Innovation Policies and Firm Features: Microeconomic Evidence from Firms in Haidian District, Beijing, China *

CHENG Xiaoyue†
Center for Applied Statistics, Renmin University of China, 100872, China

Abstract

With the goal of examining relationship between innovation policies and firm features, we use the linking data of industry enterprise innovation survey in Haidian and their corresponding financial data report to build an algorithmic model. From the results of random forests, we compare the significant features of the twelve policies referred to tax, finance, personnel, funds, protection and incentive.

Keywords: innovation policy, firm feature, random forest

1 Introduction

Policy is a very important aspect for all the researches on innovation, because specific innovation activities are always decided and controlled by enterprises themselves, and the policy is the crucial factor that can influence firm innovation but is designed and executed by the government. Polices could adjust the direction, speed, structure of the innovation, and help to overcome the obstacles of innovation such like skill shortages, problems of finance, etc.

Not only on the firms, policies make great effect on regional innovation. C. Millar et al(2005) identified three types of technology and innovation districts: (1)market-driven technology districts; (2)state-driven technology districts targeting foreign multinational companies; (3)state-driven technology districts which nurture local companies. We can find the most significant feature of technology districts is the policy orientation.

Hence, the effectiveness of innovation policies is so remarkable that countries, especially the developing countries, should pay attention to and make full use of innovation policies.

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†Email: chequered@gmai.com

Policies on firm innovation could be abundant and diverse. Policies can be made targeting any separate innovation activity or a combination of different activities, any given industry or region, technology or organization. However, in this paper we emphasize on the policy content.

In terms of content, policies can be classified into six main types:(1)tax rules; (2)finance; (3)personnel; (4)industry; (5)protection and incentives; (6)others.

Many economists have documented the role of innovation policies and the relationship between policies and innovation activities. In general, most research papers focus on the primary innovation activities or obstacles first, then turn to elaborate the relative policies on purpose to improve them, and finally, compare the changes before and after the implementation of the policies.

However, this process brings two questions. First, when we meet the problems of firm innovation, policy is necessary. But, is it effective to solve the problems? Only the change of quantitative value of R&D or other indicators can not tell how much they need the policy. The growth of R&D perhaps only comes from the developing of the whole economic environment. Second, policies that the government promulgates each time are usually a mixture of various content, it is hard to say which part of the policies take effect.

What is more, since it is difficult to measure policies by data, there are seldom papers that analyze the effectiveness of different innovation policies via quantitative methods. Thus, we try to answer these questions in this paper.

The remainder of the paper consists of five sections. Section 2 describes history of innovation policies in Haidian. In Section 3, we introduce the data used in this paper and discuss the methodology. Section 4 examines the roles of different policies, and section 5 makes conclusion.

2 Innovation policies in Haidian

Haidian District is a pioneer of today's technique innovation in China, and an important reference for the government considering new technique stratagem. Now Haidian is the biggest accumulation zone for the scientific research, education, innovative and high technology industry. 68 universities and colleges lie in Haidian, including the famous Peking University, Tsinghua University, and Renmin University. There are also 231 scientific institutions in Haidian, and the number of academicians working in Haidian is around 36% of all in China. About 378 thousand research specialist staffs are having their jobs in Haidian, and more than 4000 overseas students come back to Haidian for their venture dreams.

The development of Haidian District experiences three stages after reform and opening-up of China. The first stage is during 1980-1988, which is called the Electronic Street Period. At that time some skilled personnel once working in the universities and research institutions resigned for entering the market and established IT companies. They tried to break the old planned economy system and attempt at new management system. The second stage is during 1988-1999, called New-tech Industry Development Trial Park Period. The splitting of the first and second stage is

the establishment of Haidian Park in May, 1988. The park, with tax breaks and other preferential treatment, covering an area of about 100 square kilometers, gradually centralized a dense concentration of scientific and engineering talents. The third stage–Zhongguancun Park Period is from 1999 to now. Because Chinese government admitted the application of broadening New-tech Industry Development Trial Park in June, 1999, new policies and development are following.

