



UK evidence for the determinants of R&D intensity from a panel fsQCA[☆]



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ABSTRACT

This study investigates whether configurations of situational determinants impact R&D intensity. Using a qualitative comparative analysis (QCA), the study assesses the consistency and coverage, both cross-sectionally and over time, of these configurations. The global solution presents four alternative combinations conducive to R&D intensity and concludes that situational determinants matter. The way managers use their aspirations, the proximity of bankruptcy, and the availability of slack affects the propensity to engage in R&D. Further, the results show that firms are not all alike and highlight the differences in how these determinants combine to impact R&D intensity.

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1. Introduction

The literature highlights the importance of research and development (R&D) for the performance of firms and for the economy in general (e.g., Greenhalgh & Rogers, 2010). The present study builds on the behavioral theory of the firm (Cyert & March, 1963) and focuses on the existence of slack within firms, as well as on the factors that condition the managers' attention, such as the aspirations for performance and the potential threat of bankruptcy. Attention towards achieving certain goals is consistent with the concept of the attainment of aspirations. However, if bankruptcy threatens the firm, then managers will focus on avoiding such an extreme scenario.

A gap exists in the literature because previous studies only focus on each of the determinants separately, in particular how slack influences R&D intensity. The present study extends the theoretical argument in Chen and Miller (2007) by adopting a novel approach to look at the situational determinants of R&D intensity. This study explores the possibility that these determinants, alone or in combination, are conducive to the same outcome (innovation). This study explores a panel of UK

firms after the start of the financial crisis of 2008 (from 2009 to 2014) and adopts a qualitative comparative analysis (QCA) to examine the determinants of R&D intensity. This methodology applies the novel work of García-Castro and Ariño (2013) on the application of a QCA to panel data sets. This general framework then assesses the consistency and coverage both cross-sectionally and over time.

The next section reviews the literature on the situational determinants of R&D intensity. Section 3 explains the data collection and measures. Section 4 explains the QCA model and presents the results, while Section 5 adds a robustness analysis. Section 6 presents the main findings, and Section 7 discusses the study's limitations and possibilities for future research.

2. Literature review and propositions

The roots of the relations between the situational determinants of search as determinants of R&D intensity go back to the behavioral theory of the firm by Cyert and March (1963). The authors propose two types of stimuli search: slack and aspirations. On the one hand, slack search occurs in the presence of excess resources available for experimentation. On the other hand, feedback about performance and how slack relates to past aspirations, as well as the aspirations concerning the performance of peers, leads to problemistic search. The present study also acknowledges that the threat of bankruptcy can cause managers to relocate resources away from R&D activities (Chen & Miller, 2007). The next subsections explore how these factors determine R&D.

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2.1. Slack

In an attempt to empirically define the concept of slack, [Bourgeois \(1981\)](#) claims that slack “conveys the notion of a cushion of excess resources available in an organization that will either solve many organizational problems or facilitate the pursuit of goals outside the realm of those dictated by optimization principles” ([Bourgeois, 1981](#)). Further, slack facilitates “creative and innovative experimentation” ([Bourgeois, 1981, p. 35](#)) that suggests a positive relation between slack and R&D. [Singh \(1986\)](#) proposes that slack differs according to its degree of recoverability. Overall, slack is the cushion of resources that the firm uses to improve performance and to deal with unexpected contingencies, such as budget cuts, but more importantly for the present study, for slack search.

The theories on management have different perspectives on the relation between slack and R&D. The analyses that follow the behavioral theory of [Cyert and March \(1963\)](#) argue that slack creates leeway to accommodate future shocks to firms and thus allows them to engage in R&D and other types of activities that can potentially enhance performance. Under that approach, slack is a resource that can promote the search for R&D. In contrast, the agency theory ([Jensen & Meckling, 1976](#)) argues that slack is detrimental to performance, since unused resources are inefficient. However, a firm that has financial slack will undertake R&D regardless of the anticipated profitability. The behavioral agency theory adds managerial incentives to the relation between behavioral theory variables, such as slack and R&D investments ([Alessandri & Pattit, 2014](#)).

