National culture and innovation: a multidimensional analysis

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Abstract

Purpose – This study aims to examine the relationships between the different national culture dimensions presented by Hofstede and innovation data by country to analyze which characteristics of national culture dimensions contribute to the country becoming more innovative.

Design/methodology/approach – The study is characterized as descriptive and quantitative, using multiple linear regression equations as data analysis technique. To carry out the analysis, this study made use of secondary data from Hofstede's national culture database, data on innovation indicators from the Global Innovation Index and population data from the World Bank database. The analysis comprises data from 2015 to 2018.

Findings – National culture affects innovation rates positively. The most favorable situation to boost innovation is when there is a low distance from power, high individualism, femininity characteristics, low aversion to uncertainty, long-term orientation and a higher level of indulgence.

Originality/value – The temporal analysis comprises a wider list of countries from all continents, which had not been considered in previous studies.

Keywords Innovation, National culture

Paper type Research paper

1. Introduction

Technological changes contribute to increasing a country's prosperity through innovation (Dutta, Gurry, & Lanvin, 2016). The term "innovation" includes novelties that can be introduced in an economic system and change the relationship between producers and consumers. This relationship change is fundamental for the system's economic development (Schumpeter & Backhaus, 2003).

Considering this scenario, digital transformation has been growing and changing on a global scale; being aware of these changes is imperative for business survival (Dutta et al., 2016). Companies – as well as countries – need to innovate to compete in a rapidly changing global economy (Khan & Cox, 2017). However, few countries are prepared to adapt to these transformations (Dutta et al., 2016). Considering this, determining the factors that influence innovation significantly helps countries to target their efforts and resources in a more assertive way (Barrichello, dos Santos, & Morano, 2020).

When companies and countries are faced with a context of uncertainty and quick changes in an environment that demands constant adaptation, technological innovation presents itself as a determining factor for differentiation and competitiveness. When there is no technological innovation, the economy tends to stagnate (Fagerberg, 2003). The stationary economy stems from the exhaustion of the selling power of certain products or services, which creates opportunity for innovations (Freeman, 1984). Schumpeter and Backhaus (2003) point out that entities with greater innovation capacity tend to respond to these gaps by bringing in investment opportunities, growth, and creating more job opportunities.

According to Andrijauskienė and Dumčiuvienė (2017), despite investing in research and development and industrial infrastructure, many countries are not able to improve their innovation indicators. In this line, Shane (1993) points out that countries need to promote values that encourage innovation; only then a change in the scenario may occur. Hofstede (1983) argues that the differences in values between groups of different nations or regions is to be known as national culture. The dimensions of national culture represent preferences for one situation over another, which are capable of distinguishing countries. Hofstede (2011) also presents dimensions for assessing national culture, which are power distance, uncertainty avoidance, individualism versus collectivism, masculinity versus femininity, indulgence versus restraint and short-term orientation versus long-term orientation.

Innovation levels are affected by culture. Studies such as those of Van Everdingen and Waarts (2003), Kaasa and Vadi (2010), Mercan and Goktas (2011), Taylor and Wilson (2012), and Khan and Cox (2017) affirm that culture influences innovation. This influence exists because culture can promote a better or worse innovative environment (Kaasa, 2016). Although previous research has pondered this relationship already, the analysis of the influence of each dimension of national culture shows discrepant results among authors. Some research shows a positive relationship, some a negative relationship or even an insignificant relationship between these dimensions and innovation rates. Considering previous studies, we notice that authors often use different data either to identify innovation levels or to contemplate specific regions at a specific time, without considering a global analysis combined with a time series.

In addition to institutional quality, economic structure, organizational culture and leadership, Kroenke, Ferretti, and Junior (2018) highlight the impact of cultural factors (power distance, individualism, long-term orientation and indulgence) on innovative performance, and consequently on the economic structure of a country. Francischeto and Neiva (2019) also confirm the impact of cultural dimensions on innovation, however, claiming that the impacts may vary and reinforcing the need for more research in the area.

Recent studies follow different lines of thought, showing that national culture and innovation still present many research gaps. Khan and Cox (2017) relate national culture to creativity and innovation, signaling that a more formal understanding of culture and innovation is being developed. Andrijauskienė and Dumčiuvienė (2017) explore the dimensions of national culture by relating them to innovation. Similarly, Bukowski and Rudnicki (2019) analyze the dimensions of national culture and innovation, highlighting that the dimension individualism alone does not fully justify the role of culture. Thus, the authors point out that long-term orientation and flexibility have a positive influence on innovation; however, this study considered only a few East Asian countries.

