Cultural diverseness across subsidiaries and innovation of multinational corporations

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ABSTRACT

This study examines the effect of cultural diversity on the innovation outputs of U.S. multinational firms. Firstly, the results show that cultural diversity is notably and positively associated with innovation. Further, the positive effect of cultural diversity on innovation significantly depends on R&D investments. Other intangible assets, such as license, brand, and advertising, do not exhibit explanatory power. The co-effect of cultural diversity and R&D investment on innovation hold consistently accounting for time gap, the effect of foreignness, alternative cultural measures, and alternative econometric techniques. The evidence in this paper indicates that R&D investments in a culturally diversified setting facilitate innovations.

Keywords: Cultural diversity, R&D, intangible assets, innovation, multinational firms

JEL codes: Z1, F2, O3, F3

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"The popular conception is that companies come to China because of low labor cost… but the truth is China stopped being a low labor cost country many years ago and that is not the reason to come to China from a supply point of view. The reason is because of the skill ….. and tooling skill is very deep here ….. other companies may only focus on low-cost labor…..but that's not our focus, our focus is the quality of making the best innovation"

Tim Cook, Apple CEO

Research has documented that multinational firms play a significant role in promoting innovations, as their foreign subsidiaries serve as "centers of excellence". Frost et al. (2002) define a "center of excellence" as a business unit that embodies important sources of innovation. A "center of excellence" is shaped by two aspects: The investment made by parent firms and the local environment of subsidiaries. The prior studies have provided ample evidence on how parents' investments affect corporate innovation. For example, Hitt et al. (1997) document that the degree of international operations is positively related to the research and development (R&D) intensity. Frost and Zhou (2005) highlight that the investments that a parents made to its subsidiaries are crucial to the multinational firm as a whole, because knowledge integration within multinational firms is intensified through a reverse process. That is, knowledge is shared and transferred from subsidiaries to parents and in turn strengthens absorptive capacity and social capital for the future innovation of multinational firms. Higgins and Rodriguez (2006) and Kotabe (Kotabe, 1990) report that outsourcing R&D offshore and then importing product components can replenish the internal productivities and complement the innovative ability of multinational firms. While the existing studies provide abundant evidence that foreign investments in R&D facilitate multinational innovation, how subsidiaries' local environments affect corporate innovations remain an open question.

To investigate the influence of subsidiaries' local environments on corporate innovation, this study focuses on national culture. Innovation is deeply rooted in culture. Jacob (1988) investigates the evolution of modern scientific knowledge and provides the evidence that an integration of national culture plays a significant role in the dissemination and assimilation of scientific knowledge. The cultural explanation on innovation in different countries lays a foundation for answering such questions as how different in the development of scientific disciplines between Britain and Italy, and why the industry revolution took place first in English other than in France. Freeman (2002) discusses the cultural influence of national innovation systems between Britain and the United States and seeks to explain why the United State overtook Britain as the powerhouse of innovations in the world. Empirical studies also document how specific cultural traits impact national rates of innovation. For instance, Shane (1993,1995) argues that innovation demands the

tolerance for risk and change, and finds that countries with a strong tendency of uncertain avoidance are less innovative. Shane et al. (1995) and Taylor and Wilson (2012) find that individuals taking on innovation activities in a society with a higher degree of power distance seeks support from authorities instead of other members inside of the organization, a society with a higher degree of collectivist tends to seek cross-functional support for an innovation, while a society with a higher degree of individualism emphasizes independent innovation effort. These studies document that national culture influences the ways of society in carrying out innovation activities, and demonstrate that national-level innovation rates are fundamentally driven by cultures.

Build upon the existing studies, this paper explores how national cultural diversity within a firm affect innovation. If different culture provides alternative ways to solve problems, then it would be expected that a higher degree of cultural diversity contains more diverse ideas. The investment in the developments of such ideas would facilitate the innovation output. Using Hofstede cultural framework, the results show that, indeed, cultural diversity is positively associated with innovation measured by the count of patents and citations. These results confirm that multinational firms with a higher degree of cultural diversity have a significantly higher level of innovation than multinational firms with a lower degree of cultural diversity.

The positive relation between cultural diversity and innovation is robust after controlling for a battery of the variables documented in the literature to have an effect on innovation. Among control variables, size, Tobin's Q, profitability and the number of segments are positively related to innovation, whereas the degree of foreign operations and the number of subsidiaries are negatively associated with innovation. The positive relation between cultural diversity and innovation hold consistently after further controlling for year and industry fixed effect. With mining as the default industry, the results show that the degree of innovation in manufacturing, utility and service industries is significantly higher than in the mining industry, whereas there are insignificant differences in innovation between wholesales and mining industries. The inclusion of these variables, however, do not materially change the main result of the positive relation between cultural diversity and innovation.

This study further investigates how intangible investments affect the positive cultural diversity and innovation relation. As suggested by Shane (1993,1994), intangible investment produces an invigorating effect on the influence of culture on innovation. This effect is also important to multinational operations. Firms may not able to increase their innovation by simply expanding to more culturally distant markets without any further investments to foster the exchange of ideas between different cultures. Indeed, the results show that among various intangible investments — license, brand, advertising, developing and R&D, only developing and R&D show positive and significant moderating effect on the positive relation between cultural diversity and

innovation. However, only R&D fully explains the positive effect of cultural diversity on innovation. This result suggests that the positive effect of cultural diversity on innovation resides in the R&D investments.

To ensure the robustness of the above results, I carry out a range of tests. Given that there may be a time gap between investment made and innovation realized, I investigate one period forward innovation output to re-estimate the effect of cultural diversity and R&D. The result confirms that only R&D investments can fully explain the positive effect of cultural diversity on innovations. Further, cultural diversity may be simply a proxy for the foreignness, which is found to have a positive effect on innovation (Un, 2011). With an inclusion of various proxies for the foreignness, the main results consistently hold, suggesting that the effect of cultural diversity does not represent that of the foreignness. Moreover, I use alternative cultural frameworks — Schwartz's seven cultural dimensions, GLOBE project's nine value scores, trust, and a updated version of Hofstede's cultural dimensions by Tang and Koveos (2008) — as well as each single cultural dimension to construct cultural diversity. Throughout all these different measures of culture, the main results of this study do not materially change. Finally, I address econometric technique concerns using the Fama-MacBeth procedure, the quartile regressions and the between effects, the positive interaction effect of cultural diversity and R&D on innovation remains.

The most importance of the findings in this paper is that it shows a new angle to look at the innovation activities of multinational firms. By expanding into different markets, multinational firms have the advantage to gather talents from different cultures. As pointed out by Beugelsdijk and van Schaik (2005), social capital is vital for financial and economic growth. Thus, the ability to effectively build cross-cultural social capital provides a multinational firm with dramatic competitive advantage. The financial effect of such social capital, however, is under-explored. The previous studies on the advantages of multinational firms mainly focus on their ability to exploit low labor costs to pursue high profits or their ability to overcome cross-border barriers to increase shareholder value. This paper sheds a new light on the endowment of cultural diversity of multinational firms. It is worth noting that prior studies also document that frictions and costs associated with cultural diversity that can bring negative impact to companies (Frijns et al., 2016). This paper, however, offers evidence on the "bright side" of cultural diversity — it can provide diversified knowledge and ideas which breed innovation and promote long-term prospects of multinational firms.

This paper relates to the literature on the relation between firm boundary and innovation. Seru (2014) provides an excellent review of this strand of study. Like Seru (2014), most papers in this literature mainly focus on the effect of production and business diversification on innovation. For instance, Schoar (2002) finds that conglomerates run plants more productively than do their

stand-alone counterparts. In contrast, Seru (2014) shows firms with a larger number of divisions tend to produce a small number of innovations. Whereas Scherer (1965) finds an insignificant relation between the degree of product-line diversification and innovation.

This paper contributes to the firm boundary studies in two ways. First, I control for both the number of segments and the number of subsidiaries, to explicitly distinguish the effect on innovation caused by business and product diversification, as they represent different forms of firm boundaries (Duchin, 2010). Second, I focus on multinationals that represent another way of firm boundary, different from either business or product diversification. To this point, this paper is similar to Gao and Chou (2015), who compare domestic firms to multinationals. Technically, their approach is equivalent to compare stand-alone firms to conglomerates. However, that approach that views all multinationals are the same is likely to encounter endogenous bias (Seru, 2014). Because there are tremendous differences in the degree of diversifications among conglomerates as well as among multinationals. By concentrating on cultural diversity, this paper mainly focuses on addressing the differences in the level of international diversification and illustrating how different forms of firm boundaries affect innovation.

This paper also contributes to the studies on the financial and economic influence of culture. The recent studies have increasingly noticed that culture has a significant influence on financial activities and materialized outcomes. For example, Stulz and Williamson (2003) find the relation between national culture and credit rights. Hvide and Panos (2014) demonstrate the influence of culture on entrepreneurship. Several studies show that culture affects stock market participation and returns (Chui et al., 2010; Eun et al., 2015; Grinblatt and Keloharju, 2001; Guiso et al., 2008). In the context of international business, studies also report that cultural distances between two countries fundamentally impact financial transactions (Ahern et al., 2015; Anderson et al., 2011; Beugelsdijk and Frijns, 2010; Karolyi, 2016; Siegel et al., 2011). However, the effect of cultural diversity within multinational firms has received less attention in the literature. By investigating the relation between cultural diversity and corporate innovations, this paper aims to offer a new view of how culture impacts corporate activities.

The paper is organized as follows. Section 1 discusses related literature in. Section 2 describes the data, sample construction, and variable, and provides summary statistics. In Section 3 presents main results. Section 4 carries out a range of robustness tests. Finally, Section 5 summarizes and presents the implications of the study.

1. Literature review

This section reviews the empirical evidence on the relation between cultural diversity and innovation and develop the hypothesis on how cultural diversity influence innovation of

multinational firms. This section also discusses how investments in R&D and other intangible assets affect the relation between cultural diversity and corporate innovation.

1.1 Cultural diversity and innovation

According to Nijkamp and Poot (2015), there are two forms of cultural diversity. One form is population heterogeneity in one place (non-spatial diversity), i.e., people from different cultural backgrounds centered on one specific location. Another form of cultural diversity is population heterogeneity between places (spatial diversity), which is caused by an entity carrying out activities in multiple geographic locations where cultures are different from one another.

Existing studies mainly focus on the first form of cultural diversity (non-spatial diversity). For instance, Østergaard et al. (2011) and Parrotta et al. (2014) focus on cultural diversity in Denmark, Niebuhr (2010) focuses on cultural diversity in Germany, Ozgen et al. (2013) focus on cultural diversity in the Netherlands, Nathan and Lee (2013) focus on cultural diversity in London, Ng and Tung (1998) focus on cultural diversity in Canada, and Duranton and Puga (2001) and Ottaviano and Peri (2006) focus on cultural diversity in the United States. All these studies provide evidence that cultural diversity in one location is positively associated with knowledge transfer and innovation of that place (See Ozgen et al., 2014 for an excellent review of this literature). Therefore, these studies reach a consensus on a positive relation between non-spatial cultural diversity and innovation.

The effect of the second form of cultural diversity (spatial diversity), however, received less attention. This is mainly because it is often difficult to find a research target. Multinational firms provide an excellent platform to carry out this research, as they operate in diverse geographic locations where cultures can be significantly different from one another. Referring to existing evidence from studies on the effect cultural diversity in one location, it is expected a positive relation also exists between cultural diversity among places and innovation. There are at least five reasons as follows.

First, a higher degree of cultural diversity embodies the strong abilities of a firm to overcome cultural barriers and of organizational learning (Barkema et al., 1996). The investments of a multinational firm in expertise with a diversified background can significantly increase the firm's absorptive capacity, which in turn facilitates technological learning and innovation (Cohen and Levinthal, 1990; and Zahra et al., 2000).

Second, cultural diversity represents the openness of a firm. Whether or not an organization accepts diversified cultures represents whether it is willing to open to different ideas and new things (Kogut and Zander, 1993). The willingness to think differently is a valuable attitude to cultivate innovation.

Third, cultural diversity is helpful to overcome mental barriers. In the environment of cultural diversity, one inevitably needs to interact, communicate and cooperate with others from dissimilar cultures. In this context, it is necessary for employees to learn and experience mental adjustment to understand values and behaviors from different cultures. The experience and overcoming of mental conflicts are essential qualities of innovation (Maddux and Galinsky, 2009).

Forth, cultural diversity can promote the smoothness of the innovation process. Some cultures are detail oriented while other cultures emphasize more on outward appearance. Consequently, some cultures can make a strong commitment to manufacturing while some other cultures focus more on designing (Kotabe and Murray, 1990). Thus, cultural diversity offers opportunities for a firm to take advantage of cultural differences to improve the aspects and steps necessary to combine raw materials to finished products.

Finally, cultural diversity facilitates management innovation. Cultural diversity requires a firm to manage dispersed capabilities effectively and facilitates to optimally organize talents in different cultures (Frost et al., 2002). In this process, executives who have experience and capacity to be aware of cultural differences can continuously configure intellectual capital in line with their corresponding cultures and thus develop the best practices of management of talents form different cultures within the firm (Morris and Snell, 2011).

1.2 Cultural diversity, intangible investments and R&D

While cultural diversity provides fertile soil for innovative activities, to realize the innovation, cultural diversity needs to be leveraged (Jayne and Dipboye, 2004). It should never take for granted that innovation occurs simply by gathering individuals from different cultures. In order to ensure innovation takes place, multinational firms need to make further investments.

