UHASSELT

KNOWLEDGE IN ACTION

Faculty of Business Economics

Master of Management

Master's thesis

The effects of National culture and Geographic proximity on the innovation performance of Industry-University collaborations

Modou Lamin Sey

Thesis presented in fulfillment of the requirements for the degree of Master of Management, specialization Strategy and Innovation Management

SUPERVISOR :

dr. Relinde COLEN

2020
2021

UHASSELT

KNOWLEDGE IN ACTION

www.uhasselt.be
Universiteit Hasselt
Campus Hasselt:
Martelarenlaan 42 | 3500 Hasselt
Campus Diepenbeek:
Agoralaan Gebouw D | 3590 Diepenbeek

UHASSELT

KNOWLEDGE IN ACTION

Faculty of Business Economics

Master of Management

Master's thesis

The effects of National culture and Geographic proximity on the innovation performance of Industry-University collaborations

Modou Lamin Sey

Thesis presented in fulfillment of the requirements for the degree of Master of Management, specialization Strategy and Innovation Management

SUPERVISOR :

dr. Relinde COLEN

Disclaimer

This master thesis was written during the COVID-19 crisis in 2020. This global health crisis might have had an impact on the (writing) process, the research activities and the research results that are at the basis of this thesis.

Preface

I would first like to thank my thesis supervisor Dr Linde Colen. In addition to providing the thesis topic, she consistently allowed this paper to be my own work, but steered me in the right direction whenever she thought I needed it. Throughout the project, she provided me with very clear feedback, which helped me improve the quality of this final thesis. She was always available for questions and solved problems whenever it was needed. Additionally, I appreciate her patience and understanding during my periods of illness.

I would also like to thank all my lecturers at the Faculty of Business Economics, for giving me all the skills and valuable knowledge which will definitely shape my future entrepreneurial career. Finally, I must express my very profound gratitude to my parents and siblings for providing me with unfailing support and continuous encouragement throughout my years of study and during the process of writing this thesis.

Modou Lamin Sey

Summary

Background: Innovation has been recognized by most firms as critical for the development of novel or improved products, processes, and services to remain competitive. In light of the importance of Industry-University collaborations (IUCs) towards enhancing the competitive advantage of firms via innovation, it is vital to ensure successful outcomes of IUCs.

Objectives: The objectives of this paper are: (i) to determine whether national cultural values impact the innovation performance of IUCs, (ii) to determine the effects of the differences in national cultural values between the industry and university partners on the innovation performance of IUCs, and (iii) to determine the effects of geographical proximity on the innovation performance of IUCs.

Research Methodology: This paper used a panel dataset on the patent and publication activities of 60 of the most prominent pharmaceutical firms in the world from 1995 to 2002 to answer the research questions. The dataset consisted of 2588 observations. Negative binomial and Logistic regression models were fitted to analyse the two dependent variables DVwc (Number of patents of a firm citing the publication + the citations of those patents) and D_Dvn (If the publication has been cited by at least 1 patent). Rstudio statistical software version 1.2.1335 was used for the analysis.

Results and Discussion: The results of the analysis from both the Negative binomial and logistic regression models showed that the national cultural values of the firm's country significantly impact the innovation performance of the IUCs it is involved with. In particular, Hofstede's national cultural variables of Long term orientation (LTO) and Power distance (PD) both had a significant and negative impact on the innovation performance IUCs. This implies that IUCs involving firms from countries with higher scores on PD and LTO published less innovative publications.

The negative effects of high power distance scores on the innovation performance of IUCs are not surprising since creativity and innovation are associated with higher degrees of freedom and individuality (Erez and Nouri, 2010; Kaasa and Vadi, 2010). Individuals in societies with high power distance scores tend to lack the authority to make decisions on innovativeness which decreases their desire to solve problems (van Everdingen and Waarts, 2003; Waarts and Van Everdingen, 2005). On the other hand, individuals in low power distance societies have less rigid hierarchies to navigate due to the low power distance barriers thus they can create novel solutions to solve their societal issues (Shane, 1992; Kaasa and Vadi, 2010).

Firms in high power distance societies model their organizational culture similar to their society's national culture, as national culture deeply influence organizational culture (Mccarthy, 1998). As a result, innovation activities from such firms will be directed from above with checks and balances established to monitor output and behaviours. Such firms are also internally focused leading to reduced external idea stimulation, information gathering and organizational

learning (Büschgens et al., 2013; Lemon & Sahota, 2004). Consequently, the innovation performance of IUCs involving firms from high power distance societies would be lower.

Societies with high scores of long-term orientation take a more pragmatic approach to life. They tend to encourage thriftiness, strong savings and investment culture, and perseverance to achieve their future goals. The results of this study showed that societies with high long-term orientation scores tend to be less innovative. Long-term-oriented societies encourage thrift and long-term planning for the future and as a result, produce less innovative solutions to immediate societal challenges. In contrast, short-term orientated societies desire quicker results and hence will churn out more innovative solutions to solve immediate societal challenges (Tian et al., 2018).

Firms from short-term orientated societies face shorter product lifecycles, increasing customer demands and stiff price competition from rivals, which means that they are under high pressure to produce innovative solutions fast. Especially, considering this study consisted of firms in the pharmaceutical sector who are often under high pressure to come with new drug discoveries for current health challenges. As a result, the innovation performance of IUCs involving firms from countries that score low on Long-term orientation would be higher.

Differences in national cultural values were found not to impact the innovation performance of IUCs. Whilst congruency is associated with greater trust, congruency in national cultural values may not be enough to build trust in IUCs. This could be for several reasons. Firstly, the kind of trust that needs to be built in IUCs are mostly related to reputation effects. Reputation effects here refers to the character, expertise, reliability and competence of the partner. Secondly, a greater understanding of each others' needs and capabilities increases decision process similarity and reciprocal communication which cements trust between partners. These factors tend to require collaboration experience to cement (Mora-Valentin et al., 2004).

The results from the Negative binomial model indicated that geographic proximity had a positive and significant effect on the innovation performance of IUCs. This implies that greater physical distance between the firm and university was associated with higher innovation performance. Local and regional collaborations are not the only source of novel knowledge, rather strategic collaborations of interregional and international reach are essential for frequent acquiring of new knowledge (Owen-Smith et al., 2002). Infact, knowledge coming from distant partners have a potential for the creation of radical innovations since they are generally characterized by different paradigms. Furthermore, with the widespread availability of latest communication technologies, the need for frequent face-face communication is reduced. Thus, novel knowledge can be acquired from far away regions and the advancements in communication technology reduces the need of having to frequently meet in person.

Research Implications and Limitations: In light of the importance of Industry-University collaborations (IUCs) towards enhancing the competitive advantage of firms via innovation, it is vital to ensure successful outcomes of IUCs. The results from this study showed that the

national cultural values of the firm's country and geographic proximity between the firm and the university impact the innovation performance of IUCs.

In particular, firms from societies with high Power distance and Long term orientation (LTO) scores were associated with lower IUC innovation performance. Thus, firm managers should implement an organizational culture that fosters reduced power distance between managers and employees. A less rigid hierarchical culture would empower employees to come up with novel innovation ideas which the firm may collaborate with universities if it doesn't have the competencies to develop in-house. Furthermore, the firm's innovation activities should focus on current societal challenges.

Greater geographic distance between the firm and the university was associated with higher innovation performance. Firms collaborating with research universities, even though they may be located far away from their regions was associated with higher innovative performance. This is because knowledge coming from distant partners has the potential for the creation of radical innovations since they are generally characterized by different paradigms.

Hofstede's national cultural dimensions give average national scores for different national cultural values. Even though the cultural values of the country influences the firm's organizational culture, they are not necessarily deterministic for the individual firms in that country. For instance, a country might have on average a high power distance score but a firm from that country may have a less rigid hierarchical organisational structure and thus a lower score. Finally, the results from this paper reflect those of the pharmaceutical industry and thus cannot be confidently extrapolated to all industries.

Contents

List of Figures

List of Tables

Chapter 1: Introduction

1.1 Introduction

Innovation has been recognized by most firms as critical for the development of novel or improved products, processes, and services to remain competitive. However, many firms still find it hard to produce innovations beyond their current competencies (Stuart & Podolny, 1996). As a result, external knowledge sources can be a vital component to augment the firm's knowledge base. Hence, firms by collaborating with different external partners can fill this innovation gap by tapping into new knowledge sources.

Two major classifications of innovation are open and close innovations. Open innovation can be defined as a phenomenon in which firms make greater use of external ideas and technologies and allowing unused internal ideas and technologies to be utilized by other firms (Chesbrough, 2003a). Organisations using closed innovations generally tend to ignore critical ideas of outsiders based on their conviction of superiority with monopoly of knowledge, which leads to the 'Not Invented Here (NIH)' syndrome (Katz &Allen, 1982).

One form of open innovation is Industry-university collaborations (IUCs). IUCs can be described as the exchange of technology and knowledge from the interactions between higher education institutions and industries. In today's knowledge base societies, universities play a key role in the acquisition of economic growth (Pinheiro et al. 2015a). As a result, many governments prioritize them in their innovation policy agendas. For example, Australia, ranked among the top ten OECD countries for innovation performance, ranked last for the share of IUCs. This resulted in the country to formulate a new innovation strategy dubbed ''Ensuring Australia's Future Competitiveness through University-Industry Collaboration" (Australian Industry Group, 2015).

Universities collaborating with industry has become a mainstay in university funding, in fact a significant source of funding in the higher education sector today comes from business enterprises (OECD, 2015). In light of the importance of IUCs towards enhancing the competitive advantage of firms via innovation and its financial significance to universities, it is vital to ensure successful management of IUCs to bring to fruition these benefits on both sides.

Culture has been shown to impact innovation at both the national and organizational levels (Cameron & Quinn, 1999; Tian et al, 2018). Culture refers to "the collective programming

of the mind that distinguishes the members of one group or category of people from others" (Hofstede et al., 2010, p. 6), and this lifestyle and collective programming of the mind are "handed down from one generation to the next through means of language and imitations" (Adler, 2002, p. 16). The majority of research on national culture and innovation have focused on the effects of national culture on national innovation performance (e.g., Jones & Davis, 2000; Kaasa & Vadi, 2010; Rhyne et al., 2002; Shane 2003; Singh, 2006; Tian et al., 2018; Allred and Swan, 2004). Lin (2009), studied the effects of national culture on the innovation performance of firms. Considering how critical national culture is to innovation, its effects on the innovation performance of IUCs have not yet been studied in literature. Thus, this paper would shed new light on the impact of national cultural values on the innovation performance of IUCs.

Trust has been regarded as an important factor that fosters successful IUCs (Attia, 2015; Canhoto et al. 2016; Barnes, Pashby, & Gibbons, 2002). Trust can be defined as the positive expectations of the intentions or behaviour of another party in ambiguous situations and being psychologically willing to be vulnerable (Morgan & Hunt, 1994; Rousseau, Sitkin, Burt, & Camerer, 1998). Trust influences the information flow and strengthens the objectives of the IUC (Barnes et al., 2002). Research on trust formation between industry and university partners has shown that it is affected by past experiences in working together, historical experiences in collaborating, decision process similarity and reciprocal communication (Barnes et al., 2002; Bstieler, Hemmert, & Barczak, 2017).

According to the value congruency model, congruency is associated with positive outcomes such as greater employee satisfaction, reduced conflicts, higher work efficiency, more commitment, and higher outcome performance (Knoppen et al. 2006). A shared set of common values fosters trust by minimizing uncertainty in the way employees think, feel and work (Schein, 1985). Hofstede's cultural dimensions of power distance and masculinity-femininity, especially, may affect congruency and consequently trust formation between industry and university partners. Power distance is 'the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally' (Hofstede, 2001, p. 98). Thus, conflicts may arise when university and industry partners from countries on the opposite end of power distance scores collaborate, and vice versa for partners from similar power distance score cultures.

Feminine societies have been associated with harmony thus fostering low conflict and high trust (Kaasa and Vadi, 2010). Masculine societies on the other hand are associated with assertiveness and competition (Hofstede, 2001). As a result, when university and industry partners from societies on the opposite end of masculinity scores collaborate, conflicts may arise. Hence, taking the perspective of how national cultural similarities and differences between industry and university partners affect trust formation and consequently impact the innovation performance of IUCs brings a new perspective on the factors that foster successful IUCs innovation performance.

Frequent communication at both the management and operational levels positively impacts IUCs (Hong, Heikkinen, & Blomqvist, 2010; Wu, 2017). This includes frequent interaction, ongoing feedback, mutual information exchange and keeping partners updated about new activities. Thus, it is not surprising that geographical proximity has been found to impact the success of IUCs. Geographical proximity refers to the physical distance between the focal firm and the university. Although most evidence favours short distance between collaborating partners (e.g., Crescenzi, Filippetti, & Lammarino, 2017; Feldman, 1994), other studies show that successful IUCs tend to occur between geographically distant partners (e.g., Petruzzelli, 2011). Consequently, this paper will contribute to the existing literature on the effects of geographic proximity on the innovation performance of IUCs.

This paper uses a panel dataset on the patent and publication activities of 60 of the most prominent pharmaceutical firms in the world from 1995 to 2002 to answer the research questions. The remainder of this paper is organized as follows: Chapter 2 reviews the literature. Chapter 3 discusses the research methodology of the Study. Chapter 4 presents the results while Chapter 5 discusses the results. Chapter 6 concludes the paper.

1.1.1 Research Questions

1. Do national cultural values impact the innovation performance of Industry-University collaborations?
2. What are the effects of the differences in national cultural values between the industry and university partners on the innovation performance of Industry-University collaborations?
3. Does geographic proximity between the firm and university impact the innovation performance of Industry-University collaborations?

1.1.2 Research Objectives

The objectives of this paper are:

1. to determine whether national cultural values impact the innovation performance of Industry-University collaborations.
2. to determine the effects of the differences in national cultural values between the industry and university partners on the innovation performance of Industry-University collaborations.
3. to determine the effects of geographical proximity on the innovation performance of Industry-University collaborations.

Chapter 2: Literature Review

2.1 What is Innovation

Various classification of innovations have been created and used in literature. Technology-related innovations, such as the introduction of products that require radical amendments in the production process have been the main focus of researchers. However, the concept of innovation goes beyond radical innovation of technology-based products and can be described as something that not only brings about improvements to products and services but also changes to organizational structures and activities, to exploit new markets (Abernathy & Clark, 1985; Cumming, 1998; Johannessen, Olsen & Lumpkin, 2001). This definition of innovation is reflected in the thinking of Lundvall (1992, p. 8), who conceptualizes innovation as '... on-going processes of learning, searching and exploring, which result in new products, new techniques, new forms of organization and new markets'.

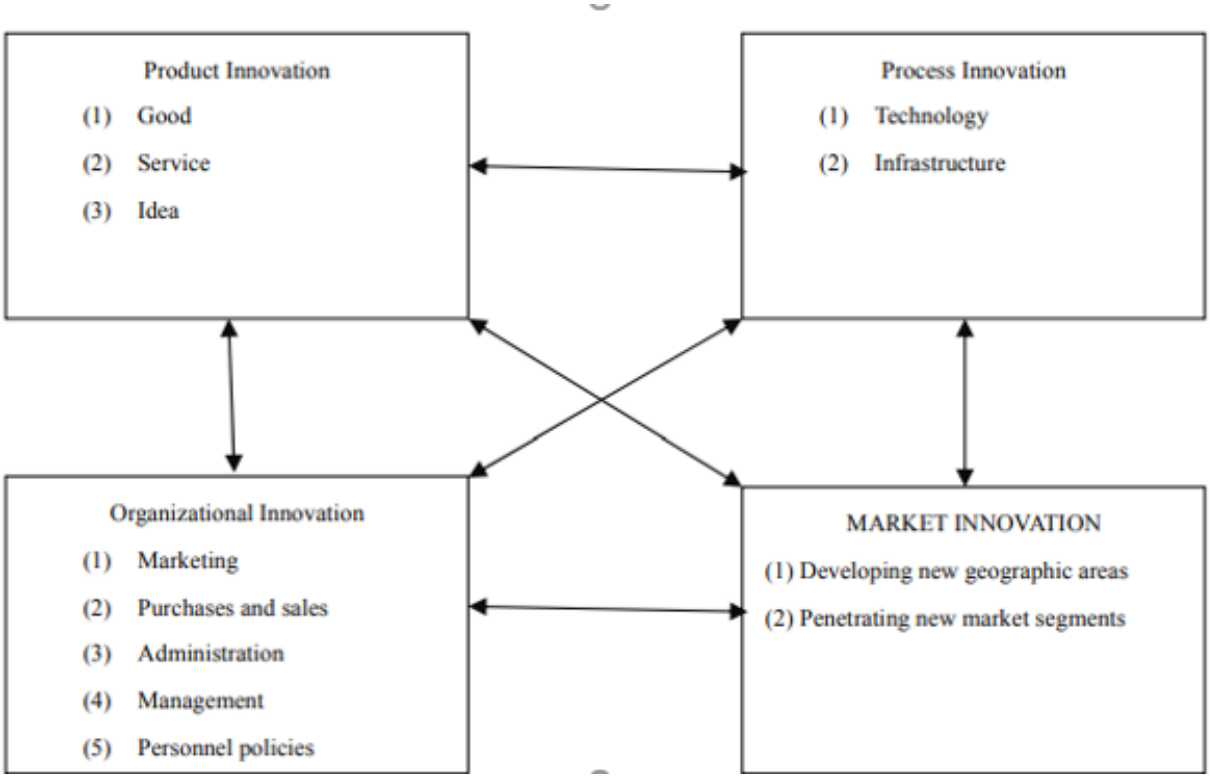

Figure 2.1: Domains of the concept of innovation, adopted from Lundvall (1992).

Product innovation can be described as a good, service or idea that a person or an organization perceives as new, though another person or organization may not see it as a novelty (Lundvall, 1992; Caraça et al., 2009). Changes in a firm's organizational structure can stimulate product innovation. For instance, a more efficient organization of internal controls leading to improved product quality. A firm's management decision to explore new markets could also result in product innovation. For instance, the information and communication technology (ICT) sector has led to the emergence of new markets resulting in products such as personal computers and GPS systems (Tidd Bessant & Pavitt, 1997).

Product innovations go in tandem with changes in processes. Examples of process innovations include reconfiguring existing production lines, installing completely new infrastructure, and implementing new technologies (Jenssen & Aasheim, 2010).

Organizational innovation involves changes in aspects of formal interaction between the people in the organization such as in relations with authority, organizational design, job roles, incentive systems, communication systems among others. A prominent example of organizational innovation is the success of standard ISO 9000, which resulted in rules for enabling transparent processes, documentation, reproducibility and controllability (Tidd et al., 1997).

Market innovation utilizes the organisation's strategy to explore new unchartered markets and penetrate new market segments. Market innovation is strongly associated with product and organizational innovation and less so with process innovation as demonstrated in the biotechnology sector (Khilji, Mroczkowski & Bernstein, 2006).

2.2 Open innovation

Open innovation can be defined as a phenomenon in which companies make greater use of external ideas and technologies in their firms and allowing unused internal ideas and technologies to be utilised by other firms. It is based on the idea that the sources of knowledge for innovation are distributed across society. An open innovation model emerged due to several factors that resulted in the previously dominant "closed innovation model" to lose its position. These factors include increased mobility of workers, increasing numbers of capable universities, venture capital availability to more startup firms, and increased competition among developed and newly industrialized countries (Chesbrough, 2003a).

There are three ways in which knowledge flows in a firm. Firstly, knowledge inflows to the focal firm via internal processes leveraging external knowledge sources. Secondly, knowledge outflows from a focal firm via external commercialization processes leveraging internal knowledge. Finally, both ways via coupling knowledge sources and commercialization processes (Chesbrough et al., 2006).

However, most attention has been paid to outside-in open innovation compared to Inside-Out and Coupled types. For instance, West and Bogers (2013) in a review of 165 open innova-

tion articles found 118 discussing outside-open innovation compared to 50 articles discussing inside-out innovation. They also found 70 articles that discussed Coupled open innovation, however, there still is a dearth of understanding of the ins and outs of coupled innovation processes.

