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Unleashing Innovative Power
Solving cognitive, social and geographic distance issues with informal institutional proximity

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Abstract Literature nowadays claims that innovation is no longer an only ‘one-organization-show’ but that more and more organizations conduct innovative activities in collaboration. To collaborate successfully, cognitive, social, geographic and institutional distances have to be bridged. Especially interesting is the moderating impact of informal institutions, as being at the basis of every human interaction. However, an extensive investigation is still missing. Therefore, the present research makes a first step in closing this research gap, revealing that informal institutional distances are like a diverse puzzle not to be underestimated, as each of the dimensions has different effects on different forms of distances.

Keywords: research collaboration; informal institutional distance; proximity interactions; patent quality

JEL Codes D91 R11 R12

1 Introduction

Since Boschma (2005) published his concept of proximities/distances[1] (namely cognitive, social, geographic, institutional and organizational distances) and their impact on collective innovation, many scholars have picked up on this topic (e. g. Ponds et al. 2007; Balland 2012; Huber 2012), mostly taking a firm- (e.g. Balland (2012)) or cluster-level (e.g. Letaifa, Rabeau (2013)) perspective. While for cognitive distance most studies agree on an inverted u-shape impact on collaborative outcome, results for the impact of social and geographic distances differ (e. g. Broekel, Boschma 2012; Bercovitz, Feldman 2011; Paier, Scherngell 2011; Werker et al. 2019). Interrelations between the different distances and whether they have been considered, can explain to a certain degree these variations (e. g. Cassi, Plunket 2015; Breschi et al. 2010; Broekel 2015).

Another important factor explaining the diversity of the results might be informal institutional distance, as at the base of every inter-firm collaboration stands a team of human beings, who work together, overcoming their personal and professional distances to achieve a common goal (Crescenzi et al. 2016; Werker et al. 2016). Besides a direct effect, a moderating effect of informal institutional distance on the impact of the other distances can be supposed, as e.g. personal disagreements, not necessarily linked to the job, can lead to failure of common projects (Werker et al. 2016; Brunetta et al. 2020; Kadam et al. 2020). This moderating effect has hardly been investigated, as studies focus on formal institutions (e. g. Ponds et al. 2007; Balland 2012; Werker et al. 2016). Accordingly, the present paper aims to shed light on the (moderating) role of informal institutional distance on team level and how it influences the outcome of inventive collaborations (number of produced high quality patents). Therefore, the paper transfers the national approach of quantitatively measuring informational institutions of Hofstede (2002) to the regional level, using EVS data, while data on the other distances are drawn from PATSTAT. Running three series of negative binomial regressions, the authors are able to show that informal institutional distances indeed have a moderating effect on cognitive, social and geographical distances and that these effects differ between the different informal institutions.

With these results the paper contributes to current literature in several ways. It not only offers a quantitative approximation of regional informal institutions, but proves that informal institutions are not only not to be neglected in collaboration studies but beyond that to be acknowledged as a serious factor, having various facets with differing effects. Additionally,

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

besides the direct effect, the present paper provides empirical evidence for the moderating effect of informal institutional distance on cognitive, social and geographic distance.

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 informal institutions and the interdependencies of distances, leading to the research gap and the hypotheses. 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 Theoretical Framework and Hypotheses

In collaborations cognitive, social, geographic, institutional, cultural and organizational distances on team level have to be bridged, influencing the outcome of the cooperation (e. g. Bercovitz, Feldman 2011; Hoegl, Proserpio 2004; Moaniba et al. 2020; Crescenzi et al. 2016; Crescenzi et al. 2017). Following Bercovitz, Feldman (2011) a team is here defined as a group of single actors, working together for a common scope, as e.g. in the present paper in research collaborations leading to the filing of a patent (the performance indicator of the team is the number of produced high quality patents). Studies investigating effectiveness, performance and innovative outcome of teamwork, often only consider (composite) indicators for team diversity or examine only some of the distances as influencing factors, ignoring hence possible interdependencies with other distances (e. g. Bunderson, Sutcliffe 2002; Barjak, Robinson 2008; Lungeanu et al. 2014; Brunetta et al. 2020; Dornbusch, Neuhäusler 2015; Moaniba et al. 2020).

2.1 Distances and Inventive Outcome on Team Level

Following the distances concept Boschma (2005) presented, there are five different distances to be distinguished, namely cognitive, social, geographic, institutional and organizational distance. Cognitive distance 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; Boschma, Lambooy 1999). At the same time, some distance is needed to make new knowledge combinations possible (Nooteboom 2000). Accordingly, most empirics on team level propose a medium cognitive distance for fruitful collaboration, as the distance should never be so big that the added value cannot compensate for the additional costs of

coordination or that there is no common technical language to allow professional communication (Werker et al. 2016; Huber 2012; Huo et al. 2019).

> **H1** Cognitive distance in a research collaboration has an inverted u-shape impact on the number of produced high quality patents.

With social distance the focus is already more on the individual level, describing the social embeddedness of interactions between actors. 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 behaviour (Boschma 2005; Uzzi 1997). However, while theory recommends a medium distance for collaboration (Boschma 2005; Balland et al. 2014; Broekel, Boschma 2012; Fitjar et al. 2016), results of empirical works investigating team-level distance are not so clear. Werker et al. (2016) only see an indirect effect of social proximity on collaborations, while others find repeated interaction (which is the proxy for social proximity in the present paper) to have a negative impact on the quality of the output (Huo et al. 2019; Crescenzi et al. 2017; Beaudry, Schiffauerova 2011).

> **H2** Social distance in a research collaboration has a positive impact on the number of produced high quality patents.

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). Studies, investigating the impact of geographic distance on team level draw a fuzzy picture. On the one hand, Moaniba et al. (2020) find positive effects of geographic distance on firm profitability as well as Heringa et al. (2014), who find positive effects on success of the collaboration in general. Moreover, studies underline the importance of international partners for successful patenting (e. g. Letaifa, Rabeau 2013; Weterings, Ponds 2009; Bathelt et al. 2004; Fitjar et al. 2016). On the other hand, Cunningham, Werker (2012), Dornbusch, Neuhäusler (2015) and Crescenzi et al. (2017) find a positive effect of geographic proximity on collaborative outcome.

> **H3** Geographic distance in a research collaboration has a u-shape impact on the number of produced high quality patents.

Boschma (2005) defines organizational distance as the degree of organizational arrangements between independent actors. Low organizational distance reveals itself in strong ties and a

rather hierarchically organized relationships while high organizational distance signifies hence that partners are rather independent (Boschma 2005). In the present paper, informal institutional distance is proxied with the help of the six Hofstede dimensions, one of which is Power Distance (Hofstede 2002). As this dimension is similar to the organizational distance Boschma (2005) describes (Hofstede (2002) defines Power Distance as a dimension reaching from an hierarchical to a democratic organizational setting), organizational distance will not be investigated separately but as part of informal institutions. Similarly, Heringa et al. (2014) treat and investigate institutional distance as part of organizational distance.

Finally, institutional distance describes how partners differ due to their formal and informal institutions, the first one consisting of rules and laws while the latter one includes routines and habits (Edquist, Johnson 1997; Boschma 2005). Relations having a high institutional distance might be at a higher risk of opportunistic behaviour, 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, as most empirical studies proxy institutional distance with aspects only covering formal institutions (e. g. Ponds et al. 2007; Balland 2012; Werker et al. 2016). Ponds et al. (2007) for example proxy institutional distance with dummies for partners being companies, research institutes or universities, Balland (2012) takes these three and adds public as a fourth entity, while Broekel (2015) defines the four categories firms, universities, extramural research organization and miscellaneous. Even Slavtchev (2013), while defining institutional proximity as common values and norms, measures this solely with geographic proximity and hence misses an extensive and thorough investigation of informal institutions.