In the same line, Gallego-Álvarez and Pucheta-Martínez (2020) analyzed the relationship between national culture and investments in innovation. It shows that companies belonging to powerful masculine societies, with low uncertainty avoidance and long-term orientation, are more likely to invest in innovation and less likely to be individualistic. Bogatyreva et al.

(2019) relates national culture dimensions to entrepreneurship and innovation, evidencing that specific aspects of national culture influence the relation between entrepreneurship and action. Nevertheless, a given set of national culture aspects can strengthen or mitigate the practice of innovative activities. Moreover, Elia, Messeni Petruzzelli, and Piscitello (2019) analyzed innovation levels in alliances of multinational companies with different national cultures. According to such perspective, subsidiaries tend to be less innovative when engaging with partners from different cultures.

Considering the importance of innovation for differentiation and competitiveness, in addition to the possible influence of culture in this context and the divergence in conclusions among authors on national culture and innovation, we aim at answering the following research question: what are the cultural characteristics that affect innovation? Therefore, we aim at examining the relationship between the different national culture dimensions presented by Hofstede and innovation data by country (GII, 2019). By doing so, we will be able to visualize which set of national culture dimensions contribute the most to boost countries' innovation rate.

To achieve the intended objective, we collected innovation indicators from 71 countries from 2015 to 2018. The time series analysis was carried out using panel data, obtaining greater consistency in the results. Data were analyzed using multiple linear regression, in which countries' national culture aspects and innovation rate were considered. Through this analysis, it was possible for us to identify which set of national culture aspects boosts countries' innovation rate.

Considering our objective, the originality of this study lies on the fact that we contemplate a larger number of countries and a more comprehensive time series than previous research. This article also contributes to existing theory by verifying the consistency of the findings and confirming the achievements of previous research. This research also has a practical value. Identifying the factors that impact innovation is a strategic information that can help creating policies and practices to contribute to improving countries' innovative and economic scenarios.

2. National culture and innovation

In the mid-1950s and 1960s, the idea that culture had an impact on company management was out of the question, and management was seen as universal, where management methods would be the same for all locations (Hofstede, 1983). It was in 1970 that the idea of universal management began to weaken. This happened due to the perception of increased, rather than reduced cultural differences within a single country or region (Hofstede, 1983). After such perception of increased cultural differences within regions, researchers started focusing on creating models to analyze culture (Trice & Beyer, 1984).

National culture is defined by Hofstede (1983) as the collective programming of the mind, which distinguishes the members of a given group from members of a different group. Also, national culture deals with the difference in values between groups of distinct nations or regions (Hofstede, 2011). These differences are one of the problems for the management of multinational and multicultural organizations, whether it be public or private (Hofstede, 1983). Nationality is important for at least three reasons: political (as nations are political units, rooted in history, with their own institutions and systems); sociological (as nationality or regionality has a symbolic value for citizens); and psychological (since thinking is partially conditioned by national culture factors) (Hofstede, 1983).

From 1983 to the present, Hofstede's national culture model is one of the most used models on how values in companies are influenced by culture. This model was based on a study that considered a large database of employee value scores collected at IBM between

1967 and 1973. The data was obtained from more than 70 countries, of which Hofstede used for the first time 40 countries with the largest groups of respondents; then, the analysis was extended to 50 countries and 3 regions (Hofstede, 2011).

The definitions of national culture and the national culture model proposed by Hofstede received criticism. McSweeney (2002) pointed out that, in order to understand a culture, it is necessary to identify the richness and diversity of national practices and institutions, and not assume its uniformity as presented by Hofstede. According to Williamson (2002), even though McSweeney's (2002) critics are insufficient to invalidate Hofstede's model, they must be considered for it raises important points to be considered when using the model.

After McSweeney's (2002) generalization criticisms, Hofstede's model received other criticisms regarding its dimensions. According to Fang (2003), the fifth dimension of Hofstede's model (short- versus long-term orientation) ignored the methodology used in the elaboration of the previous dimensions.

Although Hofstede's definition of national culture receives criticisms from other researchers, such as McSweeney (2002) and Fang (2003), mainly regarding the method used, the author responds to them pointing out studies that validated his results. Subsequent studies validating the results include groups of respondents such as commercial airline pilots and students in 23 countries, public service managers in 14 countries, high-end market consumers in 15 countries, and elites in 19 countries. The relative positions of the 40 countries in these four dimensions were expressed on a scale from 0 to 100 points. Subsequently, research carried by Hofstede and other researchers increased the number of analyzed countries to 76 (Hofstede, 2011). Despite criticisms on the method, an analysis of publications over the last 40 years carried out by Zhou and Kwon (2020) identified more than a thousand studies using Hofstede's model.

