

# Regional Integration, Venture Capital and Firm-based Innovation

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**Abstract:** Venture capital is a source of living water for enterprises' basic innovation. In this paper, we select investment events in East and Central China from 2005-2019, and use the Yangtze River Delta integration as a natural experiment to test the effect of integration policies on the promotion of basic innovation by VCs by applying a multi-period DID model. The study finds that: (1) regional integration enhances the level of basic innovation of VC-intervened firms; (2) regional integration policies shorten the institutional distance between VCs and invested firms' cities, which in turn enhances the promotional effect of venture capital on the basic innovation of firms; (3) under the background of regional integration, the growth of basic innovation of state-owned VC-intervened firms and strategic emerging firms is more significant than that of private VC-intervened firms and traditional firms; (4) the growth of basic innovation of state-owned VC-intervened firms and strategic emerging firms is more significant than that of private VC-intervened firms. emerging firms have faster growth in basic innovation. The findings of the study are of great significance in identifying the extent of the impact of integration development strategy on VC's promotion of enterprises' fundamental innovation, and in targeting the direction of development of China's venture capital, and in promoting the improvement of the innovation capacity of real enterprises.

**Keywords:** Integration policy; Venture capital; Institutional distance; Basic innovation.

## 1. Introduction

China is facing the double pressure of uncertain international environment and outstanding domestic structural contradictions, adhering to the road of independent innovation with Chinese characteristics, implementing the innovation-driven development strategy, and continuously shaping new momentum and new advantages in development are the key links to solve the current problems and promote the long-term and stable growth of the economy. The twentieth report stressed that "adhere to the core position of innovation in the overall situation of China's modernisation and construction,..... oriented to the national strategic needs, to gather forces to carry out original leading scientific and technological research, and resolutely win the battle of the key core technologies". Entity enterprises are the main force of China's original technological development, and consolidating the status of enterprise innovation main body is the key to China's innovation capacity building. Enterprise technological innovation, especially new inventions, new creations as the main content of the basic innovation due to its inherent high-risk, high investment, long cycle and other characteristics of the long-term face of the plight of insufficient resource input. Venture capital, as an important external strategic investor, plays a key role in supporting enterprise innovation and development. Wu, You, and Dong (2022) found that venture capital can enhance fundamental innovation through "value-added and monitoring effects".

Although VC intervention may contribute to the development of firms' basic innovations, previous studies have found that VCs play an important role in the development of firms' basic innovations. However, previous studies have found that VCs prefer local firms in the pre-screening stage (Cumming and Dai, 2010; Zhang Xueyong et al., 2016), resulting in high-quality projects that are difficult to be favoured by VCs and have weaker innovation potential.

The reasons for this are, firstly, the geographical distance between VCs and investee companies is too far, which will increase the degree of information asymmetry between the two parties to the transaction and exacerbate the occurrence of the principal-agent problem (Arthurs and Busenit, 2003; Xu Hong and Zhu Daoli, 2022); and secondly, the systems and norms vary across China, and the tacit knowledge possessed by VCs will be difficult to be successfully transferred (Song Yuanyang, 2015); finally, there is a circle culture in the venture capital industry (Luo Jiade et al., 2014), VCs have denser social networks locally (Qi Yong et al., 2022), and local investment can not only make use of local circles to understand the basic information of the investee, but also make use of the social network relationship to achieve enterprise value-added. In summary, venture capital has local preference behaviour, and there is the phenomenon of "Bole" and "Qianlima" not knowing each other, which leads to the lack of efficiency of enterprise basic innovation. The proposed regional integration strategy aims to promote innovation and sharing across the region, break down administrative barriers, and form an integrated market development system [Outline of the Plan for the Integrated Development of the Yangtze River Delta issued by the State Council of the Central Committee of the Communist Party of China in 2019]. The interconnection of urban infrastructure, interoperability and accessibility of trading markets, and sharing of public resources within the region (Wu Qingshan et al., 2022) is conducive to the reduction of supervisory and transaction costs as well as various uncertainty risks for VCs investing over long distances. Zhao Yuping et al. (2020) found that since the implementation of the integration policy, VC cross-provincial ties have gradually increased and the degree of local preference has been relatively alleviated. It remains to be seen whether the changes in VC investment strategies and regulatory behaviours induced by the integration policy affect the fundamental innovations of firms, and in what way

they act as a transmission mechanism.

Based on this, a multi-period double-difference model is constructed to examine the role played by regional integration between venture capital and enterprise-based innovation using venture capital events in East and Central China from 2005-2019, with the Yangtze River Delta integration event as a quasi-natural experiment. The study finds that, first, under regional integration policies, venture capital has a significant role in promoting enterprise-based innovation. Second, regional integration can reduce the institutional distance between VCs and investee firms, which in turn enhances the promotional effect of venture capital on enterprise-based innovation. Third, the integration effects are different for both the nature of VC equity and the industry characteristics of portfolio companies.

The possible contributions of this paper are: firstly, to analyse the impact of regional integration policies on the promotion of VCs' basic innovation level from both theoretical explanation and empirical analysis, and to provide theoretical and empirical evidence for the development of technological innovation of enterprises in the context of regional integration; secondly, to reveal the impact of regional integration on the promotion of VCs' basic innovation level from the perspective of "institutional distance" in new institutional economics; and secondly, to show that regional integration can reduce the institutional distance between VCs and invested enterprises, and thus enhance the promotion effect of venture capital on basic innovation. Secondly, from the perspective of "institutional distance" in new institutional economics, it reveals that regional integration can reduce the institutional distance between VCs and invested enterprises, and then promote the impact of venture capital on the basic innovation of enterprises; thirdly, it analyses the heterogeneity of the nature of VC equity and the industry characteristics of invested enterprises, and provides ideas for the development of regional integration and the promotion of the construction of a unified national market.

