does not fully reflect real option segment values and that the mispricing is partially remedied through future earnings announcements.

6 Conclusions

In this study, we apply a real options analysis to the segment level and examine the usefulness of real option segment values in predicting future returns. Forming portfolios based on the real option value of segments (RVS) yields an average 0.791% size-adjusted monthly return by buying firms with the highest RVS decile and selling those with the lowest RVS decile. The hedge returns are consistently positive in 26 out of the 33 sample years. The abnormal returns are robust after controlling for other risk factors. We also provide evidence that the real options of segments have larger values when growth opportunities mainly lie in the profitable segments. Our results indicate that real option segment value is an important component of firm value and that market prices do not fully reflect it.

Further investigation suggests that the predictability of RVS is more pronounced for firms with high growth, less analyst coverage, and good corporate governance. We also present evidence that firms exercise the real options of segments. Firms with high RVS tend to expand more profitable segments relative to less profitable segments, and that real option segment value tends to decrease in the following year. Exercising the real options of segments leads to increases in operating performance. We also show that the proportion of abnormal hedge returns around earnings announcement periods is relatively high, suggesting that market prices react to the increased performance.

Our study extends that of Chen and Zhang (2003) and suggests the importance of segment information. Together, the evidence suggests that part of the real option value at the segment level is incorporated into current stock prices and the remaining part is gradually incorporated into the stock prices, leading to a predictable pattern in the future return.

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

Appendix 1

Table 10 Variables definitions

Variables	Definitions
RVS	The real option value of segments, calculated as $\left(\sum\left[A_i{}^*\left\|ROA_i - \overline{ROA}\right\|\right]\right)/MV$ using the most recent financial information available, where A_i is the total assets for segment i, $ROA_i$is the return on assets in segment i, calculated as operating income (ops) divided by segment identifiable assets (ias); $\overline{ROA}$ is the firm- level aggregate ROA, and MV = prcc_f*csho.
DRVS	Change of RVS
NSEG	Number of segments
LGT	Firm-level growth opportunity, proxied by the consensus forecast of long-term growth rate from IBES.
WLTG	The heterogeneity of segment growth opportunities, $WLTG = \sum_i w_i(g_i - \overline{g}) + \sum_j w_j\left(\overline{g} - g_j\right)$, where g is the segment growth opportunity, proxied by the median of long-term growth forecasts for all focus firms in the same industry. $\overline{g}$ is the asset-weighted average of growth opportunity for the diversified firm. Subscript i (j) represents more (less) profitable segments—i.e., segment ROA is higher (lower) than the firm-level ROA. The weight of the segment according to the segment asset is w. WLTG > =0 (<0) indicates that growth opportunities mainly lie in the profitable (unprofitable) segments.
WAG	The distribution of asset growths within the firm, $WAG = \sum_i w_i(ag_i - \overline{ag}) + \sum_j w_j\left(\overline{ag} - ag_j\right)$, where ag_i is the asset growth of segment i from year t to t + 1. $\overline{ag}$ is the weighted average of segment asset growth for the diversified firm; Subscript i (j) represents more (less) profitable segments—i.e., segment ROA is higher (lower) than the firm-level ROA. w is the weight according to the segment asset. WAG indicates whether the firm expands more profitable segments relative to less profitable segments.
SIZE	Natural logarithm of equity market value, SIZE = log(prcc_f*csho)
BM	Book-to-market ratio, BM = ceq/(prcc_f*csho) if ceq > 0
CAPX	Capx investment, CAPX = capx/at
EP	Earnings-to-price ratio, EP = oibdp/(prcc_f*csho), where oibdp is operating income before depreciation
Accrual	Income before extraordinary items (ib) minus operating cash flow (oancf), or (Δact-Δche)-(Δlct-Δdlc-Δtxp-dp) before 1987, scaled by total assets
LEV	Sum of long-term debt (dltt) and short-term debt (dlc), scaled by total assets (at)
DNI	DNI is the change of earnings (ib), scaled by the market value at the previous year
RAW_1	Accumulative raw return in previous one year
RET	Monthly raw return
Sizeret	Monthly size-adjusted abnormal return

Appendix 2: A real case

This appendix gives an example of a firm exercising the real option value by downsizing its less profitable segment and expanding its more profitable 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. MSO expanded its more profitable segment, merchandising, and shrank its less profitable segment, internet.

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 exercising 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 … the additional revenue generated from the contractual minimums directly improves operating profit."

2. It is worth noting 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 the merchandising segment from $8871 k in 2002 to $22,547 k in 2003, almost a 200% increase, whereas the operating profit only increased from $32,972 k to $37,716 k

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