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## Culture and collaboration - an underestimated power!? The effect of regional culture on the research collaboration propensity in European regions

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# **Culture and Collaboration – an Underestimated Power!? The Effect of Regional Culture on the Research Collaboration Propensity in European Regions**

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## **Abstract**

Collaboration is an important factor for regional economic growth. Still, the literature lacks explanations why some regions collaborate more or less than expected. The present paper proposes regional culture as influencing factor, being region-specific and connected to interactive activities. Estimations are based on a sample of 155,019 collaborative patents from 134 European NUTS-2 regions. Data on regional culture was extracted from the European Values Study. Results reveal that regional culture has a significant effect on the collaboration likelihood. This influence differs due to the various dimensions of regional culture.

**Keywords:** collaboration propensity; regional culture; Hofstede; EU-regions; patents

**JEL Codes:** F00 O43 R11

## **1 Introduction**

In collaborations organizations combine their knowledge to invent successfully and generate economic growth (Tether 2002; Castaldi et al. 2015). Yet, not all organizations engage in collaborations. Regional collaboration rates depend on various organizational and regional factors, such as demographic (e.g.; de Noni et al. 2017), economic (e.g.; Bayona et al. 2001) and innovation-related aspects (e.g.; de Faria et al. 2010). Moreover, the behaviour of economic actors is to a certain degree bound by regional values, sometimes consciously and sometimes unconsciously (Saxenian 1994; Hofstede et al. 2010b). This embeddedness of the decision to collaborate in a system of regional culture has, however, been widely neglected in empirical research. The present paper, hence, investigates how regional culture influences the likelihood to engage in collaborations.

Cantner et al. (2018) developed an index that measures the specific regional effect on the collaboration likelihood, controlling for the technological structure of a region and an average regional effect. This index is called “relative regional impact” (RRI). They observe differences due to the innovative collaboration likelihood between regions, and a deviation of the observed from the econometrically expected innovative collaboration numbers. Yet, the literature does not present a conclusive explanation for this deviation. However, the literature argues that all economic actors are constrained by their cultural environment (at the regional level) to a certain degree. This influences their behaviour and, hence, their decision of whether to collaborate (Hofstede et al. 2010b; Polanyi 1944; Saxenian 1994). Thus, the present paper proposes regional culture as one explanation for the deviations observed when applying the RRI index by Cantner et al. (2018).

Empirically, the present paper combines data from the European Values Study (EVS) with patent data from the PATSTAT (2015) database provided by the European Patent Office. Regional culture is operationalized with the help of the six dimensions of culture developed by Hofstede (2010b). Research collaborations are proxied with patents filed by more than one applicant. The empirical results reveal that each dimension of regional culture significantly influences the likelihood of collaboration. As each dimension represents distinct values, it is important to consider these dimensions separately.

The remainder of this paper is organized as follows. Section two deals with the theoretical background of inventive collaborations and regional culture, deducting six hypotheses (one for each dimension of regional culture). Afterwards, section three presents the databases as well as the methodology applied. Section four describes and discusses the empirical evidences, before section five concludes.

## **2 Theoretical Framework**

### **2.1 General Motivations for Inventive Collaboration**

Inventive collaborations between organizations have been the focus of many theoretical and empirical investigations (Teece 1986; Bayona et al. 2001; Bönnte, Keilbach 2005).<sup>1</sup> The investigations have taken different perspectives (such as organizational theory, resource based view, strategic management, game theory, transaction cost view or industrial organization) and scrutinized different stages of R&D collaborations (Bayona et al. 2001; Miotti, Sachwald 2003; de Faria et al. 2010). The first step of a collaboration is the decision of whether to collaborate or not. This step is influenced by a variety of regional factors (demographic, economic and innovation-related) that are closely connected (e.g.; de Noni et al. 2017; Bayona et al. 2001; de Faria et al. 2010). Moreover, there are organizational factors, such as the absorptive capacity, that influence the decision to collaborate (Cassiman, Veugelers 2002). As the present investigation focuses on regional collaboration numbers, organization-level factors will be aggregated at the regional level.

The structure of a region is important from a demographic but as well from an economic point of view: It can be differentiated between a rather rural or a rather urban structure. This is closely connected to the concentration of both, people (demographic factors) and economic actors (economic factors) (for example firms, universities, research institutes) (Frenken et al. 2007; de Noni et al. 2017). The population of a region represents for the major part the available labour pool for an organizations (Stuart, Sorenson 2003) and thereby defines the availability, type, quality and diversity of human capital (Hervas-Oliver et al. 2011; Bogers et al. 2018; Kwan, Chiu 2015). This human capital constitutes the basis for absorptive capacity, representing the capability of organizations to recognize and exploit external information (Cohen, Levinthal 1990). It thereby is a crucial factor for the decision to collaborate: A high absorptive capacity promises high benefits from collaborations, hence, raising the probability to collaborate (Bayona et al. 2001; Cassiman, Veugelers 2002). Other demographic characteristics of the regional population that influence the average collaboration behaviour are age and gender: in general, younger and female persons tend to collaborate more (Crescenzi et al. 2007; Abramo et al. 2013).

Innovation-related factors important for the decision to collaborate include the regional variety of innovation-intensive industries (Rodríguez-Pose, Crescenzi 2008; Ponds et al. 2010) as well as certain path dependencies in innovation and collaboration behaviour (Shane 1992; Cantner, Graf 2006; de Noni et al. 2017). Additionally, an organization's own motivation to invest into innovative activities (Bodas Freitas et al. 2011) must be considered as well as the funding of collaborative research projects in a certain region (Broekel 2015).

<sup>1</sup> See Hagedoorn (2002) for an overview on R&D (research and development) collaborations.

