Advances in Management & Applied Economics, vol. 8, no. 4, 2018, 1-16
ISSN: 1792-7544 (print version), 1792-7552(online)
Scienpress Ltd, 2018

Does the environmental campaign[1] in China enhance or impede firm innovation?

Jia Xiang[2]

Abstract

This paper documents the impacts of environmental campaign on firms' innovation. Using firm-level data from CSMAR dataset, I analyze whether environmental campaign's impacts on firms' innovation are stronger on polluting firms, firms in the environmental campaign industry and the non-SOE (State Owned Enterprises). My results show that environmental campaign enhances the innovation on the whole. Specifically, we find the polluting firms will enhance innovation after the outbreak of environmental campaign due to the disappearance of environmental campaign privilege. The environmental campaign will enhance innovation in polluting firms more than other non-polluting firms in the same industry and enhance the non-polluting firms in environmental campaign industry more than those non-polluting firms in the non-environmental campaign industry. For those non-SOE firm, the enhance effects of environmental campaign on innovation are more obvious.

JEL classification numbers: G39
Keywords: Innovation; Environmental Campaign

1 Introduction

The role of innovation as a critical driver of a nation's long-term economic growth and competitive advantage has been established in the literature. Firms invest in innovations if they expect future market gains from these investments.

Innovation is a crucial driver of a nation's long-term economic growth and competitive advantage. People are all curious about optimal organizational form for nurturing innovation. As Porter (1992) states, "To compete effectively in international markets, a nation's

[1] A campaign against polluting began in China following the closing of the 18th National Congress of the Communist Party of China in 2012. Upon taking office, Xi claimed that the golden hill is not as good as the green hills, that is, to punish those polluting firms and reduce the environmental pollution.

[2] PBC School of Finance, Tsinghua University, China

Article Info: *Received*: January 6, 2018. *Revised:* February 26, 2018
Published online: July 1, 2018

businesses must continuously innovate and upgrade their competitive advantages." Lerner (2012) therefore suggests that perhaps the best way to motivate innovation is a corporate venture capital (CVC) program, that combines features of corporate research laboratories and venture backed start-ups within a powerful system that consistently and efficiently produces new ideas. Tian et al. (2015) proved that stock liquidity will impede firm innovation. There are two possible mechanisms: increased exposures to hostile takeovers and higher presence of institutional investors who do not actively gather information about firm fundamentals or monitor. Both could result in a cut in investment in innovation to boost current earnings. Cornaggia et al. (2015) showed banking competition reduces innovation. They argued that banking competition enables small, innovative firms to secure financing instead of being acquired by public corporations. Therefore, banking competition reduces the supply of innovative targets. Overall, these results shed light on the real effects of banking competition and the determinants of innovation. Tian et al. (2015) also argues that unions promote innovation. A reduction in R&D expenditures, reduced productivity of inventors, and departures of innovative inventors are plausible mechanisms through which unionization impedes firm innovation.

However, how to nurture innovation in China is still an open question debated in recent years. For example, does the recent environmental campaign enhance or impede firm innovation?

If the environmental campaign involves a firm, will the event enhance or impede the peer firm innovations in the industry? That limiting environmental campaign would increase Chinese firm innovations is not a priori obvious. On the one hand, limiting environmental campaign might increase firm innovations by making firms more competitive and more market-driven. On the other hand, limiting environmental campaign might make it less difficulty for the non-polluting firms to survive in the market. So far there has been two possible mechanisms to indicate whether the environmental campaign in China will enhance or impede firm innovation. Due to the non-polluting firms accounted for most in the market, it is crucial to investigate the effects of environmental campaign on the peer firms to gain a whole picture of firms' reaction on innovation to environmental campaign.

Mechanisms

1. Positive effects: The polluting firms might rely on connections to compete in the industry. When connections disappear in the polluting firms after the environmental campaign, the peer firms will struggle to enhance innovation to gain more market share.

2. Negative effects: The polluting firms might rely on connections to compete in the industry. When connections disappear in the polluting firms after the environmental campaign, the peer firms will relax in innovation because the competition is not fierce.