The Outside-In type of open innovation involves a firm sourcing external knowledge to add to its own innovation processes. Additionally, it includes acquiring, integrating and commercializing the external knowledge inputs (Dahlander and Gann, 2010; West and Bogers; 2013). The firm then consults its business model to determine which of the external knowledge inputs will be pushed to the market. There are various mechanisms through which firms source knowledge inflows. They include in-licensing intellectual property (IP), Industry University collaborations (IUCs), startup funding, crowdsourcing, competitions and tournaments, communities, spin-ins or spin-back, or collaborating with intermediaries, suppliers and customers (Chesbrough et al., 2006).

In the inside-out type, other firms acquire the unused and under-utilised knowledge and assets of the focal firm and utilise it in their business models. The focal firm often has problems in utilising this knowledge in their business model, as a result, the receiving firm has to discover the right business model in order to take the idea to market (Arora, Fosfuri, and Gambardella, 2001a). There are various ways in which the focal firm manages this outflow of knowledge through selling or revealing. They include outlicensing IP and technology, donating IP and technology, spin-outs, corporate venture capital, corporate incubators, joint ventures and alliances (Chesbrough 2003a, 2006a).

In the Coupled type of innovation, innovation is developed and /or commercialized through collaborating and consolidating inflows and outflows of knowledge. In other words, two or more partners collaborate to jointly invent and commercialise activities by purposively combining inflows and outflows of knowledge (Bogers, 2011; Bogers, Bekkers, and Granstrand, 2012). Couple innovations may employ mechanisms from both Outside-in and Inside-out innovation to manage their open innovation activities. The firm may also implement unique mechanisms involving complementary partners such as strategic alliances, IUCs, joint ventures, consortia, networks, ecosystems and platforms (Chesbrough et al., 2006a).

2.3 The Industry-University collaboration process

Industry–university collaborations (IUCs) have a long history in various countries (Ankrah and AL-Tabbaa 2015) and in today's knowledge base societies, universities play a key role in the acquisition of economic growth (Pinheiro et al. 2015a). IUCs have gained significant prominence in recent years propelled by the objectives of universities to go beyond their traditional core missions of research and teaching. Universities have now added a third mission, to commercialize their research, through various means including patenting, technology transfer offices and science parks (Marhl and Pausits 2011).

IUCs can be described as the exchange of technology and knowledge from the interactions between higher education institutions and industries. There are several reasons for IUCs from both the university and the firm's perspectives. Firms benefit from access to high intellectual capital such as researchers and students (Myoken, 2013); technology and knowledge (Barnes et al., 2002); and research facilities (Ankrah and AL-Tabbaa 2015). The main goal of firms is to come up with innovations that provide them with competitive advantages. Similarly, universities benefit from the injection of funds, access to industry technology, and income from licensing patents (Barnes et al., 2002).

IUCs involve many commonly studied paradigms such as cooperation, teamwork and coordination (Bedwell et al., 2012). IUCs do face decision-making challenges due to differences between the partners regarding their goals, viewpoints, motivations and routines (Bäck and Kohtamäki, 2015).

According to Amabile et al. (2001), IUCs have three characteristics. Firstly, the partners are from different professions i.e. academia and industry. Secondly, the collaboration is not between the organisations, rather it is between individuals or teams. Finally, the collaborators are not all from the same organization. Certain specific features of the collaborators are responsible for the motivation and maturity of the collaboration while the organization provides the framework for the collaboration. The two most important steps in IUCs are the Initiation and implementation phases.

2.3.1 Initiation phase

IUCs involves innovation collaborations with a partner(s) from a different organization. Hence, Academic researchers and firm representatives would have to make sure that they have the motivation to be involved in the IUC since the process is outside their usual routine (Proulx et al., 2014). Hence, motivation is a vital factor for successful collaborations.

The presence of absorptive capacity is another crucial factor in the initiation phase. Absorptive capability is defined as the ability to use prior knowledge to assess and make use of outside knowledge (Cohen and Levinthal, 1990). The main goal of IUCs is to obtain a strategic resource that the firm lacks from its collaborating institution. As a result, absorptive capacity is necessary to select the ideal partner needed for the collaboration.

Innovation outputs and outcomes have been found to have strong associations with absorptive capacity (Zahra and George, 2002). The absorptive capacity in the initiation phase can be described as the potential capacity to acquire and assimilate knowledge in contrast to realised capacity which includes knowledge transformation and exploitation (Zahra and George, 2002). Potential absorptive capacity is dependent on previous related knowledge with basic skills and even shared language. This previous related knowledge includes prior similar collaborations and understanding of partner's domain-specific routines, processes, aims, and perspectives (Rajalo and Vadi, 2017).

The initiation of IUCs starts with a specific organizational boundary experienced by the initiating partner. Organisational boundaries refer to organisation-specific delineations between organisations and their environment. There are four identified distinct organizational boundaries- efficiency, power, competence and identity. The need for IUCs is determined by the last two (Santos and Eisenhardt, 2005). The competency boundary in particular can initiate a firm to collaborate with an academic researcher. The competency boundary focuses on a firm's resources portfolio to decide which resources it needs to acquire to gain a competitive advantage. Collaboration with outside partners will be necessitated if the firm does not possess the required internal resources to gain the competitive advantage it seeks (Rajalo and Vadi, 2017).

The boundary of identity also comes into play during the initiation phase as collaboration between the two partners are affected by their organisational identities. The boundary of identity compares how the organisation identifies itself and the alignment of the organisation's routine activities to that of their innovation collaborations. Organizational members form cognitive frames by performing collective sensemaking. These frames could either facilitate or hinder working together in IUCs. Collaboration with a member of another organization becomes more complex if the cognitive frames are too rigid (Weick, 1995; Santos and Eisenhardt, 2005).

2.3.2 Implementation phase

IUCS enter the implementation phase after finding some minimal motivation. During this phase, they start exploring unfamiliar territories presenting new boundaries. During the initiation phase, organisation-specific boundaries were required and realized by the initiating partner. On the other hand, collaboration-specific boundaries are faced during the implementation phase which require collaboration specific boundary-crossing mechanisms.

Different expectations and interests may be encountered even though the different partners in the innovation collaboration came for a specific purpose. To meet these expectations, the different actors should be guided by a shared vision. Meeting these expectations will help in bringing the technological and scientific change needed in the innovation process. Two identified collaboration-specific boundaries that exists during IUCs are semantic and pragmatic boundaries (Rau et al., 2012).

Semantic boundaries refer to the differences in interpretation among diverse partners. Partners interpret the novel knowledge they encounter based on their cognitive framework different from their counterparts. However, once this semantic boundary is overcome, the knowledge sharing and innovation collaboration can begin (Dougherty, 1992; Rau et al., 2012).

Rau et al. (2012) propose the following mechanisms to solve the issue of interpretive differences among the different actors: 1) "rely on a joint structure", 2) "engage a translator", 3) "learn and adapt the counterparts' language", and 4) "develop a mutually understood language" The "rely on a joint structure" mechanism utilises a shared space such as technology

and knowledge sharing networks to bridge the semantic boundary. Examples of joint structures include technological development centres, clusters etc.

The "engage a translator" mechanism uses a mediator who understands the initial met and unmet needs of both partners. The mediator would then translate knowledge to the partner expected to absorb the knowledge with links to the partners domain.

In the "learn and adapt the counterparts' language", the partners utilise each other's contextual information based on the assumption that they can comprehend and exchange knowledge in their partner's language. However, if the collaborations are with partners from very divergent domains, difficulties may be encountered since partners find it difficult to comprehend each other's cognitive framework (Rau et al., 2012).

In the "develop a mutually understood language" mechanism, knowledge sharing occurs via representations. In contrast to the "rely on a joint structure", it is not presumed that the partners have a common comprehension of representations. During this process, a new language is developed by partners through their mutual characterization of representations (Rau et al., 2012). Semantic boundary crossing agrees with the concept of absorptive capacity because all four semantic boundary-crossing mechanisms presume a clear description of the differences in the knowledge attained by each partner and an explicit definition of the shared knowledge (Rajalo and Vadi, 2017).

Rau et al. (2012) propose the following Pragmatic boundary-crossing mechanisms 1) "anticipate interests", 2) "reframe interests" and 3) "negotiate interests". Partners try to comprehend how their counterparts make sense of things, which comes down to sense-making theory. By trying to understand sense-making among counterparts, partners know what motivates counterparts, assimilate them and their behaviours appropriately to facilitate knowledge sharing. The "reframe interests" mechanism enables partners to alter their interests to be more aligned with their counterparts' interests avoiding potential conflicts that could arise from divergent interests. The "negotiate interests" mechanism enables dialogue to achieve agreement in situations of differing interests. However, this mechanism could be long and tedious because it involves giving and receiving feedback until a consensus is reached by the parties involved (Rau et al., 2012).

2.4 Factors that impact the success of Industry-University collaborations

The factors that impact the success of IUCs can be divided into institutional, relationship, output and framework factors.

2.4.1 Institutional factors

Resources: The resources of a partner are very important in determining not only the quality and success of IUCs but also limits the number of potential partners considerably (Ferru 2010). Resources identified to be critical for IUCs include finance, time, staff and equipment. Good timing is essential for IUCs. Industry requires constant presence whereas universities face restrictions as they follow the semester structure (Wu, 2017). Additional key resources include access to highly qualified researchers, infrastructure such as lab space or technical equipment is important (Boardman and Bozeman, 2015).

Structure: the difference in organization structure of universities and industry may act to slow the success of IUCs. For instance, the bureaucratic organization of universities may lead to blurred roles of project members which could retard successful collaborations. This is especially relevant since when the parties involved in the collaboration know their roles, it ensures commitment and dedication to the project (Franco and Haase 2015). Also, a positive effect has been when the roles of the members are clarified from the beginning further smoothening the collaboration (Muscio and Vallanti 2014). Inadequate administrative support or differences in decision making may also impact collaboration successes (Franco and Haase 2015). As a result, setting up a project management team to facilitate the communication and coordination between the collaborating partners will help ameliorate this problem (Rajalo and Vadi 2017).

Willingness to change: Firms and universities could further enhance their collaboration success if they are willing to work closely and accept and implement feedback from each other for more improvements. Willingness to change is a key success factor in collaborations and it involves adapting to a variety of situations and cultures (Logar et al. 2001). However, in order to find the best way to collaborate, partners need time to learn about one another (Canhoto et al. 2016).

2.4.2 Relationship factors

Communication: Communication plays a vital role in the success of IUCs. Frequent communication such as regular interaction, continuous feedback, mutual exchange of information and updating partners about incidents, enable a common understanding. This should be implemented at both management and operational level (Hong et al., 2010; Wu ,2017). Timely and regular communication is especially beneficial for new partnerships to establish expectations about the future behaviour of partners. Partners should also select the right communication channels that favours all of them because not selecting an effective channel could be a barrier to a successful collaboration (Guan et al. 2005).

Commitment: Commitment from both partners is crucial for IUC success. Commitment refers to the degree to which a person identifies with, is loyal to and willing to put in effort in a collaboration (Attia 2015). Commitment from the top management is also vital because as

leaders, they are responsible for releasing resources needed for collaboration. Researchers with favorable views about collaborations are also more likely to be committed (Ankrah and AL-Tabbaa 2015).

Trust: Several authors consider trust as another crucial relationship variable for successful IUCs (e.g., Attia 2015; Canhoto et al. 2016). Partners in successful collaborations describe trust as being a binding factor while those in modest collaborations describe the lack of trust as negatively impacting the collaboration (Rajalo and Vadi 2017). Sufficient time should be spent by partners on developing mutual trust especially through maintaining personal contacts at the beginning of the partnership. Mistrust causes partners to divert from their original collaboration objectives because it changes the course of the information flow. Implementing similar operating and decision-making systems has been shown to sustain and strengthen trust (Barnes et al. 2002).

The relationship between trust and the type of communication has generated mixed results. Some have found face-face communication essential for building trust while others have found it not necessary to build trust (Canhoto et al., 2016). Additional ways of increasing trust include building stronger ties among partners, having an unquestionable reputation, and implementing contracts. However, in situations where strong ties exist between partners, excessive use of contractual safeguards could also weaken trust (Hemmert et al., 2014).

Culture: The differences in organisational culture may also play a role in the success of IUCs. An organisation's culture influences how the members think, feel and act when faced with challenges (Schein, 2004). Partners must recognise that cultural gaps exist between Industry and University and should strike a balance between each other's objectives and priorities. Since each organization has their own culture, partners must work quickly to identify their differences and cement a shared language early in the project (Canhoto et al., 2016). Even minor activities such as meetings can be difficult If partners have differing interpretations about the operations and impact of those meetings (Starbuck, 2001).

2.4.3 Output factors

Objectives: Incompatibility of goals of the collaborations between firms and universities may also impact the success of collaborations. For instance, the main goal of universities is to publish their findings while firms intend to keep findings secret to obtain competitive advantage over their rivals (Newberg and Dunn, 2002). It is vital to ensure that the right partnership is chosen from the beginning with similar objectives and interests to create a symbiotic winning relationship. Hence, partners must understand what they intend to gain from the collaborations to choose the ideal partnership that will create a win-win situation (Arvanitis et al., 2008). If the objectives and expectations of collaborations between partners diverge, it leads to misunderstanding and creates doubts about the priorities of both partners (Attia, 2015). Having identified the objectives and expectations of the collaboration, appropriate search strategies can help to find the right partnership. For example, Barnes et al. (2002) propose using well-

defined criteria to select the ideal partner.

Knowledge and technology transfer: Knowledge and technology transfer is another important factor for successful IUCs (Philbin, 2010). Several factors have been identified that limit knowledge transfer. They include discrepancies in knowledge base (Hong et al., 2010), cultural differences (de Medeiros et al., 2012) or inadequate knowledge transfer experience (Schofeld, 2013), knowledge and technology type (Ankrah and AL-Tabbaa, 2015) and the explicitness of the knowledge (Santoro and Bierly, 2006; Xu et al., 2014). Appropriate policies and incentives can help facilitate knowledge transfer since it is also a matter of motivation and strategy (Schofeld, 2013).

2.4.4 Framework factors

Frameworks factors may also impact the successes of IUCs and include government support, legal restrictions and the market environment. Governments through favourable policies such as- tax incentives (Bodas Freitas et al., 2013a), public funding (Flores et al., 2009; Piva and Rossi-Lamastra, 2013) or the governmental network (Rampersad, 2015) can positively impact the success of IUCs. However, the government through legal restrictions and regulations (Arvanitis et al. 2008; Attia, 2015) or inadequate regional support frameworks (Serbanica, 2011) can hinder the success of IUCs. Generally, government support is frequently needed to facilitate IUCs (de Medeiros et al. 2012; Hemmert et al. 2014; Newberg and Dunn, 2002; Schofeld, 2013). The market environement that may impact the successes of IUCs include the market potential of the research results (Ankrah and AL-Tabbaa 2015; Barnes et al. 2002; Guan et al. 2005) or market uncertainties (Hemmert et al. 2014).

The other two framework factors are contracts and intellectual property rights (IPRs). Contracts are important for several reasons such as- reducing the likelihood of disputes (Ankrah and AL-Tabbaa 2015; Barnes et al. 2002; Lee 2011), enhancing trust (Hemmert et al. 2014) and to validate whether the goals of the project have met (Xu et al. 2014). Contracts are even more crucial in complex IUCs (Starbuck, 2001) or to ensure joint use of costly infrastructure (Bychkova, 2016). As for patents or other IPRs disputes may arise from project ownership or royalty payments (Arvanitis et al., 2008; Attia 2015; Guan et al. 2005; Schofeld, 2013).

2.5 Geographic proximity and innovation

Frequent communication at both the management and operational levels positively impacts IUCs (Hong, Heikkinen, & Blomqvist, 2010; Wu, 2017). This includes frequent interaction, ongoing feedback, mutual information exchange and keeping partners updated about new activities. Thus, it is not surprising that geographical proximity has been found to impact the success of IUCs.

Geographical proximity refers to the physical distance between the focal firm and the university. Firms collaborating with universities in the same country may benefit from knowledge

spillovers from other R&D activities of similar firms which may impact the innovation performance of the firm positively (Feldman, 1994). On the other hand, too much proximity may have negative effects on innovation due to the problem of lock-ins (Boschma, 2005).

The impact of geographic proximity via international collaborations has generated mixed results. According to Guan & Chen (2011), most patenting countries have taken part in international collaborations. An increase in foreign collaborations was associated with a higher number of citations and ultimately higher scientific impact (Adams, Black, Clemmons & Stephan, 2005). Local and regional collaborations are not the only source of novel knowledge, rather strategic collaborations of interregional and international reach are essential for frequent acquiring of new knowledge (Owen-Smith et al., 2002).

On the other hand, geographically distant collaborations face higher levels of conflicts compared to geographically close collaborations. The reasons are due to the distance separating the teams and reliance on technology for communication and work. Even communication via the use of the latest technological advances was not effective in reducing conflicts among geographically distributed teams (Hinds & Bailey, 2002).

Wagner, Whetsell, & Mukherjee (2019) found that more mainstream and less novel knowledge was produced with international collaborations. According to the authors, the high citation rates to international collaboration works could be accounted for by the audience factor. In other words, many authors coming from many countries result in more access to a bigger citing community. According to Sud and Thelwall (2016), international collaboration was not beneficial except for collaborations with the United States and with some other few countries and a decrease in impact with collaborations with some other countries was observed.

2.6 Effects of National culture on organizational culture and individual behaviour

Organisations in addition to creating cultures of their own, operate within and across cultures. Members of organisations (managers and workers) may enhance or retard the organisation's activities based on the shared meanings they create and receive. This exchange of meanings operate at three levels: the micro individual or small group level, the level of the large group (e.g. managers, women/men workers) and at the overall organisational level (Griswold, 1994). National culture impacts organisations differently according to the level of the organisation. It has been observed that peoples' behaviour within organisations continue to express culturally based differences even though organisations are becoming more alike in terms of structure and technology (Alder et al., 1987).

2.7 National culture and innovation

A society's cultural values impact innovation because values that underly innovation such as creativity, ingenuity or originality would prosper more in less culturally authoritarian societies (Erez and Nouri, 2010; Kaasa and Vadi, 2010). Hofstede's cultural dimension theory is a cross-cultural communication framework developed by Geert Hofstede which has been widely applied in the discipline of multicultural psychology and other fields based on the idea of national culture. Hofstede's cultural dimension emerged from his IBM project were he studied how employees solve problems, collaborate, and treat their supervisors in different countries between 1967 and 1973. He started with four cultural dimensions but has since evolved to six, they are Power Distance Index, Individualism, Masculinity, Uncertainty Avoidance Index, Long-Term, and Indulgence (Hofstede, G., 2001).

2.7.1 Power Distance

Power distance refers to the degree to which the less powerful members of organizations and institutions accept and expect that power is distributed unequally (Hofstede et al., 2010). Several scholars agree that higher level of novelty in idea generation is demonstrated more often in low power distance cultures because power distance barriers have been broken down (Shane, 1992; Erez and Nouri, 2010; Kaasa and Vadi, 2010; Bradley et al., 2013). On the other hand, individuals in higher power societies have fewer incentives to solve societal problems via innovation because of the belief that they lack the resources or opportunities to make decision on innovativeness (van Everdingen and Waarts, 2003; Waarts and Van Everdingen, 2005). This in turn hinders consumer innovation (Steenkamp et al., 1999), technology innovation (Allred and Swan, 2004;) and national innovation rate (Shane, 1993; Taylor and Wilson, 2012). A reason for the low innovation in high power distance cultures could be the failure of top management to identify operational problems and subsequently propose innovative solutions. Furthermore, subordinates are less likely to initiate the introduction of new products and services in organizations (van Everdingen and Waarts, 2003).

2.7.2 Individualism

Individualistic societies are independent, loose and self-focusing in contrast to collective societies which are made up of solid, binding in-groups (Hofstede et al., 2010). Individualistic societies focus more on the "I" than the "we". Collectivism can be sub-divided into the family (Familism), peers (Companionship), and society (Patriotism) (Realo et al., 1997) or in-group collectivism and social collectivism (House et al., 2002).
Individualistic societies are presumed to enable risk-taking and reward entrepreneurship since the people are more likely to make individual decisions in pursuing their goals or ambitions (Allred and Swan, 2004). Additionally, individuals from individualistic cultures are more likely to adopt innovations as it would differentiate them from the other members (Steenkamp et al., 1999). Such individuals are also likely to offer suggestions for more innovative products and services which in turn will help firms increase their market share and profits (Singh, 2006).

