

## Article

# Cultural diversity and enterprise innovation: A study from the perspective of dialect

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**Abstract:** China has a vast territory. The rich and different regional culture formed over the past 5000 years is an ideal scene for the study of “culture and finance”. This paper uses the number of urban dialects and dialect differentiation index to measure regional cultural diversity, and empirically studies its impact on enterprise innovation. The results show that in areas with more diverse cultures, private high-tech enterprises will obtain more innovative output. After using instrumental variables to solve endogenous problems and excluding the impact of educational development, the conclusion of this paper is still robust. Further research also found that the greater the difference between different dialects in the city where the company is located, the greater the population inflow, the better the inclusiveness and the higher the level of intellectual property protection, the more significant the impact of dialect diversity on innovation. The conclusion of this paper will help the academic community to understand the non institutional reasons behind the unbalanced economic development of Chinese cities from a new perspective, and also provide empirical evidence from non immigrant countries with deep cultural heritage for the current international academic research on “culture and finance”.

**Keywords:** cultural diversity; dialect; enterprise innovation

## 1. Introduction

Innovation is the first driving force to lead development. Implementing the innovation driven development strategy has become a national strategic choice under the new normal of China’s economic development. Innovation is a new combination of existing knowledge and elements, which comes from the interaction of talents, ideas, opinions and experiences of different individuals. Therefore, innovation needs excellent talents and a pluralistic and inclusive ideological atmosphere, and pluralistic thoughts are mainly rooted in pluralistic cultures. The United States is a typical example. As an immigrant country, the United States has absorbed various excellent cultures from all over the world. This multi-cultural melting pot strategy is an important reason to promote American innovation, making its innovation ability leading the world [1].

According to existing theories, culture will affect people’s cognition, communication and interaction [2], and it is a deep-seated force affecting economic growth. The exchange and collision between different cultures may affect the formation of innovative ideas. Creativity should be based on the diversity of skills, ideas and cultures, which will give birth to a loose cultural atmosphere that is easier to accept unconventional ideas that break through the Convention. It will also give birth to a highly competitive social environment. In areas with diverse cultures, people from different backgrounds will communicate more frequently, which is conducive to

the overflow of local knowledge and promote innovation [3,4]. Page [5] pointed out that diverse ideas and understandings can improve the problem-solving ability and prediction ability. Therefore, diverse knowledge and different ways of thinking are very critical to innovation [6,7]. Qian [1] found that cultural diversity has significantly improved the innovation ability of American cities. He pointed out that innovation is not only the result of internal activities of enterprises, but also the result of the comprehensive effect of external factors, and diverse culture is the social driver of innovation and entrepreneurial spirit in American cities.

Although China is not a country of immigration, it has a vast territory. Different places have different natural and geographical conditions, as well as different social development tracks and historical traditions, thus forming a rich and different regional culture. At the same time, the level of social, economic and cultural development in different parts of China is extremely uneven, and there are also great differences in innovation activities, such as Talkhelm et al. [8] and Ruan et al. [9] found that there are obvious differences in innovation levels in different regions of China. Then, compared with Western immigrant countries, as a non-immigrant country, can China's unique regional cultural diversity explain the differences in enterprise innovation activities between different regions in China? Can promoting the exchange and collision of multi regional cultures become the social driving force of enterprise innovation in China? Under the background of "mass entrepreneurship and innovation" as the national development strategy, these problems have attracted more and more attention. Based on this, this paper studies the impact of cultural diversity on enterprise innovation by using the dialect types and dialect differentiation index used by cities all over the country, and using them to represent the cultural diversity of the region.

Compared with previous studies, the contribution of this paper lies in: firstly, this paper expands the scope of culture and innovation research. China has a wide range of regional cultures, which is also a natural and ideal scene for studying diversity. However, so far, the international academic community has studied the economic impact of cultural diversity, only taking immigrant countries as research samples, and few people have involved non immigrant countries. This study makes up for this shortcoming, and provides new evidence from non immigrant countries with profound cultural heritage for investigating the impact of cultural diversity on enterprise innovation behavior. Secondly, this paper strengthens the micro foundation of culture and innovation research. At present, the few literatures on culture and innovation in the world mainly focus on the impact of cultural diversity on the overall economy and innovation level of a region from the macro level. This paper uses the innovation output data of individual enterprises to carry out research from the micro level, so as to provide a more solid micro foundation for exploring the internal relationship between culture and innovation. Thirdly, this paper is the extension and deepening of the research on informal institutions and economic development. From the perspective of cultural diversity, this paper discusses the impact of culture on the innovation activities of enterprises in different cities in China, which helps the academic community to understand the non institutional reasons behind the imbalance of economic development in Chinese cities from a new perspective, and provides a strong empirical basis for the formulation of China's Regional economic development policies and the design of innovation development strategies.

## **2. Theoretical construction and research hypothesis**

### **2.1. Dialects and cultural diversity**

Cultural diversity is a multi-dimensional concept, which is affected by many factors such as language, race, religion and so on. How to accurately measure cultural diversity is a key issue in related research. In the existing literature, different scholars have tried different measurement methods. Such as Ozgen et al. [10] measure cultural diversity by ethnic and national types of residents in a region, and study the contribution of labor diversity to regional innovation. Qian [1] studied the impact of cultural diversity on urban innovation in the United States based on the Birth Nationality data of urban residents as a measure of diversity. Nathan [11] used the ethnic number of residents in a region to represent diversity, and studied the impact of cultural diversity on innovation.

