

#2103 Bremen Papers on Economics & Innovation

Unleashing Inventive Power – Solving cognitive, social and geographic distance issues with cultural proximity

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May 2021

Abstract

Cognitive, social and geographic distances between collaborators impact the likelihood to succeed together. This paper argues that cultural proximity moderates this impact. While taking Boschma's (2005) proximity concept as a point of departure, the informal part of institutional distance – cultural distance – is emphasized. Culture is defined following the concept of Hofstede et al. (2010), applying it one of the first times to the regional level. Results reveal that cultural proximity has different layers, all moderating the impact of cognitive, social and geographic distances. Out of the six investigated cultural distance layers, five moderate the impact of geographic distance, another five the one of social distance and four moderate the impact of cognitive distance.

Keywords

research collaboration, cultural distance, proximity interactions, collaboration performance

JEL Classifications

D91 ; R11 ; R12

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1. Introduction

Boschma published his concept of proximities/distances¹ (namely cognitive, social, geographic, institutional and organizational distances) and their impact on collective innovation in 2005. Since then, many scholars have picked up on this topic (e. g.; Ponds et al. 2007; Huber 2012; Balland et al. 2020), mostly taking a firm- (e. g.; Balland 2012) or cluster-level (e. g.; Letaifa, Rabeau 2013) perspective. Besides an individual direct effect, the distances are interrelated (being complements or substitutes). These interdependencies have been investigated especially for tie formation (Cassi, Plunket 2015; Broekel, Boschma 2011) and knowledge flows (Breschi, Lissoni 2009; Singh 2005) and to a lesser degree for alliance performance (e. g.; Heringa et al. 2014; Ponds et al. 2007).

At the basis of any inventive² collaboration there is always a team of inventors, working together, bringing along their different knowledge bases, experiences and attitudes. Accordingly, to work efficiently together, different distances on team level have to be bridged (Bercovitz, Feldman 2011; Moaniba et al. 2020). The present paper focuses on a so far neglected distance aspect for alliance performance: cultural distance (as a moderator) on team level. Cultural distance is part of institutional distance, which comprises formal and informal (cultural) aspects (Edquist, Johnson 1997; Boschma 2005). Direct effects of cultural distance as well as interrelations with other distances have been widely ignored, as studies mostly focus on the formal part of institutions (e. g.; Ponds et al. 2007; Balland 2012). However, keeping an eye on cultural distance could be crucial for enhancing alliance performance, as e.g. personal disagreements stemming from different cultural environments can lead to failure of common projects (e. g.; Werker et al. 2016; Brunetta et al. 2020). Accordingly, the present paper aims to shed light on the role of cultural distance on team level and how it influences the impact of the other distances on the success of an alliance.

Therefore, the paper transfers the national approach of quantitatively measuring culture of Hofstede (2002) to the regional level, using data of the European Values Study (EVS), while data on the other distances is drawn from PATSTAT. Running two series of negative binomial regressions, the authors are able to show that cultural distance indeed has a moderating effect on cognitive, social and geographical distances and that this effect differs between the different cultural dimensions. As in the case of the cultural dimension of Individualism, the effect can even be opposing as proximity in Individualism

¹ To prevent misunderstandings, in the following the term ‘distances’ will be used when referring to the concept.

² In the present paper ‘innovation’ and ‘invention’ will be used synonymously.

on one hand reinforces the negative impact of cognitive distance while it lessens the negative effects of social and geographic distances on the other hand.

With these results the paper contributes to the current literature in several ways. It not only offers a quantitative approximation of regional culture but proves that cultural distance in collaboration is not only not to be neglected but beyond that to be acknowledged as a serious factor. The paper moreover provides empirical evidence for the multiple moderating effects of cultural distances on cognitive, social and geographic distances.

The remainder of the paper is organized as follows. Chapter two gives the theoretical framework, depicting the impact of distances on the collaborative outcome, with a special focus on cultural distances and the interdependencies of distances, outlining the research gap and the propositions. The following chapter three presents the employed data and applied methodology, while in chapter four results are presented and discussed and chapter five concludes.

2. Section

Inventive collaboration happens at the inventors' level. Hence, institutional, cognitive, social, geographic and organizational distances on the team level have to be bridged, influencing the outcome of the cooperation (e. g.; Bercovitz, Feldman 2011; Moaniba et al. 2020; Crescenzi et al. 2017). Besides direct effects, the different distances are interrelated, such as e.g. geographic proximity is a substitute for social proximity as far as hard performance indicators are concerned (Heringa et al. 2014). However, the impact of cultural distance as well as its interrelations with other distances has not been investigated yet. Until now, it has been said to be covered by being the informal part of institutional distance. Institutional distance however has been proxied by aspects only covering formal institutions such as the organizational background being academic or not (Ponds et al. 2007). Others defined institutional distance as part of organizational distance and hence did not investigate institutional distance separately at all (Heringa et al. 2014).

Though cultural proximity alone is not sufficient to drive collaboration, it plays a significant role in every human interaction (Boschma 2005; Hofstede et al. 2010; Crescenzi et al. 2016). Hence, the present paper argues that cultural proximity is an important moderator of the other distances in enhancing alliance performance. In this sense, cultural proximity can be seen as the environment in which knowledge exchange becomes possible or even easier (Teixeira et al. 2008) and with this enhance collaboration performance.

2.1. Distances

The following section gives an overview over the four distances considered in this paper, namely cognitive, social, geographic and cultural distance (as the informal part of institutional distance). Special attention will be devoted to cultural distance, which accordingly to the applied definition by Hofstede (2002) will be subdivided into six different dimensions. Organizational distance and the formal part of institutional distance will not be investigated separately. Distance in the cultural dimension of Power Distance is defined as the difference in the organizational setting of an organization (Hofstede 2002), which is similar to the way previous studies define and proxy organizational distance (Broekel, Boschma 2012) and as well formal institutional distance (Ponds et al. 2007).

Cognitive distance on firm-level describes the similarity of knowledge bases between (collaboration) partners (Nooteboom 1999). While too much proximity might have drawbacks like the danger of a cognitive lock-in situation, a certain overlap of the knowledge bases is needed to communicate efficiently and absorb new knowledge (Boschma 2005; Cohen, Levinthal 1990). At the same time, some distance is needed to make new knowledge combinations possible (e. g.; Nooteboom 2000). This inverted u-shape connection for cognitive distance and innovation has been found on team-level as well (Huo et al. 2019).

Social distance describes the social embeddedness of interactions between actors (interpersonal level) (Heringa et al. 2014). Being socially close to a partner signifies that besides the formal relationship there is friendship and trust, often seen as one of the prerequisites for successful interaction, especially when including tacit knowledge (Boschma 2005; Maskell, Malmberg 1999). Too much proximity however might have negative effects as well, such as missing openness to new ways of thinking as well as the underestimation of the risk of opportunistic behavior (Boschma 2005; Uzzi 1997).

Geographic distance represents the spatial distance between partners. Short distances are connected to knowledge externalities, including the participation in the 'local buzz' (Bathelt et al. 2004), which seems to be especially important for the exchange of tacit knowledge. Again, too much proximity may lead to a spatial lock-in situation, which alone however is not said to have detrimental effects, but rather when it goes along with e.g. cognitive lock-in (Boschma 2005; Broekel, Boschma 2012).

Institutional distance is divided in a formal part which comprises differences in rules and laws and an informal part, hence how partners differ due to their routines and habits, known as well as cultural distance (Edquist, Johnson 1997; Boschma 2005). Relations having a high institutional distance might be at a higher risk of opportunistic behavior, while too much proximity might lead to an institutional lock-in as to why an

optimal distance should be targeted (Boschma 2005). The present paper approaches the part of informal institutions more in detail, and focuses on informal institutions, hence culture, as most empirical studies proxy institutional distance with aspects only covering formal institutions (e. g.; Ponds et al. 2007; Werker et al. 2016; Broekel 2015). Accordingly, the concept of cultural distance will be described more in detail in the following.

Roots of the concept of cultural distance can be traced back to the Uppsala model in international business, which describes the differences in cultural characteristics between the home and the host country in the internationalization process of a firm (Johanson, Vahlne 1977, 2009). While they still use the term of cultural pattern without further definition, over the years numerous cultural concepts have been developed, of which the concept of Hofstede (2002) from 1980 finally raised the construct of culture and how to measure it from its insignificance (Taras et al. 2009). Though other concepts of culture have been developed afterwards, among which the one by Schwartz (1994) and the one from the GLOBE project (House et al. 2001), the concept of Hofstede (2002) is most suitable for the present dataset as it has been developed based on a European case study (Hofstede et al. 2010).