However, a negative association between individualism and innovations was found by Shane (1993). Additional studies have found no significant relations between individualism and innovation (Waarts and Van Everdingen, 2005; Lin, 2009; Kaasa and Vadi, 2010; Engelen et al., 2014).
On the other hand, collective societies are perceived to be detrimental to innovations because individual objectives and activities are secondary to the group's (Jones and Davis, 2000). Nevertheless, several studies show that collectivism can be beneficial to innovations. For instance, some types of collectivism such as patriotism and nationalism (Taylor and Wilson, 2012), friends-related and social-related collectivism (Kaasa and Vadi, 2010) can strengthen innovation at the national level.

2.7.3 Masculinity

Masculine cultures are characterized by ambition, competition and material values and performance. They are expected to be more achievement and success-oriented compared to feminine cultures (De Mooij and Hofstede, 2010). Moreover, masculine societies emphasize training and development of the individuals as well as rewards and recognition of achievements. Hence, masculine societies are associated with higher levels of product innovations (Rhyne et al., 2002). However, feminine societies are more harmonious thus fostering low conflict and high trust. These attributes provide a conducive environment for individuals to cope with uncertainty which is positively associated with innovation (Kaasa and Vadi, 2010).

2.7.4 Long term orientation

This dimension examines how the current and future challenges are associated with the past. Long-term oriented societies are associated with virtues that enable future rewards such as thrift and perseverance. These societies consider values such as adaptability and problem solving as crucial (Hofstede, G., 2001). Long term-oriented cultures are likely to be more innovative since their values correspond to features associated with technological innovations such as long-term planning and investments (Jones and Davis, 2000). However due to short product lifecycles, increasing consumer tastes and intense price competition, firms are under high pressure to develop innovative market products. Thus, short-term oriented cultures could favour innovation since firms need to radically innovate in order to satisfy the fast-changing consumer needs as well as the intense competition from rivals (Tian et al., 2018).

2.7.5 Uncertainty avoidance

This dimension refers to a society's tolerance for uncertainty i.e. it measures how people in a society adopt or reject something new or that doesn't align with the status quo. These societies depend on social customs, rites and bureaucratic practices to mitigate against the unambiguity's of future events (Hofstede, 2001; House et al., 2002). The activities of societies that are high on uncertainty avoidance such as bureaucracies, strict rules and regulations lower their innovation initiatives (Allred and Swan, 2004). On the other hand, cultures with weaker

uncertainty avoidance are conducive for innovations as they typically embrace competition and violate organizational norms and procedures, factors necessary for the generation of new ideas (Shane, 1993; Jones and Davis, 2000; Lim and Park, 2013; Efrat, 2014).

2.7.6 Indulgence

This dimension refers to how flexible a society's customs allow individuals to satisfy their human desires. In other words, it measures the gratification vs control of basic human desires (Hofstede, 2001). Griffith and Rubera (2014) investigated the effects of indulgence on the relationship between technology, design innovation, and market share. Increased indulgence was associated with the strengthening of the positive effects of design innovation on changes in market share. However, increased indulgence was associated with the weakening of the positive relationship between technological innovations and market share.

2.8 National culture and Industry-University collaborations

This section discusses the relationship between national and organizational culture and how they impact the firm's innovation and consequently the innovation performance of the IUCs it is involved with. The review of Section 2.7 has shown that national cultural values play a vital but complex role in influencing innovation at the national/societal level (Tian et al, 2018). For instance, several scholars agree that higher level of novelty in idea generation is demonstrated more often in low power distance cultures because power distance barriers have been broken down (Shane, 1992; Erez and Nouri, 2010; Kaasa and Vadi, 2010; Bradley et al., 2013). It has been posited that national/societal cultural patterns deeply influence organisational culture (McCarthy, 1998).

Organizational culture has been argued to play a vital role in the success of any firm and lies at the heart of the firm's innovation (Tushman, 1997). Organizational culture has been described as "the set of shared, taken-for-granted implicit assumptions that a group holds and that determines how it perceives, thinks about, and reacts to its various environments" (Schein 1996, p. 236). The four types of organizational cultures are market, adhocracy, clan, and hierarchy.

A market culture is externally focused and is associated with competitiveness, goal achievement, and environment exchange (Desphandé & Farley, 2004). Organisations with a market culture have been associated with increased levels of innovation (Demirci, 2013). Market culture is very similar to Hofstede's national cultural dimension of masculinity.

An adhocracy culture is externally focused and is supported by a flexible organizational structure. They are distinguished by entrepreneurial dynamism and risk-taking leadership, innovation, adaptability and problem-solving (Slater et al., 2011). Organizations with an adhocracy culture have been associated with being more responsive to innovation (Knosková, 2015; Brettel et al., 2015) and new product development (Dayan et al., 2016). Adhocracy culture is very

similar to Hofstede's national cultural dimension of uncertainty avoidance.

Organisations with a clan culture are inwardly focused with a flexible organizational structure. They are characterized by teamwork, high cohesion and morale, consensus, employee commitment, human development and participation (Cameron and Quinn, 2006). Organisational cultures that stress on human development, participation and open-decision making have been associated with higher group innovativeness (Hurley, 1995). Clan culture is very similar to Hofstede's national cultural dimension of collectivism.

Organizations with hierarchical culture are internally focused with a stable structure and are characterized by stability, predictability, and efficiency (Cameron and Quinn, 2006). The internal focus of organisations with hierarchical culture has been associated with negative effects on innovation due to reduced external idea stimulation, information gathering and organizational learning (Büschgens et al., 2013; Lemon and Sahota, 2004; Naranjo Valencia et al., 2010). Hierarchical culture is very similar to Hofstede's national cultural dimension of power distance.

Since it is the firm that initiates and sets the direction of IUCs, the firm's organisational culture would also subsequently impact the innovation performance of the IUCs it is involved with. Thus, I hypothesize that the national cultural values of the firm's country would influence the firm's innovation activities and subsequently impact the innovation performance of the IUCs it is involved with.

2.9 National cultural Differences and Industry-University collaborations

This section discusses how differences in the national cultural values between industry and university partners affects trust formation and consequently impact the innovation performance of IUCs. Trust has been regarded as important factor that foster successful IUCs (Attia, 2015; Canhoto et al. 2016; Barnes, Pashby, & Gibbons, 2002). Trust can be defined as the positive expectations of the intentions or behaviour of another party in ambiguous situations and being psychologically willing to be vulnerable (Morgan & Hunt, 1994; Rousseau, Sitkin, Burt, & Camerer, 1998). Trust influences the information flow and strengthens the objectives of the IUC (Barnes et al., 2002). Research on trust formation between industry and university partners has shown that it is affected by past experiences in working together, historical experiences in collaborating, decision process similarity and reciprocal communication (Barnes et al., 2002; Bstieler, Hemmert, & Barczak, 2017).

According to the value congruency model, congruency is associated with positive outcomes such as greater employee satisfaction, reduced conflicts, higher work efficiency, more commitment, and higher outcome performance (Knoppen et al. 2006). A shared set of common values fosters trust by minimizing uncertainty in the way employees think, feel and work

(Schein, 1985). Hofstede's' cultural dimensions of power distance and masculinity, in particular, may affect congruency and consequently trust between parties. Power distance is 'the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally' (Hofstede, 2001, p. 98). Thus, conflicts may arise when university and industry partners from societies on the opposite end of power distance scores collaborate, and vice versa for partners from similar power distance score cultures.

Feminine societies have been associated with harmony thus fostering low conflict and high trust (Kaasa and Vadi, 2010). Masculine societies on the other hand are associated with assertiveness and competition (Hofstede, 2001). As a result, when university and industry partners from societies on the opposite end of masculinity scores collaborate, conflicts may arise. Thus, I hypothesize that the differences in national cultural values between the industry and university partners will impact the innovation performance of their IUCs.

Chapter 3: Research Methodology

3.1 Measuring the innovation performance of Industry-University Collaborations

An innovation performance is defined here in terms of both its technological and economic dimensions. In the technology dimension, innovation is a performance if it has a future impact on future technological inventions. In other words, subsequent inventions are built on it (Fleming, 2001; Ahuja & Lampert, 2001). From an economic dimension, innovation is considered a performance if it affects the firm's competencies and activities, as well as market potential through the value it creates. A range of different methods to measure the innovation performance of collaborations are reviewed below.

Technology mapping: technological mapping identifies inventions that cause a great increase in performance by mapping the performance criteria of technologies overtime (Tushman & Anderson, 1986; Anderson & Tushman, 1990) or by using their technological life cycle to compare competing technological solutions over time (Christensen & Bower, 1996). One drawback to this method is the difficulty in preselecting one or more performance criteria as inventions often change performance criteria. Secondly, in most situations, several subsequent inventions are required to gain the performance increase of the new technology, making it hard to identify the invention responsible for the performance. Finally, this method is hindered by its time-consuming nature. It requires conducting large-scale empirical analysis which requires systematic analysis and mapping technological progress to determine whether the innovation produces a performance (Tushman & Anderson, 1986; Anderson & Tushman, 1990).

Expert assessment: involves using expert judgment to determine the innovation performance of a technology. This is done by conducting surveys that target managers or industry experts. A pro of this method is that direct feedback can be obtained from experts about each innovation performance dimension. However, it comes with two drawbacks. Firstly, hindsight bias that favours publically identified innovations, the ones the expert is most accustomed to or those best remembered by the respondent. Secondly, experts might be difficult to locate or when found may not give detailed responses (Dewar & Dutton, 1986; Chandy & Tellis, 2000).

Hedonic price models: with this method, the invention is dismantled into its separate features, and then the contributory value of each feature is estimated. The innovation performance is determined by how influential each feature is in determining the market price of the inven-

tion. The benefits of this method are its ease of measuring value-creation and distinguishing between different product features and willingness to pay. However, this method has drawbacks. Firstly, selecting the right measurement criteria, which determines the results, might be difficult ex-ante. Secondly, this method only uses economic dimensions to measure the innovation performance and ignores the technological dimension (Henderson & Clark, 1990; Henderson, 1993).

Patent-based measures: patents provide a detailed large-scale evaluation of technological advancement. Calculating forward citations is the most widespread application of patent-based measures used to assess technological impact (Carpenter, 1981; Fleming, 2001) and market value of inventions (Gambardella et al., 2008; Hall et al., 2005). Patent-based measures have the advantage of being easy to develop and measure, however they do have drawbacks when it comes to measuring innovation performance.

Firstly, they only consider the technological impact and do not represent the features of the invention itself because they are ex-post measures. Secondly, they may not give the technological impact to the right invention rather it may be given to the follow-up invention. In other words, the invention that caused the technological development may be ignored and instead the technological impact given to the incremental invention. Finally, factors other than the features of the technological innovation might influence technological impact.

Several indicators associated with patents can be used to assess the technological dimensions of an innovation performance. The following measurements are used to determine the diversity of the source of the invention: the number of various technological classes patents cite but do not belong to (Singh & Fleming, 2010), the number of inventors that worked on it (Singh & Fleming, 2010) and the concentration of patent classes in its backward citations (Trajtenberg et al., 1997).

The degree to which an invention is built on previous knowledge is measured by the number of backward citations (Schoenmakers & Duysters, 2010). The degree to which knowledge is sourced outside of the firm's boundaries is measured by the number of citations to patents residing from other firms and the number of technological fields occurring for the first time in the patent portfolio (Rosenkopf & Nerkar, 2001; Ahuja & Lampert, 2001). The novelty of the knowledge sources of the invention is determined by the age of the patents cited, spread in age (Nerkar, 2003) and the number of references to scientific publications (Gittelman & Kogut, 2003).

In this study, patent-based measures were used to measure the innovation performance of industry-university collaborations(IUCs). Specifically, DVwc (Number of patents of a firm citing the publication + the citations of those patents) and D_DVn (If the publication has been cited by at least 1 patent) were used.

3.2 Data collection

A panel dataset was constructed on the patent and publication activities of 60 of the most prominent pharmaceutical firms in the world from 1995 to 2002. The firms have headquarters in the United States, Europe or Japan and are the largest R&D spenders (in absolute terms) in the pharmaceutical industry as reported in the 2004 EU Industrial R&D Investment Scoreboard. This ranking lists the top 500 corporate R&D investors based in Europe, and the top 500 companies based outside Europe (mainly in the US and Japan), in 2003. The dataset consisted of 2589 observations. It was found that the observation with publication id A1997XR25600033 had a missing value under the log R&D (l_rd) variable, hence it was deleted. The final dataset consisted of 2588 observations.

3.3 Conceptual model

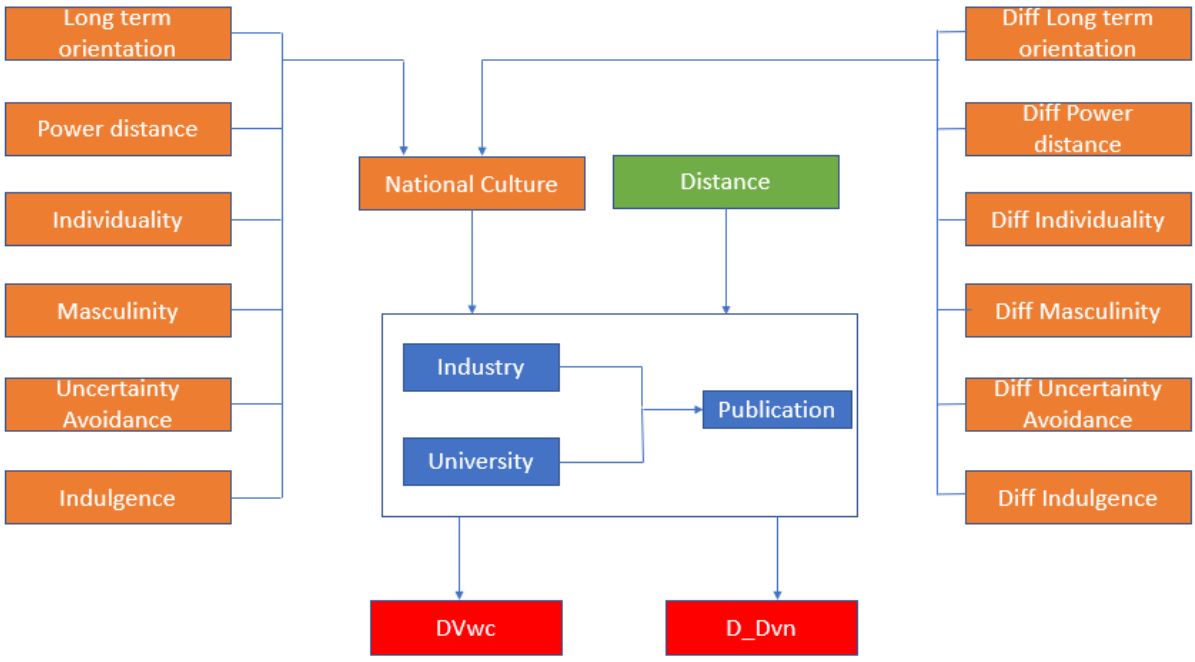

Figure 3.1: Conceptual model: the effects of national culture and geographic proximity on the innovation performance of Industry-University Collaborations

Figure 3.1 depicts the conceptual model derived from insights gained from the literature review. The model consists of three elements-independent variables, Industry-University collaboration and dependent variables. It shows the relationship between the independent variables (National culture and distance), the IUC and the dependent variables.

The independent variables are the national culture and distance variables. The national culture variable is divided into Hofstede's national cultural dimensions and their differences. The distance variable refers to the measured physical distance between the firm and the university. IUC is the industry-university collaboration that links the industry and university partners jointly working on their publications. The dependent variables are the DVwc (Number of patents of a firm citing the publication + the citations of those patents) and D_DVn (If the publication has been cited by at least 1 patent).

To sum up, the model depicts how the independent variables impact the innovation performance of IUC publications as measured by the two dependent variables.

3.4 Variables

3.4.1 Dependent Variables

DVwc (Number of patents of a firm citing the publication + the citations of those patents): This variable indicates how successful the development of the collaborate work (the publication) has been overall. DVwc is a count variable.

D_DVn (If the publication has been cited by at least 1 patent): This variable indicates whether a firm has been able to translate the publication into a patent. D_DVn is a binary variable with 0=No and 1=yes.

3.4.2 Independent Variables

The national culture independent variable is divided into Hofstede's national cultural dimensions and their differences. Hofstede's cultural dimension theory is a cross-cultural communication framework developed by Geert Hofstede which has been widely applied in the discipline of multicultural psychology and other fields based on the idea of national culture. Hofstede's cultural dimension emerged from his IBM project where he studied how employees solve problems, collaborate, and treat their supervisors in different countries between 1967 and 1973. He started with four cultural dimensions but has since evolved to six. They are Power Distance, Individualism, Masculinity, Uncertainty Avoidance Index, Long-Term, and Indulgence (Hofstede, 2001). The scores for the six Hofstede's dimensions were retrieved from the Hofstede-Insights website (Hofstede Insights, 2019).

The differences in Hofstede's national cultural dimensions between the firm's and the university's country made up the other culture variable. This difference is calculated as the absolute difference between the scores of the collaborating firm's and university's countries national cultural variable. For instance, Belgium has a power distance score of 65 while the Netherlands has a power distance score of 38. The difference in the power distance variable will be calculated as (|65-38|=27). The final independent variable is the distance variable which measures the geographic proximity between the firm and the university. The independent

variables used in this study are described as follows:

Power distance: Power distance refers to the degree to which the less powerful members of organizations and institutions accept and expect that power is distributed unequally (Hofstede et al., 2010). The power distance score ranges from 0 to 100 with 0 being the lowest and 100 the highest.

Individualism: Individualistic societies are independent, loose and self-focusing in contrast to collective societies which are made up of solid, binding in-groups (Hofstede et al., 2010). Individualistic societies focus more on the "I" than the "we". The Individualism score ranges from 0 to 100 with 0 being the lowest and 100 the highest.

Masculinity: Masculine cultures are characterized by ambition, competition and material values and performance. They are expected to be more achievement and success-oriented compared to feminine cultures (De Mooij and Hofstede, 2010). The masculinity score ranges from 0 to 100 with 0 being the lowest and 100 the highest.

Long term orientation: Long term orientation examines how the current and future challenges are associated with the past. Long term oriented societies are associated with virtues that enable future rewards such as thrift and perseverance. These societies consider values such as adaptability and problem solving as crucial (Hofstede, G., 2001). The long term orientation score ranges from 0 to 100 with 0 being the lowest and 100 the highest.

Uncertainty avoidance: Uncertainty avoidance refers to a society's tolerance for uncertainty i.e. it measures how people in a society adopt or reject something new or that doesn't align with the status quo (Hofstede, G., 2001). The Uncertainty avoidance score ranges from 0 to 100 with 0 being the lowest and 100 the highest.

Indulgence: Indulgence refers to how flexible a society's customs allow individuals to satisfy their human desires. In other words, it measures the gratification vs control of basic human desires (Hofstede, 2001). The Indulgence score ranges from 0 to 100 with 0 being the lowest and 100 the highest.

diffPD (Difference in Power Distance scores): refers to the absolute difference between the power distance scores of the collaborating firm's and university's countries.

diffIndividuality (Difference in individuality scores): refers to the absolute difference between the individuality scores of the collaborating firm's and university's countries.

diffMasculinity (Difference in masculinity scores): refers to the absolute difference between the masculinity scores of the collaborating firm's and university's countries.

diffUA (Difference in uncertainty avoidance scores): refers to the absolute difference between

the uncertainty scores of the collaborating firm's and university's countries.

diffLTO (Difference in long term orientation scores): refers to the absolute difference between the long term orientation scores of the collaborating firm's and university's countries.

diffIndulgence (Difference in indulgence scores): refers to the absolute difference between the indulgence scores of the collaborating firm's and university's countries.