The subsequent parts of this paper are structured as follows: the second part is the literature review and research hypotheses; the third part is the model construction, variable selection and data sources; the fourth part is the empirical analyses; the fifth part is the further analyses; and the last part is the conclusions of the study and policy recommendations.

## 2. Literature Review and Research Hypotheses

### 2.1. Regional Integration, Venture Capital and Basic Innovation of Enterprises

Effective financing support is the key to improve the quality of enterprise innovation. Enterprise financing mainly comes from both internal direct financing and external financing. Due to the inherent characteristics of independent innovation such as long R&D cycle, high R&D investment and high risk of failure, it is difficult for enterprises to support internal funds and obtain external financing, which results in the level of China's enterprises' original innovation being lower than that of developed countries for a long time. Venture capital was initially established to provide funding for startups with development potential, so that the scientific achievements of enterprises can be successfully transformed into productivity, and this type of financing is just right to make up for the financing gap of enterprises [Several Opinions on Promoting the Continuous and Healthy

Development of Venture Capital issued by the State Council in 2016]. However, it has been found that the elevated risks and costs due to information asymmetry make VCs prefer local or proximity investment (Zhang Xueyong et al., 2016). In the existing research on the innovation effect of geographical distance on VCs affecting invested enterprises, there are mainly the following levels: first, based on the information transfer perspective, there is a bilateral screening effect between VCs and enterprises (Fu Hui and Zhou Fangzhao, 2017), and VCs are more inclined to choose high-quality projects to accumulate reputation for their investment undertakings; whereas enterprises are more willing to choose experienced VCs to realise their rapid value-adding, therefore, both parties need to spend energy to conduct due diligence and other activities on each other to eliminate the risks that information asymmetry may bring (Huang Guangfu et al., 2014). Long-distance investment will increase the cost of information collection and communication between the two parties, and information sharing is inefficient, which is not conducive to the conclusion of the deal between the two parties. The second is based on the identity perspective. Some scholars have found that identity among executives affects corporate innovation and development (Pan Yue et al., 2016; Zhang Jie and Wang Wenkai, 2022). China's geography is vast, and there are large cultural differences between different regions, and there are large differences in cultural identity, values, and behavioural preferences between heterogeneous investors and corporate managers (Li Zhen and Li Xingyue, 2021), with lower levels of trust between the two parties, and greater costs of communication and coordination when making corporate decisions (Zhang Jie and Wang Wenkai, 2022). The sense of identity and trust between belonging to the same geographical area makes risky investors may violate the portfolio theory to make local investment (Zhang Xueyong et al. 2016; Cao Chunfang et al. 2018). Third, it is based on the resource transfer perspective. Due to administrative decentralisation, political promotion, local games and other historical reasons in China, the phenomenon of market segmentation has existed for a long time, hindering the cross-regional flow of capital. VCs' off-site investment will be hindered by local protection, which is not conducive to the transfer of human, capital and other innovation factors, resulting in a distortion of VC value-added and regulatory effects. VC and enterprise mismatch or VC regulatory deficiency means that the two sides do not cooperate in the future, while the purpose of VC investment is to obtain the dividends of enterprise innovation value-added to realise the investment income (Dutta and folta, 2016). In order to cope with VC, enterprises will pay more attention to commercial innovations that can be commercialised quickly for profits, neglecting high-risk and high-investment fundamental innovations, and missing good opportunities that can bring long-term value-added capital to enterprises (Wu You and Dong Jing, 2022).

With the development of information technology and transport networks, the "hard information" constraints and transport costs faced by long-distance investment can still be eased, but the institutional distance formed by market segmentation still shackles capital flows. In China, the administrative boundaries formed by the traditional administrative divisions have also led to the existence of institutional distance in various regions of China (Song Yuanyang and Huang Liwei, 2014). In previous studies on venture capital and corporate innovation, scholars have

mostly taken the institutional environment as a moderating variable, arguing that VC investment in regions with a favourable institutional environment is more likely to promote the level of corporate technological innovation (Zhang Chong and Jiao Weiwei, 2022; Li Mengya et al., 2021), and seldom examined whether institutional distance affects the relationship between VC and corporate innovation. Institutional differences can cause unfamiliarity and lack of recognition between the two parties to the transaction, impede the cross-regional flow of venture capital, create a mismatch between VCs and firms, and are not conducive to the enhancement of the level of fundamental innovation of firms. Regional integration policies can help break the administrative boundary effect between cities, break the traditional "vassal economy", promote the Pareto-optimal allocation of resources within the region, form a community of regional coordination, innovation, and development (Liu, Naiquan, and Wu, You, 2017; Yin, Qingmin, and Qi, Shoushuo, 2022), and reduce the institutional distance between cities in the region (Wang, Yu, and Zhang, 2022), as well as the institutional differences between cities in the region (Wang, Yu, and Zhang, 2022). distance (Wang Yu and Zhang Jingxiang, 2022). On the one hand, similar institutional environments can significantly enhance the sense of identity among groups, reduce the alienation and mistrust between VCs and enterprises, and enhance VCs' cross-city and cross-province investments within the region; and it helps VCs to understand the local market environment and legal system construction more quickly, reducing the market risks and information collection costs faced by VCs, thus correcting the mismatch between VCs and enterprises. On the other hand, regional integration means that the resources between cities can be used in the same way. On the other hand, regional integration implies the sharing of resources, free flow of factors, equalisation of public services and integration of market resources among cities, so that VCs can transfer their accumulated industry experience, innovation resources and human capital to startups, thus promoting the improvement of the basic innovation level of enterprises. Therefore, the following hypothesis is proposed:

H1: Regional integration policy can significantly enhance the level of foundational innovation of enterprises with VC intervention.

