International Journal of Innovation and Technology Management
Vol. 17, No. 8 (2020) 2050057 (19 pages)

DOI: 10.1142/S0219877020500571

World Scientific
www.worldscientific.com

Role of Cultural Diversity in Innovative Performance of International Business Collaborations

M. Moharrer*,‡ and M. Corso†,§

*Shiraz University, Iran

†Politecnico di Milano, Italy
‡moharrer@shirazu.ac.ir
§mariano.corso@polimi.it

Received 13 January 2020
Accepted 2 November 2020
Published 7 May 2021

International business (IB) collaborations can create a difference in the performance of the firms. Some previous studies had doubt if this superior performance is due to the internationalization itself or is related to the characteristics of one of the partners. However, here it is argued that difference in performance can be due to the characteristics of dyad between the partners, i.e. cultural distance. We tested the role of cultural distance (cultural diversity) between partners, while considering a network of countries. Social network analysis (SNA) is applied by utilizing UCINET software. This study built a database of around six hundred thousand patents data from The United States Patent and Trademark Office, and analyzed innovations resulting from cross-cultural collaborations. The result illustrates that increase in cultural distance decreases the number (quantity) of innovations, but has an inverted U-shape relationship with the quality of innovations. Researches which studied the relationship between cultural diversity and innovation in IB, mainly either conclude diversity hinders innovation or promotes it. This study fills this gap by analyzing two important dimensions of innovation i.e. quantity and quality of innovation.

Keywords: Cultural distance; cultural heterogeneity; innovative performance; quality of innovation; quantity of innovation; cognitive diversity; cross-cultural collaborations; global partnership (GP); desorptive capacity; absorptive capacity.

1. Introduction and Research Setting

Internationalization can create a difference in the performance of the firms. This being better can be seen in different aspects such as profit, market share, new product development, and innovation. Different factors can lead to these differences in the performance level in international business (IB). For instance, a recent study in the area of resource-based view (RBV) of the firm analyzed knowledge extracted from global partnership and found that such knowledge leads to innovative performance only when combined with the development of absorptive capacities and subcapacities that they named search and integrative capacities [Ferraris *et al.* (2019)]. Similarly, Brunetta *et al.* [2020] studied innovation network dynamics and

‡Corresponding author.

found that the duration of the collaboration affects the innovation outcome in global partnership.

Cultural diversity is another factor which plays a crucial role on the performance of international collaborations.

Primary studies in IB argue learning and transfer of knowledge consist of a one-way movement of technologies and methods from headquarters to subsidiaries [e.g. Caves (1974)]. Later studies have investigated that both parties can improve both the technological base and the competitive advantage in IB collaborations [e.g. Cantwell and Piscitello (1999)] due to reverse knowledge transfer [Kong *et al.* (2018)].

IB scholars argue that determinants of knowledge transfer within international collaboration can be related to the characteristics of knowledge [Zander and Kogut (1995); Szulanski (1996)], and characteristics of knowledge senders and recipients [Szulanski (1996); Lane and Lubatkin (1998); Gupta and Govindarajanan (2000)]. Previous studies of the knowledge transfer focused more on the characteristics of firms individually and few focused particularly on partners' relationships and their relative characteristics. On the other hand, as Lane and Lubatkin [1998] suggested, learning from a partner is a function of characteristics of the dyad in question rather than of either of the individual firms. In order to fill this gap, this study analyses the role of cultural distance (as a characteristic of dyad in question) between partners in IB collaborations, on their performance. Previous studies, which used cultural distance in different disciplines, considered the dyad relationship; hence, the network perspective of cultures is not considered in their researches. In our research, we are using the network analysis to see the effect of cultural distance on innovations in IB collaborations.

Cremer and Loebbecke [2020] studied the impact of cultural looseness on developing innovations in networks with diverse actors. Cultural looseness, is defined as Gelfand *et al.* [2006: 1225] as "the strength of social norms and the degree of sanctioning within societies." They found that in innovation networks, innovators based in culturally loose countries source knowledge of higher breadth and depth for developing innovations compared to innovators from culturally tight countries. Attah-Boakye *et al.* [2020] found that national culture has mediating influence on boardroom gender diversity and innovation.

In studies of diversity, some scholars found that increased cultural distance is associated with a negative outcomes in IB (e.g. Elia *et al.* (2019); Liu *et al.* (2018); Kostova (1999); Mäkelä *et al.* (2007)) while few found increased cultural distance is associated with positive effect [e.g. Aljanabi *et al.* (2019)]. As a result, there is a need to overcome this challenge in the literature. Here, we argue this inconsistency might be due to the performance measure and dependent variable that they are using. As we will mention in the following section, innovative performance is the best measure to capture the effect of cultural distance.

In this paper, we argue that cultural distance is a characteristic of the dyad and its collective notion; cultural heterogeneity is a characteristic of the networks. These features would play a critical role in the innovative performance in international collaborations.

The important role of innovation in international collaboration highlights the need for practical instruments that enable managers, researchers and decision makers to investigate the impact of such collaboration on the performance of companies. Hence, we proposed a method that applies patent data in a way which illustrated the effect of international collaborations.

Innovativeness has long been identified as a crucial firm capability [Hsiao and Hsu (2018); Bell and Zaheer (2007); Kogut and Zander (1992); Penrose and Penrose (2009)].

In this paper, we begin to address this question of "how cultural diversity affects innovation in collaborations across different nations." This is achieved by studying how in an international collaboration, individuals in one country contribute to the innovation of firms in others countries.

