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Studies on the influence of economic policy uncertainty on the growth of the digital economy

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Abstract
This paper outlines a theoretical mechanism for how economic policy uncertainty impacts the growth of the digital economy and argues that this uncertainty will have an incentive effect as well as a selection effect. In light of this, this paper conducts empirical research using panel data of prefecture-level cities and the uncertainty index of China's economic policy created by Baker *et al*. (2016). (1) Economic policy uncertainty is having a positive impact on the growth of the digital economy, according to the study. (2) The effects of uncertain economic policy on the digital economy vary widely. The promotion of the digital economy is negatively impacted by the uncertainty of economic policy in the eastern and southern regions, as well as in regions with large cities and high levels of economic development, but this impact is minimal or nonexistent in other regions.

Keywords: Economic policy uncertainty, Digital economy, Intermediary effect, Foreign Direct Investment (FDI)

1. Introduction
According to the Digital China Development Report (2020), the added value of the core sectors of the digital economy accounts for 7. 7% of GDP, placing China's overall digital economy second only to that of the United States.
The literature review found that, aside from not discussing the impact of economic policy uncertainty on the development of the digital economy at the empirical level, the existing research lacks a comprehensive and ideal framework to address the endogenous issues brought on by mutual causation and the ways in which economic policy uncertainty affects the development of digital economy. This paper develops a multi-period double difference (DID) model based on the panel data of 269 cities from 2011 to 2018 and empirically tests the impact of economic policy uncertainty on the development of the digital economy. It then uses the intermediary effect to verify this mechanism in order to make up for the shortcomings of earlier studies. The marginal value of this paper is reflected in the following three areas: First, using an empirical approach, the impact of economic policy uncertainty on the growth of the digital economy is discussed. This fills a gap in prior research and adds to the pertinent literature on economic policy uncertainty research. Second, this paper elaborates the theoretical mechanism of how economic policy uncertainty affects the digital economy, contending that it has both motivating and restricting effects. This argument offers a plausible theoretical justification for the connection between economic policy instability and innovation. Third, the area of study for the digital economy has grown.

2. Literature review
The marginal contribution of this paper is reflected in the following three areas: First, using empirical methods, the impact of economic policy uncertainty on the growth of the digital economy is discussed. This fills in the gaps left by earlier studies and ads to the body of knowledge on economic policy uncertainty research. Second, this paper elaborates the theoretical mechanism by which economic policy uncertainty influences the digital economy, contending that it has both an incentive and a selection effect, offering a plausible theoretical justification for the connection between economic policy uncertainty and innovation. This argument is based on work. Third, the scope of research on the digital economy has grown (Sahinoz *et al*., 2018) [4].

The global financial economy was significantly impacted by the financial crisis in 2006, and countries responded by implementing corresponding policies and measures to mitigate its negative effects. The uncertainty index of American economic policy was created by Baker and colleagues after they extracted keywords from ten major news stories in the United States, counted the frequency of articles about economic policy uncertainty, proposed that American economic policy uncertainty might delay the economy's recovery from the recession, and empirically verified that American economic policy uncertainty had a negative impact on stock price fluctuations (Al-Thaqeb & Algharabali, 2019) [5].

Digital econometrics is receiving earlier and more sophisticated attention internationally. Instances include the "Network Maturity Index" from the World Economic Forum, the "Digital Economy and Social Index" from the European Commission, the "Measuring Digital Economy: A New Perspective" report from the OECD, and the "2019 Digital Economy Report" from the United Nations Conference on Trade and Development. Currently, China primarily evaluates the state of the digital economy from the following three perspectives: First, it emphasizes innovation environment, innovation investment, and innovation performance as the internal forces driving the development of the digital economy. The Zhongguancun Index, China Innovation Index, and National Innovation Index are common examples. The second is to carry out intricate accounting for the value that the digital economy has added. Thirdly, we should create a comprehensive index system that takes into account the characteristics of the current digital economy development in China, similar to the 2018 Global Digital Economy Development Index published by Alibaba Research Institute and the 2020 China Digital Economy Growth Index (DEDI) published by CCID Consulting (Xu & Chen, 2017) [6].