Hofstede (1983) initially identified four dimensions of national culture that were largely independent: power distance (from large to small), uncertainty avoidance (from strong to weak), individualism versus collectivism, and masculinity versus femininity. Later, the researcher included two other dimensions: indulgence versus restraint and short- versus long-term orientation. The six cultural dimensions represent independent preferences for one state of affairs in relation to another, which distinguishes countries (and not individuals) from one another (Hofstede, 2011).

The power distance dimension expresses the degree to which less powerful members of society accept and expect power to be distributed unevenly (Hofstede, 1983). The fundamental question of this dimension is how a society deals with inequalities among individuals.

In societies with high power distance, individuals tend to accept a hierarchical order in which everyone has a determined place and no further justification is needed (Hofstede, 1983). In this environment, decision structures are centralized and characterized by the use of formal rules (Kaasa, 2016). In contrast, in societies with low power distance, people strive to equalize the distribution of power and demand justification for power inequalities (Hofstede, 1983).

Research conducted on power distance indicates that information sharing and dissemination can be restricted by hierarchy when power distance is high, thus, individuals tend to take less action to introduce new products (Van Everdingen & Waarts, 2003). In cultures with less power distance, there is more trust between hierarchical levels (Kaasa, 2016), which provides a freer environment where creativity is boosted and ideas are generated (Shane, 1993). Considering this, countries that have decentralized structures tend to generate more innovation (Prim, Filho, Zamur, & Di Serio, 2017).

On the one hand, in environments with higher power distance, individuals lose the opportunity to participate in decision-making processes (Kaasa, 2016). On the other hand, in environments with low power distance, communication and information exchange is more common (Shane, 1993). Nevertheless, previous research indicates that lower power distance boost innovation rate (Herbig & Dunphy, 1998; Hussler, 2004; Rinne, Steel, & Fairweather, 2012; Shane, 1993).

Considering that socialization activities encourage information sharing (Takeuchi & Nonaka, 2008), which in turn will increase knowledge and motivate individuals to bring in and develop innovation (Kaasa, 2016), the following hypothesis is proposed:

H1. The lower the power distance, the higher the innovation rate.

In contrast, the dimension individualism versus collectivism considers individualism as a preference for a loosely knit social structure, where individuals are expected to care only for themselves and their immediate relatives. Therefore, collectivism in this dimension is pointed out as a preference for a more united social structure, where individuals can expect their relatives or members of a certain group to take care of them in exchange for unquestionable loyalty (Hofstede, 1983). In collectivist environments, members have a predisposition to value participation and acceptance of social groups (Prim et al., 2017), and individuals tend to subordinate their own interests to the interests of the group (Khan & Cox, 2017).

Employees of organizations in more individualistic countries have more freedom to develop or try new products (Van Everdingen & Waarts, 2003). Previous research merging national culture with innovation presented a positive relationship between individualism and innovation (Andrijauskienė & Dumčiuvienė, 2017; Bresnahan & Greenstein, 2003; Herbig & Dunphy, 1998; Khan & Cox, 2017; Rinne et al., 2012; Williams & McGuire, 2005). Furthermore, Prim et al. (2017) explain that, in more independent cultures, citizens have greater autonomy to produce ideas and execute them, boosting innovation performance.

Thus, the relationship between individualism and innovation lies on the fact that, in individualistic societies, individuals do not have to worry about the opinion of the group, as they have greater freedom to express their own opinions (Andrijauskienė & Dumčiuvienė, 2017), which can boost creativity and innovation (Khan & Cox, 2017). Based on this assumption, the second hypothesis is formulated:

H2. The higher the individualism levels, the higher the innovation rate.

In the third dimension, masculinity versus femininity, masculinity is understood as the society's preference for achievement, heroism, assertiveness and material rewards for success, thus guiding society towards competitiveness (Hofstede, 1983). Femininity, on the other hand, represents a preference for cooperation, modesty, care for the weak and life quality, where society is oriented towards consensus (Hofstede, 1983).

In a similar research, results showed that masculine societies tend to be less innovative (Kaasa, 2016; Kaasa & Vadi, 2010; Khan & Cox, 2017; Prim et al., 2017). In environments where work quality and cooperation prevail (femininity), there is a higher error tolerance (Prim et al., 2017), people become thereby more willing to innovate. In contrast, male environments stimulate competition and material rewards, making people less innovative (Khan & Cox, 2017). However, in the same research line, Shane (1993) and Williams and McGuire (2005) did not obtain significant results, which highlight the need for further investigation.