In the present paper informal institutional distance is defined as the differences of partners in each score for the six Hofstede dimensions, namely Power Distance, Uncertainty Avoidance, Indulgence, Masculinity, Individualism and Long-term Orientation on regional level (Hofstede 2002). Most studies investigating these dimensions create an aggregate indicator (following e.g. the composed indicator, named ‘cultural distance’ proposed by Kogut and Singh (1988)[2]), based on national values (hence, all the people/firms from the same country have zero cultural distance) and not always consider all dimensions (e. g. Elia et al. 2019; Moaniba et al. 2020). This however contradicts Boschma (2005), who states that formal institutions rather work on national level, while informal ones primarily excerpt power on regional level and with this renders invalid every empirical investigation of institutional distance on regional level, which is proxied by formal characteristics. Results of the before-mentioned studies find that cultural distance in collaborations has a negative effect on firm profitability (Moaniba et al. 2020) and on team performance and with this on innovation (Kadam et al. 2020). Elia et al. (2019) find a

[2] See for example Beugelsdijk et al. 2018 or Pothukuchi et al. 2002.

negative effect, if collaborations have an exploitative character, and a positive effect, if collaborations focus on explorative contents.

Power Distance is defined as the distribution of power. Low Power Distance is characterized by a democratic organizational setting while high Power Distance signifies rather steep hierarchies. The dimension of Uncertainty Avoidance describes the degree to which people cope easily with uncertain situations, not being afraid of possible difficulties (low Uncertainty Avoidance as opposed to high Uncertainty Avoidance). Indulgence versus Restraint represents on the one end a society emphasizing freedom and happiness (Indulgence) and on the other side a community striving for thrift and strict discipline. Groups scoring high for Masculinity seek challenge and success, while the opposite side of Femininity (low Masculinity) strengthens more collaborative and harmonic aspects. Individualistic (versus collectivistic) societies show a strong self-orientation and put tasks before people. Finally, 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; Hofstede et al. 2010).

Empirically, there are only some studies investigating these dimensions and their implications for collaborations separately and they are only on firm level (Hofstede 1989; Barkema, Vermeulen 1997; Barkema et al. 1998; Malik, Zhao 2013). These studies show, that being different due to Power Distance shortens the duration of international alliances (Malik, Zhao 2013), while others do not find an influence of differences for this dimension on the operation of international collaborations (Barkema, Vermeulen 1997; Barkema et al. 1998). For distance in Uncertainty Avoidance, Hofstede (1989) argued that it is among the most difficult distances to be bridged in multinational corporations, as the attitudes connected to this dimension stem from deep psychological necessities. Barkema, Vermeulen (1997) and (Barkema et al. 1998) found empirical evidence for the harmfulness of distance in Uncertainty Avoidance for international joint ventures and their survival. While Hofstede (1989) reasons that differences in Masculinity in international corporations can be rather an advantage, as both, the care for the relationship as well as performance are important, Barkema, Vermeulen (1997) found empirical evidence that it has a negative impact on the survival of international joint ventures. However, this effect is smaller than the one observed for distance in Uncertainty Avoidance. Differences in Individualism are seen as problematic as they directly influence the kind of relationship (Hofstede 1989). Still, studies investigating this distance in international joint ventures found no significant influence on the survival of this cooperation (Barkema, Vermeulen 1997). Nevertheless, empirics show, that this dimension influences directly the attitude towards collaboration. For instance, entrepreneurs in more individualistic societies are generally more sceptical about collaborative strategies and e.g. ask for clear set rules, which is opposed to the more casual attitude of entrepreneurs from collectivist societies (Steensma

et al. 2000). Barkema, Vermeulen (1997) found evidence that distance in Long-term Orientation negatively influences the survival of international joint ventures, having besides Uncertainty Avoidance the strongest effect. Finally, for Indulgence, to the best of the authors' knowledge, there are no empirical studies on distances in this dimension and its impact on collaboration and collaborative outcome.

Taking into consideration, that theoretical and empirical studies find that distances in these dimensions are rather harmful for the survival and duration of collaborations and high quality outcomes of collaborations are based on a successful collaboration, the following general hypothesis is set:

> **H4** Distances in all six informal institutional dimensions in a research collaboration have each a negative impact on the number of produced high quality patents.

2.2 Interdependencies of Distances

Already Boschma (2005) states theoretically that there are interdependencies of the different proximities/distances. He names organizational and cognitive proximities to be complements, as taking appropriate organizational measures help fostering cognitive proximity. Geographic proximity can have a similar effect here, being a sufficient condition for actors to start interaction. Moreover, he names institutional distance as being strongly linked to all other dimensions. Menzel (2015) theorizes that for the exchange of complex knowledge, temporarily spatial proximity can bridge cognitive distance, while spatial distance can be bridged by cognitive proximity, as it facilitates communication. Moreover, distances change each other. E.g. social proximity can lead to a diminishing cognitive distance in the long run, while geographic proximity might foster social proximity (Boschma 2005).

Several scholars have investigated the interdependencies of distances empirically. However, many of them only take some of the five distances into consideration, which might lead to misinterpretations as in this way effects cannot be attributed for certain to one kind of distance (Broekel 2015).[3] Moreover, paper mostly investigate complementation and substitution effects for the sheer diffusion or exchange of knowledge, hence on whether or not a collaboration takes place (e. g. Hong, Su 2013; Agrawal et al. 2006; Cassi, Plunket 2015; Crescenzi et al. 2017). Empirics, exploring how team-level distances moderate each other's impact on collaborative outcome are very scarce, selective and superficial. Moaniba et al. (2020) find evidence, that the impact of geographic distance on firm profitability can be positively

[3] As the number of empirical results on interdependencies of distances is limited, studies not investigating all distances will still be considered in the following.

moderated by inter-country collaborations (which other studies use as proxy for cultural distance as shown above). Heringa et al. (2014) investigate interactions between geographic, social, organizational and cognitive proximities on tangible (such as whether innovations or publications have been produced) and intangible outcomes (e.g. support for ideas). When controlling each time for the other three proximities, they find that the negative effect of geographic proximity on tangible becomes weaker and less significant; the positive impact of social proximity for all forms of outcomes becomes on average stronger but less significant; for organizational proximity the negative impact becomes stronger for all sorts of outcome; and the positive impact of cognitive proximity becomes stronger for all outcome forms. Dornbusch and Neuhäusler (2015) find that the negative impact of geographic distance on the innovative performance of a team does not hold, if academic partners or large firms are included (organizational background).

However, on team level, informal institutional distance and its interdependencies with other distances is especially interesting, due to its character, being at the very basis of every human interaction (Hofstede et al. 2010). To the best of the authors' knowledge, this has not been investigated empirically yet. Creating codes of behaviour and establishing common values stands at every beginning of group formation, based on and formed by the informal institutional prerequisites every member brings along. Hence, it influences every group work and its outcome, irrespective of whether the goal is technological, economic, biological or medical (Hofstede et al. 2010). As informal institutional distance alone is not sufficient to drive (high quality) innovation, it can rather be seen as a moderator, altering the influence of the other distances (Boschma 2005; Crescenzi et al. 2016). For example rather qualitative studies on more aggregate levels find that ethnical or cultural proximity facilitates the exchange of tacit and codified knowledge over geographic distance (Täube 2005; Kerr 2008). Hence, the following hypotheses are derived, predicting a moderating influence of the five informal institutions on cognitive, social and geographic distance (H1a, H2a, H3a), easing negative impacts on innovative outcome. In a further step, it will be distinguished, whether not only the proximity in each informal institution is beneficial, but whether it is more favourable if all partners have a rather high, medium or low score in the according dimension (e.g. having a rather Long-term or Short-term Orientation) (H1b, H1c, H2b, H3b).

Cognitive Distance

> **H1a** The negative impact of a lower or higher than optimal cognitive distance in a research collaboration on the number of produced high quality patents can be reduced through informal institutional proximities.
>
> **H1b** The negative impact of a lower than optimal cognitive distance in a research collaboration on the number of produced high quality patents can be reduced by

informal institutional proximity with on average high Power Distance, low Uncertainty Avoidance, high Indulgence, high Masculinity, low Individualism and high Long-term Orientation.