While both tangible and intangible investments may matter for innovations, intangible investments play more an important role (Hall, 1993; Heirman and Clarysse, 2007; Teece, 1998). Fee et al. (2009) document that intangible investments even in the domestic market have a significant spillover effect on multinational firms' foreign cash flows. Unlike manufacture investment in fixed assets, such as property, plant, and equipment, innovation requires higher investments in skill, knowledge and expertise. Intangible investments are therefore needed in order to make sure ideas can be exchanged and utilized within the firm (Frost et al., 2002; Morris and Snell, 2011). Intangible investments are also crucial to build social networking in different cultures (Beugelsdijk and van Schaik, 2005).

Intangible assets can be generated internally through R&D activities or obtained externally through acquisition. How these two forms of intangible investments contribute to innovation depends on the strategic environment of a firm (Cassiman and Veugelers, 2006; Teece, 1986).

Studies show that intangible assets generated through internal R&D activities are more important to innovation in multinational firms operating in culturally diversified settings.

First, while knowledge on technological innovation in one country may be spilled and transferred internationally and some intangible assets such as brand and license can be acquired through direct purchase, the core technology in a country is often difficult to obtain outside of that country. Under this condition, globalizing R&D activities and conducting R&D in nationals where the breakthrough technologies take place can be a crucial way to promote innovation within the firm (Audretsch and Feldman, 1996; Bottazzi and Peri, 2007; Gerybadze and Reger, 1999).

Second, the internal R&D generation process stimulates cooperation between employees (Becker and Dietz, 2004; Ganotakis and Love, 2010). In multinational firms, these collaborations and interactions are often accompanied with cultural awareness and mutual technological learnings, which are important in fostering innovation (Benito and Gripsrud, 1992; Zeng et al., 2013).

Finally, innovations can occur geographically in different cultures. Investments in R&Ds can facilitate the combination of these innovations through an exploration and exploitation of the human capital from diverse cultural background inside the multinational firms. Therefore, R&D investments lever multinationals' advantages to make the best use of cultural diversity to realize innovation (Gallié and Legros, 2012; March, 1991).

2 Data

This section describes the innovation data, sample construction, and variables.

2.1 Sample construction

Similar to current studies on innovation, this paper uses patent and citation data from the National Bureau of Economic Research (NEBR) to capture corporate innovation output. The NBER provides detailed information on U.S. patents granted and all citations made to these patents. The NEBR patent and citation data end by 2006 and not yet been further extended. To avoid concern about obsolete data on innovation, this study focuses on the most recent years and carries out analyses for the 2004 to 2006 period. Hall et al. (2001) initially created this database and provide an instruction on how to match these data to all firms traded in the U.S. stock market by GVKEY. The original data were identified by PDPASS, the unique assignee number for each patent. The procedure of matching PDPASS with GVKEY is outlined on the NBER patent website.[1] The online documents also provide an instructive STATA sample code. Following these instructions, I

[1] The website address is http://www.nber.org/patents.

first construct patent-level data by keeping 2004 to 2006 data and those patents and citations with a clear identity. Then I match patent and citation data to each U.S. listed firm by GVKEY.[2]

Next, I construct a sample of multinational firms. The dataset employed to construct this sample is Orbis, a comprehensive dataset maintained by Bureau van Dijk. The Orbis database offers subsidiary-level information on the country of incorporation, which enable to capture cultural differences between a parent and its subsidiaries. In Orbis, I first select U.S. firms listed on the three stock exchanges: The New York Stock Exchange (NYSE), the National Association of Securities Dealers Automated Quotations (NASDAQ), and the American Stock Exchange (AMEX). I then exclude cross-listed firms as those firms may not able to truly represent the culture of the United States. I further exclude firms are classified as financial and public firms. At the subsidiary level, I first ensure all sample multinationals have foreign subsidiaries.[3] I then exclude financial subsidiaries as these firms may serve the purpose of special vehicles instead of real operations. To be certain the influential effect of cultural diversity, I ensure that parents must have a control (at least 50.01%) ownership over subsidiaries. Finally, I exclude those subsidiaries without information on the country of incorporation.

After matching patent and citation data from NBER with multinational information from Orbis, the final sample consists of 1,660 firms. Table I gives a sample destitution of these firms. Panel A shows that most sample multinationals operate in one or two foreign countries, while it is also common that sample multinationals have business in three to five different nations. The amount of multinationals increases over the period from 538 in 2004 to 571 in 2006. Panel B shows that the most of sample multinational firms have one or two foreign subsidiaries. However, there are also the widespread foreign operations of U.S. multinationals with over more than ten foreign subsidiaries. Together with Panel A, these figures suggest that U.S. multinationals tend to establish more subsidiaries in some countries than others. Panel C present patent data, showing that most of the sample firms own more than ten patents. This offers an initial indication that cultural diversity may be positively associated with innovation. Panel D suggests that most sample firms have zero citations. This is not surprising given that a patent is less likely to receive a large number of citations in a short period (recall that the sample period covers three years). Finally, Panel E indicates that most of the sample firms come from the manufacturing industry, followed by the service industry.

[2]The data are available at the website: https://sites.google.com/site/johnfanzhangcfa/research-output.

[3] Sepracor, Inc (ISIN: US8173151049, also known as Sunovion Pharmaceuticals, Inc) of 2005 is the only firm-year with zero foreign country and foreign subsidiary in the sample. I keep this firm in the sample because it established two foreign subsidiaries in Canada and the UK in 2006, along with two U.S. domestic subsidiaries.

2.2 *Variable description*

To measure innovations of multinational firms, as it has been mentioned in the previous section, I use patent and citation data from NBER database generated by Hall et al. (2001). Patents and citations are commonly employed in the existing papers as proxies for corporate innovations, as now have become standard in innovation literature (Chemmanur et al., 2014). While suffering from several imperfections, so far patents and citations are the best way to evaluate corporate innovations (Seru, 2014). Following the literature, I use the count of patents and citations to capture the "quantity" and "quality" of the innovation, respectively.

To capture cultural diversity, I take the following steps. To begin with, I measure cultural distances between a parent and each of its foreign subsidiaries. To quantity cultural distances, I primarily rely on Hofstede's (1980, 2001, 2010) cultural framework (I also use alternative cultural frameworks in the robustness tests). Hofstede (1980, 2001) defines culture as "the collective programming of the mind which distinguishes the members of one group or category of people from another". By this definition, Hofstede (2010) offers six culture dimensions: Power distance, individualism, masculinity, uncertainty avoidance, long-term orientation, and indulgence. These cultural dimensions are commonly applied in the literature to examine the impact of culture on corporate and financial activities. Based on these six dimensions, I estimate cultural distances using a formula developed by Kogut and Singh (1988) as follows,

$$Distance_{US,j} = \sqrt{\sum_{k=1}^{K} \frac{(I_{k,j} - I_{k,US})^2}{V_k}} \quad (1)$$

where $\text{Distance}_{\text{US,j}}$ is cultural distance between the U.S. where parent firm *i* is located and the host country *j* where firm *i*'s subsidiary is located. $I_{k,j}$ *i*s the score of the *k*th cultural dimension of foreign country *j*. $I_{k,US}$ is the score of the *k*th cultural dimension of the U.S. V_k is the in-sample variance of the *k*th cultural dimension. Essentially, this is a Euclidean distance which measures distance in a multi-dimensional space. It is therefore particularly suitable to capture cultural distances. Because of this advantage, the approach of Equation (1) is commonly used in the finance literature, such as Beugelsdijk and Frijns (2010), Frijns, Dodd and Cimerova (2016), Huang (2015) and Karolyi (2016).[4]

Next, for each sample multinational, I then aggregate its cultural distances to construct the measure of cultural diversity as follows:

$$Cultural\ diversity_{i,t} = \left(\sum_{j=1}^{J} Distance_{US,j}\right)_{i,t} \quad (2)$$

[4]

where $\text{Cultural diversity}_{it}$ is cultural diversity for multinational firm *i* at the end of the calendar year *t*. $Distance_{US,j}$ is cultural distance between the U.S. where parent firm *i* is located and the host country *j* where firm *i*'s subsidiary is located. In essence, cultural diversity in Equation (2) captures the total number of *J* cultural distances between firm *i* and its subsidiaries, and thus captures both cultural dispersion and cultural differences within firm *i*. Therefore, this measure of cultural diversity captures both cultural distances and the number of different cultures in which a multinational firm involved.

I consider a category of intangible assets that are relevant to multinational operations. In addition to R&D, I also include license, brand, advertising, and developing. I measure R&D activities by the ratio of R&D expenditures to total sales revenue, and measure the investment in intangible assets by the ratio of a change in total intangible assets to total assets. Because not all other forms of intangible assets are invested by each sample multinational, I use a dummy variable which equals to one if a firm invests the corresponding category of intangibles (i.e. an increase in the dollar amount of a given category of intangible assets), and otherwise zero. By doing so, I intend to investigate which intangible assets are more related to innovation outputs, in particular in a culturally diversified setting.

I also include a range of control variables in multivariate regression analyses. Following literature (Aghion et al., 2005; Seru, 2014), I control for variables that may affect innovation as follows: *Size* (sales revenue in billion dollar), *Tobin's Q* (i.e. investment opportunities measured as the ratio of the market value of total assets to the book value of total assets), *Leverage* (the ratio of the book value of debt to total capital), *Profitability* (the ratio of operating profits to total sales revenue), *Tangibility* (the ratio of tangible assets to total assets), *Age* (the number of years since the IPO), *Foreign operation* (i.e. FATA measured as foreign assets to total assets)[5], *# segments* (the count of business segments), and *# subsidiaries* (the count of subsidiaries).

Table II provides summary statistics for these variables. The mean values of the counts of patents and citations are 53.80 and 32.63, respectively. The mean value of cultural diversity is 23.53. The mean value of the R&D expenditure to total sales revenue is 17.70% and the mean value of intangible investments to total assets is 2.84%. All variables are winsorized at the 1% and 99% in two tails. The description of the construction of variables and their data source are provided in Appendix.

[5] I use FATA as a proxy for the degree of foreign operations. Because the effect of cultural diversity on multinational firm's innovation can be more affected if the firm holds a large proportion of foreign assets. This effect is different from the effect of sales of consumer products to the foreign markets. Further detail is discussed in the Section 4.2 for a robust test of the effect of foreignness.

3 Main Results

This section firstly provides evidence on the relation between cultural diversity of multinationals and their innovation output. This is comparable to the literature on the effect of cultural diversity in one location and innovations of that place. I then introduce intangible investments and show the influence of R&D on the effect of cultural diversity.

3.1 Univariate tests: Cultural diversity and innovation

The test begin with an explicit comparison of the counts of patents and citations between sample multinational firms with a higher and a lower cultural diversity. To do so, I split the sample by median into two subsamples with the high and the low cultural diversity. After this division, the subsample of high cultural diversity consists of 831 firms and the subsample of low cultural diversity includes 829 firms. Then I compare the differences in patents and in citations, respectively, between the high and the low cultural diversity subsamples. Table III reports the results.

Panel A of Table III compares the mean values. It shows that the mean patent counts for multinationals with the high and the low cultural diversity subsamples are 89.25 and 18.26, respectively. The mean counts of citations for multinationals with the high and the low cultural diversity subsamples are 54.23 and 10.99, respectively. Both differences are statistically significant at the 1% level.

Panel B of Table III compares the medians. The median patent counts for multinationals with high and low cultural diversity subsamples are 14 and 4, respectively. The median counts of citations for multinationals with high and low cultural diversity subsamples are 4 and 1, respectively. The difference in the median is then contrasted by the Wilcoxon rank-sum tests. Again, both differences are significant at the 1% level.

These results suggest that the counts of patents and citations are significantly higher for the subsample with a higher degree of cultural diversity than those of subsample with a lower degree of cultural diversity. These results offer the initial evidence that cultural diversity is positively associated with corporate innovation. However, these results are only suggestive. For instance, firms with a higher degree of cultural diversity may also be the larger firms. If this is the case, then the effect of cultural diversity is just a proxy for the effect of firm size. Therefore, it is essential to conduct multivariate analyses with controlling for the factors that matter for corporate innovation. In the next Section, I carry out this task.

3.2 Multivariate analyses: Cultural diversity and innovation

Given corporate innovation can be affected by many factors, this section examines the relation between cultural diversity and innovation with controlling for those factors, and estimate the following specification,

$$Innovation_{i,t} = \alpha + \beta_1 Cultural\ diversity_{i,t} + \beta_2 Z_{i,t} + \mu_t + \mu_S \quad (3)$$

where $Innovation_{i,t}$ is the innovation output for firm *i* and calendar year *t* as the dependent variable and captured by patents in Panel A and citation in Panel B. *Cultural diversity* is the key independent variable of interest and constructed through Equations (1) and (2). $\boldsymbol{Z}$ is a matrix of factors that are documented to affect corporate innovation and defined in Section 2. Briefly, these factors include *Size, Tobin's Q, Leverage, Profitability, Tangibility, Age, Foreign operation, # segments, and # subsidiaries*. All regressions are estimated with time (μ_t) and industry (μ_S) fixed effects to capture any macro shocks in a given year and an industry. All standard errors are White-corrected and robust in the case of heteroscedasticity.

Table IV reports the regression results. Panel A of Table IV shows the association between cultural diversity and the count of patents. In Column A.1, without controlling for any variables, I find a positive relation between cultural diversity and the counts of patents, which is significant at the 1% level. Again, this result is only suggestive. In Column A.2, I control for a range of variables stated above, while the size of the coefficient on cultural diversity reduces, it remains positive and significant at the 5% level. In Column A.3, I further include annual dummy with 2004 as the default year to control for time-related macro shocks. The result does not materially change compared to Column A.2, only with an inflated significant level of the coefficient on cultural diversity. Finally, Column A.4 adds industry dummy with mining as the default industry to control for industry-wide shocks. The positive and significant coefficient on cultural diversity holds consistently, suggesting that the positive effect of cultural diversity is distinctive and is not a proxy for the effects of those factors relevant to innovations.

