DOES ECONOMIC POLICY UNCERTAINTY AFFECT FIRM DIGITAL TRANSFORMATION?

DING XING，KANGNING XU

School of economics and management, Southeast University, Nangjing 211189, China
E-MAIL: 230198625@seu.edu.cn

Abstract:

The economic policies of different regions in China vary greatly, this research examines the impact of Chinese provincial economic policy uncertainty (EPU) on firm digital transformation. The sample of this paper is A-share listed firms in China from 2007 to 2021. We find that there is a negative relationship between provincial EPU and firm digital transformation, and this negative impact is more obvious for non-state-owned firms, firms operating in highly competitive industries, and firms that face higher EPU. Our study provides significant evidence of the influence of EPU on firm digital transformation with the provincial EPU index. This study extends the research on the economic impact of EPU in the context of developing and emerging countries.

Keywords:

Economic policy uncertainty; Digital transformation; Listed firms

1. Introduction

As digital technology continues to advance rapidly, digital transformation has become an inevitable trend in society and economic development. For developing countries, this is a rare opportunity to promote economic development. The Chinese government has promulgated many policies to promote China's digital development. For example, the "14th Five-Year Plan for Digital Economy Development" of China unveiled in 2022 was put forward to accelerate the digital transformation and upgradation of enterprises. And the process of digital transformation of companies in China has been developing rapidly in recent years. According to the 2018 and 2022 reports of Accenture, the proportion of firms with remarkable digital transformation in China increases from 7 % in 2018 to 17 % in 2022[1]. Digital transformation has huge economic and social implications. The digital transformation positively impacts innovation (Gaglio et al., 2022; Peng and Tao, 2022; Liu et al., 2023), it can solve enterprises' innovation dilemmas (Zhuo and Chen, 2023) and affect their competitive advantage (Blichfeldt and Faullant, 2021). Whether firms seize the opportunity of digital transformation determines whether they are able to occupy an advantageous position in the future.

Since the global financial crisis in 2008, the global EPU has become more volatile. The Chinese government has released many regional economic policies to promote economic development. From the 11th Five-Year Plan starting in 2006 to the 13th Five-Year Plan ending in 2020, China has issued different strategies and policies based on different regions, such as the four-region strategy, the large-scale development in the western region, the revitalization of the northeast, and the integrated development of Beijing-Tianjin - Hebei region. As China is a policy-oriented country, compared with the impact of the national-level EPU, Chinese enterprises are more affected by China's regional policy uncertainty. Since the EPU in different provinces is very different, it is necessary to use the Chinese provincial EPU index to examine the relationship between EPU and the digital transformation of enterprises.

Based on the above observation, we examine the relationship between Chinese provincial EPU and digital transformation from 2007 to 2021, using data on Chinese A-share listed firms. The question studied in this paper is whether EPU can promote firm digital transformation, whether the influence of EPU on digital transformation exists firm heterogeneity.

We contribute to the stream of research that explores the relationship between EPU and digital transformation, and we expand the research field of policy economics and digital economics. Extant literature uses the national-level EPU index which mainly captures the uncertainty of foreign policies. However, China's regional economic policies vary considerably, and the uncertainty of regional economic policies has a more important impact on domestic enterprises. It is necessary to use the Chinese provincial EPU index to

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[1] More details are available at https://www.accenture.cn/cn-zh/insights/digital/corporate-digital-transformation-index and https://www.accenture.cn/cn-zh/insights/strategy/china-digital-transformation-index-2022.

measure the effects of EPU more rigorously.

The remainder of this paper is organized as follows: Section 2 provides a review of the relevant literature and theoretical analysis. Section 3 outlines the methodology used in this study. Section 4 reports the empirical findings. Section 5 offers concluding remarks.

2. Literature review

Our research relates to the literature about the effects on firm digital transformation from EPU. It is only recently that some studies have explored the relationship between EPU and digital transformation. Using the EPU data at the country-level in China, Zhuo and Tajul (2022) were the first to study the effect of EPU on the digital transformation of enterprises. They proposed that EPU promotes enterprise digital transformation, and the economic channel is the competitive nature of the market. Because large-scale, state-owned, and strong corporate governance companies have better viability, they lack the motivation for digital transformation under EPU. Related to this kind of literature, Chen and Tian (2022) study the influence of environmental uncertainty on digital transformation. They put forward that digital transformation is not determined by a single factor, and interactions of environmental uncertainty and resource orchestration play an important role in digital transformation.

