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Exploring the relation between cultural values and R&D investment under the behavioral theory of the firm

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R&D intensity, Innovation, Cultural values, Behavioural theory of the firm

ABSTRACT

This paper explores the role cultural factors play in firms' decisions to invest in Research and Development (R&D), under the behavioural theory of the firm (Cyert & March, 1963). Based on a sample of non-financial firms from 23 countries for the period of 1990 to 2016 and two of the six Hofstede (1984) cultural dimensions, we observe that countries' cultural values are statistically significant at explaining differences in firms' R&D decisions. On one hand, there is a negative relation between firms' R&D investment decisions and countries' uncertainty avoidance. On the other hand, a positive relation is found between firms' R&D investment decision and countries' long-term orientation. Evidence is also found on the extent to which these cultural characteristics influence how firms' aspirations in relation to performance discrepancies drive R&D investment.

Introduction

This research focuses on R&D investment by firms under the framework of the behavioral theory of the firm (Cyert & March, 1963). Firm managers have aspirations in relation to several of the firm's characteristics either relative to past performance and decisions or to competitors' performance and decisions. Additionally, the so-called slack within the firm creates leeway for an R&D decision. Previous empirical evidence has shown there is a link between these two characteristics of firms and R&D investment (e.g. Alessandri & Pattit, 2014; Chen & Miller, 2007; Guedes, da Conceição Gonçalves, Soares, & Valente., 2016; O'Brien & David, 2014).

Current global competition motivates countries and firms to heavily invest in R&D and innovations as it is considered fundamental for obtaining a competitive advantage and sustaining future growth (Desjardins, 2018; Eggers & Kaul, 2018). At the same time, there has been a decrease in the role of public funding for R&D reduced from 2009 to 2016 in the OECD area (OECD, 2018), which puts even more emphasis on private R&D and its determinants. While there is evidence on the role of organizational settings and their impact on R&D investment (Driver & Guedes, 2012; Shaikh, O'Brien, & Peters, 2018) not much emphasis has been placed in understanding how underlying cultural values of each society impact the firm's decision to undertake such an uncertain and risky investment, as is the case of R&D (Shinkle, 2012). In particular, O'Brien and David (2014) propose that the behavioral theory of the firm should be adapted in order to take into account cultural differences when exploring firm's R&D investment decision.

In this paper we put forward the hypothesis that the relation between slack and R&D investment decisions is influenced by cultural values prevalent in the country of origin of the firm and test this hypothesis using firm-level data. The analysis is undertaken based on a sample of 104,431 firm-year observations of listed non-financial firms

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from 23 countries for the period of 1990-2016, retrieved from Thomson Reuters Worldscope. To control for cultural values we use the classification and dataset of Hofstede's cultural dimensions at the country level (Hofstede, 2001). In particular we focus on two cultural dimensions deemed more pertinent to the study of R&D investment at the firm-level, namely attitudes towards uncertainty and orientation towards the long or the short term. When interacting those cultural dimensions with the firm's aspirations we observe that cultural values are statistically significant at explaining differences in firms' behaviours. As such, the way firms are managed is conditioned by the cultural environment in which the firm operates.

The main contribution in this paper is first to combine a country's cultural values with the standard approach as to how situational determinants (proposed by the behavioral theory of the firm) condition R&D investment using a panel of firms from different countries. So far, in terms of research, only Lewellyn and Bao (2015) have combined both sets of variables to explore this relation in an international panel of firms. However, their study focuses on a specific sector (global paper products industry) which limits the generalizability of results.

Second, this paper provides further evidence as to the relevance of the behavioral theory of the firm by Cyert and March (1963) relative to managers' decisions. This literature already acknowledges that managers do not follow neoclassical economic theory's prediction of optimizing behaviour. Instead managers look to firm or industry outcomes to form aspirations and then make local adjustments to their decisions in order to match those aspirations. Our paper provides supporting evidence from an international dataset of listed firms in the last three decades that aspirations are important determinants of R&D decisions in conjunction with the leeway provided by slack.

Third, the empirical relevance of cultural dimensions in this paper further highlights how managerial decisions are indeed not context-free and should not be analysed abstracting from the underlying cultural environment. Additionally, Lewellyn and Bao (2015) argue that acknowledging the national cultural background of firms and managers can help explain inconsistent findings in the literature.

