

Economic Policy Uncertainty and Enterprise Innovation: an Empirical Study Based on Chinese Listed Companies

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Abstract: Economic policy uncertainty is one of the hot topics in academic research recently. Based on the mediating effect of financing constraints, this paper studies the relationship between policy uncertainty and enterprise innovation, and examines the ownership form and scale heterogeneity of Chinese A-share listed companies from 2008 to 2019. The results show that: economic policy uncertainty can promote enterprise innovation, and economic policy uncertainty enhances the financing constraints of enterprises, thus reducing its positive impact; compared with non-state-owned enterprises, economic policy uncertainty promotes state-owned enterprises more obviously; compared with small-scale enterprises, economic policy uncertainty has a greater impact on large-scale enterprises. Therefore, the government is supposed to create a good external environment for enterprise innovation and ease the financing constraints of enterprises.

1. Introduction

In 2016, China's "National innovation driven development strategy program" pointed out that China's economy has entered a period of new normal, traditional driving force has weakened, economic development needs to be put on the track of endogenous growth driven by innovation. Enterprise innovation accompanied by high risk and high investment is closely related to macro policy. Political stability and government efficiency are important factors affecting corporate innovation [2]. Since the global financial crisis, the economy has been weak and the growth rate has slowed down. The Chinese government has issued a series of policies, including 4 trillion investment plan, ten industries revitalization plan. The frequent changes of policies increase the uncertainty of economy.

Previous research on economic policy uncertainty mainly focuses on investment, financing, cost of debt and other aspects [4, 5]. So far, however, there has been little discussion about corporate innovation activities. China is transforming the economic development pattern, so these issues will have practical meaning for policy-making. In addition, External financing is the key factor for enterprises to gain sufficient funds to ensure R&D investment [6]. In the literature review of Hall and Lerner, most of the studies taking OECD countries as samples have proved the inhibitory effect of financing constraints on R&D investment [8]. At the same time, the financing difficulties caused by economic policy uncertainty have been proved by many researches and theories [9, 10]. However, few scholars in China have discussed whether there is an intermediary effect of financing constraints between economic policy uncertainty and enterprise innovation.

Based on the background and practical needs, in the era of frequent changes of economic policies, this paper examines the impact of economic policy uncertainty on enterprise innovation and draws the following conclusions: (1) economic policy uncertainty promotes enterprise innovation, it enhances financing constraints and reduces the promotion of innovation. (2) Compared with the non-state-owned enterprises, economic policy uncertainty promotes the state-owned enterprises more obviously; (3) compared with the small-scale enterprises, the promotion effect of economic policy uncertainty on large-scale enterprises is more obvious.

The contributions of this paper are as follows: (1) the research on the economic policy uncertainty mainly focuses on investment, financing, creditor's rights and other fields. This paper combines macro policy changes with micro enterprise innovation behavior to investigate the impact of economic policy uncertainty on innovation, enriching the relevant literature; (2) this paper also

examines the mediating effect of financing constraints between economic policy uncertainty and innovation, which has theoretical and practical significance; (3) this paper further analyses how the heterogeneity of property rights and scale affects the relationship between economic policy uncertainty and innovation, so as to bring enlightenment for policy-making.

2. Literature Review

There is no consensus on the definition of innovation. Prajogo and Ahme classify innovation into product innovation application achievements, product and service application types, costs and change speed according to innovation process and function [11]. Alegre and Chiva define innovation as market share, substitutability and extent of new market development [12]. As an important factor, financing constraints significantly affect enterprise innovation [13]. To some extent, fiscal policy could also mobilize the innovation enthusiasm of enterprises [15, 16]. As an important means of macro-control, fiscal policy is related to the external financing environment of enterprises and affects the promotion of innovation activities [17].

Yet there are still some divergence of views as to the direction of the impact of economic policy uncertainty on enterprise innovation. Under the interaction of investment irreversibility and uncertainty, the value of real options is enhanced. Facing the uncertainty of economic policy, enterprises may choose to delay innovation for the purpose of preserving their strength [18]. From the perspective of financial friction mechanism, when the economic uncertainty rises, financial intermediaries are apt to hold a pessimistic attitude, the interest and liquidated damages of enterprise loans will raise, and the financing cost of enterprises increases, thus reducing the investment in R&D.