Distance: the distance variable refers to the measured physical distance between the firm and university in km. The values for the distance are obtained by scaling the focal_distance variable in the data by 1000. This would give larger coefficient values making them easier to interpret.

3.4.3 Control variables

basicness level of publication (lvl): basic level of research is a categorical variable taking on either level 3 or 4.

No. of authors: number of authors within authority on publication.

year dummies: dummy variable for the year of publication from 1995-2001.

Log (R&D): : refers to the R&D expenditures in $1000 000 of parent in t-1.

Basic research publications / R&D: refers to the impact of in-house basic research given by the ratio of the number of basic research publications in the previous four years over R&D expenditures.

Basic research co-pub with acad /Basic research pubs: refers to the general effect of performing such basic research jointly with academia and is measured by the ratio of collaborative to all basic research publications of the firm.

Technological diversity: the technological diversity of a firm's technology portfolio, which in prior research has been shown to relate in a non-linear way to firms' innovation performance (e.g. Leten et al. 2007). Technological diversity is measured as the inverse Herfindahl index of the distribution of the four-year prior patent portfolio over 3-digit IPC patent classes.

Research alliances/ R&D: the number of inter-firm research alliances during the past four years (taken from the SDC Platinum database), scaled by R&D expenditures in the previous year.

pub with an academic star: dummy variable indicating whether an academic star was involved in the publication. With 1= yes and 0=No.

pub with an internal (firm) star: dummy variable indicating whether an internal star was involved in the publication. With 1= yes and 0=No.

3.5 Statistical models

3.5.1 Negative Binomial model

The dependent variable, DVwc, is a count variable, consequently the negative binomial models described below were used:

Model 1

Model 1 included only the 10 control variables.

$$y_i = b_0 + Z_i'\beta$$

Model 2

Model 2 included the national cultural dimensions and the 10 control variables.

$$y_i = b_0 + b_1x_{i1} + b_2x_{i2} + b_3x_{i3} + b_4x_{i4} + b_5x_{i5} + b_6x_{i6} + Z_i'\beta$$

Model 3

Model 3 included the national cultural dimensions differences and the 10 control variables.

$$y_i = b_0 + b_7x_{i7} + b_8x_{i8} + b_9x_{i9} + b_{10}x_{i10} + b_{11}x_{i11} + b_{12}x_{i12} + Z_i'\beta$$

Model 4

Model 4 included the distance and the 10 control variables.

$$y_i = b_0 + b_{13}x_{i13} + Z_i'\beta$$

Model 5

Model 5 included the national cultural dimensions, national cultural dimension differences, distance and the 10 control variables.

$$y_i = b_0 + b_1x_{i1} + b_2x_{i2} + b_3x_{i3} + b_4x_{i4} + b_5x_{i5} + b_6x_{i6} + b_7x_{i7} + b_8x_{i8} + b_9x_{i9} + b_{10}x_{i10} + b_{11}x_{i11} + b_{12}x_{i12} + b_{13}x_{i13} + Z_i'\beta$$

Model 6

Model 6 included the national cultural dimensions, national cultural dimension differences, and the 10 control variables.

$y_i = b_0 + b_1x_{i1} + b_2x_{i2} + b_3x_{i3} + b_4x_{i4} + b_5x_{i5} + b_6x_{i6} + b_7x_{i7} + b_8x_{i8} + b_9x_{i9} + b_{10}x_{i10} + b_{11}x_{i11} + b_{12}x_{i12} + Z_i'\beta$

Model 7

Model 7 included the national cultural dimensions, distance and the 10 control variables.

$y_i = b_0 + b_1x_{i1} + b_2x_{i2} + b_3x_{i3} + b_4x_{i4} + b_5x_{i5} + b_6x_{i6} + b_{13}x_{i13} + Z_i'\beta$

3.5.2 Logistic Regression model

The dependent variable, D_Dvn, is a binary variable, consequently the Logistic regression models described below were used:

Model 8

Model 8 included only the 10 control variables.

$logit(\pi) = log(\frac{\pi}{1-\pi}) = b_0 + Z_i'\beta$

Model 9

Model 9 included the national cultural dimensions and the 10 control variables.

$logit(\pi) = b_0 + b_1x_{i1} + b_2x_{i2} + b_3x_{i3} + b_4x_{i4} + b_5x_{i5} + b_6x_{i6} + Z_i'\beta$

Model 10

Model 10 included the national cultural dimension differences and the 10 control variables.

$logit(\pi) = b_0 + b_7x_{i7} + b_8x_{i8} + b_9x_{i9} + b_{10}x_{i10} + b_{11}x_{i11} + b_{12}x_{i12} + Z_i'\beta$

Model 11

Model 11 included the distance and the 10 control variables.

$logit(\pi) = b_0 + b_{13}x_{i13} + Z_i'\beta$

Model 12

Model 12 included the national cultural dimensions, national cultural dimension differences, distance and the 10 control variables.

$logit(\pi) = b_0 + b_1x_{i1} + b_2x_{i2} + b_3x_{i3} + b_4x_{i4} + b_5x_{i5} + b_6x_{i6} + b_7x_{i7} + b_8x_{i8} + b_9x_{i9} + b_{10}x_{i10} + b_{11}x_{i11} + b_{12}x_{i12} + b_{13}x_{i13} + Z_i'\beta$

Model 13

Model 13 included the national cultural dimensions, national cultural dimension differences and the 10 control variables.

$$logit(\pi) = b_0 + b_1x_{i1} + b_2x_{i2} + b_3x_{i3} + b_4x_{i4} + b_5x_{i5} + b_6x_{i6} + b_7x_{i7} + b_8x_{i8} + b_9x_{i9} + b_{10}x_{i10} + b_{11}x_{i11} + b_{12}x_{i12} + Z_i'\beta$$

Model 14

Model 14 included the national cultural dimensions, distance and the 10 control variables.

$$logit(\pi) = b_0 + b_1x_{i1} + b_2x_{i2} + b_3x_{i3} + b_4x_{i4} + b_5x_{i5} + b_6x_{i6} + b_{13}x_{i13} + Z_i'\beta$$

for each observation, i=1,$\cdots$,2588.

where

x_{i1}=power distance of observation i

x_{i2}=Individualism of observation i

x_{i3}=Masculinity of observation i

x_{i4}=Uncertainty of observation i

x_{i5}=Long term orientation of observation i

x_{i6}=Indulgence of observation i

x_{i7}=diffPDis of observation i

x_{i8}=diffInd of observation i

x_{i9}=diffMasc of observation i

x_{i10}=diffUncert of observation i

x_{i11}=diffLTO of observation i

x_{i12}=diffIndul of observation i

x_{i13}=distance of observation i

Z_i' is a vector of the 10 control variables

3.6 Statistical software

Rstudio statistical software version 1.2.1335 was used for the analysis.

Chapter 4: Results

4.1 Exploratory Data Analysis

Table 4.1 shows the number of publications by countries and their percentage proportions. A total of 22 countries were involved in the study. The US had the highest number of participating firms and universities at 1392 and 1226 respectively.

Table 4.1: Summary of countries by number of participating firms and universities

Country	No. of firms	No. of universities
Austria	14	12
Belgium	44	33
Croatia	1	0
Denmark	15	19
England	144	198
Finland	2	9
France	36	51
Germany	144	185
Greece	1	3
Hungary	0	4
Ireland	0	7
Italy	40	52
Japan	493	490
Netherlands	8	44
Northern Ireland	1	2
Norway	0	3
Scotland	2	45
Spain	16	28
Sweden	48	79
Switzerland	185	89
USA	1392	1226
Wales	2	9
Total No. of pubs	2588	2588

Table 4.2 shows the correlation matrix of the dependent and independent variables in the dataset. High degrees of multicollinearity were found among the national cultural dimensions.

For instance, individuality was highly correlated with UA (uncertainty avoidance), LTO (Long term orientation) and indulgence with correlation values of -0.89, -0.93 and 0.83 respectively. The negative correlation values between individuality and UA implies that societies that are high in individualistic scores have low uncertainty avoidance scores (i.e. highly individualistic societies are more tolerant of uncertainty hence will have low scores on UA). Individuality and Indulgence are positively correlated implies that highly individualistic societies have higher scores on indulgence (i.e. highly individualistic societies have higher tendencies to gratify their basic human desires).

UA was highly correlated with LTO and indulgence with correlation values of 0.83 and -0.89 respectively. UA was positively correlated with LTO implies that societies high on scores of uncertainty avoidance also scored high on LTO (i.e. societies that are intolerant of uncertainty are more likely to maintain traditional values). UA was negatively correlated with indulgence implies that societies with high scores of UA tend to score low on indulgence (i.e. societies that are intolerant of uncertainty are less likely to gratify their basic human desires).

As a result of the presence of high degrees of multicollinearity, Hofstede's cultural dimensions of Individuality, Uncertainty avoidance and indulgence were dropped. Table 4.3 shows the updated correlation matrix of all the dependent and independent variables used in this study.

Table 4.2: Correlation matrix of the dependent and the independent variables

	D_DVn	DVwc	PD	Individuality	Masculinity	UA	LTO	Indulgence
D_DVn								
DVwc	0.40****							
PD	-0.06**	-0.04*						
Individuality	0.09****	0.07***	-0.55****					
Masculinity	-0.05**	-0.03	0.50****	-0.65****				
UA	-0.09****	-0.06**	0.80****	-0.89****	0.72****			
LTO	-0.11****	-0.07***	0.46****	-0.93****	0.59****	0.83****		
Indulgence	0.08****	0.06**	-0.63****	0.83****	-0.66****	-0.89****	-0.82****	
distance	0.06**	0.04	-0.07***	0.18****	-0.05**	-0.14****	-0.21****	0.17****

p < .0001 '****'; p < .001 '***', p < .01 '**', p < .05 '*'

Table 4.3: Updated correlation matrix of the dependent and independent variables

	D_DVn	DVwc	PD	Masculinity	LTO	diffPD	diffMasculinity	diffLTO
D_DVn								
DVwc	0.40****							
PD	-0.06**	-0.04*						
Masculinity	-0.05**	-0.03	0.50****					
LTO	-0.11****	-0.07***	0.46****	0.59****				
diffPD	0.02	0.00	0.07***	-0.09****	0.07***			
diffMasculinity	0.00	-0.02	-0.01	-0.10****	0.05**	0.61****		
diffLTO	0.04	0.01	-0.06**	-0.04*	0.00	0.59****	0.53****	
distance	0.06**	0.04	-0.07***	-0.05**	-0.21****	0.44****	0.44****	0.78****

p < .0001 '****'; p < .001 '***', p < .01 '**', p < .05 '*'

Table 4.4 shows the descriptive statistics of the dependent, independent and control variables used in the study.

Table 4.4: Descriptive statistics(2588 observations)

Variable	Mean	S.D	Min	Max
Dependent Variables				
DDVn	0.11	0.31	0.00	1.00
DVwc	1.54	11.28	0.00	360.00
Key Variables				
Power Distance	42.30	8.47	11.00	73.00
Masculinity	67.49	16.61	5.00	95.00
Long term orientation	48.89	26.65	26.00	88.00
Diff Power distance	2.55	6.72	0.00	50.00
Diff Masculinity	4.32	12.14	0.00	90.00
Diff Long term orientation	6.99	15.62	0.00	64.00
distance(Km)	1.84	2.75	0.00	11.89
Control Variables				
basicness level of publication (lvl)	3.51	0.50	3.00	4.00
No. of authors	4.79	2.46	0.00	19.00
Log (R&D)	13.48	1.40	7.81	15.39
Basic research publications / R&D	1.17	1.04	0.06	18.83
Basic research co-pub with acad /Basic research pubs	0.55	0.11	0.22	1.00
Technological diversity	1.24	0.41	0.25	3.30
Research alliances/ R&D	0.04	0.08	0.00	1.55
pub with an academic star	0.22	0.42	0.00	1.00
pub with an internal (firm) star	0.11	0.31	0.00	1.00

4.2 Results of the Negative Binomial models with DVwc as dependent variable

The dependent variable, DVwc (Number of patents of a firm citing the publication + the citations of those patents), is a count variable, consequently, the negative binomial model was used. Table 4.5 shows the results of the negative binomial models.

Model 1 contained only the control variables. The coefficients of four of the ten control variables had a positive and significant effect on DVwc i.e. lvl, nauth, Research alliances / R&D and pub with an internal (firm) star. The rest of the control variables had no significant effect on DVwc.

In addition to the ten control variables in Model 1, Model 2 included the three independent variables of PD, masculinity and LTO. The coefficients of PD and LTO had significant and negative effects on DVwc. This implies that IUCs (Industry-University collaborations) involving firms from countries with higher scores on PD and LTO produce less innovative publications. On the other hand, masculinity had a significant and positive effect on DVwc implying that

IUCs involving firms from countries with higher scores on masculinity produce more innovative publications. The significant control variables in Model 1 except for Research alliances / R&D were the only significant ones in Model 2. The likelihood ratio tests showed that Model 2 had a significantly better fit than Model 1.

Model 3 included the ten control variables and the three independent variables of diffPD, diffMasculinity and diffLTO. The coefficient of diffLTO had a positive and significant effect on DVwc. This implies that higher differences in LTO scores between industry and university partners were associated with more innovative IUC publications. The coefficient of diffMasculinity had a negative and significant effect on DVwc implying that higher differences in masculinity scores between industry and university partners were associated with less innovative IUC publications. The coefficient of diffPD did not have a significant effect on DVwc. The significant control variables in Model 1 remained the only significant ones in Model 3. The likelihood ratio tests showed that Model 3 did not have a significantly better fit than Model 1.

Model 4 included the ten control variables and the distance independent variable. The coefficient of the distance coefficient had a positive and significant effect on DVwc implying that the greater the physical distance between the firm and university the more innovative the IUC publications. The significant control variables in Model 1 remained the only significant ones in Model 4. The likelihood ratio tests showed that Model 4 had a significantly better fit than Model 1.

Model 5 included all the seven independent and the ten control variables. Among the independent variables, only the coefficients of PD and LTO had a negative and significant effect on DVwc. This implies that IUCs involving firms from countries with higher PD and LTO scores produced less innovative publications. The significant control variables in Model 1 except for Research alliances / R&D were the only significant ones in Model 5. The likelihood ratio tests showed that Model 5 had a significantly better fit than Models 1, 3, and 4.

Model 6 included the ten control variables and the six independent variables of PD, masculinity, LTO, diffPD, diffMasculinity and diffLTO. Among the independent variables, only the coefficients of PD and LTO had a negative and significant effect on DVwc. This implies that IUCs involving firms from countries with higher PD and LTO scores produced less innovative publications. The significant control variables in Model 1 except for Research alliances / R&D were the only significant ones in Model 6. The likelihood ratio tests showed that Models 5 did not have a significantly better fit than Model 6.

Model 7 included the ten control variables and the four independent variables of PD, masculinity, LTO, and distance. Among the independent variables, the coefficients of PD and LTO had a negative and significant effect on DVwc. This implies that IUCs involving firms from countries with higher PD and LTO scores produced less innovative publications. The coefficient of distance had a positive and significant on DVwc implying that IUCs at a greater distance published more innovative publications. The significant control variables in Model 1 except for

Research alliances / R&D were the only significant ones in Model 7. The likelihood ratio tests showed that Models 5 did not have a significantly better fit than Model 7.

Table 4.5: Results of the Negative Binomial models with DVwc as the dependent variable

	Model 1		**Model 2**		**Model 3**		**Model 4**		**Model 5**	
	Coeff	Z-Value (P-Value)	Coeff	Z-Value (P-Value)	Coeff	Z-Value (P-Value)	Coeff	Z-Value (P-Value)	Coeff	Z-Value (P-Value)
Key Variables										
Power distance (PD)			-0.04*	-2.41 (0.0158)					-0.04**	-2.61 (0.0092)
Masculinity			0.02*	2.15 (0.0313)					0.02	1.65 (0.0091)
Long term orientation (LTO)			-0.03****	-4.77 (0.0000)					-0.02****	-4.06 (0.0000)
difference Power distance (diffPD)					0.02	1.06 (0.2912)			0.03	1.14 (0.2559)
difference Masculinity (diffMasculinity)					-0.03*	-2.23 (0.0255)			-0.02	-1.33 (0.1838)
difference Long term orientation (DiffLTO)					0.02*	2.06 (0.0393)			0.01	0.70 (0.4837)
Distance							0.10*	2.51 (0.0120)	0.05	0.67 (0.5008)
Control Variables										
basicness level of publication (lvl)	0.90****	4.00 (0.0000)	0.85***	3.83 (0.0001)	0.92****	4.12 (0.0000)	0.87***	3.88 (0.0001)	0.87***	3.92 (0.0001)
No. of authors (nauth)	0.13**	2.88 (0.0039)	0.11*	2.35 (0.0188)	0.12**	2.59 (0.0097)	0.13**	2.84 (0.0046)	0.10*	2.20 (0.0280)
Log (R&D)	0.15	1.52 (0.1297)	-0.17	-1.53 (0.1260)	0.18	1.78 (0.0749)	0.17	1.74 (0.0817)	-0.15	-1.38 (0.1689)
Basic research publications / R&D	0.07	0.56 (0.5786)	0.16	1.23 (0.2182)	0.11	0.81 (0.4168)	0.11	0.80 (0.4240)	0.17	1.28 (0.1991)
Basic research co-pub with acad /Basic research pubs	1.10	0.97 (0.3325)	1.19	1.03 (0.3015)	1.41	1.25 (0.2128)	1.44	1.27 (0.2026)	1.36	1.19 (0.2353)
Technological diversity	-0.22	-0.73 (0.4655)	0.27	0.87 (0.3846)	-0.27	-0.91 (0.3614)	-0.12	-0.42 (0.6768)	0.27	0.87 (0.3839)
Research alliances / R&D	6.47***	3.33 (0.0009)	1.83	0.95 (0.3420)	6.80***	3.53 (0.0004)	6.97***	3.62 (0.0003)	2.32	1.21 (0.2260)
pub with an academic star	-0.13	-0.49 (0.6212)	-0.06	-0.24 (0.8101)	-0.10	-0.37 (0.7083)	-0.07	-0.27 (0.7890)	-0.04	-0.15 (0.8814)
pub with an internal (firm) star	0.89*	2.45 (0.0142)	0.97**	2.71 (0.0067)	0.84*	2.30 (0.0212)	0.79*	2.17 (0.0301)	0.87*	2.44 (0.0146)
Year Dummies	Yes		Yes		Yes		Yes		Yes	
Constant	-6.71***	-3.77 (0.0002)	-1.28	-0.57 (0.5703)	-7.35****	-4.13 (0.0000)	-7.48****	-4.21 (0.0000)	-1.47	-0.65 (0.5141)
Log likelihood	-1794.30		-1781.60		-1790.70		-1791.3		-1778.00	
LR Test (vs Model 1)			25.41	(0.0000)	7.18	(0.0663)	5.96	(0.0146)	32.50	(0.0000)
LR Test (vs Model 5)	32.50	(0.0000)	7.09	(0.1313)	25.32	(0.0000)	26.54	(0.0002)		

p < .0001 '****'; p < .001 '***', p < .01 '**', p < .05 '*'

Table 4.6: Cont'd Results of the Negative Binomial models with DVwc as the dependent variable

	Model 6		**Model 7**	
	Coeff	Z-Value (P-Value)	Coeff	Z-Value (P-Value)
Key Variables				
Power distance (PD)	-0.04**	-2.59 (0.0095)	-0.04*	-2.50 (0.0124)
Masculinity	0.02	1.80 (0.0721)	0.02	1.72 (0.0849)
Long term orientation (LTO)	-0.03****	-4.65 (0.0000)	-0.02****	-4.30 (0.0000)
difference Power distance(diffPD)	0.02	1.03 (0.3042)		
difference Masculinity (diffMasculinity)	-0.01	-1.16 (0.2476)		
difference Long term orientation (DiffLTO)	0.02	1.72 (0.0852)		
Distance			0.08*	2.097 (0.0387)
Control Variables				
basicness level of publication (lvl)	0.89****	4.03 (0.0000)	0.83***	3.77 (0.0001)
No. of authors (nauth)	0.10*	2.27 (0.0233)	0.10*	2.30 (0.0217)
Log (R&D)	-0.17	-1.49 (0.1372)	-0.15	-1.35 (0.1782)
Basic research publications / R&D	0.16	1.25 (0.2129)	0.17	1.33 (0.1828)
Basic research co-pub with acad /Basic research pubs	1.34	1.17 (0.2419)	1.48	1.29 (0.1968)
Technological diversity	0.26	0.85 (0.3970)	0.32	1.04 (0.3000)
Research alliances / R&D	2.13	1.11 (0.2663)	2.24	1.17 (0.2429)
pub with an academic star	-0.04	-0.14 (0.8882)	-0.02	-0.07 (0.9450)
pub with an internal (firm) star	0.89*	2.51 (0.0121)	0.89*	2.50 (0.0126)
Year Dummies	Yes		Yes	
Constant	-1.36	-0.60 (0.5458)	-1.68	-0.75 (0.4542)
Log likelihood	-1778.2		-1779.3	
LR Test (vs Model 1)	32.09	(0.0000)	29.89	(0.0000)
LR Test (vs Model 5)	0.41	(0.5218)	2.61	(0.4560)

p < .0001 '****'; p < .001 '***', p < .01 '**', p < .05 '*'

4.3 Results of the Logistic Regression models with D_Dvn as the dependent variable

The dependent variable, D_Dvn (If the publication has been cited by at least 1 patent), is a binary variable, consequently, the Logistic Regression model was used. Table 4.6 shows the results of the Logistic Regression models.

