To what extent can GCP stimulate HPEs' Green Innovation

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1. Introduction

The "green economy" has become the focus of national and corporate development strategies since China proposed the goal of achieving carbon peaking by 2030 at the 75th session of the United Nations General Assembly in 2020. A series of policies have been introduced to promote green innovation. The Green Credit Policy (GCP) is implemented in 2012, which is an international practice that financial institutions that consider the environmental effects of enterprises when lending. It aims to adjust the flow of funds from credit resources to eventually promote a green transformation mainly targeting HPEs in China.

Previous studies have examined the positive relationship between the GCP and innovation However, they focused on the overall green patent outputs (number of applications of the patent) but they did not explore the difference in the effectiveness of the policy among the different types of technology such as alternative energy, transportation, energy conservation, waste management, agriculture and forestry, administrative regulation and design, and nuclear generation (WIPO, 2010). In this study, we analyze the impact of the GCP on innovation (number of applications) by the type of technology. Besides, studies on Chinese environmental policies may ignore the unique importance of R&D in the process of developing green patents.

2. Methodology and Data

This study examines the effect of the GCP on HPEs' all and each field of green innovation. The data was obtained from the China Stock Market & Accounting Research Database (CSMAR database)[1], which includes 4822 China's A-share listed companies from 2007 to 2016. HPEs and Non-HPEs are defined as the treatment group and the control group respectively. Based on a DID model, we analyze not only the number of applications by the type of technology but also R&D expenditure. our main specification is as follows:

$$\ln(RD)_{i,t} = \alpha Treat_i \times Post_t + \gamma Controls_{i,t} + \delta_i + \eta Industry_j \times Year_t + \varepsilon_{i,t} \quad (1)$$

$$\ln(1 + GP)_{i,t} = \beta Treat_i \times Post_{t-n} + \rho Controls_{i,t-n} + \nu_i + \sigma Industry_j \times Year_t + \omega_{i,t} \quad (2)$$

where RD and GP denote R&D expenditure and number of applications of green patent of the firm. In eq. (2), $\ln(1 + GP)_{i,t}$ is the natural logarithm of the sum of 1 and the number of green patent applications of firm i in year t. We used 4 types of technology as outcome variables, which are alternative energy production, transportation, energy conservation, waste management. In the model, $Treat_i$ is a dummy variable equals to 1 for the treatment group. $Post_t$ is a time dummy variable equal 1 for years after 2012 and 0 otherwise. $Industry_j \times Year_t$ captures the year effect by the industry which the firms belong to. $Controls_{i,t}$ is a group of control variables including firm size (Size), debt levels (Lev), enterprise risk (Risk), cash holdings (Cash), establishing years (Age), the publication of corporate social responsibility report (Dum_CSR), net profit growth (Growth), CSR index,

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[1] https://www.gtarsc.com

enterprise ownership (SOE). In order to consider the lag effect of the policy on the innovation, we used the sub-index t-n to control the n year lag. It takes 3 values, n∈ {1,2,3}.

3. Results and Conclusion

Table 1 presents the main estimated results from eq. (1). It indicates that China's GCP implementation in 2012 significantly promoted R&D investment and green innovation in HPEs. The GCP is likely to increase R&D expenditure by 40.1% to develop new green technology. For the other control variables, firm size has a positive effect on R&D expenditure for all specifications. On the contrary, age has a negative effect on R&D.

Table 2 presents the results for the impact of the GCP on overall green patent application in column (1) and applications by types of green technology which are Alternative Energy Generation, Transportation, Energy Conservation and Waste Management, respectively in column (2)-(5) with the lag for Treat×Post variables to test if the impact of the policy is changed over the years from eq. (2). Firstly, it indicates that the policy impact takes two years to develop new green technology and the policy increase the green patent applications by 56.5%. Secondly, the coefficients of $Treat \times Post_{t-2}$ are significant with positive sign for Alternative Energy Generation and the coefficients of $Treat \times Post_{t-3}$ are for Energy Conservation two or three years after policy was adopted.

Table 1. The effect of GCP on R&D expenditure (equation (1))

Dependent variable	**LnRD**	**LnRD**	**LnRD**	**LnRD**
$Treat \times Post_t$	0.401***	0.469**	0.400**	0.468**
Size	0.630***	0.691***	0.630***	0.624***
Age	-0.384***	-0.370***	-0.073	-0.378***
Dum_CSR	-0.009	0.083***		
CSR Index	0.001		0.001	
Observations	11,082	12,508	11,082	12,508
R-squared	0.398	0.442	0.398	0.441

Table 2. The Estimation of GCP on green innovation (equation (2))

Dependent variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
$Treat \times Post_{t-1}$	0.018	0.350	-0.146	-0.028	0.207
$Treat \times Post_{t-2}$	0.565*	0.372	0.035	0.386*	0.026
$Treat \times Post_{t-3}$	0.047	0.415**	0.138	0.124	-0.366*
Observations	4481	4481	4481	4481	4481
R-squared	0.084	0.087	0.021	0.062	0.054

Notes: ***, ** and * indicate 1%, 5% and 10% significant level.

Reference:

1. Hu, Guoqiang, Xiaoqi Wang, and Yu Wang. "Can the green credit policy stimulate green innovation in heavily polluting enterprises? Evidence from a quasi-natural experiment in China." *Energy Economics* 98 (2021): 105134.
2. Su, D., Lian, L. (2018). Does green credit affect the investment and financing of heavy pol- luting enterprises? *Financ. Res*. 12, 123–137 (In Chinese).