The type of nationality, race or nationality of residents in an area may change greatly in a short time with the change of immigration policy. There are a large number of documents in sociology that discuss the relationship between language and culture. They believe that language has the dual attributes of society and cognition at the same time. Language and culture are an organic whole in which subjects and objects blend with each other and are internally unified. They are a social and cultural phenomenon. Dialect is the carrier of regional culture. Behind each dialect, there are specific cultural patterns and ways of thinking [12]. People who speak different languages also have different behavior patterns [13]. Individuals who grow up in a specific dialect environment will be deeply branded with the imprint of regional culture. Once this cultural imprint is formed, it will exist for life and become a part of individual human capital. Therefore, language is a better proxy indicator of culture, which is more and more adopted in the relevant literature. Xu et al. [14] counted the number of Chinese dialects in cities at prefecture level and above in China, and investigated the impact of dialect diversity on regional economic growth.

### **2.2. Cultural diversity and innovation**

Theoretical modeling and empirical analysis so far show that innovation activities at the enterprise level are often related to enterprise characteristics such as enterprise scale, the availability of enterprise financial resources [15], regional characteristics such as competition among regional banks and institutional factors [16]. Innovation is to a large extent a new combination of existing knowledge. Enterprise innovation is not only the result of internal activities, but also the result of the comprehensive action of external factors.

The diversity of regional knowledge culture is an important part of the external environment for innovation. Culture will affect the cognition, communication and interaction between innovation subjects. The communication and collision between individuals with different cultural backgrounds and ways of thinking may promote the formation of innovative ideas, because innovative ideas and practices largely come from the interaction of different individuals' talents, ideas, opinions and experiences. As for the innovation behavior of enterprises, the regional cultural diversity represented by dialects may affect their innovation behavior through the following

ways:

First, cultural diversity is conducive to the birth of innovative ideas. Individuals with different cultural backgrounds have different ways of thinking. In regions with more cultural types, people have more diverse ways of thinking and solving problems, which increases the probability of people forming innovative ideas. Therefore, diverse knowledge and ways of thinking are crucial to innovation [6,7]. In regions with more diverse cultures, the cultural backgrounds of talents are also diverse, and the talents introduced by the company are more likely to have different cultural backgrounds. For a company's innovation team, diverse cultures and knowledge are more likely to generate new ideas. People from different cultural backgrounds will have different perspectives on problems. Therefore, it is easier to solve problems in the innovation process. Second, regional cultural diversity can enhance regional inclusiveness and attract more creative talents. In areas with more cultures, there will be more cross-cultural exchanges between individuals with different cultural backgrounds, which will enhance people's respect and tolerance for people with different cultural backgrounds. Therefore, the more diverse the culture, the more open and inclusive the ideas are. This atmosphere will attract people with cultural diversity experience and more creative. Third, cultural diversity can promote knowledge spillover and help enterprises acquire the external knowledge needed for innovation. Knowledge spillovers are often local or geographically bounded [17]. In regions with more diverse cultures, people from different backgrounds will communicate more frequently, and labor forces from different cultural backgrounds will flow more among enterprises, which will also promote knowledge and skill spillovers. There are complementary productive capacities among different types of workers [3] to improve labor skills, this provides more opportunities for enterprise innovation and reduces the cost of social innovation.

Based on the above analysis, this paper proposes hypothesis 1a: regional cultural diversity will significantly and positively affect the innovation behavior of regional enterprises, that is, the more dialects in a region, the more innovation output of regional enterprises.

However, on the other hand, the regional cultural diversity represented by dialects may also inhibit the innovative behavior of enterprises through the following ways: first, cultural diversity may bring conflicts between different cultures, which is not conducive to the dissemination of knowledge and technology. The more cultural types there are in a region, the more likely people are to have different knowledge backgrounds. Different cultures usually have different social principles and concepts. People with different cultural backgrounds may find it difficult to recognize other cultural concepts, which may lead to conflicts between different cultures and hinder interpersonal communication. Specific to the enterprise level, cultural diversity will also hinder the communication between employees. Due to differences in cultural concepts and "inter group distance", it is difficult to achieve efficient and rapid dissemination of useful information related to innovation in the region. Second, cultural diversity will increase the possibility of conflict and increase social instability. The more cultural types there are in a region, the greater the differences in people's knowledge backgrounds, and the greater the differences in norms and values, which will increase the possibility of conflict. Therefore, cultural diversity will increase

social instability factors, and then affect the innovation efficiency of enterprises. Third, cultural diversity will increase differences and is not conducive to reaching agreement. The more kinds of culture in a region, the richer people's knowledge background, and the more diverse ways of thinking, the more likely it is to have differences in the face of the same problem. The heterogeneous norms and values of individuals growing up in a specific cultural environment may lead to contradictions, and it will take longer to reach an agreement. Therefore, cultural diversity will increase team differences and reduce cooperation efficiency.

Based on the above analysis, this paper puts forward hypothesis 1b: regional cultural diversity will significantly negatively affect the innovation behavior of regional enterprises, that is, the more the number of dialects in a region, the less the innovation output of regional enterprises.

### **3. Research design**

#### **3.1. Sample selection and data source**

In this paper, a-share companies listed in Shanghai and Shenzhen stock exchanges in 2007 and 2014 are selected as samples for research, and the following screening is carried out: (1) Listed companies excluding ST and \*ST; (2) Exclude listed companies of banking, insurance, diversified finance and other financial institutions; (3) The listed companies in Tibet, ningxia, guangxi, inner Mongolia and Xinjiang are excluded. Finally, 10345 samples were obtained. The enterprise patent data used in this paper are from the State Intellectual Property Office of the people's Republic of China, the dialect diversity data are from the dictionary of Chinese dialects and the atlas of Chinese dialects, the city characteristic data are from the statistical yearbook of Chinese cities, and the company characteristic data are from the CSMAR financial research database.