Model 8 contained only the control variables. The coefficients of three of the ten control variables had a positive and significant effect on D_Dvn i.e. lvl, nauth, and pub with an internal (firm) star. The rest of the control variables had no significant effect on D_Dvn .

Model 9 included the ten control variables and the three independent variables of PD, masculinity and LTO. The coefficients of PD and LTO had significant and negative effects on D_Dvn. This implies that IUCs involving firms from countries with higher scores on PD and LTO have lower odds of publishing innovative publications. In addition to Log (R&D), only two of the significant variables from Model 8 remained significant in Model 9 i.e. lvl and nauth. The likelihood ratio tests showed that Model 9 had a significantly better fit than Model 8.

Model 10 included the ten control variables and the three independent variables of diffPD, diffMasculinity and diffLTO. None of the independent variables had a significant effect on D_Dvn. The significant control variables in Model 8 remained the only significant ones in Model 10. The likelihood ratio tests showed that Model 10 did not have a significantly better fit than Model 8.

Model 11 included the ten control variables and the distance independent variable. The coefficient of the distance coefficient had a positive and significant effect on D_Dvn. This implies that the greater the physical distance between the firm and university the higher the odds of the IUC publishing more innovative publications. The significant control variables in Model 8 remained the only significant ones in Model 11. The likelihood ratio tests showed that Model 11 had a significantly better fit than Model 8.

Model 12 included all the seven independent and the ten control variables. Among the independent variables, only the coefficient of LTO had a negative and significant effect on D_Dvn. This implies that IUCs involving firms from countries with higher LTO scores had lower odds of publishing innovative publications. In addition to Log (R&D), only two of the significant variables from Model 8 remained significant in Model 12 i.e. lvl and nauth. The likelihood ratio tests showed that Model 12 had a significantly better fit than Models 8, 10, and 11.

Model 13 included the six independent variables of PD, masculinity, LTO, diffPD, diffMasculinity and diffLTOt and the ten control variables. Among the independent variables, only the coefficient of LTO had a negative and significant effect on D_Dvn. This implies that IUCs involving firms from countries with higher LTO scores had lower odds of publishing innovative publications. In addition to Log (R&D), only two of the significant variables from Model 8 remained significant in Model 13 i.e. lvl and nauth. The likelihood ratio tests showed that Model 12 did

not have a significantly better fit than Model 13.

Model 14 included the four independent variables of PD, masculinity, LTO, distance and the ten control variables. Among the independent variables, both the coefficients of LTO and PD had a negative and significant effect on D_Dvn implying that IUCs involving firms from countries with higher LTO and PD scores had lower odds of publishing innovative publications. In addition to Log (R&D), only two of the significant variables from Model 8 remained significant in Model 13 i.e. lvl and nauth. The likelihood ratio tests showed that Model 12 did not have a significantly better fit than Model 14.

Table 4.7: Results of the Logistic Regression models with D_Dvn as the dependent variable

	Model 8		**Model 9**		**Model 10**		**Model 11**		**Model 12**	
	Coeff	Z-Value (P-Value)	Coeff	Z-Value (P-Value)	Coeff	Z-Value (P-Value)	Coeff	Z-Value (P-Value)	Coeff	Z-Value (P-Value)
Key Variables										
Power distance (PD)			-0.02*	-1.97 (0.0485)					-0.02	-1.91 (0.0556)
Masculinity			0.00	0.42 (0.6714)					0.00	0.35 (0.7274)
Long term orientation (LTO)			-0.02****	-4.17 (0.0000)					-0.02***	-3.78 (0.0002)
difference Power distance (diffPD)					0.01	0.38 (0.7038)			0.01	0.91 (0.3606)
difference Masculinity (diffMasculinity)					-0.01	-1.38 (0.1677)			-0.01	-1.18 (0.2383)
difference Long term orientation (diffLTO)					0.01	1.82 (0.0688)			0.01	0.71 (0.4800)
Distance							0.05*	2.22 (0.02615)	0.00	0.12 (0.9052)
Control Variables										
basicness level of publication (lvl)	0.51***	3.77 (0.0002)	0.43**	3.16 (0.0016)	0.50***	3.71 (0.0002)	0.49***	3.62 (0.0003)	0.43**	3.12 (0.0019)
no. of authors (nauth)	0.12****	4.95 (0.0000)	0.13****	5.28 (0.0000)	0.12****	5.01 (0.0000)	0.12***	4.96 (0.0000)	0.13****	5.28 (0.0000)
Log (R&D)	-0.05	-0.92 (0.3559)	-0.19**	-3.09 (0.0020)	-0.05	-0.89 (0.3751)	-0.06	-0.98 (0.3257)	-0.19**	-3.04 (0.0024)
Basic research publications / R&D	-0.03	-0.48 (0.6346)	-0.06	-0.84 (0.4034)	-0.03	-0.44 (0.6626)	-0.04	-0.56 (0.5768)	-0.06	-0.80 (0.4226)
Basic research co-pub with acad /Basic research pubs	0.80	1.25 (0.2118)	0.81	1.22 (0.2219)	0.79	1.23 (0.2206)	0.80	1.24 (0.2137)	0.80	1.19 (0.2329)
Technological diversity	-0.15	-0.83 (0.4070)	0.26	1.40 (0.1607)	-0.15	-0.86 (0.3887)	-0.12	-0.70 (0.4853)	0.25	1.31 (0.1901)
Research alliances / R&D	1.10	1.30 (0.1934)	-0.01	-0.01 (0.9950)	1.13	1.34 (0.1809)	1.13	1.33 (0.1824)	0.04	0.05 (0.9629)
pub with an academic star	0.02	0.11 (0.9154)	-0.02	-0.10 (0.9203)	0.01	0.07 (0.9450)	-0.01	-0.05 (0.9517)	-0.02	-0.14 (0.8893)
pub with an internal (firm) star	0.43*	2.28 (0.02245)	0.33	1.73 (0.0841)	0.39*	2.09 (0.0370)	0.39*	2.09 (0.0370)	0.30	1.56 (0.1189)
Year Dummies	Yes		Yes		Yes		Yes		Yes	
Constant	-4.05***	-3.87 (0.0001)	-0.93	-0.72 (0.4716)	-4.08***	-3.89 (0.0001)	-4.05***	-3.85 (0.0001)	-0.99	-0.77 (0.4433)
Log likelihood	-839.97		-822.36		-837.64		-837.61		-820.56	
LR Test (vs Model 8)			35.22	(0.00000)	4.67	(0.1976)	4.72	(0.0298)	38.82	(0.0000)
LR Test (vs Model 12)	38.82	(0.0000)	3.60	(0.4630)	34.15	(0.0000)		34.09(0.0000)		

p < .0001 '****'; p < .001 '***', p < .01 '**', p < .05 '*'

Table 4.8: Cont'd Results of the Logistic Regression models with D_Dvn as the dependent variable

	Model 13		**Model 14**	
	Coeff	Z-Value (P-Value)	Coeff	Z-Value (P-Value)
Key Variables				
Power distance (PD)	-0.02	-1.91 (0.0558)	-0.02*	-1.97 (0.0488)
Masculinity	0.00	0.37 (0.7102)	0.00	0.34 (0.7362)
Long term orientation (LTO)	-0.02****	-4.10 (0.0000)	-0.01***	-3.86 (0.0001)
difference Power distance(diffPD)	0.01	0.92 (0.3602)		
difference Masculinity (diffMasculinity)	-0.01	-1.17 (0.2405)		
difference Long term orientation (DiffLTO)	0.01	1.14 (0.2528)		
Distance			0.03	1.13 (0.2583)
Control Variables				
basicness level of publication (lvl)	0.43**	3.12 (0.0018)	0.43**	3.12 (0.0018)
No. of authors (nauth)	0.13****	5.30 (0.0000)	0.13****	5.30 (0.0000)
Log (R&D)	-0.19**	-3.04 (0.0023)	-0.19**	-3.04 (0.0021)
Basic research publications / R&D	-0.06	-0.80 (0.4239)	-0.06	-0.80 (0.3700)
Basic research co-pub with acad /Basic research pubs	0.80	1.20 (0.2308)	0.78	1.18 (0.2389)
Technological diversity	0.25	1.31 (0.1914)	0.26	1.40 (0.1602)
Research alliances / R&D	0.04	0.04 (0.9679)	0.06	0.07 (0.9469)
pub with an academic star	-0.02	-0.14 (0.8883)	-0.03	-0.17 (0.8682)
pub with an internal (firm) star	0.30	1.56 (0.1192)	0.32	1.65 (0.0984)
Year Dummies	Yes		Yes	
Constant	-0.99	-0.77 (0.4432)	-0.96	-0.74 (0.4579)
Log likelihood	-820.57		-821.74	
LR Test (vs Model 8)	38.80	(0.0000)	36.47	(0.0000)
LR Test (vs Model 12)	0.01	(0.9054)	2.35	(0.5026)

p < .0001 '****'; p < .001 '***', p < .01 '**', p < .05 '*'

Chapter 5: Discussion

The objectives of this paper are to determine whether national cultural values impact the innovation performance of IUCs (Industry-University collaborations), determine the effects of the differences in national cultural values between the industry and university partners on the innovation performance of IUCs, and determine the effects of geographical proximity on the innovation performance of IUCs.

Two dependent variables DVwc (Number of patents of a firm citing the publication + the citations of those patents) and D_Dvn (If the publication has been cited by at least 1 patent) were the dependent variables that measured the innovation performance of the IUC. A total of 14 models were fitted, seven models for each dependent variable.

For the fitted Negative binomial models with DVwc as the dependent variable, Models 2,5,6 and 7 were the best fitting models and there were no significant differences among their fits. For the fitted Logistic regression models with D_Dvn as the dependent variable, Models 9,12,13 and 14 were the best fitting models and there were no significant differences among their fits.

The results of the analysis from both the Negative binomial and logistic regression models show that the national cultural values of the firm's country significantly impact the innovation performance of the IUCs it is involved with. In particular, Hofstede's national cultural dimensions of Long term orientation (LTO) and Power distance (PD) both had a significant and negative impact on the innovation performance of the IUC. This implies that IUCs involving firms from countries with higher scores on PD and LTO published less innovative publications. Power distance refers to the degree to which the less powerful members of organizations and institutions accept and expect that power is distributed unequally while Long term orientation examines how the current and future challenges are associated with the past (Hofstede, G., 2001).

The negative effects of high power distance scores on the innovation performance of IUCs are not surprising since creativity and innovation are associated with higher degrees of freedom and individuality (Erez and Nouri, 2010; Kaasa and Vadi, 2010). Individuals in societies with high power distance scores tend to lack the authority to make decisions on innovativeness which decreases their desire to solve problems (van Everdingen and Waarts, 2003; Waarts and Van Everdingen, 2005). On the other hand, Individuals in low power distance societies have less rigid hierarchies to navigate due to the low power distance barriers thus they can create novel solutions to solve their societal issues (Shane, 1992; Kaasa and Vadi, 2010).

Firms in high power distance societies model their organizational culture similar to their society's national culture, as national culture deeply influence organizational culture (Mccarthy, 1998). As a result, innovation activities from such firms will be directed from above with checks and balances established to monitor output and behaviours. Such firms are also internally focused leading to reduced external idea stimulation, information gathering and organizational learning (Büschgens et al., 2013; Lemon & Sahota, 2004). Consequently, the innovation performance of IUCs of firms from high power distance societies would be lower.

Societies with high scores on long-term orientation take a more pragmatic approach to life. They tend to encourage thriftiness, strong savings and investment culture, and perseverance to achieve their future goals (Hofstede, G., 2001). The results of this study showed that countries with high long-term orientation scores tend to be less innovative. Long-term-oriented societies encourage thrift and long-term planning for the future and as a result, produce less innovative solutions to immediate societal challenges. In contrast, short-term orientated societies desire quicker results and hence will churn out more innovative solutions to solve immediate societal challenges (Tian et al., 2018).

Firms from short-term orientated societies face shorter product lifecycles, increasing customer demands and stiff price competition from rivals, which means that they are under high pressures to produce innovative solutions fast. Especially, considering this study consisted of firms in the pharmaceutical sector who are often under high pressure to come with new drug discoveries for current health challenges. As a result, the innovation performance of IUCs involving firms from countries that score low on Long-term orientation would be higher.

The results from the Negative binomial model indicated that geographic proximity had a positive and significant effect on the innovation performance of IUCs. This implies that greater physical distance between the firm and university was associated with higher innovation performance. Local and regional collaborations are not the only source of novel knowledge, rather strategic collaborations of interregional and international reach are essential for frequent acquiring of new knowledge (Owen-Smith et al., 2002). Infact, knowledge coming from distant partners have a potential for the creation of radical innovations since they are generally characterized by different paradigms. Furthermore, with the widespread availability of latest communication technologies, the need for frequent face-face communication is reduced. Thus, novel knowledge can be acquired from far away regions and the advancements in communication technology reduces the need of having to frequently meet in person.

Differences in national cultural values were found not to impact the innovation performance of IUCs. Whilst congruency is associated with greater trust, congruency in national cultural values may not be enough to build trust in IUCs. This could be for several reasons. Firstly, the kind of trust that needs to be built in IUCs are mostly related to reputation effects. Reputation effects here refers to the character, expertise, reliability and competence of the partner. Secondly, a greater understanding of each others' needs and capabilities increases decision

process similarity and reciprocal communication which cements trust between partners. These factors tend to require collaboration experience to cement (Mora-Valentin et al., 2004).

Chapter 6: Conclusion

Innovation has been recognized by most firms as critical for the development of novel or improved products, processes, and services to remain competitive. In light of the importance of Industry-University collaborations (IUCs) towards enhancing the competitive advantage of firms via innovation, it is vital to ensure successful outcomes of IUCs. The objectives of this paper are to determine whether national cultural values impact the innovation performance of IUCs (Industry-University collaborations), determine the effects of the differences in national cultural values between the industry and university partners on the innovation performance of IUCs, and determine the effects of geographical proximity on the innovation performance of IUCs. This paper used a panel dataset on the patent and publication activities of 60 of the most prominent pharmaceutical firms in the world from 1995 to 2002 to answer the research questions.

The results of the analysis from both the Negative binomial and logistic regression models showed that the national cultural values of the firm's country significantly impact the innovation performance of the IUCs it is involved with. In particular, Hofstede's national cultural variables of Long term orientation (LTO) and Power distance (PD) both had a significant and negative impact on the innovation performance of the IUC. This implies that IUCs involving firms from countries with higher scores on PD and LTO had lower innovation performance. The results from the Negative binomial model indicated that geographic proximity had a positive and significant effect on the innovation performance of IUCs implying that greater physical distance between the firm and university was associated with higher innovation performance. Differences in national cultural values were found not to impact the innovation performance of IUCs.

Research implications

In light of the importance of Industry-University collaborations (IUCs) towards enhancing the competitive advantage of firms via innovation, it is vital to ensure successful outcomes of IUCs. The results from this study showed that the national cultural values of the firm's country and geographic proximity between the firm and the university impact the innovation performance of IUCs.

In particular, firms from societies with high Power distance and Long term orientation (LTO) scores were associated with lower IUC innovation performance. Thus, firm managers should implement an organizational culture that fosters reduced power distance between managers and employees. A less rigid hierarchical culture would empower employees to come up with novel innovation ideas which the firm may collaborate with universities if it doesn't have the competencies to develop in-house. Furthermore, the firm's innovation activities should focus on current societal challenges.

Greater geographic distance between the firm and the university was associated with higher innovation performance. Firms by collaborating with universities, even though they may be far away from their regions were associated with higher innovative performance. This is because knowledge coming from distant partners has the potential for the creation of radical innovations since they are generally characterized by different paradigms.

Study Limitations

Hofstede's national cultural dimensions give average national scores for different national cultural values. Even though the cultural values of the country influences the firm's organizational culture, they are not necessarily deterministic for the individual firms in that country. For instance, a country might have on average a high power distance score but a firm from that country may have a less rigid hierarchical organisational structure thus a lower score. Finally, the results from this paper reflect those of the pharmaceutical industry and thus cannot be confidently extrapolated to all industries.

Chapter 7: References

Adams, J. D., Grant, G. C., Clemmons, J. R., & Stephan, P. E. (2005). Scientific teams and institutional collaborations: Evidence from U.S. universities, 1981–1999. Research Policy, 34(3), 259-285.

Adler, N. (2002). International Dimensions of Organizational Behavior. Cincinnati, OH: South-Western Publishing.

Adler, N. J., Doktor, R., & Redding, S. G. (1987). From the Atlantic to the Pacific Century: Cross-Cultural Management Reviewed. Yearly Review of the Journal of Management, 12(2), 295-318.

Allred, B., & Swan, K. (2004). Global versus multidomestic: culture's consequences on innovation. Management International Review, 44(1), 81-105.

Amabile, T. M., Nasco, C. P., Mueller, J., Wojcik, T., Odomirok, P. W., Marsh, M., & Kramer, S. J. (2001). Academic-practitioner collaboration in management research: a case of cross-profession collaboration. Acad. Manag. J, 44(2), 418-431.

Ankrah, S., & AL-Tabbaa, O. ((2015)). Universities–industry collaboration: a systematic review. Scand J Manag, 31, 387–408.

Arora, A., Fosfuri, A., and Gambardella, A. (2001a). Markets for Technology: The Economics of Innovation and Corporate Strategy. Cambridge, MA: MIT Press.

Attia, AM. (2015). National innovation systems in developing countries: barriers to university–industry collaboration in Egypt. Int J Technol Manage Sustain Dev, 14, 113–124.

Australian Industry Group (2015). Innovate and prosper: ensuring Australia's future competitiveness through university-industry collaboration. Retrieved from Melbourne, Victoria.

Bäcka, I., & Kohtamäki, M. (2015). Boundaries of R&D collaboration. Technovation, 45-56, 15-28. Barnes, T., Pashby, I., & Gibbons, A. (2002). Effective university–industry interaction: a multi-case evaluation of collaborative R&D projects. European Management Journal, 20(3), 272–285.

Barnes T, Pashby I, Gibbons A. (2002). Effective university–industry interaction: a multi-case evaluation of collaborative R&D projects. European Management Journal, 20(3), 272–285.

Bedwell, W. L., Wildman, J. L., DiazGranados, D., Salazar, M., S.Kramer, W., & Salas, E. (2012). Collaboration at work: An integrative multilevel conceptualization. Human Resource Management Review, 22(2), 128-145.

Boschma, R. A. (2005). Proximity and Innovation: A Critical Assessment. Regional Studies, 39(1), 61-74.

Brettel, M., Chomik, C. and Flatten, T. (2015), How organizational culture influences innovativeness, proactiveness, and risk-taking: fostering entrepreneurial orientation in SMEs. Journal of Small Business Management, 53(4), 868-885.

