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# SINGLE STIMULI, MULTIPLE RESPONSES: PERFORMANCE FEEDBACK AND FIRMS' R&D CHANGES\*

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## Abstract

The behavioral theory of the firm assumes that firms react on performance feedback by increasing their search for alternative courses of action. However, the empirical literature is full of contradictory findings. This paper puts forward the idea that at least part of these contradictions can be explained if we can identify groups of firms behaving differently from firms in other groups and theoretical propositions. The paper uses exploratory analysis of US and German industrial firms and changes in R&D expense as their response to financial performance feedback. The cluster analysis of behavioural patterns of these firms results in identifying several behaviourally distinctive groups. The findings support the idea that contradictions in previous studies may partially stem from having a different mix of heterogeneously behaving firms. Also, they point to the proposition that for further understanding of responses to performance feedback, these groups of firms should be analysed separately.

**Keywords:** Behavioral theory of the firm, performance feedback, R&D expense, ROA, US industrial firms

**JEL Classification:** D22, D91, O32

## 1. Introduction

Performance feedback informs the firm about the fit of its strategy to the environment. The behavioral theory of the firm (Cyert and March, 1963) proposes that decision makers are boundedly rational, *i.e.*, they do not strive to attain the best outcome, but merely a satisfactory one (Simon, 1955). Satisfaction derives from the situation where performance exceeds the firm's goals, so-called aspirations. These aspirations are formed

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on historical and social performance benchmarks. Historical aspiration reflects a firm's prior performance, while social aspiration reflects performance of the firm's group of peers. Attainment of these aspirations strengthens the position of a given strategy as the strategy leads to satisfactory performance. On the other hand, having an unsatisfactory strategy – *i.e.*, one that does not lead to aspiration attainment – may cause search for new alternatives and a switch to a different one.

The empirical studies of performance feedback usually analyse their research samples as large pools of homogeneously behaving firms with individual differences controlled for by variables such as slack resources, firm size, age, *etc.* However, such an approach creates idealized “average” firms that logically differ from sample to sample based on characteristics of firms included in them. This “averaging” may explain part of the contradictory findings on firms' behaviour that exist in the literature. To tackle this problem, this paper aims to assess whether there exists systematic heterogeneity in firms' behaviour – *i.e.*, whether there is heterogeneity in firms' responses to performance feedback (behaviour) and this heterogeneity can be contained in a reasonably small number of groups of similarly behaving firms. The existence of systematic heterogeneity would allow the use of a more fine-grained approach to the analysis with a potentially better fit with the data and more importantly, more in-depth view of firms' real-life decisions.

## 2. Performance Feedback and R&D Expense

The firm reacts on performance feedback with a change in its search, *i.e.*, the activity of looking for new strategic alternatives. The literature uses research and development (R&D) as the closest proxy for a search activity that is available from public financial data. Based on Cyert and March's (1963) proposition, when the firm experiences a negative attainment discrepancy (when the difference between performance and the aspiration/goal is negative, *i.e.*, when the firm does not attain its aspiration), it should increase its R&D in comparison to the situation of positive attainment discrepancy (when its performance is higher than the aspiration). This increase in R&D should reflect more search effort for alternatives that are currently not available to the firm.

The performance feedback literature studies R&D in two forms: (i) as R&D expense and its change (*e.g.*, Bromiley and Washburn, 2011); or as (ii) R&D intensity – R&D expense to sales – and its change (*e.g.*, Greve, 2003b). It is important to note that R&D expense and R&D intensity are measures of slightly different constructs (Bromiley *et al.*, 2017). In line with this, implications stemming from the study of one measure cannot be directly generalised to the firm's behaviour regarding the other one. For example, the observed changes in R&D intensity can be partially credited to changes in sales that are not caught up by changes in R&D expense.

These differences are also reflected in the findings of empirical studies (Table 1). Bromiley and Washburn (2011) and Alessandri and Pattit (2014) note that R&D expense decreases when the firm performs below aspirations and increases when it performs above aspirations. The only exception is the historical aspiration in the case of Bromiley and Washburn (2011), which has a more complicated structure – the effect of performance feedback is non-significant for their full sample but leads to decreases both below and above the aspiration for a sample of firms with at least one patent. Although there are only a few studies on R&D expense, the results already show some differences.

**Table 1: Overview of research findings on R&D as a response to performance feedback**

|                                       | <b>Below aspiration</b> | <b>Above aspiration</b>              |
|---------------------------------------|-------------------------|--------------------------------------|
| <b>R&amp;D expense</b>                |                         |                                      |
| <b>Alessandri and Pattit, 2014</b>    | Decrease                | Increase                             |
| <b>R&amp;D expense change</b>         |                         |                                      |
| <b>Bromiley and Washburn, 2011</b>    | Decrease                | Mixed (increase – SA; decrease – HA) |
| <b>R&amp;D intensity</b>              |                         |                                      |
| <b>Greve, 2003b</b>                   | Decrease                | Increase                             |
| <b>Chen and Miller, 2007</b>          | Decrease (SA)           | Decrease                             |
| <b>Chen, 2008</b>                     | Increase                | Mixed (increase – HA; decrease – SA) |
| <b>Vissa, Greve, and Chen, 2010</b>   | Increase                | Decrease                             |
| <b>O’Brien and David, 2014</b>        | Increase                | Increase                             |
| <b>Lewellyn and Bao, 2015</b>         | Not used                | Increase                             |
| <b>R&amp;D intensity change</b>       |                         |                                      |
| <b>Lucas, Knoben, and Meeus, 2018</b> | Increase                | Decrease (HA)                        |

Note: SA – social aspiration (performance goal stemming from social comparison); HA – historical aspiration (performance goal stemming from comparison with firm’s historical performance)

Source: Own review

In contrast to the lack of studies on R&D expense, the research focusing on R&D intensity offers a richer account of behavioural implications of performance feedback.

Only Greve (2003b) reports a strategic behaviour that corresponds to what we observe in R&D expense change, in this sense a decrease in R&D intensity when below aspirations and vice versa. However, this can be caused by a different cultural context (Japan in contrast to studies commonly focusing on firms from the US; O'Brien and David, 2014, who study firms from both countries indeed point to behavioural differences of Japanese firms) or a different form of calculating aspirations (Greve, 2003b, combines both historical and social aspiration into one measure; that corresponds to findings of Jirásek, 2017, who also notes differences in observed behaviour caused methodologically by combining or separating both aspiration measures).

Another study that finds that firms decrease their R&D intensity when below aspirations, in this case, the social aspiration, is by Chen and Miller (2007). On the other hand, they also report a decrease when above aspirations. In contrast to the previous, Chen (2008), Vissa *et al.* (2010), O'Brien and David (2014) and Lucas *et al.* (2018) agree with the search-related prediction of Cyert and March (1963) with R&D intensity increasing below the aspiration level.