#### **3.2. Variable description and model design**

##### **1. Dependent variable**

**Innovation:** This paper uses Python program to automatically access the Chinese and multinational patent examination information query on the website of the national patent office, capture relevant information and count the results, and finally obtain the patent application data of listed companies to measure the innovation of enterprises. It should be noted that some subsidiaries of listed companies also have patented inventions. This paper refers to [18], and only the patents applied in the name of listed companies are selected. The patents applied by subsidiaries of listed companies are not included in the number of patents of listed companies. If the patent data of a company is missing, use 0 instead.

##### **2. Independent variable**

The dialect diversity data in this paper comes from the dialect diversity data of cities at prefecture level and above in China, which are collected by Xu et al. [14] (The author thanks Professor Xu Xianxiang of Sun Yat sen University for generously providing dialect diversity data.). This data takes the region as the observation unit. According to the Chinese dialects used by the observation units at or above the county

level reported in the dictionary of Chinese dialects, the types of Chinese dialects used in a certain region are directly calculated, and the number of Chinese sub dialects used in 277 cities at or above the prefecture level (dianum) is obtained. In order to consider the differences among dialect users, Xu et al. [14] calculated the dialect differentiation index (diadiv) of the city according to the exact population using each dialect. The value of diadiv is between 0 and 1. The larger the value, the more diverse the dialect is.

### 3. Control variable

(1) Regional environmental variables: This paper adds important regional characteristic variables that may affect enterprise innovation as control variables. Firstly, considering that different provinces in China have different economic development policies and may have different geographical conditions, we have controlled the fixed effect of provinces; secondly, considering that the traffic convenience may affect the site selection, product type and innovation strategy of the enterprise, this paper also controls the traffic convenience of the prefecture level city where the listed company is located. Measured by the highway mileage per unit area of the city (perroad), the highway mileage per unit area is a panel data. Among them, the data in 2014 is temporarily missing, so the data in 2014 is replaced by the data in 2013; finally, this paper also controls the impact of the local economic development level on enterprise innovation. The economic development level is measured by whether the city where the company is located is the provincial capital city (procap) and the per capita GDP (pergdp) of the city where the company is located.

(2) Company characteristic variables: referring to the literature on enterprise innovation, this paper selects several company characteristic variables related to innovation, including the company's R & D expenditure (R & D), company size (asset), capital structure (Lev), total asset turnover (TAT), profitability (ROA), shareholding ratio of the largest shareholder (Top1), government subsidy (govsub) and firm age, except for the age of the enterprise, other company characteristic variables take the value of the previous period.

(3) Industry and year dummy variables: This paper also adds industry and year dummy variables to control industry and year impact.

Finally, this paper constructs the following model to test the research hypothesis proposed in this paper:

$$Innovation = \beta_0 + \beta_1 Diversity + \beta_2 Controls + \varepsilon \quad (1)$$

Among them, innovation represents the innovation output of enterprises measured by the number of patent applications, diversity represents dianum and diadiv represent the two dialect diversity indexes, and controls are regional characteristics, company characteristics and other control variables. Because some companies have not applied for patents, innovation is set to 0, which leads to the dependent variable in this paper is the “merged data” with 0 as the lower limit. Therefore, this paper uses Tobit model for estimation. In addition, the data are processed as follows in the empirical study: a. The quantiles of the continuous variables below 1% and above 99% in the innovation output variables and control variables are condensed; b. The standard deviation of each coefficient in this model is cluster to the company level.

## 4. Empirical results

### 4.1. Descriptive statistical results

Panel a in **Table 1** gives the descriptive statistical results of the main variables in this paper. Among them, the average value of innovation output is 14.53, the difference between the minimum value and the maximum value is large, and the variance of the variable is also large. The average number of dialects is 1.72. More than half of the cities have two or more dialects. In panel B, we have separately counted the average innovation output level of enterprises in cities with only one dialect, two dialects and more than three dialects. It can be seen that the innovation output of enterprises in cities with only one dialect is the lowest. The innovation output of enterprises in cities with two dialects is significantly higher than that in cities with only one dialect. Among cities with more than three dialects, the innovation output level of enterprises is the highest. Such mean statistical results preliminarily confirm the hypothesis of this paper, that is, the cities with more dialects have more cultural types, so the innovation output of enterprises is also more.

**Table 1.** Descriptive statistical results.

| <b>Panel A</b> |            |        |            |         |       |
|----------------|------------|--------|------------|---------|-------|
| Variable       | Mean       | Min    | Max        | Sd      | Obs   |
| Innovation     | 14.5300    | 0.0000 | 338.0000   | 44.6800 | 10345 |
| Dianum         | 1.7190     | 1.0000 | 4.0000     | 0.7280  | 10345 |
| Diadiv         | 0.2220     | 0.0008 | 0.7780     | 0.1970  | 10345 |
| <b>Panel B</b> |            |        |            |         |       |
| Variable       | Dianum = 1 |        | Dianum = 2 | P value | Obs   |
| Innovation     | 11.3772    |        | 17.8655    | 0.0000  | 8971  |
| Variable       | Dianum = 2 |        | Dianum ≥ 3 | P value | Obs   |
| Innovation     | 17.8655    |        | 20.4432    | 0.0000  | 5883  |

### 4.2. Basic regression results

**Table 2** lists the basic regression results, of which column (1) is the regression result of the impact of the number of dialects on enterprise innovation. Although the estimated result is positive, it has not passed the significance test, indicating that the diversity of dialects has not significantly promoted the innovation output of enterprises. Column (2) is the regression result of the impact of dialect differentiation index on enterprise innovation. The estimated coefficient is positive but not significant, which again shows that cultural diversity has no positive impact on enterprise innovation output. The above results for the total sample do not support the theoretical assumptions of this paper.