Under the assumptions of the “pecking order” theory ([Myers & Majluf, 1984](#)), in the presence of information asymmetry concerning the firm's value, a firm might be either under- or overvalued. In the latter case, the firm has an incentive to raise capital, which the market can then interpret as a signal of overvaluation. Therefore, firms should have internal slack to accommodate investment opportunities without sending signals to the market, which is an even stronger argument for R&D activities.

Although the theories diverge on the impact of slack on performance, all acknowledge slack's role as a cushion to finance R&D. Further, limits exist on the managers' attention. Therefore, without slack, managers cannot focus on long-term projects, such as R&D. However, too much slack encourages less discipline in terms of which projects to start and which to terminate. This indecision harms performance, which ends up outweighing the benefits of slack to innovation. For example, [Nohria and Gulati \(1996\)](#) propose an inverse-U relation between slack and innovation.

Empirical studies operationalize the concept of slack under two approaches. One approach concerns perceptual measures that result from questionnaires to assess the different types and levels of slack (e.g., [Nohria & Gulati, 1996](#)). The other approach uses accounting and financial information to quantify different levels of slack (e.g., [Herold, Jayaraman, & Narayanaswamy, 2006](#); [Lee, 2015](#); [Marlin & Geiger, 2015](#)). This study adopts the latter approach.

Following this discussion, the first research proposition is:

Proposition 1. R&D intensity increases with the availability of slack.

2.2. Aspirations

Firms compare actual performance to their aspirations, which the research calls the attainment discrepancy ([Lant, 1992](#)). The comparison can be favorable or unfavorable, where the latter case signals the need to find alternative solutions conducive to enhancing the target productivity and to incentivizing the firm to search for novelty. [Levinthal and March \(1981\)](#) model the decision as a process of adaptive search whereby firms initially try to reduce any aspiration discrepancy and then adapt aspirations to performance. Should a firm's performance fall

below the target or aspiration, they argue that firms then look for refinements in technology that are not far from current practices and increase efficiency. The firms then adapt the aspirations to performance.

[Bromiley and Harris \(2014\)](#) identify three main empirical models concerning aspirations that relate to the performance of the firm (self-aspiration) and to the performance of other firms (social aspirations). They are the weighted average model that comprises both measures of aspirations with predefined weights or endogenously determined ones, the switching model that assumes that the focus of the managers' attention switches between these two measures, and the separate model that considers both measures independently. Applying these models to R&D spending, [Bromiley and Harris \(2014\)](#) find support for the separate model with regard to aspirations. The present study investigates the impact on R&D activities of both self and social aspirations.

When firms fall below their aspirations, more risk taking occurs ([Bromiley, 1991](#); [Lant & Montgomery, 1987](#); [Miller & Chen, 2004](#); [Washburn & Bromiley, 2012](#); [Wiseman & Bromiley, 1996](#)), and innovation search and R&D spending are examples of this risk taking. Some studies provide evidence to support the concept of risk taking through R&D spending in the presence of an attainment discrepancy ([Antonelli, 1989](#); [Chen & Miller, 2007](#); [Greve, 1998](#)). Others argue that firms respond instead through cost adjustment rather than more risky options ([Washburn & Bromiley, 2012](#)).

The second proposition is as follows:

Proposition 2. R&D intensity increases when past performance is below aspirations.

2.3. Distance from bankruptcy

Managers focus on different aspects of a firm's operations, such as when a firm is under the threat of bankruptcy ([March & Shapira, 1992](#)). This potential determinant of R&D spending is all the more important in the current economic environment. After the onset of the 2008 financial crisis, bankruptcies increased in OECD countries, and in the case of the United Kingdom, rose steadily until the end of 2011 ([OECD, 2012](#)). By 2014, the indicator had still not returned to pre-crisis levels ([OECD, 2014](#)).