In the next section we explore the literature on these two complementary determinants of firm's R&D investment and put forward several testable hypotheses. In section 3 we present the empirical study, namely how the different variables are implemented and present the model. Using regression analysis, in Section 4 we present the results and discuss implications in Section 5.

Literature Review and Hypotheses

The behavioral theory of the firm originally developed by Cyert and March (1963) understands managers behaviour as a response to self or social aspirations, either regarding the firm's past behaviour or relative to the performance and choices of competitors. These behavioral aspirations can thus partially explain decisions made within the firms, conditioned by the level of slack resources within the firm. The study of how these aspirations impact decisions is enriched if cultural differences in backgrounds of firms and managers are taken into consideration (as put forward by Shinkle, 2012). The chosen approach in this paper is to combine firm-level data on financial information, to capture the theoretically relevant variables with country data on cultural dimensions.

The Behavioral Theory of the Firm

Cyert and March (1963)'s behavioral theory of the firm looks at managers' behaviour as boundedly rational, and rationalizable through routines and local adjustments in decisions, such as problemistic and slack search. As for R&D investment, it can be perceived as potentially providing a solution to performance below aspirations, but at the same time, it is a risky option with uncertain returns, and thus be overlooked as a solution for problemistic search.

Within the framework of this theory, there is the assumption of problemistic search based on performance feedback and comparison with aspiration levels (Argote & Greve, 2007). Shinkle (2012, p. 416) defines organization aspirations as "desired performance levels in specific organizational outcomes and have also been called goals and reference points". Managers will define managerial aspirations levels based on self or industry performance, which will guide their choices, and in turn if performance is below/above aspirations, managers will decrease/increase their aspirations, respectively (Lant, 1992; Lant & Shapira, 2008). According to Posen, Keil, Kim, and Meissner (2018, p. 208) "a firm's recognition of performance below its aspiration, which is the level of future performance deemed acceptable, leads to a process of search to discover a solution to the problem, resulting in behavioral change intended to restore performance to the aspired level". In terms of R&D spending, it is perceived in the literature as a form of managerial risk taking (e.g. Greve, 1998; Palmer & Wiseman, 1999).

It is however not straightforward how an attainment discrepancy will motivate managers in terms of R&D decisions. When a firm is below its aspirations, problemistic search follows and it may include taking more risks, such as increasing R&D investments (as observed for example by Bromiley, 1991; Chen & Miller, 2007). The opposite argu-

ment has also been observed for performance below aspirations (Nickel & Rodriguez, 2002) and specifically for the case where firm's performance matches industry performance albeit below self-aspirations (Lv, Chen, Zhu, & Lan, 2019).

When firms perform above aspirations, the results are also ambiguous. From the behavioral theory of the firm, we understand that if a firm is successfully attaining its aspirations, it should continue replicating past routines. However empirical research show that is not always the case (Iyer & Miller, 2008; Labianca, Fairbank, Andrevski, & Parzen, 2009).

In the present paper we model both self-aspirations based on historical firm data and social aspirations that come from comparisons with industry data as explanatory variables for R&D investment. To define the first hypothesis, we follow the theoretical predictions of the behavioral theory of the firm. Given that firm's aspirations can be defined in relation to past self-performance or to industry peer performance, we can test Hypothesis 1 in these two dimensions.

Hypothesis 1. R&D investment is positively related to performance below aspirations and independent from performance above aspirations, all else being equal.

At the same time, the hypothesis of slack search implies that the slack within firms allows them leeway to innovate. Cyert and March (1963) define organization slack as the "difference between total resources and total necessary payments" (p. 42). As resources are available within the firm, slack search allows managers to promote innovation and invest in R&D.

The majority or studies exploring slack search have opted for quantifying organization slack using accounting measures (one exception is for example Nohria and Gulati, (1996) who elicit perception of firm slack using questionnaires). Empirical results have however not been consensual in terms of the sign of the relation between slack and R&D investment, namely some studies have found a positive relation (Greve, 2003; Marlin & Geiger, 2015) or an inverse U-shaped relation (e.g. Geiger & Cashen, 2002; Nohria & Gulati, 1996).

