The Research of New Energy Industrial Innovation Effective Under Policy View

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***Abstract*--This paper employs the negative binomial regression model (RENBM) to test the relationship between policy factors and the innovation performance of new energy firms. We considered 408 policies implemented by the central government of China which are most relevant to new energy industry innovation during the period of 2007-2014.We found out that only the stringency of productive innovation policy has positive effects on new energy industrial innovation performance; the stringency of environmental protection policy and technological innovation policy and policy instability have negative impacts on new energy enterprise innovation performance. Finally, it discusses policy implications.**

I. INTRODUCTION

A package of policies for new energy industry development has been issued with "Laws of Saving on Energy Resources in R. P. of China" passed in 2007 by People's Congress and " Decision on speeding up the cultivation and development of strategic emerging industry" passed by State Council in 2010. Subsequently, new energy industries development has been gradually mentioned by local government. However, the more policies the more drawbacks appeared in the development of new energy industries in China (see Fig. 1) . On one hand, the environmental pollution is becoming more and more serious, but on the other hand the new energy industry development in China was frustrated. Such a dilemma makes people rethink that whether the Chinese new energy industry innovation policy system is reasonable or not? Whether the policy system is effective or not?

II. LITERATURE REVIEW

Policy-related issues are pervasive throughout the world and we found three classified shortage of previous studies on the performance of the industrial policy.

First, despite there were previous studies on S&T policies classification and their application in a specific industry，until now the in-depth research on mechanism and effect of combined policies[8, 37] is still lacking. Taken together, S&T, industrial, financial, tax, and fiscal policies have been combined together to form a steadily more coherent, integrated package of innovation policies [21]. Borrás and Edquist [2] argued that innovation policy instruments must be designed and combined into mixes in ways that address the problems of the innovation system. Accordingly, we think that the new energy industry innovation policy system should be combination of environmental protection policies, technological innovation policies, financial innovation policies, product innovation policies, talent policies and comprehensive policies. However, different types of new energy industry policies may have different effect on industrial innovation which lead to insufficient of the whole package of policies.

Second, the empirical research on the relationship of new energy industrial policy and the new energy industrial innovation performance was less. Huang et al [14] use the content analysis method and quantitative analysis methods to conduct a research on China's Wind Energy Policy text. Xiao and Jiang [33] argued that the newborn enterprises have greater R&D incentives to innovate compared to traditional enterprises in transition which entered the strategic emerging industries at the same time point. By distinguishing R&D incentives between different enterprises government can implement innovation support policy more effectively.

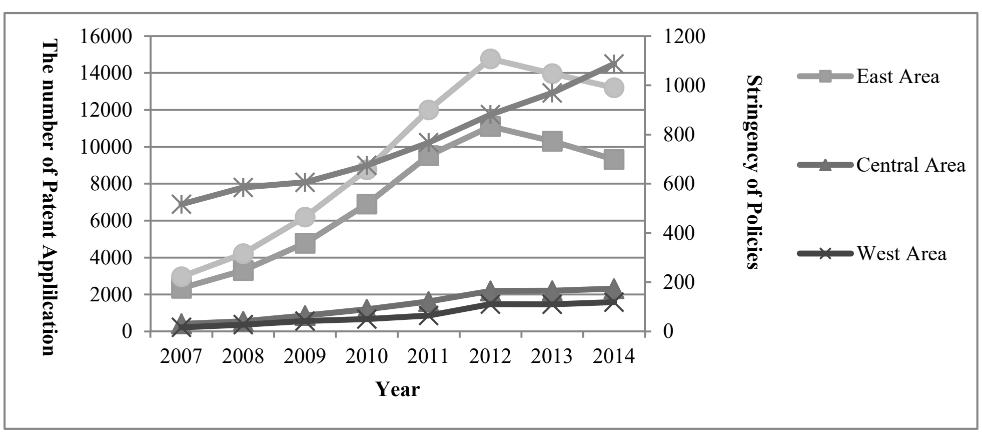

Fig. 1 Stringency of Policies and the Number of New Energy Enterprises' Patent Application

Project financing is a new, more flexible financing ways, compared to the traditional financing channels, not only can more effectively solve the problem of wind power project funding needs, but also to a certain extent, reduce the risks faced by investors, have a great attraction to investors [16].