In summary, few studies examine the correlation between EPU and digital transformation with provincial EPU index. Distinct regions within a country have different levels of economic development and various economic policies, so they are inevitably affected by EPU differently, it is necessary to examine it with provincial EPU index. To fill this gap, we examine the effect of EPU on Chinese company digital transformation using provincial-level EPU data.

3. Methodology

3.1. Data and variables

Our research scope covers 31 provinces and autonomous regions in China. Our enterprise data come from the CSMAR Database, the DRCNET Database, and the CNRDS Database. All the firms are strictly come from the 31 provinces. We start with the CSMAR Database, select China's A-share listed firms and exclude the financial firms and "special treatment" firms. We also drop firms with missing data for the main variables. Our final sample of firms includes 4,196 firms with 34,281 firm-year observations during the period 2007-2021.

3.1.1. The measurement of digital transformation

Most researchers propose that digital transformation is based on digital technologies and enables major business improvements (Fitzgerald et al., 2014; Singh and Hess, 2017; Vial, 2019; Gong and Ribiere, 2021). Because digital transformation and digital technologies are inseparable, many researchers utilize the frequency of keywords linked to digital technology in companies' annual reports to assess the digital transformation of enterprises (Zhai, et al., 2022; Zhu et al., 2022). The digital transformation data we use comes from CSMAR database. First of all, the keywords are referred to the specific keywords about digital transformation put forward by Wu, et al. (2021). Then, we exclude the expressions of negative words such as "no", "none" and "not" before the keywords, and the full-text search is carried out in the annual financial reports of listed companies. Finally, we measure digital transformation of enterprises with the sum of the frequency of all keywords.

3.1.2. The measurement of EPU

Baker et al. (2016) develop a monthly EPU index based on the frequency of EPU related keywords in newspapers with text research method, and they measure China's country-level EPU index using the South China Morning Post. Huang and Luk (2020) construct a monthly EPU index using 10 mainland newspapers distributed in major cities in China, and they produce a daily EPU index using 114 Chinese newspapers. Unlike the existing study constructing EPU index with newspaper, Lee et al. (2023) construct daily and monthly frequency Chinese EPU index based on tweets on Twitter. Different from the above studies which are all building national EPU index, Yu et al. (2021) enrich the keywords and construct a provincial monthly EPU index using the daily newspapers of 31 Chinese provinces. Distinct from Baker's China EPU dividing the target articles by all the articles, Yu et al. (2021) exclude non-economy news, and they construct EPU by dividing the target articles by economy related articles.

To study the influence of economic policy uncertainty on digital transformation more accurately, this paper mainly refers to the method of Yu et al. (2021) to construct the EPU index of 31 provinces in China from 2007 to 2021. The EPU construction method of this paper is as follows: divide the number of articles in the full-text of provincial and municipal daily newspapers containing relevant keywords of economy, policy, and uncertainty by the number of articles in the full-text of provincial and municipal daily newspapers containing relevant keywords of economy. Among them, the keyword criteria of "economy", "policy" and "uncertainty" were constructed by Yu et al. (2021).

3.1.3. Other variables

Following previous related studies (Tran, 2019; Guan et al., 2021; Lou et al., 2022), this paper control for a set of variables at firm level. Our main control variables are firms' leverage ratio (*Leverage*), size (*Size*), income growth rate (*Growth*), profitability (*ROA*), tangible asset ratio (*Tangibility*), cashflow asset ratio (*Cashflow*), and ownership type (*SOE*). Definitions of all research variables are reported in Table 1.

Table 1 Definitions of research variables.

Variables	Definitions
DT	Ln (Digital transformation index).
EPU	Economic policy uncertainty index.
Leverage	Total liabilities / total assets.
Size	Ln (total assets).
Growth	(Current operating income - last operating income) / last operating income.
ROA	Net profit / total assets.
Tangibility	Total tangible assets / total assets.
Cashflow	(Net operating cash flow + net investment cash flow) / total assets.
SOE	The value is 1 if the ultimate controller of the firm is state-owned, otherwise it is 0.