H2: Regional integration reduces the institutional distance between VCs and invested firms by shrinking the institutional distance between VCs and invested firms, which in turn enhances the foundational innovation of enterprises.

## 2.2. Heterogeneity Analysis of Regional Integration Policy Effects

Due to the nature of VCs' property rights and the different industry characteristics of invested enterprises, there are differences in the regional integration policy effects on venture capital to promote basic innovation of enterprises.

First, the nature of equity of VC institutions is closely related to regional integration policy effects. On the one hand, state-owned VCs have certain public attributes (Faccio M, 2017; Dong Jing et al., 2017) and undertake the mission of promoting local industrial restructuring, scientific and technological innovation, and regional economic development (Huang Guangfu et al. 2014; Yu Yan et al. 2014; Chen Xin et al. 2021). In the context of regional integration policies, state-owned venture capitalists are more likely to follow policy changes to make intra-regional long-distance

investments and reduce local preferences, and previous studies have shown that state-owned venture capitalists' investment decisions are long-term in nature, with a greater focus on the quality of corporate innovation and growth (Chen Xin et al., 2021; Peng Tao et al., 2022). Therefore, the implementation of regional integration policies has led to a better fit between state-owned VCs and firms, which in turn promotes fundamental innovation in firms. In addition, state-owned venture capital has a stronger authentication function, which is not only conducive to the investment and loan linkage effect with state-owned banks, but also due to its strong information advantage can drive private venture capital as well as bank investment, so that enterprises have enough funds for invention and creation. Based on the above analysis, the following hypotheses are proposed:

H3: In the context of regional integration, the intervention of state-owned venture capital is more favourable to the basic innovation of enterprises relative to private venture capital;

Second, the differences in the industry characteristics of invested firms are closely related to regional integration policy effects. First, the innovation activities of strategic emerging enterprises are cutting-edge, groundbreaking, and exploratory (Liu Fengqin and Su Meili, 2022), and at the same time risky and highly invested. These characteristics make VCs face higher information asymmetry as well as agency risk, and the need for information is more obvious (Hellmann and Puri, 2000; Huang et al., 2015), therefore, venture capital has long been suffering from inefficient resource allocation in technology-oriented strategic emerging industries (Zhang Xueyong et al., 2016; Ma Renmin et al., 2022). Second, strategic emerging firms are unable to attract high-quality VC intervention due to their high R&D investment relative to traditional firms that have poorer performance in the start-up period. Some scholars believe that high-tech firms can obtain VC investment by means of innovation signalling (Hoenen et al, 2014), but invention patents with long R&D cycles and difficult R&D are usually used as a proxy variable for innovation signalling, which makes more technology startups unable to transmit information quickly and miss out with high-quality venture capital (Ma Renmin et al, 2022). As a result, strategic emerging firms have a lower chance of obtaining venture capital investment during the start-up period. The regional integration policy allows VCs to obtain information about technology-based enterprises in the region at a lower cost and risk, increasing the probability of technology-based enterprises being selected; in addition, due to the interconnection of resources in the region, VCs are more likely to channel industry experience, manpower, and innovation resources to the invested enterprises to enhance the level of basic innovation in high-tech-based industries. Therefore, the hypothesis is proposed:

H4: Relative to traditional enterprises, VC promotes the basic innovation level of strategic emerging enterprises with venture capital intervention more strongly.

## 3. Model Construction, Variable Selection and Data Sources

### 3.1. Variable Selection

#### 3.1.1. Explained Variables

Fundamental innovation is high-tech, high-quality, high-value-added technological innovation, which is the key for enterprises to enhance their core competitiveness and long-term position in the centre of industry. According to the Patent

Law, the application and authorisation procedure of invention patent is the most complicated and strict with the longest periodicity, and the authorised application of invention patent is the only way to enhance the competitiveness of enterprises and create wealth for them. Therefore, it adopts the number of invention patents authorised by the enterprise in the year plus one to take the logarithm as the measurement index of basic innovation.

### 3.1.2. Core Explanatory Variables

The core problem of this paper is to identify the degree of influence of regional integration policy on the basic innovation of venture capital intervention enterprises, so the core explanatory variable is the integration policy dummy variable (Pol), i.e., whether the VC and the invested enterprise are in the same regional integration planning, with a two-valued dummy variable assignment. If the location of the VC and the city of the invested enterprise are in the same regional integration scope in that year, the value is assigned as 1; otherwise, the value is assigned as 0.

### 3.1.3. Core Explanatory Variables

Considering that the level of basic innovation of enterprises

may also be affected by the enterprise's own factors, the following variables are controlled with reference to Chen Deqiu et al. (2021) and Wen Jun (2018). (1) enterprise size (Size), expressed by the total assets of the enterprise plus one to take the logarithm; (2) age of the enterprise (Age), expressed by the year of the current year minus the year of registration of the enterprise plus one to take the logarithm; (3) the nature of the enterprise (State), whether the enterprise is a state-run enterprise in the current year, and if it is, it takes the value of 1; otherwise, it takes the value of 0; (4) the solvency of the enterprise is chosen as the Quick Ratio (QR), the Cash Flow Ratio (Cashflow); (5) the operating ability of the enterprise is selected as capital intensity (Cap); (6) the profitability of the enterprise is expressed by the profitability of total assets (Roa), return on net assets (Roe); (7) the development ability of the enterprise is expressed by the growth rate of operating profit (Growth); and (8) the level of risk of the enterprise is selected to be measured by the enterprise's financial leverage (Lev), the The description of variables is shown in Table 1.