We expect the positive effects to be more prevalent. If the innovation is enhanced by environmental campaign, it will be a valuable discovery. Thus we need to investigate to impacts of environmental campaign on innovation of different firms specifically. In this paper, I use annual data concerning inventions and patents of each listed companies from 2010 to 2015 in Shanghai and Shenzhen stock exchange from CSMAR database. I also search for records of violating the law and discipline on environmental protection from the website of Ministry of Environmental Protection. Using the data, I find the polluting firms will enhance innovation after the involving in the environmental campaign due to the disappearance of environmental campaign privilege. Furthermore, the environmental campaign will enhance innovation in polluting firms more than other non-polluting firms in the same industry. In

addition, the empirical results show that the environmental campaign will enhance innovation in the non-polluting firms in environmental campaign industry more than those non-polluting firms in the non-environmental campaign industry. For those non-SOE firms, the enhancing effects of environmental campaign on firms' innovation are more obvious than the SOE firms.

The remainder of the paper is organized as follows. Section 2 reviews related literature. Section 3 describes the data and variables. Section 4 illustrates our research design. Section 5 presents results of our empirical tests. Section 6 concludes.

3 Data Description and Variable Definition

3.1 Descriptions of data

We collected data about firms investigated by the Ministry of Environmental Protection. In addition, we download annual data concerning inventions and patents of each listed companies from 2010 to 2015 in Shanghai and Shenzhen stock exchange from CSMAR database. The data include stock code, full name of firms, industry code, industry name, the size of the firms, the leverage ratio of the firms, the TobinQ value of the firm, the number of years from the IPO year, number of inventions, number of utility models and number of designs[3]. The data is panel data and we have 2,334 firms, and each firm has patents data of 6 years (from 2010 to 2015), thus we have 14,004 pieces of data in total.

3.2 Definition of variables

The definitions of the main variables are shown in Table 1.

Table 1: Definition of main variables

Variable		Symbol	Definition
Whether the firm is involved in the environmental campaign		*EnvironmentalCampaign*	Takes value of 1 if the firm is involved in the environmental campaign, otherwise take value of 0.
Whether the environmental campaign of the firms or the matched polluting firms break out		*AfterEnvironmentalCampaign*	Takes value of 1 after the outbreak of environmental campaign, otherwise takes value of 0
The asset size		*Size*	The asset size of firm
The leverage ratio		*Leverage*	The leverage ratio of firm
The TobinQ value		*TobinQ*	The TobinQ value of firm
Time from the IPO year		*AfterIPO*	The number of years after the firm's IPO year
Innovation	Inventions Applications	*InventionApplication*	The number of inventions applications
	Design Applications	*DesignApplication*	The number of design applications
	UtilityModel Applications	*UtilityModelApplication*	The number of utilitymodel

[3] The number of inventions, number of utility models and number of designs are measured both in number of application and number of inforce.

			applications
	Approved Invention	*ApprovedInvention*	The number of inforced inventions of firm
	Approved Design	*ApprovedDesign*	The number of inforced design of firm
	Approved UtilityModel	*ApprovedUtilityModel*	The number of inforced utilitymodel of firm
Whether the firm is a SOE(State-owned Enterprises) firm		*SOE*	Takes value of 1 if the firm is a SOE (State-owned Enterprises) firm, otherwise take value of 0

Table 2 presents the summary statistics of the main variables. In the Table 2 Panel A, we find that the 1.9% of the firms are polluting firms and only 1.9% of firms are SOE firms. The average years from their IPO open year is 9.064 years and the median of them is 15 years. The average TobinQ value of the all the firms in the sample is 3.488 and the median of them is 3.202. The average size of firms in our sample is 21.942 billion yuan and the median of them is 22.650 billion yuan. Only 10% of the firms have a leverage ratio above 0.995 and the average leverage ratio is 0.470. As for our measure of innovation, we find that the number of inforce patents are more than the number of patents application measured by Invention, Design and UtilityModel.

Table 2: Summary statistics of main variables

Variable	No. of Obs.	Mean	S.D.	Min.	Max.
EnvironmentalCampaign	14,004	0.019	0.135	0	1
AfterEnvironmentalCampaign	14,004	0.010	0.099	0	1
Size	14,004	21.942	1.488	20.443	30.732
Leverage	14,004	0.470	0.754	0.133	46.159
TobinQ	14,004	3.488	32.252	1.121	2,512.748
AfterIPO	14,004	9.064	6.540	1	25
InventionApplication	14,004	10.710	102.864	0	5,237
DesignApplication	14,004	10.199	63.872	0	3,186
UtilityModelApplication	14,004	2.765	18.261	0	668
ApprovedInvention	14,004	20.266	298.228	0	17,151
ApprovedDesign	14,004	39.422	221.503	0	6,684
ApprovedUtilityModel	14,004	12.870	74.983	0	2,430
SOE	14,004	0.019	0.135	0	1

4 Research Design

The environmental campaign might have impacts on the polluting firms, non-polluting firms in the same industry as the polluting firms, the non-polluting firms in the non-environmental campaign industry and the non-SOE firms. The different impacts of environmental campaign among those kinds of firms remain to be explored in the following empirical design.