H1c The negative impact of a higher than optimal cognitive distance in a research collaboration on the number of produced high quality patents can be reduced by informal institutional proximity with on average high Power Distance, low Uncertainty Avoidance, high Indulgence, high Masculinity, low Individualism and medium Long-term Orientation.

Social Distance

H2a The negative impact of low social distance in a research collaboration on the number of high quality patents can be reduced through informal institutional proximities.

H2b The negative impact of a low social distance in a research collaboration on the number of produced high quality patents can be reduced by informal institutional proximity with on average high Power Distance, high Uncertainty Avoidance, low Indulgence, low Masculinity, low Individualism and medium Long-term Orientation.

Geographic Distance

H3a The negative impact of medium geographic distance in a research collaboration on the number of produced high quality patents can be reduced through informal institutional proximities.

H3b The negative impact of a medium geographic distance in a research collaboration on the number of produced high quality patents can be reduced by informal institutional proximity with on average high Power Distance, low Uncertainty Avoidance, low Indulgence, high Masculinity, low Individualism and medium Long-term Orientation.

3 Data and Methodology

3.1 Variables and Descriptives

The present analysis investigates the impact of different distances in research collaborations on the quality of co-patents in 15 European countries. Based on the distances between each inventor of a team, group averages are calculated, while placing an emphasize on the moderating effect of informal institutional 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 countries between 2007 and 2009. The time period and countries have been chosen due to the data availability for informal institutional distances which is available on regional level for the year 2008 for 15 European countries (see section below for list). All variables but those for informal institutional distances 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.

Dependent Variable

The dependant variable for patent quality 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 high quality patents. The variable has a range from zero to 237 with a mean of 3.3 (see Figure 1).

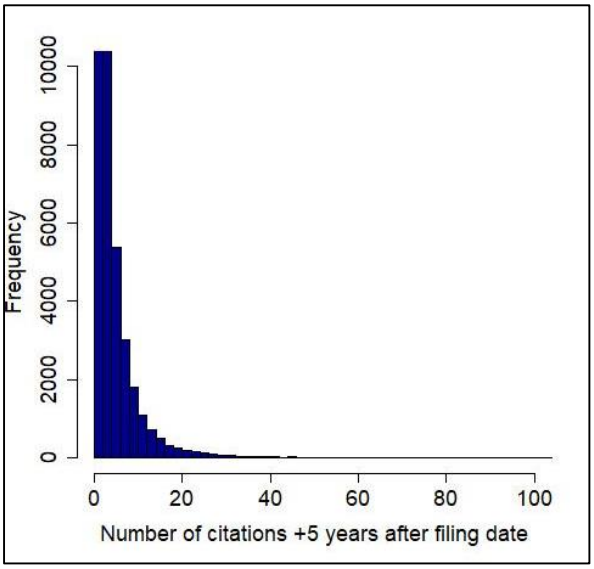

Figure 1 Pooled distribution of number of forward citations (corrected for self citations), five years after filing-date (own representation).

Independent Variables

Cognitive Distance

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

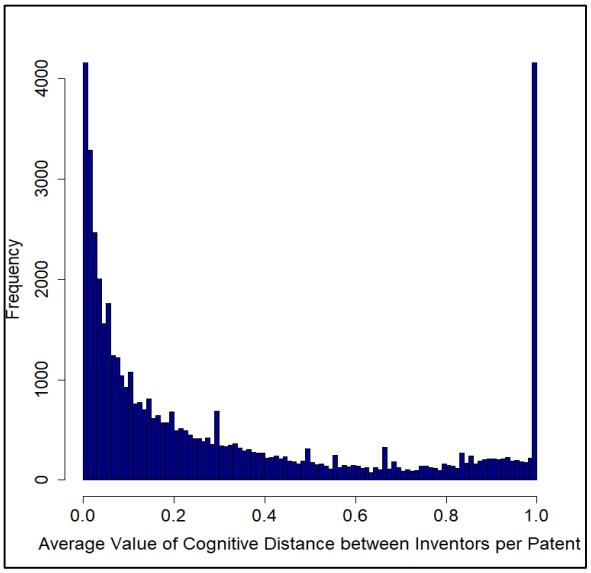

Figure 2 Pooled distribution of frequency of average cognitive distance (own representation).

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 (see Figure 2).

Social Distance

The variable for social distance has been constructed following previous works with minor adaptions due to the present research focus (e. g. Broekel 2015; Hong, Su 2013; Balland et al. 2013; Ahuja et al. 2009). 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 (see Figure 3).

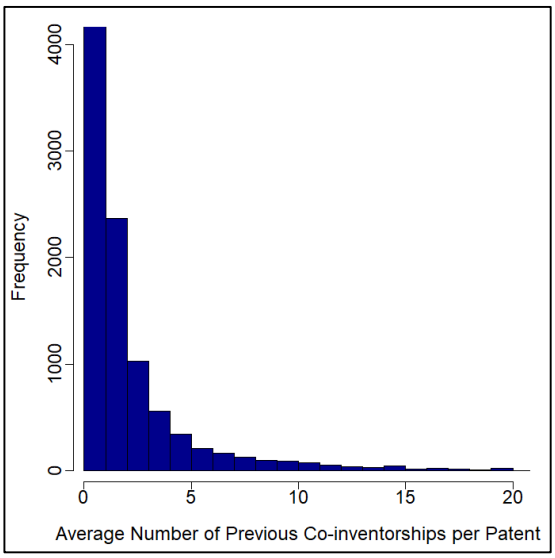

Figure 3 Pooled distribution of frequency of average social distance (own representation).

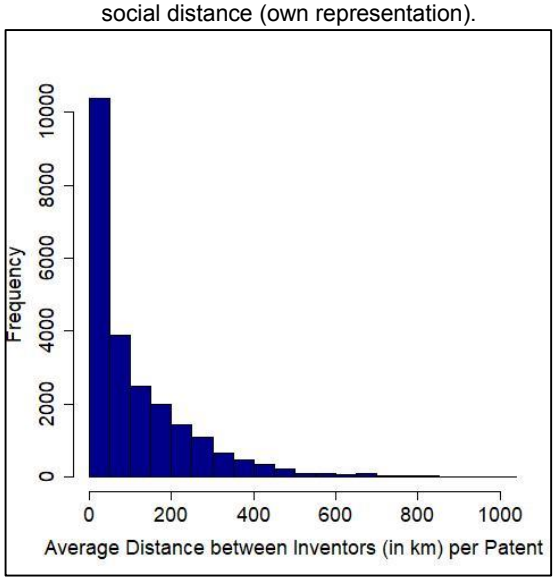

Figure 4 Pooled distribution of frequency of average geographic distance (own representation).

Geographic Distance

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 (see Figure 4).

Informal Institutional Distances

Informal institutional distance is investigated with the help of six different indices. 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). 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). 29 regions were excluded, as they had less than 20 observations, leaving 174 Nuts-2-regions for computation. Based on 18 variables from the EVS and applying confirmative factor analysis, for each region average 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 informal institutional distances were calculated. In the next step, like for the other distance variables, group averages were determined (see Figure 5).