Others argues that economic policy uncertainty will promote enterprise innovation. Due to the difference of adjustment cost, the impact of policy uncertainty on R&D investment may be different from the general investment behavior [18]. Because of the uncertainty of the profit, according to the growth option theory, enterprises may increase innovation to enhance competitiveness and obtain higher profit. Vo and Le observe that in order to remain competitive, enterprises will increase innovation to cope with the adverse effects of uncertainty [5].

3. Research Hypothesis

3.1 Economic Policy Uncertainty and Enterprise Innovation

According to the option to defer in real option theory, due to the irreversibility of investment [27], enterprises may choose to postpone investment activities, wait for more information to save strength and reduce investment losses in uncertain environment. Due to the high specificity of enterprise R&D investment, the irreversibility of investment is obvious [28]. Moreover, enterprises need a lot of funds to invest in R&D [29], so the mechanism of uncertainty acting on investment is also applicable to R&D decision-making. From the perspective of future cash flow forecast, the instability of economic policy brings about the change of enterprise income and cost, which leads to the instability of enterprise cash flow and increases the difficulty of future cash flow prediction [32]. Therefore, enterprises will be more cautious about investment decisions, resulting in the reduction of R&D investment. Based on the above theoretical background, hypothesis 1a is proposed.

H1a: Economic policy uncertainty will inhibit enterprise innovation.

In the system of real option theory, in addition to the above option to defer, there is also growth option. Growth options believe that the current investment can provide valuable learning experience for enterprises, enhance competitiveness, and create opportunities for future growth of enterprises. Therefore, enterprises decide whether to choose growth option or delay option by weighing the cost and return of investment. Under the condition of uncertainty, strengthening innovation is conducive to maintaining market power [35], thus creating opportunities for future competitiveness. In addition, Bloom et al. pointed out that the adjustment cost of R&D investment is not the same as that of ordinary investment [18], so the impact of economic policy uncertainty on innovation may not be the same as that on general investment. Therefore, we propose hypothesis 1b.

H1b: Economic policy uncertainty promotes enterprise innovation.

3.2 Economic Policy Uncertainty and Financing Constraints

The impact of policy uncertainty on financing constraints can be achieved through the following ways: economic uncertainty weakens the information processing ability of managers [38], and increases the business risk of enterprises. Therefore, investors will ask for higher rewards to offset the risks they undertake, resulting in risk premium [22] which will increase the financing cost of enterprises; At the same time, environmental uncertainty will increase the information asymmetry [39], Managers may attribute the performance changes to external factors, but it is difficult for investors to judge whether the performance decline is due to the moral hazard of managers or the uncertainty of the environment. Therefore, investors need to bear the asymmetric information and demand higher return. So his paper proposes hypothesis 2.

H2: Economic policy uncertainty will increase the financing constraints of enterprises.

3.3 The Mediating Effect of Financing Constraints between Economic Policy Uncertainty and Innovation

Economic policy uncertainty will affect enterprise innovation through financing constraints. The inhibitory effect of financing constraints on enterprise innovation is mainly reflected in the following three aspects: it is difficult for non owners to observe and control R&D investment, resulting in the low mortgage value of intangible assets [42], Secondly, due to the fact that innovation is easy to be imitated, enterprises are more cautious in disclosing R&D information, which aggravates the information asymmetry that leads to the increase of external financing cost [43]. In addition, innovation has a high adjustment cost, if the interruption of investment causes the loss of R&D personnel, it will bring losses to the enterprise [44]. When enterprises are faced with more serious financing constraints, they tend to reduce the investment in innovation activities with higher risks and costs, and apply limited funds to other projects, resulting in insufficient R&D funds and inhibiting innovation [45].

If the firm chooses the option to defer, economic policy uncertainty will inhibit the innovation; if the enterprise chooses the growth option, the economic policy uncertainty will promote the innovation. Financing constraints play an intermediary role between economic policy uncertainty and innovation, that is, economic policy uncertainty aggravates enterprise financing constraints, and financing constraints will lead to the decrease of R&D investment, which is not conducive to enterprise innovation. Therefore, this paper proposes hypothesis 3.