Panel B of Table IV reports the results using the count of citations as the dependent variable. Throughout four regressions from B.1 to B.4, I find a positive coefficient on cultural diversity, suggesting cultural diversity is also positively associated with the "quality" of innovation. This is in line with the results in Panel A. The most obvious difference between Panels A and B resides in the year dummy, which is insignificant in Panel A but turns to negative and significant in Panel B. The results indicate that the newest patents have fewer citation than the earlier patents, while the patent generation is not time dependent. However, this difference does not affect the main results – coefficients on cultural diversity consistently positive throughout patent and citation regressions suggest that cultural diversity is positively associated with both quantity and quality of innovations.

The effect of cultural diversity on innovation is economically significant as well. For example, in Column A.4 the coefficient on cultural diversity is 0.4, which amounts to a 14.4 increase in the count of patents given a one standard deviation change in cultural diversity. In Column B.4 the coefficient on cultural diversity is 0.21, correspondingly a one standard deviation change in cultural diversity, the count of citation would increase by 7.50. Given unconditional means of patents and citations are 53.80 and 32.63, respectively, a one standard deviation increase in cultural diversity offers a 26.77% increase in patents and 22.98% increase in citations. These sizes of these increases are fairly large.

In terms of control variables, firm size, Tobin's Q and profitability are positively related to corporate innovation, whereas the degree of foreign operations is negatively associated with innovations. Further, the number of segments is positively related to innovations. This result is in line with Schoar (2002), suggesting that industrial diversification is beneficial for innovation. In contrast, the number of subsidiaries is negatively related to innovations. This result is in line with Seru (2014), indicating that a larger number of subsidiaries causes the inefficiency of asset allocation in the internal capital markets, which is detrimental to corporate innovation. In addition, benchmarking to the mining industry, all other industries, except for wholesales, have a higher number of patents, in particular manufacturing and service industries, implying that with measured by patents, manufacturing and service are relatively more innovative.

Overall, the results in this section provide supporting evidence on the positive effect of cultural diversity on corporate innovation. This effect is not a proxy or influenced by other factors and is both statistically and economically significant.

3.3 The effect of investments in intangible assets

The above section shows strong evidence that cultural diversity among different places within multinational firms is positively associated with corporate innovation. This result is in line with previous findings from the effect of cultural diversity in one location (Gibson and Gibbs, 2006; Ozgen et al., 2013). However, cultural diversity can also be costly. For example, Ng and Tung (1998) find that whereas cultural diversity increases productivity, it also reduces job satisfaction and leads to higher turnovers. Frijns et al. (2016) document that cultural diversity negatively affects firm performance. Therefore, to overcome frictions and costs associated with cultural diversity, making further investments in intangible assets can be crucial (Gardberg and Fombrun, 2006). Because such investments can help multinationals to establish a mechanism to mitigate "dark side" of cultural diversity and thus enhance innovation. This section investigates how investments in intangible assets influence the effect of cultural diversity on corporate innovations.

As mentioned earlier, five categories of intangible investments are considered, including license, brand, advertising, developing and R&D. These intangible investments relate to cultural diversity during multinational operations and may affect corporate innovation. For example, Shane (1994) documents that national culture affects decisions on whether a firm should purchase licenses in order to enter a foreign market. Fee et al. (2009) show that multinationals' advertising expenditures are significantly related to their foreign cash flows. Cassiman and Veugelers (2006) find that acquiring internal or external generated knowledge are different strategies for innovation. Teece (1986) reports that different forms of intangibles significantly influence the outcome of innovation. To investigate the compound effect on corporate innovation, I introduce each of the intangible assets and interact it with cultural diversity, and then estimate the following regression,

$$\begin{aligned} Innovation_{i,t} = \alpha + \beta_1 Cultural\ diversity_{i,t} + \beta_2 Intgangible\ investment_{i,t} \\ + \beta_3 Cultural\ diversity_{i,t} * Intgangible\ investment_{i,t} + \beta_4 Z_{i,t} \\ + \mu_t + \mu_S \end{aligned} \quad (5)$$

where $Intgangible\ investment_{i,t}$ is investments in intangible assets as measured by R&D expense and change in intangible assets. β_3 captures interaction effect of cultural diversity and intangible investment. If the positive effect of cultural diversity on innovation is embodied by intangible investments, then it would expect that β_3 is positive and significant.

Table V reports the regression results. Panel A represents the results using patents as the dependent variable. In regressions A.1 to A.6, I include in turn license, brand, advertising, developing, R&D, and total intangible investments, respectively. The results show that in the six regressions, only in Regression A.5 the coefficient on cultural diversity becomes insignificant, i.e. the regression with R&D as the intangible assets. In the other five regressions, the coefficients on cultural diversity remain positive and significant. Meanwhile, the coefficients on interactions are significant in Regression A.4 and A.5, i.e. the regressions interacting cultural diversity with developing and R&D, at the 10% and 1% levels, respectively. As for intangible variables, R&D in Regression A.5 is significant and positive, suggesting R&D investments have a significantly positive effect on innovation outputs.

Panel B represents the results using citations as the dependent variable. In regressions B.1 to B.6, I include in turn license, brand, advertising, developing, R&D, and total intangible investments, and the results obtained are similar to those in Panel A. Specifically, in Regression B.5 the coefficient on cultural diversity become insignificant, and meanwhile, the coefficient on the interaction between cultural diversity and R&D become positively significant. I also estimate regressions without interactions for Panels A and B (available in the Online Appendix). The results

show that both cultural diversity and R&D are positively related to innovation, suggesting their respective standalone effect on innovations are positive.

The above evidence means that R&D investments can comprehensively explain the effect of cultural diversity on both the number of patents and citations. In other words, the effect of cultural diversity on innovation depends on R&D investments. The positive value for the effect of the interaction term would imply that the higher the investments in R&D, the greater the positive effect of cultural diversity on innovation. Similarly, the higher the cultural diversity, the greater the positive effect of R&D on corporate innovations. In short, it is well-known that R&D investments as the input for innovation significantly associate with the output of innovation, the findings of this study suggest that investing R&D in a culturally diversified setting promote further innovation outcomes.

4 Robustness tests

This section carries out a set of robustness tests to address innovation-related, cultural-related, as well as econometric technique-related concerns.

4.1 Are the main results affected by the time gap?

One related concern is that innovation may be subject to a lagged time effect. One may argue that the influence of cultural diversity and R&D investments on innovation takes effect only after a period of time. The previous tests of this paper relate cultural diversity to innovation simultaneously. However, the current effect of cultural diversity and R&D investment on innovation may be only manifested in the next period. Although the fact is that cultural diversity of a multinational firm changes very little from one period to another, it is still worthwhile to carry out tests to address the above concern.

To carry out the tests, I relate cultural diversity, R&D investments and control variables to the forward count of patents and citations. Specifically, independent variables in 2004 are related to innovations in 2005, and independent variables in 2005 are related to innovations in 2006. The results are shown in Table VI. It is noteworthy firstly that from the bottom line of Table VI, it can be seen that the number of observations significantly reduce — only 512 firm-year observations in regressions with intangibles (Regressions A.1 and B.1) and 518 firm-year observations in regressions with R&D (Regressions A.2 and B.2). This suggests that I need to reduce the sample size to conduct the tests for the lagged effect.

These tests in general, though the sample size is reduced, do not alter the main results. Panel A Table VI reports results using patents as the dependent variable and Panel B Table VI reports results using citations as the dependent variable. In Regressions A.1 and B.1, when considering all

intangible investments, the interaction becomes insignificant in Regressions A.1. In Regressions A.2 and B.2, when considering R&D, the interactions between cultural diversity and R&D are positive in both regressions using patents (A.2) and citations (B.2) as the dependent variable. The coefficients on interactions in both regressions A.2 and B.2 are significant as well. These results verify that cultural diversity through R&D affects innovation in the forward period. Therefore, with consideration of time gap for generating innovation outputs, the main results of this paper still hold.

4.2 Is cultural diversity a proxy for the foreignness?

Un (2011) argues that multinationals with a higher degree of foreignness enjoy more innovations. Because subsidiaries of multinationals are more innovative than domestic firms. The author's argument is that there are two pressures drive subsidiaries to become more successful at transforming their R&D investments into innovations. The one pressure comes from the internal capital market in multinationals. The other pressure comes from the consumer market in host countries. Consequently, multinational firms with higher a large number of foreign subsidiaries tend to have an advantage in innovation. Whereas the theory of foreignness views foreign countries as a whole and neglect cultural diversity, i.e. it does not consider the heterogeneity of culture of foreign countries, it stresses that cultural differences can be a component contribute to the degree of foreignness (Calhoun, 2002). Therefore, it is important to examine whether or not the effect of cultural diversity on innovation is merely a proxy for the effect of foreignness.

To be consistent with the definition of Un (2011), I firstly capture the degree of foreignness by the ratio of the number of foreign subsidiaries to the total number of subsidiaries (FNTN), To ensure the unbiased measure of the foreignness, I also use two alternatives: The ratio of foreign sales to total sales revenue (FSTS) and the ratio of foreign income to total income (FITI). These measures can also represent the outcome of participation in the consumer markets of foreign countries.[6] I include each of the three measures of the foreignness in turn in Equation (4), along with cultural diversity, R&D, an interaction between cultural diversity and R&D, and control variables.

Table VII reports the results for patents as the dependent variable in Panel A and for citations as the dependent variable in Panel B. In both Panels, the results show that coefficients only on FSTS are positive and significant. This result provides supporting evidence for the argument of Un (2011) that the foreignness is positively related to innovation. However, the effect is generally insignificant in other regressions or even negative (in Regression A.1). More important to the

[6] In fact, in all previous regressions I control for FATA, some may argue that it is a proxy more for the degree of foreignness. However, when a firm has a large proportion of foreign assets may indicate the firm already have experience in the local operations and therefore are more familiar with local cultures. Therefore, FATA is not an ideal proxy for the degree of foreignness.

purpose of this paper, the degree of foreignness does not change the main results. Throughout all the regressions, the coefficient on the interaction between cultural diversity and R&D are positive and significant. I also estimate regressions with interactions between R&D and each foreignness measure. The results show that the effect of the foreignness remains as the above and the interaction between R&D and FSTS become negative. However, the interaction between cultural diversity and R&D remain significantly positive in all regressions. (These results are available in the Online Appendix). Overall, this section confirms that the effect of cultural diversity is not a proxy for the effect of foreignness and that the main results hold consistently even when I consider the effect of foreignness on innovation.

4.3 Cultural diversity by alternative cultural frameworks

Although the Hofstede's framework is commonly applied in the literature as a widely accepted measure of national culture, studies also employ alternative cultural frameworks. Among them, Schwartz's (2014) cultural value orientations, GLOBE's (House et al., 2004) value indicators,[7] and the World Value Survey's trust dimension are also commonly cited in the literature. In addition, Tang and Koveos (2008) argue that economic development can shape national culture, and therefore they create an updated version of Hofstede's cultural dimensions with the incorporation of national economic growth. In this section, I replace Hofstede's culture score by each of the aforementioned cultural frameworks to estimate Equation (4) and check whether the main findings change. These results are reported in Table VIII.

I first apply Schwartz's (2014) cultural value orientations. This framework consists of seven orientations that are grouped into three pairs: Autonomy (including two orientations, intellectual autonomy and affective autonomy) vs. embeddedness, egalitarianism vs. hierarchy, and harmony vs. mastery. The seven cultural value orientations "were derived conceptually by asking what problems every society confronts and what polar value preferences might evolve to deal with these issues" (Schwartz (2014)). Schwartz (2014) believes that "these seven orientations are appropriate for comparing cultural groups to one another and for relating to societal level characteristics." Columns A.1 and B.1 of Table VIII construct cultural diversity with seven Schwartz's (2014) cultural value orientations through Equation (1) and (2). As it can be seen, the interactions between cultural diversity and R&D are positive and significant at the 1% level for both patent (A.1) and citation (B.1) regressions. Therefore, the main result that the compound positive effect cultural

[7] Though criticized by Hofstede, GLOBE covers some countries that Hofstede does not cover, such as Bolivia, Qatar and Kazakhstan. Also, there are economies covered in Schwartz, but not in Hofstede, such as Cameroon, Macao, and Yemen.

diversity and R&D on innovation holds consistently with Schwartz's (2014) cultural value orientations.

I then use the GLOBE project's (House et al., 2004) value indicators. The GLOBE project develops nine indicators: Performance orientation, assertiveness, future orientation, humane orientation, institutional collectivism, in-group collectivism, gender egalitarianism, power distance, and uncertainty avoidance. With these nine indicators, GLOBE project defines culture as "shared motives, values, beliefs, identities, and interpretations or meanings of significant events that result from common experiences of members of collectives that are transmitted across generations.". This definition emphasizes the "sharedness" of cultural indicators among members of a group. Columns A.2 and B.2 of Table VIII construct cultural diversity with nine GLOBE project's cultural value indicators by using Equation (1) and (2). Similar to the previous results, the interactions between cultural diversity and R&D are positive and significant at the 1% level for both patent (A.2) and citation (B.2) regressions. Therefore, the main result that the compound positive effect cultural diversity and R&D on innovation holds consistently with GLOBE project's cultural value indicators.

Third, I use trust to capture national culture. Using trust to represent the national culture is also a common practice in the literate, such as Guiso, Sapienza, and Zingales (2006, 2008, 2009) and Bottazzi, Da Rin, and Hellmann (2016).[8] Following the literature, I adopt the World Values Survey and compute the average answer of "Most people can be trusted" to the question "Generally speaking, would you say that most people can be trusted or that you have to be very careful in dealing with people?". I standardize the final score to be bounded between zero and one. With these scores, I construct cultural diversity using Equation (1) and (2). Results are reported in Columns A.3 and B.3 of Table VIII. Again, the interactions between cultural diversity and R&D are positive and significant at the 1% level for both patent (A.3) and citation (B.3) regressions. Therefore, the compound positive effect cultural diversity and R&D on innovation is also applicable using trust to capture national culture.