To do this, we built a database consisting of the network of the countries collaborating internationally. We tested our model on a sample consist of G20 countries with data collected from database of United States Patent Office (USPTO). Our hypotheses address the issue of role of country i on country j so the relationships and the variables are all dyadic. In order to conduct data analysis, we used network analysis and instead of the OLS regression we use quadratic assignment procedure (QAP) to get the result. In OLS regression technique, unit of analysis is individual case. But QAP regression has a unique data structure in which each matrix of relations represents a variable [Krackhardt (1987)]. Hence, QAP applies to our study as we used network analysis and work with matrices in regression analysis. We found that both dimensions of innovation which are quantity and quality of innovation of the dyad in question are influenced by the cultural distance of the nodes of such dyad. Our study contributes to different research streams like innovation, knowledge flow, cultural studies, and networks literature.

Here, we illustrate that the inconsistency in the result of researches studying the effect of cultural distance in organizations is due to studying different dependent variables. An effort on choosing more comprehensive dependent variables would have an important contribution on this research stream and explains the inconsistency in results of such studies.

In order to fill this gap and overcome this inconsistency, current research has a unique contribution which considers two dimensions of innovation, i.e. *quantity* of innovation and *quality* of innovation in investigating the effect of cultural distance. Applying these two dimensions simultaneously in a research and comparing the result of both dimensions add a new contribution to the literature and explain the inconsistency of the previous results.

In what follows, after a literature review on the role of cultural diversity and innovation, hypothesis development and research methodology are described. Then the data are analyzed followed by the results and the discussion of the study.

2. Theoretical Framework

Today IB collaborations play an important role in the economic development of countries. Some examples of IB collaborations are Alliances, Mergers and

acquisitions Multinational Companies (MNCs), etc. There are different factors which can affect the performance of such collaborations. Ferraris *et al.* [2019] analyzed knowledge extracted from global partnership and found that such knowledge leads to innovative performance only when combined with the development of absorptive capacities and sub-capacities that they named search and integrative capacities.

Different scholars have argued the effect of diversity on different variables in organizations. They have found both positive and negative outcomes for diversity in organization. As an example, Cohen and Bacdayan [1994] and Levinthal and March [1993] illustrated a trade-off between diversity of experiences, i.e. the heterogeneity and homogeneity of experiences. They stated that although homogeneous experiences help to develop expertise easier and more efficient than heterogeneous experiences, but they may lead to oversimplification of cause-and-effect relationships and superficial learning [Cohen and Bacdayan (1994); Levinthal and March (1993)].

Cultural distance is a type of diversity and is a factor at the center of attention in the literature of this field. However, as shown in the following graph, the positive side of *cultural* diversity still needs attention in the literature and even few exceptions have inconsistent results.

As a result of this inconsistency this question is raised:

What role does international cultural distance play in IB collaborations?

Researchers have examined the influence of cultural distance on different aspects like economic situation, different performance measures and entry mode choices. Result of some of these researches say cultural distance has a negative effect for the firms. Most of these studies are looking at the effect of distance on knowledge transfer. For example, they have showed technological [Zander and Kogut (1999)], cultural [Kostova (1999)], and geographical distance [Ghoshal and Bartlett (1990)] between senders and recipients significantly and negatively affect reverse knowledge transfer. The underling reasoning for negative effect is that the knowledge flows less efficiently when there is dissimilarity between the firms in international context. They argue that the less the cultural distance the more efficient the knowledge transfers between the firms.

However, two opposite arguments raise here. First, some of the challenges like communication or coordination costs posed by distance are reduced or even eliminated with the emergence of modern information technology (IT). This has led some scholars to declare the "death of distance" [Cairncross and Cairncross (1997)]. In fact, IT leads to death of that part of distance which creates negative effect like low efficient knowledge transfer in the collaborations. Second, and more important argument which is opposed the negative effect of distance is the following. The availability of new knowledge to be learnt in the collaboration is more important than the knowledge transfer. When partners in IB collaboration are from less distant cultures then it is likely that their knowledge base be similar. When people of these group get together and combine their knowledge base, it is less probable that a novel idea comes out, since they are combining similar sets of knowledge. Hence, this similarity, although facilitates knowledge transfer, would not lead to a radical innovation. Therefore, it is expected that cultural distance has a positive effect on

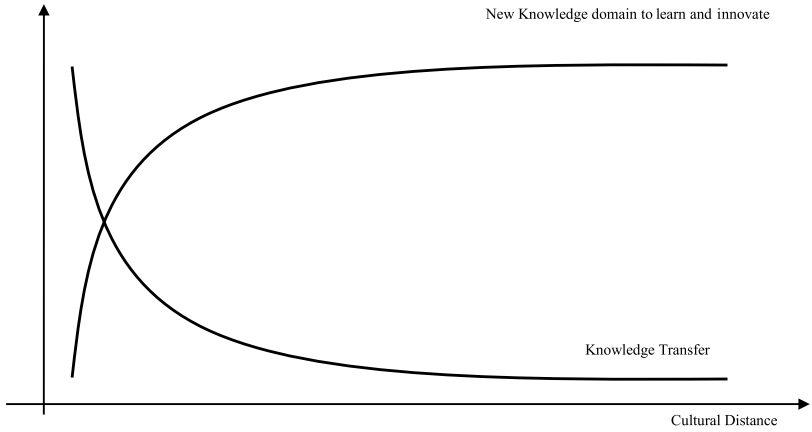

Fig. 1. Trade off between positive and negative sides of different cultural distance.

innovation. When people from different cultures gather together a pool of knowledge will be created. This paves the way for better innovation. In fact, here we argue that distance can help collaborative partners to improve new product development and as a consequence their innovation. It can be proposed that the more the cultural distance the less frequent innovation occurs due to knowledge transfer issue, but the better the innovations will appear. Considering these two different dimensions of innovation, i.e. quantity and quality, as dependent variables, has received less attention by the scholars for measuring the effect of cultural diversity and distance on innovation. This paper tries to fill this gap. The graph in Fig. 1 shows what has been discussed as the trade off between positive and negative side of cultural diversity.