Beyond these factors influencing the likelihood to collaborate for innovation, empirical studies claim that there must be some regional factor which has so far been underestimated and not considered in detail (Fritsch, Lukas 1999; Cantner et al. 2018). At this point, the present paper proposes regional culture as influencing factor as at the national level, the influence of culture on the likelihood to collaborate has already been proven empirically (e.g.; Steensma et al. 2000a; Steensma et al. 2000b). As values of culture differ, however, significantly at the subnational level this regional impact needs further investigation (e.g.; Kaasa et al. 2013, 2014).

## **2.2 Regional Culture and Inventive Collaboration**

Every human (inter-)action is constrained or enabled by cultural factors (Hofstede et al. 2010b; Boschma 2005; Huggins et al. 2018; Steensma et al. 2000a; Choi et al. 2016). Accordingly, decisions that lead to collaborations are, inter alia, embedded in their cultural environments. At the national level there is empirical evidence for the influence of culture on collaboration aspects: Dimensions of national culture are found to influence the decision to collaborate (Steensma et al. 2000b), the ability to learn to cooperate (Barkema et al. 1997) and the attitude toward collaborations (Steensma et al. 2000a). At the regional level, there are no empirical investigations scrutinizing which effects dimensions of culture can have on the likelihood to collaborate.

Empirical economic studies apply various definitions of regional culture: While for James (2005) regional culture is manifested in the dominant religion of the respective region, for Saxenian (1994) regional culture comprises everything that influences peoples' behaviour (for example shared understanding or practices). In the present paper, regional culture will be operationalized with the help of the six dimensions of culture developed by Hofstede (1984), namely high versus low Power Distance, high versus low Uncertainty Avoidance, Masculinity versus Femininity, Individualism versus Collectivism, Long- versus Short-term Orientation and Indulgence versus Restraint. These cultural dimensions are unique to regions (Hofstede et al. 2010b; Hofstede 1989; Hofstede et al. 2010b).

Hofstede's concept has been criticised extensively, concerning, amongst other things, his data being originally based on the staff of only one company (IBM) and his studies not covering the full range of values (Kaasa, Vadi 2010; Schwartz 1999). Still, it can be seen as an established approach, having been applied and replicated by Hofstede himself and others in numerous international investigations since the first publication in 1980 (e.g.; Hofstede et al. 2010b; Kaasa 2016; Shane 1993). While the model was first defined at the national level, meanwhile studies have shown that they are valid at the regional level as well (Hofstede et al. 2010a; Kaasa et al. 2013, 2014; Minkov, Hofstede 2014). Moreover, his approach clearly distinguishes between different cultural levels (such as national and corporate), thereby contributing to a clearer understanding of which cultural aspects influence the collaboration likelihood through which mechanisms. Finally, the model was developed based on a European case study. Accordingly, it can be expected that the dimensions of culture will be reflected in the data from the EVS, applied in the present paper (Hofstede et al. 2010b).

The first dimension of Power Distance refers to the extent to which power is distributed in an (un)equal way. Societies with a small Power Distance show structures with rather flat hierarchies and a tendency toward decentralization and democracy. Subordinates-superiors-relationships are here characterized by respect instead of fear (Hofstede 2001; Hofstede et al. 2010b). Kale and McIntyre (1991) propose in their conceptual framework that societies with a high value of Power Distance do not emphasize frequent and personal communication. Moreover, these societies do not strive for equity in a relationship and do not endeavour to reach aims by consensus but rather with coercion tactics. These characteristics lead to a lower level of satisfaction for organizations operating in an environment of high Power Distance and are at the same time not favourable for an inter-organizational collaboration. Furthermore, when engaging in collaborative activities, opportunism is a great uncertainty factor, which is expected to be related to a high score of Power Distance (Kale, McIntyre 1991; Doney et al. 1998). The hypothesis about the effect of Power Distance on collaborative research activities is set as follows:

***H1** A high value of Power Distance decreases the probability that there are more inventive collaborations than expected.*

Societies that score low for Uncertainty Avoidance feel comfortable with unknown or ambiguous situations, and they are tolerant and open to innovation and change. Their optimistic attitude allows them to have trust in people and at the same time not to shrink from occurring difficulties (Hofstede 2001; Hofstede et al. 2010b). At the theoretical level, Kale and McIntyre (1991) state that societies with a high Uncertainty Avoidance prefer partners with good reputation, avoid compromises in negotiations, emphasize formal over informal relationships and control processes rigorously. At the empirical level, Steensma et al. (2000a) discovered that a high level of national Uncertainty Avoidance directly increases the acceptance of collaborative activities. Working together with other firms is seen as a possibility to share risks and thereby avoid uncertainty. In another study Steensma et al. (2000b) found that the dimension of Uncertainty Avoidance (national level) has no direct significant relationship with technological alliances. However, treating Uncertainty Avoidance as an indirect factor, a high Uncertainty Avoidance value increases the awareness of technological uncertainty which leads to more technology alliances to spread risks. This coincides with earlier statements of Hofstede (1989), describing Uncertainty Avoidance as a very delicate factor in international collaborations. As the empirical evidence for collaboration is positively connected to a high value of Uncertainty Avoidance, the hypothesis is put as follows:

***H2** A high value of Uncertainty Avoidance increases the probability that there are more inventive collaborations than expected.*

When talking about masculine (as opposed to feminine) societies, one refers to an atmosphere where challenges, strength, success and advancement are very important. Moreover, there is an ego-orientation and individual decisions are preferred. In rather feminine oriented societies, collaboration and a sense of sharing prevails (Hofstede 2001; Hofstede et al. 2010b). According to the conceptual framework of

Kale and McIntyre (1991), a high Masculinity value is associated with a higher likelihood to change collaboration partners as they focus on hard outcome factors and appreciate less grown relationships. At the same time, they attribute to rather masculine societies a higher conflict potential and, accordingly, a lower likelihood to collaborate. Empirical investigations show a clear evidence for a negative relationship between a high level of Masculinity and technological alliances (Steensma et al. 2000b). The same holds for the attitude towards collaborative activities, being negative in masculine societies, as collaboration is seen here as a failure as the success must be shared (Steensma et al. 2000a; Steensma et al. 2000b). Accordingly, the following hypothesis is set:

