doi: 10.17221/230/2016-AGRICECON

The influence of national culture on changes in R&D expenses among agrochemical firms

Michal JIRASEK*

Faculty of Economics and Administration, Masaryk University, Brno, Czech Republic

*Corresponding author: mijirasek@mail.muni.cz

Jirasek M. (2017): **The influence of national culture on changes in R&D expenses among agrochemical firms**. Agric. Econ. – Czech, 63: 524–530.

Abstract: Research and development (R&D) represents a significant expenditure and investment into the future competitiveness of a given firm. The behavioural theory of the firm assumes that these expenditures are subject to changes caused by performance feedback. This paper builds upon these assumptions and extends them by considering the possible effect of national cultures on the nature of these responses to the performance feedback. The research follows 119 firms from nine countries over the period 2001–2015 and analyses their behaviour using generalized linear mixed models. The findings mostly support an effect of national cultures, measured by Hofstede's cultural dimensions, on changes in R&D expenditure and indicate that national culture is one of the factors which needs to be taken into account when utilizing the behavioural theory of the firm.

Keywords: agricultural chemicals, behavioural theory of the firm, feedback-driven behaviour, Hofstede's cultural dimensions, research and development

Innovation constitutes an important factor for sustainable competitive advantage in virtually every industry, and the fields of agriculture (e.g., Sing et al. 2015) and more specifically agricultural chemicals (abbreviated commonly as Agrochemicals) are no exception. Although research and development (R&D) in this industry does not account for as significant a proportion of revenue as in more R&D-intensive industries, for some firms it is still a very important investment. Therefore, strategic decisions about R&D expenditure should be clearly linked to a firm's strategy, especially when some innovation projects can run for years before being completed.

Consequently, firms need to provide stable financial environments for their R&D departments, to ensure that R&D budgets remain relatively stable over the short-term. Nevertheless, in reality it is easy to find reasons for why this is not always the case. Firms and their managers are subject to numerous factors which could influence and change their previous decisions. One of these factors is clearly performance feedback and firms experiencing either negative or positive performance feedback are likely to change R&D expenditure as well (Greve 2003).

The behavioural theory of the firm (Cyert and March 1963) introduced the concept of a firm setting its aspirations (e.g., certain goals in financial performance) and its behaviour depending on whether these aspirations are met or not. Firms that achieve their goals are generally satisfied with their performance and are not motivated to change their current behaviour. On the other hand, firms which do not attain their aspirations are more likely to change and are more open to risk (Kahneman and Tversky 1979). Change and risk are generally associated with R&D investment; therefore, with reference to the behavioural theory of the firm, numerous scholars (e.g. Greve 2003 or Chen and Miller 2007) suggest that underperforming firms are likely to increase their R&D expenditure – in contrast to the decrease or stagnation of R&D expenditure in firms performing above their aspirations. Such behaviour would clearly contradict the above-mentioned need for a stable financial environment for R&D and,

The paper was supported by the Masaryk University research project (Project No. MUNI/A/0909/2015 – Innovation capability as the basis for measurement of organizational innovation performance).

doi: 10.17221/230/2016-AGRICECON

therefore, could dampen the efficiency of a firm's innovation efforts.

Nevertheless, the assumptions of the behavioural theory of the firm have been tested and validated almost exclusively in the USA. Recent papers (O'Brien and David 2014; Lewellyn and Bao 2015) actually suggest that R&D expenditure is influenced by the national culture of a firm's domicile of origin. O'Brien and David (2014) showed that successful Japanese firms increase their R&D intensity (R&D to sales ratio), in contrast to the commonly reported decrease among successful US firms. Furthermore, Lewellyn and Bao (2015) supported the idea that R&D investment levels depend on certain national culture dimensions and therefore differ from country from country.

This paper extends the idea of the influence of national cultural dimensions. It suggests that not only does the overall level of R&D expenditure differ among various countries nationalities, but also that changes in R&D spending behaviour are related to performance feedback. Therefore, it is suggested that, depending on the dimension of their national cultures, there are countries which are more prone to responding to performance feedback by changing their R&D investment. If this suggestion is supported, then it has numerous implications for corporate governance of both local and global firms, as it is argued that such behaviour, resulting in increased R&D budget fluctuations, could negatively impact on firm performance.

This research is a first test of the behavioural theory of the firm conducted directly in the agrichemical industry. A one-industry study approach seems to be a necessity for more in-depth behavioural findings (as argued in Jirasek 2016). Moreover, this research adds to the literature which is still emerging on the effect of national cultures on the behaviour of firms as it represents the first test of their impact on changes of R&D in relation to performance feedback and aspiration discrepancy.

