Effects of First Patent Acquisition on the Corporate Growth†

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Abstract

This paper aims at identifying the causal effect of obtaining the first patent on the medium-sized company's growth. To control for the endogeneity between the patent acquisition and firm's performance, we use information on the distance to the nearest attorney office as an instrumental variable. We also control for the geographical location and industry of a firm, as well as the initial conditions of a firm. We find that acquiring the first patent is a long-term process even for medium size firm: only 13 % of them are successful in the 5-year window and it took 16 years (a median) from their foundation years. The probability of obtaining a patent increases as the distance to the attorney office becomes closer, which suggests that easier access to a reliable attorney contributes to the first patent acquisition. Moreover, the paper shows that such patent acquisition led to larger amount of total asset, more active R&D and higher value added. These results indicate that the patent acquisition accelerates corporate growth. Furthermore, the results show that higher probability of success to obtain patent and acceleration of patenting process due to easy access to attorney significantly contributes to the firm growth, while the patent application has smaller effect. Therefore, timely examination and facilitation of the support from attorney could be important policy measures to promote innovation.

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1. Introduction

This paper examines the causal effect of obtaining the first patent on the subsequent growth of the medium-sized companies in Japan. While sunk cost and uncertainty seems to be important barriers for the entry of a small and medium size firm into R&D (see Arqué-Castells and Mohnen, 2015), patent protection may be able to trigger the entry by reducing such barriers, which can expand the base of R&D performing firms (extensive margin). Such role of the patent protection is a part of the purpose of patent law: to encourage inventions and thereby to contribute to the development of industry. However, there is still a controversy on whether and how the patent law actually contributes to the purpose. Under such situation, Intellectual Property-related offices published report on the relationship between the acquisition of IPRs and firm performance (for example, ESA and USPTO; 2012, EPO and OHIM; 2013, OHIM; 2015). From more academic perspective, several studies, including a seminal work by Scherer (1965) and more recent work by Ernst (2001), address the issue on the innovation-promoting effect of a patent right in order to provide empirical evidence for the policy discussion of the role of the patent system.

However, not many studies focus on the rigorous identification of causal effect successfully. One of the most severe problems in analyzing the contribution of a patent on innovation performance is endogeneity that the firms with higher performance should have stronger incentive to obtain patents. Some recent studies cope well with this endogeneity problem.

Farre-Mensa et al. (2016) examines the effect of patent acquisition on the growth of startups in terms of sales, employment, subsequent patents and funding. They exploit the exogenous variation in examiners' grant rate as an instrumental variable to identify the causal effect, and find large positive effects of patent acquisition on the performance especially when the review process is accelerated. However, their estimation model seems not introduce sufficient control variables such as on technological opportunities, which may have caused a part of the bright side of patents due to the missing variable affecting the patent approvals and commercialization. Our data source includes rich information on the firms' business activity including the R&D activities so that we can control for the opportunity of R&D for the firms in the initial stage.

Galasso and Schankerman (2015) use the random allocations of judges to control for the endogeneity. They focus on the cases that the patent is invalidated where the judges at the U.S. Court of Appeals for the Federal Circuit is allocated randomly by computer program. The study shows that patent invalidation significantly increases

the citations to the focal patent only in the technology field with lower probability of invalidity, which suggests that patents impede cumulative innovation only in specific conditions. Their idea on the instrumental variable is outstanding. However, difference of the system between US and Japan preclude us from applying their method to the study on Japanese firms. While their research examines the blocking effect of patents on the cumulative innovation, this paper focuses on the effect of first patent acquisition on the corporate growth performance, including R&D activity, of the medium-sized firms.

Helmers and Rogers (2011) address the problems of identification of the effect of getting a patent, focusing on the ex-ante patenting decision of the founder of high-tech/medium-tech startups. They assume that high-tech/medium-tech startups are founded to commercialize the invention, and compare the changes in the performance between the startups patenting their inventions and those without patenting. They find that the asset growth is much larger for the patentees than non-patentees, which indicates the positive causal effect of patent.

The originality of our paper is that we identify the causal effect by exploiting the variation of the distance of the firm to the nearest patent attorney office. Advice from a patent attorney would facilitate the successful first patent acquisition of the medium-sized startups, which would then enhance their performance permanently. That is, our analysis focuses on the effects of patent acquisition in the extensive margin. We collect information on the address of all attorney offices in Japan and calculate the distance from the sample firms. This paper is also the first attempt to analyze the impact of accessibility to the patent attorney on the firms' patenting propensity and grant rate.

We find that the probability of acquiring the first patent increases as the firm is located in a close distance to the nearest office of patent attorney, which suggests that a patent attorney helps medium-sized firms to start obtaining a patent. Moreover, the paper shows that firm's performance, measured by the R&D expenditure, asset size and added value, is improved by the first patent acquisition even after controlling for the initial performance and the endogeneity.

2. Data

Data used in this study is obtained from Basic Survey of Japanese Business Structure and Activities (BSA Survey, hereafter) conducted annually by Ministry of Economy, Trade and Industry and IIP Patent Database (IIP-PD, hereafter). BSA Survey targets all enterprises with 50 or more employees and capital of 30 million

yen or more, and the response rate is about 85%. We constructed a panel data of BSA Survey between 1994 and 2013, by matching the patent data from IIP-PD. The IIP-PD, provided by Institute of Intellectual Property, is constructed from the processing data of all applications filed with the Japan Patent Office. As the IIP-PD covers all applications filed by September 2012, on a full year basis, our patent data is limited to the invention granted by 2011.

Among the respondents to the BSA Survey matched with the IIP-PD, we restrict the sample only into the manufacturing firms that do NOT have any patent and founded within 20 years at the point of 1999, to focus on the effect of the first patent acquisition of medium-sized startups. Then, we compare the firms that start acquiring patent during 2000-2004 with the firms that remain not holding patent during the sample period.