Firms diversify for different goals. The main reasons are as follows. First as RBV of the firm says, firms diversify to use their current excess resources and slack to increase their financial performance. So, the aim of this diversification is to increase financial performance. Based on this view, distant context might not be beneficial because the current resources might not work there, so the financial performance might not be the proper dependent variable to capture the effect of distance directly. The second reason why firms diversify is mentioned by agency theory. This argues that the diversification is with the aim of reducing risk. The third and last main point is not studied well in the literature. It says that firms diversify to use the opportunities exist in other clusters. Based on this view, the more distant firms go the more diverse opportunities they would discover. The aim of diversification in this view is to reach new opportunities which can lead to innovation. The first and second reasons and their corresponding outcomes (financial performance and risk) are well studied in the literature so we are going to focus on the last point. This would be a suitable factor which can capture the positive effect of distance. As a result, our research question is

What is the role of cultural distance and heterogeneity on innovative performance in IB Collaborations?

2.1. *Cultural heterogeneity*

Here in addition to cultural distance, we mention cultural heterogeneity, since we are using the network perspective. Concept of cultural distance is more suitable when we are considering a pair of countries but since we are going to see the effect in a group of countries the notion of Heterogeneity (as a collection of more than one cultural distance) would be more proper.

2.2. *Hypothesis development*

2.2.1. *Part-1: Quantity of innovation*

Some previous studies have shown that cultural distance between senders and recipients significantly and negatively affects knowledge transfer and increased cultural distance is associated with a negative outcome in IB [e.g. Elia *et al.* (2019); Liu *et al.* (2020); Kostova (1999); Mäkelä *et al.* (2007)]. Here, it is argued that cultural distance up to a point, has negative effect on innovation rate because at this level the negative part is stronger and the cultures are too similar to have the positive effect i.e. creating new knowledge in their collaboration. But as the distance enlarges the positive effect mitigates the negative effect and the innovation rate would increase. In fact, the positive side of cultural distance would mitigate the negative part by providing a diverse knowledge base for the partners. The logic is similar to the logic mentioned by Cohen and Bacdayan [1994] and Levinthal and March [1993]. They stated that although homogeneous experiences help to develop expertise easier and more efficient than heterogeneous experiences, but they may lead to oversimplification of cause-and-effect relationships and superficial, hence less innovation would raise and vice versa. The hypothesis of this argument is as follows:

Hypothesis 1: *Cultural distance and innovation rate in IB collaboration have a U-shape relationship.*

2.2.2. *Part-2: Quality of innovation*

As stated before, the positive outcome of cultural distance is rarely studied and it is the negative side which is at the center of attention in most of the studies. Most of the previous studies considered the role of distance as a negative point due to communication and cognitive issues. However, some factors are overlooked in investigating the role of distance. Although distance can create some negative points, its positive side is ignored in the literature. Being similar and having less distance can create knowledge transfer easier, and it facilitates local learning. Hence, it can make the company be myopic [Levinthal and March (1993)]. To move beyond local search, it is required that exploration span some boundaries [Rosenkopf and Nerkar (2001)]. Due to the nature of IB collaborations, increasing their boundaries in different aspects and exploiting the positive effect is possible.

As Schumpeter [1934] stated, if innovation is created out of new combinations of existing capabilities, then beyond a minimum level of R&D activities, access to addition similar capabilities does not increase valuable innovations. This is due to

the fact that all possibilities of new combinations of existing capabilities have been exhausted. Partners with diverse skills, resources, and capabilities have more to learn from each other than what partners with very similar capabilities do. Diverse capability between partners leads to creativity and innovative solutions to existing problems [Sampson (2007)].

Additionally, Gavetti [2008] argued that superior opportunities are distant. The interpretation in international context is that the ordinary opportunities and innovations are found in environments with high similarity between partners. While the superior and high quality innovations are created from collaborations among less similar partners. Therefore, if we are innovating by combining similar knowledge, we would come up to low quality innovations stem from nonsuperior opportunities. On the other hand, diversity, up to a point, can lead to high quality innovations. Hence, the following hypothesis needs to be tested:

Hypothesis 2: *In IB collaborations, the relationship between cultural distance of partners and quality of implemented innovations has inverted U-shape.*

2.3. *Research methodology*

In order to find the effect of cultural distance on quantity innovation, we have built a dataset using the American Patent Office (APO) database. Our dataset is formed by gathering patents which have an inventor from a country different from the assignee country. This will show us how different countries could contribute to the innovations of each other. We found such patents for collaboration between each pair of countries, and put data in a matrix. In the following sections it is shown how this dataset is built.

2.4. *Patent data in the research*

The United States Patent and Trademark Office (USPTO) is an agency of the U.S. Department of Commerce. The role of the USPTO is to grant patents for the protection of inventions and to register trademarks. It serves the interest of inventors and businesses with respect to their inventions and corporate products, and service identifications.

Secondary data like patent data is as an alternative of using primary data for conducting network research in IB. Studies of economic geography [e.g. Sharma and Tripathi (2017); Jaffe *et al.* (1993)] used patent citations to trace knowledge spillovers and examine their geographical reach. In their research, they considered knowledge flow leaves a paper trail in form of citation in patents. Hence, they used citation patterns to test the extent of spillover localization. They concluded that knowledge spillovers are localized.

Following that, Breschi and Lissoni (2003) argued that it is not geographical proximity itself that leads knowledge spillovers to be localized. But, it is the social networks of inventors across firms that tend to be geographically localized and creates knowledge spillovers to have a limited geographical reach. Later studies investigated questions in research on inventor networks (Cantner and Graf, 2006;

Ejermo and Karlsson, 2006; Ter Wal and Boschma, 2009). In fact, they showed that while working on patent data, we should try to find influencing variables. Patent data has been used in different research disciplines such as business administration, economics and international business. It possesses a rich amount of information.