Bstieler, L., Hemmert, M., & Barczak, G. (2017). The changing bases of mutual trust formation in inter-organizational relationships: a dyadic study of university–industry research collaborations. Journal of Business Research, 74, 47–54.

Büschgens, T., Bausch, A. and Balkin, D. (2013). Organizational culture and innovation: a meta-analytic review. Journal of Product Innovation Management, 30(4), 763-781.

Campbell J. J. (2005). Understanding Pharma: A primer on how pharmaceutical companies really work. Pharmaceutical Institute, Raleigh.

Chesbrough, H. (2003a).Open Innovation: The New Imperative for Creating and Profiting from Technology. Boston, MA: Harvard Business School Press.

Chesbrough, H. (2003b).The era of open innovation.Sloan Management Review, 44(3): 35-41.

Chesbrough, H. (2006a).Open Business Models: How to Thrive in the New Innovation Landscape. Boston, MA: Harvard Business School Press.

Chesbrough, H. and Crowther, A. K. (2006). Beyond high tech: Early adopters of open innovation in other industries. R&D Management, 36(3), 229-236.

Chiou JY, Magazzini L, Pammolli F, Riccaboni M. (2016). Learning from successes and failures in pharmaceutical R&D. Journal of Evolutionary Economics 26(2), 271-290.

Cole, J. R., and Cole, S. (1973). Social Stratification in Science. Chicago/London: University of Chicago Press.

Crescenzi, R., Filippetti, A., & Iammarino, S. (2017). Academic inventors: collaboration and proximity with industry. Journal of Technology Transfer, 42, 730-762.

Dayan, M., Zacca, R., Husain, Z. and Ryan, J.C. (2016), The effect of entrepreneurial orientation, willingness to change, and development culture on new product exploration in small enterprises. Journal of Business & Industrial Marketing, 31(5), 668-683.

De Mooij, M., & Hofstede, G. (2010). The Hofstede model: applications to global branding and advertising strategy and research. International Journal of Advertising, 29(1), 85-110.

Demirci, A.E. (2013). Strategic representation of an abstract reality: spiraling relations between organizational culture and innovativeness. Journal of Management and Strategy, 4 (3),39-55.

Desphandé, R. and Farley, J. U. (2004). Organizational culture, market orientation, innovativeness, and firm performance: An international research odyssey. International Journal of Research in Marketing, 21, 3-22.

Efrat, K. (2014). The direct and indirect impact of culture on innovation. Technovation, 34(1), 12-20.

Engelen, A., Schmidt, S., Strenger, L., & Brettel, M. (2014). Top management's transformational leader behaviors and innovation orientation: a cross-cultural perspective in eight countries. Journal of International Management, 20(2), 124-136.

Erez, M. and Nouri, R. (2010). Creativity: the influence of cultural, social, and work contexts. Management and Organization Review, 6(3), 351-370.

Feldman, M. (1994). The Geography of Innovation (Vol. 2). Dordrecht, Netherlands: Kluwer Academic Publisher.

Gambardella A. 1992. Competitive advantages from in-house scientific research: the U.S. pharmaceutical industry in the 1980s. Research Policy 21:391-407.

Gambardella A, Harhoff D, Verspagen B. 2008. The value of European patents. European Management Review 5(2):69-84.

Gassmann, O., Enkel, E., & Chesbrough, H. W. (2010). The future of open innovation. R&D Management, 40(3), 213–221.

Griffith, D., & Rubera, G. (2014). A cross-cultural investigation of new product strategies for technological and design innovations. Journal of International Marketing, 22(1), 5-20.

Griswold, W. (1994). Cultures and Societies in a Changing World. London: Pine Forge Press.

Guan, J., & Chen, Z. (2011). Patent collaboration and international knowledge flow. Information Processing and Management, 48(2012), 170–181.

Hemmert, M., Bstieler, L., & Okamuro, H. (2014). Bridging the cultural divide: trust formation in university– industry research collaborations in the US, Japan, and South Korea. Technovation, 34(10), 605–616.

Hinds, P. J., & Bailey, D. E. (2003). Out of Sight, Out of Sync: Understanding Conflict in Distributed Teams. Organization Science, 14(6), 615-632.

Hinzmann, S., Cantner, U., & Graf, H. (2019). The role of geographical proximity for project performance: evidence from the German Leading-Edge Cluster Competition. The Journal of Technology Transfer, 44(6), 1744–1783.

Hofstede, G. (2001). Culture's Consequences: Comparing Values, Behaviors, Institutions and Organizations across Nations. Thousand Oaks, CA: Sage.

Hofstede, G., & Minkov, M. (2010). Cultures and Organizations: Software of the Mind: Intercultural Cooperation and its Importance for Survival. New York: McGraw-Hill.

Home - Hofstede Insights Organisational Culture Consulting. (2019, December 09). Retrieved October 19, 2020, from https://www.hofstede-insights.com/

Hong, J., Heikkinen, J., & Blomqvist, K. (2010). Culture and knowledge co-creation in R&D collaboration between MNCs and Chinese universities. Knowledge Process Management, 17(2), 62–73.

House, R., Javidan, M., Hanges, P., & Dorfman, P. (2002). Understanding cultures and implicit leadership theories across the globe: an introduction to project GLOBE. Journal of World Business, 37(1), 3-10.

Hurley, R. (1995). Group culture and its effect on innovative productivity. Journal of Engineering and Technology Management, 12(1-2), 57-75.

Jaffe, A. B., Trajtenberg, M., & Henderson, R. (1993). Geographic localization of knowledge spillovers as evidenced by patent citations. The Quarterly Journal of Economics, 108(3), 577-598.

Jassawalla, A., & Sashittal, H. (2002). Cultures that support product-innovation processes. Academy of Management Executive, 16 (3), 42-54.

Jones, G., & Davis, H. (2000). National culture and innovation: implications for locating global R&D operations. Management International Review, 40(1), 11-39.

Jones, G., & Davis, H. (2000). National culture and innovation: implications for locating global R&D operations. Management International Review, 40(1), 11-39.

Kaasa, A., & Vadi, M. (2010). How does culture contribute to innovation? Evidence from European countries. Economics of Innovation and New Technology, 19(7), 583-604.

Kaplan S, Murray F, Henderson R. (2003). Discontinuities and senior management: assessing the role of recognition in pharmaceutical firm response to biotechnology. Industrial and Corporate Change 12(4):203-233.

Knoppen, D., S. L. Dolan, M. Diez-Pinol, and R. Bell. (2006). A triangulation analysis of value congruency in corporate spain: American dream or Spanish reality? International Journal of Human Resource Management, 539-58.

Knosková, L. (2015). Innovation processes and entrepreneurial culture for radical innovations. Amfiteatru Economic, 17(38), 342-357.

Lee, K., Woo, H., & Joshi, K. (2017). Pro-innovation culture, ambidexterity and new product development performance: polynomial regression and response surface analysis. European Management Journal, 35(2), 249-260.

Lemon, M. and Sahota, P. (2004). Organizational culture as a knowledge repository for increased innovative capacity. Technovation, 24 (6), 483-498.

Liebeskind, J. P., Oliver, A. L., Zucker, L., & Brewer, M. (1996). Social networks, Learning, and Flexibility: Sourcing Scientific Knowledge in New Biotechnology Firms. Organization Science, 7(4), 428-443.

Lin, L. (2009). Effects of national culture on process management and technological innovation. Total Quality Management & Business Excellence, 20(12), 1287-1301.

Maillat, D. (1998). From industrial networks to innovative milieus: towards an analysis of territorial production systems. Geographische Zeitschrift, 86, 1–15.

Marhl, M., & ., A. P. (2011). Third mission indicators for new ranking methodologies. Eval High Educ, 5, 43–64.

Martin, B. R., and Irvine, J. (1983). Assessing basic research – some partial indicators of scientific progress in radio astronomy. Res. Policy 12, 61–90.

Martinez C. 2011. Patent families: When do different definitions really matter? Scientometrics 86(1):39-63.

Meyer, J. (2014). Strengthening innovation capacity through different types of innovation cultures. Technology Innovation Management Review, 4, 6-16.

Miron, E., Erez, M., & Naveh, E. (2004). Do personal characteristics and cultural values that promote innovation, quality, and efficiency compete or complement each other? Journal of Organizational Behavior, 25(2), 175-199.

Mora-Valentin, E.M., Montoro-Sanchez, A., Guerras-Martin, L.A.(2004). Determining factors in the success of R&D cooperative agreements between firms and research organizations. Research Policy, 33, 17–40.

Morange, M. (1998). A History of Molecular Biology. Cambridge, Ma: Harvard University Press.

Morgan, R. M., & Hunt, S. D. (1994). The commitment-trust theory of relationship marketing. Journal of Marketing, 58(3), 20–38.

Mowery, D., Nelson, R., Sampat, B., & Ziedonis, A. (1999). The growth of patenting and licensing by U.S. universities: an assessment of the effects of the Bayh–Dole act of 1980. Research Policy, 30(2001), 99-119.

Myoken, Y. (2013). The role of geographical proximity in university and industry collaboration: case study of Japanese companies in the UK. Int J Technol Trans Commer, 12, 43–61.

Naranjo Valencia, J., Raquel, S. and Daniel, J. 2010. Organizational culture as determinant of product innovation. European Journal of Innovation Management, 13 (4), 466-480.

Narin, F. (1976). Evaluative Bibliometrics: The Use of Publication and Citation Analysis in the Evaluation of Scientific Activity. Computer Horizons.

OECD. (2015). Science, technology and industry scoreboard 2015: innovation for growth and society. Retrieved from Paris.

Owen-Smith, J., & Powell, W. W. (2004). Knowledge Networks as Channels and Conduits: The Effects of Spillovers in the Boston Biotechnology Community. Organization Science, 15(1), 5-21.

Owen-Smith, J., Riccaboni, M., Pammolli, F., & Powell, W. W. (2002). A Comparison of U.S. and European University-Industry Relations in the Life Sciences. Management Science, 48(1), 5-170.

Petruzzelli, A. (2011). The impact of technological relatedness, priorities, and geographical

distance on university–industry collaborations: a joint-patent analysis. Technovation, 31(7), 309–319.

Pinheiro, R., Langa, P., & Pausits, A. (2015a). One and two equals three?: The third mission of higher education institutions. Eur J High Educ, 5, 233–249.

Rajalo, S., & Vadi, M. (2017). University-industry innovation collaboration: Reconceptualization. Technovation, 62-63, 42-54.

Realo, A., Allik, J., & Vadi, M. (1997). The hierarchical structure of collectivism. Journal of Research in Personality, 31(1), 93-116.

Rhyne, L., Teagarden, M., & Van den Panhuyzen, W. (2002). Technology-based competitive strategies: the relationship of cultural dimensions to new product innovation. The Journal of High Technology Management Research, 13(2), 249-277.

Rousseau, D. M., Sitkin, S. B., Burt, R. S., & Camerer, C. (1998). Not so different at all: A cross-discipline view of trust. Academy of Management Review, 23(3), 393–404.

Schein, E. H. (1996). Culture: The missing concept in organization studies. Administrative Science Quarterly, 41(2), 229–240.

Shane, S. (1993). Cultural influences on national rates of innovation. Journal of Business Venturing, 8(1), 59-73.

Singh, S. (2006). Cultural differences in, and influences on, consumers' propensity to adopt innovations. International Marketing Review, 23(2), 173-191.

Slater, S. F., E. M. Olson, and C. Finnegan. (2011). Business strategy,marketing organization culture, and performance. Marketing Letters, 22, 227-42.

Steenkamp, J., ter Hofstede, F., & Wedel, M. (1999). A cross-national investigation into the individual and national cultural antecedents of consumer innovativeness. Journal of Marketing, 63(2), 55-69.

Steinmo, M., & Rasmussen, E. (2016). How firms collaborate with public research organizations: The evolution of proximity dimensions in successful innovation projects. Journal of Business Research, 69(3), 1250-1259.

Stokes, D. E. (1997). Pasteur's Quadrant: Basic Science and Technological Innovation. Washington DC: Brookings Institution Press.

Sud, P., & Thelwall, M. (2016). Not All International Collaboration s Beneficial: The Mendeley

Readership and Citation Impact of Biochemical Research Collaboration. Journal of the association for information science and technology, 67(8), 1849–1857.

Taylor, M., & Wilson, S. (2012). Does culture still matter? The effects of individualism on national innovation rates. Journal of Business Venturing, 27(2), 234-247.

Tian, M., Deng, P., Zhang, Y., & Salmador, M. P. (2018). How does culture influence innovation? A systematic literature review. Management Decision, 56(5), 1088-1107.

Trajtenberg M. 1990. A penny for your quotes: Patent citation and the value of innovations. Rand Journal of Economics, 21, 172-187.

Tushman, M. (1997). Winning through innovation. Strategy & Leadership, 25(4),14-19.

Van Everdingen, Y., & Waarts, E. (2003). The effect of national culture on the adoption of innovations. Marketing Letters, 14(3), 217-232.

Waarts, E., & Van Everdingen, Y. (2005). The influence of national culture on the adoption status of innovations: an empirical study of firm innovations across Europe. European Management Journal of Business and Psychology, 23(6), 601-610.

Wagner, C. S., Whetsell, T. A., & Mukherjee, S. (2019). International research collaboration: Novelty, conventionality, and atypicality in knowledge recombination. Research Policy, 48(5), 1260-1270.

Wu, H. (2017). The essentiality of sustainability and variety for industry collaborations with university partners. Int J Adv Corp Learn, 10, 19–29.

Zucker, L. G., Darby, M. R., & Brewer, M. B. (1998). Intellectual human capital and the birth of U.S. biotechnology enterprises. The American Economic Review, 88(1), 290-306.

Chapter 8: Appendix

Table 8.1: Correlation matrix for all the dependent and independent variables

	D_DVn	DVwc	PD	Individuality	Masculinity	UA	LTO	Indulgence	distance	diffPD	diffIndividuality	diffMasculinity	diffUA	diffLTO
D_DVn														
DVwc	0.40****													
PD	-0.06**	-0.04*												
Individuality	0.09****	0.07***	-0.55****											
Masculinity	-0.05**	-0.03	0.50****	-0.65****										
UA	-0.09****	-0.06**	0.80****	-0.89****	0.72****									
LTO	-0.11****	-0.07***	0.46****	-0.93****	0.59****	0.83****								
Indulgence	0.08****	0.06**	-0.63****	0.83****	-0.66****	-0.89****	-0.82****							
distance	0.06**	0.04	-0.07***	0.18****	-0.05**	-0.14****	-0.21****	0.17****						
diffPD	0.02	0.00	0.07***	-0.04	-0.09****	0.09****	0.07***	-0.02	0.44****					
diffIndividuality	0.02	0.00	-0.05*	-0.03	0.00	0.01	0.03	0.01	0.70****	0.59****				
diffMasculinity	0.00	-0.02	-0.01	-0.02	-0.10****	0.01	0.05**	0.02	0.44****	0.61****	0.61****			
diffUA	0.02	0.00	0.07***	-0.03	-0.05**	0.07***	0.08****	-0.03	0.59****	0.84****	0.82****	0.67****		
diffLTO	0.04	0.01	-0.06**	0.03	-0.04*	-0.02	0.00	0.05**	0.78****	0.59****	0.87****	0.53****	0.80****	
diffIndugence	0.01	0.00	-0.02	-0.03	-0.04	0.04*	0.09****	-0.06**	0.48****	0.62****	0.69****	0.54****	0.80****	0.70****

p < .0001 '****'; p < .001 '***', p < .01 '**', p < .05 '*'

Table 8.2: Correlation matrix for all the variables

	l_rd	AS_publ	IS_pub	tot_pub_rdM1	tot_coll_pub	div_4_code3	tot_alliances_RD	lvl	nauth	D_DVn	DVwc	PD	Masc	LTO	diffPD	diffMasc	diffLTO
l_rd																	
AS_publ	-0.02																
IS_pub	-0.02	0.12****															
tot_pub_rdM1	-0.47****	0.03	0.18****														
tot_coll_pub	-0.23****	0.03	-0.03	0.12****													
div_4_code3	0.25****	-0.06**	-0.09****	-0.22****	-0.08***												
tot_alliances_RD	-0.52****	0.02	0.10****	0.54****	0.28****	-0.29****											
lvl	-0.02	0.00	0.01	0.15****	0.06**	-0.07***	0.10****										
nauth	-0.08****	0.14****	0.11****	0.02	0.02	0.01	0.04*	-0.02									
D_DVn	-0.07***	0.02	0.07***	0.06**	0.05*	-0.05*	0.09****	0.08****	0.11****								
DVwc	-0.05**	-0.01	0.05**	0.05*	0.06**	-0.07***	0.10****	0.06**	0.11****	0.40****							
PD	-0.29****	-0.01	-0.04*	-0.02	-0.07***	0.15****	-0.05*	-0.09****	0.10****	-0.06**	-0.04*						
Masc	-0.24****	-0.03	-0.09****	-0.07***	-0.19****	0.23****	-0.09****	-0.05**	0.12****	-0.05**	-0.03	0.50****					
LTO	-0.17****	-0.04*	-0.15****	-0.13****	0.01	0.33****	-0.17****	-0.11****	0.05**	-0.11****	-0.07***	0.46****	0.59****				
diffPD	0.06**	0.09****	0.07***	-0.02	0.04	0.09****	-0.04	0.03	0.00	0.02	0.00	0.07***	-0.09****	0.07***			
diffMasc	0.04*	0.11****	0.06**	0.03	0.04*	0.04	-0.01	0.03	0.00	0.00	-0.02	-0.01	-0.10****	0.05**	0.61****		
diffLTO	0.01	0.09****	0.10****	0.04*	0.04	0.03	-0.01	0.04*	-0.02	0.04	0.01	-0.06**	-0.04*	0.00	0.59****	0.53****	
distance	-0.01	0.09****	0.11****	0.08****	0.00	-0.07***	0.04*	0.06**	0.02	0.06**	0.04	-0.07***	-0.05**	-0.21****	0.44****	0.44****	0.78****

p < .0001 '****'; p < .001 '***', p < .01 '**', p < .05 '*'