[Wiseman and Bromiley \(1996\)](#) review opposing theoretical arguments concerning the relation between a firm's decline and risk taking and note that the literature is far from settling the debate. When looking specifically at the attitudes toward risk, [Bowman \(1982\)](#) and [Bromiley \(1991\)](#) find that troubled firms do indeed take on more risky activities. The current study acknowledges the importance of the threat of bankruptcies and investigates whether managers reduce the R&D intensity as the distance of bankruptcy decreases.

Hence, the third proposition is as follows:

Proposition 3. R&D intensity increases as a firm's distance to bankruptcy increases.

3. Data collection and measures

3.1. Data collection

The data cover the period from 2009 to 2014 and comprise all listed firms on the London Stock Exchange available in the *Worldscope* database. To avoid industry confounding effects due to varying R&D intensities and determinants in different industries, the analysis only concerns industrial firms. The inclusion in the data set requires that all firms have data available for all relevant measures and that the data satisfies the restriction as to R&D intensity. The study winsorizes the variables at the top and bottom 2.5%. The final sample comprises 1387 firm-year observations, corresponding to an unbalanced panel of 302 firms. The firms are from the following industrial subsectors according to their 3-digit

SIC codes: Aerospace & Defense (3.82%), Construction & Materials (8.22%), Electronic & Electrical Equipment (12.55%), General Industrials (4.33%), Industrial Engineering (12.47%), Industrial Transportation (6.27%), and Support Services (52.35%) firms. The average firm's total assets are 430.6 million GBP, and the average number of employees is 6845.

3.2. Measures

3.2.1. Outcome: R&D intensity

Following Cohen and Levinthal (1989) and Driver and Guedes (2012), the search intensity corresponds to the R&D intensity, which is equal to the ratio of R&D to sales. The sample uses only firms that have an R&D intensity less than or equal to one (following Chen & Miller, 2007), because the underlying arguments apply to those firms that engage in continuous production and sales, not for those that are strictly R&D specialists.

3.2.2. Conditions

3.2.2.1. Aspirations. This study adopts the approach by Chen and Miller (2007) to operationalize the concept of aspirations and separates the historical and social components of aspirations. A firm's aspiration is its performance at $t-1$ relative to its performance at $t-2$; and the industry aspiration is the firm's performance at $t-1$ relative to the median performance of the firms that are in the same 3-digit SIC industry at $t-2$. In both cases, the measure of performance is the return on assets (ROA).

The difference between performance and the relevant aspiration measures corresponds to the discrepancy measures. Specifically, the condition *Discrepancy firm* compares performance with the self-aspiration, and *Discrepancy industry* compares performance with the social aspiration.

3.2.2.2. Slack. Following Iyer and Miller (2008), the absorbed slack corresponds to the ratio of selling, general and administrative expenses to sales; the unabsorbed slack is the ratio of current assets to current liabilities; and the potential slack is the debt to equity ratio. The following step standardizes and sums up the three measures to create a composite slack index (Chen & Miller, 2007) (the corresponding condition is *Slack*).

3.2.2.3. Distance from bankruptcy. To capture the distance from bankruptcy, the present study uses the UK version of the Altman (1968) z-score by Taffler (1983). This measure corresponds to $z = 3.20 + 12.18x_1 + 2.50x_2 - 10.68x_3 + 0.029x_4$, where x_1 is the ratio of profit before tax to current liabilities, x_2 is the ratio of current assets to total liabilities, x_3 is the ratio of current liabilities to total assets, and x_4 is the no-credit interval corresponding to the difference between quick assets and current liabilities to daily operating expenses that are $(\text{sales} - \text{profit before tax} - \text{depreciation})/365$. The corresponding condition is *Distance from bankruptcy*.