Third, there are less current research on the innovation performance from policy formulation and implementation, especially the relevant empirical research in China. In terms of policy formulation, Rogge and Hoffmann [26] find that the European Emission Trading System mainly affects the rate and direction of technological change of power generation technologies within the large-scale, coal-based power generation technological regime, to which carbon capture technologies are added as a new technological trajectory. Meanwhile, the irreducibly political character of governance for sustainable development and whilst in climate political will also influence innovation performance of new energy firms. In addition, the uncertainty of new technology may stop the step of conservative policy makers on technological change [24, 27]. Also, policy learning plays an important role of complex dynamics of socio-technical systems – particularly technological change – as a driver of policy change [15]. On the other hand, policy implementation also plays an important role on the innovation performance. Jung and Tyner [17] conduct benefit cost analysis with several uncertain input variables to determine the economics of adopting solar PV systems in Indiana based on policy instruments that could increase adoption of solar PV systems. The results show that current policies are important in reducing the cost of solar PV systems. However, with current policies, there is only 50–50 chance of solar being cheaper than electricity from grids. West, Bailey and Winter [32] uses a cultural theory framework and focus groups conducted in the South West UK to develop deeper understandings of how individuals' worldviews can inform opinions and behavior in relation to RE. Chang and Li [3] argued that energy market integration is expected to significantly promote the adoption of renewable energy. Along with energy market integration, feed-in-tariffs appears to be more cost-effective than energy portfolio standards and is recommended for the ASEAN region, albeit political barriers for policy coordination among the countries might be a practical concern.

In summary, the previous studies on the measurement and performance evaluation of new energy industrial innovation policy has made some progress [25, 4], but the research on policy continuity and potential synergistic effects among different policies still needs to be complete. Based on the 408 policies issued by the central government of China related to innovation of new energy industry， we studies the relationship between industrial policy (stringency and consistency of policy) and the performance of enterprises innovation activities by using negative binomial regression model with the panel data of listed companies in new energy industry during 2007-2014.

III. VARIABLES AND DATA SOURCES

A. Dependent Variable

We choose technical innovation capability of enterprises as the dependent variable measured by the number of patent application. We use the number patent application of new energy enterprises in the current year including invention patents, utility model patents and design patents to evaluate the efficiency of enterprises' innovation activities. Despite the patent index have some defects, such as not all the innovation achievements were applied by enterprises, it is still relatively close to innovation commercialization and objectively reflects the situation of innovation output. Therefore, patent index remains a suitable index to evaluate the efficiency of enterprises' innovation capability and is the most widely used indicators to characterize of enterprise innovation capability. At the same time, taking lagging effect of policy into account, we use the number of enterprise patent applications in a year after year to evaluate the efficiency of enterprises' innovation capability.

B. Independent Variable

1. The stringency of industrial policy (TP)

The effect of the stringency of industrial policy [23] can be evaluated by policy classification and ministers which issue the policies. We use Cheng et al [4] 's studies for reference and make the stringency of industrial policy standard listed in Table 1.

TABLE 1 THE STRINGENCY OF INDUSTRIAL POLICY STANDARD

Policy Level	CPPCC NPC[①]	the State Council's ordinance; assorted government ministries' regulation	the State Council's Interim regulations and planning; assorted government ministries' Regulations and Provisions	assorted government ministries' temporary Provisions, Measures, Opinions and Plans	Announcement; Notification
The Power of Policy Standard	5	4	3	2	1

① CPPCC: the Chinese Communist Party Central Committee; NPC: the National People's Congress

We calculate the stringency of policy using the following formula:

$$TP_{it} = \sum_{j=1}^{N} P_{ij} \qquad t \in [1990,2014] . \tag{1}$$

In this formula, i represents policy type; t represents year, t=1990，1991，…，2014；N represents the number of i type of policy in t year; j represents j piece of i type of policy in t year; TP_{it} represents the whole stringency of i type of policy in t year and P_{ij} represents the joint stringency of j piece of i type of policy.

As for the policy issued by multiple ministers, we use the highest minister level as the standard to measure the stringency of policy. Its formula is as follows:

$$TPC_{it} = \sum_{j=1}^{N} B_{ij} * P_{ij} \qquad t \in [1990,2014] \tag{2}$$

In this formula, N represents the number of policies which issued by multiple minister in t year; B_{ij} represents the number of minister involved in j piece of i type of policy.