H3: financing constraints play a mediating role between economic policy uncertainty and enterprise innovation.

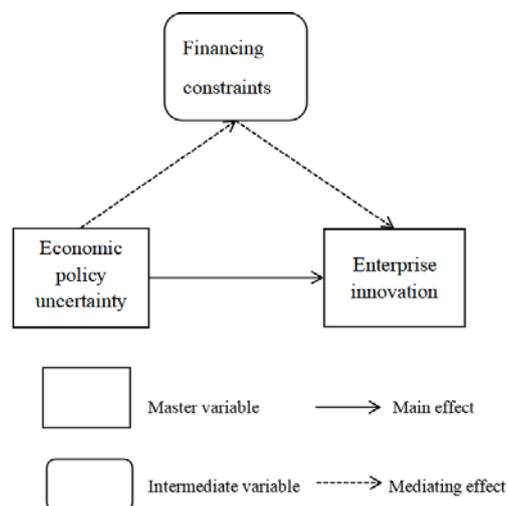


Fig.1 The Relationship between Economic Policy Uncertainty, Financing Constraints and Enterprise Innovation

4. Methodology

4.1 Sample Selection and Data Source

Since the index of economic policy uncertainty is larger after 2008, this paper selected China's A-share listed companies from 2008 to 2019 as the initial research sample. The data were screened and processed as follows: (1) financial and insurance listed companies were excluded; (2) ST and *ST companies were excluded; (3) samples that do not disclose data such as R&D investment and patent application were excluded. Finally, 5029 data samples were obtained. In addition, in order to avoid the influence of extreme values, all continuous variables were tailed at 1% - 99% level. The data of listed companies used in this paper are all from CSMAR, and the EPU index is from the website constructed by Baker, Nicholas and Davis[3]1. The software used is Stata 15.0.

4.2 Variable Definition

4.2.1 Dependent Variable: Innovation

This paper used the four indicators extracted by factor analysis to measure innovation [3], which are: 1) R&D Investment; 2) proportion of technical personnel; 3) number of invention patents; 4) intangible assets ratio. After obtaining the above indicators, the entropy method was used to give a certain weight was given to obtain a comprehensive index to measure the innovation performance of enterprises [48].

4.2.2 Independent Variable: Economic Policy Uncertainty

The EPU index constructed by Baker (2016) was used to measure the economic policy uncertainty. The arithmetic mean of 12-month EPU index was calculated to obtain an annual index, and divided the annual EPU index by 100 to ensure the consistency of order of magnitude.

$$EPU = \frac{\sum_{i=1}^{12} EPU_{i,m}}{100} \quad (1)$$

i represents the month, and m represents the company.

4.2.3 Intermediary Variable: Financing Constraint

The KZ index [50], WW index [51], and the SA index [52] have strong comprehensiveness, but KZ index and WW index contain strong endogenous variables. So this paper uses SA index to measure corporate financing constraints. The formula is $SA = -0.737size + 0.043size^2 - 0.04age$. Because SA index is negative, we usually take absolute value. The larger the value, the more serious the problem of financing constraints.

4.2.4 Control Variables

(1) Enterprise growth: Tobin Q (2) Profitability: the rate of return on net assets (3) Enterprise size: the logarithm of the total assets of the enterprise (4) Capital density: the proportion of fixed assets in total assets (5) Solvency: current ratio (6) Capital structure: asset liability ratio

Table.1. Variable Definition

| | Name | Symbol | Definition |
|-----------------------|-----------------------------|--------|--|
| Explained variable | Innovation | Innova | R&D expenditure / operating revenue, number of technicians / total number of enterprises, number of invention patents, intangible assets / total assets. Weighting synthesis with entropy method |
| Explanatory variables | Economic policy uncertainty | EPU | Annual index of EPU index |
| Intermediary variable | Financing constraints | SA | $SA = -0.737size + 0.043size^2 - 0.04age$. |

¹ www.policyuncertainty.com

| | | | |
|-------------------|-----------------------|--------|---|
| Control variables | Tobin Q | TobinQ | (equity market value + net debt market value) / total assets at the end of the period |
| | ROE | ROE | After tax profit / owner's equity |
| | Enterprise size | Size | Logarithm of total assets |
| | Fixed assets ratio | Far | Fixed assets / total assets |
| | Current ratio | Ldr | Current assets / current liabilities |
| | Asset liability ratio | Lev | Total liabilities / total assets |