4. Qualitative comparative analysis

4.1. Panel data fsQCA

According to Ragin (2008), the application of a fsQCA proceeds in four steps: calibration (i.e., transforming the outcome and variables into sets), building the truth table of the different combinations of attributes, establishing the consistency cutoff for distinguishing causal combinations that are part of or not part of the outcome, and generating equal solutions in terms of logical truth. The solutions occur along a complexity and parsimonious continuum in which the intermediate solution is often the most interpretable. Usually, fsQCA studies use cross-sectional data and do not incorporate temporal effects (with notable exceptions such as Caren & Panofsky, 2005). The current study proposes to

incorporate the time dimension and applies the solution by García-Castro and Ariño (2013), henceforth GCA. The GCA model departs from the pivotal concepts of consistency and coverage as in Ragin (2008) and analyzes the distribution of consistency and coverage across cases and over time. Furthermore, the authors propose guidelines for assessing how stable the consistencies and coverage are across cases (within consistency and within coverage) and over time (between consistency and between coverage). Therefore, GCA propose three different types of consistency: pooled consistency (POCONS), between consistency (BECONS), and within consistency (WCONS).

The BECONS measures the cross-sectional consistency for each year in the panel. The WCONS measures how consistent the relations are across time for each particular case. The panel data contain T different BECONS, N different WCONS, and a single POCONS. The acknowledgment of the difference between each of the dimensions enables the researcher to understand the relations between the conditions and the outcome. For that, the authors propose to calculate the Euclidean distance between BECONS and POCONS (the smaller the distance, the more stable the consistency over time is, and in the case where the distance is high, an evaluation of the time effects must occur in the panel) and to calculate the Euclidean distance between WCONS and POCONS to analyze how WCONS varies across cases.

The analysis assesses the (pooled) coverage (POCOV), between coverage (BECOV), and within coverage (WICOV) as in Ragin (2008).

4.2. Calibration

The fsQCA requires the scaling of cases into degrees of membership (Ragin, 2008). Therefore, this study uses three different values to calibrate the data (Woodside, 2013): 0.95 to indicate full membership, 0.5 for the crossover point (neither in nor out) and 0.05 to indicate full non-membership. Table 1 presents the calibration and fuzzy values for each condition and outcome, as well as the statistics for the sample.

4.3. Analysis of necessary and sufficient conditions

A condition (or combination of conditions) is necessary if “it is present in all instances of an outcome” (Ragin, 2000, p. 203); a condition is necessary if the outcome occurs whenever that condition(s) occurs—although the outcome might occur under other conditions (Ragin, 2008). Table 2 presents the overview of necessary conditions for R&D intensity. Following Ragin (2000), the analysis uses the threshold of 0.80 to evaluate whether a condition is ‘almost always necessary.’ The results show that none of the conditions is necessary because all are below 0.80.

The analysis in the study shows the intermediate solution because that solution has simplifying assumptions that meet the theoretical arguments. Table 3 presents the overall results for the entire panel.

The findings in Table 3 show that the solution is informative with a consistency value of 0.94 and coverage of 0.79. These values are higher than the minimum acceptable for an informative solution, following the recommendation of Ragin (2008) and Woodside (2013).

The intermediate solution presents four configurations that satisfy the 0.80 threshold, which is equivalent to four possible paths that are conducive to *R&D intensity* (where * symbolizes the logical operator AND and ~ symbolizes the absence). The configuration with higher coverage (0.63) and with a very good consistency (0.98) is *Discrepancy industry* * ~*Discrepancy firm*. This solution indicates that having better performance than competitors and having performance lower than in the past is sufficient for *R&D intensity*.

The second configuration, *Distance from bankruptcy* * ~*Slack*, has a substantial coverage (0.57) and a considerable consistency (0.97). This solution indicates that a firm far from bankruptcy does not use slack resources to engage in R&D but uses other sources of financing.

The third configuration is *Distance from bankruptcy* * ~*Discrepancy industry* that has acceptable coverage (0.55) and considerable

Table 1
Calibration values and statistics.