Currently, some academics have discussed the characteristics of the temporal and spatial distribution of the digital economy from the standpoint of empirical econometric analysis. The main focus of the analysis is on the country's overall level when examining the temporal and spatial distribution characteristics of the digital economy (Bukht, &Heeks, 2017) [7]. Some academics have also discussed the regional variations in the growth of the digital economy between the Yangtze River Economic Belt and the Yellow River Basin. Four main types can be identified based on the evaluation techniques. In order to simply reflect the significant differences and time evolution characteristics between subgroups, the time-space trend diagram of various regions is first drawn. This diagram is typically used for the basic analysis of regional differences. Second, the primary causes of regional differences are revealed using the Dagum-Gini coefficient (Valenduc&Vendramin, 2016) [8]. Thirdly, the distribution law and dynamic evolution law are described using kernel density estimation. The fourth is to use spatial agglomeration analysis to investigate the spatial characteristics of the development of the digital economy (Shen&Zhang, 2022) [9]. These records can be consulted in the course of this study.

3. Research Hypothesis

Economic Policy Uncertainty's Impact on the Urban Digital Economy

The majority of scholars in the literature currently in existence concur that the impact of enterprise investment on the economy results from the uncertainty of economic policy, and they use the real option theory to analyze the uncertainty of economic policy (Hailemariam *et al*., 2019) [11]. Empirically, Gulen and Ion (2016) [10] discovered a strong inverse relationship between capital investment and economic policy uncertainty. The impact is greater for businesses that depend more heavily on government spending and have more irreversible investment. Based on this theory, Guo *et al*. (2020) [12] came to the conclusion that enterprise investment is inhibited by economic policy uncertainty, and that effect varies over time. According to Kong *et al*. (2022) [13], the increasing unpredictability of economic policy will cause businesses' investment efficiency to decline, creating a vicious cycle that will impede business growth.

Many academics are concerned about the mechanism connecting economic policy uncertainty with innovation in today's era of scientific and technological progress and technological innovation, which is the subject of many research papers on economic policy uncertainty and enterprise investment. Two schools of thought on how economic policy uncertainty affects innovation are recognized in the literature. One school holds that economic policy uncertainty has a positive effect on innovation, while the other holds that it has a negative effect. The "uncertainty proposition" advanced by Bhagat *et al*. (2016) [14] is an example of the school of positive influence, which maintains that genuine uncertainty is the only source of profit and that profits cease to exist when events or policy changes are predictable. Uncertainty will encourage business innovation in terms of innovation. The following assumptions are made in this paper based on the literature review mentioned above:

H1a: Economic policy uncertainty has a favorable effect on the growth of the digital economy.

H1b: The uncertain nature of economic policy is detrimental to the growth of the digital economy.

The Influence Mechanism of Economic Policy Uncertainty on the Effect of Urban Digital Economy Technology Diffusion

On the one hand, the unpredictability of economic policy improves the transportation convenience of cities along the route, strengthens the connection between cities, and establishes channels for technology and information dissemination between different cities, leading to the diffusion of technology. Simultaneously, information flow reduces the investment risk caused by information asymmetry and enhances the innovation investment of businesses in various regions (Zhang *et al*., 2021) [16].

Consequently, economic policy uncertainty promotes the technological diffusion of cities along the route. On the other hand, technology diffusion can also generate new technologies and formats for digital transformation in the industrial sector. For the growth of the digital economy, technological innovation and the transformation of its

Achievements can generate new market demand and new market opportunities. This demand can also entice businesses to develop new products and models, cultivate new kinetic energy to replace old kinetic energy, and promote the digital development of the industry by means of new kinetic energy (Xu *et al*., 2022) [17]. Technology diffusion helps to promote the benign interaction between producer service industry and manufacturing industry, break through industrial boundaries to achieve integrated development, promote industrial division of labor and specialization, and achieve collaborative agglomeration between manufacturing industry and service industry, thereby generating digital and information service industry and fostering the growth of the digital economy (Arbatli, 2011) [18].

H2: Foreign direct investment mediates the relationship between economic policy uncertainty and digital economic expansion.

