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Research Article

Effects of Economic Policy Uncertainty on the Investment Behavior of Venture Capital Institutions: Evidence from China

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Venture capital (VC) has played an important financial supplementary role in the development of high-tech enterprises. With the intensification of economic policy uncertainty, VC investment behavior has been affected to a certain extent. Under the framework of the impact of economic policy uncertainty (EPU) on general corporate investment behavior, this article examines the impact of EPU on the investment behavior of VC institutions from four aspects, namely, investment quantity, investment phase, investment industry, and investment region. The study finds that in China, EPU has a good news effect, and its intensification can boost the investment quantity of VC institutions and stimulate institutions to choose more specialized investment strategies in terms of investment phase, investment industry, and investment region. The impact of EPU on the investment behavior of VC institutions changes with the investment state of the institutions. The larger the investment quantity of the VC institutions, the greater the promotion effect. VC institutions with a higher degree of investment concentration will pay more attention to specialized investment strategies.

1. Introduction

China's economy is at an important turning point from high-speed development to high-quality development. In terms of the development mode, structure optimization, and power transformation, China is facing difficult tasks. As the most important driving force for economic growth, enterprises have received continuous concern and attention from academia. As one of the main sources of the enterprise growth chain, venture capital (VC) institutions have always been known as industrial incubators. Since their establishment, they have provided important growth conditions for enterprises abandoned by traditional financial institutions [1]. Until now, at least 50% of small and medium-sized high-tech enterprises in the United States have completed the achievement of transformation with support from VC investment. With the continuous improvement of the macro environment and the continuous growth of entrepreneurship and innovation opportunities, China's VC investment has also entered a golden period of development. The reasons can be summarized into two points. First, at the institutional level, VC investment is considered to be the most suitable financing channel for the development of high-tech industries [2]. Against the background of supply-side structural reform, VC investment has received strong support from the country. For early-stage high-tech enterprises especially, the driving force of VC investment cannot be underestimated. In recent years, with the help of VC investment, well-known Chinese enterprises such as Alibaba, JD.com, and Meituan have become giants. Second, once successfully withdrawn from the invested enterprise, the VC institution can obtain huge returns, which attract a large amount of capital investment. Especially since the development of mature overseas funds such as Intel Capital, IDG Venture Capital, and Walden Fund, a large number of outstanding VC institutions such as Shenzhen Venture Capital, Sequoia China, and Golden Sand Venture Capital has emerged in China. In 2018, nearly 10,000 VC investment events took place in China, involving an amount of US$70.5 billion, which put China in a leading position in the world in this regard.

To maintain the health and momentum of the follow-up development of China's VC investment, we must have a deep understanding of various risks and opportunities that

VC institutions may face. VC institutions are usually affected by four factors: technology, operations, markets, and policy [3]. As a socialist country, China's macroeconomic policy not only directly guides the decision-making of various economic entities but also determines the behavior environment of various entities, so it is the most influential factor in the VC market [4]. At present, China is in a stage of economic transformation and economic policies show obvious uncertainty [5]. The government faces uncertainties in facing the new environment, applying new thoughts, and making new decisions. Economic entities also face uncertainties in understanding new policies, learning new directions, and adapting to the new environment [6]. The introduction of the examination system and the approval system, the IPO suspension due to policy adjustments, and the restrictions on investment industries and fields have constantly overturned the original decision and disrupted the original plan. With the deepening of economic transformation, economic policy uncertainty (EPU) has generated unprecedented decision-making challenges for China's VC entities in terms of operations, markets, and policy [7].

As important investment entities in the financial market, VC institutions have business priorities, operational modes, and organizational characteristics different from those of general enterprises. For general enterprises, the impact of EPU on investment decisions is mainly reflected in reducing the quantity of investments [8], increasing innovation investments [9], upgrading service investments [10], and other behaviors. For VC institutions, this impact is mainly reflected in three classic investment behaviors: the investment phase, investment industry, and investment region [11, 12]. Therefore, the connotation of the investment behavior of VC institutions, the impact of EPU on the investment behavior of VC institutions, and the changes of the impact under different conditions become the main research questions of this study. Using the EPU index compiled by Steven et al., this article attempts to establish a two-way fixed effects model to verify the impact of EPU on the investment behavior of VC institutions. On this basis, this article further uses the quantile regression model to examine the changes in the impact of EPU on the investment behavior of VC institutions at different investment behavior levels. The results show that EPU is both a challenge and an opportunity for VC institutions, and these two characteristics change with the investment state of VC institutions. The key contributions of this study are summarized as follows:

(i) This study does not focus on the gains and losses of a single economic policy in terms of describing the macro investment environment but takes the EPU index as a representative, explores the overall impact of macroeconomic policies on VC institutions, and enriches the research on the impact of the macro investment environment on the investment behavior of micro entities.

(ii) In terms of summarizing the investment behavior of VC institutions, this study considers both the similarities and the differences between VC institutions and general enterprises, adds the variable of investment quantity, and summarizes the investment behavior of VC institutions from a four-dimensional perspective, which broadens the idea for further in-depth studies.

(iii) This study abandons the preference for the impact on VC investment performance and examines the impact of EPU on the upstream performance from the perspective of the investment behavior of VC institutions. Through longitudinal analysis under different levels of investment behavior, this study also finds that the impact of EPU on the investment behavior of VC institutions changes with the investment state of institutions and broadens the research on the interaction between EPU and the investment behavior of VC institutions.

2. Literature Review and Research Hypotheses

Since the concept of EPU emerged in the 1980s, its impact on investment at the macro and micro levels has always been a hot topic in academic and practical fields. However, macro studies mostly regard investment as one of the channels, through which EPU affects the final economic growth, and argue that EPU can cause a decline in the overall economic growth of a country by inhibiting investment [13, 14]. Micro studies mostly regard general enterprises as the research subject and explore the impact on the corporate cash holding strategy [15], investment structure strategy [16], board network strategy [17], and other investment behaviors from the perspectives of influence direction [18] and influence channel [19]. Currently, few studies link EPU with VC institutions. Therefore, considering that VC institutions are a special kind of enterprise, their investment behaviors have certain commonalities with general enterprises [20]. This article mainly uses the three mainstream theories for general corporate investment: the option theory, financial friction theory, and information asymmetry theory, to propose the hypotheses about the impact of EPU on VC institutions.