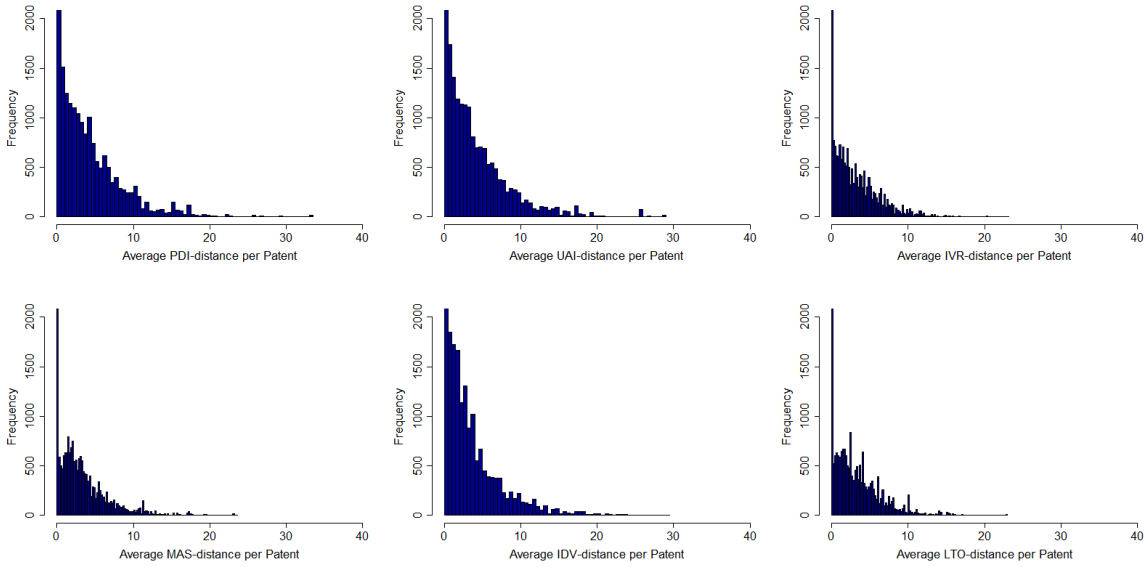

Figure 5 Pooled distribution of frequency of average informal institutional distances (PDI – Power Distance Index, UAI – Uncertainty Avoidance Index, IVR – Indulgence versus Restraint, MAS – Masculinity versus Femininity, IDV – Individualism versus Collectivism, LTO – long- versus short-term Orientation (own representation).

To generate clear results, all distances were categorized[4], generating for each but social distance three categories: low, medium and high.[5] For social distance just two categories (low and high) were built, separating partners who know each other from at least one collaboration (low distance) from those that never worked together (high distance). However, as the aim of this paper is to test, whether low informal institutional distance can improve those situations, where cognitive, social and geographic distances have a negative impact, only the respective dummies were included (see Table 1).

Table 1 Categories 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] For further insight, see Appendix 3. 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)	*Power Distance Distance*	A	lower 15% of distances		
	Uncertainty Avoidance Distance	B			
	Indulgence Distance	C			
	Masculinity Distance	D			
	Individualism Distance	E			
	Long-term Orientation Distance	F			

In simple terms, an inventor pair P consisting of inventor X and inventor Y could have a low, medium or high distance on e.g. Individualism. Having a high distance would signify that one

[4] To validate this approach, the basic regressions (regression 1-6, see Appendix 2) were calculated as well with categorical variables for the informal institutional distances, not changing the output significantly.

[5] The thresholds of 15%-margins were chosen as they were the most extreme thresholds still having enough observations (see Appendix 3).

[6] Main dataset: Robustness checks with 10%- and 20%-margins led in most cases to results with the same significance, while those with 25%-margins led more often to results with less than with similar significance. Interaction terms that changed sign in any robustness checks were excluded from all analysis.

[7] As additional robustness checks, the dummies of cognitive distance, social distance and geographic distance were interacted with the dummies for medium informal institutional distances and finally with those for high informal institutional distances. In all cases, interaction with medium informal institutional distances have the opposite significant effects of the interactions with low informal institutional distances. Interactions with high informal institutional distances have only one significant effect.

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 has a low distance in Individualism, 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 informal institutional distances are included. If a team consists of more than two inventors, the average of all possible pairs is calculated.

Table 2 Value Differences for Informal Institutions.[8] (The capital letters A-F connect this Table to Table 1. Applied thresholds are displayed.) (Own representation).

A. Low Power Distance Distance

<= 15%		>= 85%
Low Value	*Medium Value*	*High Value*
Low Power Distance	Medium Power Distance	High Power Distance

B. Low Uncertainty Avoidance Distance

<= 15%		>= 85%
Low Value	*Medium Value*	*High Value*
Low Uncertainty Avoidance	Medium Uncertainty Avoidance	High Uncertainty Avoidance

C. Low Indulgence Distance

<= 15%		>= 85%
Restraint	between Restraint and Indulgence	Indulgence

D. Low Masculinity Distance

<= 15%		>= 85%
Femininity	between Femininity and Masculinity	Masculinity

E. Low Individualism Distance

<= 15%		>= 85%
Low Value	*Medium Value*	*High Value*
Collectivism	between Collectivism and Individua-lism	Individua-lism

F. Low Long-term Orientation Distance

<= 15%		>= 85%
Low Value	*Medium Value*	*High Value*
Short-term Orientation	Medium-term Orientation	Long-term Orientation

However, these indices of informal institutional distances are able to give even more insights on 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 introduced. Dummy

[8] Similar as for the main dataset, robustness checks were conducted for the subset: Robustness checks with 10%-margins of the subset led in ten cases to less significant results, in seven cases to results with the same significance and only in one case to a result with more significance. Robustness checks with 20%- and 25%-margins of the subset led in 18 cases to less significant results, in eleven cases to the same significance and in six cases to more significance. Interaction terms that changed sign in any robustness checks were excluded from all analysis.

Lowlow (for Individualism) signifies that inventor X and Y are not only similar but that they have both a low value for Individualism (<=15%) and are hence both rather collectivistic oriented. The second dummy Lowmed (for Individualism) indicates that inventor X and Y are not only similar but have both a medium value for Individualism (>15% to <85%), signifying they have both something between a collectivistic and individualistic attitude. Finally, dummy Lowhigh (for Individualism) means that inventor X and Y are not only similar but that they have both a high value for Individualism (>=85%) and are consequently 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.

Control Variables

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; Beaudry, Schiffauerova 2011; Crescenzi et al. 2017; Sonmez 2018). The variable Family_size (II) accounts for the number of patents applied in the same patent family and is the only variable that has been taken directly from PATSTAT (2017), without further elaborations. It accounts for the value of a patent (e. g. Harhoff et al. 2003) and its efforts to protect it (e. g. Lanjouw et al. 1998; Moaniba et al. 2020). The variable Team_size (III) counts the number of inventors of a team. 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 as e.g. less promising ideas are sorted out earlier (e. g. Beaudry, Schiffauerova 2011; Singh, Fleming 2010; Sonmez 2018) 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. Cunningham, Werker 2012; 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]

Table 3 Basic information on control variables (own representation).

Variable	*Minimum*	*Maximum*	*Mean*	*Mode*
I. Group average of patent stock	1	285.5	8.1	1
II. Family_size	1	134	6	4
III. Team_size	2	87	4.2	2
IV. Number_Orgas	0	66	1.2	1
V. Number_of_countries_Orgas	0	8	1.1	1
VI. Number_of_patents_2007_2009 _group_sum_ohne_inv	0	488,149	31,027	189,741

3.2 Model Specification

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

To test H1, H2, H3 and H4, the first series of regression models are calculated, testing the direct impact of the distances on the number of produced high quality patents (see Appendix 2 for detailed regression results). In a second version of the model, H1a, H2a and H3a are tested, analysing whether low informal institutional distances diminish the negative impacts of the other distances, applying the dummies displayed in Table 1.

In a third series of models, H1b, H1c, H2b and H3b are tested, accounting for whether low informal institutional distance is rather benefitting on a very high, medium or low value level of the six informal institutions (again dummies were constructed as shown in Table 2 and described above). For this purpose, a subsample is created, only including those patents, that have for all six informal institutions a low value (low_dummy = 1), reducing the observations to 48,851. To prevent multicollinearity, the dummies of cognitive, social and geographic distance were first interacted with the dummies for low informal institutional distance at a low informal institutional level, in a second step with the dummies for low informal institutional distance at a medium informal institutional level and in a third step with low informal institutional distance on a high informal institutional level. Hence, for each step 24 models (six informal institutions dummies * four dummies (high cognitive, low cognitive, low social, medium geographic)), each including one interaction term, were calculated.[10]

[9] In Appendix 1 the correlation table of all included variables is presented, showing that none of them correlates stronger than a value of 0.48 (for informal institutions among each other 0.72, which is in line with earlier publications (Kaasa, Vadi 2010; Kaasa 2016)).

[10] Appendix 5.1 – 5.3 show for each step one regression output example, as well as a table with all coefficients and p-values for the interaction terms.