	Statistics					Calibration values at			Fuzzy values descriptives			
	N	Mean	Std. Dev.	Min.	Max.	95%	50%	5%	Mean	Std. Dev.	Min.	Max.
Outcome												
R&D intensity	1387	0.009	0.022	0	0.097	0.065	0	0	0.573	0.142	0.500	0.990
Conditions												
Slack	1387	0.000	1.725	−27.986	36.711	1.852	−0.241	−0.943	0.454	0.276	0.000	1.000
Discrepancy firm	1387	−0.003	0.120	−0.376	0.376	0.211	−0.001	−0.217	0.496	0.226	0.010	1.000
Discrepancy industry	1387	−0.023	0.135	−0.526	0.180	0.147	0.004	−0.351	0.526	0.238	0.010	0.980
Distance from bankruptcy	1387	2.426	8.290	−18.906	27.044	17.592	1.808	−11.982	0.506	0.253	0.010	0.990

consistency (0.97). This configuration shows that the distance from bankruptcy increases the R&D intensity when in combination with the firm's inferior performance relative to industry aspirations. A firm that does not fear bankruptcy can focus on R&D search.

The fourth configuration is *~Distance from bankruptcy * Discrepancy firm * Slack* that has an acceptable coverage (0.41) and considerable consistency (0.99). The configuration indicates that a firm facing proximity to bankruptcy needs to have better performance than past aspirations and have available slack resources.

4.4. Analysis of consistency and coverage distances

Table 4 shows the POCONS, BECONS, and distance measures. The analysis of the consistencies shows that either the overall consistency (0.94) or each yearly consistency is above the threshold of 0.80.

The analysis shows that the WINCONS distance (0.076) is higher than the BECONS distance (0.009). Thus, according to GCA, the result shows that the cross-sectional effects dominate the time effects. The benchmark threshold is 0.012 and is below the WINCONS distance of 0.076. This result indicates that the data are not homogenous and that some clusters of firms are persistently consistent over time.

Table 4 also displays the yearly BECONS. The evolution is relatively stable over the period of analysis. The table shows that the BECONS distance is 0.009, which is lower than the benchmark. Thus, this result shows no evidence of time effects, which might be due to the fact that the period of analysis is after the 2008 financial crisis. Additionally, Table 4 also reports the overall coverage, POCOV (0.79), and the yearly BECOV. The inspection of the table discloses that the evolution of BECOV is smooth. Overall, the coverages indicate that the configurations have a high explanatory power for the *R&D intensity*.

Table 5 presents the test for the equality of means for firms with a consistency of less than one (group 0) and for firms with a consistency equal to one (group 1). The firms display some common features in terms of slack, sales, size (assets), and self-aspiration discrepancies. However, firms with a consistency equal to one ($N = 413$) are, on average, more R&D intensive, and lie closer to bankruptcy; and have lower performance (ROA), lower self-aspirations, higher industry aspirations,

and are further away from the industry aspirations when compared with firms with a consistency of less than one.

5. Robustness analysis

In order to check the validity of the results, the study conducts several robustness checks. First, the study uses alternative calibration values: 0.90, 0.50, and 0.10. The results for the intermediate solution return the same four configurations with just a slight decrease in consistency (0.908) and coverage (0.713). The WICONS and BECONS distances have the same interpretation.

Second, the robustness analysis includes the investigation of the conditions that are conducive to *~R&D intensity*. Using a similar consistency threshold (0.80), the intermediate solution's results show a single configuration that explains 66% of the output and has a consistency of 0.868. That configuration is *~Distance from Bankruptcy * Discrepancy firm * ~Slack*. This finding means that the proximity to bankruptcy, the lack of slack resources, and even having better performance than past aspirations is conducive to not investing in R&D.