Notwithstanding, findings on firms' responses to performance above their aspiration levels are highly mixed as half of the studies report a decrease in R&D intensity when above the aspiration level, while the other report an increase in R&D intensity. Chen (2008) even indicates different responses to historical and social aspirations. Therefore, our understanding of firms' behaviour in response to performance feedback is far from conclusive.

The contradictory findings may be a consequence of numerous factors that decrease the comparability of individual studies, as partially discussed above. They may include different approaches to aspiration modelling (some studies separate social and historical aspirations into two individual variables – *e.g.*, Chen, 2008, or Lucas *et al.*, 2018 – while others use their weighted average – *e.g.*, Greve, 2003b, or Vissa *et al.*, 2010), different performance dimension (Lewellyn and Bao, 2015, use Tobin's Q, while Lucas *et al.*, 2018, use net sales; in contrast to the rest of the literature, which chooses return on assets), countries of study (*e.g.*, Vissa *et al.*, 2010, conduct their research in India, while O'Brien and David, 2014, in Japan), and various moderating factors (*e.g.*, performance expectations in the case of Chen, 2008, or transactional or relational nature of ownership in the case of O'Brien and David, 2014).

Besides these factors, I argue that there may be unobserved behavioural heterogeneity in individual samples as indicated by the research of Chen and Miller (2007) on R&D intensity and Iyer and Miller (2008) on acquisitions. Both papers use some kind of splitting of the sample based on firms' financial situation or performance feedback. Despite the fact that their sample splits are based on characteristics other than behaviour and are quite restrictive in nature (*e.g.*, Chen and Miller, 2007, split the sample in half based

on either the level of Altman's Z or the level of slack resources), they clearly indicate that some firms respond differently to performance feedback than others. If we assume that groups of such firms exist in various proportions in individual samples, some of the contradictions in the empirical literature may be simply caused by a changing proportion of these heterogeneously behaving groups of firms. The present paper tests the proposition using both individual cluster analyses of two distinctive samples and subsequent comparison of individual behavioural cluster representations in these two samples.

### 3. Methodology

The paper uses two samples of stock-exchange listed industrial firms (Global Industry Classification Standard code 20) observed over the period 2001–2015, the first consisting of 215 firms domiciled in the United States, and the second of 44 firms domiciled in Germany. Only those firms that have at least one observation of all variables related to R&D expense change and performance feedback enter the individual samples.

The choice of US industrial firms is motivated by the fact that their population is the most popular data source for performance feedback studies: out of the nine studies summarized in Table 1, four (Chen and Miller, 2007; Chen, 2008; Bromiley and Washburn, 2011; Alessandri and Pattit, 2014) draw upon various samples of US industrial firms. That makes them the first choice for a study that attempts to explain heterogeneous behaviour. Besides, I aim to replicate the study's methodology in a different context, preferably European, as previous research has shown that firms' behaviour differs from country to country (*e.g.*, O'Brien and David, 2014). Additionally, two different samples would give more support to the study findings if they showed corresponding results. The choice of Germany stems from the availability of R&D expense data for a sufficient number of firms there over the long term. Data availability makes research in smaller countries such as the Czech Republic (which also have lots of firms being subsidiaries of foreign conglomerates) impossible.

#### 3.1. Variables

In order to support comparison of results to previous research, I use the operationalization of variables commonly used in the performance feedback literature. Besides exceptions such as age, most of the variables are based on accounting measures from firms' annual reports (downloaded from the Bloomberg database).

*Firms' behaviour.* The research uses year-on-year R&D expense change as a proxy of change in firms' level of search. R&D expense is a standard measure for this purpose (Greve,

2003a) as it represents an activity that looks for new (strategic) alternatives for the firm. Change in R&D expense then corresponds to a lower or a higher intensity of this search activity.

*Aspiration level.* To simplify the analysis, it focuses only on historical aspiration. This step is motivated by two reasons. Firstly, it allows us to skip problems related to the ideal aspiration model (*i.e.*, whether historical and social aspirations should be combined into one measure and how or whether they should be separated; Bromiley and Harris, 2014). Secondly, it allows us to avoid the problem of the composition of a social reference group, which remains a puzzle for behavioural strategy scholars (Posen *et al.*, 2017). Currently, the literature lacks valid methods for constructing social aspirations. Moreover, avoiding the use of social aspiration and focusing only on historical aspiration is not rare in the literature (it is used, *e.g.*, by Ref and Shapira, 2017).

*Performance and performance feedback.* In line with the previous research (*e.g.*, Bromiley and Washburn, 2011; Alessandri and Pattit, 2014), I use return on assets (ROA, *i.e.*, EBIT divided by total assets) as a performance variable, and I construct the aspiration level as the previous year's performance. Simply said, I assume that the firm tries to perform the same or better than last year. Therefore, the firm achieves a positive attainment discrepancy between performance and aspiration when its ROA in a given year exceeds ROA it achieved the year before. Conversely, the firm achieves a negative attainment discrepancy when its ROA in a given year does not attain the level of ROA of the year before.

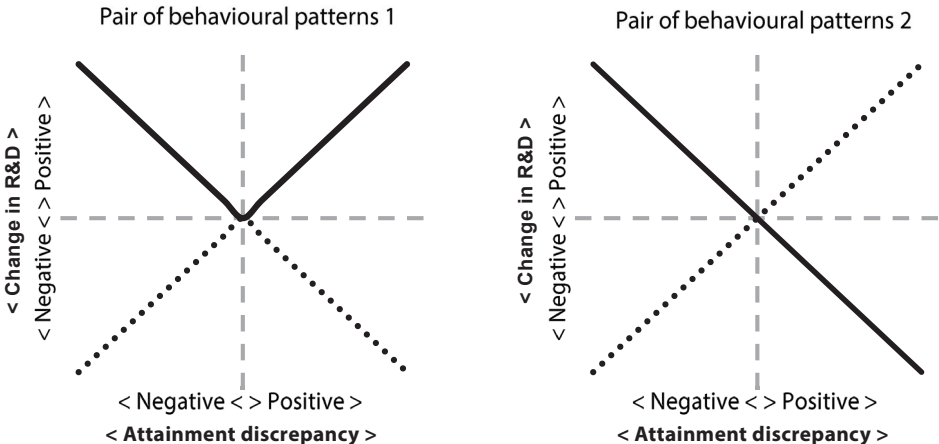
*Firms' characteristics.* For further analysis of individual clusters, I use several measures of firms' characteristics – age, market capitalisation, total assets, sales, R&D expense, R&D intensity (R&D expense divided by sales) and ROA. Besides these common “managerial” measures, I also include two measures of organisational slack. Organizational slack is a concept directly related to performance feedback (Cyert and March, 1963) that represents resources not fully used by the firm – and this paper distinguishes between available and potential slack. Consistent with the previous research (*e.g.*, Greve, 2003b; Chen, 2008), I define available slack as a current ratio (ratio of current assets and current liabilities). Potential slack is commonly measured as the ratio of debt to equity (*e.g.*, Vissa *et al.*, 2010), but due to the occurrence of several firms with low or even negative levels of shareholders' equity, which highly distorts the distribution of this ratio, I switch to an alternative measure of debt to assets (*e.g.*, Lewellyn and Bao, 2015, and partially O'Brien and David, 2014).