***H3** A high value of Masculinity decreases the probability that there are more inventive collaborations than expected.*

The dimension of Individualism (opposed to Collectivism) describes whether the group or the individual is at the centre of attention. A society that is rather oriented versus Collectivism and community, emphasizes loyalty and interpersonal relations. In comparison, in a society of high Individualism self-orientation prevails and tasks are more important than relationships (Hofstede 2001; Hofstede et al. 2010b). Starting from the theoretical basis, organizations in an individualistic society choose partners according to objective facts, take a clear self-centred position in negotiations and stress short-term benefits. Moreover, relationships are characterized by frequent conflicts, claims for success as well as accusations for failure (Kale, McIntyre 1991). Thiessen (1997) goes one step further, proposing that individualistic societies tend to contingent teamwork (opposed to clan-conditioned motivations) or pragmatic alliances (opposed to relational ties). Still, empirical investigations found that high Individualism values are negatively connected to building technological alliances as they might reduce their flexibility and independence (Steensma et al. 2000b). Moreover, high scores for Individualism are correlated with a low acceptance of collaborative activities in general. If engaging in alliances, the partners from individualistic societies stress written safeguards, protecting an organization's independence and determining the rules of collaboration (Steensma et al. 2000a). The hypothesis is put up as follows:

***H4** A high value of Individualism decreases the probability that there are more inventive collaborations than expected.*

One of Hofstede's newer dimensions is Long- versus Short-term Orientation. A short-term oriented community sees the world in black and white, valuing short-term profits and short-term relationships and striving for consensus. In contrast, a rather long-term oriented community focuses on long-term profits and relationships as well as the market position. Moreover, being long-term oriented, work life is characterized by values such as honesty, accountability and adaptiveness (Hofstede 2001; Hofstede et al. 2010b). Empirical evidence on how the dimension of Long-term Orientation influences collaborative activities is rather scarce up to now. However, collaborations are long-term engagements and their profits and benefits (for example building up resources) are not to be expected immediately.

Furthermore, collaboration is seen as an instrument to develop long-term competitive advantage (Nooteboom 2000; Combs, Ketchen 1999; Rao et al. 1990). At the same time, there are as well alliances (for instance project-based ones), aiming at short-term benefits and, hence, no long-term orientation is needed here. As in this investigation the focus lies on research collaborations leading to patent applications, it is hence expected that longer collaboration periods are necessary to arrive at this point. Taking these arguments into consideration, the following hypothesis is set:

*H5 A high value of Long-term Orientation increases the probability that there are more inventive collaborations than expected.*

The sixth dimension is called Indulgence versus Restraint. A rather indulgent group places importance on happiness, less discipline, optimism and freedom, while restraint societies show characteristics such as cynicism, strong discipline and striving for frugality (Hofstede 2001; Hofstede et al. 2010b). To the best of the author's knowledge, there are no empirical investigations on the effect of this dimension on research collaborations. Choi et al. (2016) conducted an experiment with students from business schools in the U.S. and Korea. The researchers investigated the students' collaborative behaviour by scrutinizing their twitter communication while they had to solve a number of tasks. Participants belonging to a more restrained society (low Indulgence), showed more concern for team spirit while those with a rather indulgent background focused more on their own benefits. Moreover, in collaborative engagements rules are set and have to be respected and a certain sense of discipline must be lived by the involved partners (typical for environments with low Indulgence). Accordingly, the hypothesis is formulated in the following way:

*H6 A high value of Indulgence decreases the probability that there are more inventive collaborations than expected.*

### **3 Data and Methodology**

Data for the RRI index has been derived from the PATSTAT (2015) database provided by the European Patent Office. The data for regional culture was taken from the EVS wave from 2008 (EVS 2016). To match the cultural data, patent data has been taken for the years 2007 to 2009. Dimensions of regional culture do not change too quickly in a radical way, hence, a time period covering one year before and one year after the EVS-wave has been chosen (Barkema, Vermeulen 1997; Broekel 2012; Beugelsdijk et al. 2015).

#### **3.1 Index of the relative regional impact (RRI)**

Patent data is seen as an appropriate source to generate a proxy for collaborations, as every co-authored patent can be expected to have been preceded by collaborative activities. Still, it must be considered that some collaborations might not lead to a patent application and, will thus not be captured in this analysis.

Moreover, some patents, although developed in a collaboration, are only filed by one applicant and will, accordingly, be counted as a non-collaborative patent. Finally, one should be aware that in patent data certain industries, their innovations and especially SMEs (small and medium-sized enterprises) are underrepresented (Graf 2017; Cantner, Graf 2004; Blind et al. 2006).

In total 353,726 patents (patent families) have been extracted for the 28 EU-countries for the period 2007 to 2009. All of them had at least one applicant in the respected countries. The revised dataset contained 155,019 patent applications (reduced due to missing data and adjusted for large firms).

For the computation of the RRI index developed by Cantner et al. (2018), three types of information are included: the technological field<sup>2</sup>, the region in which the applicants reside(s) and whether the patent was filed as a co-patent. Besides the observed collaboration numbers, an indicator for the expected collaboration numbers is derived. It defines how many collaborative inventions can be expected in a certain region, when taking into consideration the collaboration propensity for innovations for each technology. Finally, the observed number of collaborations and the expected number of collaborations per region are set into relation. The derived index can take a value between zero and infinite. A value of one indicates that the number of observed collaborations coincides with the expected number. This signifies that besides the technological and the average regional impact, there is no specific regional effect. While a value below one indicates less collaborations than expected (considering the technological determinants and the structure of a region), a value above one indicates more collaborations than expected (again considering the technological determinants and the structure of a region). Both last cases signify that the regional effect differs from the average regional effect (Cantner et al. 2018).