Hofstede defines culture with the help of six different dimensions, namely Power Distance, Uncertainty Avoidance, Masculinity, Individualism, Long-term Orientation and Indulgence (Hofstede 2002). To the best of the authors knowledge, there are no studies investigating the impact of regional distances in these dimensions, aggregated on team level. The following presented insights are studies based on investigations in distances on national culture, while only Kaasa and Vadi (2010) consider as well regional culture as level of investigation. They however only investigate the cultural impact on patent activity, disregarding cultural distance between partners (Kaasa, Vadi 2010).

Power Distance is defined as the distribution of power. While low Power Distance is characterized by a democratic organizational setting, high Power Distance signifies rather steep hierarchies and a need for control (e. g.; Hofstede 2002; Shane et al. 1995; Venkateswaran, George 2020). Literature connects low Power Distance to a higher innovativeness (e. g.; Shane 1992; Strychalska-Rudzewicz 2016; Kaasa 2016a) and patenting intensity (e. g.; Kaasa, Vadi 2010), especially important in the initiation stage of innovations (Ulijn, Weggeman 2001; Nakata, Sivakumar 1996) and for more radical innovations (Herbig, Miller 1992). The assumptions are, that low Power Distance implies a better communication (Hofstede 2002) through decentralization (Aldrich 1979; Dimitratos et al. 2011), trust (less control) (Hofstede 2002; Venkateswaran, George 2020) and openness towards the ideas of everyone, no matter what his or her position might be (Nakata, Sivakumar 1996). High Power Distance in comparison is positively connected to the implementation (Nakata, Sivakumar 1996) and diffusion (Dwyer et al. 2005; van den Bulte, Stremersch 2004) phase of innovation, though van Everdingen and Waarts (2003) and Yeniyurt and Townsend (2003) find a negative impact. Only very few

studies investigate distance between partners in this dimension, finding that it decreases the duration of alliances (Malik, Zhao 2013) and has a negative impact on the satisfaction with the alliance (Pothukuchi et al. 2002).

The dimension of Uncertainty Avoidance describes the degree to which people cope easily with uncertain situations and are not afraid of possible difficulties (low Uncertainty Avoidance as opposed to high Uncertainty Avoidance) (Hofstede 2002). Studies find that a low value of Uncertainty Avoidance is connected to a higher innovativeness (e. g.; Kaasa 2016a; Strychalska-Rudzewicz 2016; Herbig, Miller 1992) and more patenting (Kaasa, Vadi 2010), as both go along with acceptance of ambiguous situations, change (Shane 1993) and a bending of rules where necessary (e. g.; Shane et al. 1995). It is argued that being open to risks and plan changes (low Uncertainty Avoidance) is especially beneficial in the initiation phase of a new product development, while a controlled and planned approach (high Uncertainty Avoidance) (Offermann, Hellmann 1997; Dimitratos et al. 2011) supports the implementation of innovations (Nakata, Sivakumar 1996; Ambos, Schlegelmilch 2008). However, most studies find that adoption and diffusion of new developed products is faster in low Uncertainty Avoidance environments (e. g.; Yenyurt, Townsend 2003; van den Bulte, Stremersch 2004; Steenkamp et al. 1999). Distance in this dimension is seen as a real problem for collaboration, as the notion of uncertainty is rooted psychologically and accordingly not easily bridged. It has been shown to have a negative impact on the survival of international joint ventures (Barkema, Vermeulen 1997) as heterogeneity in Uncertainty Avoidance is connected to conflict (Elron 1997). Moreover, it has a negative impact on satisfaction with an international joint venture and as well with its efficiency (Pothukuchi et al. 2002) and tends to delay the termination of an alliance (Malik, Zhao 2013).

Groups scoring high for Masculinity seek challenge and success, while the opposite side of Femininity (low Masculinity) strengthens more collaborative and harmonic aspects (Hofstede 2002). Low Masculinity is positively associated with innovation scores (Kaasa 2016a) and patenting intensity (Kaasa, Vadi 2010) as the values of tolerance and support foster creativity and with this especially the initiation phase of innovation (Nakata, Sivakumar 1996; Kaasa 2016a). In comparison, the spirit of success and goal orientation (high Masculinity) is beneficial for the implementation (Nakata, Sivakumar 1996) and diffusion of new products (e. g.; Dwyer et al. 2005; Steenkamp et al. 1999). However, some investigations find a negative impact of high Masculinity on the adoption of a new software (Waarts, van Everdingen 2005) or no impact at all on innovation-related indicators (e. g.; Shane 1993; Sun 2009). Empirical studies on distance in the Masculinity dimension come as well to puzzling results, finding e.g. that it has a negative impact on the survival of international joint ventures (Barkema, Vermeulen 1997) and delays at the same time the termination of an alliance (Malik, Zhao 2013). Moreover, they find a positive impact on the team and international joint venture performance, which they however attribute only to the specific constellation of partners in their survey data (Elron 1997; Pothukuchi et al. 2002).

Individualistic (versus collectivistic) societies show a strong self-orientation and put tasks before people (Hofstede 2002). High Individualism is connected to high innovativeness and patent activity (e. g.; Shane 1993; Strychalska-Rudzewicz 2016; Kaasa 2016a). Characteristics associated with high Individualism are freedom of decision, open-mindedness and the support of individual initiative, which all lead to a higher creativity (e. g.; Shane 1993; Herbig, Miller 1992). Moreover, outstanding performance of individuals is rewarded and compensated in high individualistic environments (Eisenberg 1999) and people strive for social prestige (Shane 1992; Hofstede 2002). Again Nakata and Sivakumar (1996) differentiate between the initiation phase of innovation, fostered by self-confidence and a visionary approach (high Individualism) and the implementation phase (stimulated by low Individualism with collectivist characteristics such as a greater permeability of information) (Dwyer et al. 2005). Empirical results for innovation diffusion are more puzzled, as they find positive (Yeniyurt, Townsend 2003; Steenkamp et al. 1999) and negative (e. g.; Dwyer et al. 2005; Yaveroglu, Donthu 2002) effects of high Individualism. This can be caused by the fact that in the beginning of innovation diffusion, higher Individualism is still beneficial, while with growing diffusion of the innovation, an environment of lower Individualism becomes more advantageous (van Everdingen, Waarts 2003). There are not many studies on distance in this dimension. Pothukuchi et al. (2002) find that distance in the Individualism dimension has a negative impact on the performance satisfaction of alliances and Malik and Zhao (2013) note that it considerably shortens alliance duration, while others find a positive impact on alliance efficiency and team performance (Pothukuchi et al. 2002; Elron 1997).

Long-term Orientation (as opposed to Short-term Orientation) describes the degree to which the aim is a long-/short-term benefit or a long-/short-term relationship (Hofstede 2002). As this dimension has been developed later than the four described before (Hofstede, Bond 1988; Hofstede et al. 2010), less studies have investigated its impact (e. g.; Yaveroglu, Donthu 2002). High Long-term Orientation is said to have a positive impact on new product development as well as on the implementation and adoption rate of innovation as these societies emphasize their future and long-lasting relationships and dispose a rather dynamic mentality (e. g.; Nakata, Sivakumar 1996; Waarts, van Everdingen 2005). However, Dwyer et al. (2005) contradict these results, as they see in Long-term Orientation an aversion to adopt new products, leading to quicker change than people are used to. Low Long-term Orientation (hence, Short-term Orientation) is characterized by a more static approach, focused rather on the present and people put less trust in relationships which leads to a higher risk of opportunistic behavior (Nakata, Sivakumar 1996; Choi, Contractor 2016). Distance in Long-term Orientation leads to a prolongation of alliances as different views of future have to be brought together (Malik, Zhao 2013) and sometimes distance even decreases the chances of survival of alliances (Barkema, Vermeulen 1997).

Indulgence versus Restraint represents on one end a society emphasizing freedom and happiness (high Indulgence) and on the other side a community striving for thrift and strict discipline (low Indulgence, Restraint) (Hofstede 2002). Being the newest dimension, empirical findings are still scarce (Tian et al. 2018). First empirics postulate a positive impact of high Indulgence on innovativeness, as people in indulgent societies tend to be more optimistic and their strive for satisfaction and happiness motivates to continually improve (Cox, Khan 2017). This is supported by the fact that happiness fosters innovative activities (Usai et al. 2020). However, it can be assumed that distance in this dimension is not easily bridged, as partners used to freedom, will not subjugate easily to discipline (Hofstede et al. 2010).