Table 1 shows the differences in the growth rate of the performance measured by total asset, value added and R&D in 2005 and 2007 from the initial size (in 1999) between the firms starting acquiring patents and non-patentees. Note that, as shown in Table 1, the number of firms that start patenting is only about 160 while it is 1088 for non-patentees in our sample. We find that the initial size of the performance indices, especially for R&D expenses, is larger for the patentees than non-patentees, which may indicate the endogeneity of patenting activity and performance. Moreover, we see that the growth rate is higher for the firms starting patent acquisition for all performance indices.

These results suggest that the first patent acquisition is significantly correlated with the growth performance of a firm, and also indicate the importance of controlling for the endogeneity and initial technological opportunity.

Table 1. Differences in growth rate

	Firms starting patent acquisition (during 2000-2004)				Non-patentees			
	Initial size (in 1999)		Growth rate		Initial size (in 1999)		Growth rate	
	N	mean	2005	2007	N	mean	2005	2007
ln(totalasset)	160	8.16	0.49	0.79	1088	7.34	0.34	0.55
ln(added value)	159	6.46	0.79	0.91	1047	5.61	0.49	0.64
ln(1+RD)	160	2.26	1.03	2.29	1088	0.57	0.15	0.29

Table 2 shows the patent acquisition lag (period between the year of the foundation and the first patent acquisition) and the grant rate (to application) of the firms that acquired first patent during 2000-2004. We see that patent acquisition lag is quite long. Only five firms among 160 patentees acquire patent within 5 years after foundation (the median is 16 years). Therefore, Table 1 and 2 show that acquiring the first patent is a long-term process even for medium size firm: only 13 % of them (160 firms out of 1248) are successful in the 5-year window and it took 16 years (a median) from their foundation years.

We also find in Table 2 that patent acquisition lag is shorter and grant rate is lower for the firms with larger initial size, which partly indicates the endogeneity. We see ambiguous relation between acquisition lag and the growth rate. However, we find that growth rates are higher for the firms with higher grant rate.

Table 2. Patent acquisition lag and the grant rate

		N	Total asset			Value added			RD		
			Initial size (in 1999)	Growth rate		Initial size (in 1999)	Growth rate		Initial size (in 1999)	Growth rate	
				2005	2007		2005	2007		2005	2007
Patent acquisition lag (median: 16)	0-5 years	5	28370.0	-0.15	-0.07	4089.4	0.80	0.73	216.0	-0.27	3.90
	6-10 years	24	9010.2	1.33	1.34	1758.9	1.35	1.07	154.3	0.21	1.09
	11-15 years	43	12156.6	0.36	0.64	2167.5	0.56	0.67	171.5	2.38	3.92
	16-20 years	63	4650.0	0.41	0.88	808.5	1.03	1.18	69.0	1.07	1.99
	21-30 years	25	5122.2	0.24	0.50	752.6	0.08	0.56	44.2	-0.37	0.63
Grant rate (median:0.385)	High grant rate	76	5404.0	0.53	0.96	908.0	1.28	1.41	59.6	1.38	2.58
	Low grant rate	84	10608.7	0.45	0.64	1864.3	0.36	0.48	155.7	0.79	2.08

3. Estimation strategy and results

3.1 Estimation model

Our focus is on the effect of the first patent acquisition of the medium-sized firms founded within 20 years on the performance growth. For that purpose, as mentioned above, we have to control for the endogeneity of patent acquisition. Therefore, we use two-stage least squares (2SLS), exploiting the exogenous variation of the distance to the nearest attorney office as an instrumental variable.

The startups can receive advice from attorney easier when the office is located closer, which would increase the probability of successfully acquiring a patent. However, the geographical closeness to the attorney office would not directly affect the firm's financial performance.

The estimation model of the second stage is represented by equation (1). The

second stage estimation identifies the effects of starting acquiring a patent on the performance. The first stage estimation examines the determinants of first patent acquisition, focusing on the accessibility to a patent attorney, which is modeled as equation (2).

For a clear identification, we limit the sample into the firms that have never obtained patent until 1999, and compare the performance growth between the firms starting patent acquisition driven by the proximity to a patent attorney and the firms that end up as non-patentees during 2000-2004.

$$Y_{i,t} = \beta_0 + \beta_1 \ Patent_i + \boldsymbol{\gamma} \ Initial \ \ size \ \ and \ \ capability_i + \lambda_i + \ \theta_{it} + \varepsilon_{i,t}. \quad (1)$$

$$Patent_i = \alpha_0 + \ \alpha_1 \ Distance_i + \boldsymbol{\eta} \ Initial \ \ size \ \ and \ \ capability_i + \lambda_i + \ \theta_{it} + \epsilon_{i,t}. \quad (2)$$

In Equations (1) and (2), i denotes a firm, and t denotes year. Vectors $\boldsymbol{\beta}$, $\boldsymbol{\alpha}$, $\boldsymbol{\gamma}$, and $\boldsymbol{\eta}$ are coefficient parameters.

The dependent variable of the first stage estimation is the dummy variable that takes the value 1 if the firm starts acquiring patent during 2000-2004. We control for the initial size of the firm in terms of inputs of the production function which we see as exogenous variables: the number of employees and the amount of tangible asset at the initial point (in 1999). We also control for the initial size of the performance variable (or the independent variable) in 1999. The capability of the firm is controlled by R&D expenditures in 1999. We use the values of dependent variables in 2005, 2007 and 2009 for our estimations to see the short-term, middle-term, and long-term effect of a patent acquisition on the growth of performance, given the initial size. We measure the performance by the amount of total asset, added value and R&D expenditure.

Considering potential correlations between variable $Patent_i$ and the error term ($\varepsilon_{i,t}$) in Equation (1), we implement instrumental variable estimation specified by Equation (2). We use a distance to the nearest patent attorney office as an instrumental variable.