Based on the discussions above, we propose four hypotheses.

Hypothesis 4.1 *The environmental campaign will enhance innovation of the polluting firms.*
Hypothesis 4.2 *The environmental campaign will enhance innovation of the polluting firms more than those non-polluting firms in the same industry.*
Hypothesis 4.3 *The environmental campaign will enhance innovation of the non-polluting firms in environmental campaign industry more than those non-polluting firms in the non-environmental campaign industry.*
Hypothesis 4.4 *The environmental campaign will enhance innovation of the non-polluting firms in environmental campaign industry more than those non-polluting firms in the non-environmental campaign industry mainly for those non-SOE firms.*

The first question we want to know about is whether environmental campaign enhance or impede innovation significantly after the outbreak of environmental campaign. To capture the effect, we use regression discontinuity method. The regression function is as following:

Formula 4.1 *Regression*

$$Innovation_i = \alpha + \beta_1 * AfterEnvironmentalCampaign_i + \beta_2 * Control_i + \varepsilon_i$$

What we are concerning about is the coefficient of *AfterEnvironmentalCampaign*, the positive or negative sign of it could be interpreted as an enhancing or impeding impacts of outbreak of environmental campaign. In this regression, the innovation is measured by both the patent applications and approved patents.

In order to test whether there is difference between the polluting firms and their peer firms after the outbreak of environmental campaign. We are going to use difference-in-difference method to indicate that the polluting firms in the same industry as polluting firms might enhance or impede more innovation than non-polluting firms in the same industry as polluting firms after the environmental campaign. Before the difference-in-difference method, we should use propensity score matching method to match the polluting firms with those non-polluting firms.

Then we group firms as the treatment group if the one or more corrupted government officers is correlated to it, and group firms as the control group if none of arrested government officers is related to it. We calculated the propensity scores of loans in the two groups using the following Probit regression:

Formula 4.2 *Probit regression*

$$Pr(EnvironmentalCampaign_i = 1) = \Phi(\alpha + \beta * Control_i)$$

where $\Phi(\cdot)$ is the standard normal distribution function. $Control_i$ represents the variables describing the characteristics of firm *i*. $Control_i$ includes *Size*, *Leverage*, *TobinQ*, *AfterIPO*, *InventionApplication*, *DesignApplication*, *UtilityModelApplication*, *ApprovedInvention*, *ApprovedDesign* and *ApprovedUtilityModel*.

We match the polluting firms with those non-polluting firms using the data of the year when the environmental campaign broke out. The matching rule is that each environmental campaign firm is matched with a non-environmental campaign firm in the same industry with

the nearest propensity score. We calculate the propensity score considering the main characteristics of those firms, such as size, leverage, TobinQ. After the matching, we have several pairs of environmental campaign and non-polluting firms in the same industry.

Using these paired sample, we could conduct the difference-in-difference regression.

Formula 4.3 *Regression*

$$Innovation_i = \alpha + \beta_1 * EnvironmentalCampaign_i + \beta_2 * AfterEnvironmentalCampaign_i + \beta_3 * EnvironmentalCampaign \times AfterEnvironmentalCampaign_i + \beta_4 * Control_i + \varepsilon_i$$

Control variables include *Size*, *Leverage*, *TobinQ*, *AfterIPO*. Innovation is measured by *InventionApplication*, *DesignApplication*, *UtilityModelApplication*, *ApprovedInvention*, *ApprovedDesign* and *ApprovedUtilityModel*.

If the coefficient of interaction term *EnvironmentalCampaign*×*AfterEnvironmentalCampaign* is positive and significant, we can conclude that the polluting firms will enhance innovation more than the non-polluting firms in the same industry after the environmental campaign.