**Table 1.** Description of major variables

Variable Types	Variable	Symbols	Definition
Explained variable	Basic innovation	Bas_innov	Log(the invention patent of the enterprise+1)
	dummy variable	Pol	Whether VC and the invested enterprise were in the planning scope of the Yangtze River Delta urban agglomeration at the same time
Explanatory variable	Quick ratio	QR	(Current assets - inventory)/ current liabilities
	Financial leverage ratio	Lev	(Net profit + Income tax expense + finance expense)/(Net profit + Income tax expense)
	Return on total assets	Roa	Net profit/average balance of total assets
	Operating profit growth rate	Growth	(Amount of operating profit for the current period of the year - balance of operating profit for the same period of last year)/ Amount of operating profit for the same period of last year
	Nature of enterprise	State	Whether the enterprise is a state-owned enterprise? If yes, the value is 1; otherwise, it is 0
	Enterprise scale	Size	Log( total enterprise assets)
	Enterprise age	Age	Log(Year of the year - year of registration +1)
	Cash flow ratio	Cashflow	Operating cash flow/current liabilities
	Return on equity	Roe	Net profit/average balance of shareholders' equity
	Capital intensity	Cap	Total assets/operating income

## 3.2. Model construction

In 2018, President Xi Jinping announced that the integrated development of the Yangtze River Delta region has been upgraded to a national strategy, and so far the Yangtze River Delta region has developed into a national-level regional pole of increase and become one of the largest and most economically active city clusters. Therefore, taking the Yangtze River Delta urban agglomeration as an example, we study how regional integration affects the promotion of VC on enterprise technological innovation. In the process of YRD integration and development, the ECC, as an important regional coordination and deliberation platform, plays a pivotal role in its economic and social development, therefore, in the research design, the event of the establishment and

expansion of the YRD cities' ECC is taken as the policy point in time.

Among the methods for assessing policy effects, the double-difference method (DID) is one of the most widely used measurement methods, whose basic idea is to regard institutional change and new policy implementation as a "natural experiment" external to the economic system, and to assess the corresponding policy effects. The integration process of the Yangtze River Delta can be regarded as a "quasi-natural experiment". Considering the multiple expansion events, a model (1) is constructed by using the multi-period double-difference method to measure the extent to which the regional integration policy affects the promotion of two types of innovations by venture capital.

$$\text{Bas\_Innov}_{i,t} = \alpha_0 + \alpha_1 \text{Pol}_{i,t} + \sum_k \alpha_k \text{Control}_{i,t,k} + \text{Code}_i + \text{Year}_t + \text{Region}_r + \text{Industry}_j + \varepsilon_{i,t} \quad (\text{Model 1})$$

where, denotes the level of basic innovation development of the  $i$ th enterprise in year  $t$ ; denotes whether the VC and the enterprise are in the same Yangtze River Delta integration plan in that year; denotes the intrinsic characteristics of the enterprise that affect technological innovation;,, denotes individual, year, city, and industry fixed effects, respectively; and denotes other error terms.

### 3.3. Sample selection and data sources

Sample processing is mainly divided into the following steps: first of all, since the domestic VC and PE are not specifically distinguished, the nature of the investment institution is set as VC, PE; in the choice of region, since the venture capital events are mostly gathered in the central and eastern regions, this paper chooses the East China and Central China (including Shandong Province, Henan Province, Hubei Province, Hunan Province, Jiangxi Province, Fujian Province, Shanghai Municipality, Anhui Province, Jiangsu Province, Zhejiang Province, ten provinces) investment events as the research object; in the choice of time interval, considering the availability of data and the time lag of policy implementation, it will focus on the study of the two expansion events in 2010 and 2013, so 2005-2019 is selected as the time window choice. Secondly, in terms of sample processing, drawing on Wu You and Dong Jing (2020) processing, and excluding VCs and investee companies belonging to the sample of related transactions; finally, excluding samples with serious missing financial data, in order to avoid the impact of extreme outliers,

the upper and lower 1% shrinking tails were processed, and a total of 1,870 samples of 372 companies were finally screened out.

Sample data mainly come from the following databases: venture capital events in East and Central China from CV\_Source database; enterprise patent data from CNRDS database, the rest of the enterprise data from CSMAR database, and some of the missing values are supplemented by the RESSET database and by checking the annual reports of the enterprises.

### 3.4. Descriptive Statistics

Table 2 shows the descriptive statistics of the main variables. As can be seen from the table, the average value of enterprise basic innovation (Bas\_innov) is 1.085, indicating that the enterprise basic innovation R&D capability is weak; according to the maximum and minimum values, it can be seen that there are obvious differences in the basic innovation capability of each enterprise. Secondly, the mean value of the policy dummy variable (Pol) is 0.603, indicating that 60% of the samples are affected by regional integration policies in sample selection; the mean value of the nature of the enterprise (State) is 0.1194, with a median value of 0. The data as a whole shows a right-skewed distribution, which also indicates that VCs tend to choose the private enterprises with difficulties in financing but stronger innovation ability when investing. Other than that, most of the data are not abnormal, mostly showing normal distribution characteristics.