As for λ_i, we include foundation year dummies, geographical location dummies. Additional to the prefecture-level dummies, we introduce city-level dummies for the top 10 cities in terms of the number of sample firms located. Regarding to θ_{it}, we include the cross term of industry dummies and year dummies. With these extensive control variables, we can control for the potential biases associated with the importance of technological and demand opportunities at sector and location level.

3.2 Instrumental variable

One of the novelty of this paper is that we collected information on the geographical location of all patent attorneys in Japan. In Japan, patent attorney is a nationally accredited, and the address of the office he/she is working for is available to the public on the web page of Japan Patent Attorneys Association[1]. We converted the address of all patent attorneys and the address of the sample firms into the longitude and latitude code at street number level. Then we calculate the shortest distance to the nearest attorney office for all sample firms.

Table 3 shows the average distance to the nearest attorney of the sample firms by prefecture (there are 47 prefectures in Japan). We see that average distance is 9.9 km, while in Tokyo area the average distance is only about 1.2 km. To control for the influence of the geographical agglomerations in more details, we introduce the city level dummies for the firms located in top 10 cities in terms of the number of sample, in addition to 47 prefectures dummies.

Table 3. Distance to the nearest attorney by prefecture

Prefecture	num. of firms	mean (km)	SD	Prefecture	num. of firms	mean (km)	SD
1 Hokkaido	34	19.74	22.98	25 Shiga	15	6.11	5.11
2 Aomori	22	18.46	16.63	26 Kyoto	15	6.53	8.68
3 Iwate	32	33.73	16.19	27 Osaka	63	1.69	3.17
4 Miyagi	22	14.94	9.78	28 Hyogo	36	9.00	11.66
5 Akita	32	16.66	11.99	29 Nara	1	1.01	.
6 Yamagata	49	17.48	13.98	30 Wakayama	7	20.78	26.97
7 Fukushima	27	12.06	9.75	31 Tottori	13	8.97	12.02
8 Ibaraki	17	5.51	3.13	32 Shimane	2	14.34	10.23
9 Tochigi	26	4.90	3.88	33 Okayama	24	10.26	9.92
10 Gumma	26	4.96	3.01	34 Hiroshima	25	7.77	9.47
11 Saitama	39	4.26	6.48	35 Yamaguchi	13	16.37	14.55
12 Chiba	21	2.95	3.92	36 Tokushima	5	58.01	6.59
13 Tokyo	145	1.20	3.67	37 Kagawa	11	35.17	15.51
14 Kanagawa	54	1.41	1.08	38 Ehime	17	47.30	15.80
15 Niigata	35	13.77	13.62	39 Kochi	5	100.58	8.78
16 Toyama	28	6.37	3.71	40 Fukuoka	44	7.24	6.59
17 Ishikawa	14	10.63	10.98	41 Saga	8	4.15	4.13
18 Fukui	11	5.47	6.32	42 Nagasaki	11	19.83	8.39
19 Yamanashi	16	5.82	4.45	43 Kumamoto	28	15.44	12.34
20 Nagano	34	5.09	5.72	44 Oita	19	8.68	7.18
21 Gifu	33	7.30	5.99	45 Miyazaki	13	23.75	17.96
22 Shizuoka	42	4.84	4.23	46 Kagoshima	15	23.09	13.11
23 Aichi	53	2.49	3.77	47 Okinawa	0	-	-
24 Mie	26	6.18	6.02	Total	1228	9.99	14.55

[1] Unfortunately, we cannot collect historical information as the address is updated and overwritten to new information every year.

3.3. Estimation results for base model

Table 4 to 7 shows the results of the second stage estimation, where we use the total asset, value added and R&D expenditure as dependent variables, respectively. First, we see that in the first stage estimation results the distance to the nearest patent attorney office has negative and significant effect in all estimation models. These results suggest that easier access to reliable attorney promote the patenting activity of the medium-sized startups. Moreover, these results indicate that the instrumental variable works well.

According to the second stage results for total asset in Table 4, the first patent acquisition has positive effects, after controlling for the endogeneity, initial size and geographical location. The results show that middle- and long-term effects in terms of the magnitude and significance is larger than the short-term effect, which indicates that acquiring patent helps the subsequent asset growth of the medium-sized startups.

The capability of the firm measured by the R&D expenses in 1999 has statistically insignificant coefficients in the results of second stage estimation, while in the first stage they have significant positive effects. However, the total effect of R&D should be positive, since the effect of R&D through the first patent acquisition is dominant. When we multiply the coefficient of *Ln(RD_1999)* in the first stage and the coefficient of *Patent* in the second stage, it is larger than the coefficient of *Ln(RD_1999)* in the second stage. This result can also suggest that R&D promotes the firm growth only when R&D succeeds and produces patentable knowledge, while it has insignificant effect when it ends up in failure.

In Table 5 and 6, we can see the similar results: the first patent acquisition has positive effects on the subsequent growth of value added and R&D investment, while it has relatively immediate effect for the growth of R&D.

Descriptive statistics and OLS estimation results are shown in Appendix.