4. Data description and model construction

Variable Explanatory - Economic Policy Uncertainty (EPU)

Currently, the majority of academics use the Baker-China Economic Policy Uncertainty Index to measure economic policy uncertainty. In other words, the number of economic policy uncertainty-related articles in a country's primary news or media are screened out and then standardized. China can be identified by using four terms: first, "China, China," second, "economy, economy," third, "uncertainty, uncertainty," and fourth, "policy, expenditure, budget, government." For a report with four keywords including economy, uncertainty, and policy, the target document must include at least one word from each group. On this basis, synthetic text screening is performed to determine the number of target articles per month, articles unrelated to economic policy uncertainty are manually read and screened out, and the ratio of the number of target articles to the total number of articles for the month is then calculated. After numerical standardization, the economic policy uncertainty index for China is derived. Due to the monthly nature of the data, the weighted average method is utilized to transform them into annual data.

Explanatory variable-digital economy development

Not only is digital economy the proper definition of high-quality development at this stage, but it is also the only way to construct a modern economic system. Using the method of Presch *et al*. (2020) [20] as a guide, we evaluate it from five perspectives: inclusive finance, output level, Internet penetration, employee penetration, and mobile phone penetration. The other four items are the total per capita telecommunications services, per capita Internet broadband access, the ratio of computer and software employees to urban employees, and the total per capita mobile phones (Alimova, 2020) [20]. The principal component analysis technique is then utilized to standardize and reduce the dimension, and the comprehensive indicators of digital economy evaluation are synthesized.

Intermediate Variable (FDI)

Given that foreign direct investment will affect foreign investment and technology introduction in domestic enterprises' innovation projects, as well as domestic innovation capacity, this paper uses the quantity of foreign direct investment as an intermediary variable to analyze its intermediary effect in the process of economic policy uncertainty influencing innovation. This variable is measured by the amount of actual foreign direct investment from 2001 to 2019 and is expressed as foreign direct investment. Other control variables between 2001 and 2019 include gross domestic product (GDP), R&D investment (RD), and patent application (PAT). GDP is a measure of the level of economic development as a whole, so GDP is used as the control variable here. Patent applications and R&D expenditures are used to determine the innovation level of a region. The data is derived from the China Statistics Bureau's annual R&D census bulletin. R&D investment is denoted in R&D. The data for GDP, FDI, and PAT from 2001 to 2019 come from the Statistical Yearbook of China. Table 1 displays descriptive statistics about variables.

Table 1: Descriptive statistics

Variable name	Variable definition	Sample size	Mean value	Standard deviation	Minimum value	Maximum
EPU	Uncertainty index of economic policy (weighted average method)	622	228.7	199.5	74.8	828.6
DIG	Development degree of digital economy	622	3.650	2.260	1.313	15.660
FDI	Foreign direct investment	622	58.90	70.25	0.0267	267.09
MAR	Marketization level	622	6.266	2.890	-1.283	12.38
HUCA	Human capital	622	0.084	0.025	0.027	0.164
INF	Infrastructure	622	2.486	0.462	0.397	4.283

5. Empirical results and analysis

1. Benchmark regression analysis

In order to effectively reflect the linear impact of economic policy uncertainty on the development of the digital economy, the empirical analysis in this paper employs a panel regression model. The panel model's settings are as follows.

$$DIG = \alpha_{it} + \beta 1 EPU_{it} + \beta 2\ FDI + \beta 3\ MAR + \varepsilon_{it} \quad (1)$$

Table 2: Impact of economic policy uncertainty on the development of digital economy: benchmark regression

Variable	(1)	(2)	(3)	(4)	(5)	(6)
EPU	0.484***	1.518**	3.490***	0.239	0.005	0.017**
DIG		0.845***	0.031***	0.756***	0.037**	0.016***
FDI			0.093***	0.626**	0.075***	0.273***
MAR				0.028**	0.084***	0.914**
HUCA					2.660***	-0.040
INF						–0.132***
N	622	622	622	622	622	622
R^2	0.290	0.385	0.485	0.485	0.395	0.495

2. Conduction mechanism analysis (intermediary model regression analysis)

Table 3: Intermediary model regression analysis

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Ln $EPU_{i,t-1}$	0.593***	0.459***	0.934***	0.934***	0.234***	0.956***
	(0.00845)	(0.0745)	(0.0845)	(0.0124)	(0.0185)	(0.0175)
Ln $EPU_{i,t}$			0.734***			
			(0.0456)			
Constant	3.738***	3.284***	4.382***	4.586***	0.9539***	2. 185***
	(0. 0636)	(0. 169)	(0. 169)	(0. 169)	((1. 066))	(0. 169)
Control	Yes	Yes	Yes	Yes	Yes	Yes
N	622	622	622	622	622	622