Several studies have used patents as a measure of innovation performance [e.g. Morikawa (2019); Kwon *et al.* (2019); Sun *et al.* (2020); Dutta and Weiss (1997)].

Patents contain detailed description and information of the patented product and many of its technological details. Patent applicants or patent holders and inventors are among the information that patent record provides. Applicants are called assignees in APO and are those that legally possess the patent. These can be firms, research institutes or private persons, although the vast majority of patents are held by private companies [Ter Wal and Boschma (2009)].

Patent data provide information about the inventors. Inventors are the people who have roles in the realization of the invention and in the development of the patented product. The good point of patent data are that it provides name and detailed address of both patent applicant and its inventors. This helps to measure the cultural distance in collaborations occur internationally.

The patent record illustrates citations to previous patents or scientific work (backward citation) as well. The information about the patent applicant and the inventors is valuable for many researches. Especially, building a network on the basis of patents could be a helpful use of the patent data.

As we mentioned, patent gives the address of both inventor and assignee. This information is necessary for selecting the patents belonging to the geographic region under investigation. This shows whether a patent should be included in our sample or not. The underlying reason for taking the inventor's address as the selection criterion for localizing patents is that patents of multinational companies and in general any multiestablishment companies are generally assigned to the company's headquarter. As a result, while most of its inventors will be resident in the subsidiaries' region, patents realized by subsidiaries will state the headquarter address as the applicant's address [Verspagen and Duysters (2004); Ter Wal and Boschma (2009)].

While network analysis is used depending on the purpose of the research, the node in the network can be either the individual inventor or the patent applicant. Most regional network studies take the inventor as the node in the network [Ter Wal and Boschma (2009)].

Despite the importance of the effect of national cultures of partners on each other's innovation in international collaborations, few studies have considered country as the node and unit of analysis. In this paper, we are going to use countries as our nodes.

3. Social Network Analysis

The study of organizational networks has a long history in the social and behavioral sciences. It has been applied in both micro and macrolevel. Despite the significant role of networks, social network analysis (SNA) is not very common in IB literature.

However, the method has become more popular in different area of management. For instance, empirical researches of social analyses within *economics* are Cantner and Graf [2006] and Maggioni *et al.* [2007].

The basic SNA examines the nodes and the links, and the relationship between them. In the context of our study, the nodes are the countries and the links are the joint patents among them. As it is mentioned in the hypotheses, we have two different dependent variables. In the first dependent variable (matrix) the link or tie between two nodes (countries), show the number of a patent assigned to the first country which has an inventor from the other country. In the second part, the links shows the quality of innovations which have occurred in ties of first matrix. Details concerning the variables are explained more in the following parts.

3.1. *Dependent variable 1: Quantity of innovation*

The dependent variable, here, is the number of patents having an inventor from a country different from assignee country. Hence, we have data for each pair of countries. We can call this as the *Number of Joint Cross-National Patents* between two countries. In fact, for countries i and j, the P_{ij} is the number of patents of applicants from country j which have inventors from country i. The corresponding matrix is formed by the following formula:

Dependent Variable 1- Quantity of Innovation

$$\begin{array}{cc} & \textit{Assignee Country} \\ & \begin{array}{ccccc} c_1 & . & . & . & c_n \end{array} \\ \textit{Inventor Country} & \begin{pmatrix} P_{11} & . & . & . & P_{1n} \\ . & . & . & . & . \\ . & . & . & . & . \\ . & . & . & . & . \\ P_{n1} & . & . & . & P_{nn} \end{pmatrix} \begin{array}{c} c_1 \\ . \\ . \\ . \\ c_n \end{array} \end{array}$$

$$P_{mn} = \sum \text{Patent(ACNn and ICNm)}, \tag{1}$$

where P_{mn} is the number of all patents whose assignee company is located in country n and the inventor person is located in country m.

ACN means assignee country and ICN means inventor country. This matrix shows how countries contribute to the quantity of the innovations of each other.

To provide an example P_{52} equals 47. To clarify, country 5 (C5) is Canada and country 2 (C2) is Australia. Hence, based on formula (1), P_{52} is the sum of Canadian patents whose inventor is from Australia. In this example, this is an indicator of how Australia contribute to the number (quantity) of innovations occurs in Canada.

3.2. *Dependent variable 2*

3.2.1. *Quality of innovation (forward citation)*

In addition to the dataset mentioned above which is illustrates the quantity of innovation, we have built another dataset regarding the *quality* of patents and innovations. There is an inconsistency in the previous studies with respect to the value of patents. Despite this inconsistency, some similarities emerge. The most important is probably the fact that the number of forward patent citations (FPC) is closely associated with the value of a patent and quality of the innovation. Majority of the studies using FPCs reached this conclusion [Sapsalis *et al.* (2006)].

This study also applied the same technique and measured quality of patent by the number of forward citations. Therefore, for forming the second dataset, the number of forward citations for each of the patents which were inserted in the quantity matrix above was counted. Forward citations of a patent show how many patents have cited this patent. High number of forward citations is an indicator of importance of the patent hence the high quality of that innovation.

Dependent Variable 2- Quality of Innovation
(measured by Forward citation per patents)

Inventor Country \ Assignee Country	c_1	.	.	.	c_n
c_1	F_{11}	.	.	.	F_{1n}
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
c_n	F_{n1}	.	.	.	F_{nn}

$$F_{mn} = \sum \text{Forward Citation Patent(ACNn and ICNm)}, \tag{2}$$

where ACN means assignee country and ICN means Inventor country.