From the perspective of options, investment can be either real options or call options, and the impact of EPU on investment is not uniform. On the one hand, the waiting option theory, supported by Bernanke, McDonald and Siegel, and Gulen and Ion, emphasizes the bad news effect of EPU, arguing that investment is a real option on future cash flows [8, 21, 22]. For this theory, the core assumption is that investment is frictional and contains all kinds of imperceptible adjustment costs, the most important of which is the irreversibility of investment. Investment irreversibility means that the firm cannot sell the equipment at a price equal to or higher than the initial investment to recover the capital. This can be caused either by the lack of the secondary trading market or by the information asymmetry between buyers and sellers in secondary transactions. What is clear is that the degree of irreversibility varies across capital products. Generally, the more specialized the investment product, the higher the degree of investment irreversibility [23]. When the degree of irreversibility in venture capital is high, the institution can obtain the value of the waiting

option by waiting. Thus, by increasing investment frictions, EPU raises the marginal cost of investment, which increases the value of options [24]. The increase in the value of the option in turn prompts the institution to wait for a more suitable time to invest subsequently, which ultimately results in an investment deceleration effect [18, 25]. Pindyck demonstrates this with a theoretical model and concludes that it is the cost associated with adjustment that is the key to investment being affected by EPU [26]. Dixit and Pindyck further confirm the suitability of real options theory to reality by comparing net present value theory with real options theory [27].

On the other hand, the growth option effect, supported by scholars such as Myers, Bloom, and Segal et al., mainly emphasizes the good news effect of EPU [28–30]. In this theory, the overall value of the firm includes both the current value of assets and the contingent value given by investment opportunities. The investment opportunity is a call option [28], which is held by the firm itself. Under asymmetric benefit and cost mechanisms, EPU has the opportunity to drive upward the value of call options. Specifically, the cost of a firm's investment generally fluctuates only slightly in response to EPU, but the value of the potential return on investment can fluctuate significantly in response to EPU. As a result, firms would seize every opportunity to invest more in order to capture the market by making small costs [29]. Especially in a competitive environment, firms can only expand their market dominance by continuously investing, when EPU enhances the possibility of firms to capture the market through investment and increases the value of call options [31]. In addition, when investment is not completely irreversible, institutions are able to adjust the scale of investment in response to changes in the environment, and institutional managers are more likely to view investment opportunities as call options with limited losses and unlimited gains [30]. Although in the short run, the assumption of investment reversibility goes against reality to a certain extent [26], in the long run, institutions are indeed able to make decisions to a greater extent in response to changes in market information [29]. Therefore, the positive impact of EPU on investment always has its realistic rationality in either direction.

From the perspective of financial friction, VC investment can be reduced due to the financing obstacles caused by EPU. It is because there are frictions in the financial market that EPU can amplify the cost of financing. If there were no frictions in the financing market, the impact of corporate financing costs on investment decisions would be greatly diminished, when EPU is unable to exploit financing costs, significantly reducing the disincentive to invest [32]. In fact, however, frictions are ubiquitous [33]. In real markets, firms are tied to a variety of financing problems and even have to pay much higher external funding than their internal costs [34]. Especially in an environment of EPU, firms have to face increased financing costs, whether they finance internally or externally. For internal financing, as stated in the precautionary motivation theory supported by Carroll and Samwick [35], the risk represented by EPU can force enterprises to give up part of their investments to ensure internal cash flow [15, 36]. For external financing, as stated in the risk premium theory of Gilchrist et al. [32], when the capital investors of investment institutions perceive the potential risks from EPU, their expected returns increase as uncertainty rises, thereby increasing the financial burden on VC institutions [37]. Therefore, financial friction constrains the free capital of enterprises, and based on the option theory, it amplifies the inhibiting effect of EPU on VC investment.

From the perspective of information asymmetry, EPU has a positive effect on the level of VC investment. The main players in VC can be divided into three parties: individual investors, venture capitalists, and startup entrepreneurs. According to principal-agent theory, venture capitalists take advantage of the asymmetric information environment to establish a two-tier principal-agent relationship between startups and individual investors [38]. In an asymmetric information environment, where EPU increases information bias among agents, startups tend to change key information to amplify expected returns [39]. When expected returns increase, venture capitalists are more likely to focus on the potential opportunities and profits from uncertainty and less on the underlying risks and losses, thus magnifying risk-seeking characteristics [40–42]. Moreover, EPU implies increased policy ambiguity for venture capitalists, which leads to an increase in investors' investment sensitivity, relying more on their own technical judgment than on following the policy pace. Investors are more likely to notice investment details that they would not have noticed if the policy was clear, and thus they are able to increase investment efficiency [43]. In addition, although information asymmetry can also lead to insufficient information about investments in the market, which makes it difficult for venture capitalists to grasp the current investments [23], VCs are usually able to compensate for this through co-investment strategies. As evidenced by Ter Wal et al., the less experience VCs have accumulated in a particular field, the more likely they are to make co-investments [44].

Based on the above three perspectives, this article proposes a pair of competing hypotheses:

> *H1a*. EPU has an inhibiting effect on the investment quantity of venture capital institutions. In other words, EPU has a bad news effect and increases financial friction, thereby inhibiting the investment quantity of venture capital.
>
> *H1b*. EPU has the effect of promoting the investment quantity of venture capital institutions. In other words, EPU has a good news effect and blurs the situation of information asymmetry, thereby stimulating the investment quantity of venture capital.

In addition to the commonalities, there are many differences between VC institutions and general enterprises, which lead to the unique investment strategies of VC institutions. In general, the investment strategies of VC institutions can be divided into specialization strategies and diversification strategies, and the differences between the two are mainly reflected in three aspects: the investment

phase, investment industry, and investment region [11]. Specialized strategy means that investment institutions make centralized treatment in the project intervention stage, investment industry, and investment area. Diversified investment strategy means that investment institutions make decentralized treatment in the project intervention stage, investment industry, and investment region. According to the characteristics of these two strategies, we can analyze them from two perspectives such as risk and opportunity, and the benefits and costs of information.

From the perspective of risk and opportunity, EPU may be viewed as either a risk, which leads VCs to choose specialized investment strategies, or as an opportunity, which leads them to choose diversified investment strategies. When EPU is regarded as a risk, VCs tend to think about survival, i.e., how to use their limited resources to control their exposure to risky shocks. Generally, the specialization strategy implies that the VCs have a considerable degree of professional understanding and experience in the existing investment stage, industry, and region. Therefore, the use of specialized strategies can help VCs reduce the cost of information collection, decision-making, and behavior and maximize the integration of resources, so as to achieve the purpose of avoiding risks [45, 46]. When EPU is seen as an opportunity, VCs usually tend to consider the expansion problem, i.e., how to seize the opportunity to compete for the market when the situation is uncertain. In general, diversification strategy implies that VCs need to proactively reach out to unexplored investment stages, industries, and regional projects based on their original investment areas. Therefore, the use of diversification strategy can guide VCs to form their own resource networks in multiple investment stages, investment industries, and investment regions, so as to achieve resource sharing and even provide certain synergistic effects, laying the foundation for VCs' expansion [47, 48].