Similarly, the difference between non-polluting firms in environmental campaign industry more than those non-polluting firms in the non-environmental campaign industry might be solved thorough the same process. Thus we match the non-polluting firms in environmental campaign industry with those non-polluting firms in the non-environmental campaign industry using the propensity score matching. After the matching, we conduct the difference in difference method the same as above.

As the background of state-owned will change the styles and strategies of the firms a lot. It is necessary to divide the sample into SOE firms and non-SOE firms and check the difference respectively. We would like to check whether the environmental campaign effects on peer firms' innovations more or less obvious in the SOE firms. We group the firms into SOE firms and non-SOE firms, and the repeat the propensity score matching and difference in difference regression.

5 Empirical Results

Result 5.1 *The environmental campaign will enhance innovation of the polluting firms.*

In table 3, we run the regression using OLS regression method, we find the coefficient of dummy *AfterEnvironmentalCampaign* is positive and significant, which means the innovation increases significantly after the outbreak of environmental campaign. We find no matter we use the patent application and approved patents as the measure of innovation, we find the increased effects of environmental campaign outbreak is significant. It could be interpreted that the innovation is enforced if the environmental campaign outbreak. It is probably due to those polluting firms usually rely on polluting privileges to earn and remain market shares, and if the polluting privileges disappeared, the firms tend to rely on innovation to survive in the market.

Table 3 The impact of outbreak of environmental campaign on the innovation of polluting firms

This table presents the results of the OLS regression of *AfterEnvironmental Campaign* on *Innovation* and a list of control variables. Control variables include *Size, Leverage, TobinQ, AfterIPO*. *Innovation* is measured by *InventionApplication*, *DesignApplication* and *UtilityModelApplication* in Panel A, and by *ApprovedInvention*, *ApprovedDesign* and *ApprovedUtilityModel* in Panel B.

$$Innovation_i = \alpha + \beta_1 * AfterEnvironmentalCampaign_i + \beta_2 * Control_i + \varepsilon_i$$

Coefficients statistically significant at the 10%, 5%, and 1% significance level are marked by *, **, and ***, respectively. Numbers in parentheses are the standard errors.

Panel A. The impact of outbreak of environmental campaign on the innovation of polluting firms (Innovation measured by patent applications)

	Innovation		
	(1)	(2)	(3)
	InventionApplication	*DesignApplication*	*UtilityModelApplication*
AfterEnvironmentalCampaign	47.483***	12.903***	119.801***
	(12.669)	(3.073)	(20.592)
Size	49.722***	-0.710	122.165***
	(7.629)	(-0.577)	(16.085)
Leverage	4.741*	0.267	11.555*
	(2.541)	(0.463)	(6.676)
TobinQ	-3.156	-1.256	-8.248
	(-0.357)	(-1.753)	(-25.353)
AfterIPO	-6.225**	-0.060	-13.758**
	(-2.581)	(-0.132)	(-6.156)
Constant	-1,058.739***	32.582	-2,603.231***
	(-150.048)	(28.387)	(-421.550)
Observations	258	258	258
R-squared	0.210	0.226	0.186

Panel B. The impact of outbreak of environmental campaign on the innovation of polluting firms (Innovation measured by approved patents)

	Innovation		
	(1)	(2)	(3)
	ApprovedInvention	*ApprovedDesign*	*ApprovedUtilityModel*
AfterEnvironmentalCampaign	8.592***	3.474***	14.994***
	(2.353)	(0.737)	(3.752)
Size	27.698***	0.168	33.378***
	(7.774)	(0.368)	(7.301)
Leverage	2.959**	0.114	3.368*
	(1.452)	(0.645)	(1.810)
TobinQ	-2.617	0.131	-2.344
	(-5.542)	(0.210)	(-3.378)
AfterIPO	-4.094***	-0.408**	-4.679***
	(-1.105)	(-0.186)	(-0.766)
Constant	-575.2***	3.234	-697.3***
	(-79.05)	(9.306)	(-96.69)
Observations	258	258	258
R-squared	0.209	0.231	0.190

Result 5.2 *The environmental campaign will enhance innovation of the polluting firms more than those non-polluting firms in the same industry.*

The above analysis has shown that the outbreak of environmental campaign will enhance innovation of polluting firms, and we are more curious whether the effects is more obvious in polluting firms than the non-polluting firms in the same industry. We need to use difference in difference method to identify the effects. Before using the difference in difference method, we should use propensity score matching method to match each environmental campaign firm with a firm with the nearest propensity score. Thus we have 258 pairs of firms. Using the 516 firms, we could conduct the difference in difference in Table 4. The coefficient of interaction term *EnvironmentalCampaign*×*AfterEnvironmentalCampaign* is positive and significant. It could be interpreted that the outbreak of environmental campaign will enhance innovation more than the non-polluting firms in the same industry.