Policy will influence technology innovation until it is abandoned. In the reality, it is not only the policies issued in the year influence technology innovation but all the policies issued before this year influence technology innovation as well. Therefore, we need to summarize the stringency of policies on the specific time. The formula is:

$$NTP_{it} = NTP_{it-1} + TP_{it} \qquad t \in [1990,2014] \tag{3}$$

Using (1), (2) and (3), we calculated the stringency of all types of new energy industrial policies in t year. We also adjust the stringency of policies when a piece of policy was abandoned in a year.

2. Industrial policy instability (PC)

Previous studies showed that officer turnovers cause the policy instability [34]. Based on the previous studies [6,19,31], we found out that officers' turnovers data from public information between 2006-2014, such as governor (mayor or chairman of the autonomous region) and secretary of a provincial party committee (the autonomous region) . If officer turnovers of governor (mayor or chairman of the autonomous region) or secretary of a provincial party committee (the autonomous region) do not happen in a year or do happen from November to December in a year, we could ignore the influence of industrial policy instability and use industrial policy instability dummy 1 to represent. Otherwise, the industrial policy instability dummy should be zero.

C. Control Variables

In order to control the influence of other factors on enterprises' technological innovation and based on the previous studies, we use scale, ownership, age, local advantage, equity ratio, rate of return on common stockholders' equity, income ratio, management stock ratio and tobin q as the control variables. The definition and index of all the variables are listed in Table 2. Table 3 contains descriptive statistics of the data.

The scale of a firm has an important effect on the innovativeness of a firm and is therefore frequently used as a control variables in many studies related to innovations. It is measured by the logarithm of the total asset of enterprise. Firms' age related to innovation performance. Start-up firms tend to innovate more vigorously than incumbents, so we use the year of enterprise establishment to measure the firms' age. We also choose equity ratio, rate of return on common stockholders' equity, income ratio, management stock ratio and tobin q to measure the characteristic of firms [18].

In addition, a firm that operates in eastern area has more advantage than the other firms located in central and western area. In China, eastern area is much more open and convenient to develop a firm. However, firms competing more in eastern area may exert more efforts to innovate more intensively than those competing in small market, such as central area and western area.

Meanwhile, as state-owned firms always have hidden support from government and undertake much social responsibility in China, we include firms' ownership as control variable to capture the impact of firms' ownership.

TABLE 2 THE NAME, DEFINITION AND INDEX OF VARIABLES

Variables	Name of Variables	Definition of Variables	Index of Variables
Dependent Variables	Innovation Output of Enterprises	Number of Patent Application of the year	Patent
Independent Variables	Power of Industrial Policies	Power of Environmental Protection Policies	EP
		Power of Technical Innovation Policies	TIP
		Power of Financial Innovation Policies	FP
		Power of Product Innovation Policies	PP
		Power of Talent Policies	TAP
		Power of Comprehensive Policies	CP
	Industrial Policy Instability	The dummy is zero if there is turnovers on local government, otherwise the dummy is one.	PC
Control Variables	Scale	Total asset of enterprise	Scale
	Ownership	The dummy is zero if it's the private enterprise; The dummy is one if it's the state enterprise.	Ownership
	Age	The year of enterprise establishment	Age
	Local Advantage	West area[2], dummy=0; Central area, dummy=1; East area, dummy=2	Local Advantage
	Equity Ratio	Total debt/Total Shareholder	Equity Ratio
	ROE	Net profit after tax/Net asset	ROE
	Income Ratio	(Operating income in a single current quarter of a year－Operating income in a single last quarter of a year) / (Operating income in a single last quarter of a year)	Income Ratio
	Management Stock Ratio	Management Stock /Total stock	Management Stock Ratio
	Tobin Q Ratio	Total Market Value of Firm/Total Asset Value	Tobin Q

TABLE 3 DESCRIPTIVE STATISTICS

Variable	Obs	Mean	Std.Dev.	Min	Max
Innovation Output of Enterprises	966	22.48	49.28	0	456
Power of Environmental Protection Policies	968	5.844	0.188	5.545	6.136
Power of Technical Innovation Policies	968	4.195	0.316	3.912	4.691
Power of Financial Innovation Policies	968	4.600	0.355	4.025	5.063
Power of Product Innovation Policies	968	3.913	0.219	3.638	4.263
Power of Talent Policies	968	4.435	0.0640	4.304	4.500
Power of Comprehensive Policies	968	4.457	0.503	3.761	5.283
Industrial Policy Instability	959	0.751	0.433	0	1
Scale	914	22.29	1.309	19.23	26.47
Ownership	968	0.562	0.496	0	1
Age	968	17.56	4.569	5	30
Local Advantage	968	1.463	0.804	0	2
Equity Ratio	941	1.671	4.236	-104.8	34.39
ROE	941	0.0512	0.278	-4.893	0.840
Income Ratio	925	0.395	2.638	-25.37	60.22
Management Stock Ratio	941	0.0218	0.0842	0	0.619
Tobin Q Ratio	918	1.725	1.505	0.116	12.88