Considering Hofstede's (1983) definition, masculinity tends to promote more competition and femininity more cooperation. In this way, an environment that facilitates information exchange would possibly be more innovative. Collaborative environments are also presented by Chesbrough (2003) as a potential for innovation. The author defines these collaborative environments as open innovation. It is noteworthy that open innovation ends up bringing ideas from the outside of companies or countries, overcoming the limited rationality of individuals. Therefore, open innovation enables the development of new products and reach out to new markets through cooperation (Chesbrough, 2003).

According to Khan and Cox (2017), female societies focus on people and cooperation, and by doing so they provide a more favorable environment for innovation. Thus, we propose our third hypothesis:

H3. The lower the masculinity level, the higher the innovation rate.

The fourth dimension, uncertainty avoidance, analyzes the degree to which members of a society are uncomfortable with uncertainty and ambiguity (Hofstede, 1983). The latter considers how culture programs this feeling in unknown or unstructured situations (Piet, 2017).

This dimension considers how society deals with the unknown future; i.e. if society tries to control it or just let it happen without any further interference (Hofstede, 1983). Countries with high uncertainty avoidance have codes of belief and behaviors that are rigid and intolerant of different ideas (Piet, 2017), whereas in societies with low uncertainty avoidance, practice is considered more important than principles (Hofstede, 1983).

Research that relates this dimension to innovation (Andrijauskienė & Dumčiuvienė, 2017; Kaasa, 2016; Kaasa & Vadi, 2010; Shane, 1993; Williams & McGuire, 2005) mostly found that the relation between uncertainty avoidance and innovation is negative, which means that the lower the uncertainty avoidance, the higher the innovation rates. Van Everdingen and Waarts (2003) emphasize that high uncertainty avoidance imply that companies will not take unnecessary risks; they will adopt innovations only if their value has already been proved in the market.

Studies that link culture, entrepreneurship, and innovation also comprise uncertainty avoidance (Hayton, George, & Zahra, 2002). In this line, the promotion of entrepreneurial activities supports the promotion of innovation activities, and different sets of cultural characteristics distinguish nations according to higher or lower entrepreneurship and innovation levels (Woodside, Lars, & Graham, 2020).

Filion (2007) points out that, when developing a project, entrepreneurs seem to evolve in the realization of a project either through the simulation of reality or thinking ahead. The author stresses that it is difficult to conceive a new product or service without thinking ahead, for it enables the definition of an objective and a clearer path to follow.

Regarding vision of the future, entrepreneurship, and innovation, Dornelas (2003) sees innovation as the creation and introduction of products and services, which indicates the revitalization of the organization. Just as customers' needs may change, the entrepreneur must perceive this new opportunity, and then modify, improve or even create a product to meet those needs. Therefore, we formulated the fourth hypothesis:

H4. The lower the uncertainty avoidance, the higher the innovation rate.

The fifth dimension, long-term versus short-term orientation, relates to societies that prioritize or not the links with their own past while dealing with present and future challenges (Hofstede, 2011). Societies with a short-term orientation have a strong concern

about establishing the absolute truth (Piet, 2017) and prefer to maintain time-honored norms and traditions (Hofstede, 2011), while observing social change with caution, which suggests that these are less innovative (Van Everdingen & Waarts, 2003).

Countries with long-term orientation, in contrast, encourage improvements in the economy and devote significant efforts to improve and modernize education as a way of preparing for the future (Hofstede, 2011). Thus, they encourage the establishment of a few values, such as perseverance, hard work, shame, and savings (Khan & Cox, 2017), making people better prepared to be receptive to changes (Van Everdingen & Waarts, 2003).

Although only a few studies have considered long- versus short-term orientation, for it was later inserted into Hofstede's model, some authors have already carried out investigations including this dimension in the analysis. Khan and Cox (2017) and Prim et al. (2017) pointed out that societies with long-term orientation have a greater capacity for innovation. However, Andrijauskienė and Dumčiuvienė (2017) did not obtain significant results in the same sort of analysis, which indicates a possible gap in this dimension.

Prim et al. (2017) point out that long-term actions are associated with capacity for sustained innovation, where culture is directed towards planning, encourages experimentation, and presents greater error tolerance. Beugelsdijk, Maseland, and Van Hoorn (2015) show that long-term-oriented cultures are characterized by strong economies and persistence, which can be considered a favorable environment for innovation. Based on this, we developed the fifth hypothesis:

H5. The higher the long-term orientation, the higher the innovation rate.

The last dimension deals with indulgence versus restraint. According to Hofstede (2011), indulgence simulates a society that allows people to enjoy life and have fun; unlike restraint, where society suppresses the satisfaction of needs and regulates them through social norms (Piet, 2017).