Over the last decades the Hofstede concept has been subject to a lot of criticism.³ Starting from the labelling of the dimensions, the items used to measure them and the degree of abstraction (Triandis 1982), Schwartz (1994) especially criticized that the original study was not conducted to measure national culture and that only employees of a single firm were questioned. Treating all dimensions equally, assuming that certain spatial areas are homogenous due to their culture and that cultural difference (or distance) is negatively associated, are some more of the critics of the cultural distance concept (e. g.; Shenkar 2012). Besides these critics, numerous studies have applied this concept successfully. The six-dimension-model is hence not only a sustainable part of cross-cultural research but has as well shown to be universally applicable. Moreover, the Hofstede dimensions are often at the basis of newly developed models (e. g.; Drogendijk, Slangen 2006; Taras et al. 2009; Kirkman et al. 2006). The dimensions have been connected in a variety of studies with economic factors, especially with innovation (e. g.; Herbig, Miller 1992; Cox, Khan 2017), which constitutes a solid basis for the derivation of the following propositions.

To sum it up, cognitive, social, geographic and the six dimensions of cultural distance affect innovative activities. Until now, the investigation of the impact of cultural distances lacks however depth and detail. Analyses mostly proxy the direct effect of cultural distances with national level categories, ignoring regional level variance, and even more how they affect innovative group performance. Additionally, they disregard the close link of culture with cognitive, social and geographic aspects and the consequential moderating role of cultural distances. The present paper does not claim or seek evidence for cultural proximities being a necessary condition for collaboration success. Rather, cultural proximities are seen as the environment, where favorable conditions for knowledge exchange can be created. Accordingly, moderating effects of cultural proximities on other types of proximities/distances will be discussed in the following.

³ See e.g. Triandis 1982; Schwartz 1994; Fernandez et al. 1997; McSweeney 2002; Kirkman et al. 2006; Ailon 2008; Taras et al. 2009; Rinne et al. 2012; Shenkar 2012.

2.2. Interaction of Cultural Distance with other Distances

The presented cultural distances are all defined in such a way, that their extremes represent opposing attitudes (Hofstede et al. 2010). Hence, people being classified at the opposite extremes advocate contradictory positions, which might lead to conflict. This is a situation, which has to be prevented, when striving for successful collaboration (Elron 1997; Pothukuchi et al. 2002). Accordingly, proximity between partners in each of the presented cultural dimensions lowers the danger of (culture-based) conflict, rises mutual understanding and with this enhances joint performance. This might be helpful, when trying to compensate for other distances' negative impact. Therefore, partners should have the same opinion on communication style and power distribution (Power Distance), the acceptance of risks (Uncertainty Avoidance), whether competition or a healthy relationship (Masculinity) and whether the individual or the group (Individualism) is more important, whether goals are to be set with a long- or short-time horizon (Long-term Orientation) and the importance they attach to being happy (Indulgence) (Hofstede et al. 2010).

As shown before, too low or too high cognitive distance has a negative impact on alliance performance. Being culturally alike, might rise motivation to create something truly new, though being cognitively very close and to find common ground when cognitive distance is very high.

P1a The negative impact of a lower than optimal cognitive distance in a research collaboration on its performance can be reduced through cultural proximities.

P1b The negative impact of a higher than optimal cognitive distance in a research collaboration on its performance can be reduced through cultural proximities.

The danger of opportunistic behavior due to very low social distance can be reduced through being, thinking and behaving culturally alike. Accordingly, the following hypothesis can be derived:

P1c The negative impact of a low social distance in a research collaboration on its performance can be reduced through cultural proximities.

Finally, if partners are neither located close to each other nor have the advantage of entering new markets that are located far away through the collaboration, cultural proximity can help to still develop a successful collaboration.

P1d The negative impact of a medium geographic distance in a research collaboration on its performance can be reduced through cultural proximities.

However, these cultural proximities can occur on different levels (e.g. on a masculine or a feminine side). Giving even more insights of cultural distance as a moderator, the level of cultural proximity will be considered additionally in the following section.

As all distances, cognitive distance is interrelated with the other distances and its impact can be moderated (Boschma 2005). In case of a too low cognitive distance, many ideas are needed to generate high-quality outcome despite cognitively similar mindsets. Hence, everybody must feel safe and encouraged to share his or her ideas (low Power Distance) (Nakata, Sivakumar 1996). Additionally, the environment should be open to riskier ideas and connected changes in plans if things do not turn out the way they were anticipated (low Uncertainty Avoidance) (Hofstede 2002). Being cognitively close requires a great amount of ambition to succeed, as breakthrough ideas do not emerge naturally in such a setting (high Masculinity) (Kaasa 2016a). The needed creativity can be fostered through freedom to test ideas even if they might fail as well as individual recognition for outstanding ideas (high Individualism) (Herbig, Miller 1992) and optimism (high Indulgence) (Cox, Khan 2017). These listed conditions need some time to unfold their effect and hence the planning horizon should be future-oriented (high Long-term Orientation) (Hofstede 2002).

P2a The negative impact of a lower than optimal cognitive distance in a research collaboration on its performance can be reduced by cultural proximity with on average low Power Distance, low Uncertainty Avoidance, high Masculinity, high Individualism, high Long-term Orientation and high Indulgence.

Are collaboration partners highly different in their cognitive background, frequent and continuous communication is needed to not only share knowledge but to absorb it and generate subsequently outstanding ideas. Fluidity of communication is connected to a low Power Distance environment (Hofstede 2002), which is as well positively connected to the generation of radical (high-quality) patents (Herbig, Miller 1992). If partners have a higher than optimal cognitive distance, great efforts have to be made to work successfully together. Therefore, each partner has to leave his or her comfort zone (low Uncertainty Avoidance), has to be eager to succeed (high Masculinity), overcome individual interests and place the success of the group above his or her own (low Individualism), accept that it will take time to produce (high-quality) results (high Long-term Orientation) and not lose his or her optimism over time (high Indulgence).

P2b The negative impact of a higher than optimal cognitive distance in a research collaboration on its performance can be reduced by cultural proximity with on average low Power Distance, low Uncertainty Avoidance, high Masculinity, low Individualism, high Long-term Orientation and high Indulgence.

Already Boschma (2005) claims that social distance is interrelated with the other distances. Overcoming the drawbacks of low social distance, such as the risk to be betrayed caused by too much trust, a setting with clearly defined roles and positions (high Power Distance value) (Venkateswaran, George 2020; Hofstede 2002) openness for new ideas to be able to think outside of the ‘social box’ (low Uncertainty Avoidance) and discipline (low Indulgence) (Shane et al. 1995; Hofstede 2002) as well as an emphasis on a long-lasting relationship (low Masculinity and high Long-term Orientation) and the group (low Individualism) (Hofstede 2002) is supposed to be beneficial.

P2c The negative impact of a low social distance in a research collaboration on its performance can be reduced by cultural proximity with on average high Power Distance, low Uncertainty Avoidance, low Masculinity, low Individualism, high Long-term Orientation, low Indulgence.

To overcome the negative impact of not being located close to each other and tap tacit knowledge (while not being far away enough to benefit from the possibility to enter new markets either (Bathelt et al. 2004)), it is important to communicate frequently (low Power Distance) (Hofstede 2002) and have a clear set plan on how the collaboration works and which rules have to be followed while at the same time keeping the spirit of openness towards new ideas (medium Uncertainty Avoidance) (Dimitratos et al. 2011). Moreover, partners should put an emphasis on a working relationship which offers a safe environment for creativity (low Masculinity) (Kaasa 2016a), value the group while however be motivated to follow as well ideas of individuals (medium Individualism) (Mueller, Thomas 2000; Hofstede 2002), strive for long-lasting relationships, which foster trust and reduce opportunistic behavior (high Long-term Orientation) (e. g.; Choi, Contractor 2016) and have strict social norms (low Indulgence) (Cox, Khan 2017).

P2d The negative impact of a medium geographic distance in a research collaboration on its performance can be reduced by cultural proximity with on average low Power Distance, medium Uncertainty Avoidance, low Masculinity, medium Individualism, high Long-term Orientation and low Indulgence.