In the present dataset the values of the RRI index have a range between 0 and 2.08. When excluding regions where the calculation was based on less than 20 patents, the range is between 0.59 and 1.37. The region of Southern Great Plain (Hungary) has the lowest value with 0.59, signifying that considering the technological diversity of the region and an average regional effect, there are less collaborations than were expected. An example for the other extreme is Pomeranian (Poland) with a value of 1.37. This allows the conclusion that there are actual more collaborations than were expected, taking into consideration the technological diversity and an average regional effect.

### **3.2 Regional Culture**

The EVS wave from 2008 (EVS 2016) offers representative data (gender\*age) at the NUTS-2 level<sup>3</sup> for fifteen out of the 28 European countries<sup>4</sup>. For these fifteen countries, the data comprises 203 regions

<sup>2</sup> The technological affiliations according to the IPC (International Patent Classification) classes were aggregated to 35 technological fields, according to the classification developed by Schmoch (2008).

<sup>3</sup> In the following, the term “region” will always refer to the NUTS-2 level regions.

<sup>4</sup> These fifteen countries are Belgium, the Czech Republic, Germany, Finland, France, Greece, Hungary, Ireland, Italy, the Netherlands, Poland, Portugal, Sweden, Slovenia and the United Kingdom. The thirteen countries for

at the NUTS-2 level with a totality of 22,768 observations. Following Hofstede et al. (2010b) and Kaasa et al. (2014), the method of confirmative factor analysis was applied to calculate for each region measures for the six dimensions of regional culture (e.g.; Hofstede et al. 2010b; Acock 2012; Brown 2015) (see Table 1).

Questions from the EVS (GESIS – Leibniz-Institut for the Social Sciences 2010) (shortened, ID of questions in parenthesis)		Factor 1 High versus low Power Distance	Factor 2 High versus low Uncertainty Avoidance	Factor 3 Masculinity versus Femininity	Factor 4 Individualism versus Collectivism	Factor 5 Long-versus Short-term Orientation	Factor 6 Indulgence versus Restraint	Uniqueness
1	Responsibility for providing for oneself (v194)	0.7719						0.3982
2	Freedom of job choice for unemployed people (v195)	0.6012						0.5464
3	Control of the state over firms (v197)	0.6825						0.5026
4	Importance of politics (v5)		0.8480					0.2757
5	Belonging to political parties (v14)		0.4851					0.7264
6	Interest in politics (v186)		0.8579					0.2607
7	Importance of work (v1)			0.6087				0.5008
8	Necessity to have a job to develop talents (v92)			0.7323				0.4563
9	Work more important than spare time (v96)			0.6982				0.4332
10	Attitude towards people of different race (v47)				0.5145			0.7227
11	Teach children tolerance and respect (v175)				0.6692			0.5308
12	Distribution of incomes (v198)				0.4282			0.7227
13	Definition of good and evil (v104)					0.4166		0.6985
14	Marriage as an outdated institution (v150)					0.6994		0.4799
15	Proud to be a citizen of your country (v256)					0.4958		0.6150
16	Are you happy (v8)						0.8191	0.3185
17	State of health (v9)						0.7250	0.4122
18	Satisfaction with life as a whole (v66)						0.7851	0.3586

**Table 1** Rotated Factor Loadings (pattern matrix) and Unique Variances (blanks represent abs(loading) <.4)

In total, eighteen variables from the EVS, which are congruent with the definitions of the dimensions, loaded on to the six dimensions (Hofstede et al. 2010b). Due to missing data, in the end 16,482 observations (number of complete questionnaires) were included in the factor analysis. The results were

which representative data (gender\*age) was only available at the national level were excluded in the regression models later on. In calculations preceding the regression models, they were still included.

then aggregated at the regional level having thus one value (mean value) for each dimension for each region. This approach is justified by the definition of culture by Hofstede et al. (2010b). They postulate that (regional) culture and its values is a collective phenomenon, learned from and shared with people from the same (regional) environment. Analogous to the national version of the cultural dimensions, each dimension of regional culture can take a value between zero and one hundred (Hofstede et al. 2010b). After excluding regions, of which the indices were based on less than 20 observations, 174 regions remained for further computations.

To verify the approach of using the Hofstede dimensions at the regional level and basing these on the EVS-data, the regional data was aggregated at the national level<sup>5</sup> (again taking mean values) and a correlation was calculated with the original values of the Hofstede dimensions (Hofstede Insights 2018). As can be seen in Table 2, all EVS-based dimensions of national culture correlate with the corresponding original dimensions, having coefficients ranging between 0.42 (Masculinity) and 0.88 (Indulgence). They are all significant at least at the 0.05 level. There are two explanations for the occurring differences: First, the EVS-questions are not totally congruent with the original questions. Second, there might have been changes in the dimensions in the last couple of years (EVS-values being from 2008 and the Hofstede scores being partly based on the original IBM survey from the 1980s) (Kaasa et al. 2013; Hofstede et al. 2010b). Moreover, it can be observed that Power Distance (Hofstede) and Uncertainty Avoidance (EVS) have a high correlation coefficient (0.60, significant at the 0.001 level). This correlation, however, is immanent in the data and can be observed between the Hofstede scores of Power Distance and Uncertainty as well. Both dimensions are based on questions that are related to the freedom of opinion at work (Hofstede et al. 2010b).