In indulgent societies, individuals tend to be optimistic, stimulating innovation as a way of satisfying impulses related to fun and satisfaction, unlike restrictive societies, which are more pessimistic (Khan & Cox, 2017). In the organizational context, this dimension is related to organizational structure and expected behavior. Organizations with less restrict environments facilitate innovation through the consideration of new technologies, knowledge, products, and services (Prim et al., 2017).

Previous research linking indulgence and national innovation (Andrijauskienė & Dumčiuvienė, 2017; Khan & Cox, 2017; Prim et al., 2017) have shown a positive impact of this dimension on innovation rates. According to Khan and Cox (2017), indulgent cultures are more prone to creating new technologies as a way of improving life. From this perspective, we formulated the sixth hypothesis.

H6. The higher the indulgence level, the higher the innovation rate.

3. Methodology

This study aims at verifying which national culture dimensions influence countries' innovation levels. In order to meet such objective, we propose a descriptive study with quantitative approach, where secondary data will be used.

Initially, a documental analysis was carried out. Therefore, the initial data collection considered: a) national culture data provided by Hofstede's database; b) countries'

population per year using World Bank's database; and c) annual innovation data by country provided by the Global Innovation Index (GII) report.

From a population of 196 countries listed by the World Bank, we selected a sample of only 71 countries due to the lack of available data on culture and innovation in every nation (Table 1). For the analysis, we considered data from 2015 to 2018, i.e. the most recent years with available data.

Data were analyzed through multiple linear regression using panel data to verify which national culture dimensions influence countries' innovation rate. We used panel data as a measurement to assess the influence of independent variables on a given dependent variable considering a set of observations over time (Hair, Babin, Samouel, & Money, 2005). Thus, in this article such conception was applied considering the influence of national culture (measured by the Hofstede's dimensions of national culture) on the GII from 2015 to 2018.

GII is a global report that aims at providing data to assist the formulation of public policies; the report indicates how to encourage and measure innovative activities, which in turn are part of the main drivers of economic and social development (GII, 2019). The purpose of GII report is to classify the capacity and results of innovation in world economies, which comprises 129 countries and utilizes 80 indicators, ranging from research and development to the creation of high-tech applications and exports (GII, 2019). GII is co-published by Cornell University, INSEAD, and the World Intellectual Property Organization.

We considered herein Hofstede's (2011) six national culture aspects, namely, power distance; uncertainty avoidance; individualism versus collectivism; masculinity versus femininity; indulgence versus restraint; and short- versus long-term orientation as independent variables. We also present the research model and the hypotheses in Figure 1.

In addition to independent and dependent variables, we have inserted a control variable in the model: population. Control variables establish a context in which the relationship between independent and dependent variables is established (Marconi & Lakatos, 2003). The control variable was inserted to generate more robustness to the model. We believe that the larger the population, the higher the innovation rate. If the control variable is not significant while national culture is, we understand that aspects related to national culture may influence innovation.

Albania	Croatia	Indonesia	New Zealand	Slovenia
Angola	Czech Republic	Ireland	Nigeria	South Africa
Argentina	Denmark	Italy	Norway	Spain
Australia	Dominican Republic	Japan	Pakistan	Sweden
Austria	Egypt	Jordan	Peru	Switzerland
Bangladesh	El Salvador	Latvia	Peru	Tanzania
Belgium	Estonia	Lebanon	Philippines	Thailand
Brazil	Finland	Lithuania	Poland	Ukraine
Bulgaria	France	Luxembourg	Portugal	United Kingdom
Burkina Faso	Germany	Malaysia	Romania	United States
Canada	Ghana	Malta	Russia	Uruguay
Cape Green	Greece	Mexico	Saudi Arabia	
Chile	Hungary	Morocco	Serbia	
China	Iceland	Mozambique	Singapore	
Colombia	India	Netherlands	Slovakia	

