Journal of Business Research 132 (2021) 571–585

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

Exercising a firm's growth options: A portfolio approach

Pablo de Andrés [a], Gabriel de la Fuente [b], Pilar Velasco [b,*]

[a] Universidad Autónoma de Madrid and ECGI, Faculty of Economics and Business, Cantoblanco Campus, 28049 Madrid, Spain
[b] Universidad de Valladolid, Faculty of Economics and Business, Avenida Valle del Esgueva, 6, 47011 Valladolid, Spain

ARTICLE INFO

JEL classification:
L25
G32
D22
C25

Keywords:
Opportunity exploitation
Portfolio of businesses
Investment strategy
Options exercise
Real options

ABSTRACT

This paper investigates a firm's decision to exercise its growth options within the current scope of business. We contend that the point at which a firm chooses whether or not to exercise such options depends on several strategic characteristics associated to its portfolio of businesses (i.e. level of diversification, average volatility of its current business, relatedness among them, and rivalry in its core business). Using a sample of U.S. companies from 1998 to 2013, we find evidence that a firm's level of diversification and the volatility of its current business deter immediate growth option exercise. In contrast, relatedness and rivalry in its core business trigger growth options exercise. Our portfolio perspective differs from the bulk of the literature on real options, which evaluates each growth option exercise in isolation, and contributes to furthering knowledge on the drivers underlying a diversified firm's strategic investments.

1. Introduction

This study investigates a firm's decision concerning whether or not to exercise its growth options (hereinafter, GO) within the current scope of business. Prior literature has tended to explore the exercise of GO individually, overlooking the strategic characteristics associated to a firm's portfolio of businesses. Recent research surveys, such as Ipsmiller, Brouthers and Dikova (2019), urge the need to develop a portfolio perspective of option investments, a perspective which has remained largely overlooked. This paper seeks to narrow this gap by adopting a real options portfolio approach to rationalize the relationship between the risk features of the firm's whole set of businesses and the propensity to GO exercise. Our focus is on GO exercises not involving entry into a new business. By limiting our study to such investments, we discard those arising from the decision to enter a new business, whose determinants/antecedents may be of a different nature.

According to the real options (RO) approach, a firm's value is the sum of the value of its assets-in-place (AiP) and the value of its GO. Assets-in-place are full-scale currently operating businesses. GO are platforms for growth that provide the firm with a right, but not an obligation, to make a full-scale investment in the future. GO do not generate large cash flows, but limit a firm's commitment while conferring preferential access to future investment (Bowman & Hurry, 1993; Doh & Pearce, 2004; Kulatilaka & Perotti, 1998). The decision to exercise a growth option implies an irreversible full-scale investment (i.e., its exercise price) in exchange for the asset-in-place (underlying asset) that is added to the company's portfolio of business.

The decision concerning whether or not to exercise a firm's GO by materializing them into major investments (assets-in-place) and the factors affecting the value of such a decision are a central concern in strategic management literature. Previous studies that have adopted the RO approach have provided important insights by delving into the circumstances which may spark GO exercise in a wide range of contexts, such as new market entry (Brouthers & Dikova, 2010; Folta & O'Brien, 2004), venture capital (Ceccagnoli, Higgins, & Kang, 2018; Vrande & Vanhaverbeke, 2013), R&D investments (Huang & Jong, 2019; Huchzermeier & Loch, 2001), internationalization (Brouthers, Brouthers, & Werner, 2008; Rivoli & Salorio, 1996), or strategic alliances (Chi & McGuire, 1996; Estrada, Fuente, & Martin-Cruz, 2010).

This stream of literature focuses on the trade-off between the cash flows from an immediate and (to some degree) irreversible investment, and flexibility from exercise postponement (option to wait). Engaging in large sunk investments involves cash flows at the expense of sacrificing flexibility and increasing risk exposure. As a consequence, optimal timing is seen to depend on the irreversibility and risk of investment, lost cash flows that would have been generated if the firm had opted for immediate commitment, the threat of pre-emption in the underlying business, and whether or not the option is simple or compound,

* Corresponding author.
E-mail addresses: p.andres@uam.es (P. Andrés), gabriel.fuente@uva.es (G. Fuente), pilar.velasco@uva.es (P. Velasco).

https://doi.org/10.1016/j.jbusres.2021.04.074
Received 1 June 2020; Received in revised form 23 April 2021; Accepted 29 April 2021
Available online 15 May 2021

proprietary or shared (Miller & Folta, 2002).

One common feature of this prior literature is that GO exercise decisions are evaluated solely in terms of GO own characteristics, regardless of the portfolio of businesses in which they are embedded. However, GO are part of a broader portfolio at the corporate level, in which the current businesses (assets-in-place) and GO are interrelated and combine to maximize overall firm value. Studies such as Trigeorgis (1993), Vassolo, Anand and Folta (2004), and Yang, Narayanan and De Carolis (2014) show that GO are particularly interconnected, such that decisions taken on any single component impact the value of the others. Unlike financial call options, exercising a growth option may not only influence the value of its underlying real asset but also the value of other underlying GO projects within the same portfolio and even their exercise conditions.

Such an interrelation might intensify in the case of a diversified firm as a result of relations between the different businesses (Andrés, Fuente & Velasco, 2017b; Yang et al., 2014). Indeed, GO are seen to play a particular role in a diversified firm due to this sort of connection, as first stated by Raynor (2002), who argues that diversification strategies can have "option value" since they might create options on future synergies between businesses. This "options-based diversification" can add value, even if it fails to increase a firm's performance, in that it reduces risk in a way investors cannot replicate. The hedging role of GO within a portfolio of businesses is no longer a matter of spreading risk (as provided by business diversification), but about the possibility of developing strategic flexibility (Miller, 1998) in response to a declining market or an unpredictable failure of current assets-in-place, by investing in new projects whose performance might preserve a firm's prior returns (Yang et al., 2014).

A firm's economic exposure arises from a complex mixture of competitive, input supply, output demand, technological, and political risks (Miller, 1998). Such exposure affects all the current businesses in which the firm operates and, eventually, overall corporate performance. GO may help to hedge such external contingencies, thereby affecting a company's performance. On the one hand, GO are small 'bets' on potential growth. Undeveloped businesses frequently require intensive investments while delivering narrow sales and low or negative outcomes. By limiting its commitment to securing just a 'foot in the door' of such a business, the firm manages its exposure against certain contingencies. Hence, holding GO within the current scope of business might constitute a good way of undertaking a stepwise commitment in those industries and, therein, limiting downside risk while the firm develops the necessary experience and skills (Bowman & Hurry, 1993). On the other hand, GO maintain the potential for realizing large gains that might offset potential losses from other major full-scale segments. For example, depending on the actual direction of contingencies, a mature and so far profitable segment may decay and start to underperform. Under such circumstances, GO exercise could trigger their underlying businesses in order to generate sufficient gains to make up for such losses, thus reducing a firm's exposure to corporate risk.

Taking the portfolio of businesses as our baseline unit of analysis, we argue that GO exercise should depend on the risk characteristics of the diversified portfolio as a whole. If GO play a role as strategy insurance, exercising such GO would then be governed by the firm's overall risk. It is not just a question of moving from flexible positions to sunk investments (as might be the case in a financial call option), but of encompassing a broader set of considerations regarding the risk balance between AiP and GO within a diversified portfolio. In particular, we contend that the decision to exercise GO is contingent upon four different but interrelated dimensions of a firm's risk exposure: level of diversification, average volatility of its current businesses, relatedness between them, and rivalry in its core business.

Using a sample of U.S. companies from 1998 to 2013, we identify upticks in a firm's level of investment which are likely to signal GO exercise. To do so, and following prior literature (Grullon, Lyandres, & Zhadanov, 2012; Lee, Park, & Folta, 2018), we apply the spike concept by Whited (2006), which refers to firm-years of abnormally high investment activity, and we also require a significant decrease in a firm's GO relevance the year following the spike in order to ensure that those investments arise from exercising previously held GO. We exclude those non-option strategies based on setting up a new business through an immediate full commitment of resources in order to restrict our focus to those large investments arising from previously underdeveloped entries undertaken by the company. Therefore, we focus on large investments within the existing scope of businesses and that do not coincide with a new diversifying entry. In order to better identify this event, we apply Whited's (2006) different thresholds to pinpoint a large investment, the requirement of a firm's number of segments to remain unchanged and a significant reduction in a firm's GO relevance, signalling options exercise. Consistent with our hypotheses, we find that a firm's degree of diversification and the average volatility of its businesses deter GO exercise, whereas relatedness of a firm's businesses and rivalry in its core business positively drive investment decisions.

The remainder of the paper is organized as follows. The second section sets out the literature review and our hypotheses. The next section describes the sample, variables and econometric methodology. The following section presents our main empirical findings and robustness analyses. The last section discusses and concludes.

2. Literature review and hypotheses

Through RO lenses, a distinction can be drawn between two types of investments within a diversified portfolio of a given set of businesses: AiP and GO. AiP are full-scale committed investments and comprise the main current businesses in which a firm operates. In contrast, GO are minor commitments in businesses that could be expanded at some point in the future. AiP are the main source of cash for firms and enable them to exploit economies of scale and scope. However, they have limited or null flexibility value (Smit & Trigeorgis, 2009). The threat of a future decline in a firm's AiP performance encourages managers to invest in platforms for future growth. GO provide such platforms, whose exercise would offset a future decline in AiP performance. Therefore, GO establish a threshold limit to downside risk ('strategic insurance' (Raynor, 2002)), albeit at the expense of cost-scale efficiency. Given these different properties, there should be an optimal combination of AiP and GO that maximizes performance from current full-scale businesses (AiP) whilst hedging against an uncertain future through GO. Such an optimal balance of AiP and GO would thus explain GO exercise and is likely to be affected by the risk the firm is exposed to.

Risk exposure of a firm's portfolio of existing businesses is taken to be a main driver of strategic decisions. In fact, risk management is recognized as lying at the heart of corporate strategy (Bettis, 1983) and as a main factor driving a better understanding of a firm's success and failure (Lane, Cannella, & Lubatkin, 1998). Even if investors are able to replicate corporate diversification in their own portfolios, this holds true for at least two reasons. First, some stakeholders other than shareholders

(such as managers, employees, customers or suppliers) often hold undiversified portfolios with a large portion of their non-financial wealth invested in the firm. Moreover, many of their investments in the company are firm-specific since they cannot be redeployed to other business settings without a significant loss in value (Wang, Barney, & Reuer, 2003). In this regard, Wang et al. (2003) stress the importance of a firm's risk management vis-à-vis reducing the probability of financial distress and, as a result, stimulating additional firm-specific investments from its stakeholders. These investments are of paramount importance since they are usually a key source of competitive advantage and a platform for value creation (Lim & Wang, 2007; Miller, 1998; Wang et al., 2003).

Second, the risk that determines a firm's market value is not equivalent to the risk that is relevant for investment portfolio selection. Securities investors cannot usually affect the expected cash flows from each asset in their portfolio. This should not be the case for a firm and its portfolio of businesses, where midcourse strategic decisions are adopted to shape cash flows –increasing gains and limiting losses– in response to how uncertain events unfold (Bowman & Hurry, 1993; Lubatkin & Chatterjee, 1994). This capacity to affect a firm's cash flows is cornerstone to the RO approach, and offers a view of strategies that is closer to actual decision processes.