[2] East area include Beijing, Tianjin, Hebei, Shanghai, Jiangsu ,Zhejiang, Fujian, Shandong, Guangdong, Hainan and Liaoning; Central area include Shanxi, Anhui, Jiangxi, Henan, Hubei, Hunan, Jilin and Heilongjiang; West area include Inner Mongolian, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang.

D. Research sample and data source

We collect 408 pieces of new energy industrial policies through the website of The Central People's Government of the People's Republic of China, Ministry of Science and Technology, General Administration of Customs of the People's Republic of China, National Development and Reform Commission, National Energy Administration, State Administration of Taxation et al.. With the restriction of data, we collect only 121 new energy enterprise data from CSMAR database which are all listed companies. Also we eliminate inflation factor for all the capital data using real GDP and nominate GDP. We use Patent Search and Analysis of SIPO system on State Intellectual Property Office of the P.R.C website to acquire the patent application data of the new energy enterprises in our data③ and make a bar figure as Fig. 2.

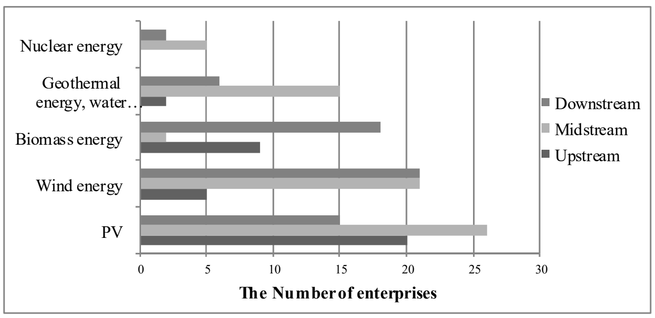

Fig. 2 Types and chain location of new energy industry

E. Model

In order to estimate the technical innovation capability of new energy firms, we use the number of patent application by those firms. The number of patent application is a count variable, this kind of variable cannot be negative, because we cannot have negative patent application. Also we have another constraint: the number of patent application is always an integer number. So we need an estimator that can be robust to these two constraints. An ordinary least squares (OLS) / generalized least squares (GLS) estimator can be used with log-transformation of count variable, for non-integer data, but it is also not possible to use this approach where the count variable assumes the value of zero, because we cannot have log (0) . Hence, we thought that models based on the classical OLS/GLS estimator were not appropriate. The simplest approach to count model is Poisson count regression model.

The Poisson model is very restrictive in that it imposes that the variance and the mean are equal. Usable data for Poisson regression are very rare. There are two ways to use count data without Poisson regression, either the quasi-maximum likelihood (QML) Poisson regression or the negative binomial regression. The variance (49.27751) of the number of patent application in our enterprises' sample is far greater than mean value (22.5212) and the number of "zero" is less than thirty which is less than the third of total enterprises' sample. We also testified that our data was overdispersion using Cameron, Trivedi and Wooldridge's measurement [22, 29]. Based on the analysis above, we choose Negative Binomial Regression Model in our research, especially random-effect Negative Binomial Regression Model.

IV. DISCUSSION

A. The influence of independent variables

The results are in Table 3. In Table 3, the results of model 1 are based on total sample. The results of model 2 and model 3 are based on different ownership. The results of model 4, model 5, and model 6 are based on different enterprises' location in China. After testifying, only model 5 passed Hausman test so we use fix effect regression on model 5. For the other models, we all choose random effect model. As can be seen from Table 3, all models have passed significant test which indicate that the data is fitting well with the model.