6. Discussion and conclusions

The study finds four different combinations that lead to R&D intensity. The first configuration shows that when the firm's performance surpasses industry aspirations and when that performance falls below past aspirations, the solution is conducive to more R&D intensity. On the one hand, the result supports the problemistic search argument of behavioral firm theory that claims that R&D intensity increases as performance falls below aspirations. A firm whose performance falls below aspirations seeks new alternatives (e.g., Wiseman & Bromiley, 1996) and engages in more R&D (Chen & Miller, 2007). When aspirations are relative to industry levels, the same reasoning should apply. However, in terms of the discrepancy relative to aspirations that are relative to the industry aspiration, the findings do not support the theoretical argument. In fact, the results show that a firm with performance superior to the industry aspiration actually engages in more R&D. The theory does not dictate a comparison benchmark but rather defines aspirations broadly. One way to reconcile the results with the theoretical argument

Table 2
Overview of necessary conditions.

Condition	Cons	Cov
Slack	0.678	0.855
~Slack	0.736	0.771
Discrepancy firm	0.755	0.871
~Discrepancy firm	0.760	0.865
Discrepancy industry	0.779	0.847
~Discrepancy industry	0.713	0.862
Distance from bankruptcy	0.754	0.852
~Distance from bankruptcy	0.716	0.831

Note: ~ represents the absence of a condition.

Table 3
Results of the intermediate solution.

	Causal configuration	Row coverage	Unique coverage	Consistency
1	<i>Distance from bankruptcy * ~Slack</i>	0.570	0.020	0.968
2	<i>Distance from bankruptcy * ~Discrepancy industry</i>	0.547	0.023	0.974
3	<i>Discrepancy industry * ~Discrepancy firm</i>	0.632	0.095	0.976
4	<i>~Distance from bankruptcy * Discrepancy firm * Slack</i>	0.410	0.026	0.989

Solution coverage: 0.787; Solution consistency: 0.943.

Table 4
Between and within consistency.

	2009	2010	2011	2012	2013	2014
Between consistency (BECONS)	0.937	0.940	0.942	0.939	0.957	0.943
Between coverage (BECOV)	0.785	0.781	0.783	0.799	0.779	0.799
BECONS distance			0.009			
WINCONS distance			0.076			
POCONS			0.943			
POCOV			0.787			
N	265	256	245	221	209	191

is to consider that self-aspirations are indeed more relevant to risk taking through R&D expenses. The findings show that falling behind self-aspirations, but from the advantaged situation of fulfilling social aspirations, permits this kind of risk taking. Overall, Proposition 2 only holds for the firm's discrepancy, as long as the firm meets social aspirations.

The second configuration indicates that when bankruptcy does not threaten firms, managers allocate resources to R&D activities. Again, the configuration validates Proposition 3 but not Proposition 1 concerning slack. The findings are consistent with the behavioral theory of the firm; as the distance from bankruptcy increases, so does R&D search. However, the results do not support the argument that slack has a direct relation to search. Actually, the results indicate that in the absence of the threat of bankruptcy, slack is not always a financing source for R&D investments. Thus, the firm can finance R&D through external funds.

The third configuration again shows that the distance from bankruptcy increases the R&D intensity (validating Proposition 3) when in combination with the condition that the firms' performance is below industry aspirations (now supporting Proposition 2). The configuration indicates that if managers are not focusing their attention on operations to avoid bankruptcy, they direct their attention to the R&D search when competitors' performances surpass the firm's performance, as Chen and Miller (2007) argue.

The fourth configuration shows that if bankruptcy threatens managers (thus contradicting Proposition 3), they need to find alternative solutions to place the firm in safer conditions. Thus, R&D might enable the firm to find new opportunities as Nohria and Gulati (1996) suggest, but the firm needs to have available slack resources (supporting Proposition 1) and have a performance better than the self-aspiration (contradicting Proposition 3).

Overall, the results indicate four distinctive paths conducive to innovation. Operating far from bankruptcy frees firms from the need for slack, as does superior performance relative to competitors. When closer to bankruptcy, firms have slack and fulfill self-aspirations. When not fulfilling self-aspirations, firms outperform competitors.