MATERIAL AND METHODS

In order to compare different national cultures, five cultural dimensions of Hofstede (Hofstede et al. 2010) were used. Although this model has been criticised by numerous authors (e.g. McSweeney 2002) and it was developed based on research done mainly in the late 1970s, it is still the most widely used national culture model. Overall it is argued that, despite problems in certain details, Hofstede's cultural dimensions distinguish among the different aspects of various national cultures and are applicable for this research. Thus, a classic 5-D model is formulated here, which excludes the more recently added dimension of Indulgence. There are several reasons for this exclusion, notably the missing scores for some countries (Israel in this case). The 5-D dimensions are Power Distance (PDI), Individualism (IDV), Masculinity (MAS), Uncertainty Avoidance (UAI) and Long Term Orientation (LTO). Linking these dimensions to performance feedback behaviour related to R&D expenditure, it is possible to assert that there could be some relationships between these two concepts.

VARIABLES

As a dependent variable, the logarithm of modified changes in R&D expenses was used. It was felt that the more commonly used R&D intensity is partially flawed for statistical purposes as firms choose the level of R&D, whereas R&D intensity is also dependent on revenues, meaning change can occur even if a firm does not make any changes in R&D investment. This approach, on the other hand, requires the use of additional controls (see below in this section). Expressing changes in R&D in a logarithmic form helps to reduce the effect of outlying observations (extreme changes in R&D). The use of a logarithmic scale required the modification of R&D expense change data, which were converted to absolute values (for negative R&D expense changes the sign was again added to their computed logarithmic values) with 100 % level considered no change in R&D expense.

To measure a firm's performance, profit margin (net profit to revenues) was utilized, where I deviated from most of the other authors studying the behavioural theory of the firm (Bromiley and Harris 2014). However, this approach follows Bromiley and Harris's (2014) research, which suggests net income as a performance indicator with the best fit with data. Instead of using net profit, the measure was related to revenues, as this filters out some other possible factors affecting its size, e.g., a firm's growth or acquisition activity.

Following Washburn and Bromiley (2012), two separate aspirations were employed – historical, which accounts for the comparison with the firm's performance in the previous year, and social, which accounts for the comparison with the previous year's performance of the firm's peers (in this case other

doi: 10.17221/230/2016-AGRICECON

firms in the sample which have a domicile in the same country). Historical discrepancy therefore corresponds to the difference between a firm's current performance and a firm's performance in the previous year. Similarly, social discrepancy corresponds to the difference between a firm's current performance and the weighted (by revenues) average of the previous year's performance of the firm's peers. Additionally, dummies were constructed to account for both historical and negative social discrepancies and to allow for a possible slope change below aspirations.

For the purpose of comparing different national cultures, the scores on the national culture dimensions quoted in Hofstede et al. (2010) were utilized, which lie in the interval 1–100, where the higher the score, the higher the country scores in the given dimension. This resource provides scores for all of the countries selected for this research.

The controls used were available and potential slack change measures, the country's change in GDP, and change in a firm's total assets. All the controls are constructed as changes as a consequence of the primary variable being in a changed state, i.e., filtering out the basic level of R&D expenditures. Both slack measures account for the underutilized resources of a firm, creating a cushion for possible experimentation and increase in R&D investment. To measure them, Marlin and Geiger's approach (2015) was used, and the available slack was the sum of the current ratio (current assets on current liabilities), a quick ratio (current assets minus inventories on current liabilities), and working capital (current assets minus current liabilities on sales), and as a potential slack the sum of debt to equity, debt to sales, and debt to assets. The change in a country's GDP accounts for the overall economic development in the environment closest to the firm. The change in a firm's assets controls the possible expansion of a firm, which could clearly cause a change in a firm's R&D investment.

DATA COLLECTION AND ANALYSIS

The data were collected from the Bloomberg database for firms operating in BICS (Bloomberg Industry Classification System) industry sub-group Agricultural Chemicals for the years 2000 to 2015. As a result of the use of changes in variables, every firm's maximum number of observations was 15 years; however, due to missing data, this was rarely the case. Out of this list, only firms with at least two consecutively reported R&D expense figures were included in order to compute at least one R&D expense change as the explained variable. The list was further limited to firms from countries with at least three such exchange-listed Agricultural Chemical firms. This procedure limited the sample to 119 firms from 9 countries (in alphabetical order: Australia, China, India, Israel, Japan, South Korea, Taiwan, the United Kingdom and the USA), which, based on Franke and Richey (2010), is considered sufficient for a multinational study.