Finally, Tang and Koveos (2008) argue that some dimensions of national culture may change over time with the development of national wealth. With the consideration of national economic dynamic as a source of the change in national culture, they develop an updated version of Hofstede's cultural scores. I construct cultural diversity with these updated scores by Equation (1) and (2) and re-estimate Equation (3). I report results in Columns A.4 and B.4 of Table VIII. In fact, using Tang and Koveos' (2008) updated Hofstede's scores inflates the magnitude of the coefficient on the interaction between cultural diversity and R&D. Meanwhile, the main result that the

[8] For detailed discussion on how trust serves as a proxy for culture and its limitation, refer to Guiso, Sapienza, and Zingales (2009, 2008, 2006).

compound positive effect cultural diversity and R&D on innovation does not materially change. Therefore, national economic dynamic does not affect the relation between cultural diversity and innovation.

Overall, using a range of alternative frameworks to construct cultural diversity, the results provide consistent evidence that R&D investments in a cultural diversified setting promote innovation. This evidence affirms that the main findings hold generally and are not specific to certain cultural measures.

4.4 Cultural diversity by single cultural dimensions

One concern with cultural diversity constructed through Equations (1) and (2) is "assumption of equivalence" (Shenkar, 2001). In other words, not all cultural dimensions in a cultural framework are equally important to a corporate activity. In this case, using a cultural diversity measure that aggregates all dimensions of a cultural framework may mask the effect of certain dimensions within the framework. To check whether the results are subject to the "assumption of equivalence", I construct cultural diversity using each single dimension with cultural distances between parent and subsidiaries from a Euclidean version of the Kogut and Singh's (1988) formula, as follows:

$$Distance^{*}_{US,j} = \sqrt{(I_{k,j} - I_{k,US})^2 / V_k} \quad (5)$$

where $Distance^{*}_{US,j}$ is cultural distance calculated with each single dimension. $I_{k,j}$ and $I_{k,US}$are the scores for cultural dimension *k* for country j and the U.S. respectively. V_k is the in-sample variance of the *k*th cultural dimension. To construct cultural diversity based on each single dimension, cultural distance computed through Equation (1) is replaced by Equation (5). Then I use cultural diversity measured by single dimensions to estimate Equation (4). The results are reported in Table IX, where Panel A uses patents as the dependent variable and Panel B uses citations as the dependent variable.

The first set of cultural diversity measures is based on each of the Hofstede's cultural dimensions: Power distance (*Hof_PDI*), individualism (*Hof_IDV*), masculinity (*Hof_MAS*), uncertainty avoidance (*Hof_UAI*), long-term orientation (*Hof_LTO*) and indulgence (*Hof_IND*).[9]

[9] Power distance "expresses the degree to which the less powerful members of a society accept and expect that power is distributed unequally". Individualism "can be defined as a preference for a loosely-knit social framework in which individuals are expected to take care of only themselves and their immediate families". Masculinity "represents a preference in society for achievement, heroism, assertiveness, and material rewards for success". Uncertainty avoidance expresses the degree to which the members of a society feel uncomfortable with uncertainty and ambiguity. Long-term orientation encourages "thrift and efforts in modern education as a way to prepare for the future". Indulgence "stands for a society that allows relatively free gratification of basic and natural human drives related to enjoying life and having fun". (Hofstede, Hofstede, and Minkov, 2010).

The results based on these dimensions are reported in the top six rows in Panels A and B of Table IX. The second set of cultural diversity measures is based on each of the Schwartz's value orientations: Harmony (*Sch_Harmony*), embeddedness (*Sch_Embeddedness*), hierarchy (*Sch_Hierarchy*), mastery (*Sch_Mastery*), affective autonomy (*Sch_AffectiveAutonomy*), intellectual autonomy (*Sch_IntellectualAutonomy*), and egalitarianism (*Sch_Egalitarianism*).[10] The results based on these dimensions are reported in the seventh to thirteenth rows in Panels A and B of Table IX. The final set of cultural diversity measures is based on each of the GLOBE project's value indicators: Assertiveness (*GLOBE_Assertiveness*), institutional collectivism (*GLOBE_InstitutionalCollectivism*), in-group collectivism (*GLOBE_InGroupCollectivism*), future orientation (*GLOBE_FutureOrientation*), gender egalitarianism (*GLOBE_GenderEgalitarianism*), humane orientation (*GLOBE_HumaneOrientation*), performance orientation (*GLOBE_PerformanceOrientation*), power distance (*GLOBE_PowerDistance*), and uncertainty avoidance (*GLOBE_UncertaintyAvoidance*).[11] The results based on these dimensions are reported in the bottom nine rows in Panels A and B of Table IX.

These results overall show that indeed, the coefficients on the interaction between cultural diversity and R&D are larger in some of cultural dimensions than others. This is in line with the argument of (Shenkar, 2001). However, all regressions show that the co-effect of cultural diversity and R&D are positive and significant at the 5% level or better. Therefore, these findings provide evidence that the main results do not materially change, even cultural diversity is constructed by specific dimensions within a cultural framework.

[10] Harmony cultures "emphasize fitting into the social and natural world, trying to appreciate and accept rather than to change, direct, or exploit.". Embedded cultures emphasize maintaining the status quo and restraining actions that might disrupt in-group solidarity or the traditional order." Hierarchy cultures "rely on hierarchical systems of ascribed roles to insure responsible, productive behavior." Mastery cultures "encourage active self-assertion in order to master, direct, and change the natural and social environment to attain group or personal goals." Affective autonomy "encourages individuals to pursue affectively positive experience for themselves." Intellectual autonomy "encourages individuals to pursue their own ideas and intellectual directions independently." Egalitarian cultures "seek to induce people to recognize one another as moral equals who share basic interests as human beings." (Schwartz, 2014)

[11] Assertiveness represents "the degree to which individuals are (and should be) assertive, confrontational, and aggressive in their relationship with others.". Institutional collectivism represents "the degree to which organizational and societal institutional practices encourage and reward (and should encourage and reward) collective distribution of resources and collective action." In-group collectivism represents "the degree to which individuals express (and should express) pride, loyalty, and cohesiveness in their organizations or families." Gender egalitarianism represent "the degree to which a collective minimizes (and should minimize) gender inequality." Humane orientation represent "the degree to which a collective encourages and rewards (and should encourage and reward) individuals for being fair, altruistic, generous, caring, and kind to others." Performance orientation represent "the degree to which a collective encourages and rewards (and should encourage and reward) group members for performance improvement and excellence." Power distance represents "the extent to which the community accepts and endorses authority, power differences, and status privileges." Uncertainty avoidance represents "the extent to which a society, organization, or group relies (and should rely) on social norms, rules, and procedures to alleviate unpredictability of future events." (House et al., 2004)

4.5 Alternative techniques

This section addresses issues regarding technique concerns. The technique employed in the previous sections is in fact a pooled cross-section regression across time. This technique implicitly assumes that all the observations in the sample are independently and randomly selected. However, while containing a relatively short period (2004-2006), the data structure of the sample is essentially the panel data. This means that the different observations regarding the same firm may auto-correlated over time. This particular can be the issue given the fact that cultural diversity of a multinational firm is fairly sticky and less likely to change dramatically over time. To address this concern, I re-estimate Regression (5) using a panel data technique. Specifically, I use the Fama and MacBeth's (1973) procedure, which firstly estimates a cross-sectional regression each year and then calculates the average coefficient for each variable. The first columns of Panels A and B of Table X report the results for patents (A.1) and citations (B.1) as dependent variables, respectively. In the patent regression (A.1), the interaction between cultural diversity and R&D is positive and significant at the 5% level. Although the interaction between cultural diversity and R&D is insignificant in the citation regression (B.1), it remains positive. It is important to aware that the dataset in this study is unbalanced panel data setting. In other words, not all firms have complete information in all years. This can reduce the reliability of standard error estimated in the Fama-MacBeth procedure.[12]

To address the above issue, I also use the between-effects model. The between-effects is a panel-data model which mainly captures the effect of a variable when it changes between firms. This is ideal for the purpose of this paper because while cultural diversity is fairly sticky and some firms may not have complete information over time, there are cross-firm differences in cultural diversity as well as R&D. The information on comparing different firms is relatively complete and therefore can provide more reliable estimations. With the between-effects model, I re-estimate Equation (4) and report results in the second columns of Panels A and B of Table X for patents (A.2) and citations (B.2) as dependent variables, respectively. As it can be seen, the coefficients on the interaction between cultural diversity and R&D are positive and significant at the 1% level. This is in line with the main results.

Finally, I address the concern regarding the distribution of variables. As shown in the summary statistics, the main variables, patents, citation and cultural diversity, are positively skewed. One related issue may be that the estimation based on the sample mean may be biased. To address this issue, I employ the quartile regression to repeat the estimation based on the median of the sample. The last columns of Panels A and B of Table X reports the results using the quartile model

[12] If a firm only has one-year observation, then it is unlikely to compute the standard error for the firm. In this case, the denominator in calculating the t-statistic would not be applicable.

based on the median for patents (A.3) and citations (B.3) as dependent variables, respectively. The results confirm the positive interaction effect between cultural diversity and R&D on innovation.

Overall, the evidence presented in this section suggests that the main results are robust to different techniques. Therefore, the finding that cultural diversity compounding with R&D investments facilitates innovation is not engendered by the data structure of this study.

5 Conclusion

The origins of technical and social innovations in the history are confined to the borders of a country. In other words, one country had to fundamentally change its culture in order to catch up industrial innovations of advanced countries (such as Japan's the Meiji Restoration of 1868). Nowadays, however, multinationals become the "centers of excellence" that connects culture across-borders, gather resources worldwide, and transfer knowledge and technology internationally. Cultural diversity thus provides multinationals with the opportunity to learn ideas generated in different cultures and integrate them into the innovation (Nakata and Sivakumar, 1996). While cultural diversity offers fertile soil for innovative activities, to realize innovation, it is essential for multinationals making investments to exploit the benefits provided by cultural diversity. As suggested by Hitt et al. (1997), the generation of innovation requires a significant amount of investments as innovation is a continuous process.

This paper empirically documents that multinationals with a higher degree of cultural diversity are more innovative compared to those with a lower degree of cultural diversity. The results show that the positive relation between cultural diversity and innovation holds consistently even after controlling for the factors documented in the literature to influence innovation. However, the relation between cultural diversity and innovation depends on R&D investment, as the results demonstrate a positive co-effect of cultural diversity and R&D investment on innovation. As a consequence, with a greater R&D investment in cultural diversified setting, a firm tends to have more innovations.

The above results are not affected by the time gap for generating innovation outputs. The positive interaction holds consistently for the effect of current cultural diversity and R&D investments on the innovations in the subsequent period. Therefore, the co-effect of cultural diversity and R&D investments in innovation can be explained in a causal way: A higher degree of investing R&D in a cultural diversified setting leads to more innovations in the next period. I also demonstrate that the effect of cultural diversity on innovation is not a proxy for that of foreignness. Further, I employ alternative cultural frameworks as well as each single cultural dimension to construct cultural diversity. The main results do not materially change. Finally, after addressing technique concerns, the main results hold robustly.

The central idea of this paper is to investigate how factors related to corporate structure affect innovation. On the one hand, the "bright side" hypothesis argues that a central headquarter can exploit synergies across divisions and allocate capital optimally across them. This may help promote innovation (Seru, 2014). On the other hands, the "dark side" of the internal capital markets includes information barriers and agency issues, which are detrimental to innovation. In this paper, I find evidence in favor of the "bright side" hypothesis in that cultural diversity helps the pursuit of novelty in innovation inside firm boundaries. I also find that by increasing R&D investments, central managers can promote innovation incentives in a cultural diversified setting. The findings in this paper are therefore consistent with the argument of Slangen and Beugelsdijk (2010) that in essence, cultural diversity is a corporate resource that needs management, exploration, and investments. This paper also partially answers the question proposed by Seru (2014): Whether the changing location of research conducted inside firms matters for innovation? In terms of cultural diversity, the answer is yes. Documenting other factors inside firm boundary affecting innovation is left for future research.

Reference

Aghion, P., Bloom, N., Blundell, R., Griffith, R., Howitt, P., 2005. Competition and innovation: An inverted-U relationship. Q. J. Econ. 120, 701–728.

Ahern, K.R., Daminelli, D., Fracassi, C., 2015. Lost in translation? The effect of cultural values on mergers around the world. J. Financ. Econ.

Anderson, C.W., Fedenia, M., Hirschey, M., Skiba, H., 2011. Cultural influences on home bias and international diversification by institutional investors. J. Bank. Financ. 35, 916–934.

Audretsch, D.B., Feldman, M.P., 1996. R&D spillovers and the geography of innovation and production. Am. Econ. Rev. 86, 630–640.

Barkema, H.G., Bell, J.H.J., Pennings, J.M., 1996. Foreign entry, cultural barriers, and learning. Strateg. Manag. J. 17, 151–166.

Becker, W., Dietz, J., 2004. R&D cooperation and innovation activities of firms—evidence for the German manufacturing industry. Res. Policy 33, 209–223.

Benito, G.R.G., Gripsrud, G., 1992. The expansion of foreign direct investments: discrete rational location choices or a cultural learning process? J. Int. Bus. Stud. 461–476.

Beugelsdijk, S., Frijns, B., 2010. A cultural explanation of the foreign bias in international asset allocation. J. Bank. Financ. 34, 2121–2131.

Beugelsdijk, S., van Schaik, T., 2005. Social capital and growth in European regions: an empirical test. Eur. J. Polit. Econ. 21, 301–324.

Bottazzi, L., Da Rin, M., Hellmann, T., 2016. The importance of trust for investment: Evidence from venture capital. Rev. Financ. Stud. 29, 2283–2318.