**Table 2.** Descriptive statistics of main variables

Variable	N	Mean	SD	Min	p50	Max
Bas_innov	1870	1.0848	1.0656	0.0000	1.0986	4.0943
Pol	1870	0.6032	0.4894	0.0000	1.0000	1.0000
QR	1870	2.5877	2.6747	0.4809	1.6484	16.9306
Lev	1870	0.3402	0.1682	0.0532	0.3223	0.7480
Roa	1870	0.0514	0.0476	-0.1584	0.0504	0.1704
Growth	1870	0.0456	1.6030	-8.9459	0.0918	6.4851
State	1868	0.1194	0.3243	0.0000	0.0000	1.0000
Size	1870	21.5310	0.9086	19.9401	21.4385	24.0141
Age	1870	2.6531	0.3770	1.3863	2.7081	3.4012
Cashflow	1870	0.2261	0.3900	-0.5776	0.1507	1.8173
Roe	1870	0.0858	0.0832	-0.3320	0.0880	0.2897
Cap	1870	2.2333	1.2442	0.5991	1.9629	7.7853

## 4. Empirical Analysis

### 4.1. Parallel trend test

The key premise of the double-difference model is the parallel trend assumption, i.e., the trend of changes in the level of basic innovation of all firms before the implementation of the regional integration policy should be parallel. According to the actual situation of the sample data, the years from 5 years before to 15 years after the implementation of regional integration are set as dummy variables, with 1 period before the implementation of the policy as the base period. The results are shown in Fig. 1, there is no significant difference between the basic innovation level of the experimental group and the treatment group

before the start of the policy, and after 2 years of the policy, the policy effects are all significant at the 1% level and show a gradual upward trend, which indicates that the regional integration policy can significantly contribute to the enhancement effect of VC on the basic innovations of the enterprises, and therefore verifies that Hypothesis 1 is established.

### 4.2. Benchmarking analysis

The above parallel trend graphs have verified the effect of regional integration policies on the level of basic innovation in firms with venture capital intervention. In the following, the multi-period DID model will be used to identify the specific effects of regional integration policies, and the benchmark regression results are shown in Table 3.

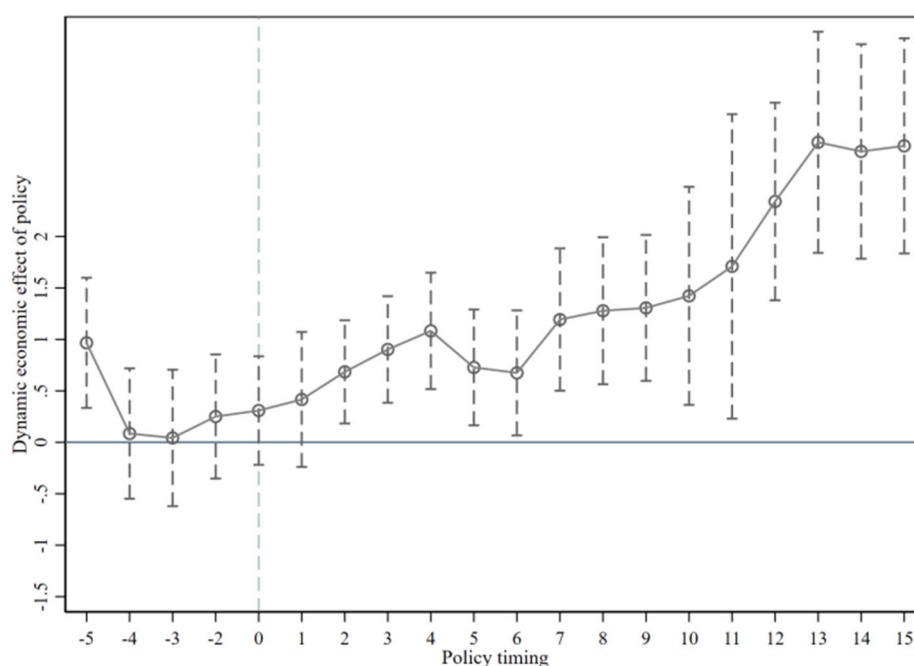


Figure 1. Parallel trend test

Table 3. Benchmark regression results for testing the effects of regional integration policies

	(1) Bas innov	(2) Bas innov
Pol	0.5567*** (2.9360)	0.5156*** (2.8817)
QR		-0.0273 (-1.3990)
Lev		-0.6291** (-2.0419)
Roa		1.4401 (0.7546)
Growth		0.0213 (0.9543)
State		0.2052 (0.9007)
Size		0.2442*** (3.5465)
Age		0.1172 (0.4429)
Cashflow		-0.1441* (-1.9117)
Roe		-1.3744 (-1.3267)
Cap		-0.0698* (-1.6661)
_cons	0.7450*** (6.5244)	-4.3179*** (-2.9590)
fixed effects	Yes	Yes
N	1870	1870
R2 a	0.6303	0.6352

Note: \*, \*\* and \*\*\* represent significant at the 10 per cent, 5 per cent and 1 per cent levels, respectively.

Column (1) in Table 3 shows the model without control variables and column (2) shows the model with control variables to test the extent to which regional integration affects the effect of venture capital on the promotion of basic innovation by firms. As shown in column (1), the coefficient of the double difference term () is 0.5567, and with the addition of control variables (as shown in column (2)), the coefficient is 0.5156, which is also significant at the 1 per cent

level. This suggests that: first, the effect of regional integration policy implementation on the impact of venture capital on the promotion of basic innovation by firms is enhanced by more than 50 per cent; second, after the inclusion of the control variables, the degree of policy impact is reduced and the equation fit is better, indicating that the control variables at the firm level affect the output of basic innovation. Among them, enterprise size (Size) has a positive effect on

enterprise basic innovation; financial leverage (Lev), cash flow ratio (Cashflow), capital intensity (Cap) has a negative impact effect on enterprise basic innovation. In summary, it can be verified that hypothesis 1 is established.