Daniel, Lohrke, Fornaciari, and Turner Jr (2004) consider that one of the most commonly used empirical implementation of the concept of slack is Bourgeois and Singh (1983)'s "ease-of-recovery" definition. Using accounting information on current assets relative to current liabilities, the authors defined the more easily accessible type of slack (available slack). Recoverable slack is less easily accessible and relates selling, general and administrative expenses to sales. Finally, potential slack is the least easily recoverable ("the capital-raising potential represented by changes in stock price is just that—potential", (Bourgeois & Singh, 1983, p. 43). The present paper focuses on the two more easily recoverable forms of slack (as for example Wiersma, 2017). Following from the behavioral theory of the firm, we put forward the following hypothesis:

Hypothesis 2. R&D investment is positively related to firms' slack resources, all else being equal.

These two hypotheses derived from the behavioral theory of the firm have been tested jointly in the empirical literature and partial supporting evidence has been found (e.g. Alessandri and Pattit 2014 for publicly traded U.S. manufacturing firms during 2001-2007; Chen and Miller 2007 for publicly traded U.S. manufacturing firms in the period 1998-2001; Guedes et al. 2016 for London Stock Exchange listed firms from 2009-2014). Our study enriches the empirical literature by using a panel of firms from several countries, which is then enriched with cultural variables, whose pertinence is discussed next.

Cultural Dimensions and Management Decisions

The national context in which a firm operates has an impact on management decisions, and this influence can operate through national cultural dimensions. Li, Griffin, Yue, and Zhao (2013, p. 1) argue that "even in a highly globalized world with sophisticated managers, culture matters" and Beckmann, Menkhoff, and Suto (2008) observe how asset managers' views and behaviour are impacted by cultural differences. Aggarwal, Faccio, Guedhami, and Kwok (2016, p. 466) define culture as including "an enduring set of beliefs or values that influences individuals' perceptions, preferences, decisions, and behaviors. It is therefore likely that culture influences business and financial decisions". In what concerns the focus of the present paper, i.e. R&D investment, Li et al. (2013) have concluded that culture indeed matters for corporate risk-taking as measured by the volatility of earnings and R&D investments. Lievenbrück and Schmid (2014) corroborate the result in the case of risk hedging by firms.

Hofstede's approach assumes that cultural differences translate into different management styles and values (Hofstede, 1984). As such, managers when faced with the same objective financial conditions may make different decisions depending on cultural values in the home country. One fundamental management decision concerns R&D investment, which involves judgments on uncertain and risky outcomes, and has a potential impact on profitability. We argue in this paper that the cultural contextual values will influence the way managers decide about R&D under the framework of the behavioral theory of the firm.

In terms of the six dimensions in Hofstede's analysis, we focus on Uncertainty Avoidance (the corresponding variable is the Uncertainty Avoidance Index - UAI) and

long-term orientation versus short-term normative orientation (for parsimony, Long Term Orientation - LTO). We argue that these cultural variables can impact the attitude to risk and investment within a firm, that is, when a firm is confronted with a discrepancy in its aspirations for a certain level of slack, the response may vary as a consequence of the cultural framework of the country. As such, these variables are likely to impact R&D investment.

Hofstede (2001) defines UA as "the extent to which a culture programs its members to feel either uncomfortable or comfortable in unstructured situations. Unstructured situations are novel, unknown, surprising, different from usual". Since risky choices, such as R&D investment are often associated with uncertain firm outcomes (Palmer & Wiseman, 1999), we can expect that in countries with high levels of uncertainty avoidance, there is less R&D investment, all else being equal. As argued by Li et al. (2013, p. 2), countries with low uncertainty avoidance, "value innovation" and do not "shun ambiguous situations".

Hypothesis 3. R&D investment is negatively related to Uncertainty Avoidance (UA), all else being equal.

As for the dimension of Long-term versus short-term orientation, according to Hofstede (2001, p. 15) it "refers to the extent to which a culture programs its members to accept delayed gratification of their material, social, and emotional needs". A long-term orientation is associated with "the fostering of virtues oriented toward future rewards—in particular, perseverance and thrift" (Hofstede, Hofstede, & Minkov, 2010, p. 239). A short-term orientation "stands for the fostering of virtues related to the past and present" (ibidem). The outcome of present R&D is uncertain and may only provide benefits in the future, so we can expect countries with a long-term orientation to be more accepting of R&D investments, all else being equal, as proposed in:

Hypothesis 4. R&D investment is positively related to Long-Term Orientation (LTO), all else being equal.