Source: Research data

Table 1.
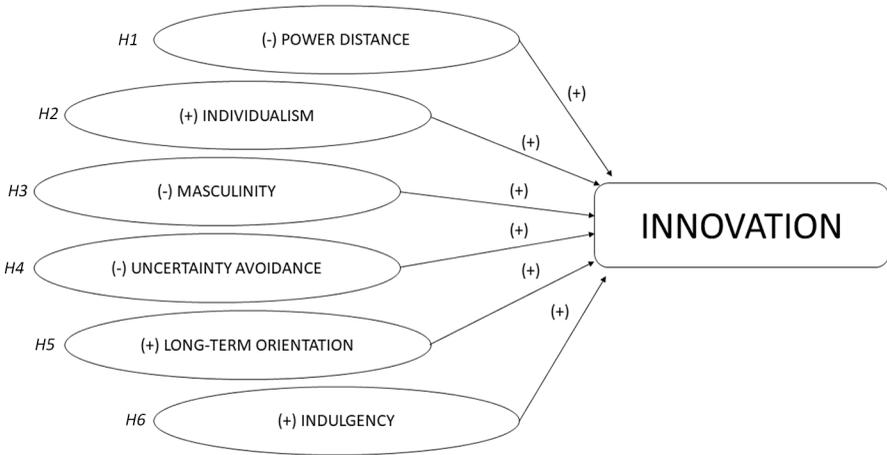Countries analyzed in
the study

Research model

Figure 1.
Research model

Source: Research data

Seeking to answer the research question, we applied a multiple linear regression equation. Initially, the ANOVA test was performed, whose purpose was to test the effect of the independent variables (six dimensions of national culture) on the dependent variable (innovation). For a multiple linear regression to be valid, ANOVA's p-value or significance must be <0.05 (Maroco, 2007).

Subsequently, we used Durbin–Watson statistic. According to Field's (2009) definition, this test evaluates the existence of serial autocorrelation in the residuals or errors. To confirm the inexistence of autocorrelation, the reference value must be less than 2 (Fávero, Belfiore, Silva, & Chan, 2009).

After confirming the inexistence of autocorrelation among the residuals, we analyzed the variance influence factor (VIF). VIF measures the effect of independent variables on the regression coefficient. According to Maroco (2007) and Fávero et al. (2009), a VIF value above or equal to 5 confirms the existence of multicollinearity between independent variables.

Finally, we analyzed the regression results. Considering the regression equation, Maroco (2007) emphasizes the importance of analyzing the R^2 coefficient of determination. This coefficient assesses the goodness of fit of a model. The reference values for this indicator depend on the subjectivity of the study, but according to Maroco (2007), the ideal value for social sciences must be equal to or above 0.5. Then, we analyzed the significance of the relationships between culture variables and the dependent variable. For a variable to be considered significant, the p-value or significance must be equal to or less than 0.05 (Hair et al., 2005).

4. Result analysis and discussion

As described previously, before verifying the influence of national culture dimensions on the innovation rate, we performed an ANOVA test to verify the existence of statistically

significant relationships. In this test, a p-value of 0.000 (<0.05) was found, which meets the requirements of the regression analysis. The outcomes of this test are shown in Table 2.

Still in Table 2, the value of the Durbin–Watson statistic was 0.481 (<2), i.e. there is no serial autocorrelation in the residuals. These results show that the model is adequate and allow us to proceed with the model analysis.

Afterwards, we analyzed the VIF to verify the existence of multicollinearity between independent variables. The results of this calculation are presented in Table 3.

The results of the VIF calculation did not exceed 2.448 (<5); therefore, there is no multicollinearity among the explanatory variables. In addition, to test the research model, we verified the influence of national culture dimensions on the innovation rate. These results are presented in Table 4.

As showed in Table 4 the control variable population was not statistically significant (p-value> 0.05) to explain the innovation rate when analyzed altogether with national culture dimensions. This result increases the robustness of our research model since country size – in terms of population – does not interfere with innovation rate. We expect that the studied variables contribute to better explain the phenomenon under investigation. Nevertheless, we also tested for statistical significance using the data provided by Table 4; thus, a summary of the hypotheses could be elaborated in Table 5.

Regarding power distance, the influence of this dimension on innovation rate is negative (Beta value negative), and the variable is significant (p-value <0.05). Accordingly, the lower

Model	Sum of squares	Degrees of freedom	Mean square	F	P-value
1					
Regression	29188.35	7	4169.764	117.267	0.000
Residual	9565.062	269	35.558		
Total	38753.412	276			

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.868	0.753	0.747	5.963	0.481

Source: Research data

Table 2.
ANOVA Test

Model	Collinearity statistics	
	Tolerance	VIF
1		
(Constant)		
Population	0.847	1.180
Power distance	0.416	2.402
Individualism *versus* Collectivism	0.409	2.448
Masculinity *versus* Femininity	0.908	1.020
Uncertainty avoidance	0.840	1.190
Long-term *versus* Short-term orientation	0.687	1.456
Indulgency *versus* Restraint	0.681	1.468

Source: Research data

Table 3.
Variance influence
factor (VIF) test

| | Unstandardized coefficients | | Standardized coefficients | | |
Model	ß	Std. error	Beta	t	P-value
1					
(Constant)	28.896	2.993		9.656	0.000
Population	−2.82E-09	0.000	−0.051	−1.558	0.120
Power distance	−0.120	0.026	−0.216	−4.598	0.000
Individualism *versus* Collectivism	0.199	0.025	0.384	8.106	0.000
Masculinity *versus* Femininity	−0.040	0.019	−0.068	−2.126	0.034
Uncertainty avoidance	−0.064	0.018	−0.118	−3.571	0.000
Long-term *versus* Short-term orientation	0.252	0.019	0.484	13.247	0.000
Indulgence *versus* Restraint	0.150	0.019	0.285	7.778	0.000