R-CODES used for data analysis

```
setwd('C:/Users/molasey/Desktop/UHASSELT/MASTER OF MANAGEMENT/YEAR 2/2nd SEMESTER/MASTER THESIS/DATA AN

M_thesis=read.csv('thesis_update.csv')
#str(M_thesis)

####Delete column #3 with x1 name.
M_thesis=M_thesis[,-3]

####check for how many countries and firms
#library(plyr)
#count(M_thesis, 'country_firm')
#count(M_thesis, 'country_univ')
#count(M_thesis, 'firmname')

###using for loop and if to create POWER DIST column
M_thesis1=M_thesis
M_thesis1$PowerDistance1=NULL
for (i in 1:dim(M_thesis1)[1]) {
if(M_thesis1$country_firm[i]=="AUSTRIA"){M_thesis1$PowerDistance1[i]=11}
if(M_thesis1$country_firm[i]=="BELGIUM"){M_thesis1$PowerDistance1[i]=65}
if(M_thesis1$country_firm[i]=="CROATIA"){M_thesis1$PowerDistance1[i]=73}
if(M_thesis1$country_firm[i]=="DENMARK"){M_thesis1$PowerDistance1[i]=18}
if(M_thesis1$country_firm[i]=="ENGLAND"){M_thesis1$PowerDistance1[i]=35}
if(M_thesis1$country_firm[i]=="FINLAND"){M_thesis1$PowerDistance1[i]=33}
if(M_thesis1$country_firm[i]=="FRANCE"){M_thesis1$PowerDistance1[i]=68}
if(M_thesis1$country_firm[i]=="GERMANY"){M_thesis1$PowerDistance1[i]=35}
if(M_thesis1$country_firm[i]=="GREECE"){M_thesis1$PowerDistance1[i]=60}
if(M_thesis1$country_firm[i]=="HUNGARY"){M_thesis1$PowerDistance1[i]=46}
if(M_thesis1$country_firm[i]=="ITALY"){M_thesis1$PowerDistance1[i]=50}
if(M_thesis1$country_firm[i]=="JAPAN"){M_thesis1$PowerDistance1[i]=54}
if(M_thesis1$country_firm[i]=="NETHERLANDS"){M_thesis1$PowerDistance1[i]=38}
if(M_thesis1$country_firm[i]=="NORTH IRELAND"){M_thesis1$PowerDistance1[i]=35}
if(M_thesis1$country_firm[i]=="SCOTLAND"){M_thesis1$PowerDistance1[i]=35}
if(M_thesis1$country_firm[i]=="SPAIN"){M_thesis1$PowerDistance1[i]=57}
if(M_thesis1$country_firm[i]=="SWEDEN"){M_thesis1$PowerDistance1[i]=31}
if(M_thesis1$country_firm[i]=="SWITZERLAND"){M_thesis1$PowerDistance1[i]=34}
if(M_thesis1$country_firm[i]=="USA"){M_thesis1$PowerDistance1[i]=40}
if(M_thesis1$country_firm[i]=="WALES"){M_thesis1$PowerDistance1[i]=35}
}

###using for loop and if to create POWER DIST column 2
```

```
M_thesis2=M_thesis
M_thesis2$PowerDistance2=NULL
for (i in 1:dim(M_thesis2)[1]) {
if(M_thesis2$country_univ[i]=="AUSTRIA"){M_thesis2$PowerDistance2[i]=11}
if(M_thesis2$country_univ[i]=="BELGIUM"){M_thesis2$PowerDistance2[i]=65}
if(M_thesis2$country_univ[i]=="CROATIA"){M_thesis2$PowerDistance2[i]=73}
if(M_thesis2$country_univ[i]=="DENMARK"){M_thesis2$PowerDistance2[i]=18}
if(M_thesis2$country_univ[i]=="ENGLAND"){M_thesis2$PowerDistance2[i]=35}
if(M_thesis2$country_univ[i]=="FINLAND"){M_thesis2$PowerDistance2[i]=33}
if(M_thesis2$country_univ[i]=="FRANCE"){M_thesis2$PowerDistance2[i]=68}
if(M_thesis2$country_univ[i]=="GERMANY"){M_thesis2$PowerDistance2[i]=35}
if(M_thesis2$country_univ[i]=="GREECE"){M_thesis2$PowerDistance2[i]=60}
if(M_thesis2$country_univ[i]=="HUNGARY"){M_thesis2$PowerDistance2[i]=46}
if(M_thesis2$country_univ[i]=="IRELAND"){M_thesis2$PowerDistance2[i]=28}
if(M_thesis2$country_univ[i]=="ITALY"){M_thesis2$PowerDistance2[i]=50}
if(M_thesis2$country_univ[i]=="JAPAN"){M_thesis2$PowerDistance2[i]=54}
if(M_thesis2$country_univ[i]=="NETHERLANDS"){M_thesis2$PowerDistance2[i]=38}
if(M_thesis2$country_univ[i]=="NORTH IRELAND"){M_thesis2$PowerDistance2[i]=35}
if(M_thesis2$country_univ[i]=="SCOTLAND"){M_thesis2$PowerDistance2[i]=35}
if(M_thesis2$country_univ[i]=="SPAIN"){M_thesis2$PowerDistance2[i]=57}
if(M_thesis2$country_univ[i]=="SWEDEN"){M_thesis2$PowerDistance2[i]=31}
if(M_thesis2$country_univ[i]=="SWITZERLAND"){M_thesis2$PowerDistance2[i]=34}
if(M_thesis2$country_univ[i]=="USA"){M_thesis2$PowerDistance2[i]=40}
if(M_thesis2$country_univ[i]=="WALES"){M_thesis2$PowerDistance2[i]=35}
}

###using for loop and if to create Individualism column 1
M_thesis3=M_thesis
M_thesis3$Individualism1=NULL
for (i in 1:dim(M_thesis3)[1]) {
if(M_thesis3$country_firm[i]=="AUSTRIA"){M_thesis3$Individualism1[i]=55}
if(M_thesis3$country_firm[i]=="BELGIUM"){M_thesis3$Individualism1[i]=75}
if(M_thesis3$country_firm[i]=="CROATIA"){M_thesis3$Individualism1[i]=33}
if(M_thesis3$country_firm[i]=="DENMARK"){M_thesis3$Individualism1[i]=74}
if(M_thesis3$country_firm[i]=="ENGLAND"){M_thesis3$Individualism1[i]=89}
if(M_thesis3$country_firm[i]=="FINLAND"){M_thesis3$Individualism1[i]=63}
if(M_thesis3$country_firm[i]=="FRANCE"){M_thesis3$Individualism1[i]=71}
if(M_thesis3$country_firm[i]=="GERMANY"){M_thesis3$Individualism1[i]=67}
if(M_thesis3$country_firm[i]=="GREECE"){M_thesis3$Individualism1[i]=35}
if(M_thesis3$country_firm[i]=="HUNGARY"){M_thesis3$Individualism1[i]=80}
if(M_thesis3$country_firm[i]=="ITALY"){M_thesis3$Individualism1[i]=76}
if(M_thesis3$country_firm[i]=="JAPAN"){M_thesis3$Individualism1[i]=46}
if(M_thesis3$country_firm[i]=="NETHERLANDS"){M_thesis3$Individualism1[i]=80}
```

```
if(M_thesis3$country_firm[i]=="NORTH IRELAND"){M_thesis3$Individualism1[i]=89}
if(M_thesis3$country_firm[i]=="SCOTLAND"){M_thesis3$Individualism1[i]=89}
if(M_thesis3$country_firm[i]=="SPAIN"){M_thesis3$Individualism1[i]=51}
if(M_thesis3$country_firm[i]=="SWEDEN"){M_thesis3$Individualism1[i]=71}
if(M_thesis3$country_firm[i]=="SWITZERLAND"){M_thesis3$Individualism1[i]=68}
if(M_thesis3$country_firm[i]=="USA"){M_thesis3$Individualism1[i]=91}
if(M_thesis3$country_firm[i]=="WALES"){M_thesis3$Individualism1[i]=89}
}

###using for loop and if to create Individualism column 2
M_thesis4=M_thesis
M_thesis4$Individualism2=NULL
for (i in 1:dim(M_thesis4)[1]) {
if(M_thesis4$country_univ[i]=="AUSTRIA"){M_thesis4$Individualism2[i]=55}
if(M_thesis4$country_univ[i]=="BELGIUM"){M_thesis4$Individualism2[i]=75}
if(M_thesis4$country_univ[i]=="CROATIA"){M_thesis4$Individualism2[i]=33}
if(M_thesis4$country_univ[i]=="DENMARK"){M_thesis4$Individualism2[i]=74}
if(M_thesis4$country_univ[i]=="ENGLAND"){M_thesis4$Individualism2[i]=89}
if(M_thesis4$country_univ[i]=="FINLAND"){M_thesis4$Individualism2[i]=63}
if(M_thesis4$country_univ[i]=="FRANCE"){M_thesis4$Individualism2[i]=71}
if(M_thesis4$country_univ[i]=="GERMANY"){M_thesis4$Individualism2[i]=67}
if(M_thesis4$country_univ[i]=="GREECE"){M_thesis4$Individualism2[i]=35}
if(M_thesis4$country_univ[i]=="HUNGARY"){M_thesis4$Individualism2[i]=80}
if(M_thesis4$country_univ[i]=="IRELAND"){M_thesis4$Individualism2[i]=70}
if(M_thesis4$country_univ[i]=="ITALY"){M_thesis4$Individualism2[i]=76}
if(M_thesis4$country_univ[i]=="JAPAN"){M_thesis4$Individualism2[i]=46}
if(M_thesis4$country_univ[i]=="NETHERLANDS"){M_thesis4$Individualism2[i]=80}
if(M_thesis4$country_univ[i]=="NORTH IRELAND"){M_thesis4$Individualism2[i]=89}
if(M_thesis4$country_univ[i]=="SCOTLAND"){M_thesis4$Individualism2[i]=89}
if(M_thesis4$country_univ[i]=="SPAIN"){M_thesis4$Individualism2[i]=51}
if(M_thesis4$country_univ[i]=="SWEDEN"){M_thesis4$Individualism2[i]=71}
if(M_thesis4$country_univ[i]=="SWITZERLAND"){M_thesis4$Individualism2[i]=68}
if(M_thesis4$country_univ[i]=="USA"){M_thesis4$Individualism2[i]=91}
if(M_thesis4$country_univ[i]=="WALES"){M_thesis4$Individualism2[i]=89}
}

###using for loop and if to create Maculinity column 1
M_thesis5=M_thesis
M_thesis5$Masculinity1=NULL
for (i in 1:dim(M_thesis5)[1]) {
if(M_thesis5$country_firm[i]=="AUSTRIA"){M_thesis5$Masculinity1[i]=79}
if(M_thesis5$country_firm[i]=="BELGIUM"){M_thesis5$Masculinity1[i]=54}
if(M_thesis5$country_firm[i]=="CROATIA"){M_thesis5$Masculinity1[i]=40}
```

```
if(M_thesis5$country_firm[i]=="DENMARK"){M_thesis5$Masculinity1[i]=16}
if(M_thesis5$country_firm[i]=="ENGLAND"){M_thesis5$Masculinity1[i]=66}
if(M_thesis5$country_firm[i]=="FINLAND"){M_thesis5$Masculinity1[i]=26}
if(M_thesis5$country_firm[i]=="FRANCE"){M_thesis5$Masculinity1[i]=43}
if(M_thesis5$country_firm[i]=="GERMANY"){M_thesis5$Masculinity1[i]=66}
if(M_thesis5$country_firm[i]=="GREECE"){M_thesis5$Masculinity1[i]=57}
if(M_thesis5$country_firm[i]=="HUNGARY"){M_thesis5$Masculinity1[i]=88}
if(M_thesis5$country_firm[i]=="ITALY"){M_thesis5$Masculinity1[i]=70}
if(M_thesis5$country_firm[i]=="JAPAN"){M_thesis5$Masculinity1[i]=95}
if(M_thesis5$country_firm[i]=="NETHERLANDS"){M_thesis5$Masculinity1[i]=14}
if(M_thesis5$country_firm[i]=="NORTH IRELAND"){M_thesis5$Masculinity1[i]=66}
if(M_thesis5$country_firm[i]=="SCOTLAND"){M_thesis5$Masculinity1[i]=66}
if(M_thesis5$country_firm[i]=="SPAIN"){M_thesis5$Masculinity1[i]=42}
if(M_thesis5$country_firm[i]=="SWEDEN"){M_thesis5$Masculinity1[i]=5}
if(M_thesis5$country_firm[i]=="SWITZERLAND"){M_thesis5$Masculinity1[i]=70}
if(M_thesis5$country_firm[i]=="USA"){M_thesis5$Masculinity1[i]=62}
if(M_thesis5$country_firm[i]=="WALES"){M_thesis5$Masculinity1[i]=66}
}

###using for loop and if to create Maculinity column 1
M_thesis6=M_thesis
M_thesis6$Masculinity2=NULL
for (i in 1:dim(M_thesis6)[1]) {
if(M_thesis6$country_univ[i]=="AUSTRIA"){M_thesis6$Masculinity2[i]=79}
if(M_thesis6$country_univ[i]=="BELGIUM"){M_thesis6$Masculinity2[i]=54}
if(M_thesis6$country_univ[i]=="CROATIA"){M_thesis6$Masculinity2[i]=40}
if(M_thesis6$country_univ[i]=="DENMARK"){M_thesis6$Masculinity2[i]=16}
if(M_thesis6$country_univ[i]=="ENGLAND"){M_thesis6$Masculinity2[i]=66}
if(M_thesis6$country_univ[i]=="FINLAND"){M_thesis6$Masculinity2[i]=26}
if(M_thesis6$country_univ[i]=="FRANCE"){M_thesis6$Masculinity2[i]=43}
if(M_thesis6$country_univ[i]=="GERMANY"){M_thesis6$Masculinity2[i]=66}
if(M_thesis6$country_univ[i]=="GREECE"){M_thesis6$Masculinity2[i]=57}
if(M_thesis6$country_univ[i]=="HUNGARY"){M_thesis6$Masculinity2[i]=88}
if(M_thesis6$country_univ[i]=="IRELAND"){M_thesis6$Masculinity2[i]=68}
if(M_thesis6$country_univ[i]=="ITALY"){M_thesis6$Masculinity2[i]=70}
if(M_thesis6$country_univ[i]=="JAPAN"){M_thesis6$Masculinity2[i]=95}
if(M_thesis6$country_univ[i]=="NETHERLANDS"){M_thesis6$Masculinity2[i]=14}
if(M_thesis6$country_univ[i]=="NORTH IRELAND"){M_thesis6$Masculinity2[i]=66}
if(M_thesis6$country_univ[i]=="SCOTLAND"){M_thesis6$Masculinity2[i]=66}
if(M_thesis6$country_univ[i]=="SPAIN"){M_thesis6$Masculinity2[i]=42}
if(M_thesis6$country_univ[i]=="SWEDEN"){M_thesis6$Masculinity2[i]=5}
if(M_thesis6$country_univ[i]=="SWITZERLAND"){M_thesis6$Masculinity2[i]=70}
if(M_thesis6$country_univ[i]=="USA"){M_thesis6$Masculinity2[i]=62}
```

```
if(M_thesis6$country_univ[i]=="WALES"){M_thesis6$Masculinity2[i]=66}
}

###using for loop and if to create Uncertainty avoid column 1
M_thesis7=M_thesis
M_thesis7$Uncert1=NULL
for (i in 1:dim(M_thesis7)[1]) {
if(M_thesis7$country_firm[i]=="AUSTRIA"){M_thesis7$Uncert1[i]=70}
if(M_thesis7$country_firm[i]=="BELGIUM"){M_thesis7$Uncert1[i]=94}
if(M_thesis7$country_firm[i]=="CROATIA"){M_thesis7$Uncert1[i]=80}
if(M_thesis7$country_firm[i]=="DENMARK"){M_thesis7$Uncert1[i]=23}
if(M_thesis7$country_firm[i]=="ENGLAND"){M_thesis7$Uncert1[i]=35}
if(M_thesis7$country_firm[i]=="FINLAND"){M_thesis7$Uncert1[i]=59}
if(M_thesis7$country_firm[i]=="FRANCE"){M_thesis7$Uncert1[i]=86}
if(M_thesis7$country_firm[i]=="GERMANY"){M_thesis7$Uncert1[i]=65}
if(M_thesis7$country_firm[i]=="GREECE"){M_thesis7$Uncert1[i]=100}
if(M_thesis7$country_firm[i]=="HUNGARY"){M_thesis7$Uncert1[i]=82}
if(M_thesis7$country_firm[i]=="ITALY"){M_thesis7$Uncert1[i]=75}
if(M_thesis7$country_firm[i]=="JAPAN"){M_thesis7$Uncert1[i]=92}
if(M_thesis7$country_firm[i]=="NETHERLANDS"){M_thesis7$Uncert1[i]=53}
if(M_thesis7$country_firm[i]=="NORTH IRELAND"){M_thesis7$Uncert1[i]=35}
if(M_thesis7$country_firm[i]=="SCOTLAND"){M_thesis7$Uncert1[i]=35}
if(M_thesis7$country_firm[i]=="SPAIN"){M_thesis7$Uncert1[i]=86}
if(M_thesis7$country_firm[i]=="SWEDEN"){M_thesis7$Uncert1[i]=29}
if(M_thesis7$country_firm[i]=="SWITZERLAND"){M_thesis7$Uncert1[i]=58}
if(M_thesis7$country_firm[i]=="USA"){M_thesis7$Uncert1[i]=46}
if(M_thesis7$country_firm[i]=="WALES"){M_thesis7$Uncert1[i]=35}
}

###using for loop and if to create Uncertainty avoid column 2
M_thesis8=M_thesis
M_thesis8$Uncert2=NULL
for (i in 1:dim(M_thesis8)[1]) {
if(M_thesis8$country_univ[i]=="AUSTRIA"){M_thesis8$Uncert2[i]=70}
if(M_thesis8$country_univ[i]=="BELGIUM"){M_thesis8$Uncert2[i]=94}
if(M_thesis8$country_univ[i]=="CROATIA"){M_thesis8$Uncert2[i]=80}
if(M_thesis8$country_univ[i]=="DENMARK"){M_thesis8$Uncert2[i]=23}
if(M_thesis8$country_univ[i]=="ENGLAND"){M_thesis8$Uncert2[i]=35}
if(M_thesis8$country_univ[i]=="FINLAND"){M_thesis8$Uncert2[i]=59}
if(M_thesis8$country_univ[i]=="FRANCE"){M_thesis8$Uncert2[i]=86}
if(M_thesis8$country_univ[i]=="GERMANY"){M_thesis8$Uncert2[i]=65}
if(M_thesis8$country_univ[i]=="GREECE"){M_thesis8$Uncert2[i]=100}
if(M_thesis8$country_univ[i]=="HUNGARY"){M_thesis8$Uncert2[i]=82}
```

```
if(M_thesis8$country_univ[i]=="IRELAND"){M_thesis8$Uncert2[i]=35}
if(M_thesis8$country_univ[i]=="ITALY"){M_thesis8$Uncert2[i]=75}
if(M_thesis8$country_univ[i]=="JAPAN"){M_thesis8$Uncert2[i]=92}
if(M_thesis8$country_univ[i]=="NETHERLANDS"){M_thesis8$Uncert2[i]=53}
if(M_thesis8$country_univ[i]=="NORTH IRELAND"){M_thesis8$Uncert2[i]=35}
if(M_thesis8$country_univ[i]=="SCOTLAND"){M_thesis8$Uncert2[i]=35}
if(M_thesis8$country_univ[i]=="SPAIN"){M_thesis8$Uncert2[i]=86}
if(M_thesis8$country_univ[i]=="SWEDEN"){M_thesis8$Uncert2[i]=29}
if(M_thesis8$country_univ[i]=="SWITZERLAND"){M_thesis8$Uncert2[i]=58}
if(M_thesis8$country_univ[i]=="USA"){M_thesis8$Uncert2[i]=46}
if(M_thesis8$country_univ[i]=="WALES"){M_thesis8$Uncert2[i]=35}
}
###using for loop and if to create LongTermOrient column 1
M_thesis9=M_thesis
M_thesis9$LongTermOrient1=NULL
for (i in 1:dim(M_thesis9)[1]) {
if(M_thesis9$country_firm[i]=="AUSTRIA"){M_thesis9$LongTermOrient1[i]=60}
if(M_thesis9$country_firm[i]=="BELGIUM"){M_thesis9$LongTermOrient1[i]=82}
if(M_thesis9$country_firm[i]=="CROATIA"){M_thesis9$LongTermOrient1[i]=58}
if(M_thesis9$country_firm[i]=="DENMARK"){M_thesis9$LongTermOrient1[i]=35}
if(M_thesis9$country_firm[i]=="ENGLAND"){M_thesis9$LongTermOrient1[i]=51}
if(M_thesis9$country_firm[i]=="FINLAND"){M_thesis9$LongTermOrient1[i]=38}
if(M_thesis9$country_firm[i]=="FRANCE"){M_thesis9$LongTermOrient1[i]=63}
if(M_thesis9$country_firm[i]=="GERMANY"){M_thesis9$LongTermOrient1[i]=83}
if(M_thesis9$country_firm[i]=="GREECE"){M_thesis9$LongTermOrient1[i]=45}
if(M_thesis9$country_firm[i]=="HUNGARY"){M_thesis9$LongTermOrient1[i]=58}
if(M_thesis9$country_firm[i]=="ITALY"){M_thesis9$LongTermOrient1[i]=61}
if(M_thesis9$country_firm[i]=="JAPAN"){M_thesis9$LongTermOrient1[i]=88}
if(M_thesis9$country_firm[i]=="NETHERLANDS"){M_thesis9$LongTermOrient1[i]=67}
if(M_thesis9$country_firm[i]=="NORTH IRELAND"){M_thesis9$LongTermOrient1[i]=51}
if(M_thesis9$country_firm[i]=="SCOTLAND"){M_thesis9$LongTermOrient1[i]=51}
if(M_thesis9$country_firm[i]=="SPAIN"){M_thesis9$LongTermOrient1[i]=48}
if(M_thesis9$country_firm[i]=="SWEDEN"){M_thesis9$LongTermOrient1[i]=53}