In formula (2), F_{mn} means sum of forward citations of all patents that have the assignee from country n and the inventor from country m. Forward citations of all patents included in each cell of matrix 1 is calculated and located in the same cell of matrix 2. However, for getting better results and normalizing this matrix, for each cell of this matrix the number of forward citations was divided by the number of patents (patent of the same cell in matrix one) in order to have forward citation per patents. For example, in matrix 1, we stated that P_{52} is 47. As country 5 (C5) is Canada and country 2 (C2) is Australia, based on formula (1), P_{52} is sum of Canadian patents whose inventor is from Australia. Now in matrix 2, F_{52} is forward citations of all patents included P_{52}. In other words, F_{52} is all forwards citations of all patents whose assignee (applicant) is from Canada and whose inventor is from Australia. This is an indicator of how Australia contribute to the quality of innovations occurs in Canada.

3.3. *Independent variable: Cultural distance*

For cultural distance between each pair of countries we used Kogut and Singh [1988] index, which is based on the score of Hofstede cultural values. This measure of cultural distance is widely used in different disciplines especially in IB field. The formula is

$$\mathrm{CD}_j = \sum \{(I_{ij} - I_{iN})^2 / V_i\}/4, \tag{3}$$

Independent Variable - Cultural Distance Innovation

Assignee Country

Inventor Country	c_1	.	.	.	c_n
c_1	D_{11}	.	.	.	D_{1n}
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
c_n	D_{n1}	.	.	.	D_{nn}

3.4. *Control variable — Human development index*

We have controlled the human development scores of the innovators' country. The **Human Development Index** (**HDI**) is an index used to rank countries by level of "human development." The HDI data released by United Nations Development Program is applied in this research.

3.4.1. *Sample selection*

We built this dataset for all Joint Cross-National Patents of G20 countries. We chose this sample to increase the robustness of our sample. G20 countries are heterogeneous, hence, there is a scope for cooperation in areas related to innovation [UNESCO (2018)].

By selecting G20 countries, we excluded all unobserved heterogeneity (except cultural heterogeneity) of the population that would lead to innovation. Heterogeneity in Investment Motivations is a factor which exists if we consider all countries in our sample. Countries especially developed countries are not willing to invest in less developed countries, so entering these less developing countries in our sample would bias our result. Heterogeneity in economic situations of countries is another factor that can bias our sample which is solved by considering only G20 countries. In fact, by considering only these countries we have also taken into account controlling for the economic situation of our sample. Next reason is that not all patents are registered in APO and they are only prestigious patents which are registered there. So, less developed countries might be less interested regarding this criterion. Hence the fact that less developed countries do not have patent registered in APO can be due to this reason and not that they are not innovating. In addition to make sure that we

are not losing a large part of the population, we built the database of joint patent for all countries and we observed that about 85% of patents belonged to the group of G20 countries. Although we have excluded other countries, we are not losing much data while we can control for unobserved heterogeneity. It is important to know that countries in our sample are economically similar, but are culturally different. These all together made the G20 countries a good sample for our study.

So, in the matrix illustrated above, G20 countries are as inventors in rows and in the columns the G20 countries are brought as the assignees (applicant companies). The size of our sample is around six hundred thousand patents which are all innovations resulted from cross cultural collaborations among G20 countries.

4. Data Analysis

As mentioned in the previous section, the dependent and independent variables in this study are matrices. We are going to find the relationship between cultural distance and innovation, i.e. regressing cross-cultural innovation (matrix) on cultural distance (matrix). Since our dependent and independent variables are matrixes, we cannot use the usual regression analysis like OLS. As result, we need to use network analysis techniques. Majority of current research in SNA area, could not be performed without access to inexpensive computational tools. This dependence on computation for research in SNA has led to creation of software packages to perform network analytic tasks. UCINET [Borgatti *et al.* (2002)] software is one of the packages which is utilized in this study.

4.1. *Quadratic assignment procedure*

To calculate the association between data in networks, a family of tests can be used based on the QAP. Data on network variables typically is represented in the form of a square matrix.

A major advantage of QAP is that the test makes no assumptions about the distribution of parameters. Instead, the QAP creates a reference distribution of random parameters that could have been derived from a dataset with the same characteristic as the dataset of the study [Dekker *et al.* (2003)].

5. Results

As it is explained earlier, this research used patent data from APO to build the required dataset. The results are shown in the following tables.

5.1. *Regression coefficients*

Knowledge transfer among partners is the primary condition of contributing to each others innovation. As Table 1 illustrates, cultural distance has a negative effect on *innovation rate* and it is significant. However, the square of cultural distance is not significant which shows the relationship among cultural distance and innovation is linear and is not U-shape. Therefore, it rejects the first hypothesis. However, it

Table 1. Regression Result 1 — Dependent variable: Quantity of innovation (measured by Number of cross-cultural patents).

Independent	Un-standardized coefficient	Standardized coefficient	Significance
Intercept	−708.713074	0.000000	
Cultural distance	−292.716736	−0.371320	0.081*
Square of cultural distance	60.057327	0.279400	0.159
Human development index (HDI)	1365.546631	0.186871	0.002***

*$P < 0.1$ and ***$P < 0.01$: Significant level.

Table 2. Regression Result 2 — Dependent variable: Quality of Innovation (measured by forward citation per patent).

Independent	Un-standardized coefficient	Standardized coefficient	Significance
Intercept	1.430823	0.000000	
Cultural distance	0.84	0.28	0.08*
Square of cultural distance	−0.24	−0.30	0.077*
HDI	−0.52	−0.019	0.387

*$P < 0.10$.

proves the first part of our justification, which stated that the more the cultural distance the less innovation occurs among the partners, but the relationship is not curve-linear.

In addition, the result shows that although the human development distance is significant, the coefficient is not very high.

The next part is related to the quality of innovation. The results are shown in Table 2. Both the coefficients of cultural distance and its square show the *inverted U-shape relationship* between cultural distance and quality of innovations occur among partners. These coefficients prove the second hypothesis of this research. This means that up to a point, the more the cultural distance the better the quality of innovations. While after a maximum point the effect decreases.