### 4.3. Treatment effect heterogeneity test

DID requires the homogeneity of treatment effects among different groups (Liu Chong et al., 2022; Goodman-Bacon2021), in order to avoid the bias of the results caused by the difference in the point of time of entering the regional integration policy as well as the difference in the length of time of accepting the treatment, we draw on the treatment of

Goodman-Bacon (2021), and decompose the multi-period DID model into two DID models, that is, the 2010 policy experiment group and control group, and 2013 policy experiment group and treatment group, and the test results are shown in Table 4. In each grouping scenario, the regional integration policy can significantly enhance the promotion effect of venture capital on the basic innovation of enterprises, in which the impact effect of the policy implementation in 2013 is smaller than that in 2010, indicating that there is a marginal diminishing effect of the regional integration policy effect.

**Table 4.** Tests for heterogeneity of treatment effects

	full-sample (1) Bas_innov	2010 as a policy point (2) Bas_innov	2013 as a policy point (3) Bas_innov
Pol	0.5156*** (2.8817)		
Pol_2010		2.1481*** (5.1424)	
Pol_2013			0.4644*** (2.7988)
N	1870	828	846
R2_a	0.6352	0.6537	0.6320

### 4.4. Robustness test

#### 4.4.1. Replacement of Explained Variables

Some scholars believe that the time required from enterprise R&D investment to patent grant is uncertain, so drawing on Wu You and Dong Jing (2022), the number of patent applications in the current year of the enterprise as a proxy for enterprise innovation, the number of patent applications for inventions in the current year of the enterprise plus one to take the logarithm of the number of applications as a basic innovation (Bas\_innov1) as a proxy indicator, the test results shown in Table 5, column (1), the test results are basically the same as the baseline. The test results are basically consistent with the baseline regression results.

#### 4.4.2. Excluding samples with investment events in core cities

Developed regions tend to have stronger innovation and entrepreneurship capabilities, a greater concentration of high-quality projects and venture capital institutions, and a higher frequency of investment events, and the degree of local preference of VCs is affected in both directions by the selection advantage brought by the agglomeration of enterprises as well as the competition harshness brought by

the agglomeration of venture capitalists (Wang Xi et al., 2013; Zhang Xueyong et al., 2016), so there is uncertainty in the investment strategies of VCs in core cities relative to other cities. In order to circumvent the error generated by investment events in core cities, this paper will exclude investment events occurring in Shanghai [The Outline of the Plan for the Integrated Development of the Yangtze River Delta Region issued by the State Council in 2019 positions Shanghai as a core city in the Yangtze River Delta region]. The samples are tested for robustness. As shown in Table 5, paragraph (2), the regression results are basically consistent after excluding the sample.

#### 4.4.3. PSM-DID

It is difficult to influence the implementation of the core explanatory variable regional integration policy with firm-based innovation as the explanatory variable, which alleviates the endogeneity problem caused by reverse causality to a certain extent. In addition, this paper will use the PSM-DID model to test whether there is a sample selection problem. Columns (3) of Table 5 report the results of PSM-DID, which are consistent with the benchmark regression results, further indicating the robustness of the results.

**Table 5.** Replacement of Explained Variables, Excluded Sample Robustness Tests and PSM-DID Results

	(1) Bas_innov1	(2) Bas_innov	(3) Bas_innov
pol	0.5387** (2.1618)	0.5416*** (2.9882)	0.5248*** (2.9732)
N	1870	1676	1870
R2_a	0.6827	0.6379	0.6394

#### 4.4.4. Placebo test

##### ① Time placebo test

In order to avoid that the difference in patent output between enterprises in the control group and enterprises in the treatment group is caused by time change. In this paper, the policy time point is advanced by 1 year, 2 years and 4 years, respectively, to construct the false policy time, which is represented by Pol\_false1, Pol\_false2 and Pol\_false4,

respectively, and replace the Pol in model (1) to carry out the regression. The results are shown in Table 7, none of the policy time advance passes the significance test. This indicates that there is no significant difference between the treatment and control group samples in terms of time trends, again demonstrating that regional integration policies can significantly increase the level of basic innovation in firms with venture capital intervention.

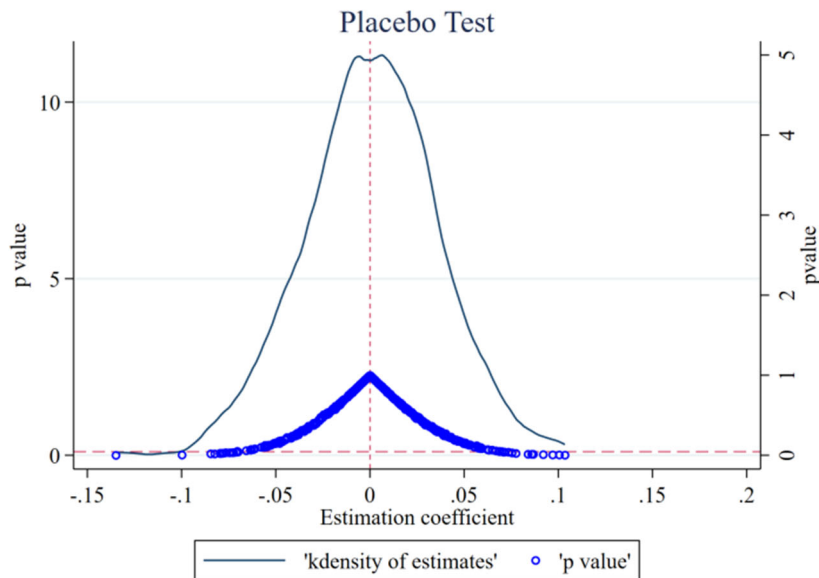
**Table 6.** Time placebo test

	(1) Bas innov	(2) Bas innov	(3) Bas innov
Pol_false1	0.2582 (1.2897)		
Pol_false2		0.0490 (0.2219)	
Pol_false4			-0.3935 (-1.4175)
N	1870	1870	1870
R2 a	0.6332	0.6327	0.6333