The data analysis was conducted using SPSS Statistics 23 statistical software. I analysed the data using the generalized linear mixed models procedure to account for the hierarchical structure of data, as error terms in observations of firms from one country might not be independent of each other. All the effects were fixed as models with random effects did not significantly improve the quality of the results. Finally, due to an unbalanced data structure and some possible violations in the model assumption, the Satterthwaite approximation (to allow for varying degrees of freedom) and a robust estimation of the fixed effects and coefficients were used.

RESULTS AND DISCUSSION

Five models were calculated (Table 1). Model 1 was calculated using only historical and social discrepancy; Model 2 extended the former by adding dummies for slope changes; Model 3 also added all the controls. These three models do not account for the influence of national cultures. Model 4 extended the basic models by incorporating the effects of national culture dimensions on both discrepancies; Model 5 then allowed further changes to the slope (the coefficients are reported in the separate Table 2).

When comparing Models 1 and 2, allowing changes to the slope significantly improves the *p*-values of both historical and social discrepancies. Model 3 cannot be directly compared with these two due to the different number of observations used for the computation of Model 3; however, both Models 2 and 3 partially contradict R&D change behaviour as assumed by the behavioural theory of the firm. Both models predict that firms will decrease R&D spending when below aspirations (which is opposite to what has been suggested by most previous research, but is nevertheless in line with, e.g., Bromiley and Washburn 2011) and stagnating when above aspirations. Differences in the significance of the coefficients between Models 4

doi: 10.17221/230/2016-AGRICECON

and 5 confirmed the importance of slope changes for firms below and above aspirations as Model 4 yielded less significant coefficients.

From the first impression, the relationship between performance discrepancy and R&D expense change is different from simpler models. As shown in Figure 1, which depicts the predicted values for an imaginary country with intermediate scores for all national culture dimensions, the general relationship does indeed correspond to the theory and contrasts

Table 1. Models of R&D expense change in relation to performance discrepancies

	Model 1	Model 2	Model 3	Model 4	Model 5[1]
Historical discrepancy	0.083**	0.005**	0.049***	−3.538	−7.385***
	0.011	0.022	0.000	0.230	0.004
Social discrepancy	−0.003	0.307***	0.208*	−2.068	−3.290**
	0.249	0.001	0.083	0.105	0.022
Soc. discrepancy * Negative soc. discrepancy dummy		−0.308***	−0.048***		
		0.001	0.001		
His. discrepancy * Negative his. discrepancy dummy		−0.004	−0.209*		
		0.436	0.080		
Historical discrepancy * PDI				0.006	0.015***
				0.380	0.009
Social discrepancy * PDI				0.010*	0.008
				0.057	0.273
Historical discrepancy * IDV				−0.001	0.010**
				0.781	0.043
Social discrepancy * IDV				0.000	−0.001
				0.831	0.914
Historical discrepancy * MAS				0.040	0.059***
				0.108	0.005
Social discrepancy * MAS				0.020*	0.044**
				0.051	0.035
Historical discrepancy * UAI				0.022	0.043***
				0.123	0.000
Social discrepancy * UAI				0.011	0.015
				0.110	0.124
Historical discrepancy * LTO				−0.001	0.011***
				0.725	0.003
Social discrepancy * LTO				−0.001	−0.004
				0.414	0.537
Total assets (change)			0.145***	0.150***	0.145***
			0.000	0.000	0.000
GDP of given country (change)			1.364***	1.310***	1.377***
			0.000	0.000	0.000
Available slack (change)			−0.001***	−0.001**	−0.001*
			0.000	0.023	0.071
Potential slack (change)			−0.020***	−0.018*	−0.017*
			0.001	0.068	0.061
Number of observations	557	557	352	352	352

Coefficient (first row of given variable) and *p*-values (second row of given variable) reported

Intercept not reported; *** < 0.01, ** < 0.05, * < 0.1; [1]dummies for particular discrepancies in interaction with cultural dimensions reported in Table 2