3. Data and Methodology

3.1. Variables and Descriptive Statistics

The present analysis investigates the impact of the combination of different distances in research collaborations on their performance in 15 European countries. Based on the distances between each inventor pair of a team, group averages are calculated, while placing an emphasize on the moderating effects of cultural distances. The observation unit is patent-level (each patent representing a research team),

considering all those that have been invented by at least two inventors, and applied in at least one of the 15 European countries⁴ between 2007 and 2009. All variables but those for cultural distance have been generated based on data retrieved from the patent database provided by the European Patent Office (PATSTAT 2017). In total, 62,723 patents have been included in the dataset (limited to those for which data for all variables were available), that have been developed by inventor teams with two to 87 inventors, filed by zero to 66 organizations.

The dependant variable of collaboration performance is proxied by patent quality. This is a count variable of forward citations, received in the subsequent five years after the filing of the respective patent (calculated day-exactly and corrected for self-citations) (Squicciarini et al. 2013). Forward citations are often used as an indicator for the R&D success, the economic value and technological importance of a single patent (Harhoff et al. 1999; Trajtenberg 1990; Hall et al. 2005). In the present paper they proxy collaboration performance (high-quality patents). The variable has a range from zero to 237 with a mean of 3.3.

To construct the variable for cognitive distance, the technological information (IPC codes) for all inventors, listed as partners on at least one of the patents in investigation, is collected for the years 2005 to 2009. These codes are then aggregated, according to the classification with 35 technological fields developed by Schmoch (2008). For each inventor a vector is built, containing all technological fields the inventor can be associated with through patent application in the five-year-period. Then, for each inventor pair, appearing as partners on the patents in investigation, the technological (cognitive) distance is calculated, based on their technological vectors, applying the cosine index. Following Ejermo (2003), the cosine index is defined in this way:

Equation 1 Cosine Index following Ejermo (2003)

$$d_{ij} = 1 - \left(\frac{\sum_{k=1}^n w_{ik} w_{jk}}{\sqrt{\sum_{k=1}^n w_{ik}^2 \sum_{k=1}^n w_{jk}^2}} \right)$$

where n represents the number of technologies and i, j, k indicate the considered technologies. The equation can take a value between zero and one, where one signifies maximum proximity. For simplicity the index has been inverted (d) so that one signifies maximum distance. In the next step, group averages are calculated, leading to one value of average cognitive distance per patent. The variable has a median of 0.1 and a mean

⁴ For 15 European countries namely Belgium, the Czech Republic, Germany, Finland, France, Greece, Hungary, Ireland, Italy, the Netherlands, Poland, Portugal, Sweden, Slovenia and Great Britain, NUTS-2-level data is available on a representative basis (gender*age) for 2008. 29 regions were excluded, as they had less than 20 observations, leaving 174 NUTS-2-regions for computation.

of 0.28. To test the hypotheses, thresholds are used for the dummies, which are displayed in Table 1.

The variable for social distance has been constructed following previous works with minor adaptations due to the present research focus (e. g.; Broekel 2015). All inventors appearing on the same patent are matched as pairs (hence a patent with three inventors would produce three pairs) and it is counted, how many times each pair has appeared ever before on a patent application. Then, for each patent a group average is calculated, which has for the data a range between zero and 76 previous co-inventorships with a mean of 0.4365. To test the hypotheses, for social distance two dummies (low and high) are built, separating partners who know each other from at least one collaboration (low distance) from those that never worked together (high distance) (see Table 1). The present dataset displays the left side (positive impact of growing social distance) of the inverted u-shape connection proposed in theory, as it is proxied by a dummy. It is hence only distinguished whether collaborators knew each other before or not. The knowing part is not further subdivided.

Taking the addresses of the inventors, translated into coordinates, for each inventor pair the physical distance in kilometres is calculated (e. g.; Broekel 2015). Then group averages are estimated, which range for the present dataset from 0 to 3,474 km, with a mean of 48 km. The dummy-thresholds, applied to test the hypotheses, are shown in Table 1. Unlike mainstream theory, the present dataset emphasizes the positive impact of being very close (profiting e.g. from knowledge spillovers) and very distant (tapping into new markets through the collaboration).

Based on the national dimensions of Hofstede, Kogut and Singh (1988) developed a composed indicator, calling it cultural distance. They first proposed a composite indicator, combining differences in all six (then only four) dimension. However, taken as a construct, literature comes to different results of the direct as well as indirect (moderating) effect of cultural distance on economic factors (e. g.; Barkema, Vermeulen 1997; Pothukuchi et al. 2002; Duan et al. 2021; Steensma et al. 2000). This might be due to the fact that results depend upon strong single dimensions (e. g.; Barkema, Vermeulen 1997; Shenkar 2012; Pothukuchi et al. 2002). Using the Hofstede dimensions separately is one possibility to overcome this shortcoming.⁵

Cultural distance is hence investigated by six different distances, one for each Hofstede dimension. The data was taken from the EVS wave from 2008 (EVS 2016), which investigates every nine years among other things values, ideas and attitudes of European citizens (EVS 2015). Based on 18 variables from the EVS (three for each dimension) and applying confirmative factor analysis, for each region (NUTS-2-level)

⁵ For an overview of literature see e.g. Herbig, Dunphy 1998; Jones, Davis 2000; Kirkman et al. 2006; Beugelsdijk et al. 2017; Tian et al. 2018.

regional measures for the six indices were calculated, following Hofstede et al. (2010) and Kaasa et al. (2014). Analogous to the original Hofstede dimensions, where Hofstede calculated the dimensions on national level, each index has a range from zero to one hundred (Hofstede et al. 2010). As each inventor can be allocated to a certain region, for every inventor pair six cultural distances were calculated, following Kogut and Singh (1988):

Equation 2 Cultural Distance following Kogut and Singh (1988)

$$CD_{ip} = \frac{(I_{ij} - I_{iu})^2}{V_i}$$

Where I stands for the index of the different dimensions i of partners j and u , with the variance V for each dimension i , leading to the cultural distance CD for each dimension i and every pair p . In the next step, like for the other distance variables, group averages were determined to then generate dummies (see Table 1).

Table 1: Dummies of Distances with Thresholds. (The grey categories of the independent variables are those with a negative impact on the number of produced high-quality patents and thus included in the models. The grey categories of the moderating variables are those supposed to reduce the negative impact of the Independent Variables and hence included in the models. Applied thresholds are displayed.⁶ The capital letters A-F connect this Table to Table 2.)⁷ (Own representation).

		Low Distance	Medium Distance	High Distance
Independent Variables	Cognitive Distance	lower 10% of value range (≤ 0.1)		upper 10% of value range (≥ 0.9)
	Social Distance	presence of former collaborations (<76)		
	Geographic Distance		distance between 10 km (≤ 10) and 100 km (<100)	
Moderating Variables (Independent)	Distance in Power Distance	A		
	Distance in Uncertainty Avoidance	B		
	Distance in Indulgence	C	lower	
	Distance in Masculinity	D	15% of	
	Distance in Individualism	E	distan- ces	
	Distance in Long-term Orientation	F		

⁶ Main dataset: Robustness checks with 10%-, 20%- and 25%-margins led to similar results, only for some terms slightly differing in significance levels.

⁷ As additional robustness checks, the dummies of cognitive distance, social distance and geographic distance were interacted with the dummies for medium cultural distances and finally with those for high cultural distances. In all cases, interaction with medium cultural distances have the opposite significant effects of the interactions with low cultural distances. Interactions with high cultural distances have no significant effects.

In simple terms, an inventor pair P consisting of inventor X and inventor Y could have a low, medium or high distance in e.g. Individualism. Having a high distance would signify that one of the inventors is rather collectivistic oriented and one rather individualistic. The second case is that pair P has a medium distance for Individualism, resulting from inventor X and Y being neither very similar nor very different. For the present investigation both of these cases are not interesting. However, if this pair P has a low distance in Individualism (lower 15%), inventor X and Y are similar (both rather collectivistic, both something in between or both rather individualistic oriented). As the present paper proposes that such similarity (or proximity) can help to reduce negative impacts of cognitive, social or geographic distance/proximity, only the dummies for low distances in the cultural distances are included. If a team consists of more than two inventors, the average of all the pairs is calculated.

Table 2: Value Differences for Cultural Dimensions.⁸ (The capital letters A-F connect this Table to Table 1. Applied thresholds are displayed.) (Own representation).