### 3.2. Estimation

There are two pairs of opposing generic patterns of firms' R&D behaviour (Figure 1). For example, in pair 1, the solid line indicates a firm that increases its R&D expense both below and above the aspiration level. The behaviour of any firm in the samples can then

be described by its resemblance to these pairs. As the pairs consist of behaviours that are direct opposites, I further work with only one behavioural pattern from each pair (depicted by the solid line in Figure 1). Based on yearly observations of individual firms, I calculate the ratio of resemblance of a given firm’s R&D behaviour to these two generic behavioural patterns.

**Figure 1: Pairs of generic behavioural patterns**



Source: Own depiction

The ratio of resemblance to each pair of behavioural patterns is formed as follows:  
 (i) a firm’s response to performance feedback in a given year is coded as 0 when it does not correspond to a given generic behavioural pattern (which means that it corresponds to the opposite, dotted one in the pair) or 1 when it corresponds;  
 (ii) a firm’s ratio of resemblance is calculated as a mean of all 0/1 for a given firm. To illustrate the above calculations, consider a firm with four yearly observations; its performance is twice below and twice above its aspiration level. When it is below an aspiration, it always decreases its R&D expense (coded as 0 for calculating both ratios); when it is above an aspiration, it always increases its R&D expense (coded as 1 for the first ratio and as 0 for the second one). The resulting ratios for the illustrative firm are therefore 0.5 for the first one (the firm is not distinguishable under this perspective, it is somewhere “in between” behavioural patterns in pair 1) and 0 for the second one (the firm’s behaviour perfectly corresponds to the opposite, dotted line or behavioural pattern in pair 2).

To identify possible groups of firms with distinctive reactions to performance feedback, I use TwoStep cluster analysis implemented in IBM SPSS Modeler 18 software. The clustering of firms is based on two calculated behavioural ratios (*i.e.*, I group firms with similar behaviours) with the log-likelihood distance/similarity measure. I leave the preset minimum number of clusters to be identified at two, and the resulting number of clusters is decided automatically by the software using the Akaike information criterion (AIC), which compares individual solutions. The characteristics of firms in individual clusters are then described based on the nine criteria mentioned above. Due to distortion caused by outliers, I use the median (and quartiles) instead of commonly used means and standard deviations to do this.

## 4. Results

### 4.1 Sample 1 – US industrial firms

The cluster analysis results in four clusters with a silhouette measure of cohesion and separation of 0.5, which is considered good. The relative sizes of clusters are 32%, 43%, 9% and 16% with the ratio of the largest to the smallest cluster being 4.6. Table 2 contains the median and the first and third quartile characteristics of firms that compose them.

According to these characteristics, Cluster 1 contains relatively large and old firms with moderate R&D intensity, good liquidity position, conservative debt position, and good profitability. Such a description would correspond to so-called “blue chips”: stable and diversified conglomerates. Firms in Cluster 2 are around the average of the whole sample on most of the criteria, except higher R&D intensity: these firms are rather R&D “specialists” focused around a single business. Similar in term of R&D intensity are firms from Cluster 3, the main difference being their relatively smaller size and age. These firms are a kind of “new entrants”, focused on growth rather than profitability, and their expectations of further growth are also reflected in a premium difference between market cap and total assets or sales. Finally, firms from Cluster 4 can be considered “decliners”, their market capitalisation relative to total assets or sales being much lower than for the others, meaning that they are out of favour among investors. Also, their R&D intensity is smaller and probably much constrained by their high debt-to-assets ratios. Figure 2 graphically illustrates the characteristics of a median firm from each cluster.