4 Results and Discussion

Appendix 2 shows the regression results of model one to six, testing for the direct impact of the different distances on the number of produced high quality patents. As proposed in H1, results show that cognitive distance has an inverted u-shape impact, signifying that a medium cognitive distance is best for generating a higher number of high quality patents. This is in line with previous studies, showing that some distance is beneficial to develop new ideas while not being too different helps to benefit mostly from each other's knowledge (e. g. Werker et al. 2016). For social distance, a positive impact on the number of produced high quality patents has been suggested (H2), which is supported by the present empirical results. Having new (and hence socially more distant) partners, might thus be beneficial, e.g. to enter new networks, and with this increase the value of the created outcome (e. g. Crescenzi et al. 2017; Balland et al. 2014). Staying as well in line with former empirical evidence, model four shows weak but significant results for geographic distance having a u-shape impact on the number of produced high quality patents (H3 is hence supported). This implies, that either being spatially very close or very distant, influences positively the number of produced high quality patents. For low geographic distance the underlying mechanism is connected to the concept of local buzz, assuming that colocation not only renders personal interaction easier but helps to profit from regional knowledge spillovers by just being there. The positive effect of high geographic distance draws on the importance of international partners, bringing new stimuli into teams and hence improving the collaborative output (e. g. Dornbusch, Neuhäusler 2015; Moaniba et al. 2020; Bathelt et al. 2004; Broekel, Boschma 2012; Fitjar et al. 2016). For informal institutional distances, five out of six have a negative coefficient (except Individualism, which is however not significant), of which three (Uncertainty Avoidance, Masculinity and Long-term Orientation) are highly significant, while Power Distance is not significant (hence, H4 is partly supported). This implies, that especially differences in the attitudes towards risk-taking, the evaluation whether success or the relationship is more important and the targeted time horizon in which results are expected, reduces the number of produced high quality patents. This is in line with literature, claiming that differences for Uncertainty Avoidance and Long-term Orientation are the most difficult ones to be bridged and differences in all three influence negatively the duration and survival of collaborations (Hofstede 1989; Barkema, Vermeulen 1997).

As far as the included control variables are concerned, all have highly significant and positive coefficients, which does not change in the following regression series. 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. Singh 2008; Sonmez 2018; Briggs 2015).

The second series of the regression model (Appendix 4) tests, whether low informal institutional distances moderate the negative effects of low/high cognitive distance, low social distance and medium geographic distance. Appendix 5 presents the third regression series, which test more in detail the impact of low informal institutional distance, splitting it up, whether it occurs on low, medium or high level of the respective dimension (see Table 2). The results of these two series are presented and discussed together, first for cognitive distance, then for social distance and finally for geographic distance.

For low cognitive distance, the interaction terms with all low informal institution distances have a positive and (very) significant effect. These results indicate that the negative impact of a too low cognitive distance on the number of produced high quality patents, is reinforced (becomes more negative) by proximity in all informal institutions (see Appendix 4) (accordingly, for a lower than optimal cognitive distance, H1a has to be rejected). At this point, it is still interesting to have a further look into low informal institutional distances, as this can occur at a low, medium or high value level (Appendix 5.1, 5.2, 5.3; see Table 4). Having a low informal institutional distance, while not being afraid of unknown situations (low value for Uncertainty Avoidance), lessens the negative impact of a too low cognitive distance on the number of produced high quality patents (negative and strongly significant interaction term). However, already having a low informal institutional distance with a little aversion to risky circumstances (medium value for Uncertainty Avoidance), turns this effect into a positive one, hence reinforcing the negative impact of cognitive proximity. This is straightforward, as the difficulty with cognitive proximity is that the knowledge bases are too close and hence it is important to engage as well in unfamiliar projects with a more unpredictable outcome. These results support parts of H1b.

> One form of informal institutional proximity compensates for a too low cognitive distance: Being open to unknown and risky projects reduces the negative impact of partners having too similar knowledge bases.

For high cognitive distance, the interaction with low Indulgence distance has a negative and significant effect (Appendix 4). This suggests, that being on the same page as far as the attitude towards the balance between freedom at work and strict discipline is concerned, reduces the negative impact of being cognitively too distant on the number of produced high quality patents. Hence, for the part of high cognitive distance, there is some evidence to approve H1a. Taking a more detailed look into low informal institutional distances and differentiating between the different values of the dimensions, additionally, some moderating effects can be observed (Appendix 5.1, 5.2, 5.3; see Table 4. It is shown that being neither too

long- nor too short-term oriented (medium Long-term Orientation value) lessens the negative impact of a too high cognitive distance, while being very short-term oriented (low value for Long-term Orientation) reinforces the effect. Hence, when bringing together very different technological backgrounds, it is important to not expect results too quickly as partners need some time to understand each other (technologically) and work together efficiently. Accordingly, there is some evidence for H1c.

> One form of informal institutional proximity compensates for a too high cognitive distance: Targeting a medium time horizon for results of the joint work reduces the negative impact of partners having too different knowledge bases.

Looking into the negative impact of low social distance, the interaction terms with low distance in Uncertainty Avoidance, Indulgence, Individualism and Long-term Orientation are negative and (very) significant (Appendix 4). This implies, that the negative impact of too close social ties on the number of produced high quality patents can be reduced by proximity in informal institutional distances (supporting H2a). The behind lying mechanism could be that the negative impact of social proximity stems from the risk of opportunistic behaviour, which again might be absent, if partners have similar informal institutional backgrounds.

Investigating more in detail the effects of low informal institutional distances, some interesting aspects are revealed (Appendix 5.1, 5.2, 5.3; see Table 4). If partners are rather comfortable with unknown situations (low value for Uncertainty Avoidance) the negative impact of social proximity is reduced. Already having an on average medium aversion against unknown situations (medium value for 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 increase the amount high quality output. If both partners are neither too individualistic nor too collectivistic (medium value for Individualism), the negative effect on the number of produced high quality patents is reduced, while focusing too much on the group (low value for Individualism) reinforces the negative effect (contradiction to H2b). 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 (high value for Long-term Orientation) and preferring hierarchical structures (high value for Power Distance) (contradiction to H2b). Hence, 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.

Some forms of informal institutional proximity compensate for a too low social distance: Being open to unknown situations and cherishing the group as well as the individual reduces the negative impact of partners having worked together many times.

The interaction terms of medium geographic distance with low informal institutional distances have all negative and very significant coefficients (Appendix 4). This implies that the negative impact of medium geographic distance on the number of produced high quality patents can be reduced through informal institutional proximities, confirming H3a. Hence, informal institutional 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.

Looking more in detail into low informal institutional distances at different value levels however, draws a more diverse picture (Appendix 5.1, 5.2, 5.3, see Table 4). Low informal institutional distance at a low level of Long-term Orientation lessens the negative impact of medium geographic distance, while already a medium level of Long-term Orientation reinforces the effect (partly rejection of H3b). Thus, 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. Moreover, low informal institutional distance at a low level of Indulgence lessens as well the negative impact of medium geographic distance, as opposed to a high level of Indulgence (partly support for H3b). 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. Additionally, low informal institutional distance at a medium level of Power Distance lessens the negative impact of medium geographic distance, implying that some hierarchical structure has to be established to guarantee the functioning of team work over some geographic distance. In the same direction points the result that low informal institutional distance at a high level of Masculinity reinforces the negative impact of medium geographic distance. 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 the number of produced high quality patents (partly contradiction to H3b). Finally, low informal institutional distance at a medium level of Individualism lessens the negative effect of medium geographic distance, while a low value for Individualism reinforces it (contradiction to H3b). These results clearly show, that at some geographic distance you have to strongly focus on the group, as already slight individualistic tendencies can e.g. lead to distrust among team members and hence undermine the common goal of producing outstanding results.

Some forms of informal institutional proximity compensate for having neither the advantages that stem from geographically distant partners nor those from geographically close partners: Being rather short-term oriented, taking rules very seriously, having an eye on the group as well as on the individual and organizing the team in e.g. a flat hierarchical system reduces the negative impact of partners located at medium geographic distance.