Bottazzi, L., Peri, G., 2007. The international dynamics of R&D and innovation in the long run and in the short run. Econ. J. 117, 486–511.

Calhoun, M.A., 2002. Unpacking liability of foreignness: identifying culturally driven external and internal sources of liability for the foreign subsidiary. J. Int. Manag. 8, 301–321.

Cassiman, B., Veugelers, R., 2006. In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. Manage. Sci. 52, 68–82.

Chemmanur, T.J., Loutskina, E., Tian, X., 2014. Corporate venture capital, value creation, and innovation. Rev. Financ. Stud. 27, 2434–2473.

Chui, A.C.W., Titman, S., Wei, K.C.J., 2010. Individualism and momentum around the world. J. Finance 65, 361–392.

Cohen, W.M., Levinthal, D.A., 1990. Absorptive capacity: A new perspective on learning and innovation. Adm. Sci. Q. 35, 128–152.

Duchin, R., 2010. Cash holdings and corporate diversification. J. Finance 65, 955–992.

Duranton, G., Puga, D., 2001. Nursery cities: Urban diversity, process innovation, and the life cycle of products. Am. Econ. Rev. 91, 1454–1477.

Eun, C.S., Wang, L., Xiao, S.C., 2015. Culture and R2. J. Financ. Econ. 115, 283–303.

Fama, E.F., MacBeth, J.D., 1973. Risk, return, and equilibrium: Empirical tests. J. Polit. Econ. 81, 607–636.

Fee, C.E., Hadlock, C.J., Pierce, J.R., 2009. Investment, financing constraints, and internal capital markets: Evidence from the advertising expenditures of multinational firms. Rev. Financ. Stud. 22, 2361–2392.

Freeman, C., 2002. Continental, national and sub-national innovation systems—complementarity and economic growth. Res. Policy 31, 191–211.

Frijns, B., Dodd, O., Cimerova, H., 2016. The impact of cultural diversity in corporate boards on firm performance. J. Corp. Financ. 41, 521–541.

Frost, T.S., Birkinshaw, J.M., Ensign, P.C., 2002. Centers of excellence in multinational corporations. Strateg. Manag. J. 23, 997–1018.

Frost, T.S., Zhou, C., 2005. R&D co-practice and 'reverse'knowledge integration in multinational firms. J. Int. Bus. Stud. 36, 676–687.

Gallié, E.-P., Legros, D., 2012. Firms' human capital, R&D and innovation: a study on French firms. Empir. Econ. 43, 581–596.

Ganotakis, P., Love, J.H., 2010. R&D, product innovation, and exporting: evidence from UK new technology based firms. Oxf. Econ. Pap. 63, 279–306.
Gao, W., Chou, J., 2015. Innovation efficiency, global diversification, and firm value. J. Corp. Financ. 30, 278–298.
Gardberg, N.A., Fombrun, C.J., 2006. Corporate citizenship: Creating intangible assets across institutional environments. Acad. Manag. Rev. 31, 329–346.
Gerybadze, A., Reger, G., 1999. Globalization of R&D: recent changes in the management of innovation in transnational corporations. Res. Policy 28, 251–274.
Gibson, C.B., Gibbs, J.L., 2006. Unpacking the concept of virtuality: The effects of geographic dispersion, electronic dependence, dynamic structure, and national diversity on team innovation. Adm. Sci. Q. 51, 451–495.
Grinblatt, M., Keloharju, M., 2001. How distance, language, and culture influence stockholdings and trades. J. Finance 56, 1053–1073.
Guiso, L., Sapienza, P., Zingales, G., 2009. Cultural biases in economic exchange? Q. J. Econ. 124, 1095–1131.
Guiso, L., Sapienza, P., Zingales, L., 2008. Trusting the stock market. J. Finance 63, 2557–2600.
Guiso, L., Sapienza, P., Zingales, L., 2006. Does culture affect economic outcomes? J. Econ. Perspect. 20, 23–48.
Hall, B.H., Jaffe, A.B., Trajtenberg, M., 2001. The NBER patent citation data file: Lessons, insights and methodological tools, NBER Working Paper 8498.
Hall, R., 1993. A framework linking intangible resources and capabiliites to sustainable competitive advantage. Strateg. Manag. J. 14, 607–618.
Heirman, A., Clarysse, B., 2007. Which tangible and intangible assets matter for innovation speed in start-ups? J. Prod. Innov. Manag. 24, 303–315.
Higgins, M.J., Rodriguez, D., 2006. The outsourcing of R&D through acquisitions in the pharmaceutical industry. J. Financ. Econ. 80, 351–383.
Hitt, M.A., Hoskisson, R.E., Kim, H., 1997. International diversification: Effects on innovation and firm performance in product-diversified firms. Acad. Manag. J. 40, 767–798.
Hofstede, G.H., 2001. Culture's consequences: comparing values, behaviors, institutions, and organizations across nations. Sage Publications, Thousand Oaks, Calif.
Hofstede, G.H., 1980. Culture's consequences: international differences in work-related values. Sage Publications, Beverly Hills, CA.
Hofstede, G.H., Hofstede, G.J., Minkov, M., 2010. Cultures and organizations : software of the mind : intercultural cooperation and its importance for survival. New York : McGraw-Hill, [2010].
House, R.J., Hanges, P.J., Javidan, M., Dorfman, P.W., Gupta, V., 2004. Culture, leadership, and organizations: The GLOBE study of 62 societies. Sage publications.
Huang, X., 2015. Thinking outside the borders: Investors' underreaction to foreign operations information. Rev. Financ. Stud. 28, 3109–3152.
Hvide, H.K., Panos, G.A., 2014. Risk tolerance and entrepreneurship. J. Financ. Econ. 111, 200–223.
Jacob, M.C., 1988. The cultural meaning of the scientific revolution. Temple University Press, Piladelphia.
Jayne, M.E.A., Dipboye, R.L., 2004. Leveraging diversity to improve business performance: Research findings and recommendations for organizations. Hum. Resour. Manage. 43, 409–424.
Karolyi, G.A., 2016. The gravity of culture for finance. J. Corp. Financ. 41, 610–625.
Kogut, B., Singh, H., 1988. The effect of national culture on the choice of entry mode. J. Int. Bus. Stud. 19, 411–432.
Kogut, B., Zander, U., 1993. Knowledge of the firm and the evolutionary theory of the multinational corporation. J. Int. Bus. Stud. 24, 625–645.
Kotabe, M., 1990. The relationship between offshore sourcing and innovativeness of U.S.

multinational firms: An empirical investigation. J. Int. Bus. Stud. 21, 623–638.
Kotabe, M., Murray, J.Y., 1990. Linking product and process innovations and modes of international sourcing in global competition: A case of foreign multinational firms. J. Int. Bus. Stud. 21, 383–408.
Maddux, W.W., Galinsky, A.D., 2009. Cultural borders and mental barriers: The relationship between living abroad and creativity. J. Pers. Soc. Psychol. 96, 1047–1061.
March, J.G., 1991. Exploration and exploitation in organizational learning. Organ. Sci. 2, 71–87.
Morris, S.S., Snell, S.A., 2011. Intellectual capital configurations and organizational capability: An empirical examination of human resource subunits in the multinational enterprise. J. Int. Bus. Stud. 42, 805–827.
Nakata, C., Sivakumar, K., 1996. National culture and new product development: An integrative review. J. Mark. 60, 61–72.
Nathan, M., Lee, N., 2013. Cultural diversity, innovation, and entrepreneurship: Firm-level evidence from London. Econ. Geogr. 89, 367–394.
Ng, E.S.W., Tung, R.L., 1998. Ethno-cultural diversity and organizational effectiveness: A field study. Int. J. Hum. Resour. Manag. 9, 980–995.
Niebuhr, A., 2010. Migration and innovation: Does cultural diversity matter for regional R&D activity? Pap. Reg. Sci. 89, 563–585.
Nijkamp, P., Poot, J., 2015. Cultural diversity: a matter of measurement, in: Nijkamp, P., Poot, J., Bakens, J. (Eds.), Economics of Cultural Diversity. Edward Elgar Cheltenham, Cheltenham, U.K. and Northampton, Massachusetts, pp. 17–51.
Østergaard, C.R., Timmermans, B., Kristinsson, K., 2011. Does a different view create something new? The effect of employee diversity on innovation. Res. Policy 40, 500–509.
Ottaviano, G.I.P., Peri, G., 2006. The economic value of cultural diversity: evidence from US cities. J. Econ. Geogr. 6, 9–44.
Ozgen, C., Nijkamp, P., Poot, J., 2013. The impact of cultural diversity on firm innovation: evidence from Dutch micro-data. IZA J. Migr. 2, 18.
Ozgen, C., Peters, C., Niebuhr, A., Nijkamp, P., Poot, J., 2014. Does cultural diversity of migrant employees affect innovation? Int. Migr. Rev. 48.
Parrotta, P., Pozzoli, D., Pytlikova, M., 2014. The nexus between labor diversity and firm's innovation. J. Popul. Econ. 27, 303–364.
Scherer, F.M., 1965. Firm size, market structure, opportunity, and the output of patented inventions. Am. Econ. Rev. 55, 1097–1125.
Schoar, A., 2002. Effects of corporate diversification on productivity. J. Finance 57, 2379–2403.
Schwartz, S.H., 2014. National culture as value orientations: Consequences of value differences and cultural distance, in: Ginsburgh, V., Throsby, D. (Eds.), Handbook of the Economics of Art and Culture. Elsevier/North-Holland, pp. 547–586.
Schwartz, S.H., 2009. Culture matters: National value cultures, sources and consequences, in: Wyer, R.S., Chiu, C., Hong, Y. (Eds.), Understanding Culture: Theory, Research, and Application. Psychology Press, New York, p. 127.
Schwartz, S.H., 2007. A theory of cultural value orientations: Explication and applications, in: Esmer, Y.R., Pettersson, T. (Eds.), Measuring and Mapping Cultures: 25 Years of Comparative Value Surveys. Brill, Leiden, Netherlands, pp. 33–78.
Seru, A., 2014. Firm boundaries matter: Evidence from conglomerates and R&D activity. J. Financ. Econ. 111, 381–405.
Shane, S.A., 1995. Uncertainty avoidance and the preference for innovation championing roles. J. Int. Bus. Stud. 47–68.
Shane, S.A., 1994. The effect of national culture on the choice between licensing and direct foreign investment. Strateg. Manag. J. 15, 627–642.
Shane, S.A., 1993. Cultural influences on national rates of innovation. J. Bus. Ventur. 8, 59–73.
Shane, S.A., Venkataraman, S., MacMillan, I., 1995. Cultural differences in innovation championing strategies. J. Manage. 21, 931–952.

Shenkar, O., 2001. Cultural distance revisited: Towards a more rigorous conceptualization and measurement of cultural differences. J. Int. Bus. Stud. 32, 519–535.
Siegel, J.I., Licht, A.N., Schwartz, S.H., 2011. Egalitarianism and international investment. J. Financ. Econ. 102, 621–642.
Slangen, A.H.L., Beugelsdijk, S., 2010. The impact of institutional hazards on foreign multinational activity: A contingency perspective. J. Int. Bus. Stud. 41, 980–995.
Stulz, R.M., Williamson, R., 2003. Culture, openness, and finance. J. Financ. Econ. 70, 313–349.
Tang, L., Koveos, P.E., 2008. A framework to update Hofstede's cultural value indices: Economic dynamics and institutional stability. J. Int. Bus. Stud. 39, 1045–1063.
Taylor, M.Z., Wilson, S., 2012. Does culture still matter?: The effects of individualism on national innovation rates. J. Bus. Ventur. 27, 234–247.
Teece, D.J., 1998. Capturing value from knowledge assets: The new economy, markets for know-how, and intangible assets. Calif. Manage. Rev. 40, 55–79.
Teece, D.J., 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. Res. Policy 15, 285–305.
Un, C.A., 2011. The advantage of foreignness in innovation. Strateg. Manag. J. 32, 1232–1242.
Zahra, S.A., Ireland, R.D., Hitt, M.A., 2000. International expansion by new venture firms: International diversity, mode of market entry, technological learning, and performance. Acad. Manag. J. 43, 925–950.
Zeng, Y., Shenkar, O., Lee, S., Song, S., 2013. Cultural differences, MNE learning abilities, and the effect of experience on subsidiary mortality in a dissimilar culture: Evidence from Korean MNEs. J. Int. Bus. Stud. 44, 42–65.

Table I
Cultural shares of patenting activity

Nation	Number of patents	Total percentage	Foreign percentage
United States	136,049	98.22%	--
Germany	1,250	0.90%	50.63%
United Kingdom	296	0.21%	11.99%
Canada	265	0.19%	10.73%
Australia	108	0.08%	4.37%
France	88	0.06%	3.56%
Japan	67	0.05%	2.71%
Sweden	62	0.04%	2.51%
Switzerland	47	0.03%	1.90%
Italy	47	0.03%	1.90%
Denmark	39	0.03%	1.58%
Finland	39	0.03%	1.58%
South Korea	37	0.03%	1.50%
Israel	33	0.02%	1.34%
Netherlands	31	0.02%	1.26%
Ireland	17	0.01%	0.69%
Brazil	9	0.01%	0.36%
Iceland	9	0.01%	0.36%
Austria	8	0.01%	0.32%
Spain	8	0.01%	0.32%
Thailand	5	0.00%	0.20%
Singapore	2	0.00%	0.08%
Belgium	1	0.00%	0.04%
Taiwan	1	0.00%	0.04%
Total	138,518	100.00%	100.00%

Table II
Sample distribution

This table summarizes the sample distribution. Country and subsidiary information are from Orbis, and patent and citation data from the National Bureau of Economic Research (NBER) U.S. Patent Citations Data File. The patent and citation data are described in detail in (Hall et al., 2001). The sample period is 2004 to October 2006. The aggregate sample includes all matched U.S. multinational firms and their patents and citations, comprising 1,660 unique firm-year observations.