The stringency of environmental protection policies in all the models decreases innovation performance of new energy enterprises. We think there are several reasons. First of all, environmental protection policies can be subdivided into four types, such as environmental law regulation, the system of three concurrencies, permission institution for discharging sewage and pollution control within a limit time institution. The types of policies mentioned above may have diverse and cumulative effect on the enterprises' technological innovation performance [9]. Secondly, there is pollution from new energy enterprises themselves, such as waste water from enterprises without treatment directly drain into lakes or rivers or no supporting facilities for pollution control in new energy enterprises. Thirdly, although the power of environmental protection policies is intensified, the punishment for environmental pollution in China is not severe. With tax and "environmental protection" gimmick for local governments, the new energy enterprises can reduce its investment in its own pollution prevention and control with rent-seeking and lower its environmental protection branch. Fourth, environmental regulation has positive effect on domestic enterprises' innovation performance with low concentration, low level of opening up and low level of technology. However, most new energy products made in China are sold overseas. With rising industrial concentration and more cutting-edge technology, the environmental protection policies in China has negative impact on enterprises innovation. Fifth, when environmental tax is considered, the relationship curve between the benefit of adoption green technology and environmental tax rate takes on a non-monotonic inverted U-shaped [36]. Although environmental tax is not implemented in China, the similar policy to environmental tax, such as charges for disposing pollutants, has been implemented only 11 years in China and much less than its implementation in developed countries,

③ The detail data can be acquired from authors if anyone needed such as USA. As a result, the performance of green technology adoption in Chinese enterprises and the power of environmental regulation could still be in the down process on a non-monotonic inverted U-shaped. Meanwhile, the policy such as "Air Pollution Control Law" and "Environmental Protection Law", two of the most strict environmental law in Chinese environmental law history, still has problems while it is implementing. For instance, in order to reduce pollutant, e.g., PM 2.5, PM10 et al, automobile volume in most large cities in China should be restricted and public transportation should be encouraged. However, most people in China take cars as a symbol of wealth more than a vehicle. To avoid the inconvenience of odd-and-even license plate rule in some cities, e.g., Beijing, lots of people bought another car which is not a good choice for air pollution control. As mentioned above, the stringency of environmental protection policies significantly have negative effect on the technological innovation performance of new energy enterprises.

The stringency of technological innovation decreases innovation performance of new energy enterprises in model 1, model 2 and model 4. However, the stringency of technological innovation increases innovation performance of new energy enterprises in model 5. On one hand, the independent R&D capabilities of most new energy enterprises in China are low and most government financial support in new energy technology R&D focus on the university and research institutes in China, which restricts the efficiency and capacity of new energy technology transformation. Although there are "Regulation on the transformation of technological achievements", "Regulation on technology transfer" et al., the intellectual property rights of technology are not clear④ and the professional technical agent are in short supply which are all probably keep the technology from the market. Meanwhile, new energy enterprises in China are lack of technology so they can only rely on cheap labor to produce low-tech products, which is not only a waste of economic and environmental resources but also reduction of average profit of the new energy product [13]. On the other hand, the results of model 2 indicate that the state-owned enterprises have policy support but they are unwilling to bear the risk of technology innovation. On contrary, the private enterprises with small size, fast response, low steering cost and high innovation motivation are more adapt to high technology development [7]. Therefore, the stringency of technological innovation significantly has negative effect on the technological innovation performance of some types of new energy enterprises.

The power of financial innovation policies increases innovation performance of state-owned enterprises and enterprises located in central area. It indicates that state-owned enterprises efficiently use government financial support. Meanwhile, state-owned enterprises have more advantage than the other types of enterprises in acquiring financial subsidies, even though higher state-owned proportion will decrease the effect of tax incentives on R&D investment [10]. According to previous studies, it is not a specific conclusion that the more financial subsidies and tax reduction the more the number of patent application is. However, when the amount of financial subsidies and tax reduction is below or beyond a scope, it will weaken innovation capability of enterprises [20]. Moreover, financial subsidies not only make up insufficient R&D investment from enterprises but also squeeze out investment from enterprises supposed to support R&D [35] themselves thus lead to low performance of innovation of enterprises. However, previous study shows that the centrally planned funding system of the 1990s was ineffective for enhancing technological progress for Chinese manufacturing firms which implies that the Chinese government should further increase the role of market force in its reforms. A more market driven model by developing more S&T initiatives to match the strategic directions of different enterprises, particularly SOEs, is recommended [11, 30].