**Table 2** Correlations between EVS-based and Hofstede dimensions of culture at the national level.

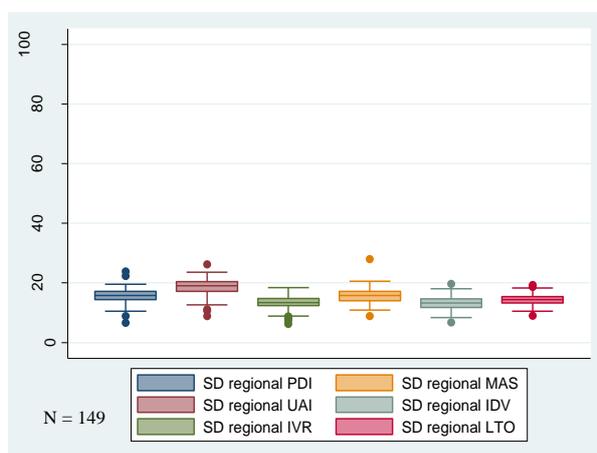
<i>N</i> = 27	PDI Hofstede	UAI Hofstede	MAS Hofstede	IDV Hofstede	LTO Hofstede	IVR Hofstede
PDI EVS	0.45*	0.49**	-0.04	-0.23	0.11	-0.50**
UAI EVS	0.60***	0.49**	0.18	-0.38.	-0.08	-0.50**
MAS EVS	0.40*	0.42*	0.42*	-0.51**	0.06	-0.52**
IDV EVS	-0.39*	-0.44*	-0.35.	0.60***	0.01	0.29
LTO EVS	-0.17	0.07	-0.14	0.19	0.59**	-0.05
IVR EVS	-0.39*	-0.33	-0.05	0.38*	-0.44*	0.88***

*Cyprus not included as no Hofstede Data available; PDI (Power Distance), UAI (Uncertainty Avoidance), MAS (Masculinity), IDV (Individualism), LTO (Long-term Orientation), IVR (Indulgence). Significance codes: ‘.’  $p < 0.10$ , ‘\*’  $p < 0.05$ , ‘\*\*’  $p < 0.01$ , ‘\*\*\*’  $p < 0.001$ . (Data source: EVS 2016; Hofstede Insights 2018).*

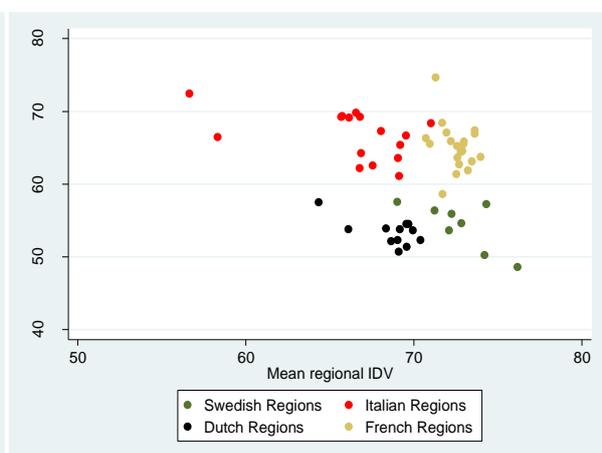
<sup>5</sup> For this correlation at the national level, all 203 regions were included. As a robustness check the regions with few observations were excluded, which change only ten correlation values by 0.01 points.

In this paper, mean values are generated by aggregating individual values at the regional level. To test whether regional variance does not exceed a certain threshold, making it impossible to talk about a regional dimension, in Figure 1 the regional variance (expressed with the help of the standard deviation) has been depicted. It can be seen that the deviations for Indulgence, Individualism and Long-term Orientation lie below the value of 20 (equal to 20 %). Moreover, for Power Distance and Masculinity only two outliers each lie above the threshold of 20 and for Uncertainty Avoidance only 25 % lie above the threshold, however, still below 30. Hence, as the variance is on average for all dimensions below 20 %, it is permissible to talk about regional dimensions.

Another test was conducted to check for national patterns in the data. In Figure 2 exemplarily the mean values for Masculinity and Individualism are depicted for Sweden, Italy, the Netherlands and France. Besides variation between the regions, national clusters can still be distinguished. To account for these national patterns, a country dummy will be included in the models.



**Figure 1** Regional variance of six dimensions for all regions (SD: Standard Deviation) (Data source: EVS 2016).



**Figure 2** Between-country differences for four European countries (Data source: EVS 2016).

PDI (Power Distance), UAI (Uncertainty Avoidance, MAS (Masculinity), IDV (Individualism), LTO (Long-term Orientation), IVR (Indulgence).

### 3.3 Variables and Model specification

The final dataset consists of 142 regions. For the dependent variable a dummy variable for the RRI index was created. The dummy has the value of 1 if the value of the RRI index was above 1 and it has the value of 0 if the index was below 1.<sup>6</sup> As the dependent variable is a binary variable, a probit model was estimated.

The main explanatory variables are the computed indices for the six dimensions of regional culture (mean values). To save some of the regional variance, two types of diversity measures were included as

<sup>6</sup> For robustness checks, the models were estimated using once a dummy split at the mean and once a dummy split at the median of the RRI index. The results did not change.

controls (per cultural dimension and region): the Gini-value and the percentage of the observations with a dimensional value score below 25 (equal to the observations in the lower quart (25%)).

Moreover, based on the theoretical reflections, a set of control variables was introduced (general, demographic, economic and innovation-related) to bring out the effects of regional culture more clearly. A country dummy was included, to control for country-specific effects. Five variables, covering various demographic aspects, were added. To include the overall regional demographic situation, life expectancy at birth as a proxy for the overall state of health and standard of living was added (Sagar, Najam 1998). The average age of population accounts for younger people being more likely to collaborate (Crescenzi et al. 2007) as it is the case for women (gender ratio included) (Abramo et al. 2013). With population density, it was taken into consideration, whether a region is rather central or peripheral. The assumption is that the first ones are better accessible, which influences the establishment and the maintenance of collaborative activities (Fritsch 2003; Crescenzi et al. 2007). Moreover, population density can be seen as a proxy for urbanization externalities, such as innovative performance, due to a better invention supporting infrastructure, such as a higher quantity of research institutes (de Noni et al. 2017; Frenken et al. 2007). Human capital is closely connected to absorptive capacity, which again is important for innovation stemming from research collaboration. Hence, a regional level of human capital was approximated with the percentage of the population between 24 and 65 years with a completed tertiary education (Cohen, Levinthal 1990; Frenken et al. 2007; Hervas-Oliver et al. 2011; Marrocu et al. 2013).