Table 4 How the negative impact of low cognitive, high cognitive, low social and medium geographic distance on the number of produced high quality patents is moderated by low informal institutional distances. (Examples: The negative impact of low cognitive distance on the number of produced high quality patents is reinforced, if there is low distance in Uncertainty Avoidance. However, when this low Uncertainty Avoidance distance occurs on a low value level, the negative impact of low cognitive distance is reduced (less negative).) Only significant results are represented. (Ø = on average, L = low values, M = medium values, H = high values) (Own representation).

				Low Cognitive Distance	*High Cognitive Distance*	*Low Social Distance*	*Medium Geographic Distance*
	Direct Effect			-	-	-	-
Change of Effect through interaction with	*Low Power Distance Distance*	value	Ø	**reinforces**			**lessens**
			L				
			M				lessens
			H			reinforces	
	Low Uncertainty Avoidance Distance	value	Ø	**reinforces**		**lessens**	**lessens**
			L	lessens		lessens	
			M	reinforces		reinforces	
			H				
	Low Indulgence Distance	value	Ø	**reinforces**	**lessens**	**lessens**	**lessens**
			L				lessens
			M				
			H				reinforces
	Low Masculinity Distance	value	Ø	**reinforces**			**lessens**
			L				
			M				
			H				reinforces
	Low Individua-lism Distance	value	Ø	**reinforces**		**lessens**	**lessens**
			L			reinforces	reinforces
			M			lessens	lessens
			H				
	Low Long-term Orientation Distance	value	Ø	**reinforces**		**lessens**	**lessens**
			L		reinforces		lessens
			M		lessens		reinforces
			H			reinforces	

Summing it up, without considering value levels, proximity in nearly all informal institutions lessens the negative impact of medium geographic distance and low social distance on the number of produced high quality patents. The negative impact of high cognitive distance can only be reduced by proximity in Indulgence. In comparison, proximity in in all informal

institutions reinforces the negative impact of low cognitive distance on the number of produced high quality patents. Considering as well value levels, it can be stated that in a team that is open for new options (low Uncertainty Avoidance) and supports the individual as well as the group (medium Individualism) the negative impacts of other distances (low cognitive, low social and medium geographic distances) can be reduced. However, a strong focus on the group reinforces it (low individualism).

5 Concluding Remarks

The present paper discusses whether proximity in informal institutions can help to reduce the negative impacts of too low or too high cognitive distance, low social distance and medium geographic distance on the number of produced high quality patents. Empirical results reveal some interesting insights, especially as the (moderating) impact of informal institutional distances has been widely neglected in literature. First of all, the results confirm the proposition that there is not one informal institution but that it has several layers which have differing or even opposing effects. It is shown, 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 informal institutional proximities. The more detailed and differentiated analysis of informal institutional proximities reveals even more insights. The six used dimensions of informal institutions have all two extremes, standing for opposing attitudes. Depending on the distance (cognitive, social, geographic) they are interacted with, the same attitude can have different influences as for the example of low Long-term Orientation, signifying an emphasizes of short-term goals. In the case of high cognitive distance, it reinforces the negative impact, while it lessens it for medium geographic distance. Moreover, the dimension of Indulgence has hardly been investigated empirically yet, which makes results for this dimension even more interesting.

Beyond these new empirical insights, the present study contributes in several ways to current literature. Starting from the fact that still most studies on informal institutions are based on qualitative data, this paper shows that quantitative analysis can give additional insights. 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). Finally, in studies investigating the interactions of distances/proximities, informal institutions 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 informal institutional data leads to some restriction of the explanatory depths of the results, as they are calculated on regional level instead of team level as all the other variables. Hence, further analysis, including individual

level data is needed to elaborate more on the influence of informal institutional 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 time slot. These dynamic interactions have already been proved empirically by Broekel (2015), however not going in detail into different aspects of informal institutional distances.

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Appendix 1: Correlation Table of all Variables

Variable	Description	Equivalent in correlation Table
Cited_in_five_years_without_selfcites	Patent Quality	A
Cog_dis_group	Cognitive Distance (group average)	B
Soc_dis_group	Social Distance (group average)	C
Geo_dis_group_km	Geographic Distance (group average)	D
PDI_reg_dis_group	Distance on Power Distance (group average)	E
UAI_reg_dis_group	Distance on Uncertainty Avoidance (group average)	F
IVR_reg_dis_group	Distance on Indulgence (group average)	G
MAS_reg_dis_group	Distance on Masculinity (group average)	H
IDV_reg_dis_group	Distance on Individualism (group average)	I
LTO_reg_dis_group	Distance on Long-term Orientation (group average)	J
Average_Pat_Stock	Number of patents the inventors can be associated with in the years 2005 – 2009 (group average)	K
Family_size	Number of patents applied in the same patent family (group average)	L
Team_size	Number of inventors on a patent	M
Number_Orgas	Number of applicants on a patent	N
Number_of_countries_Orgas	Number of different countries of the applicants on a patent	O
Number_of_patents_2007_2009_group_ohne_inv	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	P

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	-0.03***	0.10***	-0.03***	0.46***	1.00											
F	-0.04***	0.08***	-0.03***	0.39***	0.53***	1.00										
G	-0.03***	0.11***	-0.03***	0.43***	0.64***	0.57***	1.00									
H	-0.04***	0.10***	-0.02***	0.48***	0.61***	0.54***	0.57***	1.00								
I	-0.03***	0.11***	-0.03***	0.41***	0.63***	0.72***	0.62***	0.57***	1.00							
J	-0.04***	0.12***	-0.02***	0.41***	0.58***	0.57***	0.65***	0.65***	0.59***	1.00						
K	0.12***	0.12***	0.54***	-0.01***	0.02***	0.01*	0.01**	0.03***	0.01***	0.04***	1.00					
L	0.16***	-0.11***	0.03***	-0.03***	-0.05***	-0.05***	-0.05***	-0.04***	-0.06***	-0.04***	0.04***	1.00				
M	0.08***	-0.02***	-0.04***	0.06***	0.06***	0.04***	0.06***	0.07***	0.04***	0.07***	0.03***	0.38***	1.00			
N	0.02***	-0.02***	-0.01**	0.03***	0.02***	0.01**	0.02***	0.01**	0.01**	0.01**	0.01*	-0.11***	0.02***	1.00		
O	0.06***	-0.05***	0.00	0.01**	-0.01	-0.00	0.00	-0.00	-0.00	-0.01*	0.02***	0.16***	0.07***	0.07***	1.00	
P	0.02***	0.07***	0.03***	0.01*	0.05***	0.00	0.02***	0.03***	-0.00	0.01***	0.14***	-0.07***	0.01	0.06***	0.05***	1.00

Appendix 2: Regression Results (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**				0.178***
		(0.060)				(0.060)
I(Cog_dis_group2)		-0.198***				-0.276***
		(0.061)				(0.061)
Soc_dis_group			0.034***			0.035***
			(0.003)			(0.003)
Geo_dis_group_km				-0.001***		-0.0004***
				(0.0001)		(0.0001)
I(Geo_dis_group_km2)				0.00000***		0.00000***
				(0.00000)		(0.00000)
PDI_reg_distance_group					-0.003	-0.003
					(0.003)	(0.003)
UAI_reg_distance_group					-0.013***	-0.012***
					(0.003)	(0.003)
IVR_reg_distance_group					-0.001	-0.0003
					(0.004)	(0.004)
MAS_reg_distance_group					-0.014***	-0.013***
					(0.003)	(0.003)
IDV_reg_distance_group					0.005	0.004
					(0.003)	(0.003)
LTO_reg_distance_group					-0.015***	-0.015***
					(0.004)	(0.004)
Average_Pat_Stock	0.012***	0.011***	0.014***	0.011***	0.012***	0.014***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Family_size	0.046***	0.047***	0.046***	0.045***	0.045***	0.046***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Team_size	0.014***	0.013***	0.013***	0.017***	0.017***	0.015***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Number_Orgas	0.067***	0.068***	0.066***	0.069***	0.068***	0.069***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Number_of_countries_Orgas	0.120***	0.122***	0.121***	0.122***	0.122***	0.123***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(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***	0.518***	-2.093***	0.532***	0.545***	-2.134***
	(0.017)	(0.018)	(0.255)	(0.017)	(0.017)	(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	-144,010.200	-143,911.100
theta	0.786*** (0.006)	0.787*** (0.006)	0.788*** (0.006)	0.789*** (0.006)	0.791*** (0.006)	0.795*** (0.006)
Akaike Inf. Crit.	288,289.900	288,267.500	288,186.400	288,145.300	288,046.400	287,858.100
Note:						*p<0.1; **p<0.05; ***p<0.01