The reason for the result is those environmental campaign firm relied on the environmental campaign privilege to survive in the market, and will relied more on innovation when the environmental campaign privilege disappeared after environmental campaign than their non-environmental campaign peer firms.

Table 4. The different impacts of outbreak of environmental campaign on innovation of firms between polluting firms and non-polluting firms in the same industry

This table presents the results of the difference-in-difference regression results of *EnvironmentalCampaign*, *AfterEnvironmentalCampaign* and

EnvironmentalCampaign×*AfterEnvironmentalCampaign* on *Innovation* and a list of control variables. Control variables include *Size, Leverage, TobinQ, AfterIPO. Innovation* is measured by *InventionApplication, DesignApplication and UtilityModelApplication* in Panel A, and by *ApprovedInvention, ApprovedDesign* and *ApprovedUtilityModel* in Panel B.

$$Innovation_i = \alpha + \beta_1 * EnvironmentalCampaign_i + \beta_2 * AfterEnvironmentalCampaign_i + \beta_3 * EnvironmentalCampaign \times AfterEnvironmentalCampaign_i + \beta_4 * Control_i + \varepsilon_i$$

Coefficients statistically significant at the 10%, 5%, and 1% significance level are marked by *, **, and ***, respectively. Numbers in parentheses are the standard errors.

Panel A. Innovation measured by patent applications of firms

	Innovation		
	(1)	(2)	(3)
	InventionApplication	*DesignApplication*	*UtilityModelApplication*
EnvironmentalCampaign	26.95***	-30.25***	33.59***
	(4.631)	(6.105)	(5.231)
AfterEnvironmentalCampaign	-7.989	-30.39***	-11.26
	(14.25)	(5.951)	(19.70)
EnvironmentalCampaign ×AfterEnvironmentalCampaign	21.53***	34.75***	33.90
	(5.87)	(7.44)	(24.76)
Size	2.994***	1.979***	4.069***
	(0.731)	(0.305)	(1.011)
Leverage	-36.32*	-14.49	-52.30*
	(20.62)	(8.613)	(28.51)
TobinQ	-9.303***	-0.759	-13.13***
	(2.325)	(0.971)	(3.215)
AfterIPO	-2.593**	-0.624	-3.376**
	(1.019)	(0.426)	(1.408)
Constant	-5.813	2.303	-7.229
	(6.981)	(2.916)	(9.652)
Observations	516	516	516
R-squared	0.089	0.120	0.086

Table 4 Panel B. Innovation measured by approved patents of firms

	Innovation		
	(1) *ApprovedInvention*	(2) *ApprovedDesign*	(3) *ApprovedUtilityModel*
EnvironmentalCampaign	39.85***	-90.15***	84.95
	(10.74)	(18.37)	(79.44)
AfterEnvironmentalCampaign	-3.084	-59.65***	-20.45
	(29.97)	(17.77)	(77.48)
EnvironmentalCampaign×*AfterEnvironmentalCampaign*	72.45***	72.79***	197.4***
	(17.59)	(22.29)	(67.05)
Size	5.191***	5.530***	14.33***
	(1.538)	(0.912)	(3.970)
Leverage	-51.15	-56.15	-166.3
	(43.37)	(25.23)	(111.9)
TobinQ	-18.92***	-2.083	-51.10***
	(4.892)	(2.901)	(12.32)
AfterIPO	-4.899**	0.257	-10.61*
	(2.143)	(1.271)	(5.531)
Constant	-11.28	5.332	-26.76
	(14.68)	(8.708)	(37.90)
Observations	516	516	516
R-squared	0.184	0.200	0.186

Result 5.3 *The environmental campaign will enhance innovation of the non-polluting firms in environmental campaign industry more than those non-polluting firms in the non-environmental campaign industry.*

Before the difference in difference method, we should also use propensity score matching method to match each environmental campaign firm with a firm with the nearest propensity score. Thus we have 12,808 pairs of firms. Using the 25,616 firms, we could conduct the difference in difference in Table 5. The coefficient of interaction term *EnvironmentalCampaign*×*AfterEnvironmentalCampaign* is still positive and significant. It could be interpreted that the outbreak of environmental campaign will enhance innovation of the non-polluting firms in environmental campaign industry more than those non-polluting firms in the non-environmental campaign industry.