3.2. Base-line regression specification

To test the effects of EPU on firm digital transformation, we construct regression model (1).

$$DT_{i,t} = \alpha + \beta EPU_{i,t} + \gamma' Control_{i,t} + Firm_i + Province_i + Year_t + \varepsilon_{i,t} \qquad (1)$$

where *i* denotes firm, *t* denotes time, and ε is the residual term. The dependent variable *DT* refers to a firm's digital transformation. *EPU* is the economic policy uncertainty. *Firm* is a firm dummy variable, *Province* is a region dummy variable and *Year* is a year dummy variable. *Control* represents a series of firm-specific control variables that affect digital transformation, including firms' leverage ratio (*Leverage*), size (*Size*), income growth rate (*Growth*), profitability (*ROA*), tangible asset ratio (*Tangibility*), cashflow asset ratio (*Cashflow*), and ownership type (*SOE*).

4. Results

4.1. Descriptive statistics

Table 2 presents a descriptive statistical analysis of the variables used in our analysis. It shows that the median of firm digital transformation is 0.693 while its minimum and maximum is zero and 6.301, respectively.

Table2 Descriptive statistics.

Variables	N	Mean	Median	SD	Min	Max
DT	34281	1.238	0.693	1.382	0	6.301
EPU	34281	0.528	0.523	0.119	0.187	0.834
Leverage	34281	0.412	0.403	0.224	0.007	9.429
Size	34281	22.08	21.87	1.323	17.88	28.64
Growth	34263	0.342	0.125	11.86	-1.309	1878
ROA	34281	0.0420	0.0420	0.104	-4.946	7.446
Tangibility	34281	0.929	0.958	0.0910	0.125	1
Cashflow	34280	-0.0170	-0.007	0.113	-1.915	2.872
SOE	34281	0.355	0	0.479	0	1

Specifically, Figure. 1 shows that the minimum values from 2007 to 2021 are all zero, and the medians are also almost zero. This evidence reflects that most of these firms have not yet undergone digital transformation or are at a lower level of digitalization, and the digital transformation process of firms varies greatly.
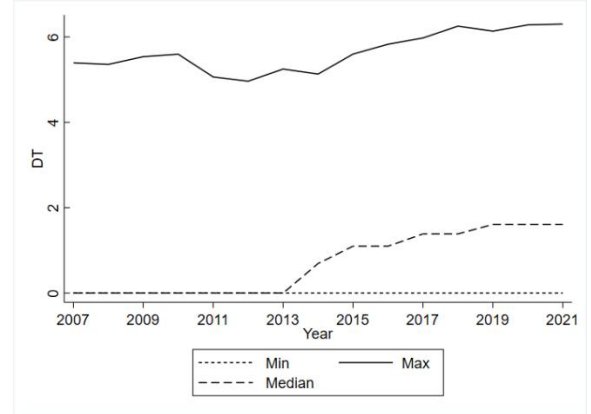

Figure. 1. Distribution of digital transformation (DT) by year

Figure. 2 shows that from 2007 to 2021, the range of EPU is very large every year, indicating that there is a huge disparity in EPU among 31 provinces. The EPU suffered by firms in different provinces is definitely different. In addition, the maximum and minimum of EPU show a trend of rapid increase at first and then decrease slowly, and the median of EPU also shows a similar trend. However, the trend of median EPU is gradually approaching the maximum by year. This shows that EPU in various provinces of China are undergoing structural changes, and the proportion of provinces with larger EPU is increasing. Therefore, it is necessary to use the provincial EPU index to examine the impact of EPU.
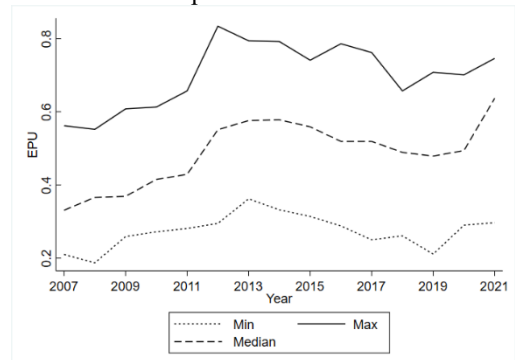

Figure. 2. Distribution of economic policy uncertainty (EPU) by year

4.2. Baseline results

The fixed effects model and the random effects model are compared using the Hausman test, and the results of the test provide evidence against the null hypothesis, so we choose fixed effects model for regression analysis.