From the perspective of benefits and costs of information, the question about whether EPU leads VCs to choose diversification or specialization strategies is also unclear. On the one hand, when a VC is in an environment of high EPU, it may adopt a diversified investment strategy out of the idea of information sharing. Diversification strategy can drive VCs to reach information outside the original investment circle, thus creating a sharing effect between the new information and the original information, bringing more social interaction, connection, and value to the VCs, and mitigating some of the negative effects of information asymmetry [48, 49]. On the other hand, in an environment of EPU, information is a critical factor in seizing market opportunities, and VCs, realizing the importance of reducing the time and material investment required to collect information, may focus more on leveraging their own information advantages in the original investment stage, investment industry, and investment region. This will reduce the exploration of new fields and the possibility of investment failure [50, 51]. Based on the above, this study proposes the following hypotheses:

H2a. EPU can guide venture capital institutions to use specialized investment strategies in terms of investment phase, industry, and region.

H2b. EPU can guide venture capital institutions to use diversified investment strategies in terms of investment phase, industry, and region.

3. Model Setting and Data Description

3.1. Variable Selection

3.1.1. Measurement of EPU. This article uses a mainland newspaper-based index compiled by Steven et al. to measure China's EPU. This index is based on the compilation method of the BBD index [13] and uses two newspapers in mainland China, *People's Daily* and *Guangming Daily*, to quantify concepts related to uncertainty in China since October 1949. To better match the sample data, this article standardized the EPU data and used the weighted geometric mean to convert the monthly data of China's EPU index into the annual EPU index [52], that is

$$\mathrm{EPU}_t = \sqrt[12]{\mathrm{MEPU}_{t1} \times \mathrm{MEPU}_{t2} \times \ldots \times \mathrm{MEPU}_{t12}}, \quad (1)$$

where EPU is the annual EPU index and MEPU is the monthly EPU index of the corresponding year.

3.1.2. Investment Behavior of Venture Capital Institutions. Considering the homogeneity of VC institutions and general enterprises, this study regards investment quantity, which is the most intuitive investment behavior of general enterprises, as one of the most intuitive and main investment behaviors of VC institutions. Specifically, this study uses the total investment amount of VC institutions in the observation year to measure the investment quantity of VC institutions [8].

Considering the differences between VC institutions and general enterprises, after Gupta and Sapienza studied the investment phase, investment industry, and investment region as the main VC strategy [11], this study also conducts research on the behavior of VC investment on this basis. Specifically, this study uses the HHI (Herfindahl–Hirschman index) to describe the investment situation of VC institutions in various phases, industries, and regions. The HHI is a representative indicator reflecting the degree of concentration and can measure the investment concentration degree of VC institutions in various investment phases, investment industries, and investment regions:

$$HHI_a = \sum \left(\frac{\text{Number of } a \text{ events for investement class } i}{\text{Total number of investement events}} \right)^2, \quad (2)$$

where the phases of enterprise development are divided into the seed stage, startup stage, expansion stage, and maturity stage. The industrial classification refers to the industrial classification for national economic activities, and the regional classification refers to the first-level administrative divisions.

3.1.3. Control Variables. In order to control the factors that affect the investment behavior and try to avoid the deviation caused by omitted variables, this study adds some control

Table 1: Variable names and meanings.

Type of variable	Variable name	Variable description
Explained variable	Investment quantity (quantity)	The logarithm of the total investment expenditure of the venture capital institution in observation year
	Investment phase (phase)	HHI of the investment phase of the venture capital institution in observation year
	Investment industry (industry)	HHI of the investment industry of the venture capital institution in observation year
	Investment region (region)	HHI of the investment region of the venture capital institution in observation year
Explanatory variable	Economic policy uncertainty (EPU)	Annualized 12-month economic policy uncertainty index
Control variable	Micro control variable	
	Location of fund (LOC)	LOC is 1 if the location of the fund is domestic, and 0 otherwise
	Institution age (AGE)	Years of the establishment of the venture capital institution by the sample observation year
	Cumulative number of investment events (INV)	Number of investments, in which the venture capital institution participated before the sample observation year
	Number of successful IPO (IPO)	Number of successful IPO withdrawals of the venture capital institution before the sample observation year
	Size of venture capital institution (SIZE)	The natural logarithm of the average value of funds managed by venture capital investment during the sample period
	Macro control variable	
	Economic growth rate (GDP)	GDP year-on-year growth rate in the sample observation year
	Index of consumer sentiment (ICS)	Index of consumer sentiment in the sample observation year
	Stock returns (STOCK)	The average growth rate of the Shanghai and Shenzhen composite indices, multiplied by 100
	Market issuance (MARKET)	Number of domestic A-share newly listed companies in the sample observation year
	Global policy uncertainty (GPU)	Annualized 12-month global policy uncertainty index

variables when analyzing the investment behavior of venture capital institutions. Drawing on relevant studies by Kaplan and Schoar and Lutz et al., the control variables used in this study include both individual characteristics of VCs and the characteristics of the macro environment (Table 1) [53, 54].

The individual characteristics of VCs are used to describe the investment status of individual institutions. In this study, we use the nature of ownership (LOC), the age of the institution (AGE), and the scale of venture capital institutions (SIZE) to measure the institutional attributes of venture capital institutions, and the cumulative number of investment events (INV) and investment success (IPO) to measure the investment experience of venture capital institutions.

The macro-environmental characteristics are used to describe the investment background of venture capital institutions. This study uses economic growth rate (GDP) and consumer confidence index (ICS) to measure the overall domestic macro background, stock returns (STOCK), and market issuance (MARKET) to measure the sentiment of the domestic investment market, and global uncertainty (GPU) to measure the investment pressure brought by the international environment.

3.2. Model Construction. Based on the characteristics of unbalanced panel data in this article, considering that VC institutions are affected by unobservable individual differences and the macro environment when making decisions, this study constructs the following two-way fixed effect model to verify the above hypotheses:

$$Y_{\mathrm{it}}^{n} = \beta_0 + \beta_1 \mathrm{EPU}_{\mathrm{it}} + \sum_{m=2}^{10} \beta_m \mathrm{CONTROL}_{m,\mathrm{it}} + \mu_i + \sum \mathrm{year} + \varepsilon_{\mathrm{it}}, \tag{3}$$

where Y_{it}^{n} refers to the four dimensions of investment behavior, specifically investment quantity ($\mathrm{Quantity}_{\mathrm{it}}$), investment phase ($\mathrm{Phase}_{\mathrm{it}}$), investment industry ($\mathrm{Industry}_{\mathrm{it}}$), and investment region ($\mathrm{Region}_{\mathrm{it}}$), μ_i is the unobservable individual effect, $\sum \mathrm{year}$ is the time effect, and $\varepsilon_{\mathrm{it}}$ is the time-varying disturbance term of an individual.