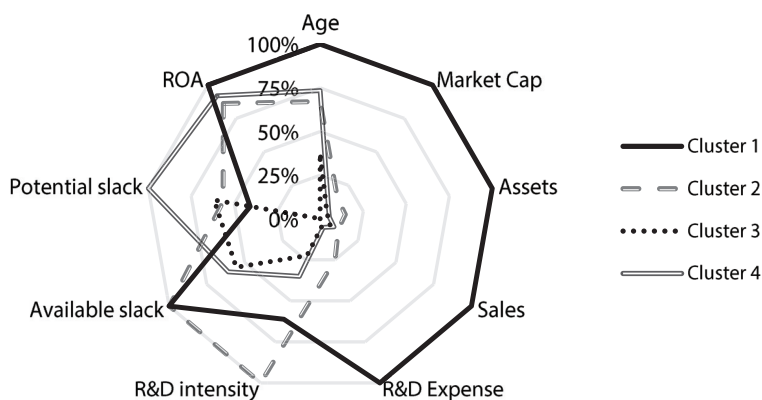


**Table 2: Characteristics of individual clusters (US sample)**

|                                | Age (years) | Market cap (mil. \$) | Assets (mil. \$) | Sales (mil. \$) | R&D expense (mil. \$) | R&D intensity (%) | Avail. slack (current ratio) | Potent. slack (debt to assets) | ROA (EBIT to assets; in %) |
|--------------------------------|-------------|----------------------|------------------|-----------------|-----------------------|-------------------|------------------------------|--------------------------------|----------------------------|
| <b>Cluster 1 (n = 69)</b>      |             |                      |                  |                 |                       |                   |                              |                                |                            |
| <b>1<sup>st</sup> quartile</b> | 15          | 56                   | 155              | 31              | 1.78                  | 2.26              | 1.68                         | 0.07                           | -2.60                      |
| <b>Median</b>                  | 32          | 519                  | 1,160            | 254             | 8.01                  | 3.83              | 2.42                         | 0.17                           | 6.30                       |
| <b>3<sup>rd</sup> quartile</b> | 70          | 1,579                | 5,202            | 1,291           | 36.73                 | 10.77             | 3.20                         | 0.30                           | 9.70                       |
| <b>Cluster 2 (n = 92)</b>      |             |                      |                  |                 |                       |                   |                              |                                |                            |
| <b>1<sup>st</sup> quartile</b> | 11          | 21                   | 24               | 4               | 0.55                  | 1.96              | 1.40                         | 0.09                           | -82.60                     |
| <b>Median</b>                  | 22          | 79                   | 169              | 30              | 1.99                  | 6.26              | 2.41                         | 0.23                           | -4.70                      |
| <b>3<sup>rd</sup> quartile</b> | 52          | 587                  | 2,272            | 600             | 12.47                 | 57.96             | 3.75                         | 0.44                           | 7.60                       |
| <b>Cluster 3 (n = 20)</b>      |             |                      |                  |                 |                       |                   |                              |                                |                            |
| <b>1<sup>st</sup> quartile</b> | 7           | 17                   | 6                | 1               | 0.08                  | 0.32              | 0.85                         | 0.13                           | -348.70                    |
| <b>Median</b>                  | 12          | 30                   | 52               | 17              | 0.31                  | 1.40              | 1.34                         | 0.25                           | -74.00                     |
| <b>3<sup>rd</sup> quartile</b> | 47          | 217                  | 798              | 247             | 2.38                  | 62.40             | 2.54                         | 0.84                           | 5.80                       |
| <b>Cluster 4 (n = 34)</b>      |             |                      |                  |                 |                       |                   |                              |                                |                            |
| <b>1<sup>st</sup> quartile</b> | 8           | 8                    | 17               | 3               | 0.09                  | 0.40              | 0.86                         | 0.21                           | -105.10                    |
| <b>Median</b>                  | 24          | 39                   | 62               | 23              | 0.41                  | 2.20              | 1.47                         | 0.41                           | -0.10                      |
| <b>3<sup>rd</sup> quartile</b> | 58          | 275                  | 2,729            | 1,812           | 2.80                  | 15.54             | 2.44                         | 1.65                           | 4.60                       |

Source: Own calculation

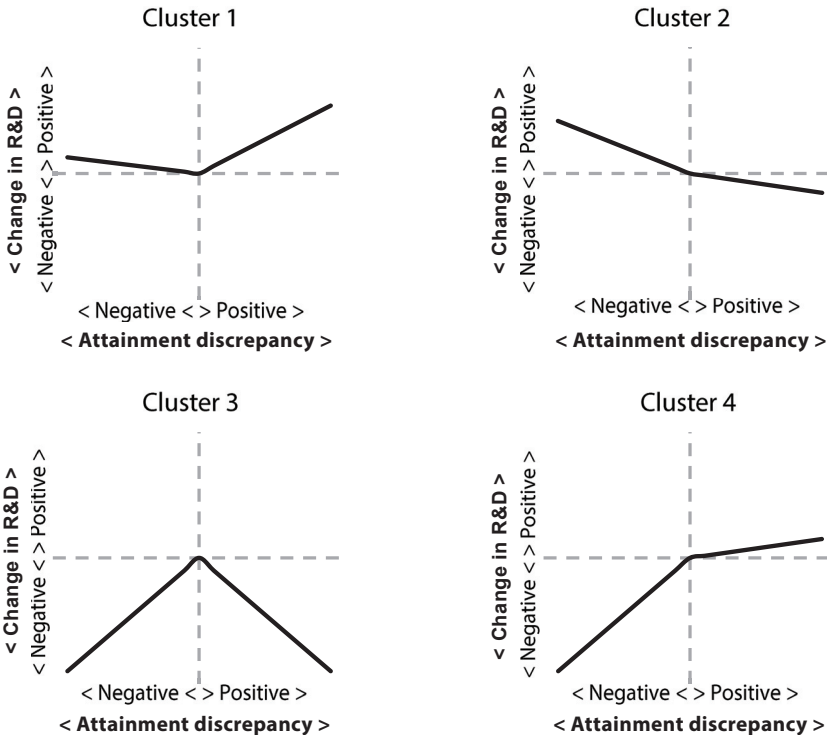
**Figure 2: Median firm characteristics for individual clusters (US sample)**



Source: Own depiction

Figure 3 contains behavioural patterns of median firms from individual clusters; the clusters' distributions of ratios of a resemblance to each pair of generic behavioural patterns are presented in the Appendix. As for the firm representing Cluster 1, its response to the performance below aspiration is positive but close to the horizontal line, meaning that the reaction to the negative attainment discrepancy (when performance is lower than aspiration) is likely to be different among firms in the cluster. On the other hand, the positive attainment discrepancy is related to an increase in R&D expense. The median firm from Cluster 2 (“specialists”) indicates rather increases in R&D expense in times of the negative discrepancy, while it does not consistently respond to the positive discrepancy. The median firm from Cluster 3 decreases its R&D expense in both cases. Also, the median firm from Cluster 4 diminishes its R&D with the negative discrepancy; its behaviour in the positive discrepancy indicating an increase but close to the horizontal line.

**Figure 3: Median firm behavioural patterns for individual clusters (US sample)**



Source: Own depiction

## 4.2 Sample 2 – German industrial firms

The cluster analysis results in three clusters with a silhouette measure of cohesion and separation of 0.5, which is considered good. The relative sizes of clusters are 23%, 66% and 11% with the ratio of the largest to the smallest cluster being 5.8. Table 3 contains the median and the first and third quartile characteristics of firms that compose them.

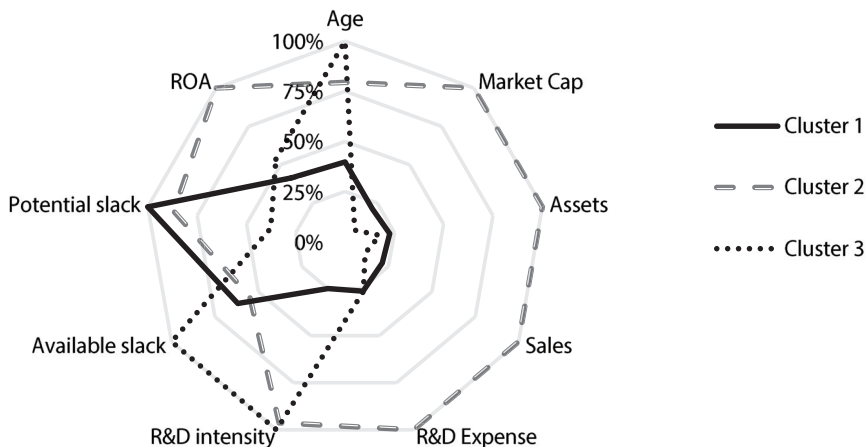
**Table 3: Characteristics of individual clusters (German sample)**