Table 3 presents the results of regression (1). The table shows that, on the whole, EPU has a significantly negative correlation with digital transformation. When we cluster standard errors (columns 2) and control other variables (columns 3 and 4), the results still hold significantly. This means that firms are more reluctant to digital transformation when they face higher levels of EPU. The above results show when enterprises face a high level of economic policy uncertainty, they prefer not to carry out digital transformation. Compared to the strategic growth option theory, enterprises are more inclined to show the strategic investment mode of waiting for the right time before digital transformation, which is put forward by real options theory. Increased EPU makes firms financing difficult and not to implement digital transformation. This is contrary to the previous research conclusions obtained by using the national economic policy uncertainty index (Zhu et al., 2023; Xu and Liu, 2023; Yang et al., 2023), the main reason is that the EPU index used in previous literature is national, which mainly measures the economic policy uncertainty brought by countries outside China, while the provincial EPU used in this paper describes the economic policy uncertainty caused by the internal economic policy changes of the country and provinces.

Table 3 Results of baseline regression.

Variables	(1) DT	(2) DT	(3) DT	(4) DT
EPU	-0.448***	-0.439***	-0.394***	-0.386***
	(0.066)	(0.121)	(0.065)	(0.116)
Leverage			-0.009	-0.007
			(0.035)	(0.057)
Size			0.255***	0.255***
			(0.012)	(0.031)
Growth			0.0004***	0.0004***
			(0.0001)	(0.0001)
ROA			-0.115**	-0.112*
			(0.053)	(0.065)
Tangibility			-0.864***	-0.863***
			(0.079)	(0.195)
Cashflow			0.001	-0.01
			(0.039)	(0.054)
SOE			-0.029	-0.028
			(0.033)	(0.075)
Constant	1.469***	1.467***	-3.364***	-3.371***
	(0.035)	(0.064)	(0.28)	(0.663)
Firm FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster SE	No	Yes	No	Yes
Observations	33806	33673	33790	33657
R-squared	0.777	0.777	0.784	0.785

Note: We clustered standard errors at the fourth level industry classification when indicated. Robust standard errors are reported in parentheses. ***, **, and * means significant at the level of 1%, 5%, and 10%, respectively.

With regard to control variables, the estimated coefficients are generally as expected. Consistent with Chemmanur et al. (2019), the coefficient of *Size* is positive and significant at the 1% level in regressions. This indicates that larger firms are more capable and have more capital, so they are more inclined to digital transformation. The coefficient of *Growth* is positive significantly at the 1% level in column 3 and column 4. This suggests that greater operating income growth is associated with higher-level digital transformation. The coefficient of *Tangibility* is negative significantly at the 1% level in regressions. This finding indicates that firms with higher tangible assets shares are less likely to conduct digital transformation. This result is in line with the findings of the current literature (Pang and Wang, 2020; Chang et al., 2019).

4.3. Heterogeneity analysis

4.3.1. EPU and digital transformation by firm ownership

To explore whether the influence of EPU on digital transformation exists heterogeneity of firm ownership, we classify the samples into state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs) based on the ownership structure of listed firms. As shown in Table 4 (columns 1 and 2), the regression coefficient of EPU to enterprise digital transformation in non-SOEs is -0.512, which is significant at the 1% level. The regression coefficient of EPU on digital transformation in SOEs is -0.173 and significant at the 10% level. This indicates that non-state-owned enterprises are more acute to EPU, and when facing economic policy uncertainty, they prefer not to have a digital transformation. Generally speaking, compared with SOEs, it is more difficult for non-SOEs to obtain various resources, and external financing is more difficult and the cost is relatively higher. Therefore, non-SOEs are more affected by EPU.

Table 4 Results of heterogeneity analysis.