Count	0	1-2	3-5	6-10	11-100	>100	Total
Panel A: By number of foreign countries							
2004	0	168	147	95	128	0	538
2005	1	176	148	98	128	0	551
2006	0	219	149	81	122	0	571
Total	1	563	444	274	378	0	1,660
Panel B: By number of foreign subsidiaries							
2004	0	145	116	96	155	26	538
2005	1	153	121	90	162	24	551
2006	0	181	132	92	141	25	571
Total	1	479	369	278	458	75	1,660
Panel C: By number of patents							
2004	1	145	85	63	189	55	538
2005	2	145	109	71	174	50	551
2006	0	166	88	79	184	54	571
Total	3	456	282	213	547	159	1,660
Panel D: By number of citations							
2004	89	86	67	59	166	71	538
2005	161	128	91	46	100	24	550
2006	410	82	42	13	24	1	572
Total	660	296	200	118	290	96	1660

Table II
Summary statistics

This table provides descriptive statistics on the variables used in the analysis over the period between 2004 and 2006. All statistics are computed at the firm level. Patent and Citation are the count of patent and citation owned by sample firms. Cultural diversity is calculated using the aggregate of cultural distances between parent and subsidiaries from Euclidean version of the Kogut and Singh's (1988) formula: $Distance_{US,j} = \sqrt{\sum_{k=1}^{K} \frac{(I_{k,j} - I_{k,US})^2}{V_k}}$, where $I_{k,j}$ and $I_{k,US}$ are the scores for cultural dimension k for country j and the U.S. respectively. The main measure of culture is based on Hofstede's cultural dimensions, including power distance index (PDI), uncertainty avoidance index (UAI), individualism index (IDV), masculinity index (MAS), long-term orientation (LTO), and Indulgence (IND). Size is total sales revenue in billion dollar. Tobin's Q is the ratio market value to book value of total assets. Leverage is the ratio of total debt to total capital. Profitability is the ratio of operating revenue to total sales revenue. Tangibility is the ratio of Plant, Property and Equipment (PP&E) to total assets. Age is the number of years since Initial Public Offering (IPO). Foreign operation is the ratio of foreign assets to total assets. # segments is the number of business segments. # subsidiaries is the number of subsidiaries. R&D is research and development (R&D) expense to total sales revenue. Intangible invest is the ratio of the change in intangible assets to total assets. Variables are winsorized at 1% and 99% at both tails. The data sources are summarized in Appendix.

Variables	N	Mean	Std. Dev.	25th percentile	median	75th percentile
Patent	1,660	53.80	213.94	2	7	27
Citation	1,660	32.63	192.43	0	1	9
Cultural diversity	1,660	23.53	34.28	4.44	10.10	25.52
Size	1,612	6.06	21.82	0.22	0.90	3.44
Tobin's Q	1,610	2.37	1.33	1.47	1.94	2.82
Leverage	1,613	1.97	2.77	1.32	1.76	2.39
Profitability	1,611	-0.07	0.97	0.04	0.09	0.15
Tangibility	1,611	0.18	0.14	0.08	0.14	0.24
Age	1,412	21.60	23.00	7	13	23
Foreign operation	1,265	15.16	18.69	1.85	8.22	20.61
# segments	1,660	2.80	1.83	1	3	4
# subsidiaries	1,660	37.58	123.34	5	12	30.5
R&D	1,469	17.07	49.56	2.16	6.90	16.07
Intangible invest	1,489	2.84	8.94	-0.48	0.17	2.85

Table IV
Baseline results

This table report the regression results of innovation, with patent and citation as proxies, on cultural diversity of multinational firms and a set of control variables. Patent and Citation are the count of patent and citation owned by sample firms. Cultural diversity is calculated using the aggregate of cultural distances between parent and subsidiaries from Euclidean version of the Kogut and Singh's (1988) formula: $Distance_{US,j} = \sqrt{\sum_{k=1}^{K} \frac{(I_{k,j} - I_{k,US})^2}{V_k}}$, where $I_{k,j}$ and $I_{k,US}$are the scores for cultural dimension k for country j and the U.S. respectively. The main measure of culture is based on Hofstede's cultural dimensions, including power distance index (PDI), uncertainty avoidance index (UAI), individualism index (IDV), masculinity index (MAS), long-term orientation (LTO), and Indulgence (IND). All control variables are described in Appendix. For regressions with year dummies, the default year is 2004. For regressions with industry dummies, the default year is mining industry. All control variables are described in Appendix. In the parentheses, t-statistics are presented. *, **, and *** stand for the 1%, 5% and 10% significant level, respectively.

	Panel A: Patent				Panel B: Citation			
	A.1	A.2	A.3	A.4	B.1	B.2	B.3	B.4
Cultural diversity	1.55***	0.47**	0.48***	0.40**	0.78***	0.25***	0.24***	0.21**
	(6.10)	(2.55)	(2.70)	(2.08)	(3.75)	(2.63)	(2.58)	(2.35)
Size		1.86*	1.86*	2.29**		0.67*	0.66*	0.82**
		(1.95)	(1.94)	(2.25)		(1.76)	(1.78)	(2.03)
Tobin's Q		7.46**	7.27**	7.94***		4.85*	4.67*	4.91*
		(2.53)	(2.48)	(2.66)		(1.83)	(1.82)	(1.87)
Leverage		0.04	-0.002	-0.12		-1.57	-1.53	-1.46
		(0.02)	(-0.00)	(-0.08)		(-0.82)	(-0.84)	(-0.78)
Profitability		5.91**	5.69**	6.52***		5.28***	6.70***	7.39***
		(2.46)	(2.43)	(2.78)		(2.66)	(3.00)	(3.10)
Tangibility		-63.07	-63.11	-8.21		-7.00	-16.38	-4.81
		(-1.44)	(-1.44)	(-0.21)		(-0.24)	(-0.59)	(-0.15)
Age		0.54	0.53	0.48		-0.22	-0.12	-0.16
		(1.30)	(1.31)	(1.14)		(-1.28)	(-0.75)	(-0.95)
Foreign operation		-0.60***	-0.61***	-0.64***		-0.45***	-0.45***	-0.45***
		(-2.71)	(-2.71)	(-2.76)		(-2.89)	(-2.87)	(-2.80)
# segments		11.47***	11.49***	11.77***		5.85**	5.27**	5.22**
		(3.43)	(3.43)	(3.35)		(2.57)	(2.45)	(2.45)
# subsidiaries		-0.12	-0.12	-0.15*		-0.07*	-0.06*	-0.07*
		(-1.44)	(-1.49)	(-1.68)		(-1.94)	(-1.71)	(-1.86)
2005			-6.31	-3.52			-42.17***	-41.33***
			(-0.67)	(-0.38)			(-3.71)	(-3.71)
2006			8.98	11.51			-56.11***	-55.20***
			(0.73)	(0.92)			(-5.28)	(-5.31)
Construction				122.90**				43.16
				(2.46)				(1.00)
Manufacturing				144.07***				58.44**
				(2.85)				(2.28)
Utility				112.65**				66.39*
				(2.32)				(1.75)
Wholesale				47.17				19.30
				(0.88)				(0.80)
Retail				78.26*				34.72
				(1.80)				(1.51)
Services				157.46**				48.67**
				(2.25)				(2.00)
Constant	17.42***	-14.96	-15.21	-167.90***	14.22***	3.684	39.963***	-17.406
	(3.37)	(-1.31)	(-1.04)	(-2.58)	(3.50)	(0.37)	(3.47)	(-0.64)
Adjusted R^2	0.061	0.105	0.105	0.117	0.019	0.030	0.067	0.068
Observations	1,660	1,069	1,069	1,069	1,660	1,069	1,069	1,069

Table V
Location strategy and the effect of cultural diversity on innovation

This table report the regression results for the effect of various intangible investments on the relation between cultural diversity and innovation using patent and citation as proxies, on cultural diversity of multinational firms. Intangible investments include license, brand, advertising, developing, and research and development (R&D). License, brand, advertising, development are dummy variables which equal to one if their amount increase compared to the previous year. Otherwise zero. R&D is the ratio of R&D expenses to total sales revenue. Intangible Invest is the ratio of the change in total intangibles to total assets. Patent and Citation are the count of patent and citation owned by sample firms. Cultural diversity is calculated using the aggregate of cultural distances between parent and subsidiaries from Euclidean version of the Kogut and Singh's (1988) formula: $Distance_{US,j} = \sqrt{\sum_{k=1}^{K} \frac{(I_{k,j} - I_{k,US})^2}{V_k}}$, where $I_{k,j}$ and $I_{k,US}$ are the scores for cultural dimension k for country j and the U.S. respectively. The measure of culture is based on Hofstede's cultural dimensions, including power distance index (PDI), uncertainty avoidance index (UAI), individualism index (IDV), masculinity index (MAS), long-term orientation (LTO), and Indulgence (IND). All control variables are described in Appendix. In the parentheses, t-statistics are presented. *, **, and *** stand for the 1%, 5% and 10% significant level, respectively.

	Panel A: Patent						Panel B: Citation					
	A.1	A.2	A.3	A.4	A.5	A.6	B.1	B.2	B.3	B.4	B.5	B.6
Cultural diversity	0.43**	0.36*	0.39*	0.34*	-0.16	0.54***	0.22**	0.26**	0.22**	0.21**	-0.12	0.28***
	(2.17)	(1.83)	(1.88)	(1.79)	(-0.75)	(3.24)	(2.39)	(2.45)	(2.33)	(2.29)	(-1.26)	(2.79)
CD * License	-0.26						-0.13*					
	(-1.49)						(-1.68)					
CD * Brand		0.09						-0.21*				
		(0.33)						(-1.85)				
CD * Advertising			0.09						-0.18			
			(0.25)						(-0.91)			
CD * Developing				3.00*						0.05		
				(1.84)						(0.18)		
CD * R&D					0.10***						0.06***	
					(3.37)						(2.67)	
CD * Intangible Invest						-0.26						-0.21
						(-0.23)						(-0.32)
License	-24.32**						-5.52					
	(-2.09)						(-1.19)					
Brand		13.22						5.26				
		(0.68)						(1.62)				
Advertising			-6.50						20.17			
			(-0.20)						(0.95)			
Development				-15.40						0.61		
				(-0.57)						(0.11)		
R&D					0.90***						0.61**	
					(2.62)						(2.25)	
Intangible Invest.						-14.10						-26.90
						(-0.41)						(-1.49)
Size	2.27**	2.30**	2.29**	2.19**	2.43**	5.80***	0.82**	0.81**	0.82**	0.82**	0.89**	2.08**
	(2.24)	(2.25)	(2.25)	(2.20)	(2.40)	(3.05)	(2.01)	(2.01)	(2.03)	(2.01)	(2.19)	(2.48)
Tobin's Q	8.39***	7.98***	7.93***	7.01**	3.81	8.56***	5.03*	4.99*	4.87*	4.89*	1.98	4.74*
	(2.71)	(2.67)	(2.61)	(2.24)	(1.43)	(2.64)	(1.88)	(1.89)	(1.84)	(1.84)	(0.89)	(1.65)
Leverage	-0.16	-0.09	-0.12	-0.17	1.10	-0.30	-1.47	-1.46	-1.44	-1.46	-0.97	-1.59
	(-0.10)	(-0.06)	(-0.08)	(-0.12)	(0.75)	(-0.16)	(-0.79)	(-0.79)	(-0.78)	(-0.78)	(-0.52)	(-0.79)
Profitability	6.87***	6.14**	6.54***	6.11***	77.27***	16.00**	7.47***	7.19***	7.32***	7.38***	54.94***	12.75**
	(2.83)	(2.55)	(2.77)	(2.65)	(3.70)	(2.58)	(3.09)	(3.05)	(3.07)	(3.08)	(2.89)	(2.35)
Tangibility	0.51	0.49	0.48	0.45	0.46	0.32	-4.57	-4.59	-4.81	-4.66	4.52	-8.23

	(1.19)	(1.13)	(1.14)	(1.07)	(1.05)	(0.79)	(-0.15)	(-0.15)	(-0.15)	(-0.15)	-0.12	(-0.25)
Age	-7.37	-5.67	-8.18	-3.42	7.47	-10.41	-0.15	-0.15	-0.16	-0.16	-0.18	-0.28
	(-0.19)	(-0.15)	(-0.21)	(-0.09)	(0.16)	(-0.28)	(-0.90)	(-0.93)	(-0.96)	(-0.96)	(-1.03)	(-1.52)
Foreign operation	-0.64***	-0.64***	-0.64***	-0.66***	-0.54**	-0.69***	-0.45***	-0.46***	-0.45***	-0.45***	-0.40***	-0.45***
	(-2.75)	(-2.74)	(-2.76)	(-2.98)	(-2.38)	(-2.76)	(-2.79)	(-2.82)	(-2.82)	(-2.81)	(-2.65)	(-2.63)
# segments	11.69***	11.47***	11.83***	11.78***	14.01***	5.07	5.17**	5.42**	5.04**	5.22**	6.55***	3.12*
	(3.32)	(3.37)	(3.29)	(3.37)	(3.77)	(1.60)	(2.43)	(2.49)	(2.40)	(2.45)	(2.80)	(1.77)
# subsidiaries	-0.15*	-0.15*	-0.15*	-0.14	-0.16*	-0.45***	-0.07*	-0.07*	-0.07*	-0.07*	-0.07**	-0.18**
	(-1.68)	(-1.67)	(-1.69)	(-1.62)	(-1.75)	(-2.86)	(-1.85)	(-1.83)	(-1.95)	(-1.84)	(-1.98)	(-2.41)
Constant	-12.92	-8.97	-10.18	-7.22	-44.96**	3.99	30.45***	29.07***	30.74***	31.30***	12.52	38.79***
	(-0.73)	(-0.51)	(-0.56)	(-0.41)	(-1.97)	(0.19)	(2.70)	(2.59)	(2.74)	(2.79)	(0.92)	(3.09)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.118	0.117	0.116	0.129	0.154	0.216	0.067	0.067	0.067	0.067	0.095	0.096
Observations	1,069	1,069	1,069	1,069	1,001	1,010	1,069	1,069	1,069	1,069	1,001	1,010

Table VI

Cultural diversity, intangibles and innovation relation with effect of time lag

This table report the regression results for the effect of intangible investments and cultural diversity on corporate innovation using patent and citation as proxies. Patent and Citation are the one-year forward count of patents and citations owned by sample firms. R&D is the ratio of R&D expenses to total sales revenue. Intangible Invest is the ratio of the change in total intangibles to total assets. Cultural diversity is calculated using the aggregate of cultural distances between parent and subsidiaries from Euclidean version of the Kogut and Singh's (1988) formula: $Distance_{US,j} = \sqrt{\sum_{k=1}^{K} \frac{(I_{k,j} - I_{k,US})^2}{V_k}}$, where $I_{k,j}$ and $I_{k,US}$ are the scores for cultural dimension k for country j and the U.S. respectively. The measure of culture is based on Hofstede's cultural dimensions, including power distance index (PDI), uncertainty avoidance index (UAI), individualism index (IDV), masculinity index (MAS), long-term orientation (LTO), and Indulgence (IND). All control variables are described in Appendix. In the parentheses, t-statistics are presented. *, **, and *** stand for the 1%, 5% and 10% significant level, respectively.