The results indicate that firms are not all alike and differences are persistently consistent over time. The results highlight that firms are, on average, more R&D intensive, lie closer to bankruptcy, have lower performance (ROA), and have higher discrepancy in self-aspirations

Table 5
Test of equality of means between firms with consistency < 1 (group 0) and consistency = 1 (group 1).

Variable	Group 0 Consistency < 1	Group 1 Consistency = 1	t test
R&D intensity	0.002	0.023	0.000***
Slack	0.010	−0.019	0.752
Distance from bankruptcy	2.846	1.648	0.014**
Performance (ROA)	0.025	0.005	0.011**
Firm aspirations	0.028	0.004	0.005***
Industry aspirations	0.040	0.044	0.000***
Discrepancy firm aspirations	−0.004	0.001	0.475
Discrepancy industry aspirations	−0.015	−0.039	0.002***
Sales	457,367.60	472,018.70	0.765
Assets	385,939.70	431,465.60	0.330

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

but lower discrepancy with social aspirations. The results indicate that firms might use R&D as a way to overcome the aspirations not met and the proximity to bankruptcy, as in Chen and Miller (2007).

These results show that the situational determinants matter. How managers set their aspirations, either relative to past performance or to the competitor's performance, affects the propensity of engaging in search. The threat of bankruptcy and the availability of slack are also pivotal to achieving the outcome. Furthermore, the results indicate that what matters for R&D are the combinations the determinants form. More importantly, the findings inform managers, and potentially policy makers about alternative configurations with several paths that are conducive to R&D intensity. In fact, understanding how a myriad of paths is conducive to innovation, more than just through slack, is crucial to the competitive health of organizations, which ultimately has crucial implications for national competitiveness.

7. Limitations and future research

As in any piece of research, the present study has some limitations. First, the present empirical application focuses on UK firms in the aftermath of the crisis. The findings might not apply to another country or period. Second, the theoretical concepts underlying the relation between R&D intensity and situational determinants translate into the empirical application of measures common in the literature, but other operationalizations are possible and might be worth exploring. Third, the study relies on the novel analytical approach of GCA, which as the authors acknowledge, could add refinements, for example, concerning relevant and appropriate thresholds.

This analytical approach identifies panel structures, but as GCA note does not identify the structure that better fits the data. In this respect, the present study uses a test for the equality of means in order to identify different characteristics within firms. Nevertheless, future research can use different analytical methods to identify patterns in the data. A potential extension concerns the role of free cash flow because the present findings show that internal funding is also central to R&D investments.

Overall, this study highlights the relevance of QCA to the exploration of management issues. In the particular application to the firm's R&D intensity, the method shows paths conducive to R&D within firms, which goes beyond merely identifying the “net effects” of explanatory variables (Woodside, 2013, p. 463) and toward a more comprehensive approach to innovation issues.

References

- Alessandri, T. M., & Pattit, J. M. (2014). Drivers of R&D investment: the interaction of behavioral theory and managerial incentives. *Journal of Business Research*, 67(2), 151–158.
- Altman, E. I. (1968). Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *Journal of Finance*, 23(4), 589–609.
- Antonelli, C. (1989). A failure-inducement model of research and development expenditure: Italian evidence from the early 1980s. *Journal of Economic Behavior & Organization*, 12(2), 159–180.
- Bourgeois, L. J. (1981). On the measurement of organizational slack. *Academy of Management Review*, 6(1), 29–39.
- Bowman, E. H. (1982). Risk seeking by troubled firms. *Sloan Management Review*, 23(4), 33 (pre-1986).
- Bromiley, P. (1991). Testing a causal model of corporate risk taking and performance. *Academy of Management Journal*, 34(1), 37–59.
- Bromiley, P., & Harris, J. D. (2014). A comparison of alternative measures of organizational aspirations. *Strategic Management Journal*, 35(3), 338–357.
- Caren, N., & Panofsky, A. (2005). TQCA A technique for adding temporality to qualitative comparative analysis. *Sociological Methods & Research*, 34(2), 147–172.
- Chen, W. R., & Miller, K. D. (2007). Situational and institutional determinants of firms' R&D search intensity. *Strategic Management Journal*, 28(4), 369–381.
- Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: the two faces of R & D. *The Economic Journal*, 569–596.
- Cyert, R. M., & March, J. G. (1963). *A behavioral theory of the firm*. Englewood Cliffs, NJ: Prentice-Hall 2.
- Driver, C., & Guedes, M. J. C. (2012). Research and development, cash flow, agency and governance: UK large companies. *Research Policy*, 41(9), 1565–1577.