Appendix 3: Calculation of Distance Dummies

Variable	Name	Applied Threshold	Frequencies	Other tested thresholds (no significant differences occurred)
Cognitive distance - low	CogLowDum	lower 10 % of value range (<= 0.1)		20 %
Cognitive distance - high	CogHighDum	upper 10 % of value range (>= 0.9)		20 %
Social distance - low	SocLowDum	presence of former collaborations (<76)		< 75
Geographic distance - medium	GeoMedDum	distance between 10 km and 100 km (>=10 - <100)		>=25 - <100
Informal Institutional Distances - low	PDILowDum	lower 15 % of distance	57,096 / 62,723	lower 10 % lower 20 %
	UAILowDum		56,192 / 62,723	
	IVRLowDum		56,011 / 62,723	
	MASLowDum		56,133 / 62,723	
	IDVLowDum		57,776 / 62,723	
	LTOLowDum		55,426 / 62,723	
Informal Institutional Distances – low distance in low value area	PDI_lowlow15	lower 15 % of distance AND lower 15 % of value range	1,483 / 48,851	lower 10 % of distance & lower 10 % of value range lower 20 % of distance & lower 20 % of value range
	UAI_lowlow15		3,240 / 48,851	
	IVR_lowlow15		597 / 48,851	
	MAS_lowlow15		774 / 48,851	
	IDV_lowlow15		1,989 / 48,851	
	LTO_lowlow15		4,241 / 48,851	
Informal Institutional Distances – low distance in medium value area	PDI_lowmed15	lower 15 % of distance AND everything between lower/upper 15 % of value range	46,855 / 48,851	lower 10 % of distance & lower 10 % of value range lower 20 % of distance & lower 20 % of value range
	UAI_lowmed15		45,611 / 48,851	
	IVR_lowmed15		43,361 / 48,851	
	MAS_lowmed15		46,456 / 48,851	
	IDV_lowmed15		45,685/ 48,851	
	LTO_lowmed15		44,307 / 48,851	
Informal Institutional Distances – low distance in high value area	PDI_lowhigh15	lower 15 % of distance AND upper 15 % of value range	513 / 48,851	lower 10 % of distance & lower 10 % of value range lower 20 % of distance & lower 20 % of value range
	UAI_lowhigh15		0 / 48,851	
	IVR_lowhigh15		4,893 / 48,851	
	MAS_lowhigh15		1,621 / 48,851	
	IDV_lowhigh15		1,177 / 48,851	
	LTO_lowhigh15		303 / 48,851	

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

Appendix 4: Regression Results with Interaction Terms with Low Informal Institutional Distances (example regression output and table with all interaction coefficients)

	Dependent variable:
	Cited_in_five_years_without_selfcites
CogLowDum	-0.064*
	(0.034)
CogHighDum	-0.108***
	(0.017)
SocLowDum	-0.005
	(0.012)
GeoMedDum	-0.155***
	(0.012)
PDILowDum15	0.004
	(0.029)
UAILowDum15	0.077***
	(0.020)
IVRLowDum15	0.009
	(0.020)
MASLowDum15	0.114***
	(0.020)
IDVLowDum15	-0.026
	(0.024)
LTOLowDum15	0.094***
	(0.020)
Average_Pat_Stock	0.011***
	(0.0004)
Family_size	0.044***
	(0.001)
Team_size	0.019***
	(0.002)
Number_Orgas	0.071***
	(0.006)
Number_of_countries_Orgas	0.117***
	(0.013)
Number_of_patents_2007_2009_group_sum_ohne_inv	0.00000***
	(0.00000)
CogLowDum:PDILowDum15	0.066*
	(0.036)
Constant	0.315***
	(0.035)
Observations	62,723
Log Likelihood	-143,917.000
theta	0.794*** (0.006)
Akaike Inf. Crit.	287,869.900
Note:	*p<0.1; **p<0.05; ***p<0.01

The coefficients of all but the interaction terms did not change significantly between each of the 24 models.

	Coefficient	*p-value*	*Significance*
CogLowDum:PDILowDum15	0,066	0,069	*
CogLowDum:UAILowDum15	0,092	0,007	***
CogLowDum:IVRLowDum15	0,063	0,057	*
CogLowDum:MASLowDum15	0,111	0,001	***
CogLowDum:IDVLowDum15	0,140	0,000	***
CogLowDum:LTOLowDum15	0,117	0,000	***
CogHighDum:PDILowDum15	-0,065	0,449	
CogHighDum:UAILowDum15	-0,018	0,797	
CogHighDum:IVRLowDum15	-0,153	0,084	*
CogHighDum:MASLowDum15	0,014	0,861	
CogHighDum:IDVLowDum15	-0,169	0,167	
CogHighDum:LTOLowDum15	0,162	0,101	
SocLowDum:PDILowDum15	-0,055	0,145	
SocLowDum:UAILowDum15	-0,196	0,000	***
SocLowDum:IVRLowDum15	-0,068	0,049	**
SocLowDum:MASLowDum15[#]	-0,096	0,006	***
SocLowDum:IDVLowDum15	-0,187	0,000	***
SocLowDum:LTOLowDum15	-0,061	0,066	*
GeoMedDum:PDILowDum15	-0,109	0,004	***
GeoMedDum:UAILowDum15	-0,182	0,000	***
GeoMedDum:IVRLowDum15	-0,175	0,000	***
GeoMedDum:MASLowDum15	-0,092	0,011	**
GeoMedDum:IDVLowDum15	-0,153	0,000	***
GeoMedDum:LTOLowDum15	-0,100	0,003	***

[#] Interaction-terms not included in discussion due to sing-changes in robustness-checks.

Appendix 5: Regression Results with Interaction Terms of Low Informal Institutional Distances on Different Levels

Appendix 5.1: Regression Results with Interaction Terms of Low Informal Institutional Distances on a Low Level of the Informal Institutions (example regression output and table with all interaction coefficients)

	Dependent variable:
	Cited_in_five_years_without_selfcites
CogLowDum	0.019
	(0.013)
CogHighDum	-0.096***
	(0.018)
SocLowDum	-0.034**
	(0.014)
GeoMedDum	-0.199***
	(0.015)
PDI_lowlow15	-0.004
	(0.059)
UAI_lowlow15	-0.061**
	(0.024)
IVR_lowlow15	-0.040
	(0.054)
MAS_lowlow15	-0.171***
	(0.047)
IDV_lowlow15	-0.086***
	(0.032)
LTO_lowlow15	0.135***
	(0.020)
Average_Pat_Stock	0.012***
	(0.0005)
Family_size	0.042***
	(0.001)
Team_size	0.020***
	(0.002)
Number_Orgas	0.066***
	(0.006)
Number_of_countries_Orgas	0.110***
	(0.014)
Number_of_patents_2007_2009_group_sum_ohne_inv	0.00000***
	(0.00000)
CogLowDum:PDI_lowlow15	-0.064
	(0.071)
Constant	0.609***
	(0.022)
Observations	48,851
Log Likelihood	-113,533.500
theta	0.784*** (0.007)
Akaike Inf. Crit.	227,103.100
Note:	*p<0.1; **p<0.05; ***p<0.01

The coefficients of all but the interaction terms did not change significantly between each of the 24 models.