One key tool for managing the whole range of risk exposures across a firm's portfolio of businesses is GO. In contrast to AiP diversification, which relies on volatility reduction by combining uncorrelated full-scale assets within a portfolio, GO provide strategic hedging for corporate downside risk by developing flexibility (Andrés, Fuente, & Velasco, 2017a; Miller, 1998; Raynor, 2002). GO offer the possibility of taking advantage of current foothold investments in the event that full-scale, mature businesses become exhausted (Miller & Waller, 2003). By exercising its GO, a firm seeks to maintain above-average returns should their products become obsolete or simply less competitive as a result of unexpected shifts in demand, competitors' decisions, or government regulations, among others (Miller, 1998; Williamson, 2001).

Both AiP diversification itself and GO can allow a firm to reduce its dependence on the uncertainty of any single industry, albeit differently. By combining two or more negatively correlated (or weakly correlated) businesses, diversification helps to smooth a firm's income stream, thereby reducing its return volatility. This risk-reducing outcome stems from an overall averaging effect. By contrast, GO allow a firm to reduce its exposure to economic slumps in any of its main full-scale businesses. In the event of economic downturns, GO provide managers with the ability to intervene by investing in developing businesses. Therefore, the main outcome from GO emerges in the form of minimizing a firm's downside risk (Del Viva, Kasanen, & Trigeorgis, 2017; Miller, 1998; Raynor, 2002). Corporate risk is also reduced, but as a result of the greater flexibility to respond to environmental uncertainties in a timely fashion.[1]

Based on this different role played by AiP diversification and GO, we can expect both strategies to be complementary in hedging a firm's risk exposure. As a consequence, the decision regarding whether or not to exercise a firm's GO will depend on the characteristics of its portfolio of businesses as a whole. In particular, we consider four risk features which can impact the propensity to GO exercise: a firm's level of diversification, the average volatility of its current business, the relatedness among them, and rivalry in its core business.

First, managers can reduce a firm's idiosyncratic risk by distributing its resources across the various full-scale businesses. However, the greater the range of these businesses within a firm's portfolio (i.e. the diversification level), the greater the number of GO needed to hedge their possible failure. Greater diversification implies a lower volatility of a firm's income stream, but also a wider scope of market positions that need to be covered by GO in order to limit downside risk. As a result, we expect a negative relationship between the degree of diversification and a firm's GO exercise decision. A reduction in the range of businesses releases the need for GO hedging and, therefore, encourages GO exercise. Hypothesis 1 posits this relationship:

H1. The lower (higher) the degree of diversification, the more (less) likely a GO exercise is to occur.

A second variable which might determine the weight of a firm's GO within its diversified portfolio is the average volatility of its AiP. Lower AiP volatility might encourage GO exercise. Holding unexercised GO will provide insurance against exposure to environmental and industry uncertainties and therefore be preferable to option exercise. Consistent with this argument, Lyandres and Zhdanov (2013) confirm that the mix of AiP and GO is an important determinant in the likelihood of survival, particularly because a firm's GO portfolio value alleviates the risk of default. As a consequence, the lower the volatility of a firm's current businesses, the less necessary and valuable its GO in order to provide a response to changeable environmental contingencies. Accordingly, we propose Hypothesis 2:

H2. The lower (greater) the average volatility of a firm's businesses, the more (less) likely a GO exercise is to occur.

Another important characteristic of a firm's portfolio of business that is likely to influence GO exercise is diversification relatedness. Related diversification is considered to outperform unrelated diversification (Becerra, 2009; Markides & Williamson, 1994; Schommer, Richter, & Karna, 2019) since it can take greater advantage of synergies across multiple divisions, thus alleviating the threat of a future decline in AiP and reducing a firm's need to hedge through GO. Lubatkin and Chatterjee (1994) argue that relatedness provides synergies that other diversification types cannot, and that these advantages allow the firm to respond more effectively, and in a more timely manner, to environmental uncertainties.

Complementarily, related diversification fosters firm flexibility through inter-temporal economies of scope from resource redeployment between businesses over time, which can play a further substitutive role of the flexibility granted by GO to hedge corporate exposure in response to future shocks to the firm. Such an internal reallocation advantage favours the most attractive use of corporate resources, which proves less costly and less irreversible the more related those business units are (Helfat & Eisenhardt, 2004; Sakhartov & Folta, 2014). Relatedness reduces the costs required to shift resources from one business to another existing one and makes it easier to reverse resource allocation (if required) in the future, thus increasing its flexibility to respond to environmental pressures (Dickler & Folta, 2020). Recent research has pointed to the hedging role of redeployability within existing business units of a diversified firm (Aivazian, Rahaman, & Zhou, 2019; Lieberman, Lee, & Folta, 2017). For example, Lieberman et al. (2017) find that redeployability reduces the cost of failure in businesses and promotes experimentation within them because the potential of internal reallocation entails lower sunk costs and facilitates exits. Since this complementary flexibility granted by redeployability across related businesses reduces dependency on any single business, fewer GO need to be held and the more likely it is that GO exercise will occur. Accordingly, we state Hypothesis 3:

H3. The more (less) related the diversification, the more (less) likely a GO exercise is to occur.

[1] While spreading risk could be replicated by financial investors, skewness from GO (only exercised in the case of positive outcomes) provides a strategy insurance against unexpected change, such as those emerging from technological innovation and competitive dynamics, which cannot be replicated with a portfolio of focused firms (Raynor, 2002). Recent research reveals that financial investors might be rationally willing to accept lower average returns in exchange for skewness (Mitton & Vorkink, 2007). In accordance with such rational preferences, Del Viva et al. (2017) show that investors try to increase their portfolio skewness by including a number of stocks with more GO.

Our last proposed dimension of a firm's diversified portfolio that is likely to affect its GO exercise is rivalry in its core business. Strategic management literature has often drawn on measures of risk as proposed by the financial portfolio theory that might not fully correspond to the risk concept which non-financial stakeholders are concerned with. While efficiently diversified investors might pay attention to measures of return volatility, other stakeholders may be more interested in the likelihood of creating and maintaining superior levels of performance in their firms (Ruefli, Collins, & Lacugna, 1999), which directly depend on rivalry in their core businesses. Prior literature suggests the relevance of rivalry in explaining corporate-level resource allocations (McGrath, Chen, & Macmillan, 1998; Morandi-Stagni, Santaló, & Giarratana, 2020). A firm can intensify GO exercise in its secondary industries as a means of compensating declining performance in its core business (Miller, 2004; Penrose, 1959; Rumelt, 1974).

Aguerrevere (2009) points out that the strategic behaviour of market participants shapes the relative importance of AiP and GO on a firm's value. Similarly, recent research such as Décaire, Gilje and Taillard (2020) shows that real options exercises are related to peer exercise behaviour. Meslier, Tacneng and Tarazi (2014) and Vo (2017) show that increased competition usually operates as a signal of such a threat of decline, thereby triggering GO exploitation. By GO exercise in its minor industries, a firm reduces its dependence on its core business and is able to acquire competitive advantages from synergistic interrelationships. This allows the firm to mobilize advantages such as low cost, high buyer loyalty or administrative know-how (Lubatkin & Chatterjee, 1994) in order to offset some of the disadvantages stemming from greater rivalry. These competitive advantages allow the firm to uphold its market positions against its rivals in alternative industries in which the firm is already operating, thereby reducing its exposure in the core business. Consistent with these arguments, recent studies such as Ljubownikow and Ang (2020), support the notion that firms shape their diversification strategy as a strategic response in an effort to escape greater competitive intensity. Following on from these arguments, rivalry in a firm's core business of a diversified firm is likely to accelerate engagement in its embryonic businesses, prompting GO exercise decisions. Thus, we hypothesize:

H4. The greater (lower) the rivalry in a firm's core business, the more (less) likely a GO exercise is to occur.

3. Research design: Data, variables and econometric model

3.1. Dataset and sample selection

Our empirical analysis departs from an unbalanced panel sample of U.S. listed companies from 1998 through 2013. Our initial sample covers all publicly traded U.S. companies included in the Worldscope database for that period. Our dataset comprises both active and inactive firms to mitigate potential survivorship bias. We obtain annual firm data from Worldscope and market data from Datastream. These databases are accessed through Thomson One package by Thomson Reuters, which offers full coverage of U.S. companies filing with the Securities Exchange Commission. Additionally, we collect industry information from the U.S. Census Bureau (Statistics of U.S. Businesses), which provides annual data for U.S. business establishments by geography, industry, and enterprise size.

Following prior literature, we use Berger and Ofek's (1995) criteria to select the sample. Accordingly, we exclude firm-years with any business segment in the financial industry (SIC codes 6000–6999) or with non-positive sales. We discard observations containing missing data on total capital, total sales, and segment-level sales. We also restrict our sample to those firm-years with total sales greater than or equal to $20 million, and whose sum of segment sales is within the 99–101% range of the firm's reported total sales. Finally, we rule out firm-years with missing values for our model variables as well as those reporting only one business segment[2], since relatedness can only be calculated for diversified firms. Our final panel sample for estimating our full models consists of 8524 firm-year observations corresponding to 1499 firms (1438 active firms and 61 inactive firms). To mitigate outlier problems, we winsorize our continuous variables at the 1% and 99% levels.

3.2. Variables

One key issue in our study is to capture whether or not a firm pursues GO exercises in a given year. According to previous literature, such as Grullon et al. (2012) and Lee et al. (2018), GO exercise is captured by investment spikes, which are upticks in a firm's level of investment. Following those studies, we draw on Whited's spike concept (2006) that identifies firm-years of abnormally high investment activity. The first problem to tackle is how to delimit the levels of investment that may signal GO exercise, since firms may also invest certain amounts each period for other reasons, such as maintaining or creating new GO. According to Whited (2006), an investment spike occurs if the ratio of investment to total assets is alternatively two or three times greater than the firm-median of said ratio.[3] Moreover, in order to avoid mixing evidence from GO exercise and GO creation, we discard those investments whose main outcomes are new GO. Accordingly, we only select those spikes that lead to a significant reduction in a firm's GO value. In particular, we require a firm's Tobin Q to decrease the year following the investment spike. Moreover, such a variation in absolute terms must be equal to or above the sample median.[4]

Secondly, we need to isolate those large investments within the existing scope of businesses that do not coincide with entry into a new business. As explained earlier, this is a key issue for our research purpose in order to avoid noise in our analyses and discard those diversification patterns based on full-scale initial investments, which previous works have shown to be inconsistent with a real-option logic of investment (Andrés et al., 2017a; Bowman & Hurry, 1993). With this aim in mind, for a spike to be considered as an option exercise, we require the firm's number of businesses to remain unchanged relative to the period before the spike. In this way, we ensure that the options being exercised come from a strategy pursued by the company within its portfolio of businesses and, therefore, that the abnormal level of investment is not simply the result of setting up a new business.[5] To compute the number of businesses, we employ disaggregation of industries at the 3-digit and 2-digit SIC code level alternatively to check the robustness of our results. We avoid using the 4-digit SIC code classification since such narrower segment data is more likely to suffer from managerial discretion due to the closer similarity between some of the industries, thus leading to a more inconsistent definition of the business segment over time (Folta & O'Brien, 2004; Villalonga, 2004).

Taking these criteria, we define two sets of alternative specifications of our dependent variable (GO exercise, *EXERCISE*). On the one side, based on 3-digit SIC codes, we define: *EXERCISE2_3d* (*EXERCISE3_3d*), which equals 1 if the firm's ratio of capital expenditures to total assets is two times (three times) greater than the firm-median, and the number of segments at the 3-digit SIC code level remains constant, and 0 otherwise.

[2] In order to avoid severe restrictions in the number of observations in our sample, we consider businesses at the 4-digit SIC code level when applying this filter.

[3] Results remain robust when applying Whited's (2006) alternative investment threshold of 2.5 times greater than the firm-median. Results are available upon request.

[4] As a result of this requirement for computing our dependent variable, our sample for estimation purposes is restricted to the period 1998–2012.