Own calculation using SPSS 23

doi: 10.17221/230/2016-AGRICECON

Table 2. Slope changes coefficients for the Model 5

Historical discrepancy * PDV * Negative his. discrepancy dummy	0.033*** 0.001
Social discrepancy * PDV * Negative soc. discrepancy dummy	0.006 0.407
Historical discrepancy * IDV * Negative his. discrepancy dummy	0.002 0.852
Social discrepancy * IDV * Negative soc. discrepancy dummy	0.003 0.810
Historical discrepancy * MAS * Negative his. discrepancy dummy	–0.015 0.458
Social discrepancy * MAS * Negative soc. discrepancy dummy	–0.021 0.483
Historical discrepancy * UAI * Negative his. discrepancy dummy	0.004 0.484
Social discrepancy * UAI * Negative soc. discrepancy dummy	0.006 0.606
Historical discrepancy * LTO * Negative his. discrepancy dummy	–0.029*** 0.000
Social discrepancy * LTO * Negative soc. discrepancy dummy	0.013 0.264

Own calculation using SPSS 23

with the previous results as it expects the firms from such a country to increase their R&D spending when below aspirations and decrease it when above aspirations. The slope change is in a different direction to the one expected as it points to a sharp decrease in spending in the latter case, which is opposite to the expected stagnation. The reason for this slope change could be caused by the fact that only two coefficients of slope change were significant. The relationship between discrepancy and R&D expense change was only plotted for historical aspiration, as only the dimension of Masculinity is significant for social aspiration.

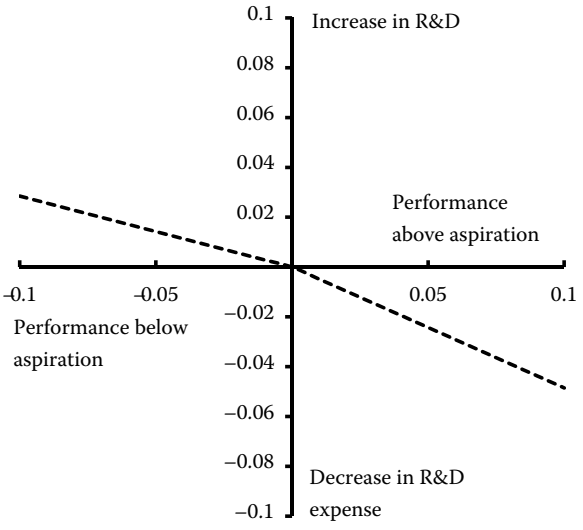

Figure 1. Estimated values for the effect of historical discrepancy on an imaginary country with a national culture dimensions score set to 50

Visualization using predicted values from Model 5

When discussing the results of Model 5, it is important to ask why the effects related to historical aspiration yielded far more significant results than those connected with social aspiration. Although it is possible to hypothesize that national culture is not that strong an influence when compared with peers, the nature of particular dimensions (Hofstede et al. 2010) partially contradicts this. One of the underlying reasons probably lies in the vagueness of what peers (or competitors) mean for a particular firm. It is easy to imagine that some firms will compare themselves with others in the same country, while some firms (especially those with global operations) will compare themselves with selected peers from a range of different countries. Nevertheless, the significance of the Masculinity dimension is a very important finding in the case of social discrepancy as this dimension is directly linked to competing with others (Hofstede et al. 2010: 161).

On the other hand, historical aspiration is much more easily definable. As all five national culture dimensions are measured on the same scale, it is possible to divide them into two groups based on the magnitudes of the estimated effect on R&D expense change. The first consists of the Masculinity and Uncertainty Avoidance dimensions, which have a relatively high impact on the explained variable, and the second which consists of Power distance, Individualism and Long Term Orientation with a relatively smaller impact. When not taking slope changes into consideration, *ceteris paribus*, the firms from countries with high scores on dimensions from the first group are expected to deviate (similarly with firms in Bromiley and Washburn's research, 2011) more from the behaviour predicted by the theory than those from countries with low scores.

When comparing US and Japanese contexts, which O'Brien and David (2014) studied, firms from both countries can be expected to behave *ceteris paribus* differently, as the USA scores relatively low on these

doi: 10.17221/230/2016-AGRICECON

dimensions (MAS 62 and UAI 46) and Japan relatively high (MAS 95 and UAI 92). This corresponds to the results of the above-mentioned authors who pointed to the differences in the behaviour of purely Japanese firms, although the relationship is not exactly the same as predicted by this research. What is interesting is that none of the dimensions in the case of historical aspirations has a negative sign – which would further confirm the predicted behaviour in favour of the assumptions of behavioural theory. This observation could be caused by the data and by the procedure, and needs to be further tested in future research.