Source: Research data

Table 4.
Regression data

N	Description	Result
H1	The lower the power distance, the higher the innovation rate	Not rejected
H2	The higher the individualism, the higher the innovation rate	Not rejected
H3	The lower the masculinity level, the higher the innovation rate	Not rejected
H4	The lower the uncertainty avoidance, the higher the innovation rate	Not rejected
H5	The higher the long-term orientation, the higher the innovation rate	Not rejected
H6	The higher the indulgence levels, the higher the innovation rate	Not rejected

Source: Research data

Table 5.
Hypotheses and
results

the power distance, the higher the innovation rate; thus, *H1* could not be rejected. This dimension of culture deals with power inequalities among people. This result is similar to those found by Shane (1993), Herbig and Dunphy (1998), Hussler (2004), Rinne, Steel, and Fairweather (2012), Kaasa (2016), and Andrijauskienė and Dumčiuvienė (2017).

Switzerland, which is one of the most innovative countries according to GII (2019), presents one of the lowest levels of power distance. There, people believe that inequalities should be minimized. This means equal rights, accessible superiors, decentralized power, open communication among hierarchical levels, and consequently the exchange of knowledge for innovation. Sweden, which presents excellent innovation rates (GII, 2019), also has low power distance levels, similar to Switzerland. The lower the power distance, the more countries strive to equalize power among people, increasing access to information and boosting innovation.

The dimension individualism versus collectivism, in contrast, had a positive Beta value ($ß = 0.199$) and could be considered significant (*p*-value <0.05). Thus, the greater the individualism, the higher the innovation rate, not rejecting *H2*. Taylor and Wilson (2012) explain that individualism has a positive and strong relationship with innovation. However, the authors emphasize that collectivism, in the sense of patriotism and nationalism, promotes innovation at the national level, while collectivism (in the sense of family) interfere with innovation rates and can hamper the progress of science and technology.

We can mention the USA (ranking third in the GII – 2019) as a country where individualism influences innovation, which, according to Hofstede's database, is more

individualistic than Brazil (ranking 66th in the GII – 2019). Such outcomes are understandable because innovation is pointed out as the act of putting into practice ideas that emerge from the individual, and the group may or may not support them (Williams & McGuire, 2005). In other words, in a collectivist environment, good ideas may not be approved by the whole and may end up not being put into practice. Furthermore, in individualistic societies, individuals are freer to experiment new ideas (Kaasa & Vadi, 2010). Another issue that justifies such finding is that individualism tends to provide less loyalty (Herbig & Dunphy, 1998).

Results regarding the positive relationship between individualism and innovation corroborate the studies accomplished by Shane (1993), Herbig and Dunphy (1998), Williams and McGuire (2005), Rinne, Steel, and Fairweather (2012), Andrijauskienė and Dumčiuvienė (2017), and Prim et al. (2017). The findings of the present article also clarify a few issues raised by Kaasa and Vadi (2010) when indicating divergences and doubts regarding the influence of individualism on innovation. Unlike the study accomplished by these authors, the data from our research cover countries other than European, and the time series consider a longer period of observations. In other words, individualism, when analyzed globally, influences innovation rate positively.

The dimension masculinity versus femininity has a negative relationship with innovation ($\beta = -0.04$, and p-value <0.05), not rejecting *H3*. In other words, in greater presence of cooperation, modesty, care for the weak and life quality, the more innovative the society. Society, in this context, is more consensus-oriented and egalitarian (related to femininity).

This finding corroborates the outcomes presented by Kaasa and Vadi (2010), Kaasa (2016), and Khan and Cox (2017). By analyzing the cooperation context, these results can be linked to cooperation and product development networks. Today, internal R&D activities are no longer seen strategic; instead, they make room small companies to get access to innovation through partners, such as universities, startups and innovation centers (Chesbrough, 2003). Based on such concept, companies that do not develop internal R&D activities can compete with large organizations that have specific R&D departments, generating more innovation.

The analysis of uncertainty avoidance shows that the lower the uncertainty avoidance, the higher the innovation rate ($\beta = -0.064$ and p-value <0.05), not rejecting *H4*. This result corroborates the findings of Shane (1993), who presents a similar result regarding this dimension. Despite more than 20 years after Shane's (1993) research, with updated population size and technology indicators, we have found similar results, which strengthens the relationship between uncertainty avoidance and innovation. The findings of the present article also corroborate the results found by Williams and McGuire (2005), Kaasa and Vadi (2010), Kaasa (2016), and Andrijauskienė and Dumčiuvienė (2017).