A set of four economic variables has been included, to account for the overall regional employment situation. The first one is a general employment rate including every person older than 25 years, proxying for general available labour force (Ponds et al. 2010; Crescenzi et al. 2007). Moreover, two special employment rates were included, as these branches are expected to be important in inventive activities and give an insight into the sectoral distribution of employment: employment in manufacturing and employment in technical, scientific and professional activities (de Noni et al. 2017). Finally, an unemployment rate has been added (as percentage of the economically active population between 20 and 64) giving insights on the stability of the market (Rodríguez-Pose, Crescenzi 2008).

Besides demographic and economic variables, innovation-related variables were added. To account for interregional differences in inventive productivity, the weighted number of patents was included (de Noni et al. 2017; Griliches 1990). As de Faria et al. (2010) state, organizations that invest more in R&D consider collaboration to be more important for innovation. Hence, a variable of organizational R&D expenditure is included, accounting for the attitude towards collaborative inventions and the size of the R&D section. To take average collaboration numbers into consideration, variables for inventive SMEs that collaborate and co-publications (public-private) were included. Moreover, the literature states that high-tech industries collaborate more for R&D. Therefore, a variable for organizations innovating at a non-technological level was added. The same holds for the level of novelty: More radical innovations seem to stem from collaborative arrangements, for which a variable for new-to-the-firm/new-to-the-

market products accounts (Miotti, Sachwald 2003; Bayona et al. 2001; Hagedoorn et al. 2003). Finally, it must be considered that innovative collaboration is commonly a subject of subsidies, fostering R&D collaboration especially in regions with weak innovativeness (Broekel 2015). Hence, a variable with weighted funding has been constructed.<sup>7</sup>

#### **4 Results and Discussion**

Table 3 presents the summary of the four estimated probit models.<sup>8</sup> The independent variables of interest are the six dimensions of regional culture. As the dimensions are not significantly correlated to each other, they have been integrated into the same models. All six dimensions of regional culture gain significance when controlling for demographic, economic and innovation-related factors (Model 4). As the direction of the influence does not change for any of the six dimensions when adding more control variables, only the full model (Model 4) will be examined more closely. While all dimensions of regional culture have a significant effect on the number of collaborative activities, two of the six hypotheses have to be rejected (H1 and H3).

Looking at the control variables (see Appendix 1 for the full regression results), all but life expectancy and sales of new to the firm/market innovations have significant effects. Most of the controls have the anticipated effects. The missing significance of the average life expectancy of a new-born might stem from the fact that this indicator does not have a great variance among the investigated regions.<sup>9</sup> Interesting is the result for population density, having a very weak but significant negative effect. This proposes that not agglomerations alone lead to a higher probability of more collaborative innovations (Fritsch 2003). Another unexpected result is the highly significant and quite strongly negative effect of education. This suggests that having high stock of regional human capital, a collaboration might not be needed to, for instance, produce innovations. Moreover, a strong absorptive capacity can be helpful to exploit internal resources even more, hence, not foster collaboration.

<sup>7</sup> Sources for the control variables are Charron et al. (2016), European Commission 2018 and European Union 2012, 2016a, 2016b, 2016c, 2016d, 2018a, 2018b, 2018c.

<sup>8</sup> For the entire regression output, please see Appendix 1.

<sup>9</sup> For the dataset used in Model 4 (reduced to 134 regions due to missing data for the control variables), life expectancy at birth has a mean of 79.96 years, a standard deviation of 2 years, a minimum of 73.3 years and a maximum of 82.9 years.

**Table 3** Probit estimation results (Average marginal effects).

<i>Dummy for the RRI index</i>	(1)	(2)	(3)	(4)
<b>Regional Power Distance</b>	0.019 (0.015)	0.023 (0.017)	0.029. (0.017)	0.032* (0.016)
<b>Regional Uncertainty Avoidance</b>	0.008 (0.012)	0.009 (0.011)	0.009 (0.011)	0.024* (0.012)
<b>Regional Masculinity</b>	0.039** (0.015)	0.031* (0.016)	0.024 (0.015)	0.032* (0.016)
<b>Regional Individualism</b>	-0.009 (0.019)	-0.007 (0.021)	-0.035. (0.019)	-0.029. (0.016)
<b>Regional Long-term Orientation</b>	0.030. (0.017)	0.030. (0.018)	0.041* (0.017)	0.047*** (0.013)
<b>Regional Indulgence</b>	-0.043* (0.019)	-0.055** (0.018)	-0.065*** (0.018)	-0.046** (0.017)
Gini values for each of the six dimensions of regional culture	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>
Percentage of observations with a score below 25 for each of the six dimensions of regional culture	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>
Country Dummy	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>
Demographic Controls		<i>included</i>	<i>included</i>	<i>included</i>
Economic Controls			<i>included</i>	<i>included</i>
Innovation-related Controls				<i>included</i>
<b>Pseudo R<sup>2</sup></b>	0.21	0.27	0.37	0.48
<b>Mean VIF</b>	4.80	5.87	7.26	9.33
<b>N</b>	142	134	134	134

*Annotations: Significance codes: ‘.’ p < 0.10, ‘\*’ p < 0.05, ‘\*\*’ p < 0.01, ‘\*\*\*’ p < 0.001. Standard errors in parentheses. Tests for robustness and variance inflation factor were conducted; The 134 regions of the final model belong to eleven countries.*

A high value for Power Distance was supposed to decrease the probability that there are more collaborative arrangements than expected (H1). However, estimation results show a weak but significantly positive influence: If Power Distance increases by one unit, the probability that there are more collaborations than expected increases by 3.2 percentage points. This indicates that a preference of hierarchical structure, clearly set guidelines and a rather strict allocation of responsibilities creates a positive environment for collaborative activities. The dissent with Kale and McIntyre (1991) could stem from the fact that they only conducted 60 qualitative interviews, gaining hence only an insight into a couple of cases. The second hypothesis that must be rejected due to estimation results, is the one stating that higher Masculinity values decrease the probability that there are more collaborations than expected (H3). The estimation results of the present study show a significantly positive effect: if Masculinity increases by one unit, the probability for more collaborations than expected increases by 3.2 percentage points. From this can be derived that an ambitious, competitive and result-oriented environment foster the engagement in collaborations. Contradictions to earlier research may arise for several reasons:

Steensma et al. (2000b) investigated only small and independent manufacturing enterprises in five countries, ignoring inter-regional differences and just looking at the national level. Steensma et al. (2000a) scrutinized just the attitude towards collaboration and not the actual engagement in collaborative activities.