This study selected the annual data of China's VC institutions from 1997 to 2019 as the research sample. Before the empirical analysis, we sorted out the VC events that occurred from 1997 to 2019, excluded the data without investment quantity, and obtained a total of 6,561 investment events from 1,666 VC institutions. We excluded the data without investment phase, investment region, and investment industry and obtained a total of 5,156 investment events from 1,287 VC institutions. The VC investment data were selected from the Zero2IPO database, and the economic policy uncertainty was selected from the EPU1 index jointly published by Stanford University and the University of Chicago.

3.3. Data Description. Observing the trend of China's EPU (Figure 1), we can find that the EPU in China has the characteristics of periodic fluctuations. Before 2007, there were no major political and economic events in China, so the level of EPU in China was stable and relatively low. From

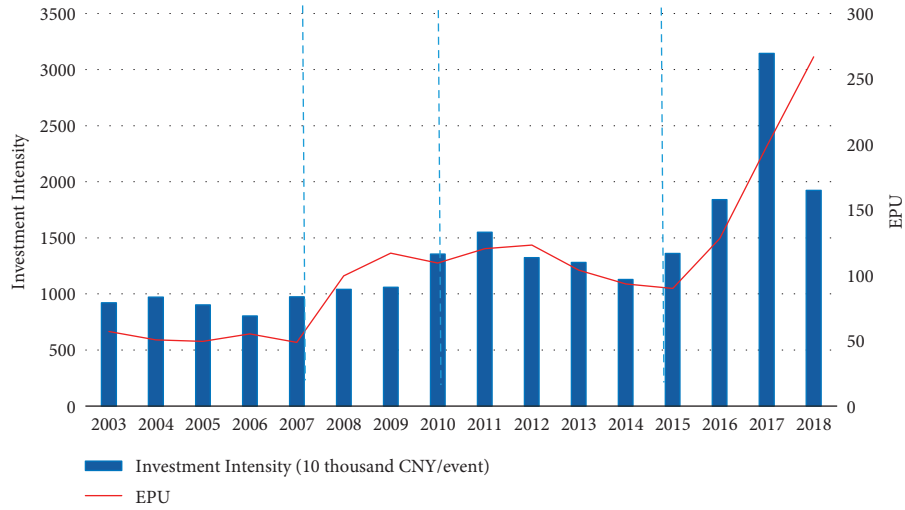

Figure 1: EPU and the quantity of venture capital investment in China.

2007 to 2009, the level and fluctuation of EPU in China were significantly higher than during the first stage. This was mainly due to the global financial crisis in 2008, and the Chinese government frequently adjusted economic policies to save the market. In the first half of 2010 to 2014, events such as the change in national leaders and the European debt crisis occurred one after another, so a high level of EPU was maintained. In the second half, no major events occurred, so there was a gradual downward trend in the level of EPU in China. In 2015 and after, events such as China's economic new normal, the Sino-US trade friction, and the global COVID-19 pandemic, occurred one after another; thus, the EPU in China began to grow rapidly again with violent fluctuations.

Considering the fluctuating trend of investment intensity in China, we find that the VC investment intensity and EPU are almost synchronized. This means that there are certain positive correlations between EPU and concentration of the VC investment.

The investment quantity, investment phase, investment industry, and investment region, as the reflections of willingness to invest in VC, also show the following characteristics according to the corresponding statistical descriptions (Table 2).

In terms of investment quantity, China's VC investment has great volatility, which is not only reflected in the whole industry but also reflected in individual institutions. In terms of the whole industry, the overall standard deviation of quantity is 1.965. Compared to the indicators of other investment behaviors, it is evident that the total investment of different institutions in the same year is quite different. On this basis, this study finds that the overall sample mean of quantity is 1.473, which is far from the overall maximum value of 11.131 and the minimum value of −6.908. Therefore, this study speculates that the investment of institutions themselves in different years may also have a large gap. Thus, this study takes the overall sample mean of quantity 1.473 as the dividing line and randomly samples 10% of the institutions with larger and smaller quantity values respectively.

Table 2: Descriptive statistics for each variable.

Variable	Mean	Std. dev.	Min	Max
Quantity	1.473	1.965	−6.908	11.131
Phase	0.766	0.271	0.250	1.000
Industry	0.662	0.346	0.027	1.000
Region	0.744	0.312	0.048	1.000
EPU	1.341	0.167	1.051	1.773
LOC	0.797	0.402	0.000	1.000
SIZE	8902.614	28813.510	0.001	347175.000
AGE	20.157	7.265	0.000	112.000
IPO	4.016	13.078	0.000	239.000
INV	28.599	74.335	1.000	1240.000
GDP	0.083	0.019	0.060	0.142
ICS	1.390	0.233	1.135	1.931
STOCK	0.093	0.432	−0.644	1.315
MARKET	3939.752	2583.941	18.000	7509.000
GPU	1.201	0.125	1.040	1.545

Through preliminary observation of the scatter plot of the total investment of the sample institutions in different years, this study finds that the total investment of a single institution in different years also has a large difference.

In terms of investment strategies, China's VC institutions show a high degree of investment concentration in phases, industries, and regions. The HHI has always been considered by the U.S. Department of Justice as a good indicator of industrial concentration. It is generally believed that when the HHI of an industry is greater than 0.3, the industry is considered to be in a state of high oligopoly. In this study, the overall mean values of phase, industry, and region are 0.766, 0.662, and 0.744, respectively, which means that the HHI of venture capital institutions in terms of investment stage, investment industry, and investment region is far higher than 0.3. Therefore, it can be considered that the investment concentration of venture capital institutions in industries, regions, and stages is relatively high; that is, China's venture capital industry shows certain specialized investment characteristics.

4. Empirical Results

4.1. Estimation Results for Benchmark Equation. Incorporating the above descriptive statistical results and the observation on each variable, we first winsorized the variables to avoid the influence of abnormal data on the research results. Based on this, we conducted regression analysis on the dependent variables, including $Quantity_{it}$, $Phase_{it}$, $Industry_{it}$ and $Region_{it}$. The results are listed in Table 3. The Hausman test results of the four equations are all significant at the 1% level. It can be found that the relationship between EPU and the investment behavior of VC institutions is adaptable to a fixed effects model.