[5] Note that even GO exercises which do not involve entry into a new business imply modifying the level of a firm's diversification and relatedness, since such investments affect sales distribution among current businesses. We thank a reviewer's suggestion for highlighting this issue.

Table 1
Distribution of GO exercises over the sample years.

	EXERCISE2_3d		EXERCISE3_3d	
Year	no. EXERCISE2_3d = 1	% EXERCISE2_3d = 1	no. EXERCISE3_3d = 1	% EXERCISE3_3d = 1
1998	0	0.00	0	0.00
1999	125	15.06	47	12.88
2000	120	14.46	75	20.55
2001	110	13.25	48	13.15
2002	45	5.42	18	4.93
2003	16	1.93	7	1.92
2004	43	5.18	14	3.84
2005	38	4.58	13	3.56
2006	53	6.39	27	7.40
2007	83	10.00	35	9.59
2008	79	9.52	31	8.49
2009	18	2.17	10	2.74
2010	27	3.25	11	3.01
2011	44	5.30	16	4.38
2012	29	3.49	13	3.56
TOTAL	830	100	365	100
	EXERCISE2_2d		**EXERCISE3_2d**	
Year	**no. EXERCISE2_2d = 1**	**% EXERCISE2_2d = 1**	**no. EXERCISE3_2d = 1**	**% EXERCISE3_2d = 1**
1998	0	0.00	0	0.00
1999	127	15.07	48	12.97
2000	123	14.59	76	20.54
2001	114	13.52	50	13.51
2002	46	5.46	19	5.14
2003	16	1.90	7	1.89
2004	43	5.10	14	3.78
2005	38	4.51	13	3.51
2006	55	6.52	27	7.30
2007	83	9.85	35	9.46
2008	79	9.37	31	8.38
2009	18	2.14	10	2.70
2010	27	3.20	11	2.97
2011	45	5.34	16	4.32
2012	29	3.44	13	3.51
TOTAL	843	100	370	100

This table contains GO exercise distribution (number and percentage of firm-year observations displaying a GO exercise). The variables *EXERCISE2_3d*, *EXERCISE 3_3d*, *EXERCISE 2_2d* and *EXERCISE 3_2d* are the alternative proxies for the occurrence of a GO exercise based on different thresholds (a firm's ratio of CAPEX to assets greater than two or three times the firm median) and the different SIC industry classification (either 3-digit or 2-digit SIC code levels). *EXERCISE2_3d* is equal to 1 if the firm's ratio of capital expenditures to total assets is two times greater than the firm-median and the number of 3-digit SIC code segments remains constant, and 0 otherwise. *EXERCISE3_3d*, equals 1 if the firm's ratio of capital expenditures to total assets is three times greater than the firm-median and the number of 3-digit SIC code segments remains constant, and 0 otherwise. *EXERCISE2_2d* is equal to 1 if the firm's ratio of capital expenditures to total assets is two times greater than the firm-median and the number of 2-digit SIC code segments remains constant, and 0 otherwise. *EXERCISE3_2d*, takes the value of 1 if the firm's ratio of capital expenditures to total assets is three times greater than the firm-median and the number of 2-digit SIC code segments remains constant, and 0 otherwise. In all of them, we select only those spikes leading to a decrease in a firm's Tobin Q the year following the investment spike, and such a variation in absolute terms must be equal to or above the sample median.

On the other, from a broader industry classification such as the 2-digit SIC code, we apply this same logic to define *EXERCISE2_2d* and *EXERCISE3_2d*, alternatively.

To measure a firm's level of diversification (*DIVERSIF*), we employ the total entropy measure (Jacquemin & Berry, 1979):

$$DIVERSIF = \sum_{s=1}^{n} P_s \times \ln\left(\frac{1}{P_s}\right)$$

where 'P_s' is the proportion of a firm's sales in business '*s*' for a corporation with '*n*' different 4-digit SIC segments. The higher the *DIVERSIF*, the greater the diversification.

The volatility of a firm's businesses (*VOL*) is calculated as the average of the volatility of the different 2-digit SIC code sectors in which the firm operates, weighted by the proportion of the firm's sales allocated in each sector. The volatility of each 2-digit SIC code sector is measured as the average of the volatility of all unisegment firms operating in that industry. Consistent with prior studies, such as Grullon et al. (2012), we estimate a firm's annual volatility as the standard deviation of the firm's daily returns during year *t*.

As far as relatedness is concerned, prior literature considers a multisegment company as related diversified when its divisions belong to the same 2-digit SIC industry. Following Robins & Wiersema (2003), we measure relatedness (*RELATED*) from total entropy measure, which is split into unrelated and related entropy:

$$RELATED = DIVERSIF - UNRELATED$$

Table 2
Correlation matrix between GO exercise and measures of growth opportunities.

	EXERCISE2_3d	EXERCISE3_3d	EXERCISE2_2d	EXERCISE3_2d	$MBAR_{t-2}$	$MBAR_{t-1}$	$MBAR_t$	$MBAR_{t+1}$	$MBAR_{t+2}$	Q_{t-2}	Q_{t-1}	Q_t	Q_{t+1}	Q_{t+2}
EXERCISE2_3d	1.0000													
EXERCISE3_3d	0.6574***	1.0000												
EXERCISE2_2d	0.9908***	0.6503***	1.000											
EXERCISE3_2d	0.6508***	0.9904***	0.6566***	1.000										
$MBAR_{t-2}$	0.0574***	0.0329***	0.0580***	0.0329***	1.000									
$MBAR_{t-1}$	0.0734***	0.0482***	0.0745***	0.0486***	0.8698***	1.000								
$MBAR_t$	0.0648***	0.0447***	0.0665***	0.0455***	0.7932***	0.8699***	1.000							
$MBAR_{t+1}$	−0.0243***	−0.0130*	−0.0233***	−0.0122*	0.7432***	0.7845***	0.8611***	1.000						
$MBAR_{t+2}$	−0.0290***	−0.0224***	−0.0282***	−0.0224***	0.6891***	0.7378***	0.7983***	0.8865***	1.000					
Q_{t-2}	0.0500***	0.0290***	0.0506***	0.0289***	0.9963***	0.8653***	0.7893***	0.7345***	0.6866***	1.000				
Q_{t-1}	0.0651***	0.0422***	0.0663***	0.0424***	0.8657***	0.9960***	0.8653***	0.7803***	0.7345***	0.8689***	1.000			
Q_t	0.0587***	0.0475***	0.0605***	0.0405***	0.7874***	0.8651***	0.9956***	0.8568***	0.7930***	0.7913***	0.8687***	1.000		
Q_{t+1}	−0.0318***	−0.0188***	−0.0308***	−0.0182**	0.7374***	0.7790***	0.8558***	0.9944***	0.8797***	0.7415***	0.7826***	0.8607***	1.000	
Q_{t+2}	−0.0364***	−0.0265***	−0.0357***	−0.0267***	0.6845***	0.7322***	0.7931***	0.8813***	0.9928***	0.6894***	0.7370***	0.7976***	0.8863***	1.000

This table presents the pairwise correlations between the (lags, present and lead values) of growth opportunities and large investments. *EXERCISE2_3d*, *EXERCISE3_3d*, *EXERCISE2_2d* and *EXERCISE3_2d* are the alternative proxies for the occurrence of a GO exercise based on different thresholds (a firm's ratio of CAPEX to assets greater than two or three times the firm median) and the different SIC industry classification (either 3-digit or 2-digit SIC code levels). In all of them, we select only those spikes that lead to a decrease in a firm's Tobin Q the year following the investment spike, and such a variation in absolute terms must be equal to or above the sample median. *MBAR* and *Q* are proxies for growth opportunities. *MBAR* is the market-to-book assets ratio as defined by Adam and Goyal (2008) and *Q* is Tobin's Q as computed in Cao et al. (2008). ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 3
Descriptive statistics and correlation matrix for explanatory variables.

	N	Mean	Median	Std. deviat.	Min.	Max.	DIVERSIF	VOL	RELATED	RIVAL	SIZE	LEVERAGE	GDPgrowth	INDUSTRYgrowth
DIVERSIF	8,524	0.6043	0.6193	0.2952	0.0001	1.3002	1.000							
VOL	8,524	0.2476	0.0775	0.6498	0.0198	4.6726	0.0047	1.000						
RELATED	8,524	0.2486	0.0000	0.3064	0.0000	1.0979	0.4143***	−0.0143	1.000					
RIVAL	8,524	10.397	9.924	1.4647	6.9726	13.099	−0.0549***	0.1075***	0.0052	1.000				
SIZE	8,524	6.5136	6.5589	1.9712	2.2976	10.495	0.1686***	0.0231**	0.1265***	−0.2007***	1.000			
LEVERAGE	8,524	0.2430	0.2232	0.2011	0.0000	1.0495	−0.0391***	−0.0086	−0.0302***	−0.0959***	0.1302***	1.000		
GDPgrowth	8,524	0.0238	0.0250	0.0180	−0.0280	0.0470	0.0054	−0.0171	0.0295**	0.0102	−0.1015***	0.0304**	1.000	
INDUSTRYgrowth	8,524	0.1181	0.0885	0.9909	−0.9651	40.271	−0.0086	−0.0132	−0.0072	0.0190*	−0.0200*	0.0079	0.0834***	1.000

This table provides the main summary descriptive statistics and pairwise correlations for the explanatory variables. *VOL* is the volatility of a firm's portfolio of businesses and is computed as the average of the volatility of the different 2-digit SIC code sectors in which the firm operates, weighted by the proportion of the firm's sales allocated in each sector. *RIVAL* denotes rivalry in the core business and is calculated as the natural logarithm of the number of firms operating in the same 2-digit SIC code industry as the core business of the corresponding firm. *DIVERSIF* measures a firm's level of diversification and is taken as the total entropy index by Jacquemin and Berry (1979). *RELATED* denotes the degree of relatedness between businesses and is Jacquemin and Berry's (1979) related entropy index. Control variables: *SIZE*, calculated as the natural logarithm of book value of total assets; *LEVERAGE*, measured by the ratio of total debt to total assets; *GDPgrowth*, calculated as the U.S. gross domestic product annual change based on 2009 dollars; and *INDUSTRYgrowth*, measured by the annual growth rate of a firm's 2-digit primary industry. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 4
Difference of means tests between GO exercise and non-GO exercise firm-year observations.