The reason for the result might be that all the non-polluting firms in the environmental campaign industry will make more efforts to gain more market shares because the privilege of the polluting firms disappeared and the market is more fair. In contrary, the firms in the non-environmental campaign industry will have no incentive to invest in innovation.

Table 5 The different impacts of outbreak of environmental campaign on innovation of firms

between polluting firms in the environmental campaign industry and non-environmental campaign industry

This table presents the results of the difference-in-difference OLS regression of *EnvironmentalCampaign*, *AfterEnvironmentalCampaign* and *EnvironmentalCampaign*×*AfterEnvironmentalCampaign* on *Innovation* and a list of control variables. Control variables include *Size*, *Leverage*, *TobinQ*, *AfterIPO*. *Innovation* is measured by *InventionApplication*, *DesignApplication and UtilityModelApplication* in Panel A, and by *ApprovedInvention*, *ApprovedDesign* and *ApprovedUtilityModel* in Panel B.

$$Innovation_i = \alpha + \beta_1 * EnvironmentalCampaign_i + \beta_2 * AfterEnvironmentalCampaign_i + \beta_3 * EnvironmentalCampaign_i \times AfterEnvironmentalCampaign_i + \beta_4 * Control_i + \varepsilon_i$$

Coefficients statistically significant at the 10%, 5%, and 1% significance level are marked by *, **, and ***, respectively. Numbers in parentheses are the standard errors.

Panel A. Innovation measured by patent applications of firms

	Innovation		
	(1)	(2)	(3)
	InventionApplication	*DesignApplication*	*UtilityModelApplication*
EnvironmentalCampaign	16.62***	-10.45***	21.56***
	(3.623)	(5.134)	(7.312)
AfterEnvironmentalCampaign	-6.955	-32.09***	-21.36***
	(13.34)	(3.476)	(2.780)
EnvironmentalCampaign×*AfterEnvironmentalCampaign*	27.42***	52.85***	15.09***
	(3.872)	(9.234)	(4.374)
Size	3.238***	1.823***	5.659***
	(0.325)	(0.249)	(1.011)
Leverage	-43.42**	-17.49***	-32.50*
	(21.55)	(5.113)	(18.76)
TobinQ	-7.234***	-0.239	-33.13***
	(1.235)	(0.895)	(7.215)
AfterIPO	-6.334***	-1.583***	-6.498***
	(1.019)	(0.126)	(1.232)
Constant	-4.434	3.545	-2.767
	(5.341)	(3.981)	(4.981)
Observations	25,616	25,616	25,616
R-squared	0.182	0.194	0.185

Panel B. Innovation measured by approved patents of firms

	Innovation		
	(1) *ApprovedInvention*	(2) *ApprovedDesign*	(3) *ApprovedUtilityModel*
EnvironmentalCampaign	7.687***	-80.62***	45.27
	(2.744)	(12.969)	(79.34)
AfterEnvironmentalCampaign	-2.873	-67.35***	-10.35
	(34.03)	(7.267)	(23.32)
EnvironmentalCampaign ×*AfterEnvironmentalCampaign*	12.78***	55.05***	47.45***
	(2.678)	(12.43)	(13.78)
Size	6.839***	3.782***	17.38***
	(1.328)	(0.732)	(2.692)
Leverage	-45.79	-78.99***	-121.3
	(37.49)	(12.57)	(99.82)
TobinQ	-23.70***	-3.546***	-81.25***
	(3.567)	(0.932)	(11.33)
AfterIPO	-3.678***	0.343	-20.40***
	(0.257)	(1.437)	(2.438)
Constant	-32.58	5.332***	-34.65**
	(28.43)	(1.708)	(16.54)
Observations	25,616	25,616	25,616
R-squared	0.189	0.183	0.197

Result 5.4 *The environmental campaign will enhance innovation of the non-polluting firms in environmental campaign industry more than those non-polluting firms in the non-environmental campaign industry mainly for those non-SOE firm.*