4.3 Model Building

This paper used panel data, Hausman test showed that fixed effect is more appropriate than random effect, so this paper used fixed effect model to test the impact of economic policy uncertainty on enterprise innovation performance. This paper constructed the following intermediary model to test the role of financing constraints between economic policy uncertainty and enterprise innovation with reference to Wen and Ye [53].

$$Innova_{i,t} = \alpha_0 + c_0 EPU + \alpha CONTROLS + \varepsilon_{i,t} \quad (2)$$

$$SA_{i,t} = \alpha_0 + \alpha_1 EPU + \alpha CONTROLS + \varepsilon_{i,t} \quad (3)$$

$$Innova_{i,t} = \alpha_0 + c_1 EPU + \beta_1 SA + \alpha CONTROLS + \varepsilon_{i,t} \quad (4)$$

c_0 is the total effect of economic policy uncertainty on innovation, α_1 is the effect of economic policy uncertainty on financing constraints, β_1 is the impact of financing constraints on innovation after controlling the influence of economic policy uncertainty, c_1 is the direct effect of economic policy uncertainty on innovation after controlling the intermediate variable, and the product of $\alpha_1\beta_1$ is mediating effect. If $\alpha_1\beta_1$ is significant at the same time, the impact of economic policy uncertainty on innovation is realized at least partly through financing constraints. If $\alpha_1\beta_1$ and c_1 are the same sign, then financing constraints play a positive mediating effect between economic policy uncertainty and innovation; if $\alpha_1\beta_1$ and c_1 sign are opposite, then financing constraints play a negative mediating effect in the impact of economic policy uncertainty on innovation.

5. Result

5.1 Descriptive Statistics

The results of descriptive statistics are reported in Table 2. It can be seen that the innovation performance in the samples varies greatly, with the minimum value of 0.001 and the maximum value of 0.843, and the innovation performance is generally low, with an average value of 0.108. The economic uncertainty index fluctuates greatly, the minimum value is 0.989, the maximum value is 7.919, and the standard deviation is 1.761, which indicates that the policy changes greatly during the sample period, and enterprises are faced with greater uncertainty. The minimum financing constraint index is 2.507 and the maximum is 4.278, which reflects that there are some differences in financing constraints during the sample period.

Table.2. Descriptive Statistics

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|----------|-------|--------|-----------|--------|--------|
| Innova | 5,029 | 0.120 | 0.108 | 0.001 | 0.843 |
| EPU | 5,029 | 4.070 | 1.761 | 0.989 | 7.919 |
| SA | 5,029 | 3.379 | 0.281 | 2.507 | 4.278 |
| TobinQ | 5,029 | 2.216 | 1.326 | 0.886 | 9.648 |
| ROE | 5,029 | 0.065 | 0.123 | -1.029 | 0.376 |
| Size | 5,029 | 21.916 | 1.168 | 19.138 | 27.062 |
| Far | 5,029 | 0.200 | 0.130 | 0.001 | 0.846 |
| Ldr | 5,029 | 2.895 | 2.771 | 0.215 | 17.997 |
| Lev | 5,029 | 0.368 | 0.187 | 0.050 | 0.988 |

5.2 Empirical Results and Analysis

5.2.1 Economic Policy Uncertainty and Innovation -- Based on the Intermediary Effect of Financing Constraints

The results are shown in Table 3. Model 2 was regressed and the results were shown in column (1) of Table 3. The coefficient c_0 of total effect is 0.003, which is significantly positive at the level of 1%. This proves that H1b, Chinese enterprises will choose to increase innovation to enhance competitiveness in the face of economic policy uncertainty, and economic policy uncertainty promotes enterprise innovation as a whole. The results of model 3 are shown in column (2). The coefficient of explanatory variable α_1 is 0.022, which is significantly positive at the level of 1%. Therefore, it is verified H2, that is when the uncertainty increases, it will produce higher risk premium and enhance the financing constraints of enterprises. Model 4 was regressed, the results are shown in column (3) of Table 3. It can be seen that the coefficient β_1 is -0.165, which is significantly negative at the level of 1%. Because the test coefficients α_1 and β_1 are significant, the impact of economic policy uncertainty on enterprise innovation is at least partially realized through financing constraints. At the same time, the direct effect c_1 of economic policy uncertainty on enterprise innovation is 0.006, which is significantly positive at the level of 1%. It shows that there is a partial mediating effect, the promotion effect of economic policy uncertainty on enterprise innovation is only partially realized through financing constraints. Economic policy uncertainty increases financing constraint and inhibits enterprise innovation, which verifies H3.