Panel A: Difference of means test with *DIVERSIF*					
EXERCISE2_3d = 0	EXERCISE2_3d = 1	Difference	EXERCISE3_3d = 0	EXERCISE3_3d = 1	Difference
(1)	(2)	(1)-(2)	(1)	(2)	(1)-(2)
0.1931	0.1502	0.0429***	0.1925	0.1351	0.0574***
		(3.7174)			(3.3258)
EXERCISE2_2d = 0	EXERCISE2_2d = 1	Difference	EXERCISE3_2d = 0	EXERCISE3_2d = 1	Difference
(1)	(2)	(1)-(2)	(1)	(2)	(1)-(2)
0.1929	0.1543	0.0386***	0.1925	0.1386	0.0539***
		(3.3704)			(3.1469)
Panel B: Difference of means test with *VOL*					
EXERCISE2_3d = 0	EXERCISE2_3d = 1	Difference	EXERCISE3_3d = 0	EXERCISE3_3d = 1	Difference
(1)	(2)	(1)-(2)	(1)	(2)	(1)-(2)
0.2419	0.2126	0.0293	0.2418	0.1801	0.0617*
		(1.2876)			(1.8115)
EXERCISE2_2d = 0	EXERCISE2_2d = 1	Difference	EXERCISE3_2d = 0	EXERCISE3_2d = 1	Difference
(1)	(2)	(1)-(2)	(1)	(2)	(1)-(2)
0.2419	0.2121	0.0298	0.2418	0.1806	0.0612*
		(1.3174)			(1.8102)
Panel C: Difference of means test with *RELATED*					
EXERCISE2_3d = 0	EXERCISE2_3d = 1	Difference	EXERCISE3_3d = 0	EXERCISE3_3d = 1	Difference
(1)	(2)	(1)-(2)	(1)	(2)	(1)-(2)
0.2466	0.2688	−0.0222	0.2469	0.2658	−0.0189
		(-1.0596)			(-0.5959)
EXERCISE2_2d = 0	EXERCISE2_2d = 1	Difference	EXERCISE3_2d = 0	EXERCISE3_2d = 1	Difference
(1)	(2)	(1)-(2)	(1)	(2)	(1)-(2)
0.2464	0.2745	−0.0281	0.2469	0.2735	−0.0266
		(-1.3755)			(-0.8597)
Panel D: Difference of means test with *RIVAL*					
EXERCISE2_3d = 0	EXERCISE2_3d = 1	Difference	EXERCISE3_3d = 0	EXERCISE3_3d = 1	Difference
(1)	(2)	(1)-(2)	(1)	(2)	(1)-(2)
10.5314	10.6576	−0.1262**	10.5326	10.7266	−0.1940**
		(-2.3462)			(-2.4157)
EXERCISE2_2d = 0	EXERCISE2_2d = 1	Difference	EXERCISE3_2d = 0	EXERCISE3_2d = 1	Difference
(1)	(2)	(1)-(2)	(1)	(2)	(1)-(2)
10.5312	10.6611	−0.1299**	10.5325	10.7333	−0.2008**
		(-2.4321)			(-2.517)

This table shows the difference of means tests for the different explanatory variables between firm years in which there is a GO exercise and those in which there is not. *EXERCISE2_3d*, *EXERCISE3_3d*, *EXERCISE2_2d* and *EXERCISE3_2d* are the alternative proxies for the occurrence of a GO exercise based on different thresholds (a firm's ratio of CAPEX to assets greater than two or three times the firm median) and the different SIC industry classification (either 3-digit or 2-digit SIC code levels). In all of them, we only select those spikes that lead to a decrease in a firm's Tobin Q the year following the investment spike, and such a variation in absolute terms must be equal to or above the sample median. Panel A contains the difference of means tests for *VOL*, the volatility of a firm's portfolio of businesses, which is computed as the average of the volatility of the different 2-digit SIC code sectors in which the firm operates, weighted by the proportion of the firm's sales allocated in each sector. Panel B shows the difference of means tests for the variable *RIVAL*, which denotes rivalry at the core business and is calculated as the natural logarithm of the number of firms operating in the same 2-digit SIC code industry as the core business of the corresponding firm. Panel C comprises the difference of mean tests for *DIVERSIF*, which denotes a firm's degree of diversification and is taken as the total entropy index by Jacquemin and Berry (1979). Panel D displays the difference of means tests for *RELATED*, the degree of relatedness between businesses measured by Jacquemin and Berry's related entropy index. t-statistics are in parentheses. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

where $UNRELATED = \sum_{r=1}^{m} P_r \times \ln(\frac{1}{P_r})$ and 'P_r' is the proportion of a firm's sales in business 'r' for a corporation with 'm' different 2-digit SIC segments.

Following Folta & Miller (2002), we compute the degree of rivalry in a firm's core business (*RIVAL*) by the number of rivals actively operating in the same product domain. *RIVAL* is calculated as the natural logarithm of the number of firms operating in the same 2-digit SIC code industry as the core business of the corresponding firm. We gather yearly data on the total number of U.S. firms by NAICS codes from the U.S. Census Bureau and then match NAICS codes to SIC codes.

Finally, we include a set of control variables that are of paramount importance for corporate investment decisions: a firm's size, a firm's leverage, gross domestic product growth, and industry growth. We proxy size (*SIZE*) by the natural logarithm of the book value of total assets. Since large firms hold fewer unexercised options, the larger a firm, the lower the probability of exercising additional GO (Bernardo & Chowdhry, 2002). Leverage (*LEVERAGE*) is measured by the ratio of total debt to total assets. The higher the leverage, the lower the financial flexibility to exploit further GOs. Moreover, Myers (1977) notices that debt may lead to valuable investment opportunities being passed up, especially when debt matures after GO expire. Finally, gross domestic

Table 5
Baseline model (Eq. (1)).

Variables	Dependent variable: EXERCISE2_2d				Dependent variable: EXERCISE3_2d			
	(1)		(2)		(3)		(4)	
	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect
Intercept	−1.8957***		−0.9463		−1.7733***		−1.7859	
	(0.2765)		(0.8624)		(0.4018)		(1.2401)	
DIVERSIF	−0.2311*	−0.0121*	−0.2334*	−0.0107*	−0.4851***	−0.0098***	−0.5061***	−0.0086***
	(0.1242)	(0.0065)	(0.1300)	(0.0060)	(0.1794)	(0.0037)	(0.1818)	(0.0033)
VOL	−0.1469**	−0.0077**	−0.1018*	−0.0047*	−0.0996	−0.0020	−0.0497	−0.0008
	(0.0668)	(0.0035)	(0.0613)	(0.0028)	(0.0906)	(0.0018)	(0.0792)	(0.0014)
RELATED	0.2845***	0.0149***	0.2355**	0.0108**	0.3936**	0.0079**	0.3668**	0.0062**
	(0.1099)	(0.0058)	(0.1134)	(0.0052)	(0.1602)	(0.0032)	(0.1639)	(0.0028)
RIVAL	0.0618***	0.0032***	0.0579***	0.0027***	0.0601**	0.0012**	0.0572*	0.0010*
	(0.0202)	(0.0010)	(0.0211)	(0.0010)	(0.0291)	(0.0006)	(0.0298)	(0.0005)
Controls								
SIZE	−0.0913***	−0.0048***	−0.0902***	−0.0042***	−0.1571***	−0.0032***	−0.1610***	−0.0027***
	(0.0173)	(0.0009)	(0.0184)	(0.0008)	(0.0288)	(0.0005)	(0.0300)	(0.0005)
LEVERAGE	−0.4910***	−0.0258***	−0.5661***	−0.0261***	−0.3966	−0.0080	−0.4233*	−0.0072*
	(0.1814)	(0.0094)	(0.1914)	(0.0086)	(0.2430)	(0.0050)	(0.2495)	(0.0044)
GDPgrowth	2.5261	0.1326	−63.7813	−2.9369	1.9668	0.0396	−9.0489	−0.1542
	(1.6992)	(0.0891)	(43.4223)	(1.9726)	(2.3379)	(0.0485)	(60.3648)	(1.0295)
INDUSTRYgrowth	−0.0160	−0.0008	−0.0228	−0.0010	−0.0197	−0.0004	−0.0853	−0.0014
	(0.0103)	(0.0005)	(0.1400)	(0.0064)	(0.0156)	(0.0003)	(0.1719)	(0.0030)
Year fixed effects	NO		YES		NO		YES	
Clustered standard errors by firm	YES		YES		YES		YES	
N	8524		7935		8524		7935	
Pseudo R^2	0.0436		0.0921		0.0813		0.1225	
Log likelihood	−994.4783		−929.1826		−495.6598		−467.1568	
p-value chi2	0.000		0.000		0.000		0.000	

This table summarizes the probit estimation results for our baseline model (Eq. (1)). The probit estimated coefficients and the marginal effects for the explanatory variable are displayed (standard error in parentheses). GO exercise occurrence is regressed on the volatility of a firm's portfolio of businesses, rivalry in the core business, degree of diversification and relatedness. *EXERCISE2_2d* and *EXERCISE3_2d* are the alternative proxies for the event of a GO exercise based on different thresholds (a firm's ratio of CAPEX to assets greater than two or three times the firm median), at the 2-digit SIC code level. In all of them, we only select those investment spikes that lead to a decrease in a firm's Tobin Q the year following the GO exercise, and such a variation in absolute terms must be equal to or above the sample median. *VOL* is the volatility of a firm's portfolio of businesses and is computed as the average of the volatility of the different 2-digit SIC code sectors in which the firm operates, weighted by the proportion of the firm's sales allocated in each sector. *RIVAL* denotes rivalry in the core business and is calculated as the natural logarithm of the number of firms operating in the same 2-digit SIC code industry as the core business of the corresponding firm. *DIVERSIF* measures a firm's level of diversification and is taken as the total entropy index by Jacquemin and Berry (1979). *RELATED* denotes the degree of relatedness between businesses and is Jacquemin and Berry's related entropy index. Control variables: *SIZE*, calculated as the natural logarithm of book value of total assets; *LEVERAGE*, measured by the ratio of total debt to total assets; *GDPgrowth*, calculated as the U.S. gross domestic product annual change based on 2009 dollars; and *INDUSTRYgrowth*, measured by the annual growth rate of a firm's 2-digit primary industry. Standard errors (clustered by firm) are in parentheses below each estimated coefficient. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively. The log-likelihood ratio (LR) test follows a χ^2 distribution.

product growth (*GDPgrowth*) and industry growth (*INDUSTRYgrowth*) control for the economic cycle attractiveness and the expansion behaviour of a firm's industry peers, respectively. These two factors are likely to affect a firm's investment cycle. *GDPgrowth* is calculated as the U.S. gross domestic product annual change based on 2009 dollars; and *INDUSTRYgrowth* is measured by the annual growth rate of sales of a firm's 2-digit SIC primary industry.

3.3. Descriptive statistics

Table 1 shows the distribution of GO exercises in the sample. The alternative industry classification used does not lead to a substantial difference in the number of GO exercises. Most occurred between 1999 and 2001 (about 45% of the sample total). There is also a noticeable peak in 2007–2008, with said years marking the onset of the financial crisis. During the rest of the sample period, the distribution of the number of GO exercises across years remained quite stable.

To verify the accuracy of our *EXERCISE* proxies for identifying large investments implying GO exercise, we compute the pairwise correlations of these proxies with two widely used measures of GO: the market-to-book assets ratio (Adam & Goyal, 2008; Folta & O'Brien, 2004), and Tobin's Q (Alessandri, Tong, & Reuer, 2012; Cao, Simin, & Zhao, 2008; Wright, Ferris, Sarin, & Awasthi, 1996). We follow Adam and Goyal (2008) to compute the market-to-book assets ratio (*MBAR*) and we apply Cao et al.'s (2008) definition of Tobin's Q (*Q*). We also consider two lag values and two lead values of *MBAR* and *Q*. Table 2 reports the correlations. *EXERCISE* dummies are positively correlated with the lags and present values of *MBAR* ($MBAR_{t-2}$, $MBAR_{t-1}$ and *MBAR*), and are statistically significant at the 1% level. This indicates that firms displaying a GO exercise have greater prior GO available. In contrast, *EXERCISE* variables show a negative correlation with the lead values of *MBAR* ($MBAR_{t+1}$ and $MBAR_{t+2}$). These latter correlations are greater in absolute value at lower investment thresholds. Results are robust to the use of *Q*.

Finally, Table 3 summarizes the descriptive statistics of our variables and the correlation between them. The positive correlation between *RIVAL* and *VOL* (0.1075, p-value = 0.0000) suggests that firms which are more exposed to rivalry in the core business are also subject to greater average volatility in their businesses. *SIZE* and *LEVERAGE* display negative significant correlations with *RIVAL*. Particularly noticeable is the correlation between *SIZE* and *RIVAL* (-0.2007, p-value = 0.0000), suggesting that larger firms enjoy lower levels of rivalry in their core industry. *RIVAL* has a positive correlation with *INDUSTRYgrowth* (0.0190, p-value = 0.0787), indicating that competitive rivalry increases in industry expansive cycles. In addition, related diversification (*RELATED*) is positively associated with *SIZE*, probably because of

Table 6
Baseline model (Eq. (1)). Additional robustness checks using *EXERCISE2_3d* and *EXERCISE3_3d*.