##### ② Change the treatment group

By randomly setting the "pseudo" treatment group method to exclude the influence of unpredictable factors on the policy effect, at this time, the policy effect of regional integration should be insignificant, that is, the regression coefficient of the "pseudo" treatment group should be around the zero point. The model was estimated by repeating the stochastic process

500 times, and the kernel density plot in figure 5 shows that the mean of the estimated coefficients for the randomly selected treatment group falls near zero, with a p-value of 0.1 or higher, and the actual estimated coefficient for regional integration is 0.5156, which is in the range of small probability events in the figure below, again demonstrating the robustness of the conclusions of the study.



**Figure 2.** Randomised setting of treatment groups

## 5. Further Analyses

### 5.1. Mechanism examination of regional integration effects

#### 5.1.1. Mechanism test model construction

The above has tested that regional integration policy plays a facilitating role in the basic innovation of VC-intervened enterprises, in order to further test whether it affects the basic innovation of enterprises by shortening the institutional distance between the cities of VCs and invested enterprises and then, with reference to the research methodology of Wen

Zhonglin and Ye Baojuan (2014), we carry out the following mechanism tests.

First, to test whether regional integration policies shrink the institutional distance between the two places of VCs and investee firms. For this purpose, model (2) is developed:

$$ID_{i,t} = \beta_0 + \beta_1 Pol_{i,t} + \sum_n \beta_n Control_{i,t,n} + Year_t + region_r + \zeta_{i,t} \quad (\text{Model2})$$

In model (2), denotes the institutional distance between the two places of VCs and firms, denotes other control variables

that affect the institutional distance, and denotes other disturbance terms. Firstly, the formula for the measurement of institutional distance is, where,  $\alpha_1$  denotes the institutional environment of the city where the enterprise and VC are located, respectively; the measurement of the institutional environment refers to Sun Wenjiu and Gao Yujie (2022), which uses principal component analysis to calculate the institutional environment of each prefecture-level city. Second, the selection of control variables draws on Song Yuanyang (2015) to select the population density (Dpop), disposable income of residents (Consume), social fixed

investment (Invest) and other factors that may affect the institutional distance between the two places in the invested region. The effect of regional integration on the institutional distance between cities is expressed in model (2), and if it is significantly negative, it indicates that regional integration policies can shrink the institutional distance between the two places.

Second, it is tested whether regional integration enhances VC intervention in firms' basic innovations by shrinking the institutional distance between the two places. To this end, model (3) is constructed.

$$\text{Bas\_Innov}_{i,t} = \alpha_0 + \alpha_1 \text{Pol}_{i,t} + \sum_k \alpha_k \text{Control}_{i,t,k} + \text{Code}_i + \text{Year}_t + \text{Region}_t + \text{Industry}_j + \varepsilon_{i,t} \quad (\text{Model3})$$

In model (3) is a random perturbation term, which indicates the degree of mediating effect of institutional distance. If it is significantly negative and the absolute value is less than the absolute value, it indicates that the reduction of institutional distance can play a mediating role in the process of regional integration to promote the intervention of venture capital in the process of enterprise-based innovation, otherwise it indicates that there is no mediating effect.

### 5.1.2. Mechanism test results

The test results of whether institutional distance reduction can enhance the fundamental innovation of venture capital intervention enterprises are shown in Table 8.

Table 8 shows that institutional distance shrinkage can enhance the promotion effect of VCs on firms' fundamental innovations. First, column (1) of Table 8 shows that the

coefficient of regional integration on institutional distance is -0.9592 and is significant at the 1% level, indicating that regional integration can shrink the institutional distance between VCs and investee firms. Second, institutional distance shrinkage enhances the promotion effect of VCs on firms' fundamental innovation. Column (3) shows that the coefficient of the impact of institutional distance on enterprise-based innovation is -0.0868, and the coefficient of the impact of regional integration policy on enterprise-based innovation decreases after adding institutional distance, indicating that regional integration can shrink the institutional distance between VCs and invested firms, which in turn enhances the promotion effect of VCs on enterprise-based innovation. Therefore, the verification of hypothesis 2 is established [The mechanism test is equally passed by sobel method test].

**Table 8.** Mechanism test results of institutional distance

	(1)	(2)	(3)
	Bas_innov	Zhidu	Bas_innov
Pol	0.5156*** (2.8817)	-0.9592*** (-4.4831)	0.4719*** (2.6706)
Zhidu			-0.0868** (-2.3332)
control variables	Con	Con	Con
fixed effects	Yes	Yes	Yes
R2_a	0.6352	0.4600	0.6365

## 5.2. Heterogeneity test of regional integration effect

According to the previous section, due to the nature of the equity of the VC institutions and the characteristics of the invested enterprise industry, the regional integration policy effect are different, the following will test the heterogeneity of the differences respectively.

### 5.2.1. Test the difference in the effect of integration policy on the nature of equity of different VCs

This paper will be the existence of state-owned background of venture capital institutions divided into state-owned VC, the rest is divided into private VC, test the nature of venture capital institutions equity differences on the regional integration policy effect, test results as shown in columns (1) and (2) of Table 9. First, regardless of the nature of equity of VCs is state-owned or private, regional integration policy can enhance the promotion effect of VCs on basic innovation of invested firms, which again confirms that hypothesis 1 holds.