	Panel A: Patent (forward)		Panel B: Citation (forward)	
	A.1	A.2	B.1	B.2
Cultural diversity	0.85**	-0.20	0.16*	-0.03
	(2.17)	(-0.68)	(1.83)	(-0.38)
CD * Intangible Invest	2.14		1.09**	
	(0.77)		(1.97)	
CD * R&D		0.12**		0.02**
		(2.56)		(2.00)
Intangible Invest.	-93.47*		-39.14***	
	(-1.70)		(-3.09)	
R&D		1.12*		0.26*
		(1.66)		(1.75)
Size	6.93***	1.93*	1.17**	0.34*
	(4.9)	(1.91)	(2.56)	(1.69)
Tobin's Q	8.89*	5.88	0.77	0.28
	(1.95)	(1.37)	(0.70)	(0.28)
Leverage	-4.17**	0.53	-1.38*	-0.53
	(-2.01)	(0.34)	(-1.70)	(-0.80)
Profitability	43.71**	103.37**	11.36**	24.21**
	(2.17)	(2.38)	(2.26)	(2.32)
Tangibility	-28.28	14.69	-11.99	-5.72
	(-0.49)	(0.21)	(-0.81)	(-0.33)
Age	-0.38*	-0.11	-0.17**	-0.08
	(-1.69)	(-0.42)	(-2.18)	(-1.05)
Foreign operation	-0.75**	-0.58*	-0.18**	-0.14*
	(-2.37)	(-1.82)	(-2.01)	(-1.81)
# segments	1.77	15.02***	-0.19	1.85*
	(0.44)	(2.77)	(-0.27)	(1.79)
# subsidiaries	-0.71**	-0.07	-0.14**	-0.03
	(-2.57)	(-0.31)	(-2.19)	(-0.71)
Constant	3.58	-85.19***	14.48***	-1.58
	(0.21)	(-2.78)	(3.05)	(-0.25)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.283	0.182	0.143	0.094
Observations	512	518	512	518

Table VII
Cultural diversity and the degree of foreignness

This table report the regression results for the effect of cultural diversity and R&D investments on corporate innovation using patent and citation as proxies, after controlling for the degree of foreignness, measured by three proxies: FNTN (the ratio of the number of foreign subsidiaries to total number of subsidiaries), FSTS (the ratio of foreign sales revenue to total sales revenue), and FITI (the ratio of foreign income to total income). Patent and Citation are the count of patent and citation owned by sample firms. R&D is the ratio of R&D expenses to total sales revenue. Cultural diversity is calculated using the aggregate of cultural distances between parent and subsidiaries from Euclidean version of the Kogut and Singh's (1988) formula: $Distance_{US,j} = \sqrt{\sum_{k=1}^{K} \frac{(I_{k,j} - I_{k,US})^2}{V_k}}$, where $I_{k,j}$ and $I_{k,US}$ are the scores for cultural dimension k for country j and the U.S. respectively. The measure of culture is based on Hofstede's cultural dimensions, including power distance index (PDI), uncertainty avoidance index (UAI), individualism index (IDV), masculinity index (MAS), long-term orientation (LTO), and Indulgence (IND). All control variables are described in Appendix. In the parentheses, t-statistics are presented. *, **, and *** stand for the 1%, 5% and 10% significant level, respectively.

	Panel A: Patent			Panel B: Citation		
	A.1	A.2	A.3	B.1	B.2	B.3
Cultural diversity	-0.01	-0.24	-0.21	-0.07	-0.16	-0.12
	(-0.07)	(-0.98)	(-0.83)	(-0.78)	(-1.56)	(-1.13)
R&D	0.71***	0.80***	1.44***	0.37**	0.46**	0.65*
	(3.06)	(2.73)	(3.13)	(2.24)	(2.12)	(1.77)
CD * R&D	0.10***	0.09***	0.09***	0.06***	0.05***	0.05**
	(3.70)	(3.31)	(2.76)	(3.03)	(2.81)	(2.50)
FNTN	-44.64***			-14.48		
	(-3.00)			(-1.59)		
FSTS		0.84***			0.41**	
		(3.08)			(2.20)	
FITI			0.02			0.02
			(0.72)			(1.34)
Size	2.86**	2.81**	2.90**	1.08**	1.07**	1.10**
	(2.45)	(2.45)	(2.46)	(2.24)	(2.24)	(2.23)
Tobin's Q	3.75	6.07**	3.66	2.31	2.91	2.63
	(1.59)	(2.35)	(1.19)	(1.21)	(1.35)	(0.98)
Leverage	0.43	1.02	1.12	-1.24	-1.25	-1.41
	(0.33)	(0.65)	(0.66)	(-0.77)	(-0.66)	(-0.63)
Profitability	55.32***	63.46***	109.01***	32.89***	41.36***	56.16**
	(3.92)	(3.67)	(3.59)	(2.94)	(2.85)	(2.15)
Tangibility	31.01	-32.38	-68.06	10.42	-13.51	-26.21
	(0.48)	(-0.72)	(-1.18)	(0.27)	(-0.39)	(-0.60)
Age	0.52	0.65	0.79	-0.11	-0.12	-0.13
	(1.19)	(1.43)	(1.35)	(-0.58)	(-0.61)	(-0.52)
# segments	10.30***	15.39***	17.06***	5.09**	7.26***	7.66***
	(2.91)	(4.13)	(3.84)	(2.45)	(3.36)	(3.07)
# subsidiaries	-0.20*	-0.17	-0.19*	-0.09**	-0.08**	-0.09**
	(-1.91)	(-1.62)	(-1.81)	(-2.15)	(-1.98)	(-2.06)
Constant	-22.29	-90.42***	-59.36**	17.74	-9.95	7.73
	(-0.93)	(-3.74)	(-2.26)	(1.34)	(-0.59)	(0.50)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.141	0.168	0.155	0.085	0.099	0.09
Observations	1,252	1,143	886	1,252	1,143	886

Table X
Further Robustness

This table report the results for the effect of cultural diversity and R&D investments on corporate innovation using patent and citation as proxies. I use three alternative techniques: Fama-MacBeth procedure, Quartile Regression, and Between Effect. Patent and Citation are the count of patent and citation owned by sample firms.Cultural diversity is calculated using the aggregate of cultural distances between parent and subsidiaries from Euclidean version of the Kogut and Singh's (1988) formula: $Distance_{US,j} = \sqrt{\sum_{k=1}^{K} \frac{(I_{k,j} - I_{k,US})^2}{V_k}}$, where $I_{k,j}$ and $I_{k,US}$ are the scores for cultural dimension k for country j and the U.S. respectively. The measure of culture is based on Hofstede's cultural dimensions, including power distance index (PDI), uncertainty avoidance index (UAI), individualism index (IDV), masculinity index (MAS), long-term orientation (LTO), and Indulgence (IND). R&D is the ratio of R&D expenses to total sales revenue. All control variables are described in Appendix. In the parentheses, t-statistics are presented. *, **, and *** stand for the 1%, 5% and 10% significant level, respectively.

	Panel A: Patent			Panel B: Citation		
	Fama-MacBeth procedure	Between Effect	Quartile Regression	Fama-MacBeth procedure	Between Effect	Quartile Regression
	A.1	A.2	A.3	B.1	B.2	B.3
Cultural diversity	-0.26	-0.40	0.12	-0.08	-0.24	0.00
	(-2.90)	(-1.13)	(1.07)	(-2.85)	(-1.42)	(0.02)
R&D	1.32	0.41	0.10**	0.38	0.42	0.00
	(1.83)	(0.55)	(2.24)	(2.76)	(1.14)	(0.08)
R&D * Cultural diversity	0.10**	0.12***	0.03***	0.07	0.08***	0.01***
	(7.58)	(3.16)	(4.82)	(1.60)	(4.00)	(3.02)
Controls, year and industry fixed effects	YES	YES	YES	YES	YES	YES
Average/Pseudo0.016/Adjusted R^2	0.223	0.154	0.074	0.164	0.099	0.016
Observations	1,001	1,001	1,001	1,001	1,001	1,001

Table IX
The effect of cultural diversity and intangible investment on innovation: Cultural dimensions

This table report the regression results for the effect of cultural diversity and R&D investments on corporate innovation using patent and citation as proxies. I use each dimensions in Hofstede's, Schwartz and GLOBE's cultural framework to capture national culture. Hofstede's cultural dimensions include six dimensions: Power distance index (Hof_PDI), uncertainty avoidance index (Hof_UAI), individualism index (Hof_IDV), masculinity index (Hof_MAS), long-term orientation (Hof_LTO), and Indulgence (Hof_IND). Schwartz's cultural framework include seven dimensions: Harmony, Embeddedness, Hierarchy, Mastery, Affective autonomy, Intellectual autonomy and Egalitarianism. GLOBE project covers nine dimensions: Assertiveness, Institutional Collectivism, Ingroup Collectivism, Future Orientation, Gender Egalitarianism, Humane Orientation, Performance Orientation, Power Distance, Uncertainty Avoidance. Based on the cultural scores of these dimensions, cultural diversity is calculated using cultural distances between parent and subsidiaries from Euclidean version of the Kogut and Singh's (1988) formula: $Distance^{*}_{US,j} = \sqrt{(I_{k,j} - I_{k,US})^2 / V_k}$, where $I_{k,j}$ and $I_{k,US}$ are the scores for cultural dimension k for country j and the U.S. respectively. Patent and Citation are the count of patent and citation owned by sample firms. R&D is the ratio of R&D expenses to total sales revenue. All control variables are described in Appendix. In the parentheses, t-statistics are presented. *, **, and *** stand for the 1%, 5% and 10% significant level, respectively.

	Cultural diversity	R&D	CD*R&D	Controls	Year +Industry FE	Adjusted R^2	Observations
Panel A: Patent							
Hof _ PDI	-0.65	1.13***	0.35***	YES	YES	0.160	1,001
	(-1.08)	(3.65)	(3.36)				
Hof _ IDV	-0.36	1.17***	0.21***	YES	YES	0.155	1,001
	(-0.95)	(3.40)	(3.29)				
Hof _ MAS	-0.09	1.04***	0.26***	YES	YES	0.150	1,001
	(-0.12)	(3.320	(2.88)				
Hof _ UAI	-0.46	0.99***	0.30***	YES	YES	0.156	1,001
	(-0.78)	(3.11)	(3.38)				
Hof _ LTO	-0.23	0.74**	0.22***	YES	YES	0.148	1,001
	(-0.39)	(2.04)	(3.18)				
Panel B: Citation							
Hof _ PDI	-0.40	0.74***	0.20**	YES	YES	0.118	1,001
	(-1.44)	(2.81)	(2.51)				
Hof _ IDV	-0.25	0.78***	0.12**	YES	YES	0.113	1,001
	(-1.35)	(2.74)	(2.42)				
Hof _ MAS	-0.18	0.68**	0.15**	YES	YES	0.110	1,001
	(-0.59)	(2.53)	(2.44)				
Hof _ UAI	-0.37	0.64**	0.18***	YES	YES	0.116	1,001
	(-1.31)	(2.48)	(2.63)				
Hof _ LTO	-0.21	0.52*	0.13***	YES	YES	0.109	1,001
	(-0.89)	(1.86)	(2.74)				

Table VIII

The effect of cultural diversity and intangible investment on innovation: Alternative measures of culture

This table report the regression results for the effect of cultural diversity and R&D investments on corporate innovation using patent and citation as proxies. I use four alternative measures to capture national culture: Schwartz cultural framework (Schwartz), GLOBE project's value scores (GLOBE), trust from the World Value Survey questions: " Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?" (Trust), and a updated version of Hofstede's scores by (Tang and Koveos, 2008) (TK). Based on these cultural scores, cultural diversity is calculated using the aggregate of cultural distances between parent and subsidiaries from Euclidean version of the Kogut and Singh's (1988) formula: $Distance_{US,j} = \sqrt{\sum_{k=1}^{K} \frac{(I_{k,j} - I_{k,US})^2}{V_k}}$, where $I_{k,j}$ and $I_{k,US}$ are the scores for cultural dimension k for country j and the U.S. respectively. Patent and Citation are the count of patent and citation owned by sample firms. R&D is the ratio of R&D expenses to total sales revenue. All control variables are described in Appendix. In the parentheses, t-statistics are presented. *, **, and *** stand for the 1%, 5% and 10% significant level, respectively.