A. Low Distance in Power Distance			B. Low Distance in Uncertainty Avoidance		
$\leq 15\%$		$\geq 85\%$	$\leq 15\%$		$\geq 85\%$
Low Value	Medium Value	High Value	Low Value	Medium Value	High Value
Low Power Distance	Medium Power Distance	High Power Distance	Low Uncertainty Avoidance	Medium Uncertainty Avoidance	High Uncertainty Avoidance
C. Low Distance in Indulgence			D. Low Distance in Masculinity		
$\leq 15\%$		$\geq 85\%$	$\leq 15\%$		$\geq 85\%$
Restraint	between Restraint and Indulgence	Indulgence	Femininity	between Femininity and Masculinity	Masculinity
E. Low Distance in Individualism			F. Low Distance in Long-term Orientation		
$\leq 15\%$		$\geq 85\%$	$\leq 15\%$		$\geq 85\%$
Low Value	Medium Value	High Value	Low Value	Medium Value	High Value
Collectivism	between Collectivism and Individualism	Individualism	Short-term Orientation	Medium-term Orientation	Long-term Orientation

However, these indices of cultural distances are able to give even more insights how they can function as moderators. Staying with the presented example and presuming that pair P shows a low distance in Individualism, three new dummies are

⁸ Similar as for the main dataset, robustness checks were conducted for the subset. However, variables for 10%-margin dummies did not have in all cases enough observations and results for the 25%-margin became highly volatile. Hence, robustness checks were conducted for 20%-margins. In most cases, as for the main dataset, only minor changes in significance could be observed.

introduced. The dummy 'low IDV distance on low IDV level' signifies that inventor X and Y are similar due to Individualism on a low value level ($\leq 15\%$) and are hence both rather collectivistic oriented. The second dummy 'low IDV distance on medium IDV level' indicates that inventor X and Y are similar due to Individualism on a medium value level ($>15\%$ to $<85\%$), signifying they have both something between a collectivistic and individualistic attitude. Finally, dummy 'low IDV distance on high IDV level' means that inventor X and Y are similar due to Individualism on a high value level ($\geq 85\%$) and are consequently both of a rather individualistic character. Like before, if a team consists of more than two inventors, the average of all possible pairs is calculated. As shown in Table 2 this classification is done for each of the six indices.

To account for other factors influencing patent quality, a set of control variables is included. Taking into consideration that some inventors are involved in a number of patent applications, having hence a higher probability to generate as well high-quality patents, a variable is generated, indicating the group average of how many patents the inventors can be associated with in the years 2005 – 2009 (variable I in Table 3). This variable is similar to the often-used quality measure for star scientists or star inventors, referring to those inventors, being e.g. highly cited or having contributed to many patents and are hence held to have an especially high inventive capacity (e. g.; Bercovitz, Feldman 2011; Crescenzi et al. 2017). The variable Family size (II) accounts for the number of patents applied in the same patent family and accounts for the value of a patent (e. g.; Harhoff et al. 2003) and its efforts to protect it (e. g.; Moaniba et al. 2020). With the variable Team size (III) the number of inventors of a team are counted. It has been shown that team size not only impacts the likelihood to generate a patent (e. g.; Bercovitz, Feldman 2011), but as well its novelty (e. g.; Lee et al. 2015), its quality (e. g.; Beaudry, Schiffauerova 2011; Singh, Fleming 2010) and its impact (e. g.; Huo et al. 2019). The same holds for patents assigned to several applicants (these patents are more likely to be more successful) as to why a variable is included, counting the number of applicants filing a patent (IV) (e. g.; Singh, Fleming 2010). Moreover, a variable was computed, counting the number of different countries the applicants of one patent are from (variable V in Table 3), as international patents tend to be more valuable (e. g.; Harhoff et al. 2003; Beaudry, Schiffauerova 2011). To proxy for the innovation capability of companies (e. g.; Moaniba et al. 2020; Sonmez 2018), a variable was included, summing up the number of patents the applicants of the investigated patent have filed in the years 2007 – 2009, excluding the patent in investigation and excluding all patents on which the applicants are listed as inventors (variable VI in Table 3).⁹

⁹ In Appendix 1 the correlation table of all included variables is presented, showing that none of them correlates stronger than a value of 0.54. However, for cultural dimensions, a higher correlation among each other was expected, as already shown in earlier publications (Kaasa, Vadi 2010; Kaasa 2016b).

Table 3: Basic information on control variables (main dataset, own representation).

Variable	Minimum	Maximum	Mean	Mode
<i>I. Group average of patent stock</i>	1	285.5	8.1	1
<i>II. Family size</i>	1	134	6	4
<i>III. Team size</i>	2	87	4.2	2
<i>IV. Number of Organizations</i>	0	66	1.2	1
<i>V. Number of Countries the Organizations are from</i>	0	8	1.1	1
<i>VI. Sum of filed patents (2007-2009) of the Organizations</i>	0	488,149	31,027	189,741

3.2. Model Specification

In total, two series of regression models are estimated. Due to the nature of the dependent variable, a negative binomial regression has been chosen.

To prove that the present dataset reflects literature, one regression without interactions is calculated, testing for the direct impact of the distances on the likelihood to generate high-quality patents. As shown in Appendix A2, the dataset is in line with literature. The results on which the following results are based are displayed in Appendix A3 and A4 and summarized in Table 4. To test P1a, P1b, P1c and P1d the first series of regression models are calculated, analyzing whether low cultural distances diminish the negative impacts of the other distances (Appendix A3). In a second series of models, P2a, P2b, P2c and P2d are tested, accounting for whether low cultural distances are rather benefitting on a very low (Appendix A4.1), medium (Appendix A4.2) or high (Appendix A4.3) value level of the six dimensions. For this purpose, a subsample is created, only including those patents, that have in all six dimensions a low distance value (at the 15% threshold), reducing the observations to 56,356. To prevent multicollinearity, the dummies of cognitive, social and geographic distance were first interacted with the dummies for low cultural distances at a low value level, in a second step with the dummies for low cultural distances at a medium value level and in a third step with low cultural distances on a high value level. Hence, for each step 24 models (six cultural distance dimension dummies * four distance dummies (high cognitive, low cognitive, low social, medium geographic)), each including one interaction term, were calculated.¹⁰

¹⁰ Appendix A4.1 – A4.3 show for each step the coefficients and significances for the interaction terms

4. Results and Discussion

As far as the included control variables are concerned, all have highly significant and positive coefficients, which does not change throughout the regression series (Appendix A2). This indicates that the average number of produced patents per inventor, the family size, the team size, the number of organizations involved as well as the number of patents they have produced between 2007 and 2009 and the number of different countries they come from positively influence the number of produced high-quality patents. These findings are in line with previous empirical studies (e. g.; Sonmez 2018).

For **low cognitive distance**, the interaction terms with low distance in Uncertainty Avoidance, Individualism and Long-term orientation have a positive and significant effect (Appendix A3). These results indicate that the negative impact of a too low cognitive distance on collaboration performance, is reinforced (becomes even more negative) by proximity in these three cultural distances (accordingly, P1a has to be rejected). At this point, it is interesting to have a closer look at interactions with low cultural distances, as this can occur at a low (Appendix A4.1), medium (Appendix A4.2) or high (Appendix A4.3) value level. As predicted in P2a, having a low cultural distance on a high value level of Masculinity level lessens the negative impact of a too low cognitive distance on collaboration performance. It is hence important to thrive for success to enhance collaboration performance. Moreover, fostering creativity through recognition of outstanding performances of the individual (high Individualism) (Herbig, Miller 1992) helps enhance collaboration performance (partly support for P2a). However, having a low cultural distance on a low value level of Long-term Orientation (being rather short-term oriented), even reinforces the negative impact of a too low cognitive distance.

Two forms of cultural proximity compensate for a too low cognitive distance: It is not only important to be culturally close but to be 1) rather success oriented (Masculinity) and 2) to reward individuals for their efforts (Individualism) to overcome the negative impact of partners having too similar knowledge bases.