**Table 2.** Basic regression results.

|                  | Total sample   |                | Distinguish between invention patent and non invention patent |               |                 |               |
|------------------|----------------|----------------|---------------------------------------------------------------|---------------|-----------------|---------------|
| Variable         | (1) Innovation | (2) Innovation | (3) Inn_inv                                                   | (4) Inn_non   | (5) Inn_inv     | (6) Inn_non   |
| Dianum           | 9.2343 (1.03)  |                | 2.7492** (2.05)                                               | 2.2226 (1.06) |                 |               |
| Diadiv           |                | 395555 (1.15)  |                                                               |               | 6.2043** (2.16) | 1.6965 (0.24) |
| Control variable | Control        | Control        | Control                                                       | Control       | Control         | Control       |
| Pseudo $R^2$     | 0038           | 0038           | 0.081                                                         | 0068          | 0.081           | 0068          |
| N                | 10345          | 10345          | 10345                                                         | 10345         | 10345           | 10345         |

Note: the figures in brackets are the statistical value of T; \*\*\*, \*\*\* and \* are significant at 1%, 5% and 10% significance levels, the same below.

Considering the possible reasons, although the existing research literature on diversity shows that the scale and diversity of knowledge in cities can promote regional innovation, there are different types of innovation. Some processes of enterprises are often learned from other enterprises, which is entirely due to the learning effect and is not completely original. Therefore, dialect diversity may not have a positive impact on innovation such as process improvement. This indicates that it may be considered separately according to the type of patent application. In the previous analysis, this paper also points out that dialect diversity mainly affects the innovation output of enterprises through three mechanisms: diversified knowledge, openness and inclusiveness of ideas, and knowledge spillover, which means that dialect diversity may have a positive impact on such innovations that require creative ideas and breakthroughs in existing technologies.

According to the patent law of the people's Republic of China (hereinafter referred to as the Patent Law), china's patents are divided into three categories, namely, invention patents, utility model patents and design patents. A patent for invention refers to a new technical solution for a product, method or improvement thereof; a patent for utility model means a new technical solution to the shape, structure or combination of the product which is suitable for practical use; a patent for design refers to a new design that is aesthetically pleasing and suitable for industrial application for the shape, pattern or their combination of products and the combination of color, shape and pattern. The patent law stipulates that invention patents need substantive examination system, while utility model patents and design patents do not need substantive examination system, only formal examination system. This also shows that invention patents are the part with the highest technical content in patents, especially creative thinking is needed to break through the existing technology. The diversified knowledge represented by diversified dialects, the openness and inclusiveness of ideas and knowledge spillovers can have a positive impact on creative thinking and creativity, which may promote the breakthrough of more invention patented technologies. Relatively speaking, utility model patents or design patents do not need to make major breakthroughs in the existing technology. In this study, it may be reflected that dialect diversity can not significantly increase the number of non invention patent applications.

Based on the above analysis, according to the division of Chinese patents in the patent law of China, this paper divides the patents applied by enterprises into invention patents (inn\_inv) and non invention patents (inn\_non), and carries out regression



respectively. The estimation results in **Table 2** show that the more diverse the dialects, the more the number of invention patents applied by enterprises, which shows that the diversity of dialects significantly improves the innovation output of enterprises, there is no significant impact on the non invention patents of enterprises.

### 4.3. Discussion by sample

The positive effect of cultural diversity on enterprise innovation has been previously confirmed. Considering that the innovation effect of cultural diversity may vary depending on the nature of property rights and the industry, this part further examines the relationship between cultural diversity and enterprise innovation based on these two factors. It should be noted that since cultural diversity has no significant impact on non invention patents, this part of the study mainly selects the number of invention patent applications to measure the innovation output of enterprises.

#### 1. Discussion based on the nature of property rights

Enterprise innovation needs good incentives, advanced management systems and talents with open thinking and creativity. It also needs to constantly exchange new knowledge with the outside world. The management system of state-owned enterprises is relatively conservative, with distinct levels and emphasis on obedience. In addition, state-owned enterprises are relatively closed, and the mobility of employees is poor, which objectively hinders the knowledge exchange between enterprises and the outside world. Relatively speaking, private enterprises may be more able to attract employees with different cultural backgrounds and open minds. The corporate culture is more active and the communication between employees with different cultural backgrounds is more frequent. In addition, the mobility of employees in private enterprises is large, which can also bring new external knowledge to enterprises. Based on the above analysis, this paper believes that the impact of cultural diversity on innovation may be different due to the nature of enterprise property rights. To confirm the above analysis, this paper divides the samples of state-owned enterprises and private enterprises into regression according to the nature of property rights. **Table 3** gives the relevant estimation results. In the sample of state-owned enterprises, the coefficient estimation results of dianum and diadiv failed to pass the significance test. In the sample of private enterprises, the estimated coefficient is significantly positive, indicating that the promotion of cultural diversity on innovation mainly exists in private enterprises, and the impact on state-owned enterprises is relatively limited.