Table 4. Estimation results: Total asset

	Short term (in 2005)				Middle term (in 2007)				Long term (in 2009)			
	Second stage: *Ln(total asset)*		First stage: *Patent*		Second stage: *Ln(total asset)*		First stage: *Patent*		Second stage: *Ln(total asset)*		First stage: *Patent*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Patent	0.983	1.084			1.621**	1.818**			1.953**	2.285*		
	(1.504)	(1.372)			(2.171)	(1.983)			(1.973)	(1.726)		
Ln(Distance)			-0.044***	-0.037**			-0.050***	-0.042***			-0.044**	-0.036**
			(-2.734)	(-2.408)			(-3.035)	(-2.686)			(-2.523)	(-2.126)
Ln(total asset_1999)	0.792***	0.803***	0.064***	0.038*	0.776***	0.799***	0.065***	0.038*	0.701***	0.736***	0.063***	0.031
	(13.928)	(16.199)	(3.145)	(1.949)	(10.817)	(12.439)	(3.018)	(1.792)	(7.793)	(9.228)	(2.633)	(1.321)
Ln(employee_1999)	0.016	0.018	-0.007	-0.009	0.046	0.050	-0.012	-0.012	0.051	0.053	-0.010	-0.009
	(0.417)	(0.458)	(-0.340)	(-0.458)	(0.910)	(0.929)	(-0.523)	(-0.586)	(0.860)	(0.824)	(-0.423)	(-0.408)
Ln(tang asset_1999)	0.024	0.025	-0.000	-0.000	-0.013	-0.013	-0.004	-0.003	-0.010	-0.013	-0.001	0.001
	(1.179)	(1.164)	(-0.007)	(-0.043)	(-0.436)	(-0.420)	(-0.329)	(-0.287)	(-0.285)	(-0.348)	(-0.094)	(0.054)
Ln(1+RD_1999)		-0.041		0.061***		-0.081		0.061***		-0.110		0.063***
		(-0.789)		(7.661)		(-1.334)		(7.508)		(-1.239)		(7.279)
Constant	2.191***	2.195***	-0.119	-0.107	2.109***	2.022**	-0.362	-0.255	2.855***	2.755***	-0.472	-0.338
	(4.019)	(3.925)	(-0.405)	(-0.379)	(2.703)	(2.576)	(-1.208)	(-0.884)	(3.005)	(2.805)	(-1.569)	(-1.169)
*Year*Industry*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Foundation year dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Prefecture dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
City dummy (for top 10)	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	739	739	739	739	717	717	717	717	650	650	650	650
F-test	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5. Estimation results: Value added

	Short term (in 2005)				Middle term (in 2007)				Long term (in 2009)			
	Second stage: *Ln(value added)*		First stage: *Patent*		Second stage: *Ln(value added)*		First stage: *Patent*		Second stage: *Ln(value added)*		First stage: *Patent*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Patent	1.787*	1.860			2.792**	2.996**			3.718*	4.332		
	(1.650)	(1.475)			(2.321)	(2.139)			(1.798)	(1.556)		
Ln(Distance)			-0.045***	-0.039**			-0.050***	-0.044***			-0.041**	-0.033*
			(-2.650)	(-2.417)			(-2.847)	(-2.636)			(-2.158)	(-1.831)
Ln(value added_1999)	0.530***	0.538***	0.034**	0.015	0.442***	0.474***	0.041***	0.019	0.447***	0.489***	0.032**	0.013
	(8.969)	(10.983)	(2.322)	(1.080)	(5.866)	(7.609)	(2.825)	(1.339)	(4.190)	(5.280)	(2.001)	(0.831)
Ln(employee_1999)	0.130**	0.132**	0.010	0.005	0.214***	0.219***	-0.006	-0.008	0.299***	0.318**	-0.008	-0.013
	(2.102)	(2.134)	(0.487)	(0.247)	(2.795)	(2.755)	(-0.268)	(-0.381)	(2.722)	(2.562)	(-0.350)	(-0.552)
Ln(tang asset_1999)	0.077**	0.081***	0.020**	0.011	0.072**	0.082**	0.015	0.008	0.065	0.088	0.016	0.006
	(2.368)	(2.763)	(2.200)	(1.311)	(2.003)	(2.332)	(1.530)	(0.858)	(1.168)	(1.641)	(1.510)	(0.586)
Ln(1+RD_1999)		-0.038		0.067***		-0.115		0.063***		-0.219		0.068***
		(-0.425)		(8.096)		(-1.203)		(7.478)		(-1.106)		(7.343)
Constant	3.158***	3.163***	-0.041	-0.045	2.903**	2.795**	-0.271	-0.181	2.739*	2.533	-0.386	-0.248
	(3.634)	(3.584)	(-0.137)	(-0.158)	(2.512)	(2.418)	(-0.893)	(-0.622)	(1.675)	(1.500)	(-1.250)	(-0.844)
*Year*Industry*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Foundation year dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Prefecture dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
City dummy (for top 10)	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	699	699	699	699	675	675	675	675	582	582	582	582
F-test	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6. Estimation results: R&D

	Short term (in 2005)				Middle term (in 2007)				Long term (in 2009)			
	Second stage: *Ln(1+RD)*		First stage: *Patent*		Second stage: *Ln(1+RD)*		First stage: *Patent*		Second stage: *Ln(1+RD)*		First stage: *Patent*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Patent	4.672**	3.700*			3.974**	3.075*			5.523**	5.070*		
	(2.316)	(1.722)			(2.381)	(1.695)			(2.442)	(1.833)		
Ln(Distance)			-0.047***	-0.039**			-0.054***	-0.044***			-0.048***	-0.037**
			(-2.945)	(-2.525)			(-3.272)	(-2.812)			(-2.726)	(-2.214)
Ln(1+RD_1999)		0.345**		0.064***		0.324***		0.064***		0.133		0.065***
		(2.367)		(8.084)		(2.588)		(7.927)		(0.692)		(7.662)
Ln(employee_1999)	0.142	0.084	0.023	0.008	0.221*	0.165*	0.019	0.005	0.151	0.130	0.019	0.004
	(1.147)	(0.835)	(1.211)	(0.456)	(1.940)	(1.689)	(0.946)	(0.239)	(1.100)	(1.051)	(0.891)	(0.216)
Ln(tang asset_1999)	0.064	0.027	0.027***	0.015**	0.038	0.000	0.024***	0.012	0.016	0.002	0.027***	0.014
	(0.895)	(0.519)	(3.413)	(1.999)	(0.627)	(0.005)	(2.837)	(1.505)	(0.194)	(0.031)	(2.972)	(1.605)
Constant	-0.165	-0.436	0.057	-0.003	-1.696	-1.711	-0.159	-0.136	-0.093	-0.115	-0.310	-0.256
	(-0.097)	(-0.290)	(0.195)	(-0.012)	(-1.013)	(-1.144)	(-0.540)	(-0.485)	(-0.046)	(-0.059)	(-1.047)	(-0.908)
*Year*Industry*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Foundation year dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Prefecture dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
City dummy (for top 10)	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	739	739	739	739	717	717	717	717	650	650	650	650
R2	0.013	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.162	0.000	0.000	0.000