For **high cognitive distance**, there are no significant results for interactions with the six cultural dimensions at low distance (Appendix A3). Hence, there is no basis for support or contradiction for P1b. At this point, it is again interesting to have a closer look

One form of cultural proximity compensates for a too high cognitive distance: Targeting a medium time horizon for results of the joint work (Long-term Orientation) reduces the negative impact of partners having too different knowledge bases.

at interactions with low cultural distances, at a low (Appendix A4.1), medium (Appendix A4.2) or high (Appendix A4.3) value level. The interaction terms of high cognitive distance with low cultural distance on a high value level of Individualism as well as low

cultural distance on a low value level of Long-term Orientation have a significant and positive effect. This suggests, that being focused too much on the success of the individual (high Individualism) and expecting results quickly (low Long-term Orientation), reinforces the negative impact of being cognitively too distant on collaboration performance. Hence, there is neither support nor contraction for P2b for Individualism and Long-term Orientation. However, already having a low cultural distance on a medium value level of Long-term Orientation turns the effect into a negative one, hence lessening the negative impact.

Looking into the negative impact of **low social distance**, the interaction terms with low distance in Uncertainty Avoidance, Individualism and Indulgence are negative and (very) significant (Appendix A3). This implies, that the negative impact of too close

Three forms of cultural proximity compensate for a too low social distance: 1) Being open to unknown situations (Uncertainty Avoidance), 2) cherishing the group as well as the individual (Individualism) and 3) stressing happiness over rules (Indulgence) reduces the negative impact of partners having worked together many times.

social ties on collaboration performance can be reduced by proximity in cultural distances (supporting P1c). The reason could be that the negative impact of social proximity stems from the risk of opportunistic behavior, which again might be reduced, if partners have similar cultural backgrounds. At this point, it is again interesting to have a closer look at interactions with low cultural distances, at a low (Appendix A4.1), medium (Appendix A4.2) or high (Appendix A4.3) value level. If partners are rather comfortable with unknown situations and open to new ideas (low cultural distance on a low value level of Uncertainty Avoidance) the negative impact of social proximity is reduced (partly support for P2c). Already having an on average medium aversion against unknown situations (low cultural distance on a medium value level of Uncertainty Avoidance), reinforces the negative impact of low social distance. Reasons might be that being socially close, one can rely on the partner and should hence be open to new ideas and opportunities (unknown situations) to enhance collaboration performance. Putting an emphasis on happiness instead of strict rules (low cultural distance on a high value level of Indulgence) lessens the negative impact of a too low social distance, while already low cultural distance on a medium value level of Indulgence reinforces the negative impact. This could be due to the fact that opportunism is not prevented by strict rules but by motivating partners to be successful and hence being happy. If both partners are neither too individualistic nor too collectivistic (low cultural distance on a medium value level of Individualism), the negative effect on collaboration performance is reduced, while focusing too much on the group (low cultural distance on a low value level of Individualism) reinforces the negative effect (contradiction to P2c). Hence, as social ties are close, it is important to promote both, the group as well as the individual as there is no need to further strengthen the group-feeling. Other characteristics, reinforcing the negative impact are focusing too much on the far-away future (low cultural distance on

a high value level of Long-term Orientation) and preferring hierarchical structures (low cultural distance on a high value level of Power Distance) (contradiction to P2c). Hence,

Six forms of cultural proximity compensate for having neither the advantages that stem from geographically distant partners nor those that stem from geographically close partners: 1) Being rather short-term oriented (Long-term Orientation), 2) considering the functioning of the team and success as being equally important (Masculinity), 3) having an eye on the group as well as on the individual (Individualism), 4) organizing the team in e.g. a flat hierarchical system (Power Distance) and 5) pointing rather on discipline – however without losing optimism (6) – (Indulgence) reduces the negative impact of partners located at medium geographic distance

being already socially close, it is not necessary and hence not an advantage, emphasizing additionally the team and if social ties are given, it is counterproductive to focus on hierarchical structures instead of collaborating on eye-level.

The interaction terms of **medium geographic distance** with low cultural distances have all but for distance in Power Distance negative and (very) significant coefficients (Appendix A3). This implies that the negative impact of medium geographic distance on collaboration performance can be reduced through cultural proximities, supporting P1d. Hence, cultural proximity might help to be part of the local buzz, normally reserved for those actors being located closely to each other, even if there is some geographic distance. At this point, it is again interesting to have a closer look at interactions with low cultural distances, at a low (Appendix A4.1), medium (Appendix A4.2) or high (Appendix A4.3) value level. This draws a more diverse picture. Low cultural distance at a low level of Long-term Orientation lessens the negative impact of medium geographic distance, while already low cultural distance at a medium level of Long-term Orientation reinforces the effect. Thus, the team members have to thrive for quick results to be successful, if they are located at some geographic distance, as they are on the one side left out from the local buzz and on the other side there are no international partners, opening the doors to new distant markets. Additionally, low cultural distance at a medium level of Power Distance lessens the negative impact of medium geographic distance. However, cultural distance at a low and a high level of Power Distance reinforces the negative impact (contradiction to P2d). This implies that there has to be found a balance between hierarchical structures and collaboration on eye-level to guarantee the functioning of the teamwork over some geographic distance. In the same direction points the result that low cultural distance at a high level of Masculinity reinforces the negative impact of medium geographic distance, while low cultural distance on a medium level of Masculinity lessens it. Hence, not looking at the functioning of the relationship with the group and just focusing on the success, does not lead to a positive impact on collaboration performance. Low cultural distance at a medium level of Individualism lessens the negative effect of medium geographic distance, while low cultural distance on a low value level for Individualism reinforces it (support for P2d). These results clearly

show, that besides supporting individuals and their ideas, you have to have an eye on the group at some geographic distance, as too strong individualistic tendencies can e.g. lead to distrust among the team members and hence undermine the common goal of producing outstanding results. Moreover, low cultural distance at a low and medium level of Indulgence lessens as well the negative impact of medium geographic distance (support for P2d), as opposed to cultural proximity at a high level of Indulgence. This leads to the conclusion that it is very important to hold on to set rules to win the confidence of the geographically distant partner, while focusing on happiness is not trustworthy over some geographic distance.

Table 4: How the negative impact of low cognitive, high cognitive, low social and medium geographic distance on collaboration performance is moderated by low cultural distances. (Examples: The negative impact of low cognitive distance on collaboration performance is reinforced, if there is low distance in Individualism. However, when this low cultural distance occurs on a high value level of Individualism, the negative impact of low cognitive distance is reduced (less negative).) Only significant results are represented. (\emptyset = on average, L = low value level, M = medium value level, H = high value level) (Own representation).

				Low Cognitive Distance	High Cognitive Distance	Low Social Distance	Medium Geographic Distance
Direct Effect				-	-	-	-
Change of Effect through interaction with	Low Distance in Power Distance	value	\emptyset				
			L				reinforces
			M				lessens
			H			reinforces	reinforces
	Low Distance in Uncertainty Avoidance	value	\emptyset	reinforces		lessens	lessens
			L			lessens	
			M			reinforces	
			H				
	Low Distance in Masculinity	value	\emptyset				lessens
			L				
			M				lessens
			H	lessens			reinforces
	Low Distance in Individualism	value	\emptyset	reinforces		lessens	lessens
			L			reinforces	reinforces
			M			lessens	lessens
			H	lessens	reinforces		
	Low Distance in Long-term Orientation	value	\emptyset	reinforces			lessens
			L	reinforces	reinforces		lessens
			M		lessens		reinforces
			H			reinforces	
	Low Distance in Indulgence	value	\emptyset			lessens	lessens
			L				lessens
			M			reinforces	lessens
			H			lessens	reinforces

Summing it up, without considering value levels, proximities in many cultural dimensions lessen the negative impact of medium geographic distance and low social distance on collaboration performance. The negative impact of too low cognitive distance

cannot be reduced by proximity in general but is even reinforced by proximity in Uncertainty Avoidance, Individualism and Long-term Orientation. On the negative impact of a too high cognitive distance, cultural proximity in general has no significant effect at all. Considering as well value levels, it becomes even more obvious that the six cultural dimensions have not only different impacts but that it is really important to not only include the fact whether partners are cultural distant or not but on which value levels, as their impacts are highly diversified for cognitive, social and geographic distance.

5. Concluding Remarks

The present paper discusses whether proximity in cultural dimensions can help to reduce the negative impacts of too low cognitive distance, too high cognitive distance, low social distance and medium geographic distance on collaboration performance. Empirical results reveal some interesting insights into how diversified the impact of cultural distances are, especially as the (moderating) impact of cultural distance has been widely neglected in literature.