Variables	Dependent variable: EXERCISE2_3d				Dependent variable: EXERCISE3_3d			
	(1)		(2)		(3)		(4)	
	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect
Intercept	−1.9168***		−0.9630		−1.8200***		−1.8174	
	(0.2827)		(0.8630)		(0.4058)		(1.2319)	
DIVERSIF	−0.2105*	−0.0107*	−0.2124*	−0.0095*	−0.4539**	−0.0092**	−0.4754**	−0.0082**
	(0.1257)	(0.0064)	(0.1312)	(0.0059)	(0.1783)	(0.0037)	(0.1810)	(0.0033)
VOL	−0.1474**	−0.0075**	−0.1054*	−0.0047*	−0.0973	−0.0020	−0.0505	−0.0009
	(0.0695)	(0.0035)	(0.0643)	(0.0029)	(0.0921)	(0.0019)	(0.0803)	(0.0014)
RELATED	0.2488**	0.0127**	0.2049*	0.0092*	0.3466**	0.0071**	0.3214*	0.0056*
	(0.1103)	(0.0056)	(0.1136)	(0.0051)	(0.1652)	(0.0034)	(0.1682)	(0.0029)
RIVAL	0.0605***	0.0031***	0.0561***	0.0025***	0.0567*	0.0012*	0.0538*	0.0009*
	(0.0208)	(0.0010)	(0.0216)	(0.0010)	(0.0297)	(0.0006)	(0.0303)	(0.0005)
Controls								
SIZE	−0.0881***	−0.0045***	−0.0875***	−0.0039***	−0.1454***	−0.0030***	−0.1494***	−0.0026***
	(0.0175)	(0.0009)	(0.0186)	(0.0009)	(0.0287)	(0.0005)	(0.0300)	(0.0005)
LEVERAGE	−0.4945***	−0.0252**	−0.5659***	−0.0254***	−0.3874	−0.0079	−0.4105	−0.0071
	(0.1861)	(0.0094)	(0.1959)	(0.0087)	(0.2507)	(0.0053)	(0.2562)	(0.0046)
GDPgrowth	2.3197	0.1180	−63.2422	−2.8450	2.0030	0.0408	−9.3834	−0.1629
	(1.7186)	(0.0873)	(43.3423)	(1.9236)	(2.3238)	(0.0487)	(59.8410)	(1.0401)
INDUSTRYgrowth	−0.0127	−0.0006	0.0261	0.0012	−0.0187	−0.0004	−0.0889	−0.0015
	(0.0087)	(0.0004)	(0.1337)	(0.0060)	(0.0149)	(0.0003)	(0.1716)	(0.0030)
Year fixed effects	NO		YES		NO		YES	
Clustered standard errors by firm	YES		YES		YES		YES	
N	8524		7935		8524		7935	
Pseudo R^2	0.0410		0.0872		0.0723		0.1128	
Log likelihood	−962.3737		−901.7729		−483.9482		−456.7519	
p-value chi2	0.000		0.000		0.000		0.000	

This table summarizes the probit estimation results for our baseline model (Eq. (1)). The probit estimated coefficients and the marginal effects for the explanatory variable are displayed (standard error in parentheses). GO exercise occurrence is regressed on the volatility of a firm's portfolio of businesses, rivalry in the core business, degree of diversification, and relatedness. *EXERCISE2_3d* and *EXERCISE3_3d* are the alternative proxies for the event of a GO exercise based on different thresholds (a firm's ratio of CAPEX to assets greater than two or three times the firm median), at the 3-digit SIC code level. In all of them, we only select those investment spikes that lead to a decrease in a firm's Tobin Q the year following the GO exercise, and such a variation in absolute terms must be equal to or above the sample median. *VOL* is the volatility of a firm's portfolio of businesses and is computed as the average of the volatility of the different 2-digit SIC code sectors in which the firm operates, weighted by the proportion of the firm's sales allocated in each sector. *RIVAL* denotes rivalry in the core business and is calculated as the natural logarithm of the number of firms operating in the same 2-digit SIC code industry as the core business of the corresponding firm. *DIVERSIF* measures a firm's level of diversification and is taken as the total entropy index by Jacquemin and Berry (1979). *RELATED* denotes the degree of relatedness between businesses and is Jacquemin and Berry's related entropy index. Control variables: *SIZE*, calculated as the natural logarithm of book value of total assets; *LEVERAGE*, measured by the ratio of total debt to total assets; *GDPgrowth*, calculated as the U.S. gross domestic product annual change based on 2009 dollars; and *INDUSTRYgrowth*, measured by the annual growth rate of a firm's 2-digit primary industry. Standard errors (clustered by firm) are in parentheses below each estimated coefficient. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively. The log-likelihood ratio (LR) test follows a χ^2 distribution.

larger companies' greater ability to exploit advantages such as economies of scope.

3.4. Econometric approach and empirical models

To test our hypotheses, we perform a number of empirical analyses. As preliminary tests, we carry out a set of difference of means tests for all the variables involved in our subsequent regressions in order to ascertain whether they differ significantly between firm-year observations that show GO exercise and those that do not.

Given the dichotomous nature of our dependent variable *EXERCISE*, we then use a probit model to estimate the likelihood of pursuing a GO exercise. Our baseline model is:

$$\begin{aligned}\text{Prob}(EXERCISE = 1) &= \beta_0 + \beta_1 \text{DIVERSIF}_{it} + \beta_2 \text{VOL}_{it} + \beta_3 \text{RELATED}_{it} \\ &\quad + \beta_4 \text{RIVAL}_{it} + \beta_5 \text{SIZE}_{it} + \beta_6 \text{LEVERAGE}_{it} \\ &\quad + \beta_7 \text{GDPgrowth}_{t} + \beta_8 \text{INDUSTRYgrowth}_{it} + \varepsilon_{it} \end{aligned} \quad (1)$$

where *i* denotes each company, *t* represents the time period, and ε_{it} is the error term. This equation is estimated alternatively with the four different proxies *EXERCISE2_3d*, *EXERCISE3_3d*, *EXERCISE2_2d* and *EXERCISE3_2d*, in order to test the consistency of our results.

In all regressions, we use firm-clustered standard errors to account for unobserved firm effects (Petersen, 2009). This also enables us to control for residual dependence within a firm[6]. Year fixed effects are

[6] Additional robustness estimations have been conducted by including firm fixed effects. Results prove to be robust and are available upon request.

also included to account for time invariant characteristics.

The intrinsically nonlinear nature of probit models might make the results more complex to interpret. Rather than simply displaying the sign and statistical significance of the estimated coefficients, reporting the marginal effect proves illustrative; namely how a unit change in one particular explanatory variable changes the probability of the outcome variable (Wiersema & Bowen, 2009).

4. Empirical findings

4.1. 1. Univariate analyses

Table 4 presents a set of mean-comparison tests between GO exercise (*EXERCISE* = 1) and non-GO exercise firm-year observations (*EXERCISE* = 0). In line with our conjectures, GO exercises show a lower degree of diversification on average than non-GO exercise observations, thus supporting Hypothesis 1 (beyond a 1% level of statistical significance in all cases). Also as expected, GO exercise observations are accompanied by lower volatility in a firm's businesses (Hypothesis 2), with these differences being statistically significant, except for the lowest investment threshold. As regards Hypothesis 3, we note that GO exercise observations display higher degrees of diversification relatedness, but that mean differences are not statistically significant. As for rivalry, we find that GO exercise observations display a higher *RIVAL*, this result being statistically significant across the various difference of means tests. These differences become more economically significant the higher the investment threshold imposed for the dependent variable definition, and concur with Hypothesis 4.

4.2. Baseline model

Our regression estimates are presented in Table 5. Table 6 reports additional robustness checks using alternative *EXERCISE* proxies. The pseudo-R^2 ranges between 0.04 and 0.12, indicating moderate explanatory power. Pseudo R^2 is usually low in probit models (e.g. Ejermo & Schubert, 2017; Graña, Benavides-Espinosa, & Roig-Dobón, 2018). It is not fully equivalent to the R^2 in ordinary least squares and only provides an approximation of the goodness-of-fit (Graña et al., 2018). Since there is no particular benchmark for the pseudo-R^2, the goodness-of-fit is normally assessed by an alternative measure such as the Log-likelihood-ratio (LR) test (Wiersema & Bowen, 2009), which compares the fit of two competing models: a null model and the alternative model (the estimated model). This test supports the fit of our models across all estimations.

DIVERSIF exhibits statistical significance across all estimates and proves economically significant. These findings confirm the relevance of a firm's diversification in the decision to exercise GO. As predicted in Hypothesis 1, *DIVERSIF* presents a negative and statistically significant coefficient. We find that as a firm increases its level of diversification by one standard deviation, the probability of a GO exercise falls by about 0.24–0.36 percentage points.

As far as *VOL* is concerned, the estimated coefficient only displays statistical significance at lower investment thresholds, being borderline significant at the 10% level when accounting for year fixed effects. The marginal effect for this variable reveals that if *VOL* increases by one standard deviation, the likelihood of a GO exercise decreases by about 0.30–0.50 percentage points. These empirical findings reveal that firms subject to greater volatility in their businesses are less likely to exercise their GO. This evidence lends support to Hypothesis 2, although we find no statistical significance for this variable when the investment threshold is imposed at the highest level (either *EXERCISE3_3d* or *EXERCISE3_2d*). One possible reason for this loss of significance is simply the exclusion of medium-size GO whose exercise is related to volatility. Whatever the case, our results are consistent with the hedging role of GO against the average volatility of a firm's businesses.

In accordance with Hypothesis 3, *RELATED* has a positive and statistically significant effect in all regressions, showing that companies which have more related business segments evidence less need to keep their GO unexercised. If *RELATED* increases by one standard deviation, the probability of a GO exercise rises by about 0.17–0.46 percentage points. Results are robust across the different *EXERCISE* proxies, although this variable is more significant in economic terms at the most reduced threshold values. Moreover, we consider an alternative proxy for relatedness measured in relative terms; namely the ratio of related entropy over total entropy (Amit & Livnat, 1988). Results are robust.[7]

The coefficient of *RIVAL* is positive and statistically significant across the alternative estimations. The effect of this variable on the likelihood of a GO exercise displays greater economic and statistical significance for lower investment thresholds. As shown in column (1) in Table 5, if *RIVAL* goes up by one standard deviation, the probability of GO exercise increases by 0.47 percentage points. Companies with a higher rivalry in their core businesses are more likely to undertake large investments within a diversified portfolio, thus providing strong support for Hypothesis 4. Our evidence suggests that while *VOL* only exerts an influence at lower threshold values, *RIVAL* also significantly influences GO exercises at higher thresholds. Such differences reveal the prevalence of *RIVAL* to spark exploitation of a firm's opportunities, even for a narrower range of exercises.

Taken together, these results are consistent with our univariate statistics, and support Hypotheses 1, 2, 3 and 4. In contrast to our difference of means tests, *RELATED* displays a statistically significant effect on the likelihood of a GO exercise. Overall, *VOL* and *DIVERSIF* discourage firms from exercising their GO, whereas *RIVAL* and *RELATED* encourage GO exercise.