	Patent				Citation			
	Schwartz	GLOBE	Trust	TK	Schwartz	GLOBE	Trust	TK
	A.1	A.2	A.3	A.4	B.1	B.2	B.3	B.4
Cultural diversity	-0.19	-0.23	-0.39	-0.24	-0.13	-0.13	-0.35	-0.16
	(-0.82)	(-1.01)	(-0.68)	(-0.94)	(-1.35)	(-1.34)	(-1.23)	(-1.39)
R&D	0.68**	0.81**	0.93***	0.83***	0.44*	0.54**	0.63**	0.53**
	(2.05)	(2.51)	(2.89)	(2.68)	(1.73)	(2.16)	(2.39)	(2.24)
CD * R&D	0.10***	0.11***	0.34***	0.14***	0.06***	0.07***	0.20***	0.08***
	(3.44)	(3.48)	(3.50)	(3.47)	(2.80)	(2.62)	(2.66)	(2.59)
Size	2.44**	2.44**	2.42**	2.43**	0.89**	0.89**	0.88**	0.89**
	(2.41)	(2.41)	(2.40)	(2.41)	(2.20)	(2.20)	(2.18)	(2.19)
Tobin's Q	3.8	3.79	3.49	3.51	1.92	1.86	1.83	1.75
	(1.42)	(1.41)	(1.36)	(1.33)	(0.86)	(0.84)	(0.84)	(0.80)
Leverage	1.23	1.2	1.11	1.19	-0.88	-0.93	-0.94	-0.9
	(0.84)	(0.82)	(0.77)	(0.83)	(-0.48)	(-0.51)	(-0.51)	(-0.50)
Profitability	73.73***	74.78***	77.70***	72.03***	50.67***	52.12***	54.98***	49.71***
	(3.72)	(3.79)	(3.79)	(3.78)	(2.82)	(2.96)	(2.98)	(3.00)
Tangibility	8.78	8.24	7.94	7.73	5.86	5.26	4.96	5.35
	(0.19)	(0.18)	(0.18)	(0.17)	(0.16)	(0.14)	(0.13)	(0.14)
Age	0.46	0.46	0.43	0.45	-0.18	-0.19	-0.19	-0.19
	(1.06)	(1.04)	(1.02)	(1.03)	(-1.05)	(-1.05)	(-1.09)	(-1.07)
Foreign operation	-0.54**	-0.53**	-0.55**	-0.54**	-0.41***	-0.40***	-0.40***	-0.40***
	(-2.41)	(-2.36)	(-2.36)	(-2.32)	(-2.65)	(-2.62)	(-2.68)	(-2.59)
# segments	14.15***	14.17***	14.01***	13.95***	6.52***	6.47***	6.61***	6.41***
	(3.71)	(3.69)	(3.80)	(3.65)	(2.78)	(2.74)	(2.83)	(2.73)
# subsidiaries	-0.15*	-0.15*	-0.16*	-0.16*	-0.07**	-0.07**	-0.07**	-0.07**
	(-1.68)	(-1.72)	(-1.84)	(-1.76)	(-1.97)	(-1.98)	(-2.01)	(-1.97)
Constant	-50.94**	-46.68**	-45.02*	-47.85**	8.89	11.72	12.29	10.66
	(-2.13)	(-2.04)	(-1.95)	(-2.06)	(0.65)	(0.86)	(0.90)	(0.78)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.154	0.157	0.156	0.159	0.098	0.099	0.096	0.102
Observations	1,001	1,001	1,001	1,001	1,001	1,001	1,001	1,001

Appendix I
Cultural shares of subsidiary

Nation	Number of patents	Total percentage	Foreign percentage
United States	32,503	51.05%	--
United Kingdom	4,757	7.47%	15.26%
Germany	2,600	4.08%	8.34%
Canada	2,122	3.33%	6.81%
France	2,119	3.33%	6.80%
Netherlands	1,971	3.10%	6.32%
Mexico	1,331	2.09%	4.27%
Italy	909	1.43%	2.92%
Australia	902	1.42%	2.89%
China	889	1.40%	2.85%
Ireland	801	1.26%	2.57%
Brazil	778	1.22%	2.50%
Spain	752	1.18%	2.41%
Switzerland	742	1.17%	2.38%
Belgium	706	1.11%	2.27%
Japan	700	1.10%	2.25%
Sweden	589	0.93%	1.89%
Singapore	503	0.79%	1.61%
Denmark	437	0.69%	1.40%
Hong Kong	388	0.61%	1.24%
South Africa	337	0.53%	1.08%
Argentina	324	0.51%	1.04%
Malaysia	313	0.49%	1.00%
Norway	307	0.48%	0.99%
Austria	299	0.47%	0.96%
India	287	0.45%	0.92%
South Korea	260	0.41%	0.83%
Portugal	254	0.40%	0.81%
Venezuela	247	0.39%	0.79%
Luxembourg	239	0.38%	0.77%
Thailand	237	0.37%	0.76%
Poland	220	0.35%	0.71%
Finland	200	0.31%	0.64%
Hungary	195	0.31%	0.63%
New Zealand	188	0.30%	0.60%
Czech	186	0.29%	0.60%
Colombia	180	0.28%	0.58%
Chile	176	0.28%	0.56%
Taiwan	168	0.26%	0.54%
Philippines	160	0.25%	0.51%
Russia	134	0.21%	0.43%
Indonesia	130	0.20%	0.42%
Israel	129	0.20%	0.41%
Greece	115	0.18%	0.37%
Panama	108	0.17%	0.35%
Peru	105	0.16%	0.34%
Turkey	101	0.16%	0.32%
Egypt	97	0.15%	0.31%
Guatemala	95	0.15%	0.30%
Uruguay	88	0.14%	0.28%
Nigeria	82	0.13%	0.26%
Puerto Rico	77	0.12%	0.25%
Costa Rica	73	0.11%	0.23%
Ecuador	67	0.11%	0.21%
Romania	66	0.10%	0.21%
Dominican republic	49	0.08%	0.16%

Morocco	47	0.07%	0.15%
Saudi Arabia	47	0.07%	0.15%
Slovakia	46	0.07%	0.15%
Salvador	44	0.07%	0.14%
Ukraine	42	0.07%	0.13%
United Arab Emirates	38	0.06%	0.12%
Cyprus	37	0.06%	0.12%
Honduras	36	0.06%	0.12%
Pakistan	36	0.06%	0.12%
Jamaica	35	0.05%	0.11%
Kenya	34	0.05%	0.11%
Bolivia	27	0.04%	0.09%
Slovenia	26	0.04%	0.08%
Vietnam	23	0.04%	0.07%
Latvia	22	0.03%	0.07%
Zimbabwe	22	0.03%	0.07%
Bulgaria	21	0.03%	0.07%
Trinidad and Tobago	21	0.03%	0.07%
Estonia	20	0.03%	0.06%
Croatia	20	0.03%	0.06%
Namibia	18	0.03%	0.06%
Algeria	17	0.03%	0.05%
Kazakhstan	15	0.02%	0.05%
Lithuania	15	0.02%	0.05%
Malta	13	0.02%	0.04%
Lebanon	12	0.02%	0.04%
Sri Lanka	12	0.02%	0.04%
Tanzania	12	0.02%	0.04%
Bangladesh	11	0.02%	0.04%
Qatar	11	0.02%	0.04%
Cameroon	9	0.01%	0.03%
Angola	8	0.01%	0.03%
Macao	7	0.01%	0.02%
Mozambique	7	0.01%	0.02%
Uganda	7	0.01%	0.02%
Bosnia and Herzegovina	6	0.01%	0.02%
Ghana	6	0.01%	0.02%
Jordan	6	0.01%	0.02%
Moldova	6	0.01%	0.02%
Zambia	6	0.01%	0.02%
Belarus	4	0.01%	0.01%
Iceland	4	0.01%	0.01%
Malawi	4	0.01%	0.01%
Yemen	4	0.01%	0.01%
Fiji	3	0.00%	0.01%
Macedonia	3	0.00%	0.01%
Senegal	3	0.00%	0.01%
Serbia	2	0.00%	0.01%
Suriname	2	0.00%	0.01%
Kuwait	1	0.00%	0.00%
Total	63,670	100.00%	100.00%

Appendix II
Variable Description

Variables	Description	Source
	Innovation	
Patent	The number of patents of a multinational firm.	NBER
Citation	The number of cited patents of a multinational firm.	NBER
	Cultural diversity	
Cultural diversity	The aggregate of cultural distances between parent and subsidiaries from the Euclidean version of the Kogut and Singh's (1988) formula: $Distance_{US,j} = \sqrt{\sum_{k=1}^{K} \frac{(I_{k,j}-I_{k,US})^2}{V_k}}$, where $I_{k,j}$ and $I_{k,US}$are the scores for cultural dimension $k$for country j and the U.S. respectively. The main measure of culture is based on Hofstede's cultural dimensions, including power distance index (PDI), uncertainty avoidance index (UAI), individualism index (IDV), masculinity index (MAS), long-term orientation (LTO), and Indulgence (IND). For robustness test, I also use four alternative measures to capture national culture: Schwartz cultural framework (Schwartz), GLOBE project's value scores (GLOBE), trust from the World Value Survey questions: " Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?" (Trust), and a updated version of Hofstede's scores by (Tang and Koveos, 2008) (TK).	Orbis
Hof _ PDI	Cultural diversity by Hofstede's power distance dimension	Orbis
Hof _ IDV	Cultural diversity by Hofstede's individualism dimension	Orbis
Hof _ MAS	Cultural diversity by Hofstede's masculinity dimension	Orbis
Hof _ UAI	Cultural diversity by Hofstede's uncertainty avoidance dimension	Orbis
Hof _ LTO	Cultural diversity by Hofstede's long-term orientation dimension	Orbis
Hof _ IND	Cultural diversity by Hofstede's indulgence dimension	Orbis
Sch_Harmony	Cultural diversity by Schwartz's harmony dimension	Orbis
Sch_Embeddedness	Cultural diversity by Schwartz's embeddedness dimension	Orbis
Sch_Hierarchy	Cultural diversity by Schwartz's hierarchy dimension	Orbis
Sch_Mastery	Cultural diversity by Schwartz's mastery dimension	Orbis
Sch_Affective autonomy	Cultural diversity by Schwartz's affective autonomy dimension	Orbis
Sch_ Intellectual autonomy	Cultural diversity by Schwartz's intellectual autonomy dimension	Orbis
Sch_Egalitarianism	Cultural diversity by Schwartz's egalitarianism dimension	Orbis
GLOBE_Assertiveness	Cultural diversity by GLOBE's assertiveness dimension	Orbis
GLOBE_InstitutionalCollectivism	Cultural diversity by GLOBE's institutional collectivism dimension	Orbis
GLOBE_InGroupCollectivism	Cultural diversity by GLOBE's in-group collectivism dimension	Orbis
GLOBE_FutureOrientation	Cultural diversity by GLOBE's future orientation dimension	Orbis

GLOBE_GenderEgalitarianism	Cultural diversity by GLOBE's gender egalitarianism dimension	Orbis
GLOBE_HumaneOrientation	Cultural diversity by GLOBE's humane orientation dimension	Orbis
GLOBE_PerformanceOrientation	Cultural diversity by GLOBE's performance orientation dimension	Orbis
GLOBE_PowerDistance	Cultural diversity by GLOBE's power distance dimension	Orbis
GLOBE_UncertaintyAvoidance	Cultural diversity by GLOBE's uncertainty avoidance dimension	Orbis
	Intangible investment	
R&D	The ratio of research and development (R&D) expenses to total sales revenue	Datastream
Intangible invest	The ratio of the change in intangible assets to total assets	Datastream
License	Dummy variable if increase investment in license, otherwise zero.	Datastream
Brand	Dummy variable if increase investment in brand, otherwise zero.	Datastream
Advertising	Dummy variable if increase investment in advertising, otherwise zero.	Datastream
Developing	Dummy variable if increase investment in developing, otherwise zero.	Datastream
	Controls	
Size	The total sales revenue in billion dollar.	Datastream
Tobin's Q	The ratio market value to book value of total assets	Datastream
Leverage	The ratio of total debt to total capital	Datastream
Profitability	The ratio of operating revenue to total sales revenue	Datastream
Tangibility	The ratio of Plant, Property and Equipment (PP&E) to total assets	Datastream
Age	The number of years since Initial Public Offering (IPO)	Orbis
Foreign operation	The ratio of foreign assets to total assets	Datastream
# segments	The number of business segments	Datastream
# subsidiaries	The number of subsidiaries	Orbis

Appendix III
Univariate analysis

This table compares the counts of patents and citations between multinational firms with high and low cultural diversity. Sample firms are split into the high and low cultural diversity subsamples by median. Panel A compares the means of patent and citation counts between the high and low cultural diversity subsamples. Panel B compares the medians of patent and citation counts between the high and low cultural diversity subsamples. The difference in mean is conducted by t-test and the difference in median is conducted by the Wilcoxon rank-sum test. The description of the measures of patent, citation and cultural diversity are given in Appendix,

		Patent		Citation	
Panel A: By mean					
	N	Mean	Std. Err. (t-statistic)	Mean	Std. Err. (t-statistic)
High cultural diversity	831	89.25	9.85	54.23	8.80
Low cultural diversity	829	18.26	3.17	10.99	3.26
High-Low		70.99***	(6.85)	43.24***	(4.61)
Panel B: By median					
	N	Median	Rank sum (z-statistic)	Median	Rank sum (z-statistic)
High cultural diversity	831	14	826939.5	4	795068.5
Low cultural diversity	829	4	551690.5	1	583561.5
High-Low		10***	(14.05)	3***	(11.11)