The stringency of product innovation policies increase innovation performance of all new energy enterprises, state-owned new energy enterprises and new energy enterprises located in east area. Previous study indicated that the more competent external environment the better for a firm's product innovativeness [5]. Also the higher uncertainty of external environment for enterprises the greater hindrance of the inflow of external technical knowledge that can be used to promote product creativity [1]. Absorptive capacity of enterprises located in east area is much better than the new energy enterprises located in the other area in China. As absorptive capacity enables to introduce external new knowledge into the new product development process，thus it may impact product innovativeness. Also knowledge creation capability positively impacts product innovativeness and knowledge creation capability mediates the relationship between absorptive capacity and product innovativeness [28] which probably explain the reason why the stringency of production innovation policies has significant positive effect on technological innovation performance of new energy enterprises.

The power of talent policies increase innovation performance of private new energy enterprises and new energy enterprises located in central area in China. Without policy support, the desire for talent of private enterprises is much more than state-owned enterprises. However, better human resources will contribute much more to innovation performance of enterprises in a long term.

The power of comprehensive policies only increase innovation performance of new energy enterprises located in central area. We think that although several pieces of leading policies were issued by the State Council, such as "Decision on accelerating the cultivation and development of strategic

④ In China, most intellectual property rights of technology are held by research staff in university or research institutes. They don't have the full rights to sell or to exchange their intellectual property rights of technology and they should share the profit with their university or research institute. So they may not have the desire to transform technology into products.

emerging industries" and "Opinions on promoting the healthy development of photovoltaic industry" et al., they are all too macroscopic to guide the development of enterprises. As a result, the power of comprehensive policies has not significant effect on most types of new energy enterprises' technological innovation performance.

Policy instability decrease innovation performance of all and state-owned new energy enterprises. On one hand, in the year of officers' turnover, new energy enterprises, especially state-owned enterprises, are more likely to change the purpose of raised capital when confronting possible policy adjustment and based on the need for new relationship with governments [31]. On the other hand, the pollution treatment effect of new energy enterprises themselves will be affected by the local legal system, and officers turnover will broke the old relationship between enterprises and officers so as to motivate new energy enterprises to control their own pollution [19].

B. The influence of control variables

As can be seen from Table 3, the scale of new energy enterprises increases technological innovation performance of most types of new energy enterprises but decrease technological innovation performance of enterprises located in east area. This might indicate that enterprises located in east area rely much more on technological innovation but not capital scale. Moreover, the more the capital scale the more capital advantage enterprises have, which is better for policy implementation and easier for enterprises to enjoy preferential policies. Besides, enterprises which are highly capitalized are capable of deeply understanding policies and taking fully advantage of them for the rational distribution of R&D investment. All the reasons which mentioned above might lead to the result that the scale of new energy enterprises has significant positive effect on technological innovation performance of most types of new energy enterprises.

TABLE 4 THE REGRESSION RESULTS

Variables	Name of Variables	Dependent Variables：patent application					
		Model 1 (All)	Model 2 (State -owned)	Model 3 (Private)	Model 4 (East)	Model 5 (Central)	Model 6 (West)
Independent Variables	EP	-4.373** (1.894)	-5.487** (2.597)	-3.371 (2.484)	-4.976** (2.295)	-5.064 (3.276)	-1.278 (3.407)
	TIP	-1.804** (0.764)	-3.000*** (1.005)	-0.407 (1.086)	-1.662* (0.977)	3.453** (1.648)	-0.0599 (1.308)
	FP	0.713 (0.723)	2.008** (1.024)	-0.503 (0.930)	0.606 (0.890)	2.774** (1.181)	0.0221 (1.351)
	PP	3.780*** (1.436)	5.201*** (1.957)	2.395 (1.999)	4.104** (1.818)	-6.982** (3.105)	0.182 (2.452)
	TAP	3.727 (2.972)	-1.889 (4.016)	8.771** (4.059)	3.263 (3.728)	25.24*** (6.367)	5.532 (5.214)
	CP	0.509 (0.448)	0.934 (0.604)	-0.140 (0.601)	0.683 (0.550)	-1.873*** (0.690)	-0.593 (0.766)
	PC	-0.211** (0.0973)	-0.265** (0.129)	-0.120 (0.142)	-0.190 (0.123)	0.201 (0.163)	-0.147 (0.216)
Control Variables	Scale	0.205*** (0.0690)	0.173** (0.0836)	0.698*** (0.133)	0.109 (0.0797)	1.139*** (0.340)	1.186*** (0.180)
	Ownership	-0.206 (0.183)			-0.480** (0.218)	2.391*** (0.669)	-1.370*** (0.442)
	Age	-0.0488** (0.0196)	-0.0662*** (0.0251)	0.0372 (0.0329)	-0.0228 (0.0216)	-0.339*** (0.106)	0.301*** (0.0766)
	Local advantage	-0.183* (0.109)	-0.552*** (0.200)	0.169 (0.147)			
	Equity Ratio	-0.00912 (0.00872)	-0.0138* (0.00722)	0.0369 (0.0341)	-0.00954 (0.00888)	-0.227** (0.108)	0.0243 (0.0659)
	ROE	-0.0114 (0.129)	-0.0387 (0.200)	-0.487 (0.303)	-0.0133 (0.135)	3.117*** (1.018)	0.194 (0.382)
	Income ratio	0.0102 (0.0117)	0.0118 (0.0125)	0.0430 (0.0471)	0.0101 (0.0132)	0.240* (0.123)	0.115 (0.0780)
	Management stock ratio	1.897*** (0.710)	-258.3** (106.8)	2.560*** (0.725)	1.589* (0.819)	6.796* (4.024)	5.463** (2.712)
	Tobin Q	-0.0947** (0.0380)	-0.164*** (0.0573)	0.0361 (0.0528)	-0.131*** (0.0490)	0.314** (0.125)	0.0579 (0.0673)
Constant		-6.775 (10.95)	18.05 (15.32)	-40.03*** (14.52)	-1.797 (13.70)	-94.35*** (21.80)	-45.95** (19.31)
Observations		869	509	360	557	65	188
Number of company code		121	68	53	81	9	25
Hausman test P-value		0.2900	0.5237	0.7456	0.4829	0.0042***	0.3766