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

3.4. Effects of early patent acquisition

Next, we analyze whether the timing of patent acquisition matters. More specifically, we examine whether the positive effect of patent acquisition becomes stronger when the grant lag, which is defined as the monthly period between the application date and the grant date, becomes shorter, due to the proximity to attorney. For that purpose, we use the categorical variable taking the value 1 if the firms do not have any patent, value 2 if the firms acquire the first patent during 2000-2004 but the grant lag is longer than the median, and the value 3 if the firms obtain the first patent during the 5-year window and the grant lag is shorter than the median.

Table 7 to 9 show the results for each performance index. We see positive effect of early patent acquisition relative to rejected application. Therefore, the timely acquisition of a patent is quite important for the firm growth. These results also suggest the importance of the support by attorney to improve the efficiency of patenting activity of the medium-sized startups for their growth.

3.5. Effects of first patent application

Lastly, we investigate the effects of first patent application, whereby we can see the relative importance of the patent grant. To examine such effect, we use the dummy variable taking 1 if the firms start filing patent application during 2000 and 2004 as a dependent variable of the first stage estimation, limiting the sample to the firms without any patent application before1999. Table 10 shows the IV estimation results using the same framework and the estimation model in the previous section.

In the first stage estimation results, we see significantly negative coefficients of distance to the attorney. This result suggests that the patent attorney contributes to promote patent application. However, we also find that the magnitude and significance of the effect of patent application in the second stage is smaller than that of paten acquisition in Table 4. Therefore, patent registration is more important than just filing application for the firm growth. The results also indicate that the positive effect of accessibility of patent attorney on firm growth is through the improvement of grant rate rather than through the promotion of patent application.

We can see the similar trend when we use value added and R&D as performance indices in Appendix as Table A2 and A3, respectively.

Table 7. Effect of shorter grant lag: Total asset

	Short term (in 2005)				Meddle term (in 2007)				Long term (in 2009)			
	Second stage: *Ln(total asset)*		First stage: *Early grant*		Second stage: *Ln(total asset)*		First stage: *Early grant*		Second stage: *Ln(total asset)*		First stage: *Early grant*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Early grant	0.555	0.600			0.981**	1.079**			1.151**	1.301*		
	(1.530)	(1.406)			(2.219)	(2.045)			(2.066)	(1.848)		
Ln(Distance)			-0.077***	-0.067***			-0.082***	-0.071***			-0.075***	-0.063**
			(-3.040)	(-2.730)			(-3.229)	(-2.899)			(-2.758)	(-2.391)
Ln(total asset_1999)	0.806***	0.815***	0.088***	0.048	0.793***	0.814***	0.090***	0.050	0.730***	0.761***	0.082**	0.035
	(16.330)	(18.941)	(2.735)	(1.545)	(12.252)	(13.968)	(2.688)	(1.516)	(9.620)	(11.216)	(2.198)	(0.968)
Ln(employee_1999)	0.011	0.013	-0.005	-0.008	0.034	0.036	-0.007	-0.008	0.047	0.048	-0.014	-0.012
	(0.305)	(0.333)	(-0.135)	(-0.242)	(0.693)	(0.700)	(-0.191)	(-0.237)	(0.839)	(0.810)	(-0.372)	(-0.355)
Ln(tang asset_1999)	0.023	0.023	0.002	0.001	-0.018	-0.018	-0.002	-0.001	-0.021	-0.025	0.007	0.010
	(1.142)	(1.130)	(0.108)	(0.078)	(-0.628)	(-0.628)	(-0.091)	(-0.041)	(-0.616)	(-0.685)	(0.318)	(0.470)
Ln(1+RD_1999)		-0.032		0.096***		-0.067		0.090***		-0.084		0.091***
		(-0.719)		(7.536)		(-1.276)		(7.076)		(-1.209)		(6.710)
Constant	2.021***	2.011***	0.096	0.115	2.091***	1.916***	-0.581	-0.423	2.677***	2.578***	-0.564	-0.371
	(3.975)	(3.907)	(0.205)	(0.256)	(2.754)	(2.603)	(-1.247)	(-0.941)	(3.122)	(2.971)	(-1.210)	(-0.823)
*Year*Industry*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Foundation year dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Prefecture dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
City dummy (for top 10)	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	739	739	739	739	717	717	717	717	650	650	650	650
F-test	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.001

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8. Effect of shorter grant lag: Value added