Policies in Haidian District are made from three levels: National Level, Beijing Municipal Level, District and County Level. The national policies include accelerating the growth of several high-tech industries; encouraging the companies to seek financing by listing on the stock market; reforming property rights of state-owned high-tech enterprises; subsidizing the "Torch Program" and technological innovation of medium & small-sized enterprises; reducing or exempting of tax for identified high-tech enterprises; providing preferential terms of foreign exchange account, telecom fee, entering and leaving the country; etc. The policies at the Beijing Municipal Level include rewards for outstanding contribution skilled personnel and returned overseas Chinese scholars; subsidizing specific industries and programs; setting up Z-Park developing special funds; loan interest subsidy and loan guarantee; inducting venture capital investment; aiding financially the high-tech industry association; etc. The policies at the District and County Level include rewards for firm foundation or immigration; attracting skilled personnel via supplying title of registered permanent residence; financial support to technical transfer, R&D, export for earning foreign exchange; awarding the investment intermediaries; etc.

From the view of time, we can find that the innovation policies formed two periods. In the first period, there were no clear innovation policies before 1988, and very few policy regulations which only referred to several preferential fields such as tax, finance, foreign exchange before 1999. This feature indicates the economic system was still not effective in those days, neither the government paid enough attention on firm innovation. In the second period, 1999-2005, plenty of regulations and policies emerged focusing on every innovation aspect. We can see the resolution of the government to drive on the technology progress which is believed will finally create more value to repay the country.

3 Data and methodology

3.1 Linking data of firm innovation survey and government data

This research is based on the data from both industry enterprise innovation survey in Haidian and their corresponding financial data report. The survey was made up of two questionnaires named Industrial Enterprise Innovation Questionnaire and Entrepreneur Questionnaire. The financial data report consists of the basic situation of the firm's management and especially the factory's R&D activity. From this data system we finally get 563 corporation observations, between which some have innovative activities while some not.

Of those 563 firms, 466 answered the questions of policy effectiveness. Thus, the 466 firms are our subject of study. In the questionnaire all of the entrepreneurs were asked to identify the influence – high or low, of 12 items of innovation policies. The contents of the 12 policies are showed

in Table 1, and the answers are demonstrated in Figure 1.

Table 1: Main innovation policies in Haidian

Item	Content
1	Counting tech researching expense into costs
2	Deducting income tax by tech researching expense
3	Reducing income tax for high-tech enterprises
4	Quickening depreciation of R&D equipments
5	Being exempted from sales tax of technology transfer and exploiture
6	Finance support
7	Government procurement
8	Protecting the intellectual property
9	Industrial policy
10	Foreign economic and trade policy
11	Encouraging to cultivate and attract specialists
12	Allowing enterprises to take charge of the technology projects of government

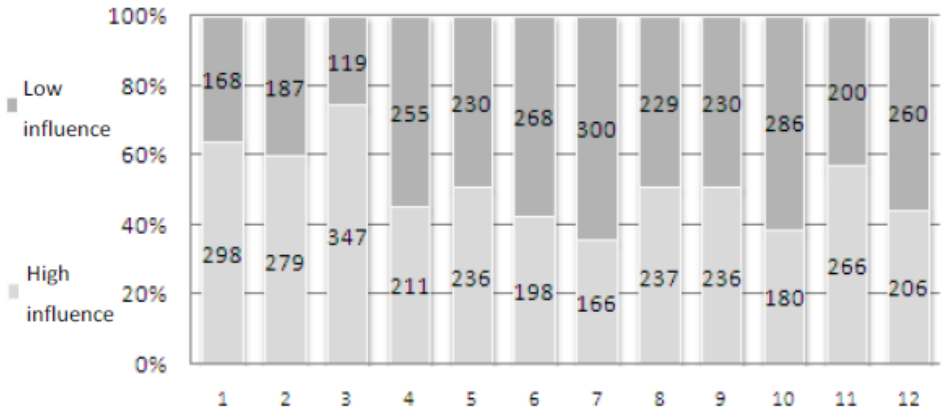

Figure 1: Policies influenced on firm innovation

We can class the 12 policies into the six types of innovation policies: No. 1-5 are tax rules; No. 6 is finance; No. 9 is industry; No. 11 is personnel; No. 7,8,10,12 are protection and incentives.

In the following of the paper, we are going to find out the distinction of firms that chose different influences of each policy.

3.2 Random forests – a method of machine learning

The random forests method, introduced by Breiman (2001), are a combination of tree predictors such that each tree depends on the values of a random vector sampled independently and with the same distribution for all trees in the forest.

To measure the importance of the m^{th} variable, the values of the m^{th} variable are randomly permuted in all of the cases left out in the current bootstrap sample. Then these cases are run down the current tree and their classification noted. At the end of a run consisting of growing many trees, the percent increase in misclassification rate due to noising up each variable is computed. This is the measure of variable importance via random forests.