As regards our control variables, both *SIZE* and *LEVERAGE* discourage GO exercise. This finding of *SIZE* ties in with existing research such as Bernardo & Chowdhry (2002). Larger companies are more likely to have already materialized many of their GO through their expansion process, thus having fewer unexercised options remaining. More leveraged firms may have greater financial constraints to undertake large investment, and their financial situation may deter them from exercising their options. This result is consistent with Myers (1977), who argues that leverage is negatively associated with the relative importance of GO over a firm's total market value. *GDPgrowth* and *INDUSTRYgrowth* show no statistical significance in any of these regressions.

Finally, additional robustness analyses are conducted by lagging all our explanatory variables by one year in order to alleviate potential endogeneity problems from reverse causality. A similar procedure has been applied in prior works such as Baele, De Jonghe & Vennet (2007)[8]. These estimations are displayed in Tables A1 and A2 of the Appendix A. Broadly speaking, all the previously described results remain robust. It is worth noting that *RIVAL* exhibits statistical significance in a lower number of regressions, which might also be due to the loss of observations in the regression sample caused by the use of lagged variables.

5. Discussion and conclusion

5.1. Discussion and significance of the results

This paper examines a firm's decision to exercise its GO within its current range of businesses. As far as we know, our study is the first attempt to analyse the drivers of GO exercise in diversification strategies taking the portfolio of businesses as the unit of analysis. Our findings confirm that firms manage their GO as a strategic hedging instrument. We find that the GO exercise decision depends on a firm's overall risk exposure as shaped by the degree of diversification, the average volatility of its current businesses, relatedness among them, and rivalry in its core business.

[7] Results are available upon request.

[8] We thank an anonymous reviewer for this suggestion.

Our evidence shows a dissuasive effect of a greater level of diversification on a firm's GO exercises. This evidence suggests that a narrower range of businesses requires a lower variety of unexercised GO, implying that diversification and GO hedging are not substitutive but in fact complementary strategies. This finding concurs with previous studies such as Lim & Wang (2007), who argue that managers can complement corporate diversification with financial hedging such as futures, swaps or financial options contracts.

Greater volatility in a firm's businesses encourages companies to hold their GO, which is consistent with the value of the strategic hedge provided by GO to respond to unexpected future contingencies (Miller, 1998; Wang et al., 2003). The type of diversification also has an effect, with firms that diversify into more related businesses being more likely to exercise their GO. This evidence is also consistent with the hedging role of GO and is in line with previous works which show the potential of related diversification for creating synergies that can enhance a firm's performance (Markides & Williamson, 1994), and redeployability of resources between businesses, which enhances a firm's flexibility (Sakhartov & Folta, 2014). Both effects reduce a firm's hedging need through GO. Finally, rivalry encourages GO exercise, since companies are likely to offset a potential decline in performance in that industry with other businesses in which the firm is already operating at a lower scale. The opposite effect of volatility and rivalry on GO exercise is consistent with the multidimensional nature of risk and confirms the need to complement traditional financial measures with other managerially relevant alternatives (Ruefli et al., 1999). Our evidence also ties in with the integrated risk management approach (Miller, 1992; Miller & Waller, 2003) by challenging previously isolated treatment of uncertainties.

5.2. Contributions

The core novelty of our research lies in combining a real options approach and a portfolio perspective of a firm's businesses in order to obtain a better understanding of how likely it is to exercise its GO. By doing so, this paper makes contributions to both RO and diversification literatures. As regards the former, this study provides fresh theoretical insights into existing RO literature by framing a firm's GO exercise decision in a portfolio approach, as requested by the latest surveys, such as Ipsmiller et al. (2019). We show that GO can offer a strategy insurance that firms consider when exercising their GO within a diversified business portfolio. Such a corporate-level view is a distinguishing feature of our research compared with prior literature that examines GO exercise in isolation.

Complementarily, our research provides theoretical grounds for moving the RO approach forward to become one of the theoretical pillars in the field of strategy (Trigeorgis & Reuer, 2017). Overall, our research reveals that RO can prove a worthwhile strategic decision-making perspective to explain observed investment allocation decisions (and their diversity across the universe of firms) whose value is overlooked by narrower perspectives.

As for diversification literature, this study advances our theoretical understanding of the motives to unfold diversification strategies by considering the dual composition of a firm's assets: AiP and GO. This places us in a better position to predict and identify the particular causal mechanisms which trigger GO exercise, thereby giving us a broader insight into the map of successful/failed diversification practices observed across companies. Our work reveals the usefulness of the RO perspective for exploring in greater depth the sources of competitive advantage and firm heterogeneity for the context of corporate diversification. Our findings add to those of Andrés et al. (2017b), Sakhartov & Folta (2014), and Yang et al. (2014) in suggesting the omission of the effect of diversification on GO as one of the limitations of traditional literature concerning corporate diversification performance.

Our findings also add further insights into the benefits of related diversification beyond synergies (Helfat & Eisenhardt, 2004; Lieberman et al., 2017; Sakhartov & Folta, 2014). Our results suggest that GO and redeployability might serve as substitutive hedging devices within the current scope of businesses. We show that related diversification encourages the exercise of GO. This might be partly explained by the substitutive relationship between GO and relatedness in its role to hedge corporate exposure. Resource redeployability across related businesses offers the firm additional flexibility to act in response to future shocks, thus reducing its need for GO strategic insurance. In addition, our research satisfies prior demands for further investigation into the causal mechanisms behind firm growth (McKelvie & Wiklund, 2010) and provides a theoretical motivation of the differences in firms' growth paths from a value creation perspective.

Finally, this study also responds to the invitation made by prior research to provide further empirical testing on RO analysis (Cuervo-Cazurra & Un, 2010; Ipsmiller et al., 2019). One remaining challenge is to delve deeper into which strategic phenomena may benefit from an RO insight, linking the valuation and qualitative approaches of strategic RO analysis, and performing more empirical studies to enhance theory (Cuervo-Cazurra & Un, 2010). We contribute to narrowing said gap by analysing and empirically testing how an RO-portfolio logic and its fundamentals can predict and explain diversification investment behaviours.

5.3. Managerial implications

Our results provide implications for researchers and managers when evaluating a firm's decision to exercise its GO within the scope of diversified businesses. Our research acknowledges the prominent role managers play in creating a competitive advantage when implementing their diversification strategies. In this regard, it is crucial to consider not only that diversification matters, but also the mix of AiP and GO in determining the risk that concerns both shareholders and non-financial stakeholders alike. Indirectly, our study reveals the usefulness of developing and promoting RO awareness in their management teams to recognize and appraise a firm's investment opportunities (Driouchi & Bennett, 2011). Managers should seek to ensure they acquire such know-how as a requirement to implement flexibility in their decision-making practices and actually benefit from a firm's GO.

5.4. Limitations and future research

This paper suffers from a number of limitations that could be addressed in future research and it also raises a number of challenging questions that remain for further inquiry. Our results suggest that other additional factors are likely to play a part in explaining a firm's decision to exercise its GO within its scope of business. Our findings reveal that it is not only the individual conditions of each GO that matter. The characteristics of the business portfolio as a whole are also relevant.

However, the economic significance of some results is still small and leaves room for further research to extend such risk portfolio features.

Moreover, this research can serve as a starting point to invite further research from alternative theoretical lenses that might explore additional firm-level and industry-level contingencies. In doing so, it could be enriching to consider not only direct relationships, but also to explore potential mediating pathways. Our research opens up promising avenues to move the integrated risk management approach to the empirical arena in order to test the interrelations between the different risk elements. It might prove particularly interesting to bear in mind factors related to managerial behaviour, such as cognitive biases (cognitive theory) and incentive alignment (agency theory). As recent reviews such as Guerras-Martin et al. (2020) suggest, it would also be convenient to investigate how top managers handle their portfolios for success.

Given the importance we document that GO have on a firm's diversification implementation, further investigation is also required into the behavioural approach of RO decision-making. Undoubtedly, managerial capabilities are extremely heterogeneous across companies. How does managers' RO know-how affect the recognition and exploitation of a firm's GO value? It would be interesting to delve into the role of managerial behavioural factors (e.g. cognitive biases, self-seeking behaviour), to explore a firm's motivations to diversify and the diversification pattern adopted. This could improve our knowledge of a firm's RO awareness in strategic decision-making.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors benefited from the valuable comments provided by Santiago Mingo (the associate editor), anonymous reviewers, Valentín Azofra, Vicenzo Butticè, Timothy Folta, Massimiliano Guerini, Philip Jaggs, Evila Piva, Cristina Rossi, as well as participants at the ACEDE Conference in Vigo (2016), the AEFIN Finance Forum in Madrid (2016), the EURAM Conference in Glasgow (2017), the Entrepreneurship Workshop at Universidad Carlos III de Madrid (2019), and the research seminars at the Politecnico di Milano (2019). The authors wish to thank the ACEDE conference (Spanish Academy of Management) for having been given the Best Paper Award. This work was supported by the Regional Government of Castilla y León (grant number VA260U14), the Regional Government of Madrid and the European Social Fund (grant number EARLYFIN, S2015/HUM-3353), and the Spanish Ministry of Science and Innovation (grant number ECO2017-84864-P and ECO2017-85356-P).

Appendix A

See Tables A1 and A2.

Table A1
Baseline model (Eq. (1)) with lagged values of explanatory variables: *EXERCISE2_2d* and *EXERCISE3_2d* as proxies for GO exercise.

Variables	Dependent variable: EXERCISE2_2d				Dependent variable: EXERCISE3_2d			
	(1)		(2)		(3)		(4)	
	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect
Intercept	−1.7424***		−2.8333***		−1.9878***		−1.7896**	
	(0.3220)		(0.7613)		(0.4678)		(0.8617)	
DIVERSIF(t-1)	−0.2917**	−0.0137**	−0.2997**	−0.0128**	−0.4939**	−0.0086**	−0.4817**	−0.0078**
	(0.1348)	(0.0065)	(0.1355)	(0.0058)	(0.2007)	(0.0038)	(0.1961)	(0.0033)
VOL(t-1)	−0.0168	−0.0007	0.0439	0.0019	−0.0079 (0.0785)	−0.0001	0.0311 (0.0771)	0.0005 (0.0012)
	(0.0543)	(0.0025)	(0.0489)	(0.0020)		(0.0014)		
RELATED(t-1)	0.2254*	0.0106*	0.2245*	0.0095*	0.3531* (0.1859)	0.0061*	0.3599**	0.0058**
	(0.1225)	(0.0058)	(0.1235)	(0.0052)		(0.0033)	(0.1832)	(0.0030)
RIVAL(t-1)	0.0222	0.0010	0.0211	0.0009	0.0507 (0.0317)	0.0009 (0.0006)	0.0515*	0.0008*
	(0.0230)	(0.0011)	(0.0233)	(0.0010)			(0.0312)	(0.0005)
Controls	YES		YES		YES		YES	
Year fixed effects	NO		YES		NO		YES	
Clustered standard errors by firm	YES		YES		YES		YES	
N	7,057		7,057		7,057		7,057	
Pseudo R^2	0.0657		0.0937		0.1034		0.1211	
Log likelihood	−806.6805		−782.5415		−396.6257		−388.8078	
Wald test chi2 (degrees of freedom)	94.93*** (8)		154.26*** (20)		61.26*** (8)		82.96*** (20)	

This table summarizes the probit robustness estimations for our baseline model (Eq. (1)) by using the lagged values of explanatory variables to mitigate endogeneity concerns. The probit estimated coefficients and the marginal effects for the explanatory variable are displayed (standard error in parentheses). GO exercise occurrence is regressed on the lagged values of volatility of a firm's portfolio of businesses, rivalry in the core business, degree of diversification, and relatedness. *EXERCISE2_2d* and *EXERCISE3_2d* are the alternative proxies for the event of a GO exercise based on different thresholds (a firm's ratio of CAPEX to assets greater than two or three times the firm median), at the 2-digit SIC code level. In all of them, we only select those investment spikes that lead to a decrease in a firm's Tobin Q the year following the GO exercise, and such a variation in absolute terms must be equal to or above the sample median. *VOL* is the volatility of a firm's portfolio of businesses and is computed as the average of the volatility of the different 2-digit SIC code sectors in which the firm operates, weighted by the proportion of the firm's sales allocated in each sector. *RIVAL* denotes rivalry in the core business and is calculated as the natural logarithm of the number of firms operating in the same 2-digit SIC code industry as the core business of the corresponding firm. *DIVERSIF* measures a firm's level of diversification and is taken as the total entropy index by Jacquemin and Berry (1979). *RELATED* denotes the degree of relatedness between businesses and is Jacquemin and Berry's related entropy index. Control variables: *SIZE*, calculated as the natural logarithm of book value of total assets; *LEVERAGE*, measured by the ratio of total debt to total assets; *GDPgrowth*, calculated as the U.S. gross domestic product annual change based on 2009 dollars; and *INDUSTRYgrowth*, measured by the annual growth rate of a firm's 2-digit primary industry. Standard errors (clustered by firm) are in parentheses below each estimated coefficient. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively. The log-likelihood ratio (LR) test follows a χ^2 distribution.