Method

For the empirical analysis, data for the period of 1990-2016 from all non-financial listed firms in 23 countries is retrieved from Thomson Reuters Worldscope. The original sample started with a selection of 51 countries which are often the focus of analysis of influential international studies (e.g. Covrig, Defond, & Hung, 2007; Leuz & Verrecchia, 2000; Persakis & Iatridis, 2017). However, data requirements, as explained next, impose restrictions on which firms are included in the dataset and consequently lead to the loss of 28 countries. Firms are excluded from the sample if they have no R&D, if the ratio of R&D-to-sales is larger than one, or lack the needed data to calculate the variables used. Given the nature of some of the explanatory variables, it is required that for each combination of country, year and two-digit SIC code there are at least 5 firms available and that each country has at least 100 observations to be included in the final sample. Data for the countries' cultural dimensions is retrieved from Hofstede (2015).

The final sample is comprised of 104,431 firm-year observations. With the exception of the Hofstede dimensions, all continuous variables are winsorised at the top/bottom 1% to avoid the effect of outliers. Tables 1 and 2 provide a breakdown of the final sample by country and by industry, respectively.

Table 1
Sample breakdown by country

Countries	N	Percent
Australia	601	0.58
Canada	1,963	1.88
China	4,281	4.1
Denmark	183	0.18
Finland	396	0.38
France	744	0.71
Germany	2,119	2.03
Greece	245	0.23
Hong Kong	1,370	1.31
Israel	1,034	0.99
Italy	159	0.15
Japan	30,460	29.17
Malaysia	216	0.21
Netherlands	215	0.21
Singapore	273	0.26
South Africa	184	0.18
South Korea	9,317	8.92
Sweden	768	0.74
Switzerland	993	0.95
Taiwan	11,823	11.32
Turkey	824	0.79
United Kingdom	4,708	4.51
United States	31,555	30.22
Total	**104,431**	**100**

As can be seen from Table 1, Japan and the United States dominate the sample, although there is a wide variety of countries, which allows for differences in cultural charac-

teristics. From Table 2, we observe that firms in the Technology Hardware & Equipment and Electronic & Electrical Equipment industries are the ones most represented in the sample. There is a clear increase in the R&D intensity during the sample period, which is present in almost all the sectors, but particularly in the technological and software sectors. This data is not reported here, but is available upon request.

Table 2
Sample breakdown by industry

Industries	N	Percent
Aerospace & Defense	1,594	1.53
Alternative Energy	448	0.43
Automobiles & Parts	4,198	4.02
Beverages	511	0.49
Chemicals	7,427	7.11
Construction & Materials	6,340	6.07
Electricity	151	0.14
Electronic & Electrical Equipment	13,657	13.08
Fixed Line Telecommunications	167	0.16
Food & Drug Retailers	107	0.1
Food Producers	3,944	3.78
Forestry & Paper	676	0.65
Gas, Water & Multiutilities	299	0.29
General Industrials	2,085	2
General Retailers	577	0.55
Health Care Equipment & Services	5,514	5.28
Household Goods & Home Const.	2,873	2.75
Industrial Engineering	10,472	10.03
Industrial Metals & Mining	2,307	2.21
Industrial Transportation	245	0.23
Leisure Goods	2,814	2.69
Media	832	0.8
Mining	401	0.38
Mobile Telecommunications	196	0.19
Oil & Gas Producers	466	0.45
Oil Equipment & Services	563	0.54
Personal Goods	3,259	3.12
Pharmaceuticals & Biotechnology	5,256	5.03
Software & Computer Services	9,284	8.89
Support Services	2,330	2.23
Technology Hardware & Equipment	14,760	14.13
Tobacco	114	0.11
Travel & Leisure	564	0.54
Total	**104,431**	**100**

Next we present in detail how the dependent variable and independent variables were constructed from the data following options in the previous literature. Control variables are included that are not discussed in the literature review, but are relevant to capture other effects that may be impacting the dependent variable. These controls include the distance from bankruptcy and industry effects, such as industry growth and R&D intensity.

Dependent Variable

Research intensity is used as the dependent variable and, following Chen and Miller (2007) and Cohen and Levinthal (1989), is proxied by R&D divided by sales (rd_sales).

Firm and Industry Discrepancy

Regarding firm discrepancy (firm_discrepancy), we follow Chen and Miller (2007) and define firm discrepancy as the difference between the firm's Return on Assets (ROA) relative to the previous year ROA. As for industry discrepancy (ind_discrepancy), it is defined as the difference between the firm's ROA relative to the median ROA in the 2-digit Standard Industrial Classification (SIC) industry in the specific country of the focal firm in the prior year.