**Table 3.** Sample regression of state-owned enterprises and private enterprises.

| Variable         | State-owned enterprise |               | Private enterprise |                |
|------------------|------------------------|---------------|--------------------|----------------|
|                  | (1)                    | (2)           | (3)                | (4)            |
| Dianum           | 1.7314 (0.75)          |               | 3.0010* (1.85)     |                |
| Diadiv           |                        | 0.8676 (0.10) |                    | 8.3871* (1.94) |
| Control variable | Control                | Control       | Control            | Control        |
| Pseudo $R^2$     | 0.099                  | 0099          | 0074               | 0074           |
| $N$              | 4448                   | 4448          | 5897               | 5897           |

Note: this part is regression by sample. Column (1) (2) is the sample of 4448 State-owned enterprises, and column (3) (4) is the sample of 5897 Private enterprises.

## 2. Industry based discussion

Sustainable technological innovation capability is a necessary condition for modern companies to survive and develop in a highly changing competitive environment. Therefore, innovation practice is more typical in high-tech industries. With the rapid development of high-tech industry, these enterprises need a large number of innovations ahead of other enterprises to win the market competition. In view of the differences in corporate innovation between high-tech industries and non-high-tech industries, Adhikari and Agrawal [18] conducted a sample study when studying the impact of regional risk preference culture on corporate innovation. Their research found that companies in the high-tech industry have more innovation opportunities, so they need open-minded and creative talents. Relevant enterprises will pay attention to attracting diverse talents. The main feature of the high-tech industry is that in areas with highly intensive technology and knowledge, the more diverse the culture, the more likely the knowledge and technology accumulated within the enterprise will collide with other cultures and ideas and stimulate the generation of innovative ideas. There are many innovation activities in the high-tech industry, so it is inevitable that there will be more innovation attempts. Diversified talents are valued in innovation-oriented enterprises and give full play to their personal talents. In addition, because innovation activities are easy to fail, the cultural atmosphere of high-tech enterprises is relatively active and tolerant, and the corporate culture with risk preference is conducive to these enterprises and their corresponding innovative talents to dare to continue to try. Relatively speaking, non-high-tech industries have less requirements for innovation than high-tech industries, and their demand for innovative talents and ideas is not so urgent. Therefore, the positive effect of diversity culture on the innovation activities of such enterprises is relatively small. Based on this, this paper argues that the impact of cultural diversity on the innovation of high-tech industries and non-high-tech industries may be different.

In order to confirm the above analysis, this paper refers to the measurement method of the literature related to enterprise innovation, and sets the industry classification according to the industry classification in the industry classification guidelines for listed companies issued by the CSRC in 2012, and divides the enterprises into two categories: high-tech industry and non-high-tech industry. In this paper, the enterprises in the electronic industry, pharmaceutical and biological products industry, information technology industry, chemical fiber manufacturing industry, chemical raw materials and chemical products manufacturing industry, instrumentation and cultural and office machinery manufacturing industry are identified as high-tech enterprises, while others are classified as non-high-tech industries. In the samples of non-high-tech industries in **Table 4**, the coefficient estimation results of dianum and diadiv did not pass the significance test, while in the samples of high-tech industries, the estimation coefficient was significantly positive, which was consistent with the expectations of this paper, indicating that cultural diversity significantly promoted the innovation output of enterprises in high-tech industries.

**Table 4.** Sub sample regression of high-tech industry and non-high-tech industry.

| Variable         | Non-high-tech industry |              | High tech industry |               |
|------------------|------------------------|--------------|--------------------|---------------|
|                  | (1)                    | (2)          | (3)                | (4)           |
| Dianum           | 0.2562 (0.07)          |              | 2.8965*** (9.56)   |               |
| Diadiv           |                        | 23307 (0.21) |                    | 7.2587 (5.66) |
| Control variable | Control                | Control      | Control            | Control       |
| Pseudo $R^2$     | 0.175                  | 0.175        | 0040               | 0.040         |
| $N$              | 3462                   | 3462         | 6883               | 6883          |

Note: this part is regression by sample. Column (1) (2) is the sample of 3462 non-high-tech enterprises, and column (3) (4) is the sample of 6883 High-tech enterprises.

#### 4.4. Regression of instrumental variables

This study may be endogenous. Cultural diversity will promote enterprise innovation, and innovative behavior may also promote regional cultural diversity. In the process of innovation, the collision of existing knowledge will form new thinking, new ideas and even new knowledge. Therefore, the positive relationship between cultural diversity and innovation behavior observed in this paper may also be because innovation behavior increases cultural diversity.

In order to overcome the possible endogenous problems, this paper uses the Chinese terrain slope index based on grid scale extracted by Feng et al.[19] as a tool variable to re-examine the impact of cultural diversity on enterprise innovation behavior. The reason why terrain gradient is chosen as a tool variable is that terrain is an important natural condition in a region, and the formation of dialect in history is usually closely related to terrain. Generally speaking, the more complex the terrain is, the greater the slope is, and the more mountains and rivers there are, the more likely this area is to be divided into different relatively closed small areas in history, and the population is also divided accordingly, thus forming a variety of dialects in this area. Accordingly, each dialect area will form a unique local culture ([20]). Therefore, the steeper the terrain gradient in a region, the easier it is to form diverse cultures, that is, the cultural diversity of a region is positively related to its terrain gradient value. However, innovation will not affect the terrain, which is a natural condition. Especially in modern society, with the continuous increase of traffic convenience, the impact of terrain gradient on corporate behavior decisions is becoming smaller and smaller. At the same time, this paper controls the regional control variables such as the level of regional economic development. Therefore, it can be considered that the terrain slope has no direct impact on the innovation behavior of enterprises.