First of all, the results confirm that there is not one mainstream culture but that it has several layers which have differing or even opposing moderating effects. It is proven, that the negative impact of low and high cognitive distance, as well as the ones of low social distance and medium geographic distance can be reduced through cultural proximities. The more detailed and differentiated analysis of cultural proximities reveals however, that cultural proximity can by no means be seen as a universal remedy for negative impacts of other distances. It rather depends on the distance (cognitive, social, geographic) to be moderated and on the value level of the cultural dimension whether the negative impact is reinforced or reduced. Moreover, the same cultural dimension can have opposing effects, as for the example low cultural distance of Long-term Orientation. On a low value level, signifying an emphasis of short-term goals, it reinforces the negative impact of too high and too low cognitive distance, while it lessens it for medium geographic distance. These findings have some managerial implications as well, as they can e.g. be considered when putting together a team, in the design of processes (e.g. concerning time horizons) as well as when implementing incentives (e.g. rewards for individuals).

Beyond these new empirical insights, the present study contributes in several ways to current literature. Starting from the fact that still most studies on cultural distance use composed indicators (on national level) (e. g.; Barkema et al. 1997; Duan et al. 2021), this paper shows one more time, that such an approach is not only imprudent but senseless. Moreover, it is among the first studies, applying the Hofstede dimensions on regional level and hence adds explanatory power compared to the studies only using national level data (e. g.; Kaasa et al. 2014; Moaniba et al. 2020; Elia et al. 2019). Additionally, the dimension of Indulgence has hardly been investigated empirically yet

(e. g.; Tian et al. 2018; Cox, Khan 2017), which makes results for this dimension even more interesting. Finally, in studies investigating the interactions of distances/proximities, cultural distances (as part of institutional distance or separately) have been widely ignored or proxied by formal institutions (e. g.; Ponds et al. 2007; Broekel 2015).

Besides these new insights, the structure of the cultural data leads to some restriction of the explanatory depths of the results, as they are derived from a regional average instead directly from team level as the other variables. Hence, further analysis, including cultural data based on the exact team members is needed to elaborate more on the influence of cultural distances in research groups. Another shortcoming of the present study is that it focuses only on 15 European countries and that partners being from other countries had to be removed from the dataset. However, 15 countries with a total of 174 investigated regions still represent a dataset leading to reliable results. Finally, the dynamic aspect of distances has been ignored in this investigation, focusing on the interaction of distances and using only one point in time. These dynamic interactions have already been proved empirically by Broekel (2015) and Balland et al. (2014), however not going in detail into different aspects of cultural distances.

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Appendix

A1: Correlation Table of all Variables

Equivalent in correlation	Description	Variable
A	Patent Quality	Cited_in_five_years_without_self_cites
B	Cognitive Distance (group average)	Cog_dis_group
C	Social Distance (group average)	Soc_dis_group
D	Geographic Distance (group average)	Geo_dis_group_km
E	Distance in Power Distance (group average)	PDI_reg_CD_group
F	Distance in Uncertainty Avoidance (group average)	UAI_reg_CD_group
G	Distance in Indulgence (group average)	MAS_reg_CD_group
H	Distance in Masculinity (group average)	IDV_reg_CD_group
I	Distance in Individualism (group average)	LTO_reg_CD_group
J	Distance in Long-term Orientation (group average)	IVR_reg_CD_group
K	Number of patents the inventors can be associated with in the years 2005 – 2009 (group average)	Average_Pat_Stock
L	Number of patents applied in the same patent family (group average)	Family_size
M	Number of inventors on a patent	Team_size
N	Number of applicants on a patent	Number_Orgas
O	Number of different countries of the applicants on a patent	Number_of_countries_Orgas
P	Number of patents the applicants of a patent have filed in the years 2007 – 2009, excluding the patent in investigation and excluding all patents on which the applicants are listed as inventors	Number_of_patents_2007_2009_group_ohne_inv

N = 62,723	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
A	1.00															
B	-0.02***	1.00														
C	-0.03***	0.09***	1.00													
D	-0.02***	-0.04***	0.04***	1.00												
E	-0.02***	-0.06***	0.02***	0.30***	1.00											
F	-0.02***	-0.05***	0.02***	0.21***	0.18***	1.00										
G	-0.02***	-0.07***	0.01	0.33***	0.37***	0.20***	1.00									
H	-0.02***	-0.07***	0.02***	0.27***	0.37***	0.48***	0.26***	1.00								
I	-0.03***	-0.09***	0.00	0.27***	0.25***	0.26***	0.35***	0.29***	1.00							
J	-0.02***	-0.08***	0.02***	0.31***	0.35***	0.29***	0.26***	0.35***	0.39***	1.00						
K	0.12***	-0.12***	-0.54***	-0.01***	0.01*	0.01*	0.04***	0.01*	0.03***	0.01***	1.00					
L	0.16***	0.11***	-0.03***	-0.03***	-0.04***	-0.04***	-0.03***	-0.05***	-0.02***	-0.04***	0.04***	1.00				
M	0.08***	0.02***	0.04***	0.06***	0.03***	0.02***	0.05***	0.02***	0.05***	0.04***	0.03***	0.38***	1.00			
N	0.02***	0.02***	0.01**	0.03***	0.01**	0.00	0.00	0.01*	0.00	0.02***	0.01*	-0.11***	0.02***	1.00		
O	0.06***	0.05***	-0.00	0.01**	-0.00	0.01	-0.01	0.00	-0.01*	0.01	0.02***	0.16***	0.07***	0.07***	1.00	
P	0.02***	-0.07***	-0.03***	0.01*	0.05***	-0.01*	0.03***	-0.01**	0.00	0.01*	0.14***	-0.06***	0.01	0.06***	0.05***	1.00

A2: Basic Regressions (GLM NB) of Direct Impact of Distances on Number of Produced High-Quality Patents.

	Dependent variable:					
	Cited_in_five_years_without_selfcites					
	(1)	(2)	(3)	(4)	(5)	(6)
Cog_dis_group		0.130** (0.060)				0.169*** (0.060)
I(Cog_dis_group2)		-0.198*** (0.061)				-0.260*** (0.061)
Soc_dis_group			0.034*** (0.003)			0.035*** (0.003)
Geo_dis_group_km				-0.001*** (0.0001)		-0.001*** (0.0001)
I(Geo_dis_group_km2)				0.00000*** (0.00000)		0.00000*** (0.00000)
PDI_reg_CD_group					-0.023*** (0.007)	-0.018** (0.007)
UAI_reg_CD_group					-0.014*** (0.003)	-0.014*** (0.003)
IVR_reg_CD_group					-0.010** (0.005)	-0.007 (0.005)
MAS_reg_CD_group					-0.021*** (0.005)	-0.017*** (0.005)
IDV_reg_CD_group					0.001 (0.005)	0.002 (0.005)
LTO_reg_CD_group					-0.020*** (0.004)	-0.019*** (0.004)
Average_Pat_Stock	0.012*** (0.0004)	0.011*** (0.0004)	0.014*** (0.0004)	0.011*** (0.0004)	0.012*** (0.0004)	0.014*** (0.0004)
Family_size	0.046*** (0.001)	0.047*** (0.001)	0.046*** (0.001)	0.045*** (0.001)	0.045*** (0.001)	0.046*** (0.001)
Team_size	0.014*** (0.002)	0.013*** (0.002)	0.013*** (0.002)	0.017*** (0.002)	0.016*** (0.002)	0.015*** (0.002)
Number_Orgas	0.067*** (0.006)	0.068*** (0.006)	0.066*** (0.006)	0.069*** (0.006)	0.068*** (0.006)	0.069*** (0.006)
Number_of_countries_Orgas	0.120*** (0.013)	0.122*** (0.013)	0.121*** (0.013)	0.122*** (0.013)	0.122*** (0.013)	0.124*** (0.013)
Number_of_patents_2007_2009_group_sum_ohne_inv	0.00000*** (0.00000)	0.00000*** (0.00000)	0.00000*** (0.00000)	0.00000*** (0.00000)	0.00000*** (0.00000)	0.00000*** (0.00000)
Constant	0.514*** (0.017)	0.518*** (0.018)	-2.093*** (0.255)	0.532*** (0.017)	0.538*** (0.017)	-2.112*** (0.255)
Observations	62,723	62,723	62,723	62,723	62,723	62,723
Log Likelihood	-144,138.000	-144,124.700	-144,085.200	-144,063.700	-144,047.300	-143,941.100
theta	0.786*** (0.006)	0.787*** (0.006)	0.788*** (0.006)	0.789*** (0.006)	0.790*** (0.006)	0.793*** (0.006)
Akaike Inf. Crit.	288,289.900	288,267.500	288,186.400	288,145.300	288,120.700	287,918.100