We further decompose the discrepancy measures into positive (pos_firm_discrepancy and pos_ind_discrepancy) and negative discrepancy variables (neg_firm_discrepancy and neg_ind_discrepancy), which are calculated as the multiplication of a dummy variable which takes the value of 1 if the discrepancy measure exhibits a positive value, and 0 otherwise, with the relevant firm or industry discrepancy. Such approach allows the model to capture an eventual asymmetry in the way firms respond to different discrepancy measures, in line with the ambiguous empirical evidence concerning these effects.

Slack Measures

Given that this study focuses on the role of internal slack on the manager's decision of investing on R&D, only the available and recoverable slack measures are used, and we follow Bourgeois (1981) definition. Available slack (a_slack) is defined as the current ratio and calculated as total current assets divided by total current liabilities, while recoverable slack (rec_slack) is measured as the ratio of selling, general and administrative expenses divided by total revenue. Both these measures are included independently in the estimated model as they capture different levels of slack that are at the managers' disposal, where available slack is immediately available to the manager while recov-

erable slack is harder for the manager to use (Greve, 2003).

Hofstede Cultural Dimensions

Regarding the Hofstede cultural dimensions variables, both the Uncertainty Avoidance Index (UAI) and Long-Term Orientation Index (LTO) are used.

As for the original scores in each of the cultural dimensions, "they are always relative scores in which the lowest country is situated around zero and the highest around 100" (Hofstede, 1984, p. 84). For the UAI, a low index means a country with low uncertainty avoidance and a high value of 100 or slightly higher means the strongest uncertainty avoidance; the index for LTO means that the higher the value of the index the more long-term oriented the country is (Hofstede et al., 2010). Given the differences in the magnitude of these variables and the previous variables, UAI and LTO were scaled by 100.

Data for the countries' cultural dimensions is retrieved from Hofstede (2015). It has been argued that underlying national cultural features do not change over time in terms of countries' relative positions (e.g. Beugelsdijk, Maseland, & van Hoorn, 2015; Inglehart & Baker, 2000).

Distance from Bankruptcy

A control variable that is often used to account for a firm's financial situation is how far from bankruptcy the firm appears, by inspecting financial and accounting data. This is used as a control by for example Chen and Miller (2007) and Guedes et al. (2016). The distance from bankruptcy (zscore) is proxied by the Altman's (1968) z-score and calculated as:

$$zscore = 1.2\frac{working\ capital}{total\ assets} + 1.4\frac{retained\ earnings}{total\ assets} + 3.3\frac{income\ before\ interest\ expense\ and\ taxes}{total\ assets} + 0.6\frac{market\ capitalization}{total\ liability} + 1\frac{total\ revenue}{total\ assets} \quad (1)$$

Industry Effects

Following Chen and Miller (2007), contemporaneous industry search intensity (ind_rd_sales) is included in the model as a control variable and is calculated as the mean R&D-to-sales in the 2-digit SIC industry in the specific country for the year. In addition, industry sales growth (ind_growth) is also included in the model and is calculated as the change in total sales in the 2-digit SIC industry in the specific country for the year, from the past to the current year.

Model

The testing of the hypotheses is done by estimating the following main models:

$$rd\_sales_{i,t} = \beta_1 + \beta_2 ind\_growth_{i,t} + \beta_3 ind\_rd\_sales_{i,t} + \beta_4 a\_slack_{i,t-1} + \beta_5 rec\_slack_{i,t-1} + \beta_6 zscore_{i,t-1} + \beta_7 pos\_firm\_discrepancy_{i,t-1} + \beta_8 neg\_firm\_discrepancy_{i,t-1} + \beta_9 UAI + \beta_{10} LTO + \varepsilon_{i,t} \quad (2)$$

$$rd\_sales_{i,t} = \beta_1 + \beta_2 ind\_growth_{i,t} + \beta_3 ind\_rd\_sales_{i,t} + \beta_4 a\_slack_{i,t-1} + \beta_5 rec\_slack_{i,t-1} + \beta_6 zscore_{i,t-1} + \beta_{11} pos\_ind\_discrepancy_{i,t-1} + \beta_{12} neg\_ind\_discrepancy_{i,t-1} + \beta_9 UAI + \beta_{10} LTO + \varepsilon_{i,t} \quad (3)$$

The previous models only differ on the use of firm or industry discrepancies as capturing managers' aspirations, based on the work by Chen and Miller (2007). Following the findings by Petersen (2009), Gow Ormazabal and Taylor (2010) and Thompson (2011), and given the panel data nature of the sample, these are estimated using firm and year clustered standard errors. Table 3 presents the descriptive statistics and correlation coefficients for the variables used in the empirical analysis.