One of the reasons that may explain such outcome is the fact that uncertainty avoidance aspects are like entrepreneurs' personality. According to Dornelas (2003) and Filion (2007), the particularities of an entrepreneur are supported by three main pillars: being proactive, being innovative, and willing to take risks, which is connected with the propensity to deal with uncertainty. This connection was also evidenced by Hayton, George, and Zahra (2002) when analyzing the relationship between national culture and entrepreneurship.

The analysis of long-term versus short-term orientation indicates that long-term orientation has a positive influence on innovation rate ($\beta = 0.252$ and p-value <0.05), thus not rejecting *H5*. These results are similar to those found by Khan and Cox (2017),

and imply that long-term oriented societies tend to be more persistent, and thus more innovative than short-term oriented societies (Beugelsdijk et al., 2015). In addition, the efforts of long-term oriented societies are usually devoted to modernizing education and economy, better preparing them for the future (Beugelsdijk et al., 2015). These findings are in line with the metrics of the global innovation rate (GII), since quality education is one of the main pillars of the index.

The analysis of indulgence versus restraint also indicated a positive and significant influence of indulgence on the innovation rate ($\beta = 0.150$ and p-value <0.05), not rejecting *H6*. This result indicates that indulgence encourages people to enjoy life, have fun, and to be free (Hofstede, 2011).

Hofstede (2011) sees indulgence as the search for happiness. Indulgent societies encourage innovation as a way of continually satisfy needs related to fun and life (Khan & Cox, 2017). Therefore, previous studies also found a positive relation between indulgence and innovation rate (Andrijauskienė & Dumčiuvienė, 2017; Khan & Cox, 2017; Prim et al., 2017).

Considering the adjusted coefficient of determination R^2, we conclude that, altogether, the six culture dimensions proposed by Hofstede can explain 74.7% of the countries' innovation rate.

5. Conclusion
The aim of this research was to analyze which national culture dimensions proposed by Hofstede (2011) influence countries' innovation rate. The analysis considered the past four years with complete data (2015 to 2018); in this way, the findings presented herein are not just a portrait of a specific moment in each region but a temporal and global analysis.

Considering the longitudinal profile of this study, culture ended up having a moderately high explanatory power for the innovation rate, and country size (in terms of population size) cannot be associated with the innovations generated by the country.

In our analysis, we identified that for countries to be more innovative, they must have as culture features:

- low power distance, for it increases access to communication and knowledge among hierarchical levels, enabling more innovations;
- individuals who are not intimidated by creating and executing ideas in front of a group;
- environments that provide collaboration instead of competition, in order to gather knowledge and, consequently, generate innovations;
- individuals with stronger entrepreneurial character to face uncertainties and to take risks when implementing innovative ideas;
- long-term mindset, i.e. preparing citizens through education for a promising future; and
- an environment free from pressure and oppression and prioritizing life quality, only then individuals will be more willing to innovate.

Considering the importance of innovation for countries and organizations' economic development, and the positive influence of national culture on innovation rate, the outcomes of this research bring about valuable insights for countries and for organizations.

This study provides governing authorities who pursue development through innovation with relevant information. In this sense, we recommend that countries that wish to be more innovative should guide their beliefs and values, directing their culture towards cooperation, promoting communication, encouraging individuals to take risks, thinking about the future, developing new ideas and promoting a freer environment.

The results presented herein bring a discussion about previous research on national culture and innovation. This way, based on the updated time series chosen for this analysis and the updated innovation indicators of countries, which were not considered in previous studies – our findings are robust and assert which national culture dimensions really impact innovation rate. In addition, they contribute to advancements in theory by confirming previously found results and elucidating a few previous studies that, either for conceptual or methodological reasons, led to some dubious findings.

As an agenda for future research, we suggest researchers to analyze the constituent pillars of the GII, such as infrastructure, business sophistication and education quality to verify which culture dimensions are more likely to explain each one of the pillars. In addition, we also suggest the identification of the essential culture dimensions that effectively contribute to global innovation. Also, one could analyze these same cultural aspects by grouping clusters of developed or developing countries to verify if countries with similar cultural aspects present different innovation rates.

Finally, as innovation cannot be explained by culture alone, we suggest researchers to analyze other elements that contribute to the development of a favorable environment for innovation. One suggestion would be the analysis of the influence of countries' corruption level on innovation rates. In addition, an analysis of how culture affects the corruption level, and consequently countries' innovation rate, could be included.

As a research limitation, we affirm that only a few countries presented indicators related to short-term versus long-term orientation and indulgence versus restraint, which considerably reduced our sample size.

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