At the same time, in the equation of investment quantity, the coefficient of EPU is 2.480, which is significant at the 5% level. In the equations of investment phase, investment industry, and investment region, the coefficients of EPU are 1.666, 2.010, and 1.778, respectively, all of which are significant at the 1% level. Therefore, we believe that EPU not only stimulates the investment quantity of VC institutions but also boosts the investment concentration of VC institutions in investment phases, investment industries, and investment regions.

4.2. Discussion on Endogeneity. In terms of endogeneity, this article considers both macro and micro factors. From the micro perspective, the explanatory variable in this article is the EPU at the macro level, and the explained variable is the investment behavior of VC institutions at the micro level. The influence of micro individuals on macro indicators is almost negligible, so the endogeneity problem caused by bidirectional causality is alleviated to a large extent. In addition, according to Gulen and Ion, when studying the impact of EPU on corporate investment, the most important problem was the endogeneity caused by the missing variable of corporate future investment opportunities [8]. In this study, the indicators, including the institutional capital, the cumulative number of investment events, and the number of successful investments, are introduced into the four equations. These indicators basically summarize the investment opportunities at the individual institutional level. Therefore, when considering the instrumental variable, we focus on the distortion of results caused by the absence of macro investment opportunities.

In the original model, the GDP growth rate depicts the macro development of China in the current year relative to that in the previous year. The index of consumer sentiment predicts consumers' plans for future consumption life from the perspective of consumption. The stock returns and market issuance describe the current level of investment in the domestic market from the investment perspective. The global policy uncertainty is the nonlocal feature of some VC investments, including the overall uncertain environment in domestic and foreign countries. Among the five indicators, GDP growth rate and the index of consumer sentiment involve the prediction of the future market to a certain extent. However, the ability of GDP growth rate to predict the future is not strong, and VC institutions do not directly face consumers, resulting in a slight lag in the ability of these two indicators to comprehensively reflect future investment. Therefore, in satisfying the main conditions of the instrumental variable, this study selects the macroeconomic performance indicator-leading indicator (MacroPI) as an instrumental variable in the regression model. The rationality of this instrumental variable can be demonstrated separately in the theoretical and empirical models.

In theory, MacroPI can be used as an instrumental variable for EPU for two reasons. On the one hand, MacroPI is absolutely exogenous and closely related to EPU. Based on the survey of entrepreneurs, MacroPI integrates the entrepreneurs' judgments on the operation of enterprises and the operation of the macroeconomy and objectively reflects the development trend of the future economy from the enterprise level. Both MacroPI and EPU are macroeconomic indicators, and their degree of correlation is significant. On the other hand, MacroPI mainly affects the investment behavior of VC institutions by affecting EPU. MacroPI is regarded as a macro barometer and is a reference for many economic, fiscal, and monetary policies. Therefore, it must have a significant impact on China's EPU, thus affecting the investment behavior of VC institutions.

Empirically, this study tested the rationality of the instrumental variable in three steps:

First, we conducted the Hausman test and the Davidson–MacKinnon test on the four dimensions of the investment behavior of VC institutions. The results showed that the endogeneities of investment region, investment phase, and investment industry were evident in the two tests. Although the endogeneity of investment quantity was not evident in the Hausman test, its endogeneity was detected in the supplementary Davidson–MacKinnon test (Table 4). Therefore, in order to avoid the interference of endogeneity on the results as much as possible, our analysis model for the four dimensions would include the instrumental variable, which is the macroeconomic performance indicator. Then, based on the ideas of Acemoglu et al. and Miguel et al. [55, 56], we put MacroPI into four equations to investigate its rationality. Table 4 lists that MacroPI has a significant positive effect on the investment quantity of VC institutions, but after adding EPU to the regression model, the impact of MacroPI on the investment quantity of VC institutions is less significant, and the significance of EPU is enhanced. This shows that the impact of MacroPI on the investment quantity of VC institutions is covered by EPU. In other words, the impact of MacroPI on the investment quantity of VC institutions in China is mainly due to EPU. Like the investment quantity, MacroPI also has a significant positive effect on the specialization level of VC institutions in investment phases, industries, and regions. Moreover, after EPU was added to the regression model, the impact of MacroPI on the specialization level of VC institutions in investment phases, industries, and regions is no longer significant. This shows that the impact of MacroPI on the specialization level of VC institutions in investment phases, industries, and regions can be largely covered by EPU. In other words, the impact of MacroPI on the specialization level of VC institutions in China is mainly due to EPU.

Table 3: Estimation results of benchmark equations.

	Equation (1) Quantity	Equation (2) Phase	Equation (3) Industry	Equation (4) Region
EPU	2.480** (1.083)	1.666*** (0.166)	2.010*** (0.216)	1.778*** (0.205)
LOC	−2.106*** (0.088)	−0.133*** (0.017)	−0.257*** (0.023)	−0.229*** (0.019)
SIZE	−0.002*** (9.75e − 05)	−0.001*** (0.001)	−0.001*** (0.001)	−0.001** (0.001)
AGE	−0.037** (0.018)	0.007** (0.003)	0.010** (0.004)	0.004 (0.013)
IPO	0.044*** (0.014	0.003 (0.003)	0.008** (0.003)	0.001 (0.002)
INV	−0.023*** (0.002)	−0.003*** (0.001)	−0.004*** (0.001)	−0.003*** (0.001)
GDP	30.045 (24.922)	28.061 (4.241)	38.2124*** (5.211)	31.716*** (4.887)
ICS	−3.092** (1.481)	0.905*** (0.203)	1.052*** (0.271)	0.696*** (0.263)
STOCK	1.302*** (0.373)	0.098* (0.055)	0.167** (0.070)	0.231*** (0.068)
MARKET	0.001** (0.001)	−9.04e − 06 (0.001)	−5.87e − 06 (0.001)	0.001 (0.001)
GPU	7.390* (3.958)	−2.640*** (0.542)	−3.249*** (0.717)	−2.430*** (0.697)
_cons	−8.641*** (2.563)	−1.640*** (0.552)	−2.464*** (0.653)	−2.089*** (0.585)
Individual	Control	Control	Control	Control
Year	Control	Control	Control	Control
N	6561	5156	5156	5156
Hausman	55.25***	104.81***	54.50***	128.56***
P value	0.0000	0.0000	0.0000	0.0000

Note. *, **, and ***represent the significance at the 10%, 5%, and 1% levels, respectively. The robust standard errors are shown in parentheses. Control represents the control for individual effects and time effects. The coefficients of the variables LOC and SIZE are estimated using LSDV (least squares dummy variable).