The integration of these two tables gives an interesting conclusion which is rare in the literature. *The more the cultural distance the less the number of innovations, but up to a point, the better the quality of innovations occurs in cross cultural collaborations.*

6. Discussion and Conclusion

6.1. *Aim of the research*

While there is still not a full consensus about the effect of international collaborations on innovation performance, we advanced the knowledge on the topic by analyzing the effect of cultural diversity on innovative performance in international collaborations and how firms exploit knowledge from their international partners.

6.2. *Theoretical contributions*

Diversity between partners in international collaboration can affect the ways in which they recognize, value, and assimilate each other's knowledge [Cohen and

Levinthal (1990); Monteiro and Birkinshaw (2017)]. Strategy literature and primary studies in IB has widely stated the negative impact of cultural diversity on innovative performance in international collaborations. In fact, in studies of diversity some scholars found that increased cultural distance is associated with a negative outcome in IB [Liu *et al.* (2018); Kostova (1999); Mäkelä *et al.* (2007)].

However, later studies have investigated that both parties in IB collaborations can improve the technological base and also increase their competitive advantage [e.g. Cantwell and Piscitello (1999)] due to factors such as reverse knowledge transfer [Kong *et al.* (2018)]. In addition, some scholars found increased cultural distance is associated with positive effect [e.g. Aljanabi *et al.* (2019)].

This research has several implications for theory and contributions to the current literature. This paper answers the question of how cultural diversity affects innovation in collaborations across different nations. By considering two dimensions of innovation, i.e. quantity and quality, it tries to discover underlying reason of the controversial effect of culture on innovation, found in previous studies. We applied data of around six hundred thousand patents from United States Patent Office (USPTO) which are all innovations resulted from international collaborations among G20 countries.

While majority of previous studies either acknowledged the positive or negative effect of cultural distance (diversity) on innovation, our results show that cultural distance has a twofold effect on innovations raised from IB collaborations. The effect depends on which dimension of innovation we consider. First, we found that cultural diversity and quantity of innovations has a negative relationship. In other words, the more the cultural diversity the smaller number of innovations would result from those cross-cultural collaborations.

One underlying reason can be the fact that cultural differences create barriers to efficient knowledge transfer. Cultural differences can lead to increase of coordination and negotiation costs; as a result, it makes it more difficult to transfer knowledge which is a requisite of innovation [Bell and Zaheer (2007)].

The second contribution is that more cultural diversity promotes the quality of innovations. Quality increases by cultural diversity due to the fact that cultural distance increases the probability of accessing to more novel sets of knowledge bases and variety of cognitive styles. Cantwell and Piscitello [2014] stated that the availability of a bigger pool of knowledge through the international connectedness of MNC firms has gained in importance. Finding of this study approves this statement in the IB and strategy context.

However, as the relationship is inverted U-shape, quality of innovations increases with cultural distance up to a point and when the cultural distance is too much, the negative effect arises and the quality starts to decrease. Therefore, when the cultures are too different the negative effect of cultural distance, i.e. inefficient knowledge transfer, matters and the quality of innovations decreases after that point.

To summarize, while less cultural diversity increases the number of innovations, more cultural diversity, up to a point, promotes the quality of innovations.

6.3. *Managerial contributions*

This research can affect the foreign market entry strategies and location choices of multinational firms. It also illustrates human resource managers that recruiting staff from different cultures can be beneficial for the companies which need high quality innovations. It is especially important in the current trend of internationalization of businesses and the huge number of migrations of high skilled workers. It helps mangers by shedding light on the importance of the diversity of cultures. Organizations can benefit from the potentials existing in distant cultures and achieve breakthrough innovations.

As Malhotra *et al.* [2009] in their study titles "Distance factors and target market selection" mentioned, today due to the wide scale of internationalization, success is not only the matter of marketing. But it is also a factor of recruiting human resources who fit the strategy and resources of the company. In addition, new human resources are required to complement the competencies of the recruiting company. This paper illustrates how cultural diversity in IB collaborations, plays role on the innovation performance of the companies.

One implication of this study is aligned with the result of Ferraris *et al.* [2019] which highlights how cross cultural knowledge transfer from international collaborations is becoming a crucial topic both for theory and practice. This is due to the fact that companies will be called even more than today to develop or to adapt knowledge management competencies, tools and infrastructure to efficiently and effectively take advantage of distant and heterogeneous knowledge.

6.4. *Research limitations and future developments*

This study applied secondary data. Future researches could collect data and enhance the result of this study. Suggestion for further researches includes investigating the role of absorptive capacity in relation between cultural distance and innovation which can contribute to the literatures of strategy, IB and innovation. Absorptive capacity which was first defined by Cohen and Levinthal [1990], enables a firm to identify, assimilate, transform, and apply valuable external knowledge, hence it can be a moderator variable in the relationship between cultural distance and innovation. Due to the fact that for Cohen and Levinthal [1990], absorptive capacity depends greatly on prior related knowledge and diversity of background, utilizing absorptive capacity concept in this cultural diversity model can be very interesting for the scholars in these fields.

In addition to absorptive capacity, the newer notion of desorptive capacity can also be studied in this model. The notion of desorptive capacity was developed as a complement to the concept of absorptive capacity in outward knowledge transfer [Lichtenthaler and Lichtenthaler (2010)]. Desorptive capacity is the ability to release knowledge toward a recipient that is able to give it [Dell'Anno and del Giudice (2015)]. It can have a significant role for managing innovation in networks [Müller-Seitz (2011)].

It is highly recommended to study desorptive capacity. Because on one hand, desorptive capacity is particularly important for networks and collaborations with

mutual, bidirectional knowledge transfer. On the other hand, this research studied innovation in network of countries with cross national collaborators of mutual knowledge transfer. Therefore, for future studies, it is recommended to consider desorptive capacity concept and enrich this study.