|                                | Age (years) | Market cap (mil. \$) | Assets (mil. \$) | Sales (mil. \$) | R&D expense (mil. \$) | R&D intensity (%) | Avail. slack (current ratio) | Potent. slack (debt to assets) | ROA (EBIT to assets; in %) |
|--------------------------------|-------------|----------------------|------------------|-----------------|-----------------------|-------------------|------------------------------|--------------------------------|----------------------------|
| <b>Cluster 1 (n = 10)</b>      |             |                      |                  |                 |                       |                   |                              |                                |                            |
| <b>1<sup>st</sup> quartile</b> | 16          | 44                   | 160              | 105             | 0.24                  | 0.17              | 1.13                         | 0.16                           | 1.20                       |
| <b>Median</b>                  | 45          | 111                  | 641              | 177             | 3.71                  | 0.81              | 1.73                         | 0.19                           | 2.60                       |
| <b>3<sup>rd</sup> quartile</b> | 119         | 1,378                | 6,961            | 1,278           | 13.30                 | 5.84              | 2.35                         | 0.31                           | 6.00                       |
| <b>Cluster 2 (n = 29)</b>      |             |                      |                  |                 |                       |                   |                              |                                |                            |
| <b>1<sup>st</sup> quartile</b> | 33          | 73                   | 270              | 120             | 3.03                  | 1.82              | 1.23                         | 0.06                           | 4.70                       |
| <b>Median</b>                  | 89          | 523                  | 2,833            | 827             | 14.09                 | 3.13              | 1.54                         | 0.16                           | 6.30                       |
| <b>3<sup>rd</sup> quartile</b> | 124         | 1,200                | 6,142            | 1,884           | 57.94                 | 4.96              | 2.53                         | 0.20                           | 10.90                      |
| <b>Cluster 3 (n = 5)</b>       |             |                      |                  |                 |                       |                   |                              |                                |                            |
| <b>1<sup>st</sup> quartile</b> | 13          | 34                   | 227              | 16              | 1.10                  | 1.90              | 2.15                         | 0.05                           | -9.00                      |
| <b>Median</b>                  | 112         | 39                   | 499              | 95              | 3.74                  | 3.26              | 2.81                         | 0.07                           | 3.40                       |
| <b>3<sup>rd</sup> quartile</b> | 137         | 331                  | 2 479            | 498             | 16.21                 | 3.50              | 6.47                         | 0.09                           | 10.70                      |

Source: Own calculation

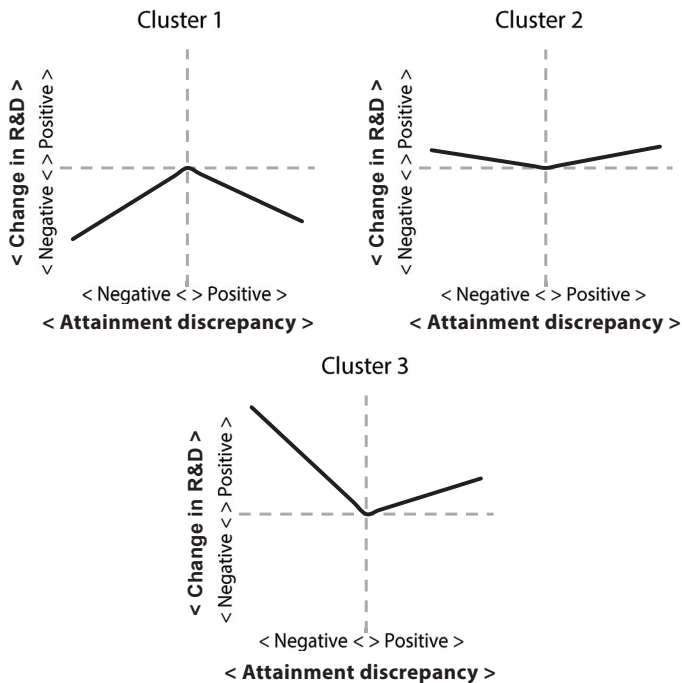
According to these characteristics, Cluster 1 contains relatively young firms of various size and R&D intensity, and higher debt ratios and corresponding lower profits. In these characteristics, the group corresponds to the more established form of “new entrants” cluster identified among the US firms. Firms from Cluster 2 have their characteristics rather spread or around the middle of the distribution, except their bigger size and higher profitability. In this sense, they correspond to the US “blue chips”. Finally, firms from Cluster 3 are generally older and smaller in market capitalisation and sales, have a high current ratio and low levels of debt. Their profitability is, on the other hand, spread from loss-makers to high profits. In this sense, they are “specialists” focused around a single business. Figure 4 graphically illustrates the characteristics of a median firm from each cluster.

**Figure 4: Individual clusters' median firm characteristics (German sample)**



Source: Own depiction

**Figure 5: Median firm behavioural patterns for individual clusters (German sample)**



Source: Own depiction

Figure 5 contains behavioural patterns of median firms from individual clusters; the clusters' distributions of ratios of resemblance to each pair of behavioural patterns are presented in the Appendix. The median firm from Cluster 1 increases its R&D expense in both the case of positive and the case negative attainment discrepancy between performance and aspiration. The behaviours of the median firms from Cluster 2 and Cluster 3 are quite similar. However, the median firm from Cluster 3 has more aggressive reactions to performance feedback in both cases of attainment discrepancy. In this sense, the behaviour of the Cluster 2 median firm is close to the horizontal line, meaning that firms from this cluster may not respond strongly to performance feedback.

### 4.3 Stability and validity of cluster analyses

As the stability and validity of clusters represent an important criterion for assessment of cluster analyses (Clatworthy *et al.*, 2005), I pay considerable attention to these topics as well. When re-running the cluster analyses with random 75% cases of each sample, the number of identified clusters is relatively stable and increases or decreases by one from time to time. I also re-run the analyses with random 50% cases of each sample, but in this case, the results for the German sample become less stable – which is understandable due to the low number of firms present in the full sample. What is also important regarding stability, clusters do not tend to mix up in these repeated cluster analyses, *i.e.*, a given case remains in the group with the same cases. This is not surprising since the firms in clusters reported in the study largely tend to closely share behavioural patterns as evident from distributions presented in the Appendix (where we can see that the distributions are usually not spread over the whole range).

The validity for the field of study is demonstrated by the analysis of firms' characteristics. Since it is possible to identify values of certain characteristics shared by the firms in the same cluster (and not used as clustering variables), the research shows that it is meaningful and valid to use cluster analysis of firms' behavioural patterns. Also, the identification of clusters with similar characteristics in two independent samples supports the idea and is further strengthened by the similarity in the behaviour of these groups that I discuss further below.