Table.4. Empirical Test Results

| | (1) | (2) | (3) |
|-----------------|-----------------------|-----------------------|-----------------------|
| VARIABLES | Innova | SA | Innova |
| EPU | 0.003*** (3.797) | 0.022*** (33.32) | 0.006*** (4.753) |
| SA | | | -0.165*** (-3.093) |
| TobinQ | -0.001 (-0.845) | -0.009*** (-5.692) | -0.003** (-1.996) |
| ROE | -0.022*** (-2.920) | -0.038*** (-4.743) | -0.028*** (-3.623) |
| Size | 0.014* (1.939) | 0.082*** (7.443) | 0.027*** (3.078) |
| Far | 0.052** (2.576) | 0.025 (0.779) | 0.057*** (2.726) |
| Ldr | 0.006 (1.575) | -0.007*** (-6.395) | 0.001 (0.513) |
| Lev | -0.021 (-1.264) | -0.017 (-0.894) | -0.024 (-1.491) |
| Constant | -0.190 (-1.225) | 1.532*** (6.176) | 0.063 (0.432) |
| Observations | 5,029 | 5,029 | 5,029 |
| R-squared | 0.030 | 0.762 | 0.045 |
| Number of Stkcd | 1,979 | 1,979 | 1,979 |

Robust t-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.2.2 Robustness Check

Because it is difficult for the micro innovation activities of enterprises to affect the national macro policies, there is almost no reverse causality problem. Therefore, this paper attempts to test the robustness of the model by re-measuring and redefining explanatory variables.

(1) Re measurement of explanatory variables

This paper uses the geometric average method [54] and the weighted average method [54] instead of the arithmetic average to re measure. The results show that the direction of the variables are basically consistent with the conclusion.

$$EPU1 = \sqrt[12]{\prod_{m=1}^{12} EPU_{i,m}} \quad (5)$$

i represents the company and m represents the month.

$$EPU2 = \frac{EPU_{i,1} + 2EPU_{i,2} + \dots + 11EPU_{i,11} + 12EPU_{i,12}}{1 + 2 + \dots + 11 + 12} \quad (6)$$

(2) Redefinition and measurement of key variables

In this paper, the important variables are redefined. This paper selects the number of invention patent applications as the proxy variable of innovation output [56], and adds it to 1 to take logarithm, and repeats the above empirical analysis. The results are consistent with the above, so the results of this paper are more robust.

For the financing constraint variables, this paper uses the short-term net capital [56]: (cash holdings + inventory + (accounts receivable - accounts payable)) divided by total assets, to measure the financing constraints. The smaller the ratio, the greater the financing constraints. Repeat the above empirical process, the conclusion is consistent with the above.

6. Heterogeneity Test

6.1 The Heterogeneity Test of Enterprise Ownership

In China, the form of enterprise ownership is an important source of heterogeneity. The important position of state-owned enterprises and the relationship between government and enterprise will make it easier for them to obtain policy preference and financial support [56]. Therefore, this paper classifies the samples into state-owned enterprises and non-state-owned enterprises according to the nature of enterprise equity in CSMAR database. The regression results are shown in columns (1) and (2) of table 5. The results show that when economic policy uncertainty increases, the innovation performance of state-owned enterprises and non-state-owned enterprises is enhanced, but the EPU coefficient of state-owned enterprises is higher than that of non-state-owned enterprises, which are 0.007 and 0.008 respectively. The empirical p value obtained by bootstrap method was 0.081, which was significant at the level of 10%, which verified that the difference between groups was statistically significant. In conclusion, the economic policy uncertainty promotes the innovation of state-owned enterprises more than that of non-state-owned enterprises.