Significance codes: *10%level, ** 5% level, and ***1% level.

The ownership dummy decrease technological innovation performance of new energy enterprises located in east and west area but increase technological innovation performance of new energy enterprises located in central area. This indicate that the technological innovation capability of state-owned new energy enterprises located in west and east area is weaker than private new energy enterprises while the technological innovation capability of state-owned new energy enterprises located in central area is stronger than private new energy enterprises. It probably because that state-owned enterprises are willing to do more “rent-seeking” activities to acquire more financial support from all aspect which reveals that why there are more and more corrupt cases have happened in energy industry. As in socialist state, such as China, the more policy burden state-owned enterprises bear the more policy support they will get. Moreover, the more shared actors involved in projects the less technological diversity will be. In China, shared actors related to state-owned enterprises are much more than they are related to private enterprises. Also the longer the enterprises established the harder for them to transit and innovate.

Local advantage dummy has not significant effect on private new energy enterprises’ technological innovation performance but increase technological innovation performance of state-owned new energy enterprises. It indicates that with the development of market economy in China, the technological innovation performance of state-owned enterprises in developed areas, such east area, has gradually declined. A unified government can easily strike the bargains required to secure political support for new technology programs. However, in the developed areas, market plays more important part in economy than governments which cause a waste of governments’ R&D investment.

Moreover, the higher equity ratio the lower solvency enterprises have which cause weaker technological innovation performance of enterprises.

ROE only increase technological innovation performance of new energy enterprises located in central area. On one hand, the higher of investment return the better technological innovation performance of new energy enterprises. One the other hand, the technological innovation capability of new energy enterprises is weaken probably due to increasing debt, which could cause rising ROE and R&D investment reduction of new energy enterprises.

Management stock ratio only decreases technological innovation performance of state-owned new energy enterprises and increase technological innovation performance of the other new energy enterprises. When management stock ratio is in a certain range, the higher management stock ratio the better performance of enterprises have will motivate technological innovation of new energy enterprises. Innovation performance of state-owned new energy enterprises are much lower than the other types of new energy enterprises due to not only obvious governments influence but also its own low performance.

The other two control variables——income ratio and tobin q either increase or decrease technological innovation performance of new energy enterprises. We think that on one hand, new energy enterprises need to invest a lot in the initial stage (R&D stage) but its profitability has a certain lag. On the other hand, financial subsidies for new energy industry will not definitely promote the rapid growth of the listing corporation.

V. ROBUSTNESS ANALYSIS

In this section, we report several robustness test results[⑤]. We consider mainly whether the factors that affect the innovation performance of new energy enterprises remain robust. In particular, we want to check the robustness of policy variables that significantly affect the innovation performance of new energy enterprises.