Results

We use panel regression analysis of R&D to sales for the panel of firms described above. Table 4 presents the results when the aspirations are defined relative to past performance of the firm (firm discrepancy) and Table 5 considers peer effects with the performance discrepancy calculated in relation to the median of the industry (industry discrepancy).

In both Tables 4 and 5, column (1) tests the hypotheses concerning the behavioral theory of the firm in isolation. As postulated by the behavioral theory of the firm, the net impact of lagged measures of slack within the firm is positive and statistically significant, corroborating Hypothesis 2 that the more slack resources, the more leeway firms have to invest in R&D.

As for aspirations, both firm discrepancy and industry discrepancy have statistically significant coefficients, corroborating the prediction that firms indeed react to aspiration levels. Firms that exhibit a positive discrepancy, i.e. have performance above aspirations, tend to invest more in R&D, which is contrary to Hypothesis 1 (that follows from the behavioral theory of the firm, whereby firms would not change their decision). For firms that exhibit a negative discrepancy, the coefficient is negative: the closer they

Table 3
Descriptive statistics and Pearson correlations

Panel A: Descriptive Statistics

	Obs	Mean	SD	Min	Max
rd_sales_t	104,431	0.057	0.082	0.000	0.458
ind_growth_t	104,431	0.071	0.154	-0.281	0.777
$ind\_rd\_sales_t$	104,431	0.043	0.036	0.002	0.140
a_slack_{t-1}	104,431	2.436	1.978	0.414	12.336
rec_slack_{t-1}	104,431	0.282	0.244	0.030	1.450
$zscore_{t-1}$	104,431	0.037	0.057	-0.191	0.328
$pos\_firm\_disc_{t-1}$	104,431	0.032	0.082	0.000	0.549
$neg\_firm\_disc_{t-1}$	104,431	-0.034	0.078	-0.503	0.000
$pos\_ind\_disc_{t-1}$	104,431	0.032	0.058	0.000	0.315
$neg\_ind\_disc_{t-1}$	104,431	-0.049	0.123	-0.805	0.000
UAI	104,431	0.656	0.226	0.080	1.120
LTO	104,431	0.652	0.300	0.212	1.000

Panel B: Pearson correlations

		1	2	3	4	5	6	7	8	9	10	11	12
1	rd_sales_t	1											
2	ind_growth_t	-0.031	1										
3	$ind\_rd\_sales_t$	0.515	-0.092	1									
4	a_slack_{t-1}	0.295	0.008	0.198	1								
5	rec_slack_{t-1}	0.689	-0.041	0.498	0.210	1							
6	$zscore_{t-1}$	0.060	0.056	0.074	0.519	-0.075	1						
7	$pos\_firm\_disc_{t-1}$	0.187	0.027	0.162	0.032	0.221	-0.046	1					
8	$neg\_firm\_disc_{t-1}$	-0.246	0.017	-0.150	-0.045	-0.328	0.137	0.169	1				
9	$pos\_ind\_disc_{t-1}$	0.080	0.048	0.176	0.201	0.002	0.368	0.306	0.104	1			
10	$neg\_ind\_disc_{t-1}$	-0.364	0.018	-0.184	0.037	-0.575	0.333	-0.113	0.603	0.221	1		
11	UAI	-0.284	-0.079	-0.295	-0.139	-0.290	-0.118	-0.147	0.156	-0.184	0.182	1	
12	LTO	-0.355	0.096	-0.455	-0.151	-0.402	-0.043	-0.181	0.176	-0.188	0.216	0.706	1

Notes: all correlations statistically significant at a 1% level.