## 5. Discussion

The cluster analyses led to the identification of four clusters in the case of US firms and three clusters in the case of Germany. According to their relative characteristics, they are called “blue chips”, “specialists”, “new entrants”, and “decliners”, with the last one present only in the US sample. What is important, the median firm behavioural patterns

of “blue chips” and “new entrants” (and cluster distributions of ratios of resemblance) largely correspond to their peers in the other sample. In the case of “specialists”, there is a difference between firms’ response to positive attainment discrepancy. The absence of “decliners” in the German sample is understandable when we acknowledge the smaller number of firms in this sample. As this cluster represents only 16% of firms in the US sample (only the “new entrants” cluster has a smaller share), it would be represented with around seven firms in the German sample when we assume the same proportion in both samples – which is not even the case here. First of all, this number is already small for a new cluster to arise and, additionally, it can be affected greatly with just a small deviation in the number of these firms (*e.g.*, if there were only five such firms). Finally, since declining firms are likely to be threatened by a bankruptcy (or take-over), there may be selected out easily in such a small sample.

The behavioural pattern of “blue chips” (Cluster 1 in the US sample and Cluster 2 in the German sample) is likely connected with following a stable strategy as increase or decrease in R&D expense can go hand in hand with changing levels of sales and profitability. Indeed, it is quite common among industrial firms to peg their R&D expense to sales (*i.e.*, they fix their R&D intensity), which would lead to an increase in good times and a decrease in bad times. Such a clear decrease is, however, not observed for the negative discrepancy and that points out to some change in strategy (more investment spent on R&D as the firm tries to discover new strategic alternatives). The original behavioral theory of the firm (Cyert and March, 1963), building upon the concept of satisficing (Simon, 1955) suggests that successful alternatives remain in place, while unsuccessful alternatives change – which corresponds to what we can observe in the behavioural pattern of “blue chips”.

However, the behavioural patterns of “specialists” (Cluster 2 in the US sample and Cluster 3 in the German sample) are different. Again, we observe an increase in R&D expense in response to negative discrepancy, this time more dynamic. In the case of positive attainment discrepancy, there is a difference in firms’ responses between the two samples. However, in both cases, the responses are not that distant from the horizontal axis, meaning that there is no exclusive form of firms’ behaviour in this case. It is likely that other factors play a role in this pattern – both more rational (an effort to improve financial position) and less rational (confidence and focus on further improvement of short-term results by limiting costs).

The seemingly meaningless behavioural pattern of “new entrants” (Cluster 3 in the US sample and Cluster 1 in the German sample) is not isolated in the literature. Bromiley and Washburn (2011) observe a similar pattern for historical aspiration of US industrial firms holding at least one patent. However, a direct correspondence between the two results is

dubious as firms that form clusters of “new entrants” are rather small and young, meaning that they are less likely to hold a patent than larger and older companies from other clusters (although this possibility cannot be utterly ruled out). In this case, I expect their decreases in R&D expense to be a result of a limited (although not severely) financial situation and a need to show investors some profitability. Regardless of the reason, for such firms, the propositions of the behavioral theory of the firm do not hold, or are diminished by other, more important factors (similar diminishment is noted by Jirásek, 2017, for smaller pharmaceutical firms that are often waiting for their first drug approval).

In general, the situation is similar in the cluster of “decliners” (Cluster 4 in the US sample, not identified in the German sample), who are limited in their resources, having already amassed substantial debt and showing less profitable performance, and apparently not able to invest more resources in R&D when they underperform. The negative discrepancy, therefore, results rather in cost-cutting (similarly to what Bromiley and Washburn, 2011, observe). On the other hand, in the case of positive discrepancy, there are some signs of increases in R&D – which further support consideration of these firms as “decliners” as they likely try to improve their competitiveness when the situation allows.

Neither of the analyses (on the US or the German sample) indicates that these behavioural clusters should be something specific to the two countries’ contexts. Therefore, I suggest that the research implications should be applied to performance feedback studies both in different countries and with firms having different characteristics (*e.g.*, non-listed ones, other industries), at least as a cautionary measure or a robustness check. In this sense, the research has value for considerably different contexts, such as firms in the Czech Republic, which are different in the composition from the firms in the studied samples (Czech firms are mostly privately held and smaller in size in general).

## 5.1 Further research

The findings of the research support intra-sample heterogeneity of responses to performance feedback. Commonly, this heterogeneity is “erased” with controls leading to the behaviour of the ideal firm. However, as we have seen above, such an ideal firm may exist, but it is not likely to be representative of all other firms. As a few researchers already work with splitting the samples based on certain criteria (*e.g.*, Chen and Miller, 2007; Iyer and Miller, 2008), I believe that such an approach should be followed further and ideally, future sample splitting should be based on sample properties and not on a-priori decisions. Further research can, therefore, use cluster analysis to first divide the sample according to firms’ behaviour and then study the behaviour in detail.

Studying differences in behaviour in more depth is necessary as the propositions of the behavioral theory of the firm hold mainly for the “blue chips” and “specialists” clusters, consisting of rather established firms. The theoretical explanation of the behaviour of firms falling into the “decliners” cluster may draw upon survival threat (Chen and Miller, 2007), but behaviour of “new entrants” is worth further research interest and can potentially explain the observed inconsistency in findings of previous studies. The identification of clusters is only rough, and it is highly likely that, *e.g.*, the “new entrants” cluster also contains firms that are not in the entry stage, especially in the German sample, where the “decliners” cluster is missing. On the other hand, it may be interesting to look at these exceptions and explain why more matured firms behave like this.

## 5.2 Limitations

Some authors even consider R&D as “pure search” (*e.g.*, Greve, 2003a), minimally affected by effects of change-making or risk-taking. However, it can also be viewed as a result of this search, manifestation of a new strategic alternative that the firm adopts (change in R&D as a decision to refocus the firm’s competitive strategy). I agree with Posen *et al.* (2017) that this combination is problematic as these two aspects cannot be decoupled. Still, R&D expense is arguably the best proxy for search that we can publicly access.

The research contained in this paper is clearly limited by some simplifications in the methodology that are mentioned in the respective section (use of only historical aspiration and simplified coding of firms’ responses to performance feedback), yet I consider it robust enough to support the propositions raised. Apparently, there is heterogeneity in firms’ behaviour. Luckily for future research, though, this heterogeneity can be contained in a meaningful number of sub-sector groups.

## 6. Conclusion

The paper puts forward the idea that firms react heterogeneously to performance feedback, the mechanism in which (as proposed by the behavioral theory of the firm) firms compare their performance with their aspirations/goals. Such heterogeneity in responses may explain a part of the contradictory findings in the current literature simply by having different proportions of behavioural groups in individual samples. The dominance of a certain group, and, therefore, a behavioural pattern, may outweigh the others when using regression analyses in one sample, while in another sample, the same group can be underrepresented, leading to a different pattern of response to performance feedback.