	Short term (in 2005)				Meddle term (in 2007)				Long term (in 2009)			
	Second stage: *Ln(value added)*		First stage: *Early grant*		Second stage: *Ln(value added)*		First stage: *Early grant*		Second stage: *Ln(value added)*		First stage: *Early grant*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Early grant	0.962*	0.978			1.625**	1.713**			2.101*	2.358*		
	(1.709)	(1.539)			(2.445)	(2.275)			(1.945)	(1.731)		
Ln(Distance)			-0.084***	-0.075***			-0.085***	-0.077***			-0.073**	-0.061**
			(-3.105)	(-2.895)			(-3.144)	(-2.948)			(-2.483)	(-2.179)
Ln(value added_1999)	0.551***	0.555***	0.041*	0.012	0.470***	0.496***	0.053**	0.021	0.484***	0.520***	0.040	0.011
	(11.265)	(13.061)	(1.765)	(0.522)	(7.442)	(9.192)	(2.348)	(0.925)	(5.680)	(6.896)	(1.587)	(0.446)
Ln(employee_1999)	0.126**	0.127**	0.023	0.015	0.194***	0.196***	0.002	-0.001	0.284***	0.296***	-0.008	-0.014
	(2.101)	(2.128)	(0.685)	(0.458)	(2.678)	(2.655)	(0.066)	(-0.026)	(2.831)	(2.742)	(-0.207)	(-0.393)
Ln(tang asset_1999)	0.083***	0.084***	0.031**	0.018	0.070**	0.077**	0.027*	0.017	0.066	0.083*	0.029*	0.013
	(2.798)	(3.124)	(2.172)	(1.295)	(2.023)	(2.300)	(1.780)	(1.149)	(1.278)	(1.691)	(1.720)	(0.837)
Ln(1+RD_1999)		-0.016		0.105***		-0.086		0.094***		-0.162		0.101***
		(-0.217)		(7.957)		(-1.101)		(7.074)		(-1.108)		(7.049)
Constant	2.863***	2.861***	0.230	0.224	2.845***	2.762**	-0.431	-0.297	2.514*	2.334	-0.470	-0.266
	(3.541)	(3.525)	(0.486)	(0.495)	(2.620)	(2.556)	(-0.911)	(-0.653)	(1.731)	(1.590)	(-0.990)	(-0.586)
*Year*Industry*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Foundation year dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Prefecture dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
City dummy (for top 10)	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	699	699	699	699	675	675	675	675	582	582	582	582
F-test	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.001

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9. Effect of shorter grant lag: R&D

	Short term (in 2005)				Meddle term (in 2007)				Long term (in 2009)			
	Second stage: *Ln(1+RD)*		First stage: *Early grant*		Second stage: *Ln(1+RD)*		First stage: *Early grant*		Second stage: *Ln(1+RD)*		First stage: *Early grant*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Early grant	2.681**	2.075*			2.434**	1.843*			3.315**	2.925*		
	(2.391)	(1.788)			(2.399)	(1.718)			(2.488)	(1.907)		
Ln(Distance)			-0.082***	-0.069***			-0.088***	-0.074***			-0.080***	-0.064**
			(-3.227)	(-2.825)			(-3.443)	(-3.009)			(-2.931)	(-2.459)
Ln(1+RD_1999)		0.375***		0.099***		0.348***		0.093***		0.190		0.093***
		(3.010)		(7.898)		(3.148)		(7.445)		(1.227)		(7.020)
Ln(employee_1999)	0.149	0.085	0.037	0.014	0.209*	0.152	0.035	0.015	0.176	0.143	0.023	0.003
	(1.260)	(0.876)	(1.235)	(0.497)	(1.826)	(1.560)	(1.151)	(0.491)	(1.339)	(1.211)	(0.723)	(0.096)
Ln(tang asset_1999)	0.084	0.039	0.039***	0.021*	0.043	0.001	0.037***	0.020	0.021	-0.000	0.044***	0.026*
	(1.331)	(0.848)	(3.143)	(1.750)	(0.730)	(0.026)	(2.831)	(1.570)	(0.258)	(-0.001)	(3.100)	(1.835)
Constant	-0.809	-0.957	0.339	0.245	-1.832	-1.815	-0.300	-0.267	-0.326	-0.329	-0.354	-0.278
	(-0.495)	(-0.676)	(0.735)	(0.556)	(-1.117)	(-1.248)	(-0.657)	(-0.609)	(-0.167)	(-0.182)	(-0.774)	(-0.632)
*Year*Industry*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Foundation year dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Prefecture dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
City dummy (for top 10)	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	739	739	739	739	717	717	717	717	650	650	650	650
R2	0.005	0.000	0.001	0.000	0.002	0.000	0.001	0.000	0.116	0.000	0.001	0.001

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10. Effects of patent application: Total asset

	Short term (in 2005)				Meddle term (in 2007)				Long term (in 2009)			
	Second stage: *Ln(total asset)*		First stage: *Application*		Second stage: *Ln(total asset)*		First stage: *Application*		Second stage: *Ln(total asset)*		First stage: *Application*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Application	0.301	0.307			0.668	0.666			0.997	0.999		
	(0.606)	(0.644)			(1.138)	(1.146)			(1.001)	(1.017)		
Ln(Distance)			-0.057***	-0.059***			-0.056***	-0.057***			-0.038*	-0.039**
			(-2.986)	(-3.140)			(-2.967)	(-3.040)			(-1.945)	(-1.988)
Ln(total asset_1999)	0.865***	0.862***	0.050**	0.036	0.866***	0.870***	0.057**	0.039	0.784***	0.782***	0.052**	0.038
	(19.916)	(21.655)	(2.133)	(1.512)	(15.659)	(17.420)	(2.295)	(1.556)	(10.739)	(12.131)	(1.993)	(1.461)
Ln(employee_1999)	-0.009	-0.008	-0.028	-0.028	0.021	0.020	-0.034	-0.033	0.010	0.011	-0.023	-0.021
	(-0.219)	(-0.215)	(-1.088)	(-1.105)	(0.426)	(0.422)	(-1.321)	(-1.308)	(0.186)	(0.196)	(-0.884)	(-0.799)
Ln(tang asset_1999)	0.019	0.019	-0.005	-0.005	-0.023	-0.023	-0.014	-0.013	-0.005	-0.005	-0.017	-0.017
	(0.958)	(0.956)	(-0.367)	(-0.395)	(-0.874)	(-0.891)	(-0.980)	(-0.918)	(-0.158)	(-0.156)	(-1.163)	(-1.143)
Ln(1+RD_1999)		0.006		0.039***		-0.009		0.040***		0.004		0.031***
		(0.260)		(3.662)		(-0.292)		(3.808)		(0.114)		(2.767)
Constant	1.786***	1.792***	0.396	0.454	1.571***	1.444***	0.173	0.269	2.009***	2.019***	0.371	0.448*
	(4.019)	(3.960)	(1.411)	(1.633)	(3.216)	(2.978)	(0.614)	(0.965)	(3.204)	(2.976)	(1.430)	(1.732)
*Year*Industry*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Foundation year dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Prefecture dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
City dummy (for top 10)	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	614	614	614	614	596	596	596	596	527	527	527	527
F-test	0.000	0.000	0.002	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.008	0.002

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4. Conclusion

This paper examined the causal effects of the first patent acquisition on the performance growth of the firms. We focused on the medium size manufacturing firms (the size of the employees is more than 50) which did not have any patent in 1999 but were established within the last 20 years. We found that only 13 % of them got the first patent in the following 5 years and it took 16 years (median) from their foundation year. Thus, acquiring the first patent is a long-term process which a patent attorney may significantly help.