Column (1) and column (4) of **Table 5** give the estimated results of instrumental variables. Among them, columns (1) (2) are the regression results of the first stage. It can be seen that the terrain slope variable Podu is significantly positively correlated with the two dialect diversity indicators, indicating that the terrain slope can be used as a tool variable of cultural diversity. The F statistics of weak instrumental variable test are 182 and 212 respectively, both of which are far greater than 10, which conforms to the empirical rule and rejects the original assumption that there are weak instrumental variables. Column (3) and column (4) are the regression results of the second stage. It can be seen from the table that the regression results of instrumental

variables are still significantly positive, which again confirms the research conclusion of this paper, that is, the diversity of local dialects does promote enterprise innovation. This result shows that after solving the endogenous problem, the conclusion of this paper is still valid, and the research conclusion is robust.

**Table 5.** Regression results of instrumental variables.

| Variable         | (1) Dianum       | (2) Diadiv       | (3) Innovation | (4) Innovation |
|------------------|------------------|------------------|----------------|----------------|
| Dianum           |                  |                  | 1. (1.86)      |                |
| Diadiv           |                  |                  |                | 6.7191* (1.86) |
| Podu             | 0.0682*** (6.15) | 0.0201*** (6.97) |                |                |
| Control variable | Control          | Control          | Control        | Control        |
| Adj/pseudo $R^2$ | 0.526            | 0.424            | 0.225          | 0.224          |
| $N$              | 4463             | 4463             | 4463           | 4463           |

#### 4.5. Excluding the influence of education development level

The level of educational development is a crucial factor to determine the ability of innovation. A good higher education can not only provide intellectual and knowledge support for scientific and technological innovation, but also cultivate a large number of high-quality talents with innovative ability. Since the resumption of the college entrance examination, china's education has made great progress after more than 30 years of development. From a national perspective, the number of dialects in cities in the south is relatively more, the more diverse the culture is, and the economic development level in the south is also significantly higher. A higher level of economic development may promote the development of education. In today's era of knowledge economy, the technological innovation of enterprises depends heavily on the advanced knowledge created by universities, cutting-edge scientific research achievements and high-level talents cultivated by universities. With more and more emphasis on education in various places and the continuous progress of education level, can the diversity of regional culture still play a positive role in the innovation of enterprises?

In order to eliminate the influence of the level of education development, this paper successively adds the variables that reflect the level of regional education development, such as the number of colleges and universities in the city (Colle), the number of colleges and universities per capita (percolle), and the proportion of the number of colleges and universities in the total population (perstu). The results in **Table 6** show that after controlling the impact of education development level, the positive effect of cultural diversity on enterprise innovation is still significant. This also shows that the impact of cultural diversity on the economy is relatively stable and will not change due to the development of education.

**Table 6.** Influence of controlling education development level.

| Variable              | <div>Control the number of colleges and universities</div> <div>Control the number of colleges and universities per capita</div> <div>Control the proportion of college students</div> |                   |                   |                   |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|-------------------|
|                       | (1)                                                                                                                                                                                    | (2)               | (4)               | (5)               |
| Dianum                | 3.0299*** (10.37)                                                                                                                                                                      | 3.0248*** (10.25) | 3.1319*** (10.37) | 3.0318*** (10.04) |
| Colle/percolle/perstu |                                                                                                                                                                                        | 0.4607** (2.54)   | 41.9985*** (4.27) | 0.0025*** (2.88)  |
| Control variable      | Control                                                                                                                                                                                | Control           | Control           | Control           |
| Pseudo $R^2$          | 0.045                                                                                                                                                                                  | 0045              | 0045              | 0.045             |
| $N$                   | 4463                                                                                                                                                                                   | 4442              | 4401              | 4401              |

#### 4.6. Further study

##### 1. Influence of cultural differences

(1) The impact of North-South differences. China has a vast territory and a large north-south boundary. Moreover, with the Yangtze River as the boundary, the north and the South have formed very different local cultures, which provides a natural dividing line for the study of cultural and economic development. To a great extent, the cultural differences between the north and the South can be reflected in the characteristics of dialects. The formation of dialects is naturally related to the natural geographical conditions. In the northern region, there are few rivers and mountains, and the terrain is relatively flat, so the differences between different Northern dialects are smaller. The cultural differences behind different dialects are relatively small. In the south, there are many mountains, rivers, lakes and seas. The terrain fluctuates greatly and changes a lot. There are great differences in the pronunciation of different dialects, often “different sounds within ten miles”. Therefore, although this paper calculates the dialect types of each prefecture level city based on dialect fragments, the pronunciation differences between southern dialect fragments are significantly greater, and the corresponding cultural distance is also greater. If cultural diversity will indeed enhance the innovation output of enterprises, it can be expected that the more different cultures can bring complementary knowledge and ideas, the stronger the knowledge spillover effect, and the communication between the more different cultures is also more conducive to the formation of an inclusive social atmosphere. Based on the above analysis, this paper believes that the positive impact of cultural diversity on enterprise innovation in southern dialect areas should be more obvious than that in northern dialect areas.