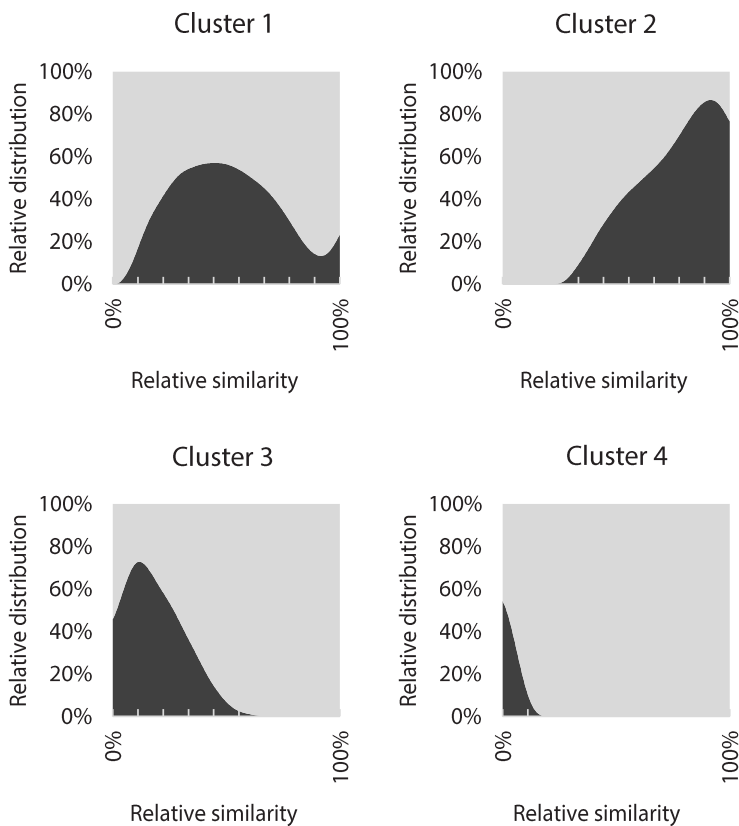
The paper uses cluster analyses of behavioural patterns of firms from two separate samples – US and German industrials – regarding R&D change as the form of response



to performance feedback. The findings indeed support the idea that there are groups of firms that react differently from both other groups and the original propositions of the theory. Furthermore, the proportions of this cluster vary highly between the two samples. Based on this, the research proposes that analysing a large number of firms as one homogeneous sample negatively affects the reliability of research. Additionally, by following this approach, it also potentially erases parts of firms' distinctive behaviour while limiting our understanding of their decision-making. Therefore, splitting the sample based on carefully selected firms' characteristics may enrich our understanding of behavioural patterns of various types of firms and lead to more conclusive findings.