For our identification, we exploited the variation of the distance to the nearest patent attorney office. Easier access to a patent attorney increases the opportunity to receive an advice which would increase the patent propensity of the startups.

The estimation results showed that acquiring patent has long-lasting positive effects on the performance measured by the asset size, added value, and R&D, even after controlling for the endogeneity and heterogeneity of the technological and demand opportunities. Therefore, the patenting activity facilitated by a patent attorney should contribute to the promotion of innovation by accelerating the growth of medium-sized firms. Furthermore, the results showed that geographical closeness to the patent attorney increases early grant, which can be an important driver of the firm growth. However, the effect of the first application is much smaller than that of first grant, which indicates the importance of patent registration than filing for the firm growth. Our results suggest that providing a timely examination and facilitating the support from an attorney should be important policy measures to promote innovation.

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Appendix

Table A1 shows the OLS estimation results. We find that patent acquisition has statistically significant positive effect even in the early stage, which suggests the importance to control for the endogeneity. We also see that, comparing the OLS estimation results, results of IV regression in Table 4 to 7 has larger coefficients of patent acquisition.

Table A2 and A3 show the estimation results when we use value added and R&D as dependent variable to see the effect of patent application. We see insignificant effect of patent application on the performance indices, though the instrument variable works. These results suggest that improving grant rate should be important for the firm growth.

Table A4 shows the descriptive statistics.

Table A1. Results of OLS estimation

	Short term (in 2005)			Middle term (in 2007)			Long term (in 2009)		
	Ln(total asset)	*Ln(value added)*	*Ln(RD)*	*Ln(total asset)*	*Ln(value added)*	*Ln(RD)*	*Ln(total asset)*	*Ln(value added)*	*Ln(RD)*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Patent	0.146**	0.304***	0.428**	0.221***	0.345***	0.789***	0.182**	0.231*	0.871***
	(2.298)	(2.926)	(2.579)	(3.031)	(3.347)	(4.441)	(2.364)	(1.744)	(4.756)
Ln(employee_1999)	0.023	0.096***	0.076**	-0.022	0.098***	0.027	-0.016	0.105***	0.059
	(1.242)	(4.272)	(2.300)	(-0.976)	(4.159)	(0.716)	(-0.645)	(3.392)	(1.484)
Ln(tang asset_1999)	0.009	0.139***	0.116	0.029	0.197***	0.179**	0.033	0.256***	0.153*
	(0.276)	(2.622)	(1.474)	(0.737)	(3.611)	(2.061)	(0.789)	(3.714)	(1.713)
Ln(1+RD_1999)	0.018	0.068***	0.557***	0.019	0.056**	0.473***	0.026	0.064**	0.413***
	(1.289)	(2.978)	(15.694)	(1.189)	(2.470)	(12.387)	(1.518)	(2.194)	(10.425)
Ln(totalasset_1999)	0.841***			0.866***			0.808***		
	(25.829)			(22.025)			(18.550)		
Ln(value added_1999)		0.569***			0.537***			0.561***	
		(15.656)			(14.817)			(12.040)	
Constant	1.963***	2.852***	-0.907	1.385***	1.876**	-2.157*	1.916***	0.839	-1.777
	(4.309)	(3.927)	(-0.775)	(2.623)	(2.583)	(-1.716)	(3.642)	(0.969)	(-1.445)
*Year*Industry*	yes	yes	yes	yes	yes	yes	yes	yes	yes
Foundation year dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes
Prefecture dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes
City dummy (for top 10)	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	739	699	739	717	675	717	650	582	650
R2	0.809	0.600	0.424	0.757	0.596	0.373	0.731	0.551	0.361

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A2. Effects of patent application: Value added

	Short term (in 2005)				Meddle term (in 2007)				Long term (in 2009)			
	Second stage: *Ln(value added)*		First stage: *Application*		Second stage: *Ln(value added)*		First stage: *Application*		Second stage: *Ln(value added)*		First stage: *Application*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Application	0.979	1.007			1.298	1.294			2.632	2.634		
	(1.225)	(1.322)			(1.542)	(1.558)			(1.458)	(1.502)		
Ln(Distance)			-0.061***	-0.065***			-0.061***	-0.062***			-0.042**	-0.044**
			(-3.010)	(-3.219)			(-3.018)	(-3.106)			(-2.017)	(-2.095)
Ln(value added_1999)	0.646***	0.640***	0.024	0.013	0.593***	0.597***	0.032*	0.018	0.581***	0.581***	0.025	0.020
	(12.789)	(13.380)	(1.262)	(0.717)	(10.551)	(11.576)	(1.692)	(0.942)	(6.522)	(6.944)	(1.299)	(1.036)
Ln(employee_1999)	0.150**	0.149**	-0.014	-0.015	0.201***	0.201***	-0.024	-0.025	0.317***	0.317***	-0.018	-0.018
	(2.378)	(2.361)	(-0.545)	(-0.608)	(2.881)	(2.877)	(-0.906)	(-0.963)	(3.041)	(3.042)	(-0.667)	(-0.680)
Ln(tang asset_1999)	0.063**	0.060**	0.009	0.004	0.074***	0.075***	0.000	-0.003	0.130***	0.129***	-0.007	-0.011
	(2.421)	(2.344)	(0.865)	(0.356)	(2.644)	(2.647)	(0.039)	(-0.286)	(2.872)	(2.647)	(-0.566)	(-0.967)
Ln(1+RD_1999)		0.024		0.047***		-0.013		0.044***		0.002		0.032***
		(0.538)		(4.087)		(-0.288)		(3.958)		(0.026)		(2.646)
Constant	3.085***	3.058***	0.509	0.483	1.867**	1.851**	0.052	0.099	-0.230	-0.229	0.643**	0.691**
	(3.636)	(3.634)	(1.474)	(1.423)	(2.191)	(2.176)	(0.157)	(0.300)	(-0.167)	(-0.162)	(2.178)	(2.353)
*Year*Industry*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Foundation year dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Prefecture dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
City dummy (for top 10)	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	577	577	577	577	554	554	554	554	464	464	464	464
F-test	0.000	0.000	0.021	0.001	0.000	0.000	0.008	0.000	0.000	0.000	0.024	0.008