First, we consider the impact of financial policy power on innovation by substituting the power of financial policy with government financial fund. We use the amount of government financial support without inflation to substitute the power of financial policy. We find that government financial support without inflation still marginally significant in increasing (or decreasing) the likelihood of specialized new energy enterprises innovation performance the same as the power of financial policy.

Second, we consider the separate effects of comprehensive policy power and the other type of policy power. We include both the power of comprehensive policy and the other type policy simultaneously. However, the comprehensive policy may include the other type of policies and both of them are likely to influence each other. To this end, we re-estimated the models excluding the power of comprehensive policy from the model, the variable of the other type of policy power still marginally significant in increasing (or decreasing) the likelihood of specialized new energy enterprises innovation performance.

Meanwhile, we also consider the separate effects of control variables, i.e., ROE and income ratio. In Table 3, we include both ROE and income ratio simultaneously. However, these variables are likely to influence each other. In particular, as ROE increase, we might expect income ratio to increase. Therefore, it would be informative to establish the unconditional impact of both ROE and income ratio. To this end, we re-estimated the models excluding either ROE or income ratio from the model, the variable of policy power still marginally significant in increasing (or decreasing) the likelihood of specialized new energy enterprises innovation performance.

In sum, we find that our results for the variables that drive the innovation performance of new energy enterprises remain robust to various specifications. The variables that significantly affect the innovation performance of new energy enterprises are robust to the model changes considered in this

⑤ The robustness test results can be acquired from authors if anyone needed.

section.

VI. CONCLUSION AND POLICY IMPLICATION

In this paper, we employed the negative binomial regression model (RENBM) to test the relationship between policy factors and the innovation performance of new energy firms. We considered 408 policies implemented by the central government of China which are most relevant to new energy industry innovation during the period of 2007-2014. Our analysis starts from classifying new energy industry innovation policies into environmental protection policies, technological innovation policies, financial innovation policies, product innovation policies, talent policies and comprehensive policies. We then evaluate the stringency of different types of policies with the level of policy formulation organization. Using firm-level patent data from 121 new energy firms and the negative binomial regression model analysis, we provide an empirical estimation of the stringency of different types of policies that affect firms' innovation performance. Our empirical analysis shows that only the stringency of productive innovation policy has positive effects on new energy industrial innovation performance; the stringency of environmental protection policy and technological innovation policy and policy instability have negative impacts on new energy enterprise innovation performance. It is probably because the stringency of different types of policies has different even opposite effect on technological innovation performance of new energy enterprises which may weaken the whole effect of industrial innovation policy system. In the meantime, we also considered the impact of policy instability. In most countries in the world, government transformation is very common and China is not an exception. However, government transformation is not good for policy implementation because each politician may has his/her own political principle and different learning skill. As a result, the instability of policy may decrease technological innovation performance of new energy enterprises, especially state-owned enterprises. As state-owned enterprises may undertake more social responsibility from local and central governments' political needs, they need more time to adapt government transformation while rebuilding the relationship between the new governments and themselves.

There are several options for improving the innovation policy system of new energy industry in China. Stringency is the most determining feature of policy design. Timing is also decisive but it appears to be of secondary importance. Stringency and policy issued timing both play important parts in new energy industry innovation. Therefore, taking advantage of market is most important. There are two reasons why new energy industry policy system in China was failed. One is low technological capability while the other is low-end products is over supplied but the demand for low-end products went through severe depression. Hence one can see that the new energy industry in China was driven by policy motivation. However, the correct approach to improve new energy industrial policy system is less government intervention when the market is sufficient and more government intervention when the market is insufficient in order to motivate innovation. Secondly, governments should pay more attention to creating a fair and square market environment, weakening the policy tilt of a certain type of enterprises and optimizing the allocation of resources. Then, governments also should keep the stability and consistency of policy. The study find that abnormal returns can be achieved within two weeks after the announcement but gradually decrease until they totally disappear after eighteen months. The reason for this temporal price effect is because the information about industrial policy is released over time. Institutional investors can benefit from their comparative advantage in analyzing public information and exploit of other investors' overreaction to stale news. Retail investors may lose money because of the resulting return reversal. As a result of all these, those firms that are supposed to benefit from thee industrial policy cannot obtain long-term and stable financing from the domestic stock market [12]. Finally, governments should pay more attention on the timing policies issued because the performance of policies always takes some time.

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