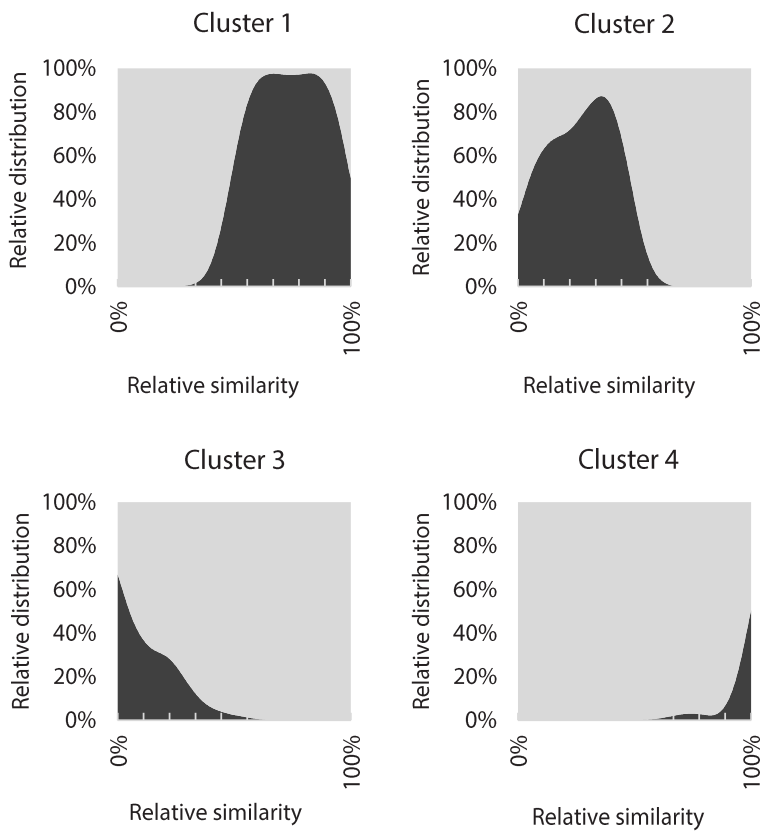
## Appendix

**Figure 6: Cluster similarity to generic pair of behavioural patterns 1 (US sample)**



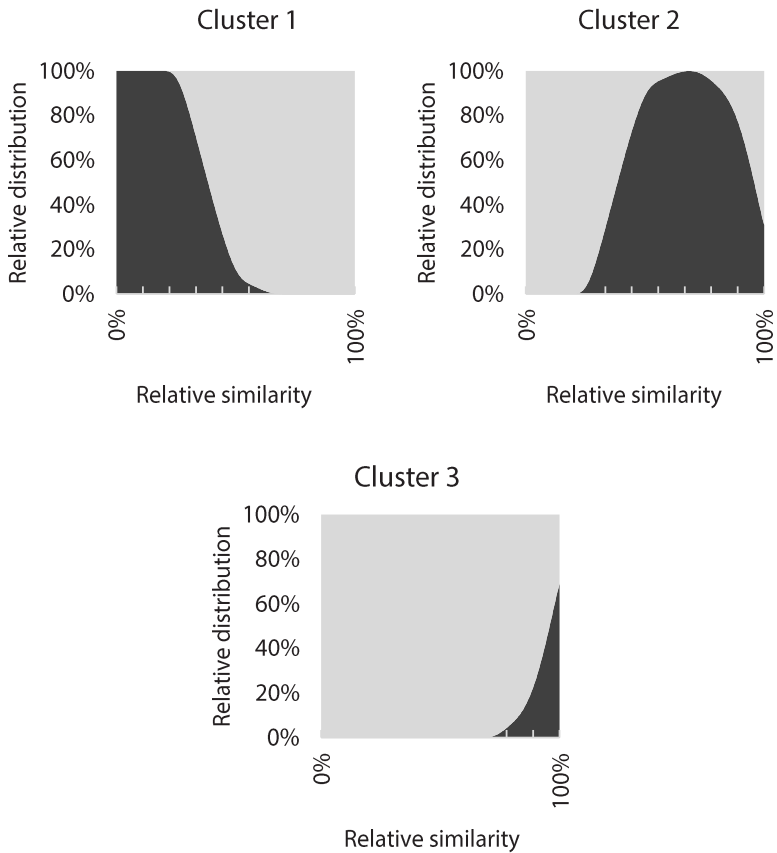
Source: Own depiction

**Figure 7: Cluster similarity to generic pair of behavioural patterns 2 (US sample)**



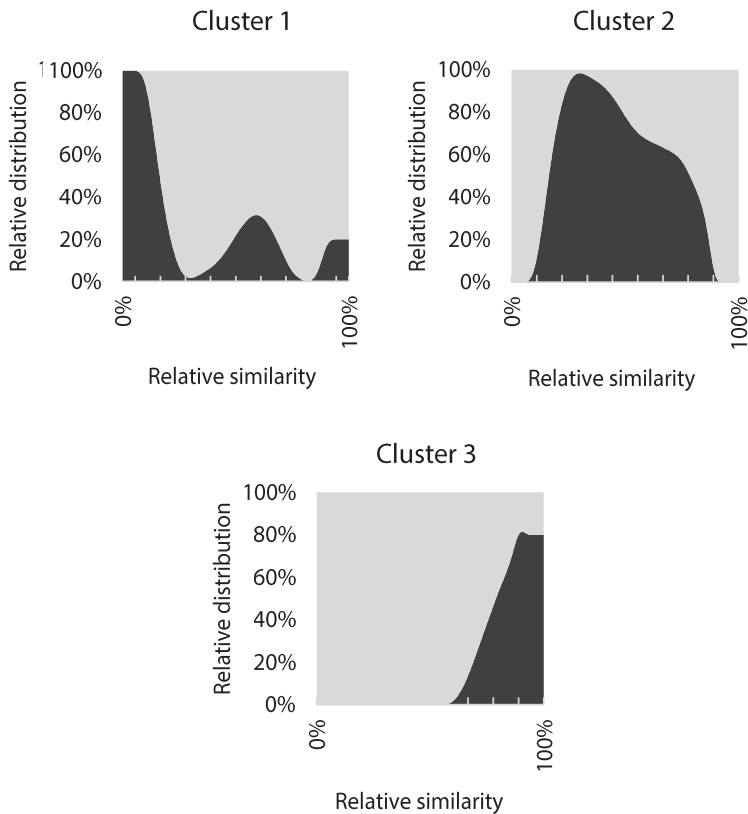
Source: Own depiction

**Figure 8: Cluster similarity to generic pair of behavioural patterns 1 (German sample)**



Source: Own depiction

**Figure 9: Cluster similarity to generic pair of behavioural patterns 2 (German sample)**



Source: Own depiction

## 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, <https://doi.org/10.1016/j.jbusres.2012.11.001>
- Bromiley, P., Harris, J. D. (2014). A Comparison of Alternative Measures of Organizational Aspirations. *Strategic Management Journal*, 35(3), 338–357, <https://doi.org/10.1002/smj.2191>
- Bromiley, P., Rau, D., Zhang, Y. (2017). Is R&D Risky? *Strategic Management Journal*, 38(4), 876–891, <https://doi.org/10.1002/smj.2520>

- Bromiley, P., Washburn, M. (2011). Cost Reduction vs Innovative Search in R&D. *Journal of Strategy and Management*, 4(3), 196–214, <https://doi.org/10.1108/17554251111152243>
- Chen, W.-R. (2008). Determinants of Firms' Backward- and Forward-Looking R&D Search Behavior. *Organization Science*, 19(4), 609–622, <https://doi.org/10.1287/orsc.1070.0320>
- Chen, W.-R., Miller, K. D. (2007). Situational and Institutional Determinants of Firms' R&D Search Intensity. *Strategic Management Journal*, 28(4), 369–381, <https://doi.org/10.1002/smj.594>
- Clatworthy, J., Buick, D., Hankins, M., Weinman, J., Horne, R. (2005). The Use and Reporting of Cluster Analysis in Health Psychology: A Review. *British Journal of Health Psychology*, 10(3), 329–358, <https://doi.org/10.1348/135910705x25697>
- Cyert, R. M., March, J. G. (1963). *A Behavioral Theory of the Firm*. Upper Saddle River: Prentice Hall/Pearson Education.
- Greve, H. R. (2003a). *Organizational Learning from Performance Feedback: A Behavioral Perspective on Innovation and Change*. Cambridge: Cambridge University Press. ISBN 0 521 81831 1.
- Greve, H. R. (2003b). A Behavioral Theory of R&D Expenditures and Innovations: Evidence from Shipbuilding. *Academy of Management Journal*, 46(6), 685–702, <https://doi.org/10.2307/30040661>
- Iyer, D. N., Miller, K. D. (2008). Performance Feedback, Slack, and the Timing of Acquisitions. *Academy of Management Journal*, 51(4), 808–822, <https://doi.org/10.5465/amj.2008.33666024>
- Jirásek, M. (2017). R&D Investment Behavior of US Pharmaceutical Firms. *International Journal of Innovation Science*, 9(2), 205–219, <https://doi.org/10.1108/ijis-08-2016-0030>
- Lucas, G. J. M., Knobens, J., Meeus, M. T. H. (2018). Contradictory yet Coherent? Inconsistency in Performance Feedback and R&D Investment Change. *Journal of Management*, 44(2), 658–681, <https://doi.org/10.1177/0149206315584821>
- O'Brien, J. P., David, P. (2014). Reciprocity and R&D Search: Applying the Behavioral Theory of the Firm to a Communitarian Context. *Strategic Management Journal*, 35(4), 550–565, <https://doi.org/10.1002/smj.2105>
- Posen, H., Keil, T., Kim, S., Meissner, F. (2018). Renewing Research on Problemistic Search - A Review and Research Agenda. *Academy of Management Annals*, 12(1), 208–251, <https://doi.org/10.5465/annals.2016.0018>
- Ref, O., Shapira, Z. (2017). Entering New Markets: The Effect of Performance Feedback near Aspiration and Well Below and above it. *Strategic Management Journal*, 38(7), 1416–1434, <https://doi.org/10.1002/smj.2561>
- Simon, H. A. (1955). A Behavioral Model of Rational Choice. *Quarterly Journal of Economics*, 69(1), 99–118, <https://doi.org/10.2307/1884852>

Vissa, B., Greve, H. R., Chen, W.-R. (2010). Business Group Affiliation and Firm Search Behavior in India: Responsiveness and Focus of Attention. *Organization Science*, 21(3), 696–712, <https://doi.org/10.1287/orsc.1090.0475>

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, <https://doi.org/10.1287/orsc.7.5.524>