Acknowledgment

We would like to express our gratitude to Professor Stephen Tallman, Professor Giuseppe Soda, Dr. Allya Koesoema and Dr. Alireza Sadeghian for all the valuable guidelines and support that they provided us for doing this research.

References

Aldrich, H. (1976). Resource dependence and in the organizational relations: Local employment service offices and social services sector organizations. *Administration & Society*, **7**, 4: 419–454.

Aljanabi, A., Hamasaleh, S. and Mohd Noor, N. (2019). Cultural diversity and operational performance: Entrepreneurial orientation as a mediator. *International Journal of Quality & Reliability Management*, **36**, 9: 1522–1539.

Attah-Boakye, R. *et al.* (2020). The impact of board gender diversity and national culture on corporate innovation: A multi-country analysis of multinational corporations operating in emerging economies. *Technological Forecasting and Social Change*, **161**.

Bell, G. G., & Zaheer, A. (2007). Geography, networks, and knowledge flow. *Organization Science*, **18**, 6: 955–972.

Borgatti, S. P., Everett, M. G. and Freeman, L. C. (2002). *Ucinet for Windows: Software for Social Network Analysis*, Harvard, MA: Analytic Technologies.

Breschi, S. and Lissoni, F. (2003). Mobility and social networks: Local knowledge spillovers revisited: *CESPRI*, working paper no. 142.

Breschi, S. and Lissoni, F. (2004). Knowledge networks from patent data: methodological issues and research targets. *Handbook of Quantitative Science and Technology Research: The use of Publication and Patent Statistics in Studies on S&T Systems.*

Brunetta, F., Marchegiani, E. and Peruffo, E. (2020). When birds of a feather don't flock together: Diversity and innovation outcomes in international R&D collaborations, *Journal of Business Research*, **114**, 436–445.

Cairncross, F. and Cairncross, F. (1997). The death of distance: How the communications revolution will change our lives (Vol. 302). Boston, MA: Harvard Business School Press.

Cantwell, J. A. and Piscitello, L. (1999). The emergence of corporate international networks for the accumulation of dispersed technological capabilities. *Management International Review*, **39**, 1: 123–47.

Caves, R. E. (1974). Multinational firms, competition, and productivity in host-country markets. *Economica*, **41**, 176–193.

Cohen, W. M. and Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation, *Administrative Science Quarterly*, **35**, 1: 128–152.

Cantner, U. and Graf, H. (2006). The network of innovators in Jena: An application of social network analysis, *Research Policy, Elsevier*, **35**, 4: 463–480.

Cantwell, J. and Piscitello, L. (2014). Historical changes in the determinants of competence creation in MNC subunits: The increasing role of international knowledge, *Industrial and Corporate Change*, **23**, 3: 633–660.

Cohen, W. M. and Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation, *Administrative Science Quarterly*, **35**, 1: 128–152.

Cohen, W. M. and Levinthal, D. A. (1989). Innovation and learning: The two faces of R&D, *The Economic Journal*, September, (99), 569–596.

Cohen, M. D. and Bacdayan, P. (1994). Oganizational routines are stored as procedural memory: Evidence from a laboratory, *Organization Science*, **5**, 4; 554–568.

Cremer, S. and Loebbecke, C. (2020). Patented innovations developed in networks: The role of cultural looseness, *Industrial Marketing Management*, **89**, 459–470, doi: 10.1016/j.indmarman.2019.12.013.

Dell'Anno, D. and del Giudice, M. (2015). Absorptive and desorptive capacity of actors within university-industry relations: Does technology transfer matter?*Journal of Innovation and Entrepreneurship*, **4**, 13. doi: 10.1186/s13731-015-0028-2.

Dekker, D., Krackhardt, D. and Snijders, T. (2003). Multicollinearity Robust QAP for Multiple-Regression, North American Association for Computational Social and Organization Sciences (NAACSOS) Conference, Pittsburgh, PA, USA, 22-25 June 2003.

Dosi, G. (1982). Technological paradigms and technological trajectories, *Research Policy*, **11**, 147–162.

Dutta, S. and Weiss, A. (1997). The relationships between a firm's level of technological innovativeness and its pattern of partnership agreements, *Management Science*, **43**, 3: 343–356.

Ejermo, O. and Karlsson, C. (2006). Interregional inventor networks as studied by patent coinventorships, *Research Policy*, **35**, 412–430.

Elia, S., Messeni Petruzzelli, A. and Piscitello, L. (2019). The impact of cultural diversity on innovation performance of MNC subsidiaries in strategic alliances, *Journal of Business Research*, **98**, 204–213.

Ferraris, A., Devalle, A., Ciampi, F. and Couturier, J. (2019). Are global R&D partnerships enough to increase a company's innovation performance? The role of search and integrative capacities, *Technological Forecasting and Social Change*, **149**, 119750.

Gavetti, G. (2008). Toward a Behavioral Theory of Strategy [summer school Presentation]. IRI Summer School, Volterra, Italy.

Gelfand, M., Nishii, L. and Raver, J. (2006). On the nature and importance of cultural tightness-looseness, *Journal of Applied Psychology*, **91**, 6: 1225–1244.

Gupta, A. K. and Govindarajanan, V. (2000). Knowledge flows within multinational corporations, *Strategic Management Journal*, **21**, 4: 473–496.

Hagedoorn and Cloodt (2003). Measuring innovative performance: Is there an advantage in using multiple indicators? *Research Policy*, **32**, 1365–1379.

Hsiao, Y. C. and Hsu, Z. X. (2018). Firm-specific advantages-product innovation capability complementarities and innovation success: A core competency approach, *Technology in Society*, **55**, 78–84.

Harrison, D. A. and Klein, K. J. (2007). What's the difference? Diversity constructs as separation, variety, or disparity in organizations, *Academy of Management Review*, **32**, 1199–1228.