Table A2
Baseline model (Eq. (1)) with lagged values of explanatory variables: *EXERCISE2_3d* and *EXERCISE3_3d* as proxies for GO exercise.

Variables	Dependent variable: EXERCISE2_3d				Dependent variable: EXERCISE3_3d			
	(1)		(2)		(3)		(4)	
	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect
Intercept	−1.8120***		−2.8075***		−2.1525***		−1.9690**	
	(0.3266)		(0.7674)		(0.4668)		(0.8545)	
DIVERSIF(t-1)	−0.2518*	−0.0116*	−0.2603*	−0.0109*	−0.4090**	−0.0073**	−0.3979**	−0.0066**
	(0.1365)	(0.0064)	(0.1369)	(0.0058)	(0.2007)	(0.0038)	(0.1964)	(0.0034)
VOL(t-1)	−0.0403	−0.0018	0.0211	0.0009	−0.0073 (0.0781)	−0.0001	0.0314 (0.0773)	0.0005 (0.0013)
	(0.0604)	(0.0027)	(0.0535)	(0.0022)		(0.0014)		
RELATED(t-1)	0.2019*	0.0093*	0.1987*	0.0083*	0.3093* (0.1791)	0.0055*	0.3185*	0.0053*
	(0.1234)	(0.0057)	(0.1241)	(0.0052)		(0.0033)	(0.3185)	(0.0030)
RIVAL(t-1)	0.02607	0.0012	0.0245	0.0010	0.0575* (0.0319)	0.0010*	0.1964*	0.0010*
	(0.0234)	(0.0011)	(0.0237)	(0.0010)		(0.0006)	(0.0314)	(0.0005)
Controls	YES		YES		YES		YES	
Year fixed effects	NO		YES		NO		YES	
Clustered standard errors by firm	YES		YES		YES		YES	
N	7,057		7,057		7,057		7,057	
Pseudo R^2	0.0631		0.0917		0.0972		0.1151	
Log likelihood	−788.5751		−764.5059		−395.3754		−387.4989	
Wald test chi2 (degrees of freedom)	91.63*** (8)		152.09*** (20)		55.73*** (8)		81.97*** (20)	

This table summarizes the probit robustness estimations for our baseline model (Eq. (1)) by using the lagged values of explanatory variables to mitigate endogeneity concerns. The probit estimated coefficients and the marginal effects for the explanatory variable are displayed (standard error in parentheses). GO exercise occurrence is regressed on the lagged values of volatility of a firm's portfolio of businesses, rivalry in the core business, degree of diversification, and relatedness. *EXERCISE2_3d* and *EXERCISE3_3d* are the alternative proxies for the event of a GO exercise based on different thresholds (a firm's ratio of CAPEX to assets greater than two or three times the firm median), at the 3-digit SIC code level. In all of them, we only select those investment spikes that lead to a decrease in a firm's Tobin Q the year following the GO exercise, and such a variation in absolute terms must be equal to or above the sample median. *VOL* is the volatility of a firm's portfolio of businesses and is computed as the average of the volatility of the different 2-digit SIC code sectors in which the firm operates, weighted by the proportion of the firm's sales allocated in each sector. *RIVAL* denotes rivalry in the core business and is calculated as the natural logarithm of the number of firms operating in the same 2-digit SIC code industry as the core business of the corresponding firm. *DIVERSIF* measures a firm's level of diversification and is taken as the total entropy index by Jacquemin and Berry (1979). *RELATED* denotes the degree of relatedness between businesses and is Jacquemin and Berry's related entropy index. Control variables: *SIZE*, calculated as the natural logarithm of book value of total assets; *LEVERAGE*, measured by the ratio of total debt to total assets; *GDPgrowth*, calculated as the U.S. gross domestic product annual change based on 2009 dollars; and *INDUSTRYgrowth*, measured by the annual growth rate of a firm's 2-digit primary industry. Standard errors (clustered by firm) are in parentheses below each estimated coefficient. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively. The log-likelihood ratio (LR) test follows a χ^2 distribution.

References

Adam, T., & Goyal, V. (2008). The investment opportunity set and its proxy variables. *The Journal of Financial Research, 31*(1), 41–63. https://doi.org/10.1111/j.1475-6803.2008.00231.x.

Aguerrevere, F. (2009). Real options, product market competition and asset returns. *The Journal of Finance, 64*(2), 957–983. https://doi.org/10.1111/j.1540-6261.2009.01454.x.

Aivazian, V., Rahaman, M., & Zhou, S. (2019). Does corporate diversification provide insurance against economic disruptions? *Journal of Business Research, 100*, 218–233. https://doi.org/10.1016/j.jbusres.2019.03.044.

Alessandri, T., Tong, T., & Reuer, J. (2012). Firm heterogeneity in growth option value: The role of managerial incentives. *Strategic Management Journal, 33*(13), 1557–1566. https://doi.org/10.1002/smj.1992.

Amit, R., & Livnat, J. (1988). Diversification strategies, business cycles and economic performance. *Strategic Management Journal, 9*(2), 99–110. https://doi.org/10.1002/smj.4250090202.

Andrés, P., Fuente, G., & Velasco, P. (2017a). Does it really matter how a firm diversifies? Assets-in-place diversification versus growth options diversification. *Journal of Corporate Finance, 43*, 316–339. https://doi.org/10.1016/j.jcorpfin.2017.01.011.

Andrés, P., Fuente, G., & Velasco, P. (2017b). Diversification, relatedness and growth options value: Beyond a linear relationship. *Long Range Planning, 50*(6), 840–861. https://doi.org/10.1016/j.lrp.2017.01.003.

Baele, L., De Jonghe, O., & Vennet, R. (2007). Does the stock market value bank diversification? *Journal of Banking & Finance, 31*(7), 1999–2021. https://doi.org/10.1016/j.jbankfin.2006.08.003.

Becerra, M. (2009). *Theory of the firm for strategic management: Economic value analysis* (1st ed.). Cambridge University Press.

Berger, P. G., & Ofek, E. (1995). Diversification's effect on firm value. *Journal of Financial Economicsc, 37*(1), 39–65. https://doi.org/10.1016/0304-405X(94)00798-6.

Bernardo, A., & Chowdhry, B. (2002). Resources, real options, and corporate strategy. *Journal of Financial Economics, 63*(1), 211–234. https://doi.org/10.1016/S0304-405X(01)00094-0.

Bettis, R. A. (1983). Modern financial theory, corporate strategy and public policy: Three conundrums. *Academy of Management Review, 8*(3), 406–415. https://doi.org/10.2307/257829.

Bowman, E., & Hurry, D. (1993). Strategy through the option lens: An integrated view of resource investments and the incremental-choice process. *The Academy of Management Review, 18*(4), 760–782. https://doi.org/10.2307/258597.

Brouthers, K., Brouthers, L., & Werner, S. (2004). Real options, international entry mode choice and performance. *Journal of Management Studies, 45*(5), 936–960. https://doi.org/10.1111/j.1467-6486.2007.00753.x.

Brouthers, K., & Dikova, D. (2010). Acquisitions and real options: The greenfield alternative. *Journal of Management Studies, 47*(6), 1048–1071. https://doi.org/10.1111/j.1467-6486.2009.00875.x.

Cao, C., Simin, T., & Zhao, J. (2008). Can growth options explain the trend in idiosyncratic risk? *The Review of Financial Studies, 21*(6), 2599–2633. https://doi.org/10.1093/rfs/hhl039.

Ceccagnoli, M., Higgins, M., & Kang, H. (2018). Corporate venture capital as a real option in the markets for technology. *Strategic Management Journal, 39*(13), 3355–3381. https://doi.org/10.1002/smj.2950.

Chi, T., & McGuire, D. (1996). Collaborative ventures and value of learning: Integrating the transaction cost and strategic options perspectives on the choice of market entry modes. *Journal of International Business Studies, 27*(2), 285–307. https://doi.org/10.1057/palgrave.jibs.8490136.

Cuervo-Cazurra, A., & Un, A. (2010). Why some firms never invest in formal R&D. *Strategic Management Journal, 31*(7), 759–779. https://doi.org/10.1002/smj.836.

Décaire, P., Gilje, E., & Taillard, J. (2020). Real option exercise: Empirical evidence. *The Review of Financial Studies, 33*(7), 3250–3306. https://doi.org/10.1093/rfs/hhz092.

Del Viva, L., Kasanen, E., & Trigeorgis, L. (2017). Real options, idiosyncratic risk skewness, and diversification. *Journal of Financial and Quantitative Analysis, 52*(1), 215–241. https://doi.org/10.1017/S0022109016000703.

Dickler, T., & Folta, T. B. (2020). Identifying internal markets for resource redeployment. *Strategic Management Journal, 41*(13), 2341–2371. https://doi.org/10.1002/smj.3205.

Doh, J., & Pearce, J. (2004). Corporate entrepreneurship and real options in transitional policy environments: Theory development. *Journal of Management Studies, 41*(4), 645–664. https://doi.org/10.1111/j.1467-6486.2004.00448.x.

Driouchi, T., & Bennett, D. (2011). Real options in multinational decision-making: Managerial awareness and risk implications. *Journal of World Business, 46*(2), 205–219. https://doi.org/10.1016/j.jwb.2010.05.007.