	Coefficient	*p-value*	*Significance*
CogLowDum:PDI_lowlow15	-0,064	0,368	
CogLowDum:UAI_lowlow15	-0,101	0,031	**
CogLowDum:IVR_lowlow15	-0,083	0,439	
CogLowDum:MAS_lowlow15	-0,057	0,550	
CogLowDum:IDV_lowlow15	-0,034	0,573	
CogLowDum:LTO_lowlow15[#]	0,093	0,024	**
CogHighDum:PDI_lowlow15	0,496	0,150	
CogHighDum:UAI_lowlow15	-0,049	0,626	
CogHighDum:IVR_lowlow15	0,458	0,131	
CogHighDum:MAS_lowlow15[#]	-0,724	0,084	*
CogHighDum:IDV_lowlow15	0,447	0,127	
CogHighDum:LTO_lowlow15	0,458	0,006	***
SocLowDum:PDI_lowlow15	-0,031	0,665	
SocLowDum:UAI_lowlow15	-0,159	0,001	***
SocLowDum:IVR_lowlow15	0,066	0,590	
SocLowDum:MAS_lowlow15	-0,117	0,254	
SocLowDum:IDV_lowlow15	0,124	0,046	**
SocLowDum:LTO_lowlow15	-0,011	0,791	
GeoMedDum:PDI_lowlow15[#]	0,128	0,085	*
GeoMedDum:UAI_lowlow15	-0,088	0,173	
GeoMedDum:IVR_lowlow15	-0,327	0,008	***
GeoMedDum:MAS_lowlow15	0,060	0,554	
GeoMedDum:IDV_lowlow15	0,167	0,016	**
GeoMedDum:LTO_lowlow15	-0,182	0,000	***

[#] Interaction-terms not included in discussion due to sing-changes in robustness-checks.

Appendix 5.2: Regression Results with Interaction Terms of Low Informal Institutional Distances on a Medium Level of the Informal Institutions (example regression output and table with all interaction coefficients)

	Dependent variable:
	Cited_in_five_years_without_selfcites
CogLowDum	-0.032
	(0.059)
CogHighDum	-0.097***
	(0.018)
SocLowDum	-0.032**
	(0.014)
GeoMedDum	-0.195***
	(0.015)
PDI_lowmed15	0.012
	(0.050)
UAI_lowmed15	0.073***
	(0.023)
IVR_lowmed15	0.009
	(0.020)
MAS_lowmed15	0.286***
	(0.029)
IDV_lowmed15	0.135***
	(0.024)
LTO_lowmed15	-0.172***
	(0.021)
Average_Pat_Stock	0.012***
	(0.0005)
Family_size	0.042***
	(0.001)
Team_size	0.020***
	(0.002)
Number_Orgas	0.065***
	(0.006)
Number_of_countries_Orgas	0.108***
	(0.014)
Number_of_patents_2007_2009_group_sum_ohne_inv	0.00000***
	(0.00000)
CogLowDum:PDI_lowmed15	0.047
	(0.061)
Constant	0.284***
	(0.066)
Observations	48,851
Log Likelihood	-113,482.700
theta	0.786*** (0.007)
Akaike Inf. Crit.	227,001.400
Note:	*p<0.1; **p<0.05; ***p<0.01

The coefficients of all but the interaction terms did not change significantly between each of the 24 models.

	Coefficient	*p-value*	*Significance*
CogLowDum:PDI_lowmed15	0,047	0,438	
CogLowDum:UAI_lowmed15	0,098	0,035	**
CogLowDum:IVR_lowmed15	0,011	0,772	
CogLowDum:MAS_lowmed15[#]	0,098	0,071	*
CogLowDum:IDV_lowmed15	0,020	0,668	
CogLowDum:LTO_lowmed15	-0,061	0,128	
CogHighDum:PDI_lowmed15	-0,042	0,810	
CogHighDum:UAI_lowmed15	0,049	0,629	
CogHighDum:IVR_lowmed15	-0,114	0,143	
CogHighDum:MAS_lowmed15	0,106	0,520	
CogHighDum:IDV_lowmed15	-0,064	0,301	
CogHighDum:LTO_lowmed15	-0,346	0,030	**
SocLowDum:PDI_lowmed15	-0,060	0,346	
SocLowDum:UAI_lowmed15	0,154	0,001	***
SocLowDum:IVR_lowmed15[#]	0,089	0,018	**
SocLowDum:MAS_lowmed15	0,014	0,809	
SocLowDum:IDV_lowmed15	-0,123	0,017	**
SocLowDum:LTO_lowmed15	-0,022	0,584	
GeoMedDum:PDI_lowmed15	-0,131	0,043	**
GeoMedDum:UAI_lowmed15	0,091	0,155	
GeoMedDum:IVR_lowmed15[#]	-0,176	0,000	***
GeoMedDum:MAS_lowmed15[#]	-0,123	0,050	**
GeoMedDum:IDV_lowmed15	-0,134	0,026	**
GeoMedDum:LTO_lowmed15	0,156	0,001	***

[#] Interaction-terms not included in discussion due to sing-changes in robustness-checks.

Appendix 5.3: Regression Results with Interaction Terms of Low Informal Institutional Distances on a High Level of the Informal Institutions (example regression output and table with all interaction coefficients)

	Dependent variable:
	Cited_in_five_years_without_selfcites
CogLowDum	0.016
	(0.013)
CogHighDum	-0.097***
	(0.018)
SocLowDum	-0.031**
	(0.014)
GeoMedDum	-0.199***
	(0.015)
PDI_lowhigh15	-0.134
	(0.089)
IVR_lowhigh15	-0.044**
	(0.019)
MAS_lowhigh15	-0.199***
	(0.035)
IDV_lowhigh15	-0.215***
	(0.039)
LTO_lowhigh15	-0.166**
	(0.074)
Average_Pat_Stock	0.012***
	(0.0005)
Family_size	0.042***
	(0.001)
Team_size	0.020***
	(0.002)
Number_Orgas	0.067***
	(0.006)
Number_of_countries_Orgas	0.108***
	(0.014)
Number_of_patents_2007_2009_group_sum_ohne_inv	0.00000***
	(0.00000)
CogLowDum:PDI_lowhigh15	-0.035
	(0.117)
Constant	0.627***
	(0.022)
Observations	48,851
Log Likelihood	-113,533.900
theta	0.784*** (0.007)
Akaike Inf. Crit.	227,101.700
Note:	*p<0.1; **p<0.05; ***p<0.01

The coefficients of all but the interaction terms did not change significantly between each of the 20 models.

	Coefficient	*p-value*	*Significance*
CogLowDum:PDI_lowhigh15	-0,035	0,766	
CogLowDum:IVR_lowhigh15	-0,018	0,639	
CogLowDum:MAS_lowhigh15[#]	-0,127	0,052	*
CogLowDum:IDV_lowhigh15[#]	-0,202	0,033	**
CogLowDum:LTO_lowhigh15	-0,010	0,952	
CogHighDum:PDI_lowhigh15	-0,060	0,777	
CogHighDum:IVR_lowhigh15	0,112	0,162	
CogHighDum:MAS_lowhigh15	-0,068	0,706	
CogHighDum:IDV_lowhigh15[#]	0,213	0,006	***
CogHighDum:LTO_lowhigh15	-0,755	0,168	
SocLowDum:PDI_lowhigh15	0,303	0,034	**
SocLowDum:IVR_lowhigh15[#]	-0,112	0,004	***
SocLowDum:MAS_lowhigh15	0,057	0,402	
SocLowDum:IDV_lowhigh15	0,069	0,445	
SocLowDum:LTO_lowhigh15	0,341	0,041	**
GeoMedDum:PDI_lowhigh15	0,125	0,328	
GeoMedDum:IVR_lowhigh15	0,229	0,000	***
GeoMedDum:MAS_lowhigh15	0,141	0,073	*
GeoMedDum:IDV_lowhigh15	-0,061	0,616	
GeoMedDum:LTO_lowhigh15	0,077	0,733	

[#] Interaction-terms not included in discussion due to sing-changes in robustness-checks.