if(M_thesis9$country_firm[i]=="SWITZERLAND"){M_thesis9$LongTermOrient1[i]=74}
if(M_thesis9$country_firm[i]=="USA"){M_thesis9$LongTermOrient1[i]=26}
if(M_thesis9$country_firm[i]=="WALES"){M_thesis9$LongTermOrient1[i]=51}
}

###using for loop and if to create LongTermOrient column 2
M_thesis10=M_thesis
M_thesis10$LongTermOrient2=NULL
for (i in 1:dim(M_thesis10)[1]) {
if(M_thesis10$country_univ[i]=="AUSTRIA"){M_thesis10$LongTermOrient2[i]=60}
```

```
if(M_thesis10$country_univ[i]=="BELGIUM"){M_thesis10$LongTermOrient2[i]=82}
if(M_thesis10$country_univ[i]=="CROATIA"){M_thesis10$LongTermOrient2[i]=58}
if(M_thesis10$country_univ[i]=="DENMARK"){M_thesis10$LongTermOrient2[i]=35}
if(M_thesis10$country_univ[i]=="ENGLAND"){M_thesis10$LongTermOrient2[i]=51}
if(M_thesis10$country_univ[i]=="FINLAND"){M_thesis10$LongTermOrient2[i]=38}
if(M_thesis10$country_univ[i]=="FRANCE"){M_thesis10$LongTermOrient2[i]=63}
if(M_thesis10$country_univ[i]=="GERMANY"){M_thesis10$LongTermOrient2[i]=83}
if(M_thesis10$country_univ[i]=="GREECE"){M_thesis10$LongTermOrient2[i]=45}
if(M_thesis10$country_univ[i]=="HUNGARY"){M_thesis10$LongTermOrient2[i]=58}
if(M_thesis10$country_univ[i]=="IRELAND"){M_thesis10$LongTermOrient2[i]=24}
if(M_thesis10$country_univ[i]=="ITALY"){M_thesis10$LongTermOrient2[i]=61}
if(M_thesis10$country_univ[i]=="JAPAN"){M_thesis10$LongTermOrient2[i]=88}
if(M_thesis10$country_univ[i]=="NETHERLANDS"){M_thesis10$LongTermOrient2[i]=67}
if(M_thesis10$country_univ[i]=="NORTH IRELAND"){M_thesis10$LongTermOrient2[i]=51}
if(M_thesis10$country_univ[i]=="SCOTLAND"){M_thesis10$LongTermOrient2[i]=51}
if(M_thesis10$country_univ[i]=="SPAIN"){M_thesis10$LongTermOrient2[i]=48}
if(M_thesis10$country_univ[i]=="SWEDEN"){M_thesis10$LongTermOrient2[i]=53}
if(M_thesis10$country_univ[i]=="SWITZERLAND"){M_thesis10$LongTermOrient2[i]=74}
if(M_thesis10$country_univ[i]=="USA"){M_thesis10$LongTermOrient2[i]=26}
if(M_thesis10$country_univ[i]=="WALES"){M_thesis10$LongTermOrient2[i]=51}
}

M_thesis11=M_thesis
M_thesis11$Indulgence1=NULL
for (i in 1:dim(M_thesis11)[1]) {
if(M_thesis11$country_firm[i]=="AUSTRIA"){M_thesis11$Indulgence1[i]=63}
if(M_thesis11$country_firm[i]=="BELGIUM"){M_thesis11$Indulgence1[i]=57}
if(M_thesis11$country_firm[i]=="CROATIA"){M_thesis11$Indulgence1[i]=33}
if(M_thesis11$country_firm[i]=="DENMARK"){M_thesis11$Indulgence1[i]=70}
if(M_thesis11$country_firm[i]=="ENGLAND"){M_thesis11$Indulgence1[i]=69}
if(M_thesis11$country_firm[i]=="FINLAND"){M_thesis11$Indulgence1[i]=57}
if(M_thesis11$country_firm[i]=="FRANCE"){M_thesis11$Indulgence1[i]=48}
if(M_thesis11$country_firm[i]=="GERMANY"){M_thesis11$Indulgence1[i]=40}
if(M_thesis11$country_firm[i]=="GREECE"){M_thesis11$Indulgence1[i]=50}
if(M_thesis11$country_firm[i]=="HUNGARY"){M_thesis11$Indulgence1[i]=31}
if(M_thesis11$country_firm[i]=="ITALY"){M_thesis11$Indulgence1[i]=30}
if(M_thesis11$country_firm[i]=="JAPAN"){M_thesis11$Indulgence1[i]=42}
if(M_thesis11$country_firm[i]=="NETHERLANDS"){M_thesis11$Indulgence1[i]=68}
if(M_thesis11$country_firm[i]=="NORTH IRELAND"){M_thesis11$Indulgence1[i]=69}
if(M_thesis11$country_firm[i]=="SCOTLAND"){M_thesis11$Indulgence1[i]=69}
if(M_thesis11$country_firm[i]=="SPAIN"){M_thesis11$Indulgence1[i]=44}
if(M_thesis11$country_firm[i]=="SWEDEN"){M_thesis11$Indulgence1[i]=78}
if(M_thesis11$country_firm[i]=="SWITZERLAND"){M_thesis11$Indulgence1[i]=66}
```

```
if(M_thesis11$country_firm[i]=="USA"){M_thesis11$Indulgence1[i]=68}
if(M_thesis11$country_firm[i]=="WALES"){M_thesis11$Indulgence1[i]=69}
}

M_thesis12=M_thesis
M_thesis12$Indulgence2=NULL
for (i in 1:dim(M_thesis12)[1]) {
if(M_thesis12$country_univ[i]=="AUSTRIA"){M_thesis12$Indulgence2[i]=63}
if(M_thesis12$country_univ[i]=="BELGIUM"){M_thesis12$Indulgence2[i]=57}
if(M_thesis12$country_univ[i]=="CROATIA"){M_thesis12$Indulgence2[i]=33}
if(M_thesis12$country_univ[i]=="DENMARK"){M_thesis12$Indulgence2[i]=70}
if(M_thesis12$country_univ[i]=="ENGLAND"){M_thesis12$Indulgence2[i]=69}
if(M_thesis12$country_univ[i]=="FINLAND"){M_thesis12$Indulgence2[i]=57}
if(M_thesis12$country_univ[i]=="FRANCE"){M_thesis12$Indulgence2[i]=48}
if(M_thesis12$country_univ[i]=="GERMANY"){M_thesis12$Indulgence2[i]=40}
if(M_thesis12$country_univ[i]=="GREECE"){M_thesis12$Indulgence2[i]=50}
if(M_thesis12$country_univ[i]=="HUNGARY"){M_thesis12$Indulgence2[i]=31}
if(M_thesis12$country_univ[i]=="IRELAND"){M_thesis12$Indulgence2[i]=65}
if(M_thesis12$country_univ[i]=="ITALY"){M_thesis12$Indulgence2[i]=30}
if(M_thesis12$country_univ[i]=="JAPAN"){M_thesis12$Indulgence2[i]=42}
if(M_thesis12$country_univ[i]=="NETHERLANDS"){M_thesis12$Indulgence2[i]=68}
if(M_thesis12$country_univ[i]=="NORTH IRELAND"){M_thesis12$Indulgence2[i]=69}
if(M_thesis12$country_univ[i]=="SCOTLAND"){M_thesis12$Indulgence2[i]=69}
if(M_thesis12$country_univ[i]=="SPAIN"){M_thesis12$Indulgence2[i]=44}
if(M_thesis12$country_univ[i]=="SWEDEN"){M_thesis12$Indulgence2[i]=78}
if(M_thesis12$country_univ[i]=="SWITZERLAND"){M_thesis12$Indulgence2[i]=66}
if(M_thesis12$country_univ[i]=="USA"){M_thesis12$Indulgence2[i]=68}
if(M_thesis12$country_univ[i]=="WALES"){M_thesis12$Indulgence2[i]=69}
}

###create collab column
M_thesis13=M_thesis
M_thesis13$collab_type=NULL
for (i in 1:dim(M_thesis13)[1]) {
if(M_thesis13$country_firm[i]==M_thesis13$country_univ[i]){
M_thesis13$collab_type[i]=0}

if(M_thesis13$country_firm[i]!=M_thesis13$country_univ[i]){
M_thesis13$collab_type[i]=1}
}

###scale focal distance by 1000
M_thesis14=M_thesis
```

```
M_thesis14$distance=NULL
for (i in 1:dim(M_thesis14)[1]) {
M_thesis14$distance[i]=M_thesis14$dist_foc_univ[i]/1000}

#####create new variable for year
M_thesis15=M_thesis
M_thesis15$yd=NULL
for (i in 1:dim(M_thesis15)[1]) {
if(M_thesis15$yd1[i]==1){
M_thesis15$yd[i]=0}
if(M_thesis15$yd2[i]==1){
M_thesis15$yd[i]=1}
if(M_thesis15$yd3[i]==1){
M_thesis15$yd[i]=2}
if(M_thesis15$yd4[i]==1){
M_thesis15$yd[i]=3}
if(M_thesis15$yd5[i]==1){
M_thesis15$yd[i]=4}
if(M_thesis15$yd6[i]==1){
M_thesis15$yd[i]=5}
if(M_thesis15$yd7[i]==1){
M_thesis15$yd[i]=6}
}



###merge all columns into new dataset
M_thesisMerge=cbind(M_thesis, M_thesis1$PowerDistance1, M_thesis2$PowerDistance2, M_thesis3$Individualis
M_thesis4$Individualism2, M_thesis5$Masculinity1, M_thesis6$Masculinity2, M_thesis7$Uncert1,
M_thesis8$Uncert2, M_thesis9$LongTermOrient1, M_thesis10$LongTermOrient2,
M_thesis11$Indulgence1,M_thesis12$Indulgence2,M_thesis13$collab_type,M_thesis14$distance,
M_thesis15$yd)

####rename columns
colnames(M_thesisMerge)[31] <- "PDis1"
colnames(M_thesisMerge)[32] <- "PDis2"
colnames(M_thesisMerge)[33] <- "Ind1"
colnames(M_thesisMerge)[34] <- "Ind2"
colnames(M_thesisMerge)[35] <- "Masc1"
colnames(M_thesisMerge)[36] <- "Masc2"
colnames(M_thesisMerge)[37] <- "Uncert1"
colnames(M_thesisMerge)[38] <- "Uncert2"
colnames(M_thesisMerge)[39] <- "LTO1"
```

```
colnames(M_thesisMerge)[40] <- "LTO2"
colnames(M_thesisMerge)[41] <- "Indul1"
colnames(M_thesisMerge)[42] <- "Indul2"
colnames(M_thesisMerge)[43] <- "collab_type"
colnames(M_thesisMerge)[44] <- "distance"
colnames(M_thesisMerge)[45] <- "yd"

###Create columns of differences between culture values and take abs value
M_thesisMerge$diffPDis=abs(M_thesisMerge$PDis2-M_thesisMerge$PDis1)
M_thesisMerge$diffInd=abs(M_thesisMerge$Ind2-M_thesisMerge$Ind1)
M_thesisMerge$diffMasc=abs(M_thesisMerge$Masc2-M_thesisMerge$Masc1)
M_thesisMerge$diffUncert=abs(M_thesisMerge$Uncert2-M_thesisMerge$Uncert1)
M_thesisMerge$diffLTO=abs(M_thesisMerge$LTO2-M_thesisMerge$LTO1)
M_thesisMerge$diffIndul=abs(M_thesisMerge$Indul2-M_thesisMerge$Indul1)

####make yd a dummy###
M_thesisMerge$yd=factor(M_thesisMerge$yd)
#class(M_thesisMerge$yd)
#dim(M_thesisMerge)

#####check for duplicates- 1026 rows repeat at least once after checking
#n_occur=data.frame(table(M_thesisMerge$pubid))
#dim(n_occur)
#n_occur[n_occur$Freq > 1,]
#dim(n_occur[n_occur$Freq > 1,])


# Remove duplicated rows based on pubid
library(tidyverse)
library(dplyr)
M_thesisMerge1=M_thesisMerge[!duplicated(M_thesisMerge$pubid), ]
#dim(M_thesisMerge1)

####find missing values and delete row
sum(is.na(M_thesisMerge1))
#apply(is.na(M_thesisMerge1), 2, which)
M_thesisMerge1=na.omit(M_thesisMerge1)




###correlation matrix of dependent and independent varables
corrm=M_thesisMerge1
```

```
apply(is.na(corrm), 2, which)
#dim(M_thesisMerge1)
#str(M_thesisMerge1)
library(Hmisc)
library(xtable)
###variables: D_DVno,DVwco,PDis, Ind, Masc, Uncert, LTO, Indul, distance.
#corrm1= corrm[,c(17,19,31,33,35,37,39,41,44)]
#corrm1= corrm[,c(6,7,8,11,13,14,15,21,22,17,19,31,35,39,46,48,50, 44)]
#corrm1= corrm[,c(17,19,31,35,39,46,48,44)]
dim(corrm1)
#corrm2=rcorr(as.matrix(corrm1))
#mcor<-round(cor(corrm1),2)
#upper<-mcor
#upper[upper.tri(mcor)]<-""
#upper<-as.data.frame(upper)
#upper
#print(xtable(upper), type="latex")

corstars <-function(x, method=c("pearson", "spearman"), removeTriangle=c("upper", "lower"),
result=c("none", "html", "latex")){

#####Compute correlation matrix
require(Hmisc)
x <- as.matrix(x)
correlation_matrix<-rcorr(x, type=method[1])
R <- correlation_matrix$r # Matrix of correlation coeficients
p <- correlation_matrix$P # Matrix of p-value

## Define notions for significance levels; spacing is important.
mystars <- ifelse(p < .0001, "****", ifelse(p < .001, "*** ", ifelse(p < .01, "**  ", ifelse(p < .05, "

## trunctuate the correlation matrix to two decimal
R <- format(round(cbind(rep(-1.11, ncol(x)), R), 2))[,-1]

## build a new matrix that includes the correlations with their apropriate stars
Rnew <- matrix(paste(R, mystars, sep=""), ncol=ncol(x))
diag(Rnew) <- paste(diag(R), " ", sep="")
rownames(Rnew) <- colnames(x)
colnames(Rnew) <- paste(colnames(x), "", sep="")

## remove upper triangle of correlation matrix
if(removeTriangle[1]=="upper"){
Rnew <- as.matrix(Rnew)
```

```
Rnew[upper.tri(Rnew, diag = TRUE)] <- ""
Rnew <- as.data.frame(Rnew)
}

## remove lower triangle of correlation matrix
else if(removeTriangle[1]=="lower"){
Rnew <- as.matrix(Rnew)
Rnew[lower.tri(Rnew, diag = TRUE)] <- ""
Rnew <- as.data.frame(Rnew)
}

## remove last column and return the correlation matrix
Rnew <- cbind(Rnew[1:length(Rnew)-1])
if (result[1]=="none") return(Rnew)
else{
if(result[1]=="html") print(xtable(Rnew), type="html")
else print(xtable(Rnew), type="latex")
}
}
corstars(corrm1, result="latex")

####frequencies of firm countries
table(M_thesisMerge1$country_firm)
table(M_thesisMerge1$country_univ)

prop.table(table(M_thesisMerge1$country_firm))
tbl <- table(M_thesisMerge1$country_firm)
cbind(tbl,prop.table(tbl))

####descriptive stats of all variables
library(summarytools)
descr(M_thesisMerge1,headings = TRUE,
stats = "common")


#######################################################
######STATISTICAL MODELS#################
#######################################################

####NEGATIVE BINOMIAL MODELS WITH DVwco AS DEPENDENT#######
###model with controls only
library(MASS)
modelnb1=glm.nb(DVwc~lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_publ
```

```
+IS_pub, data=M_thesisMerge1)
summary(modelnb1)

###model with controls and the 3 cultural values
modelnb2=glm.nb(DVwc~lvl+lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_pu
+IS_pub
+PDis1+Masc1+LTO1, data=M_thesisMerge1)
summary(modelnb2)

###model with controls and the 3 cultural diff values
modelnb3=glm.nb(DVwc~lvl+lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_pu
+IS_pub
+diffPDis+diffMasc+diffLTO, data=M_thesisMerge1)
summary(modelnb3)

###model with controls and distance
modelnb4=glm.nb(DVwc~lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_publ
+IS_pub+distance, data=M_thesisMerge1)
summary(modelnb4)

###model with controls,distance, cultural values and cultural diff values
modelnb5=glm.nb(DVwc~lvl+lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_pu
+IS_pub+distance+PDis1+Masc1+LTO1
+diffPDis+diffMasc+diffLTO, data=M_thesisMerge1)
summary(modelnb5)

modelnb6=glm.nb(DVwc~lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_publ
+IS_pub+diffPDis+diffMasc+diffLTO+PDis1+Masc1+LTO1, data=M_thesisMerge1)
summary(modelnb6)

modelnb7=glm.nb(DVwc~lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_publ
+IS_pub+distance+PDis1+Masc1+LTO1, data=M_thesisMerge1)
summary(modelnb7)



###likelihood ratio test model 1 vs all others
library(lmtest)
lrtest (modelnb1, modelnb2)
lrtest (modelnb1, modelnb3)
lrtest (modelnb1, modelnb4)
lrtest (modelnb1, modelnb5)
lrtest (modelnb1, modelnb6)
```

```
lrtest (modelnb1, modelnb7)


###likelihood ratio test model 5 vs all others
library(lmtest)
lrtest (modelnb1, modelnb5)
lrtest (modelnb2, modelnb5)
lrtest (modelnb3, modelnb5)
lrtest (modelnb4, modelnb5)
lrtest (modelnb6, modelnb5)
lrtest (modelnb7, modelnb5)



####LOGISTIC REGRESSION MODELS WITH D_Dvn AS DEPENDENT VARIABLE#######
###model with controls only
library(MASS)
modelb1=glm(D_DVn~lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_publ
+IS_pub, data=M_thesisMerge1, family = binomial)
summary(modelb1)

###model2 with controls and cultural values
modelb2=glm(D_DVn~lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_publ
+IS_pub+PDis1+Masc1+LTO1, data=M_thesisMerge1, family = binomial)
summary(modelb2)

###model3 with controls and diff in cultural values
modelb3=glm(D_DVn~lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_publ
+IS_pub+diffPDis+diffMasc+diffLTO, data=M_thesisMerge1, family = binomial)
summary(modelb3)

###model with controls and distance
modelb4=glm(D_DVn~lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_publ
+IS_pub+distance, data=M_thesisMerge1,family = binomial)
summary(modelb4)

###model with controls,distance, cultural values and cultural diff values
modelb5=glm(D_DVn~lvl+lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_publ
+IS_pub+PDis1+Masc1+LTO1
+diffPDis+diffMasc+diffLTO+distance, data=M_thesisMerge1,family = binomial)
summary(modelb5)

modelb6=glm(D_DVn~lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_publ
```

```
+IS_pub+PDis1+Masc1+LTO1+diffPDis+diffMasc+diffLTO, data=M_thesisMerge1,family = binomial)
summary(modelb6)

modelb7=glm(D_DVn~lvl+nauth+yd+l_rd+tot_pub_rdM1+tot_coll_pub+div_4_code3+tot_alliances_RD+AS_publ
+IS_pub+PDis1+Masc1+LTO1+distance, data=M_thesisMerge1,family = binomial)
summary(modelb7)

###likelihood ratio test model1 vs model3
library(lmtest)
lrtest (modelb1, modelb2)
lrtest (modelb1, modelb3)
lrtest (modelb1, modelb4)
lrtest (modelb1, modelb5)
lrtest (modelb1, modelb6)
lrtest (modelb1, modelb7)

###likelihood ratio test model 5 vs all others
library(lmtest)
lrtest (modelb1, modelb5)
lrtest (modelb2, modelb5)
lrtest (modelb3, modelb5)
lrtest (modelb4, modelb5)
lrtest (modelb6, modelb5)
lrtest (modelb7, modelb5)
```