Finally, we used two-stage least squares (2SLS) to bring instrumental variables into the test to address endogeneity, following the lines of Acemoglu et al. and Miguel et al. [55, 56]. In the first stage, we used EPU as the dependent variable and MacroPI as the independent variable, kept the control variables unchanged to perform the regression analysis, and obtained the results listed in Table 5. It can be found that the impact of MacroPI on EPU is significant at the 1% level in the four-dimensional model, and the robust F values of the four regression models are all much greater than 10. Therefore, the possibility of the weak instrumental variable is rejected.

In the second stage, we used the four dimensions of the investment behavior of VC institutions as the dependent variables, used the EPU1 obtained from the first-stage fitting as the independent variable, kept the control variables unchanged to perform the regression analysis, and obtained the results listed in Table 5. Compared to the benchmark test results, it can be found that the impacts of EPU on the four dimensions of the investment behavior of VC institutions change in different magnitudes after the addition of MacroPI. Yet overall, the direction and significance of the impacts remain unchanged, which proves that after excluding the endogeneity caused by missing variables, the conclusions of this study are still robust.

After solving the endogeneity problem, it can be found that on the one hand, EPU does promote the investment quantity of VC institutions, which is consistent with the inference of previous descriptive statistics. 2SLS regression is performed on equation (1). The estimated coefficient of EPU is 3.343, which is significant at the 1% level. Compared to the benchmark regression, the promotion effect is slightly improved. This effectively confirms hypothesis H1b of this study. It means that when EPU changes, VC institutions are more vulnerable to positive factors such as call options and information asymmetry. Based on the first-stage estimation results of the instrumental variable (Table 5), we find that before EPU promotes the investment quantity of VC institutions, the macroeconomic performance indicator also has a positive effect on EPU. This also means that the macroeconomic performance indicator also promotes the great influence of positive factors such as call options. Meanwhile, EPU also has a positive stimulating effect on the concentration degree of VC institutions in investment phases, industries, and regions. 2SLS estimation was performed on equations (2) to (4). The estimated coefficients of EPU are 0.771, 0.876, and 0.905, respectively, all of which are significant at the 1% level. Compared to the benchmark regression, all stimulation effects decrease significantly. However, it still confirms hypothesis H2a of this study, which states that EPU can stimulate VC institutions to use specialized investment strategies.

In general, EPU can prompt China's VC institutions to increase investment in areas already covered and shows that the uncertainty is both an opportunity and a challenge. To avoid the unlimited risk brought by the challenge, VC institutions tend to use specialized investment strategies. To seize the opportunity of increasing market share brought by the opportunity, VC institutions tend to increase investment in areas already covered.

4.3. Robustness Test

4.3.1. Sample Period Adjustments. This study uses data from 1997 to 2019 to study the impact of EPU on the investment behavior of VC institutions. However, most of the existing research on VC investment began in 2005. According to the textbook *Equity Investment Fund*, China's equity investment before 2005 was basically in the exploratory and initial stage. There were few market participants and VC events, and investment behavior was irregular. Therefore, to avoid

Table 4: Rationality test for the MacroPI instrumental variable.

	Quantity				Phase	
EPU	2.480** (1.083)		9.625*** (3.734)	1.666*** (0.166)		1.677*** (0.382)
MacroPI		3.042*** (1.329)	−8.766* (5.18)		1.381*** (0.138)	−0.010 (0.298)
Individual	Control	Control	Control	Control	Control	Control
Year	Control	Control	Control	Control	Control	Control
N	6561	6561	6561	5156	5156	5156
Hausman test		0.6397			0.000	
Davidson–MacKinnon test		0.0749			2.4e−06	
	Industry				Region	
EPU	2.010*** (0.216)		1.858*** (0.492)	1.778*** (0.205)		2.343*** (0.463)
MacroPI		1.667*** (0.179)	0.126 (0.418)		1.474*** (0.170)	−0.468 (0.421)
Individual	Control	Control	Control	Control	Control	Control
Year	Control	Control	Control	Control	Control	Control
N	5156	5156	5156	5156	5156	5156
Hausman test		0.000			0.000	
Davidson–MacKinnon test		$7.3e-08$			$2.0e-09$	

Note. *, **, and ***represent the significance at the 10%, 5%, and 1% levels, respectively.

Table 5: Comparison between the estimation results of the instrumental variable in two-stage least squares (2SLS) and the benchmark results.

		The first-stage regression		
		EPU1		
MacroPI		0.181*** (0.005)		
F value	1493.52	1122.34	1122.34	1122.34
	The second-stage regression and the benchmark regression			
	Quantity	Phase	Industry	Region
EPU1 (2SLS regression)	3.343*** (0.718)	0.771*** (0.140)	0.876*** (0.174)	0.905*** (0.147)
EPU (benchmark regression)	2.480** (1.083)	1.666*** (0.166)	2.010*** (0.216)	1.778*** (0.205)
Individual	Control	Control	Control	Control
Year	Control	Control	Control	Control
N	6032	4728	4728	4728

Note. **and ***represent the significance at the 5% and 1% levels, respectively.

irregularities from interfering with the empirical results, this article adjusted the sample period from 2005 to 2019 and estimated again. In addition, most of the existing research on EPU agreed that the 2008 financial crisis caused global EPU to rise to a new height. Therefore, we adjusted the sample period from 2008 to 2019 and estimated again. The two estimation results are listed in Table 6. We can find that the results of the two sample period adjustments are all significant at the 1% level and the results are similar to the empirical results of the full sample, indicating that the results of this study are robust.

4.3.2. Replacement of the EPU Measurement Method. This study considers replacing the main proxy variables to demonstrate the robustness of the obtained results. Currently, the measurement of annual EPU is mainly divided into two types: one is the weighted geometric mean (i.e., the annual $\mathrm{EPU}_t = \sqrt[12]{\mathrm{MEPU}_{t1} \times \mathrm{MEPU}_{t2} \times \ldots \times \mathrm{MEPU}_{t12}}$), where t represents the month), and the other is the arithmetic mean (i.e., $\mathrm{EPU}_t = \sum_{t=1}^{12} \mathrm{MEPU}_t/12$, where t represents the month). In previous paragraphs, we used the weighted geometric mean to measure EPU, so we used the arithmetic mean to process the EPU index and re-estimated the impact of EPU on the investment behavior of VC institutions. The estimation results are listed in Table 7. It can be found that the conclusions obtained after the index replacement are similar to the previous conclusions, so the conclusions obtained in this study are robust.