Table 4
Firm discrepancy results

Variables	(1)	(2)	(3)
ind_growth_{t}	0.004	0.001	0.000
	(0.004)	(0.004)	(0.004)
$ind\_rd\_sales_{t}$	0.466***	0.462***	0.461***
	(0.020)	(0.021)	(0.020)
a_slack_{t-1}	0.005***	0.005***	0.005***
	(0.000)	(0.000)	(0.000)
rec_slack_{t-1}	0.180***	0.179***	0.179***
	(0.004)	(0.004)	(0.004)
$Zscore_{t-1}$	0.039**	0.030*	0.032*
	(0.015)	(0.016)	(0.016)
$pos\_firm\_disc_{t-1}$	0.038***	0.035***	0.020
	(0.007)	(0.007)	(0.016)
$neg\_firm\_disc_{t-1}$	-0.044***	-0.040***	-0.037
	(0.010)	(0.010)	(0.023)
UAI		-0.020***	-0.024***
		(0.003)	(0.003)
LTO		0.007***	0.012***
		(0.003)	(0.002)
$UAI*pos\_firm\_disc_{t-1}$			-0.065**
			(0.027)
$UAI*neg\_firm\_disc_{t-1}$			0.073**
			(0.033)
$LTO*pos\_firm\_disc_{t-1}$			0.082**
			(0.036)
$LTO*neg\_firm\_disc_{t-1}$			-0.067
			(0.044)
Constant	-0.031***	-0.021***	-0.021***
	(0.001)	(0.003)	(0.003)
Observations	104,431	104,431	104,431
***R*-squared**	0.534	0.536	0.536

Notes: Two-way (firm and year) clustered standard errors estimation used. Standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 5
Industry discrepancy results

Variables	(1)	(2)	(3)
ind_growth_{t}	0.005	0.001	0.001
	(0.005)	(0.005)	(0.005)
$ind\_rd\_sales_{t}$	0.473***	0.466***	0.468***
	(0.020)	(0.021)	(0.021)
a_slack_{t-1}	0.005***	0.005***	0.005***
	(0.000)	(0.000)	(0.000)
rec_slack_{t-1}	0.181***	0.180***	0.180***
	(0.004)	(0.004)	(0.004)
$Zscore_{t-1}$	0.033**	0.024	0.025
	(0.016)	(0.017)	(0.017)
$pos\_ind\_disc_{t-1}$	0.020**	0.014*	-0.037*
	(0.008)	(0.008)	(0.022)
$neg\_ind\_disc_{t-1}$	-0.020***	-0.016**	-0.012
	(0.007)	(0.007)	(0.021)
UAI		-0.021***	-0.024***
		(0.003)	(0.003)
LTO		0.007***	0.007***
		(0.003)	(0.003)
$UAI*pos\_ind\_disc_{t-1}$			0.010
			(0.028)
$UAI*neg\_ind\_disc_{t-1}$			0.023
			(0.032)
$LTO*pos\_ind\_disc_{t-1}$			0.082**
			(0.037)
$LTO*neg\_ind\_disc_{t-1}$			-0.025
			(0.048)
Constant	-0.030***	-0.019***	-0.018***
	(0.001)	(0.002)	(0.003)
Observations	104,431	104,431	104,431
***R*-squared**	0.532	0.534	0.534

Notes: Two-way (firm and year) clustered standard errors estimation used. Standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

are to matching their aspiration (that is, lower discrepancy in absolute terms), the less R&D investment is made, whereas the further away they are (that is, higher discrepancy in absolute terms), the more R&D investment is made, all else being equal. This result for firms with negative discrepancy corroborates Hypothesis 1, whereby R&D investment allows firm to address problemistic search.

For these regressions, the control of industry R&D intensity is positive statistically significant, which is expected that in more R&D intensive sectors, a firm exhibits more R&D intensity. A higher zscore of the firm, proxying more distance from bankruptcy, yields more R&D investment.

In column (2) we add the cultural dimension variables of uncertainty avoidance and long-term orientation. The coefficients for UAI are negative in both tables and statistically significant as hypothesized in Hypothesis 3. Controlling for the other variables in the model, the more a country exhibits uncertainty avoidance, the lower the investment in R&D a firm in that country will undertake. Hypothesis 4 proposes a positive relation between LTO and R&D intensity and this is corroborated in the data, whereby a firm in a country with an outlook more towards the future engages more in R&D investment.

In column (3) we enrich the model and include interactions of the cultural dimensions and the firm and industry discrepancy in each table respectively. We hypothesize that being above or below aspirations interacts with the country's UAI and LTO.