Jaffe, A. B., Trajtenberg, M. and Henderson, R. (1993). Geographic localization of knowledge spillovers as evidenced by patent citations, *Quarterly Journal of Economics*, **108**, 577–598.

Kogut, B. and Singh, H. (1988). The effect of national culture on the choice of entry mode, *Journal of International Business Studies*, **19**, 411–432.

Kogut, B. and Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology, *Organization Science*, **3**, 3: 383–397.

Kong, L., Ciabuschi, F. and Martin, O. M. (2018). Expatriate managers' relationships and reverse knowledge transfer within emerging market MNCs: The mediating role of subsidiary willingness, *Journal of Business Research*, **93**, 216–229.

Kostova, T. (1999). Transnational transfer of strategic organizational practices: A contextual perspective, *Academy of Management Review*, **24**, 308–324.

Krackhardt, D. (1987). QAP Partialling as a Test of Spuriousness. *Social Networks*, **9**, 171–186.

Kwon, D. S., Li, D. and Sohn, S. Y. (2019). Identifying innovation in socialist countries through patent analysis focused on Cuba and Vietnam, *World Patent Information*, **59**.

Lane, P. J. and Lubatkin, M. (1998). Relative absorptive capacity and interorganizational learning, *Strategic Management Journal*, **19**, 5: 461–478.

Levinthal, D. and March, J. (1993). The Myopia of Learning, *Strategic Management Journal*, **14**, 95–112.

Lichtenthaler, U. and Lichtenthaler, E. (2010). Technology transfer across organizational boundaries: Absorptive capacity and desorptive capacity, *California Management Review*, **53**, 154–170.

Liu, A., Lu, C. and Wang, Zh. (2020). The roles of cultural and institutional distance in international trade: Evidence from China's trade with the Belt and Road countries, *China Economic Review*.

Maggioni, M., Nosvelli, M. and Uberti, E. (2007). Space versus networks in the geography of innovation: A European analysis. *Pap Reg Sci*, **86**, 3: 471–493.

Mäkelä, J. P., Taulu, S., Pohjola, J., Ahonen, A. and Pekkonen, E. (2007). Effects of subthalamic nucleus stimulation on spontaneous sensorimotor MEG activity in a Parkinsonian patient. In *International Congress Series*, Elsevier, Vol. 1300, pp. 345–348.

Marco, A. C. (2007). The dynamics of patent citations, *Economics Letters*, **94**, 2: 290–296.

Malhotra, S., Sivakumar, K. and Zhu, P. C. (2009). Distance factors and target market selection: The moderating effect of market potential, *International Marketing Review*, **26**, 561–673.

Monteiro, L. F. and Birkinshaw, J. (2017). The external knowledge sourcing process in multinational corporations, *Strategic Management Journal*, **38**, 2: 342–362.

Morikawa, M. (2019). Innovation in the service sector and the role of patents and trade secrets: Evidence from Japanese firms, *Journal of the Japanese and International Economies*, **51**, 43–51.

Müller-Seitz, G. (2011). Absorptive and desorptive capacity-related practices at the network level — the case of SEMATECH, *R&D Management*, **42**, 1: 90–99.

Penrose, E. and Penrose, E. T. (2009). *The Theory of the Growth of the Firm*. Oxford University Press.

Roethlisberger, F. J. and Dickson, W. J. (2003). Management and the Worker (Vol. 5). Psychology Press.

Rosenkopf, L. and Nerkar, A. (2001). Beyond local search: boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal*, **22**, 4: 287–306.

Sapsalis, E., Van Pottelsberghe, B. and Navon, R. (2006). Academic versus industry patenting: An in-depth analysis of what determines patent value, *Research Policy*, **35**, 1631–1645.

Sampson, R. C. (2007). R&D alliances and firm performance: The impact of technological diversity and alliance organization on innovation. *Academy of Management Journal*, **50**, 2: 364–386.

Schumpeter, J. A. (1934). *Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest and the Business Cycle'*. Harvard University Press, Cambridge.

Sharma, P. and Tripathi, R. C. (2017). Patent citation: A technique for measuring the knowledge flow of information and innovation, *World Patent Information*, **51**, 31–42.

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm, *Strategic Management Journal*, **17**, Winter Special Issue: 27–43.

Sun, W., Zhao, Y. and Sun, L. (2020). Big data analytics for venture capital application: Towards innovation performance Improvement, *International Journal of Information Management*, **50**, 557–565.

Ter Wal, A. and Boschma, R. (2009). Applying social network analysis in economic geography: framing some key analytic issues, *The Annals of Regional Science*, **43**, 3: 739–756.
Trajtenberg, M. (1990). A penny for your quotes: patent citations and the value of innovations, *RAND Journal of Economics*, **21**, 1: 172–187.
UNESCO (2018). *Skills and Innovation in G20 Countries*. UNESCO Institute for Statistics.
Verspagen, B. and Duysters, G. (2004). The small worlds of strategic technology alliances, *Technovation*, **24**, 563–571.
Zander, U. and Kogut, B. (1999). Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test, *Organization Science*, **6**, 1: 76–92.

Biography

Mariano Corso is Professor of "Leadership and Innovation" at Politecnico di Milano. He co-founded the Digital Innovation Observatories at Politecnico di Milano and President and Scientific Director at P4I — Partners4Innovation. He is senior advisor in Change Management and Digital Transformation for companies and Public Administrations and promoted and co-ordinated national and international research projects and authored many scientific publications of which more than 180 at the international level.

Masoomeh Moharrer is PhD in Management and Industrial engineering. Her phd specialization was Innovation, Strategy and International Business. Currently she is assistant professor in Tourism Management department in Shiraz University. She is advisor of start ups and science and technology parks. Her research interests are innovation management, Smart tourism and inclusiveness in tourism.