4.3.3. Replacement of Estimation Method. This study mainly adopts the 2SLS method to overcome the endogeneity problem. However, when heteroscedasticity exists, the two-step GMM (generalized method of moments) method can capture the heteroscedasticity information more acutely because it requires fewer assumptions and only needs to satisfy the moment conditions. Therefore, it is more effective than the 2SLS method and the obtained results are more reliable. Thus, this article uses the two-step GMM method to estimate the robustness of the whole sample, bringing MacroPI as the instrumental variable corresponding to EPU into the estimation, and the results are listed in Table 8. It can be found that the results of the two-step GMM estimation are the same as the results of 2SLS. This indicates that the sample size used in this study is large enough, and the conclusions obtained are robust and credible.

4.4. Heterogeneity Analysis. Based on the Hausman test, we find that compared to the random effects model, the two-way fixed effects model can better explain the correlation between variables. However, for panel regression, both random effects and fixed effects can only reflect a single fixed relationship and the significance level between variables. It is difficult to obtain the different effects of EPU on the investment behavior of VC institutions under different investment behaviors. Therefore, after the initial test, it is helpful to conduct further research using panel quantile regression to understand the overall impact of EPU on the investment behavior of VC institutions.

In addition, both the two-way fixed effects model and the 2SLS model are based on the least squares estimation method and examine the mean regression of the explanatory variables on the explained variables. However, it is difficult to fit the real data to the assumption of the least squares method, which may easily lead to unrepresentative conclusions and poor robustness. In this case, Koendker and Bassett [57] proposed quantile regression, which makes no specific assumptions about the sample distribution but can make the conclusion more robust. Moreover, the least squares estimation can only reveal the impact of EPU on the investment behavior variable of VC institutions at the average level, while quantile regression can specifically describe the impact of EPU on the overall conditional distribution of the investment behavior of VC institutions. This means that through quantile regression, the impact of EPU on the investment behavior of VC institutions obtained in this study will be more stable and representative.

The quantile regression model settings in this study are as follows:

$$Q_{Y_{i,t}}\left(\tau | X_{i,t}\right) = X_{i,t}'\beta(\tau). \tag{4}$$

The coefficient estimation formula is as follows:

$$\widehat{\beta}(\tau) = \min_{\beta} \sum_{t=1}^{T} \sum_{i=1}^{n} \rho_{\tau k}\left(Y_{i,t} - X_{i,t}'\beta(\tau)\right), \tag{5}$$

Table 6: Robustness test for split samples.

	Quantity	Phase	Industry	Region
EPU (2008–2019)	6.928*** (2.015)	1.909*** (0.433)	2.243*** (0.526)	2.438*** (0.462)
EPU (2005–2019)	3.710*** (0.889)	0.946*** (0.165)	1.080*** (0.204)	1.138*** (0.174)
EPU (original 2SLS regression)	3.343*** (0.718)	0.771*** (0.140)	0.876*** (0.174)	0.905*** (0.147)
Individual	Control	Control	Control	Control
Year	Control	Control	Control	Control

Note. ***represents the significance at the 1% level.

Table 7: Robustness test for EPU* index replacement.

	Quantity	Phase	Industry	Region
EPU	3.343*** (0.718)	0.771*** (0.140)	0.876*** (0.174)	0.905*** (0.147)
EPU*	15.496*** (4.315)	2.422*** (0.555)	2.750*** (0.674)	2.841*** (0.610)
Individual	Control	Control	Control	Control
Year	Control	Control	Control	Control
N	6032	4728	4728	4728

Note. ***represents the significance at the 1% level.

Table 8: Robustness test for the two-step GMM method.

	Quantity	Phase	Industry	Region
EPU (GMM estimation)	3.343*** (0.718)	0.771*** (0.140)	0.876*** (0.174)	0.905*** (0.147
EPU (2SLS regression)	3.343*** (0.718)	0.771*** (0.140)	0.876*** (0.174)	0.905*** (0.147)
Individual	Control	Control	Control	Control
Year	Control	Control	Control	Control
N	6032	4728	4728	4728
Instrumented	EPU			
Included instruments	AGE, IPO, INV, GDP, ICS, STOCK, MARKET, and GPU			
Excluded instruments	MacroPI			

Note. ***represents the significance at the 1% level.

where $\tau \in (0,1)$ is the quantile, $Y_{i,t}$ represents the observation of the four investment behavior levels of individual i in year t, $X_{i,t}$ is the sample observation of explanatory variables, $Q_{Y_{i,t}}(\tau|X_{i,t})$ is the conditional quantile of the investment behavior level $Y_{i,t}$ at the τ quantile, $\beta(\tau)$ is the coefficient of each explanatory variable affecting the investment level $Y_{i,t}$ at the τ quantile, and $\rho_{\tau k} = k(\tau - I(k<0))$ is a piecewise linear function. For the τ value, this study took a value every 0.1 quantiles for a total of nine values. Starting from 0.1, as shown in Figures 2 to 5, the solid line is the estimated coefficient of the investment behavior variable, and the upper and lower dashed lines are the boundaries of the 95% confidence interval.

Based on the panel quantile result of Quantity (Figure 2), on the one hand, EPU has a stable effect on promoting the investment quantity of VC institutions. The estimated coefficients of EPU are consistently positive from the 10th to 90th quantiles, and all coefficients are significant at the 1% level. This shows that at all levels of investment quantity, the increase in EPU can significantly stimulate the investment willingness of VC institutions, which is consistent with the previous conclusion that the influence of positive factors is greater than the influence of negative factors. On the other hand, as the investment quantity of VC institutions increases, the positive impact of EPU on the investment quantity is enhanced. In the case where the estimated coefficient of EPU is positive, the absolute value of the coefficient increases continuously from the 10th to the 90th quantile. This indicates that as the investment quantity increases, negative factors such as real options have a weaker impact than positive factors such as call options. In other words, for institutions with larger investment quantities, EPU means more opportunities. VC institutions with larger investment quantities tend to seize the opportunity of rising EPU to increase investment and expand their market share.

Based on the panel quantile results of phase, industry, and region, on the one hand, EPU has a stable effect on promoting the concentration degree of VC investment phases, industries, and regions. The estimated coefficients of EPU in the three models are consistently positive from the 10th to 90th quantiles, and all coefficients are significant at the 1% level. This indicates that under all concentration degrees in investment phases, industries, and regions, the increase in EPU can significantly stimulate VC institutions to narrow the investment scope, which is consistent with the spatial concentration theory verified by equations (2) to (4) in the preliminary test. On the other hand, as the concentration degree of VC institutions in investment phases, industries, and regions increases, the positive impact of EPU on the investment industry and region has different degrees of magnification. From Figures 3 to 5, it can be found that the EPU coefficients of the investment phase, industry, and region increase significantly from the 10th to the 90th quantile. Based on the background and strength of VC

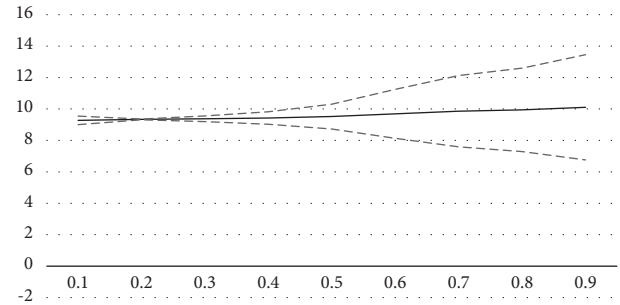

Figure 2: Quantity-EPU quantile regression result.