The reason we use random forests, an algorithmic model in this paper is that, with data gathered from uncontrolled observations on complex systems, the priori assumption that market would generate the data through a classical parametric model selected by the economists can result in questionable conclusions that cannot be substantiated by appeal to goodness-of-fit tests and residual analysis. The best available solution to a data problem might be a data model; then again it might be an algorithmic model.

In our research, the data is quite irregular. First, there are nearly 240 indicators in this database, but only 466 observations. Although we can choose to cut 90% variables, doing that will delete lots of information too. Second, those variables are of three data frames: integer, factor, ordered factor. Third, there are so many missing values in the data, if we delete all of the cases having missing values, only around 200 firms left. Fourth, even if the data is complete, do the continuous variables follow the normal distribution so that we can use the usual data models? The answer is no. Seldom are the financial indicators following normal distribution, which means OLS regression and ANOVA are not fit for our analysis. To avoid all the problems the data brings, we have to choose methods from machine learning(or data mining), the algorithmic models.

4 Policies and firm innovation

The following Table 2 listed the five most significant features that have high relation with the policy evaluation for each policy. Importance(Imp.) represents the increase of misclassification rate if we leave that feature out. And contrast(high/low) reflects the mean of that feature grouped by the relative policy evaluation.

We can conclude from Table 2 that Policy No.1 Counting tech researching expense into costs usually influences on the firms that speak higher of housing, share holding incentives; have higher probability to award bonus; and spend more office expenses.

Policy No.2 Deducting income tax by tech researching expense usually influences on the firms that speak higher of housing, share holding, and share option incentives; and whose discontinued R&D items are less likely to happen after the program began and be not long-term postponed.

Table 2: The five most important features of each innovation policy

Item	Policy	Feature	Imp.	Contrast(high/low)
1	Counting tech researching expense into costs	Effect of housing incentive	1.1950	1.6415/1.7436
		R&D item discontinued after program began	1.1038	2.2639/2.1957
		Effect of share holding incentive	0.9893	1.6538/2
		Whether to award bonus	0.7941	1.0358/1.108
		Office expenses	0.5945	675/459
2	Deducting income tax by tech researching expense	Effect of housing incentive	1.3511	1.6538/1.725
		R&D item discontinued after program began	0.9278	2.2424/2.2308
		Effect of share holding incentive	0.8891	1.6481/2.0286
		Whether was discontinued R&D item postponed	0.8068	2.7879/2.6731
		Effect of share option incentive	0.7032	1.8636/2.069
3	Reducing income tax for high-tech enterprises	Effect of share holding incentive	1.3119	1.7077/2.0417
		Firm's administrative relationship	1.1818	5.6107/5.1868
		R&D item discontinued after program began	1.0505	2.2143/2.2941
		R&D item discontinued before program began	0.9662	2.7857/2.6765
		Whether was discontinued R&D item postponed	0.9190	2.7976/2.5882
4	Quickening depreciation of R&D equipments	R&D item discontinued after program began	1.2716	2.2292/2.2429
		R&D item discontinued before program began	1.1220	2.75/2.7571
		E-business sales amount	1.0254	205876/22617
		Effect of housing incentive	1.0009	1.5714/1.78
		Advertising expenses	0.9883	5938/392
5	Being exempted from sales tax of technology transfer and exploiture	Effect of housing incentive	1.4019	1.66/1.7143
		Effect of share holding incentive	1.3376	1.72/1.8974
		R&D item discontinued after program began	1.3091	2.2264/2.2462
		Who did process R&D	1.2723	1.6514/1.6332
		Cash inflow from financing activities	1.0088	65155/12315
6	Finance support	Effect of share option incentive	1.8158	1.9524/2
		Effect of housing incentive	1.6084	1.675/1.6923
		Effect of share holding incentive	1.4711	1.7143/1.8723
		R&D item discontinued before program began	1.3780	2.775/2.7436
		R&D item discontinued after program began	1.2153	2.2/2.2564