The findings of this research are limited in several regards. In particular, the sample which was studied consisted only of firms reporting R&D expenses, which does not represent the entire Agricultural Chemicals industry sub-group as listed on the stock markets throughout the world. Additionally, a large body of evidence concerning the differences between private and listed firms has been gathered over the past decades (e.g., the seminal work of Trostel and Nichols 1982). The IBISWorld (2016) research report states that there are more than 7000 firms operating in this industry, so the variety of behavioural responses in this industry is arguably much more complex. This research therefore explains some behavioural differences among listed firms which are more or less pursuing product innovation strategies. One additional limitation lies in the assumption that a firm's domicile corresponds to the nationality of the top management team (as the main decision maker in investment in R&D), which may not necessarily be the case for every firm examined.

More research is needed to study behavioural responses to performance feedback, both in other industries and/or in different countries. In addition, the use of other national culture studies (such as GLOBE, House et al. 2004) could shed more light on this topic and complement research based on the classic Hofstede national culture dimensions.

In this paper, I examined the effects of performance feedback, i.e., attaining or not attaining aspirations, on the behavioural responses of agrochemical firms with regard to R&D expenses. Its main assumption, that behaviour is shaped by national cultures, was confirmed by the panel data analysis of agrochemical firms from nine countries. The results also confirmed that both historical and social aspirations play important roles in decision making, although they also highlight potential problems with the composition of a firm's benchmark group.

REFERENCES

Bromiley P., Harris J.D. (2014): A comparison of alternative measures of organizational aspirations. Strategic Management Journal, 35: 338–357.

Bromiley P., Washburn M. (2011): Cost reduction vs innovative search in R&D. Journal of Strategy and Management, 4: 196–214.

Cyert R.M., March J.G. (1963): A Behavioral Theory of the Firm. Prentice Hall, Upper Saddle River.

Chen W.-R., Miller K.D. (2007): Situational and institutional determinants of firms' R&D search intensity. Strategic Management Journal, 28: 369–381.

Franke G.R., Richey Jr. R.G. (2010): Improving generalizations from multi-country comparisons in international business research. Journal of International Business Studies, 41: 1275–1293.

Greve H.R. (2003): Organizational Learning from Performance Feedback: A Behavioral Perspective on Innovation and Change: A Behavioral Perspective on Innovation and Change. Cambridge University Press, Cambridge.

Hofstede G.H., Hofstede G.J., Minkov M. (2010): Cultures and organizations: software of the mind: intercultural cooperation and its importance for survival. 3rd Ed. McGraw-Hill, New York.

House R.J., Hanges P.J., Javidan M., Dorfman P.W., Gupta V. (2004): Culture, leadership, and organizations: the Globe study of 62 societies. Sage, Thousands Oak.

IBISWorld (2016): Global Fertilizers & Agricultural Chemicals Manufacturing: Market Research Report. Available at http://www.ibisworld.com/industry/global/global-fertilizers-agricultural-chemicals-manufacturing.html (accessed Jun 24, 2016).

Jirasek M. (2016): Innovative behavior of U.S. Pharmaceutical Firms. In: Grant K.A., Wise S. (eds): Proceedings of the 4th International Conference on Innovation and Entrepreneurship. Academic Conferences and Publishing International, Reading.

Kahneman D., Tversky A. (1979): Prospect theory: An analysis of decision under risk: An analysis of decision under risk. Econometrica, 47: 263–291.

Lewellyn K.B., Bao S. (2015): R&D investment in the global paper products industry: A behavioral theory of the firm and national culture perspective. Journal of International Management, 21: 1–17.

McSweeney B. (2002): Hofstede's model of national cultural differences and their consequences: A triumph of faith – a failure of analysis. Human Relations, 55: 9–118.

O'Brien J.P., David P. (2014): Reciprocity and R&D search: Applying the behavioral theory of the firm to a com-

doi: 10.17221/230/2016-AGRICECON

munitarian context. Strategic Management Journal, 35: 550–565.

Singh S., Kiran R., Goyal D. (2015): Identification of key factors for enhancing competitiveness: an exploratory study of the selected agri-biotech firms of Punjab in India. Agricultural Economics, 61: 179–188.

Trostel A.O., Nichols M.L. (1982): Privately-held and publicly-held companies: A comparison of strategic choices and management processes. Academy of Management Journal, 25: 47–62.

Washburn M., Bromiley P. (2012): Comparing aspiration models: The role of selective attention. Journal of Management Studies, 49: 896–917.

Received July 21, 2016
Accepted September 19, 2016
Published online July 21, 2017