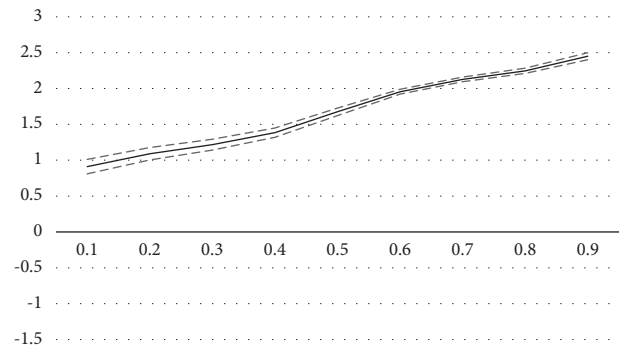

Figure 3: Phase-EPU quantile regression result.

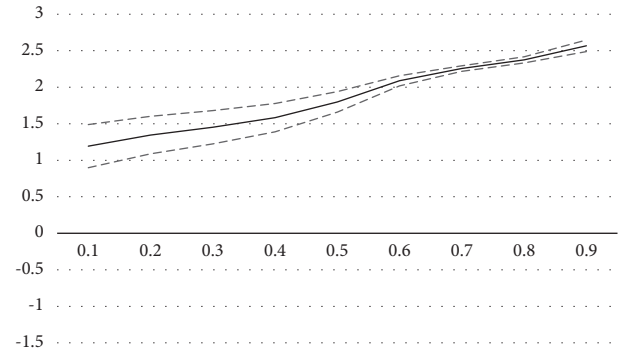

Figure 4: Industry-EPU quantile regression result.

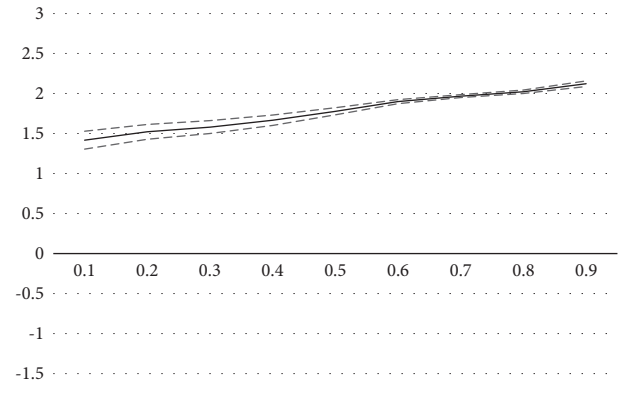

Figure 5: Region-EPU quantile regression result.

institutions, a low concentration degree in investment phases, industries, and regions indicates that the VC institution plans to expand the market. This expansion usually means higher decision-making costs. In general, institutions with an excellent investment state are more able to bear this cost. Therefore, for VC institutions with a low concentration degree in investment phases, industries, and regions, or VC institutions with an excellent investment state, the impact of EPU on changing their investment behavior is relatively weak.

5. Conclusions and Inspirations

Combining the investment behavior framework of general enterprises and the behavior characteristics of venture capital institutions, this study summarizes the connotation of investment behavior of venture capital institutions, namely, investment scale, investment stage, investment industry, and investment area. From these four aspects, this study examines the impact of EPU on the investment behavior of venture capital institutions. The results show the following: (1) regarding the impact of EPU on the investment behavior of venture capital institutions, in China, EPU has a good news effect on the investment quantity of VC institutions. Under the influence of the macroeconomic performance level, the growth option effect, and the risk-seeking characteristics caused by information asymmetry lead VC institutions to regard EPU as an opportunity, thereby increasing investment. At the same time, EPU has a stimulating effect on the concentration degree of VC institutions in investment phases, investment industries, and investment regions. In other words, VC institutions can increase their investment in areas already covered to face the challenges brought by EPU and avoid risks. (2) Regarding the change of the impact of EPU on the investment behavior of venture capital institutions, the impact of EPU on the investment behavior of VC institutions changes with the investment state of institutions. The effect of EPU on promoting the investment quantity of VC institutions is enhanced as the investment quantity increases. The stimulating effect of EPU on the concentration degree of VC institutions in investment phases, investment industries, and investment regions is enhanced as the concentration degree increases. This shows that institutions with an excellent investment state are less affected by EPU.

Based on the research results above, this study proposes three policy recommendations for functional departments to better guide VC investment: (1) enhance market confidence and improve the macroeconomic performance level. In the case of a relatively high level of macroeconomic performance, positive factors such as call options have a strong capacity to affect the investment decisions of VC institutions in China. Therefore, we can amplify the promotion effect of EPU on investment and maximize the use of the opportunity feature of EPU by improving the macroeconomic performance level and enhancing the confidence of VC institutions. (2) Increase the transparency and continuity of economic policies. The increase in EPU can prompt VC institutions to increase the investment concentration degree,

thereby affecting the expansion and development of the innovation and entrepreneurship industry in China. This is not conducive to the subsequent optimization of China's microstructure in a period of economic transformation. Therefore, the transparency of economic policies is of great significance for both the market and enterprises. For the VC institutions in China, the enhancement of economic policy transparency is equivalent to reducing the high-impact market challenges and institutional challenges. Therefore, it can guide these institutions to form a more accurate development expectation, make diversified strategic adjustments to adapt to the plan, and accumulate momentum for the sustainable development of the market institutions in China. (3) Strengthen the guidance to key VC institutions. VC institutions that are characterized by large investment quantity and a low degree of concentration in investment phases, investment industries, and investment regions are greatly promoted and less discouraged by EPU. Therefore, the government can strengthen the guidance on the investment industry for key VC institutions to support key technological fields and use the relative concentration of strength to counter the unease that EPU brings to the entire market.

In addition, this study also has certain limitations. Improving the accuracy of the measurement index can increase the accuracy and persuasiveness of the results. Therefore, further research generated by this study should focus on finding a more comprehensive and accurate measurement index to describe EPU and provide more precise guidance for relevant departments.

Data Availability

The data used in this study were obtained from the Zero2IPO Database.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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