In addition, we also want to know more about whether those enhance effect is more or less obvious in SOE firms. We divide the sample into two groups, one is the SOE firms and the other is the non-SOE firms. The same difference in difference process in conducted in both the SOE firms and non-SOE firms. We have 3,270 pairs of firms in the SOE firms group and 9,538 pairs of firms in the non-SOE firms group. The innovation is also measured by patents application and approved patents. We find among the SOE firms, the difference in the impacts of environmental campaign on innovation between the non-polluting firms in environmental campaign industry and those non-polluting firms in the non-environmental campaign industry disappeared. However, among those non-SOE firms, the difference in the impacts of environmental campaign on innovation between the non-polluting firms in environmental campaign industry and those non-polluting firms in the non-environmental campaign industry become more significant. The explanation for the results is that those non-SOE firms are more sensitive to the competition of market because the lack of backup from the country and government. When some firms involved in environmental campaign in the same industry, the non-SOE firms might focus more on the innovation in order to gain

more market shares in the market. As for the SOE firm, they are supported by the government and less motivated to promote innovation when the environmental campaign broke out.

Table 6 The different impacts of outbreak of environmental campaign on innovation of firms between polluting firms in the environmental campaign industry and non-environmental campaign industry (Grouped by SOE firms and non-SOE firms)

This table presents the results of the difference-in-difference OLS regression of *EnvironmentalCampaign*, *AfterEnvironmentalCampaign* and *EnvironmentalCampaign*×*AfterEnvironmentalCampaign* on *Innovation* and a list of control variables. Control variables include *Size, Leverage, TobinQ, AfterIPO. Innovation* is measured by *InventionApplication, DesignApplication and UtilityModelApplication* in Panel A and Panel C, and by *ApprovedInvention, ApprovedDesign* and *ApprovedUtilityModel* in Panel B and Panel D.

$$Innovation_i = \alpha_i + \beta_1 * EnvironmentalCampaign_i + \beta_2 * AfterAfterEnvironmentalCampaign_i + \beta_3 * EnvironmentalCampaign_i \times AfterEnvironmentalCampaign_i + \beta_4 * Control_i + \varepsilon_i$$

Coefficients statistically significant at the 10%, 5%, and 1% significance level are marked by *, **, and ***, respectively. Numbers in parentheses are the standard errors.

Panel A. Innovation measured by patent application of firms (SOE firms)

	Innovation		
	(1)	(2)	(3)
	InventionApplication	*DesignApplication*	*UtilityModelApplication*
EnvironmentalCampaign	129.3***	9.215***	166.7***
	(33.44)	(1.986)	(47.81)
AfterEnvironmentalCampaign	18.36	2.385	23.45
	(37.40)	(4.459)	(52.75)
EnvironmentalCampaign×*AfterEnvironmentalCampaign*	-12.53	4.509	-9.473
	(14.06)	(5.253)	(12.11)
Size	25.95***	0.029	32.67***
	(4.901)	(0.584)	(6.910)
Leverage	-146.4***	-3.926*	-195.7***
	(40.750)	(2.293)	(57.30)
TobinQ	-2.536	-0.899	-5.758
	(6.250)	(0.745)	(8.810)
AfterIPO	-5.406**	-0.734***	-7.333**
	(2.095)	(0.250)	(2.954)
Constant	-558.3***	4.135	-689.1***
	(122.1)	(14.55)	(172.1)
Observations	6,540	6,540	6,540
R-squared	0.128	0.236	0.201

Panel B. Innovation measured by patent application of firms (non-SOE firms)

	Innovation		
	(1)	(2)	(3)
	InventionApplication	*DesignApplication*	*UtilityModelApplication*
EnvironmentalCampaign	-7.356***	-80.13***	-11.84***
	(1.959)	(9.080)	(3.831)
AfterEnvironmentalCampaign	-8.092***	-73.15***	-10.74***
	(2.705)	(8.300)	(3.502)
EnvironmentalCampaign ×*AfterEnvironmentalCampaign*	13.74***	78.34***	23.09***
	(3.585)	(11.01)	(4.642)
Size	0.667***	4.328***	0.821***
	(0.157)	(0.481)	(0.203)
Leverage	8.912	-8.200	12.779*
	(5.529)	(16.97)	(7.158)
TobinQ	-0.123	-1.946	-0.650
	(0.457)	(1.402)	(0.592)
AfterIPO	-0.852***	-0.977	-0.809**
	(0.291)	(0.894)	(0.377)
Constant	0.176	2.526	0.332
	(1.000)	(3.070)	(1.295)
Observations	19,076	19,076	19,076
R-squared	0.283	0.194	0.178