A high value of Uncertainty Avoidance was supposed to increase the probability that organizations engage more frequently in collaborative activities than expected (H2). This is confirmed by the results. If Uncertainty Avoidance increases by one unit, the probability that there are more collaborations than expected increases by 2.4 percentage points. Consequently, the desire to avoid uncertain situations and share risks as well as the acceptance of many detailed rules lead on average to more collaborative engagements. This enriches the results of previous research as Steensma et al. (2000a) found this relation for small and independent manufacturing firms in seven countries at the national level (Sweden, Norway, Finland, Indonesia, Mexico, Greece and Australia). Moreover, it deepens the already existing evidence of studies only finding an indirect influence or the influence when two partners differ in their Uncertainty Avoidance score (Steensma et al. 2000b; Barkema, Vermeulen 1997).

Following hypothesis H4, Individualism at a higher value level was associated with a decreasing probability that there are more collaborative activities than expected. Based on the present results, this hypothesis can be confirmed. An increase of Individualism by one unit, leads to a decrease of the probability that there are more collaborations than expected by 2.9 percentage points. This broadens again the outcome of Steensma et al. (2000b), finding a negative influence of high Individualism on the likelihood of small and independent manufacturing enterprises to engage in collaboration. While they find this link for five countries at the national level in different parts of the world (Mexico, Indonesia, Australia, Sweden and Norway), the present study can confirm their results for eleven European countries at the regional level. The results signify that a rather self-centred ideology indeed leads to an aversion to teamwork and joint goals (Kale, McIntyre 1991; Steensma et al. 2000a; Hofstede et al. 2010b).

As has been anticipated by hypothesis H5, a high value for Long-term Orientation increases the probability that there are more collaborative arrangements than expected. Among the six dimensions, Long-term Orientation has the strongest and most significant effect: An increase of one unit of Long-term Orientation is connected to an increase of 4.7 percentage points of the probability that there are more collaborations than expected. This confirms the assumption that collaborations that lead to patent applications need more forward planning and perseverance. Moreover, this underlines that aiming at slow results and focusing on the market position fosters the engagement in collaborative activities.

Finally, hypothesis H6 proposes that a high value of Indulgence decreases the probability that there are more collaborations than expected. In the estimations, this hypothesis is confirmed as an increase of Indulgence by one unit is connected to a decrease of the probability that there are more collaborations than expected by 4.6 percentage points. Hence, only emphasizing optimism, giving personal free time a

great importance and granting less attention to discipline does not create a favourable environment for the engagement in collaborations. Instead, characteristics such as having a sense of discipline and attaching importance to social norms support collaborative activities.

Summarizing, the empirical evidence underlines that the likelihood to collaborate for innovations not only depends on hard factors such as demographic, economic or innovation-related variables. In contrast, dimensions of regional culture play a role in the decision of whether engaging in a collaboration or not as well. All six cultural dimensions of Hofstede have a significant effect, four of them meeting the expected direction of the effect. In total, regions with high levels of Power Distance, Uncertainty Avoidance, Masculinity and Long-term Orientation tend to have a higher probability to have more innovative collaborations than expected. Those regions with high scores for Individualism or Indulgence have a lower probability that there are more collaborations than anticipated.

## **5 Concluding Remarks**

Collaborative innovation shows an unequal spatial distribution (Cantner, Graf 2006). With their RRI index, Cantner et al. (2018) consider a technological and an average regional effect. They find a divergence of the observed from the expected collaboration number, proposing stimulating or hindering regional factors. So far, however, the literature lacks further investigations on the nature of these factors.

The present paper has proposed regional culture as explanatory variable for the gap between the observed and the expected collaboration numbers per region. Three aspects lead to this proposition: Every human (inter-)action, such as the decision to collaborate, is culturally embedded (Hofstede et al. 2010b); at the national level, empirical studies have found a direct impact of cultural values on the likelihood to collaborate (Steensma et al. 2000b); cultural values differ at the subnational level (Kaasa et al. 2014).

Applying the cultural concept of Hofstede (2001) to the regional level, for each of the 134 included European NUTS-2 regions six values of cultural dimensions are approximated. They are proposed as explanatory variables for the gap between the observed and the expected number of collaborations. All of them have a significant effect. Results reveal that a region with a tendency towards ambition, clear rules, a strict allocation of responsibilities and discipline tends to collaborate more. Additionally, putting the team before the individual, being patient and looking far ahead fosters collaborative activities as well. In contrast, aspects like democratic environments, the focus on harmony, being too imprudent and self-centred, only enjoying life and striving for short-term goals have a negative effect on the likelihood to collaborate.

With these results the present paper contributes to the existing literature especially in the following three ways: It first confirms, what first empirical studies have shown: The Hofstede dimensions, originally designed at the national level, are manifested at the regional level as well (e.g.; Kaasa et al. 2014;

Hofstede et al. 2010a). Secondly, regional culture significantly influences the likelihood to collaborate at the regional level. And thirdly, regional culture exerts its impact through different dimensions of values which, accordingly, have to be considered separately.