Table.5 Heterogeneity Test

| VARIABLES | (1) | (2) | (3) | (4) |
|--------------|----------------------|--------------------|----------------------|--------------------|
| | Non state-owned | state-owned | small-scale | large-scale |
| EPU | 0.007*** (4.38) | 0.008*** (2.82) | 0.004*** (2.89) | 0.010** (2.58) |
| SA | -0.202*** (-3.18) | -0.162* (-1.66) | -0.102** (-1.97) | -0.062 (-0.51) |
| TobinQ | -0.003** (-2.14) | -0.001 (-0.40) | -0.004 (-2.57) | 0.007 (1.33) |
| ROE | -0.033*** (-3.73) | -0.009 (-0.52) | -0.020*** (-2.92) | -0.052* (-1.73) |
| Size | 0.037*** (3.61) | -0.006 (-0.31) | 0.014** (2.33) | 0.029 (0.95) |
| Far | 0.049** (2.11) | 0.104** (2.41) | 0.036* (1.73) | 0.098 (1.64) |
| Ldr | 0.001 (0.64) | -0.000 (-0.09) | 0.000 (0.16) | 0.004 (1.01) |
| Lev | -0.016 (-0.91) | -0.043 (-1.05) | -0.020 (-1.34) | -0.031 (-0.41) |
| Constant | -0.050 (-0.34) | 0.812 (1.51) | 0.151 (0.95) | -0.353 (-0.45) |
| Observations | 3896 | 1133 | 3735 | 1294 |

| | | | | |
|---------------------------|--------|-------|----------|-------|
| R-squared | 0.069 | 0.035 | 0.034 | 0.053 |
| Difference between groups | -0.001 | | -0.006 | |
| Empirical p-value | 0.081* | | 0.001*** | |

Robust t-statistics in parentheses,***p<0.01, **p<0.0, *p<0.1

State owned enterprises have stronger political connections and can obtain more policy information, so policy uncertainty has less impact on them. Because non-state-owned enterprises are more sensitive to changes in the economic environment, non-state-owned enterprises are more likely to invest their limited resources into activities that are more likely to bring economic benefits when faced with increasing uncertainty in order to maintain the short-term competitiveness, the economic policy uncertainty promotes the innovation of state-owned enterprises more than that of non-state-owned enterprises.

6.2 The Heterogeneity Test of Enterprise Scale

The size of an enterprise affects its ability to take risks when the environment changes. The impact of economic policy uncertainty on innovation activities of enterprises of different sizes may be different. This paper takes the average value of the total assets of companies in the same industry and the same year [56]. The enterprises whose asset size is greater than the average value are defined as large-scale enterprises, and the rest are small-scale enterprises. The results of grouping regression are shown in columns (3) and (4). The results show that when the economic policy uncertainty increases, the innovation activities of large enterprises and small enterprises are significantly enhanced, but compared with small-scale enterprises, the EPU coefficient of large-scale enterprises is higher, which is 0.004 and 0.010, respectively. The empirical p value obtained by bootstrap method was 0.001, which was significant at 1% level, which verified that the difference between groups was statistically significant. It is concluded that the economic policy uncertainty promotes the innovation of large enterprises more than small enterprises. Large scale enterprises have rich resources and strong talent strength, so they can resist R&D risk when the environment changes. Small scale enterprises are relatively lack of management process and experience, so they are faced with higher risks, so the promotion effect of scale enterprise innovation is greater than that of small-scale enterprise.

7. Conclusion

Economic policy uncertainty is one of the hot topics in academic research in recent years. The change of macro policy environment will have a profound impact on the micro level behavior of enterprises, and innovation driven has always been the development strategy of China, so we should pay enough attention to enterprise innovation activities. Based on the sample of China's A-share listed companies from 2008 to 2019, this paper and draws the following conclusions: (1) financial constraints play a negative intermediary effect between economic policy uncertainty and enterprise innovation, which means economic policy uncertainty increases financing constraints, thus inhibiting its positive promotion effect on enterprise innovation. (2) Compared with non-state-owned enterprises, economic policy uncertainty has a more obvious role in promoting state-owned enterprises. (3) Compared with small-scale enterprises, the innovation activities of large-scale enterprises are more promoted by economic policy uncertainty.

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