Second, under the regional integration policy, VCs with state-owned background have a greater impact on the fundamental innovation of enterprises. As shown in columns (1) and (2) of Table 9, when the VC is a state-owned institution, the Pol coefficient is 0.9646 and is significant at the 5% level; when the VC is a private institution, the Pol coefficient is 0.5393, which is significant at the 1% level, so the state-owned VC promotes the effect of basic innovation of the enterprise more under the background of regional integration, and verifies that H3 holds.

### 5.2.2. Integration policy on the impact of enterprises in different industries difference test

In this paper, the whole sample is divided into strategic emerging enterprises and traditional enterprises, in which the strategic emerging enterprises are divided according to the National Bureau of Statistics issued the "Strategic Emerging Industries Catalogue (2018)", query whether the main business of the enterprise is included in the catalogue, if it exists, then it is divided into strategic emerging enterprises,

otherwise it is a traditional enterprise, to test whether differences in the characteristics of the industry of the enterprise affects the effect of the regional integration policy, and the test results are As shown in columns (3) and (4) of Table (9). In the context of regional integration, the role of venture capital in enhancing the fundamental innovation of strategic emerging firms is more obvious. From columns (3) and (4) of Table 9, the integration policy effect () of strategic

emerging enterprises and traditional enterprises is 0.9437 and 0.4056, respectively, with a large gap between the policy effects of the two, and they are both significant at the 1% level, indicating that, relative to the traditional enterprises, regional integration can significantly improve the mismatch between strategic emerging enterprises and venture capital, which in turn promotes the development of their foundational innovation. In summary, hypothesis H4 is verified.

**Table 9.** Heterogeneity test results

	State-owned VC	Private VC	Strategic emerging enterprise	Traditional enterprise
	(1)	(2)	(3)	(4)
	Bas innov	Bas innov	Bas innov	Bas innov
Pol	0.9646**	0.5393***	0.9437***	0.4056***
	(2.5221)	(3.0831)	(2.7562)	(2.4065)
N	746	1124	610	1260
R2_a	0.6093	0.6736	0.6067	0.6579

## 6. Research Conclusions and Policy Recommendations

Venture capital is an important external financing channel for technological innovation of enterprises in China, but due to the administrative boundary effect and the institutional distance formed by local protectionism, which leads to the existence of obvious local preference of risk institutions, there is a long-term mismatch in the venture capital market, and the original innovation of enterprises is weak. This paper takes the enterprises receiving venture capital in East and Central China from 2005 to 2019 as the research object, and sets the Yangtze River Delta integration process as a "quasi-natural experiment" to test whether the regional integration policy affects the effect of venture capital intervention on enterprises' basic innovation. The study finds that: firstly, regional integration policy can enhance the promotion effect of VC on basic innovation of enterprises; secondly, the implementation of integration policy can shorten the institutional distance between cities in the region, alleviate the agency risk, market risk and execution risk caused by the information asymmetry between VCs and invested enterprises, and then promote basic innovation of enterprises; thirdly, the effect of integration policy is affected by the nature of the equity of VC institutions and the industry characteristics of invested enterprises; thirdly, the effect of integration policy is influenced by the nature of the equity of VC institutions and the industry characteristics of invested enterprises. Thirdly, the integration policy effect is affected by the nature of the equity of the VC and the industry characteristics of the invested enterprise: when the VC has a state-funded background, the invested enterprise is a strategic emerging enterprise, and the city in which the enterprise is located is a peripheral area, the regional integration policy effect is more prominent; when the VC is a private institution, the invested enterprise is in a traditional industry, and the city in which the enterprise is located is a central city, the integration policy effect is relatively low.

Based on the above conclusions, the following policy recommendations are put forward: first, deeply implement the strategy of coordinated regional development, break down local protectionism, market segmentation and administrative barriers among cities, promote the flow of information, capital, technology and other innovation factors in a wider

scope, gradually promote the construction of a national unified market with fair competition and full openness, and create a good institutional environment for the inter-regional flow of venture capital; give play to the role of radiation-driven role of core cities, and play an important role in upgrading the economic efficiency of VCs. Second, encourage state-owned capital to enter the venture capital market. Secondly, encourage state-owned capital to enter the venture capital market, give full play to the extensive social network and information advantages of state-owned capital, invest more state-owned assets in high-quality projects, alleviate the difficulties of financing constraints of small and medium-sized enterprises and start-up science and technology enterprises, and inject living water into their scientific and technological innovations; moreover, give full play to the "corrective effect" of the government's guiding fund to drive social capital to follow up and invest in start-ups. In addition, the government's guidance fund will have a "corrective effect", leading social capital to follow up and invest in start-ups and high-tech enterprises, alleviating the current situation of investment market failure, and realising capital elements to better serve the development of innovation quality of real enterprises. Thirdly, accelerate the construction of various credit information sharing platforms, encourage the collection and sharing of various types of enterprise-related credit information by multiple subjects and in multiple ways, and continuously improve the accuracy, completeness and timeliness of the information; deepen the application of big data, and establish and improve the credit evaluation index system for startups to break the "data barriers" and "information silos". Deepen the application of big data, establish and improve the credit evaluation index system for startups, break down "data barriers" and "information islands", alleviate the information asymmetry between venture capital and startups, promote venture capital institutions to go out of their home, improve the suitability of venture capital and startups, and promote the quality of technological innovation and efficiency of enterprises.

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