To test this view, this paper sets up a new dummy variable south. If the enterprise is located in the south of the Yangtze River, it is taken as 1, otherwise it is taken as 0, and then it is multiplied by the dialect diversity variable and re regressed. The estimated results are given in columns (1) and (2) of **Table 7**. It should be pointed out that the empirical samples after this part are limited to private high-tech enterprises. It can be seen that the estimated coefficients of the two cross multiplication terms are significantly positive, which indicates that in the southern region, dialect diversity can better promote the innovation output of enterprises. This result supports the viewpoint of this paper.

**Table 7.** Impact of cultural differences.

| Variable         | North South difference |                   | Dialect level difference |                  |
|------------------|------------------------|-------------------|--------------------------|------------------|
|                  | (1)                    | (2)               | (3)                      | (4)              |
| Dianum           | 2.6385*** (8.88)       |                   | 1.3957*** (4.37)         |                  |
| Diadiv           | 3.9756*** (2.95)       |                   | 5.0865*** (3.44)         |                  |
| Dia x Sou        | 0.6825* (1.92)         | 10.2064*** (6.51) |                          |                  |
| Dia x ifuni      |                        |                   | 3.0587 (10.84)           | 126704*** (7.76) |
| Control variable | Control                | Control           | Control                  | Control          |
| Pseudo $R^2$     | 0.045                  | 0045              | 0045                     | 0.045            |
| $N$              | 4463                   | 4463              | 4463                     | 4463             |

(2) The influence of dialect level differences. The differences of local dialects are not only between the northern and southern dialects, but also between dialects at different levels. There are obvious differences in grammatical structure and pronunciation between the two dialects; however, if it is between two dialects in the same dialect area, the pronunciation difference is relatively small, and the cultural difference between the two sides is also small. Therefore, when counting the types of regional dialect fragments, it is necessary to consider the above differences, that is, whether the dialect fragments in the region belong to the same dialect region. There are great differences in pronunciation, grammatical structure and culture among dialect fragments belonging to different dialect regions. Among the dialects belonging to the same dialect area, the pronunciation and grammatical structure are relatively similar, and the corresponding cultural differences are small. This difference will affect the complementary effect between dialects [20], and dialects and cultures with large differences are more likely to produce knowledge spillover effect. Based on this, this paper believes that dialect level differences will affect the promotion of cultural diversity on enterprise innovation. If different dialect areas in different regions belong to different dialect areas, the promotion of cultural diversity in the region will be more significant.

In order to verify the above analysis, this paper recalculates the number of dialect areas that each prefecture level city dialect patch belongs to, and sets a dummy variable ifuni. When the number of dialect regions is greater than 1, ifuni is assigned as 1, which means that different dialect fragments in the region span the dialect region. Otherwise, ifuni is assigned as 0, which means that different dialect fragments in the region belong to the same dialect region. Then, ifuni is multiplied by the dialect diversity index to re estimate the model. The estimation results are given in columns (3) and (4) of **Table 7**. The results show that the coefficients of the two cross multiplicative terms are significantly positive at the level of 1%, which indicates that if the dialect of a region crosses the dialect area, the dialect diversity can promote enterprise innovation.

## 2. Impact of regional inclusiveness

The previous theoretical analysis shows that regional cultural diversity can enhance regional inclusiveness and attract more creative talents. Regional inclusiveness is also reflected in other aspects. For example, Mellander and Florida [21] believe that the number of gay people and artists in a region can measure the

inclusiveness of the region. Similarly, art performers are also a relatively unique group. To become an art performer, you need to dare to accept this unique profession, which is related to the acceptance and tolerance of yourself and the surrounding people to special things. Therefore, the more artists there are in a place, the more inclusive the tradition of the region may be. Inclusion will reduce barriers to communication between people, especially people from different cultural backgrounds, and thus create more opportunities for knowledge spillover [1]. Based on this, this paper argues that in more inclusive regions, cultural diversity is more likely to have a positive impact on enterprise innovation.

In order to confirm the above analysis, this paper obtains the number of art performance groups (tola) owned by the unit population in different regions of China from the China Statistical Yearbook database to measure the degree of regional inclusiveness. Then it multiplies with the two cultural diversity indicators and re estimates the model. In order to avoid multiple collinearities, we centralize the regional inclusiveness indicators and cultural diversity indicators. **Table 8** shows that the coefficient estimation results of dialect diversity variable and tola multiplication term are significantly positive, indicating that regional inclusiveness is indeed conducive to the play of dialect diversity.

### 3. Impact of regional population mobility

With the development of China's economy, industrialization and urbanization make population mobility more and more frequent in Chinese society. Population mobility will also be accompanied by cross regional cultural exchanges. In areas with more immigrants, a large number of immigrants may bring a variety of foreign cultures. Areas with a large immigrant population are generally more open and inclusive. The immigrant population will bring talents and knowledge with diverse cultural backgrounds to the region, which is conducive to the formation of innovative ideas. If there are more local cultures and more foreign cultures brought by a large number of immigrants, there will be more frequent exchanges between local and foreign cultures. Based on this, this paper argues that, compared with non immigrant cities, the cultural diversity of immigrant cities may have a more significant impact on enterprise innovation.

This paper tests the above analysis by using the data of inter provincial population mobility in the sixth population census of China. The index of population inflow of each province popu greater than 0 indicates the net inflow of population, and less than 0 indicates the net outflow of population. In order to avoid multicollinearity, this paper centers popu and dialect diversity indicators and multiplies them to re estimate the model. The relevant estimation results are given in column (3) (4) of **Table 8**. The results show that the coefficient estimation results of dianum, diadiv and popu are significantly positive, indicating that population inflow does strengthen the impact of cultural diversity on enterprise innovation.