- García-Castro, R., & Ariño, M. A. (2013). A general approach to panel data set-theoretic research. *COMPASS working paper 2013–76*, published online 30 December 2013.
- Greenhalgh, C., & Rogers, M. (2010). *Innovation, intellectual property, and economic growth*. Princeton University Press.
- Greve, H. R. (1998). Performance, aspirations and risky organizational change. *Administrative Science Quarterly*, 43(1), 58–86.
- Herold, D. M., Jayaraman, N., & Narayanaswamy, C. R. (2006). What is the relationship between organizational slack and innovation? *Journal of Managerial Issues*, 18(3), 372–392.
- Iyer, D. N., & Miller, K. D. (2008). Performance feedback, slack, and the timing of acquisitions. *Academy of Management Journal*, 51(4), 808–822.
- Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305–360.
- Lant, T. K. (1992). Aspiration level adaptation: An empirical exploration. *Management Science*, 38(5), 623–644.
- Lant, T. K., & Montgomery, D. B. (1987). Learning from strategic success and failure. *Journal of Business Research*, 15(6), 503–517.
- Lee, S. (2015). Slack and innovation: Investigating the relationship in Korea. *Journal of Business Research*, 68(9), 1895–1905.
- Levinthal, D., & March, J. G. (1981). A model of adaptive organizational search. *Journal of Economic Behavior & Organization*, 2(4), 307–333.
- March, J. G., & Shapira, Z. (1992). Variable risk preferences and the focus of attention. *Psychological Review*, 99(1), 172–183.
- Marlin, D., & Geiger, S. W. (2015). A reexamination of the organizational slack and innovation relationship. *Journal of Business Research*, 68(12), 2683–2690.
- Miller, K. D., & Chen, W. -R. (2004). Variable organizational risk preferences: Tests of the March–Shapira model. *Academy of Management Journal*, 47(1), 105–115.
- Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, 13(2), 187–221.
- Nohria, N., & Gulati, R. (1996). Is slack good or bad for innovation? *Academy of Management Journal*, 39(5), 1245–1264.
- OECD (2012). *OECD science, technology and industry outlook 2012*. OECD Publishing.
- OECD (2014). *Entrepreneurship at a glance 2014*. OECD Publishing.
- Ragin, C. C. (2000). *Fuzzy-set social science*. Chicago: University of Chicago Press.
- Ragin, C. C. (2008). *Redesigning social inquiry: Fuzzy sets and beyond*. (Wiley Online Library).
- Singh, J. V. (1986). Performance, slack, and risk taking in organizational decision making. *Academy of Management Journal*, 29(3), 562–585.
- Taffler, R. J. (1983). The assessment of company solvency and performance using a statistical model. *Accounting and Business Research*, 13(52), 295–308.
- Washburn, M., & Bromiley, P. (2012). Comparing aspiration models: The role of selective attention. *Journal of Management Studies*, 49(5), 896–917.
- Wiseman, R. M., & Bromiley, P. (1996). Toward a model of risk in declining organizations: An empirical examination of risk, performance and decline. *Organization Science*, 7(5), 524–543.
- Woodside, A. G. (2013). Moving beyond multiple regression analysis to algorithms: Calling for adoption of a paradigm shift from symmetric to asymmetric thinking in data analysis and crafting theory. *Journal of Business Research*, 66(4), 463–472.