Item	Policy	Feature	Imp.	Contrast (high/low)
7	Government procurement	Effect of share option incentive	1.5192	1.7692/2.0526
		R&D item discontinued after program began	1.3308	2.2059/2.25
		R&D item discontinued before program began	1.0319	2.7941/2.7381
		Effect of share holding incentive	0.9742	1.5517/1.9167
		Who did process R&D	0.9246	1.6613/1.632
8	Protecting the intellectual property	Effect of share option incentive	1.6961	2.0455/1.931
		R&D item discontinued after program began	1.3774	2.22/2.25
		R&D item discontinued before program began	1.2130	2.78/2.7353
		Effect of share holding incentive	1.1773	1.6829/1.8958
		Whether was discontinued R&D item postponed	1.1499	2.82/2.6765
9	Industrial policy	Whether was discontinued R&D item postponed	1.3657	2.875/2.6429
		R&D item discontinued after program began	1.3608	2.2083/2.2571
		R&D item discontinued before program began	1.2455	2.7708/2.7429
		Effect of share option incentive	1.1140	1.9615/2
		Website amount by the end of year	0.9741	0.2011/0.1609
10	Foreign economic and trade policy	Effect of share option incentive	1.7980	1.7/2.0488
		Effect of housing incentive	1.7126	1.5152/1.7797
		Effect of share holding incentive	1.4306	1.5556/1.9032
		R&D item discontinued after program began	1.1705	2.1389/2.2805
		Export product sales revenue	0.9877	47025/11174
11	Encouraging to cultivate and attract specialists	R&D item discontinued after program began	1.5761	2.2143/2.2581
		Effect of share holding incentive	1.2188	1.6863/1.9474
		Whether was discontinued R&D item postponed	1.2025	2.8393/2.6452
		Effect of share option incentive	1.0379	1.96/2
		Cash outflow from financing activities	1.0193	47976/19264
12	Allowing enterprises to take charge of the technology projects of government	Effect of share option incentive	1.5686	2/1.9643
		R&D item discontinued after program began	1.2454	2.1778/2.274
		PC amount by the end of year	1.1240	178/19
		Employee's educational expenses	1.1052	142/69
		Cash outflow from operating activities	1.0830	595298/109667

Policy No.3 Reducing income tax for high-tech enterprises usually influences on the firms that speak higher of share holding incentive; whose administrative relationship are complex; and whose discontinued R&D items are more likely to happen after the program began but be not long-term postponed.

Policy No.4 Quickening depreciation of R&D equipments usually influences on the firms that have higher E-business sales amount and advertising expenses; speak higher of housing incentive.

Policy No.5 Being exempted from sales tax of technology transfer and exploiture usually influences on the firms that speak higher of housing, share holding incentives; have more cash inflow from financing activities; and whose discontinued R&D items are more likely to happen after the program began.

Policy No.6 Finance support usually influences on the firms that speak higher of share option, housing, and share holding incentives; and whose discontinued R&D items are more likely to happen after the program began.

Policy No.7 Government procurement usually influences on the firms that speak higher of share option and share holding incentives; and whose discontinued R&D items are more likely to happen after the program began.

Policy No.8 Protecting the intellectual property usually influences on the firms that speak higher of share holding incentive but a little lower of share option incentive; and whose discontinued R&D items are more likely to happen after the program began, but be not long-term postponed.

Policy No.9 Industrial policy usually influences on the firms that speak higher of share option incentive; have larger website amount by the end of year; and whose discontinued R&D items are more likely to happen after the program began, but be not long-term postponed.

Policy No.10 Foreign economic and trade policy usually influences on the firms that speak higher of share option, housing, and share holding incentives; and have more export product sales revenue.

Policy No.11 Encouraging to cultivate and attract specialists usually influences on the firms that speak higher of share option and share holding incentives; have more cash outflow from financing activities; and whose discontinued R&D items are more likely to happen after the program began, but be not long-term postponed.

Policy No.12 Allowing enterprises to take charge of the technology projects of government Policy usually influences on the firms that speak a little more poorly of share option incentive; have more PCs by the end of year and more cash outflow from operating activities; spend more employeeąŕs educational expenses.

5 Conclusion and future work

With the goal of examining relationship between innovation policies and firm features, we use the linking data of industry enterprise innovation survey in Haidian and their corresponding financial data report to build an algorithmic model. From the results of random forests, we compare the significant features of the twelve policies referred to tax, finance, personnel, funds, protection and incentive.

The next work of this research will discuss the further reason that specific firms like some specific policies. The form of these relationships should be discussed to find out a complete analytical system. Besides, we are possible to find the proper approach to measure the effectiveness of innovation policies quantitatively, since we have calculated the importance of most significant features.

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