Variables	(1) non-SOEs DT	(2) SOEs DT	(3) High EPU DT	(4) Low EPU DT	(5) High LI DT	(6) Low LI DT
EPU	-0.512***	-0.173*	-0.341**	0.013	-0.379***	-0.303***
	(0.084)	(0.102)	(0.152)	(0.147)	(0.095)	(0.096)
Leverage	-0.039	-0.199***	0.046	-0.078*	-0.058	-0.02
	(0.041)	(0.075)	(0.07)	(0.048)	(0.063)	(0.047)
Size	0.272*	0.193*	0.277*	0.239*	0.231*	0.291*

	(1)	(2)	(3)	(4)	(5)	(6)
	**	**	**	**	**	**
	(0.016)	(0.019)	(0.021)	(0.016)	(0.018)	(0.018)
Growth	0.0004	0.001***	0.0002	0.002*	0.0005***	0.002
	(0.001)	(0.0001)	(0.0001)	(0.001)	(0.0001)	(0.002)
ROA	-0.118**	0.11	-0.201**	-0.107**	-0.358***	-0.043
	(0.057)	(0.208)	(0.102)	(0.051)	(0.101)	(0.046)
Tangibility	-0.842***	-0.305*	-0.792***	-0.949***	-0.789***	-1***
	(0.094)	(0.163)	(0.132)	(0.113)	(0.112)	(0.129)
Cashflow	0.058	-0.265***	0.021	0.006	0.01	0.005
	(0.046)	(0.073)	(0.062)	(0.055)	(0.057)	(0.057)
SOE			-0.021	-0.067	-0.018	-0.006
			(0.063)	(0.043)	(0.048)	(0.05)
Constant	-3.425***	-2.985***	-3.92***	-3.185***	-2.923***	-4.095***
	(0.374)	(0.452)	(0.502)	(0.382)	(0.428)	(0.439)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	21657	12075	14646	17988	16324	16428
R-squared	0.802	0.749	0.805	0.797	0.822	0.781

Note: Robust standard errors are reported in parentheses. ***, **, and * means significant at the level of 1%, 5%, and 10%, respectively.

4.3.2. EPU and digital transformation with different EPU

In order to test whether different EPU levels affect the digital transformation of enterprises, we divide the sample into two groups by year on the basis of the median of EPU, samples with EPU higher than the median of EPU are classified as high EPU group, and the rest are low EPU group. We run our baseline regression for these two groups in Table 4 (columns 3 and 4). We find that EPU has a negative effect on digital transformation at a significant level of 5% in firms with high EPU, while the coefficient is not significant in firms with low EPU. These results mean that when EPU is low, the digital transformation process of firms will not be affected, but when EPU is high, firms will delay digital transformation. This is similar to Hao et al. (2022), who find that enterprises respond differently when facing different levels of EPU.

4.3.3. EPU and digital transformation with different market competition

To test the effect of EPU on digital transformation under different degrees of market competition, the samples are divided into two groups according to the median of market competition every year. We use the industry Lerner index (LI) to measure industrial competitiveness. Those above the median of market competition are classified as the high market competition group (high LI), and the rest as the low market competition group (low LI). We then regress digital transformation on EPU and other control variables for each group using regression (1). We present the regression results in Table 4 (columns 5 and 6).

The results show that there is heterogeneity in the impact of EPU on digital transformation at different levels of market competition. The estimated coefficient for EPU is -0.379 for firms in the high market competition (column 5), and -0.303 for firms in the low market competition (column 6), which are both significant at the 1% level. This result demonstrates that EPU inhibits digital transformation of firms with higher market competition. When in high market competition, firms' innovation will receive fewer profit incentives (Liebman and Reynolds, 2019), so they will reduce digital transformation under the circumstances of increased EPU. These heterogeneity analyses confirm our main result again.

5. Conclusion

We examine the effect of EPU on digital transformation in China from 2007 to 2021 at the micro-enterprises level. We find that EPU has a negative effect on firm digital transformation. The main reason is that increased EPU makes corporate financing more difficult and innovation investment costs more in this case, firms will wait until a suitable time for digital transformation. That is, compared to the strategic growth option theory, the negative effect of uncertainty on innovation investment put forward by the real options theory is more obvious. The heterogeneity analyses show that EPU's effect on digital transformation is stronger for non-SOE, which confirms that firms that have lesser resources are more susceptible to EPU. We also find that the firms in highly competitive industries are more affected by this negative effect. When firms face high EPU, they are even less willing to digital transformation.

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