Note:

*p<0.1; **p<0.05; ***p<0.01

A3: Regression Results for Interaction Terms with Low Cultural Distances

Interaction term	Coefficient	Significance
<i>low cognitive distance*low PDI distance</i>	0,022	
<i>low cognitive distance*low UAI distance</i>	0,152	**
<i>low cognitive distance*low MAS distance</i>	0,076	
<i>low cognitive distance*low IDV distance</i>	0,142	**
<i>low cognitive distance*low LTO distance</i>	0,145	**
<i>low cognitive distance*low IVR distance</i>	0,006	
<i>high cognitive distance*low PDI distance</i>	0,120	
<i>high cognitive distance*low UAI distance</i>	0,055	
<i>high cognitive distance*low MAS distance</i>	0,212	
<i>high cognitive distance*low IDV distance</i>	-0,120	
<i>high cognitive distance*low LTO distance</i>	-0,338	
<i>high cognitive distance*low IVR distance</i>	-0,078	
<i>low social distance*low PDI distance</i>	0,092	
<i>low social distance*low UAI distance</i>	-0,347	***
<i>low social distance*low MAS distance</i>	0,029	
<i>low social distance*low IDV distance</i>	-0,182	**
<i>low social distance*low LTO distance</i>	0,050	
<i>low social distance*low IVR distance</i>	-0,183	**
<i>medium geo distance*low PDI distance</i>	-0,114	
<i>medium geo distance*low UAI distance</i>	-0,111	*
<i>medium geo distance*low MAS distance</i>	-0,173	**
<i>medium geo distance*low IDV distance</i>	-0,230	***
<i>medium geo distance*low LTO distance</i>	-0,169	***
<i>medium geo distance*low IVR distance</i>	-0,246	***

A4: Regression Results for Interaction Terms with Low Cultural Distances on Different Value Levels

A4.1: Regression Results for Interaction Terms with Low Cultural Distances on a Low Level of the Cultural Dimensions

<i>Interaction term</i>	<i>Coefficient</i>	<i>Significance</i>
<i>low cognitive distance*low PDI distance on low PDI level</i>	-0,084	
<i>low cognitive distance*low UAI distance on low UAI level</i>	-0,068	
<i>low cognitive distance*low MAS distance on low MAS level</i>	0,006	
<i>low cognitive distance*low IDV distance on low IDV level</i>	-0,061	
<i>low cognitive distance*low LTO distance on low LTO level</i>	0,076	*
<i>low cognitive distance*low IVR distance on low IVR level</i>	-0,070	
<i>high cognitive distance*low PDI distance on low PDI level</i>	0,200	
<i>high cognitive distance*low UAI distance on low UAI level</i>	-0,122	
<i>high cognitive distance*low MAS distance on low MAS level</i>	-0,558	
<i>high cognitive distance*low IDV distance on low IDV level</i>	0,297	
<i>high cognitive distance*low LTO distance on low LTO level</i>	0,374	**
<i>high cognitive distance*low IVR distance on low IVR level</i>	0,473	
<i>low social distance*low PDI distance on low PDI level</i>	-0,014	
<i>low social distance*low UAI distance on low UAI level</i>	-0,110	**
<i>low social distance*low MAS distance on low MAS level</i>	-0,080	
<i>low social distance*low IDV distance on low IDV level</i>	0,134	**
<i>low social distance*low LTO distance on low LTO level</i>	-0,060	
<i>low social distance*low IVR distance on low IVR level</i>	0,063	
<i>medium geo distance*low PDI distance on low PDI level</i>	0,147	**
<i>medium geo distance*low UAI distance on low UAI level</i>	0,039	
<i>medium geo distance*low MAS distance on low MAS level</i>	0,152	
<i>medium geo distance*low IDV distance on low IDV level</i>	0,164	***
<i>medium geo distance*low LTO distance on low LTO level</i>	-0,174	***
<i>medium geo distance*low IVR distance on low IVR level</i>	-0,287	**

A4.2: Regression Results for Interaction Terms with Low Cultural Distances on a Medium Level of the Cultural Dimensions

<i>Interaction term</i>	<i>Coefficient</i>	<i>Significance</i>
<i>low cognitive distance*low PDI distance on medium PDI level</i>	0,059	
<i>low cognitive distance*low UAI distance on medium UAI level</i>	0,067	
<i>low cognitive distance*low MAS distance on medium MAS level</i>	0,059	
<i>low cognitive distance*low IDV distance on medium IDV level</i>	0,035	
<i>low cognitive distance*low LTO distance on medium LTO level</i>	-0,051	
<i>low cognitive distance*low IVR distance on medium IVR level</i>	0,027	
<i>high cognitive distance*low PDI distance on medium PDI level</i>	0,099	
<i>high cognitive distance*low UAI distance on medium UAI level</i>	0,121	
<i>high cognitive distance*low MAS distance on medium MAS level</i>	0,170	
<i>high cognitive distance*low IDV distance on medium IDV level</i>	-0,020	
<i>high cognitive distance*low LTO distance on medium LTO level</i>	-0,265	*
<i>high cognitive distance*low IVR distance on medium IVR level</i>	-0,101	
<i>low social distance*low PDI distance on medium PDI level</i>	-0,088	
<i>low social distance*low UAI distance on medium UAI level</i>	0,106	**
<i>low social distance*low MAS distance on medium MAS level</i>	-0,011	
<i>low social distance*low IDV distance on medium IDV level</i>	-0,133	***
<i>low social distance*low LTO distance on medium LTO level</i>	0,026	
<i>low social distance*low IVR distance on medium IVR level</i>	0,071	**
<i>medium geo distance*low PDI distance on medium PDI level</i>	-0,181	***
<i>medium geo distance*low UAI distance on medium UAI level</i>	-0,036	
<i>medium geo distance*low MAS distance on medium MAS level</i>	-0,201	***
<i>medium geo distance*low IDV distance on medium IDV level</i>	-0,147	***
<i>medium geo distance*low LTO distance on medium LTO level</i>	0,159	***
<i>medium geo distance*low IVR distance on medium IVR level</i>	-0,138	***

A4.3: Regression Results for Interaction Terms with Low Cultural Distances on a High Level of the Cultural Dimensions

<i>Interaction term</i>	<i>Coefficient</i>	<i>Significance</i>
<i>low cognitive distance*low PDI distance on high PDI level</i>	0,003	
<i>low cognitive distance*low MAS distance on high MAS level</i>	-0,107	*
<i>low cognitive distance*low IDV distance on high IDV level</i>	-0,195	**
<i>low cognitive distance*low LTO distance on high LTO level</i>	0,042	
<i>low cognitive distance*low IVR distance on high IVR level</i>	-0,032	
<i>high cognitive distance*low PDI distance on high PDI level</i>	-0,137	
<i>high cognitive distance*low MAS distance on high MAS level</i>	-0,151	
<i>high cognitive distance*low IDV distance on high IDV level</i>	0,189	**
<i>high cognitive distance*low LTO distance on high LTO level</i>	-0,769	
<i>high cognitive distance*low IVR distance on high IVR level</i>	0,101	
<i>low social distance*low PDI distance on high PDI level</i>	0,412	***
<i>low social distance*low MAS distance on high MAS level</i>	0,089	
<i>low social distance*low IDV distance on high IDV level</i>	0,069	
<i>low social distance*low LTO distance on high LTO level</i>	0,285	*
<i>low social distance*low IVR distance on high IVR level</i>	-0,093	**
<i>medium geo distance*low PDI distance on high PDI level</i>	0,265	**
<i>medium geo distance*low MAS distance on high MAS level</i>	0,194	***
<i>medium geo distance*low IDV distance on high IDV level</i>	-0,004	
<i>medium geo distance*low LTO distance on high LTO level</i>	-0,070	
<i>medium geo distance*low IVR distance on high IVR level</i>	0,174	***

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Published by
University of Bremen, Faculty of Business Studies & Economics,
Institute for Economic Research and Policy (ierp)
Max-von-Laue-Straße 1, 28359 Bremen, Germany

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Bremen Papers on Economics & Innovation #2103

Responsible Editor: Prof. Dr. Dirk Fornahl

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ISSN 2629-3994

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