**Table 8.** Impact of regional inclusiveness, population mobility and intellectual property protection.

| Variable         | Impact of regional inclusiveness |                   | Impact of regional population mobility |                    | Impact of intellectual property protection |                   |
|------------------|----------------------------------|-------------------|----------------------------------------|--------------------|--------------------------------------------|-------------------|
|                  | (1)                              | (2)               | (3)                                    | (4)                | (5)                                        | (6)               |
| Dianum           | 1.6787*** (23.55)                |                   | 2.7276*** (31.44)                      |                    | 2.6819*** (27.51)                          |                   |
| Diadiv           |                                  | 4.1452*** (9.57)  |                                        | 8.9156*** (43.18)  |                                            | 9.6145*** (33.17) |
| Dia ×            |                                  |                   |                                        |                    |                                            |                   |
| Tola/Popu/IPR    | 0.0004*** (54.69)                | 0.0011*** (16.17) | 66.5873*** (9.95)                      | 104.0427*** (3.14) | 0.0114 (1.33)                              | 0.3232*** (8.28)  |
| Tola/Popu/IPR    | 0.0005*** (87.97)                | 0.0005*** (30.35) | 18.6664*** (4.14)                      | 10.1443** (1.96)   | 0.0079* (1.73)                             | 0.0344*** (6.85)  |
| Control variable | Control                          | Control           | Control                                | Control            | Control                                    | Control           |
| Pseudor2         | 0.044                            | 0.043             | 0.041                                  | 0.041              | 0.045                                      | 0.041             |
| N                | 4463                             | 4463              | 4463                                   | 4463               | 4463                                       | 4463              |

4. The impact of local intellectual property protection on R & D investment has externalities, and the private return of R & D investment is often less than the social return. Previous studies have shown theoretically and empirically that intellectual property protection has a significant impact on enterprise innovation activities. If the protection of intellectual property is insufficient, enterprises will lack the motivation for independent research and development. On the contrary, enterprises will have incentives to carry out innovation activities [22,23]. In areas with better intellectual property protection, enterprises dare to innovate, dare to absorb and reserve innovative talents with diverse backgrounds, and lay a foundation for the long-term competitiveness of enterprises. The multicultural environment is conducive to these enterprises attracting a large number of innovative talents and facilitating the acquisition of external knowledge of these enterprises. In areas with weak intellectual property protection, enterprises tend to choose low-cost plagiarism instead of high-cost and high-risk independent innovation. Therefore, the positive effect of multicultural environment on enterprise innovation may be limited.

In order to test the above analysis, this paper introduces the local intellectual property protection strength indicator IPR, which is derived from the intellectual property protection strength data of [24], and then multiplies it with the dialect diversity variable to re estimate the model. The relevant indicators are also centralized. The estimated results are given in columns (5) and (6) of **Table 8**. The results in the table show that in places with better intellectual property protection, dialect diversity can better promote enterprise innovation, which supports the point of this paper.

## 5. Conclusion and enlightenment

The intersection and integration of “culture and finance” is a new hot spot in academic research in recent years. China has a long history and vast territory. Different regions have formed rich and different regional cultures, and often take local dialects as the carrier. It is an ideal scene to study “culture and finance”. Based on the perspective of cultural diversity, this paper uses complex and diverse Chinese dialects to represent culture, and empirically examines the impact of cultural diversity on enterprise innovation. The main conclusions of this paper are as follows:

(1) In the total sample regression, the impact of cultural diversity on innovation



output is not significant. However, after subdividing the patent data into invention patents and non invention patents, it is found that the impact of cultural diversity on non invention patents is not obvious, but it has a significant positive impact on the invention patents of enterprises. (2) According to the nature of enterprise property rights and the industry segmentation samples, it is found that the positive effect of cultural diversity on enterprise innovation mainly exists in private enterprises and high-tech enterprises, while the effect on state-owned enterprises and non-high-tech enterprises is not significant. Moreover, after using instrumental variable regression to solve the possible endogenous problems, and excluding the impact of the level of education development on the results, the conclusion of this paper is still valid. (3) This further study found that compared with the northern dialects, the differences between different southern dialects are greater, so the role of cultural diversity will be more significant. Cultural differences are also reflected in the differences of dialect levels. If the dialect types of a region span a large dialect region, cultural diversity can promote enterprise innovation. In addition, this study also found that in regions with stronger regional inclusiveness, the more diverse cultures can promote enterprise innovation. Population mobility can increase the cultural diversity of the inflow area, thus strengthening the positive impact of cultural diversity on entrepreneurship and innovation. Where intellectual property rights are well protected, dialect diversity can promote enterprise innovation.

From the above conclusions, the Enlightenment of this paper is that China is rich in cultural resources, and the regional culture is complex and has its own characteristics. The exchange and collision of various cultures will promote the formation of innovative ideas. Enterprises need to give full play to the influence of multiculturalism, carry out cross-cultural interaction and knowledge sharing with the external environment, and absorb and reserve talents with multicultural backgrounds, which is very helpful for enterprises to obtain better innovation ability and output. However, to promote innovation through multiculturalism, enterprises need to establish advanced management systems and cultivate an open and inclusive organizational culture, so as to attract innovative talents with active thinking and form effective interaction with the external cultural environment. Giving full play to the influence of multiculturalism requires the cooperation of external institutional environment. Only by establishing a good intellectual property protection system and the excellent conditions provided by rich cultural resources can they better serve the innovation strategy of enterprises, and multicultural resources can become the driving force of national innovation and development.

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