Nevertheless, the empirical investigation has a number of limitations. First of all, it only covers eleven European countries, among which the variety in regional culture can be expected to be rather low. Moreover, it can be argued that political borders (that were taken as spatial entities) do not coincide with the spatial extension of regional culture. Besides the above-mentioned issues when using patent data, they moreover limit the investigation to formal relationships. The effect of regional culture on informal collaboration might be a subject of further investigations. Moreover, in future analysis it could be of interest to integrate the collaboration partners as well. This would make it possible to include the concept of cultural proximity (distance) and to distinguish between region-internal versus -external collaborations (Boschma 2005; Kogut, Singh 1988; Shenkar 2001).

Regional policies that foster collaborative innovation activities could incorporate the insights on regional culture and its effect. As a first step they could raise the awareness for the influence of regional culture on inventive collaborations through, for example, workshops on intercultural competence. Additionally, the knowledge on regional differences of culture could be integrated into collaboration funding. Thereby, advantages for collaborations stemming from the cultural portfolio of the region could be fostered. At the same time, aspects rather unfavourable for collaborations could be addressed to turn them into strengths, by, for instance, encouraging to strive more for long-term goals instead of striving for short-term benefits.

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#### **Data Availability Statement**

The dataset analysed during the current study is publicly available from the PATSTAT database as well as the European Values Study.

#### **Compliance with Ethical Standards**

#### **Competing Interests: Financial interests/ Non-financial interests**

The author reports there are no competing interests to declare.

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**Appendix 1: Complete probit estimation results (Average marginal effects).**

<i>Dummy for the RRI index</i>	(1)	(2)	(3)	(4)
<b>Regional Power Distance</b>	0.019 (0.015)	0.023 (0.017)	0.029. (0.017)	0.032* (0.016)
<b>Regional Uncertainty Avoidance</b>	0.008 (0.012)	0.009 (0.011)	0.009 (0.011)	0.024* (0.012)
<b>Regional Masculinity</b>	0.039** (0.015)	0.031* (0.016)	0.024 (0.015)	0.032* (0.016)
<b>Regional Individualism</b>	-0.009 (0.019)	-0.007 (0.021)	-0.035. (0.019)	-0.029. (0.016)
<b>Regional Long-term Orientation</b>	0.030. (0.017)	0.030. (0.018)	0.041* (0.017)	0.047*** (0.013)
<b>Regional Indulgence</b>	-0.043* (0.019)	-0.055** (0.018)	-0.065*** (0.018)	-0.046** (0.017)
Gini value of regional Power Distance	0.425 (2.043)	1.063 (2.074)	2.603 (1.991)	3.028 (2.047)
Gini value of regional Uncertainty Avoidance	5.583* (2.268)	7.135** (2.421)	6.083** (2.314)	7.614** (2.452)
Gini value of regional Masculinity	0.211 (2.969)	-0.331 (2.896)	-2.369 (2.656)	-3.819 (2.597)
Gini value of regional Individualism	-7.409* (3.408)	-8.748** (3.236)	-12.410*** (3.097)	-11.438*** (2.928)
Gini value of regional Long-term Orientation	-1.402 (2.700)	-2.339 (2.662)	-3.035 (2.373)	-3.189 (2.476)
Gini value of regional Indulgence	-4.055 (2.919)	-5.196. (2.693)	-9.735*** (2.957)	-7.254* (3.048)
Percentage of observations with a score below 25 for PDI	0.885 (1.215)	0.726 (1.245)	-0.310 (1.278)	-0.711 (1.266)
Percentage of observations with a score below 25 for UAI	0.387 (2.110)	0.108 (2.152)	-0.798 (1.996)	-1.495 (2.038)
Percentage of observations with a score below 25 for MAS	2.329 (2.272)	1.371 (1.997)	0.871 (1.875)	2.158 (2.224)
Percentage of observations with a score below 25 for IDV	0.233 (3.684)	4.857 (4.124)	8.731* (3.583)	11.343* (4.623)
Percentage of observations with a score below 25 for LTO	2.593 (1.733)	3.287. (1.708)	4.925** (1.566)	5.583*** (1.387)
Percentage of observations with a score below 25 for IVR	-8.103. (4.159)	-4.716 (3.846)	-1.059 (3.842)	-0.850 (4.058)
Country Dummy	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>

<i>Dummy for the RRI index</i>	(1)	(2)	(3)	(4)
Life expectancy at birth		0.073 (0.052)	0.039 (0.055)	0.084 (0.058)
Population density		-0.000* (0.000)	-0.000*** (0.000)	-0.000** (0.000)
Average age of population		-0.041. (0.025)	-0.016 (0.022)	-0.040. (0.022)
Gender ratio		0.048 (0.034)	0.049 (0.033)	0.112** (0.038)
Education		-0.021* (0.010)	-0.067*** (0.014)	-0.063*** (0.015)
Employment rate (>25 years)			0.048** (0.016)	0.072*** (0.018)
Employment rate in manufacturing			0.022* (0.011)	0.031** (0.011)
Employment rate in technical/ scientific/professional activities			0.212*** (0.059)	0.213*** (0.060)
Unemployment rate (years 20-64)			0.081** (0.029)	0.077* (0.031)
Patents per million inhabitants				-0.002* (0.001)
Business R&D expenditure (% of GDP)				0.973* (0.417)
Share of innovative SMEs that collaborate				1.944* (0.803)
Number of public-private co- publications				-1.239** (0.478)
Non-technological innovators (% of all SMEs)				-4.611*** (-1.198)
Sales of innovations (% of turnover)				0.035 (0.685)
Funding per Person				0.001* (0.000)
<b>Pseudo R<sup>2</sup></b>	0.21	0.27	0.37	0.48
<b>Mean VIF</b>	4.80	5.87	7.26	9.33
<b>N</b>	142	134	134	134

Annotations: Significance codes: '.'  $p < 0.10$ , '\*'  $p < 0.05$ , '\*\*'  $p < 0.01$ , '\*\*\*'  $p < 0.001$ . Standard errors in parentheses. Tests for robustness and variance inflation factor were conducted; The 134 regions of the final model belong to eleven countries.

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