Panel C. Innovation measured by approved patents of firms (SOE firms)

	Innovation		
	(1)	(2)	(3)
	ApprovedInvention	*ApprovedDesign*	*ApprovedUtilityModel*
EnvironmentalCampaign	230.2***	13.72***	536.3***
	(72.09)	(2.931)	(188.4)
AfterEnvironmentalCampaign	43.27	1.789	80.65
	(80.63)	(12.23)	(210.7)
EnvironmentalCampaign× *AfterEnvironmentalCampaign*	60.91	20.74	167.4
	(95.00)	(14.41)	(248.3)
Size	44.20***	0.361	110.0***
	(10.57)	(1.603)	(27.62)
Leverage	-229.9***	-8.961	-633.5***
	(57.76)	(13.31)	(209.3)
TobinQ	-9.013	0.574	-29.89
	(13.48)	(2.044)	(35.21)

AfterIPO	-11.91***	-0.573	-26.46**
	(4.517)	(0.685)	(11.80)
Constant	-948.4***	-2.216	-2,298***
	(263.2)	(39.92)	(687.9)
Observations	6,540	6,540	6,540
R-squared	0.244	0.232	0.254

Panel D. Innovation measured by approved patents of firms (non-SOE firms)

	Innovation		
	(1)	(2)	(3)
	ApprovedInvention	*ApprovedDesign*	*ApprovedUtilityModel*
EnvironmentalCampaign	-17.34***	-224.1***	-43.31***
	(2.560)	(27.93)	(9.111)
AfterEnvironmentalCampaign	-3.401	-166.5***	-11.19
	(2.340)	(25.53)	(8.327)
EnvironmentalCampaign ×*AfterEnvironmentalCampaign*	11.74***	174.2***	54.55***
	(3.101)	(33.85)	(11.04)
Size	1.075***	12.56***	2.850***
	(0.136)	(1.479)	(0.482)
Leverage	-7.245	-84.43	18.19
	(4.783)	(52.19)	(17.02)
TobinQ	-0.316	-7.605*	-3.512**
	(0.395)	(4.314)	(1.407)
AfterIPO	-0.0375	1.857	-1.702*
	(0.252)	(2.751)	(0.897)
Constant	-0.013	5.562	0.094
	(0.865)	(9.445)	(3.080)
Observations	19,076	19,076	19,076
R-squared	0.221	0.123	0.268

6 Conclusion

This paper documents the impacts of environmental campaign on firms' innovation. Using firm-level data of each listed companies from 2010 to 2015 in Shanghai and Shenzhen stock exchange from CSMAR database and records of violating the law and discipline and committing crimes from the website of the Ministry of Environmental Protection, I analyze whether environmental campaign's impacts on firms' innovation are stronger on polluting firms, firms in the environmental campaign industry and the non-SOE. My results show that

environmental campaign enhances the innovation on the whole. Specifically, we find the polluting firms will enhance innovation after the outbreak of environmental campaign due to the disappearance of environmental campaign privilege. The environmental campaign will enhance innovation in polluting firms more than other non-polluting firms in the same industry and enhance the non-polluting firms in environmental campaign industry more than those non-polluting firms in the non-environmental campaign industry. For those non-SOE firm, the enhance effect of environmental campaign on innovation are more obvious.

Based on the above findings, we conclude that the environmental campaign will enhance firms' innovation.

ACKNOWLEDGEMENTS. This is a text of acknowledgements.

References

[1] Bradley D, Kim I, Tian X. Do Unions Affect Innovation?. Management Science, **63**(7), (2016), 2251-2271.

[2] Cornaggia, J., Mao, Y., Tian, X., & Wolfe, B., Does Banking Competition Affect Innovation?. Journal of Financial Economics, **115**(1), (2015), 189-209.

[3] Fang V W, Tian X, Tice S. Does Stock Liquidity Enhance or Impede Firm Innovation?. The Journal of Finance, **69**(5), (2014), 2085-2125.

[4] Lerner, J. The Architecture of Innovation: The Economics of Creative Organizations. Cambridge: Harvard Business Review Press, 2012.

[5] Porter, Michael, Capital Disadvantage: America's Failing Capital Investment System, Harvard Business Review, **70**(5), (1992), 65–82.