Ejermo, O., & Schubert, T. (2017). Do higher wages reduce knowledge worker's job mobility? Evidence for Swedish inventors. *Journal of Management Studies, 55*(1), 108–145. https://doi.org/10.1111/joms.12317.
Estrada, I., Fuente, G., & Martín-Cruz, N. (2010). Technological joint venture formation under the real options approach. *Research Policy, 39*(9), 1185–1197. https://doi.org/10.1016/j.respol.2010.05.015.
Folta, T. B., & Miller, K. D. (2002). Real options in equity partnerships. *Strategic Management Journal, 23*(1), 77–88. https://doi.org/10.1002/smj.209.
Folta, T. B., & O'Brien, J. (2004). Entry in the presence of dueling options. *Strategic Management Journal, 25*(2), 121–138. https://doi.org/10.1002/smj.368.
Graña, F., Benavides-Espinosa, M., & Roig-Dobón, S. (2018). Determinants of silent and explicit industrial design. *Journal of Business Research, 88*, 314–320. https://doi.org/10.1016/j.jbusres.2017.11.028.
Grullon, G., Lyandres, E., & Zhdanov, A. (2012). Real options, volatility, and stock returns. *The Journal of Finance, 67*(4), 1499–1537. https://doi.org/10.1111/j.1540-6261.2012.01754.x.
Guerras-Martin, L. A., Ronda-Pupo, G. A., Zúñiga-Vicente, J. A., & Benito-Osorio, D. (2020). Half a century of research on corporate diversification: A new comprehensive framework. *Journal of Business Research, 114*, 124–141. https://doi.org/10.1016/j.jbusres.2020.03.037.
Helfat, C., & Eisenhardt, K. (2004). Inter-temporal economies of scope, organizational modularity, and the dynamics of diversification. *Strategic Management Journal, 25*(13), 1217–1232. https://doi.org/10.1002/smj.427.
Huang, H., & Jong, S. (2019). Public funding for science and the value of corporate R&D projects: Evidence form project initiation and termination decisions in cell therapy. *Journal of Management Studies, 56*(5), 1000–1039. https://doi.org/10.1111/joms.12423.
Huchzermeier, A., & Loch, C. (2001). Project management under risk: Using the real options approach to evaluate flexibility in R&D. *Management Science, 47*(1), 85–101. https://doi.org/10.1287/mnsc.47.1.85.10661.
Ipsmiller, E., Brouthers, K., & Dikova, D. (2019). 25 years of real options empirical research in management. *European Management Review, 16*(1), 55–68. https://doi.org/10.1111/emre.12324.
Jacquemin, A., & Berry, C. (1979). Entropy measure of diversification and corporate growth. *The Journal of Industrial Economics, 27*(4), 359–369. https://doi.org/10.2307/2097958.
Kulatilaka, N., & Perotti, E. C. (1998). Strategic growth options. *Management Science, 44*(8), 1021–1031. https://doi.org/10.1287/mnsc.44.8.1021.
Lane, P., Cannella, A., & Lubatkin, M. (1998). Agency problems as antecedents to unrelated mergers and diversification: Amihud and Lev reconsidered. *Strategic Management Journal, 19*(6), 555–578. https://doi.org/10.1002/(SICI)1097-0266(199806)19:6<555::AID-SMJ955>3.0.CO;2-Y.
Lee, J., Park, J., & Folta, T. B. (2018). CEO career horizon, corporate governance, and real options: The role of economic short-termism. *Strategic Management Journal, 39*(10), 2703–2725. https://doi.org/10.1002/smj.2929.
Lieberman, M., Lee, G., & Folta, T. B. (2017). Entry, exit and the potential for resource redeployment. *Strategic Management Journal, 38*(3), 526–544. https://doi.org/10.1002/smj.2501.
Lim, S. S., & Wang, H. (2007). The effect of financial hedging on the incentives for corporate diversification: The role of stakeholder firm-specific investments. *Journal of Economic Behavior & Organization, 62*, 640–656. https://doi.org/10.1016/j.jebo.2005.04.012.
Ljubownikow, G., & Ang, S. (2020). Competition, diversification and performance. *Journal of Business Research, 112*, 81–94. https://doi.org/10.1016/j.jbusres.2020.03.002.
Lubatkin, M., & Chatterjee, S. (1994). Extending modern portfolio theory into the domain of corporate diversification: Does it apply? *Academy of Management Journal, 37*(1), 109–136. https://doi.org/10.5465/256772.
Lyandres, E., & Zhdanov, A. (2013). Investment opportunities and bankruptcy prediction. *Journal of Financial Markets, 16*(3), 439–476. https://doi.org/10.1016/j.finmar.2012.10.003.
Markides, C., & Williamson, P. (1994). Related diversification, core competences and corporate performance. *Strategic Management Journal, 15*(special issue), 149–165. https://doi.org/10.1002/smj.4250151010.
McGrath, R., Chen, M., & Macmillan, I. (1998). Multimarket maneuvering in uncertain spheres of influence: Resource diversion strategies. *Academy of Management Review, 23*(4), 724–740. https://doi.org/10.5465/amr.1998.1255635.
McKelvie, A., & Wiklund, J. (2010). Advancing firm growth research: A focus on growth mode instead of growth rate. *Entrepreneurship Theory and Practice, 34*(2), 261–288. https://doi.org/10.1111/j.1540-6520.2010.00375.x.
Meslier, C., Tacneng, R., & Tarazi, A. (2014). Is bank income diversification beneficial? Evidence from an emerging economy. *Journal of International Financial Markets Institutions & Money, 31*, 97–126. https://doi.org/10.1016/j.intfin.2014.03.007.
Miller, D. (2004). Firms' technological resources and the performance effects of diversification: A longitudinal study. *Strategic Management Journal, 25*(11), 1097–1119. https://doi.org/10.1002/smj.411.
Miller, K. D. (1992). A framework for integrated risk management in international business. *Journal of International Business Studies, 23*(2), 311–331. https://doi.org/10.1057/palgrave.jibs.8490270.
Miller, K. D. (1998). Economic exposure and integrated risk management. *Strategic Management Journal, 19*(5), 497–514. https://doi.org/10.1002/(SICI)1097-0266(199805)19:5<497::AID-SMJ958>3.0.CO;2-M.
Miller, K. D., & Folta, T. B. (2002). Option value and entry timing. *Strategic Management Journal, 23*(7), 655–665. https://doi.org/10.1002/smj.244.
Miller, K. D., & Waller, G. (2003). Scenarios, real options and integrated risk management. *Long Range Planning, 36*(1), 93–107. https://doi.org/10.1016/S0024-6301(02)00205-4.
Mitton, T., & Vorkink, K. (2007). Equilibrium underdiversification and the preference for skewness. *The Review of Financial Studies, 20*(4), 1255–1288. https://doi.org/10.1093/revfin/hhm011.
Morandi-Stagni, R., Santaló, J., & Giarratana, M. (2020). Product-market competition and resource redeployment in multi-business firms. *Strategic Management Journal, 41*(19), 1799–1836. https://doi.org/10.1002/smj.3207.
Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of Financial Economics, 5*(2), 147–175. https://doi.org/10.1016/0304-405X(77)90015-0.
Penrose, E. (1959). *The theory of the growth of the firm* (3rd ed.). Oxford University Press.
Petersen, M. (2009). Estimating standard errors in Finance panel data sets: Comparing approaches. *The Review of Financial Studies, 22*(1), 435–480. https://doi.org/10.1093/rfs/hhn053.
Raynor, M. (2002). Diversification as real options and the implications of firm-specific risk and performance. *The Engineering Economist, 47*(4), 371–389. https://doi.org/10.1080/00137910208965041.
Rivoli, P., & Salorio, E. (1996). Foreign direct investment and investment under uncertainty. *Journal of International Business Studies, 27*(2), 335–357. https://doi.org/10.1057/palgrave.jibs.8490138.
Robins, J., & Wiersema, M. (2003). The measurement of corporate portfolio strategy: Analysis of the content validity of related diversification indexes. *Strategic Management Journal, 24*(1), 39–59. https://doi.org/10.1002/smj.282.
Ruefli, T., Collins, J., & Lacugna, J. (1999). Risk measures in strategic management research: Auld lang syne? *Strategic Management Journal, 20*(2), 167–194. https://doi.org/10.1002/(SICI)1097-0266(199902)20:2<167::AID-SMJ9>3.0.CO;2-Q.
Rumelt, R. (1974). *Strategy, structure, and economic performance*. Harvard University Press.
Sakhartov, A., & Folta, T. B. (2014). Resource relatedness, redeployability, and firm value. *Strategic Management Journal, 35*(12), 1781–1797. https://doi.org/10.1002/smj.2182.
Schommer, M., Richter, A., & Karna, A. (2019). Does the diversification-firm performance relationship change over time? A meta-analytical review. *Journal of Management Studies, 56*(1), 270–298. https://doi.org/10.1111/joms.12393.
Smit, H., & Trigeorgis, L. (2009). Valuing infrastructure investment: An option games approach. *California Management Review, 51*(2), 79–100. https://doi.org/10.2307/41166481.
Trigeorgis, L. (1993). The nature of option interactions and the valuation of investments with multiple real options. *Journal of Financial and Quantitative Analysis, 28*, 1–20. https://doi.org/10.2307/2331148.
Trigeorgis, L., & Reuer, J. (2017). Real options theory in strategic management. *Strategic Management Journal, 38*(1), 42–63. https://doi.org/10.1002/smj.2593.
Vassolo, R., Anand, J., & Folta, T. (2004). Non-additivity in portfolios of exploration activities: A real options-based analysis of equity alliances in biotechnology. *Strategic Management Journal, 25*(11), 1045–1061. https://doi.org/10.1002/smj.414.
Villalonga, B. (2004). Diversification discount or premium? New evidence from BITS establishment-level data. *The Journal of Finance, 59*(2), 479–506. https://doi.org/10.1111/j.1540-6261.2004.00640.x.
Vo, X. (2017). How does the stock market value bank diversification? Evidence from Vietnam. *Finance Research Letters, 22*, 101–104. https://doi.org/10.1016/j.frl.2017.06.005.
Vrande, V., & Vanhaverbeke, W. (2013). How prior corporate venture capital investments shape technological alliances: A real options approach. *Entrepreneurship Theory and Practice, 37*(5), 1019–1043. https://doi.org/10.1111/j.1540-6520.2012.00526.x.
Wang, H., Barney, J., & Reuer, J. (2003). Stimulating firm-specific investment through risk management. *Long Range Planning, 36*(1), 49–59. https://doi.org/10.1016/S0024-6301(02)00203-0.
Whited, T. (2006). External finance constraints and the intertemporal pattern of intermittent investment. *Journal of Financial Economics, 81*(3), 467–502. https://doi.org/10.1016/j.jfineco.2005.07.007.
Wiersema, M., & Bowen, H. (2009). The use of limited dependent variable techniques in strategy research: Issues and methods. *Strategic Management Journal, 30*(6), 679–692. https://doi.org/10.1002/smj.758.
Williamson, P. (2001). Strategy as options on the future. In M. Cusumano, & C. Markides (Eds.), *Strategic thinking for the next economy* (pp. 157–178). Jossey-Bass A Wiley Company.
Wright, P., Ferris, S., Sarin, A., & Awasthi, V. (1996). Impact of corporate insider, blockholder, and institutional equity ownership on firm risk taking. *Academy of Management Journal, 39*(2), 441–463. https://doi.org/10.2307/256787.
Yang, Y., Narayanan, V., & De Carolis, D. (2014). The relationship between portfolio diversification and firm value: The evidence from corporate venture capital activity. *Strategic Management Journal, 35*(13), 1993–2011. https://doi.org/10.1002/smj.2190.

Pablo de Andrés is a professor at the Universidad Autónoma de Madrid (Spain) and a research member at the ECGI. He has focused his research on the analysis of financial decisions, real options and corporate governance. He has published in journals such as Journal of Corporate Finance, Journal of Business Finance & Accounting, Journal Banking & Finance, or Corporate Governance: An International Review. He was a Visiting Researcher at Harvard University and Cass Business School.

Gabriel de la Fuente is an associate professor at the Universidad de Valladolid (Spain). His research interests focus on corporate finance, real options and sustainability. He has

published his research in journals such as Journal of Corporate Finance, Research Policy, Journal of Banking & Finance or Journal of Business Finance & Accounting. He has been associate editor of BRQ Business Research Quarterly.

Pilar Velasco is a lecturer at the Universidad de Valladolid (Spain). Her primary research interests range between corporate strategy and corporate finance. She has published in journals such as Long Range Planning, Journal of Corporate Finance or Journal of Banking & Finance. She was a Visiting Researcher at London Business School and IE Business School.