3. Heterogeneity analysis

Regional differences exist in terms of economic development, local policies, and innovations. To investigate the regional heterogeneity of the effect of economic policy uncertainty on the growth of the digital economy, each province is divided into central, eastern, and western regions. Table 4 demonstrates the group's regression. The negative coefficient for the impact of economic policy uncertainty on the growth of the digital economy is 1% in the central and eastern regions and 10% in the western regions. This indicates that as economic policy uncertainty increases, the development of the digital economy in the central and eastern regions will decline. The western region has the lowest absolute value of the lnEPU coefficient, indicating that the impact of economic policy uncertainty on its level of digital economy development is weaker than in the other two regions. This may be because the western region is underdeveloped, its policies lag behind, its sensitivity to economic policy uncertainty is low, its own development is limited, and its investment and innovation are limited. On the basis of a relatively low level of innovation, the unpredictability of economic policies will limit the uncertainty risk.

The central region is more sensitive to economic policy uncertainty than the eastern region. This may be a result of its relatively developed economy, high degree of marketization, rapid response mechanism to changes in rules and policies, and strong risk perception, which enable it to adapt rapidly to the unpredictability of economic policy changes and low sensitivity to innovation. In addition, it can be observed that only in the western region does FDI have a significant positive impact on the level of digital economy development. The lower the level of digital economy development, the greater the sensitivity of foreign direct investment to innovation levels. This is because the western region lacks innovation and resources. Agriculture and heavy industry make up the majority of its developed industries, resulting in low levels of foreign investment, competitiveness, and technology. Therefore, the introduction of foreign direct investment will rapidly result in the expansion of market technology and the enhancement of innovation level.

Table 4: Heterogeneity analysis

Variable	(1) Eastern region	(2) Central region	(3) Western region
Ln $EPU_{i,t-1}$	0.088***	0.856***	-0.254***
	(0.035)	(0.834)	(0.485)
Ln $EPU_{i,t}$	0.0163	0.00845	0.0264
	(0.0348)	(0.0034)	(0.00834)
Constant	5.342	4.354	3.567
	(0.365)	(0.374)	(0.234)
Control	Yes	Yes	Yes
N	198	109	109

6. Conclusions

This paper concludes through an empirical test that the uncertainty of economic policy has a positive impact on the development of the digital economy, and FDI plays an intermediary role in this impact mechanism. This conclusion is based on existing literature and data analysis. Economic policies are unpredictable, which has caused changes in market dynamics. Increased market information asymmetry and growing economic policy uncertainty cause foreign investors to lose faith in the Chinese market, which results in a decline in FDI and foreign direct investment (FDI). The level of innovation is influenced by FDI and the competitiveness and technology spillover effects. FDI has a positive effect on innovation. Therefore, the decline in foreign direct investment brought on by the increased unpredictability of economic policy will impede the development of the digital economy even more.

First, stabilize the economic policy fluctuation trend and encourage innovation and development. The growth of the digital economy is positively correlated with economic policy uncertainty, according to empirical research. In light of the foregoing, this paper contends that the government should fully comprehend the current economic situation before formulating economic policies, issue economic policies in accordance with the economic situation, control the range of economic policy fluctuation within a certain range, consolidate the confidence of domestic and foreign investors in China's government behavior, emphasize the government's role in maintaining stability, and increase the innovation power of domestic firms. The government should also support technological innovation businesses or projects and introduce policies that will benefit the populace, such as R&D support and innovation support, to promote innovation across the board.

Second, in the context of the digital economy, human capital has emerged as a key driver of foreign direct investment.

Major developed nations place a high value on scientific and technological talent, and developing talent has turned into a strategic advantage. The growth of the digital economy can lower the cost of higher education for individuals. More people now have access to higher education thanks to the growth of online and distance learning, which raises the quality of human capital. In the age of the digital economy, the quantity and quality of innovative talent are crucial factors in determining a nation's foreign direct investment, illuminating the need for us to focus on the development of digital economy talent. The level of human capital or innovative talents in EU nations should be taken into account when Chinese businesses invest directly there.

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