In Table 4 for firm discrepancy results, the coefficients on the discrepancy dummy variables are no longer statistically significant. It should be noted that in column (1), the coefficients were statistically significant, although the direction of the relation was not fully consistent with the theoretical predictions. For a firm performing above self-aspirations, the higher the UAI, the lower the R&D investment (in fact the coefficient of the interaction amplifies the negative relation found for the UAI variable). For a firm below aspirations, the coefficient on the interaction is positive, which in conjunction with the coefficient for UAI alone dampens the negative effect of uncertainty avoidance. So, when the performance is poor relative to the benchmark (in this case the firm's own performance) the dissuading effect of uncertainty avoidance is less strong.

Concerning LTO, the coefficient on the level variable is positive and the effect is amplified when firms are above aspirations. There is however no incremental effect for below aspirations firms. So a firm in a beneficial position compared to past performance will further its investment in R&D, the more the country is oriented towards the long term.

The results are similar in terms of direction in Table 5 – column (3), where the discrepancy is in relation to industry median performance. Only the coefficient for the positive industry discrepancy is statistically significant and negative in column (3). In terms of the interaction between the relative aspirations position of the firm and the cultural dimensions, only LTO for a positive industry discrepancy is statistically significant and positive, generating a positive effect from the higher long-term orientation on R&D investment. In the model without interaction, again the coefficients on UAI and LTO are respectively negative and positive as postulated by Hypotheses 3 and 4.

Discussion and Conclusion

We explore firm-level data to provide further evidence that cultural values at the country level influence firms' R&D choices. Using the framework of the behavioral theory of the firm, we explore the situational determinants of R&D investment, namely aspirations and slack within the firm, but interact these variables with the cultural values of Hofstede of uncertainty avoidance and long-term orientation. Our results show consistent evidence for cultural dimensions impacting R&D search activities of the firms in the sample. This paper adds to the literature on R&D and innovation by using a panel of firms across different countries and expanding the approach of the behavioral theory of the firm to account for cultural differences between the countries. Given the importance that innovation can play in a country's future development, these results are consequential to designing country specific R&D promotion policies. This should be done acknowledging that slack resources and aspirational levels condition managerial decisions, but also that the cultural context of the country in its outlook towards uncertainty and the future also play a role.

Our study is to our knowledge the first that uses a panel of firms from different countries to combine the framework of the behavioral theory of the firm, acknowledging satisficing choices from managers in terms of R&D investment in response to aspirations and availability of slack, and the role of cultural dimensions, to better understand this relation. A previous paper by Lewellyn and Bao (2015) explored this relation but focused on a single sector, making their conclusions sector-specific and limited. We enrich the literature by extending the analysis across sectors. The results show how countries cultural characteristics impact R&D investment across most economic activity sectors.

Additionally, as briefly presented in the literature overview, the evidence has not been consistent in supporting the direction of impact of aspirations on managerial decisions. Aspirations measured in relation to past performance of the firm or of peers have been found to consistently matter for decisions such as R&D investment, however the

behavioral theory suggests that performance above aspirations should not catalyse changes in behaviour, whereas performance below aspirations, should create problemistic search and increase R&D investment. This paper adds to the literature partially contradicting these predictions when cultural variables are not considered. When these discrepancies in aspirations are interacted with the cultural dimensions, the direction of change is impacted, albeit not necessarily towards the theoretical predictions.

The research approach presented in this paper can thus further clarify in what circumstances behavioral determinants impact managerial decisions. There are nonetheless limitations which can be explored in future research. By focusing just on listed firms, which are normally just a subset of all the firms in every country and which is likely to exclude smaller firms, we do not consider how non-listed firms make their R&D investment decisions. It should however be noted that previous research has documented many idiosyncrasies of small and medium firms relative to larger firms (e.g., Lumpkin, McKelvie, Gras, & Nason, 2010; Marom, Lussier, & Sonfield, 2019). It would thus be relevant to extend the analysis to more directly account for those specificities, as well as the nature of ownership, namely family vs. non-family (e.g., Ahluwalia, Mahto, & Walsh, 2017; Bendickson, Davis, Cowden, & Liguori, 2015; Campbell, Line, Runyan, & Swinney, 2010; Chrisman & Patel, 2012). Moreover, it would also be interesting to explore the extent to which different firms and countries' corporate governance regimes interact with aspirations and slack and condition the decision to invest on R&D.

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