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A3. Effects of patent application: R&D

	Short term (in 2005)				Meddle term (in 2007)				Long term (in 2009)			
	Second stage: *Ln(1+RD)*		First stage: *Application*		Second stage: *Ln(1+RD)*		First stage: *Application*		Second stage: *Ln(1+RD)*		First stage: *Application*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Application	1.495	1.926	.	.	1.548	1.566	.	.	4.496	4.551*	.	.
	(1.061)	(1.560)	(.)	(.)	(1.039)	(1.174)	(.)	(.)	(1.630)	(1.700)	(.)	(.)
Ln(Distance)			-0.058***	-0.060***			-0.058***	-0.058***			-0.039**	-0.040**
			(-3.038)	(-3.190)			(-3.052)	(-3.104)			(-2.012)	(-2.042)
Ln(1+RD_1999)		0.494***		0.042***		0.490***		0.043***		0.326***		0.034***
		(7.559)		(3.967)		(6.814)		(4.175)		(3.005)		(3.086)
Ln(employee_1999)	0.267***	0.180**	-0.004	-0.011	0.203*	0.112	-0.008	-0.016	0.182	0.144	-0.000	-0.004
	(2.741)	(2.020)	(-0.164)	(-0.497)	(1.916)	(1.157)	(-0.349)	(-0.704)	(1.383)	(1.119)	(-0.006)	(-0.175)
Ln(tang asset_1999)	0.119***	0.035	0.015*	0.009	0.097**	0.017	0.010	0.003	0.111**	0.054	0.005	-0.001
	(2.723)	(0.940)	(1.736)	(0.992)	(2.139)	(0.436)	(1.053)	(0.313)	(1.978)	(0.988)	(0.496)	(-0.096)
Constant	-1.263	-1.287	0.529*	0.550**	-2.493**	-1.815	0.322	0.375	-3.406*	-2.977	0.502**	0.549**
	(-0.941)	(-1.057)	(1.928)	(2.030)	(-2.004)	(-1.534)	(1.172)	(1.383)	(-1.687)	(-1.444)	(1.993)	(2.199)
*Year*Industry*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Foundation year dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Prefecture dummy	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
City dummy (for top 10)	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	614	614	614	614	596	596	596	596	527	527	527	527
F-test	0.011	0.000	0.004	0.000	0.161	0.000	0.005	0.000	0.679	0.000	0.014	0.003

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A4. Descriptive statistics

	all				Firms starting patent acquisition (during 2000-2004)				Non-patentees			
	Obs	Mean	Min	Max	Obs	Mean	Min	Max	Obs	Mean	Min	Max
Ln(added value_2005)	718	6.03	0.00	10.0	105	6.82	4.03	10.0	613	5.89	0.00	9.5
Ln(added value_2007)	625	6.06	0.69	10.3	92	6.88	4.34	10.3	533	5.92	0.69	10.0
Ln(added value_2009)	536	5.86	1.10	9.7	85	6.48	3.99	9.7	451	5.74	1.10	9.7
Ln(sales_2005)	718	8.21	5.38	13.5	105	8.85	6.41	13.5	613	8.09	5.38	12.8
Ln(sales_2007)	643	8.29	5.71	13.9	93	8.95	6.05	13.9	550	8.18	5.71	13.0
Ln(sales_2009)	581	8.13	5.82	13.7	90	8.64	6.34	13.7	491	8.03	5.82	12.8
Ln(RD_2005)	718	0.81	0.00	7.9	105	2.12	0.00	7.9	613	0.59	0.00	7.6
Ln(RD_2007)	643	0.87	0.00	8.0	93	2.40	0.00	7.7	550	0.61	0.00	8.0
Ln(RD_2009)	581	0.91	0.00	7.8	90	2.43	0.00	7.8	491	0.63	0.00	7.6
Ln(employee_2005)	718	5.01	3.93	8.8	105	5.24	3.97	8.5	613	4.97	3.93	8.8
Ln(employee_2007)	643	5.08	3.93	9.0	93	5.31	3.97	9.0	550	5.04	3.93	8.7
Ln(employee_2009)	581	5.12	3.93	9.0	90	5.34	3.99	9.0	491	5.08	3.93	8.4
Ln(employee_1999)	718	5.04	3.93	8.4	105	5.26	4.03	7.6	613	5.00	3.93	8.4
Ln(tang asset_1999)	718	6.30	0.00	11.1	105	7.01	0.69	11.1	613	6.17	0.00	11.0
Ln(RD_1999)	718	0.82	0.00	7.5	105	2.23	0.00	7.5	613	0.57	0.00	6.5
Distance	718	10.03	0.04	107.1	105	6.28	0.05	86.5	613	10.67	0.04	107.1
Patent	718	0.15	0.00	1.0	-	-	-	-	-	-	-	-
Application	718	0.06	0.00	1.0	-	-	-	-	-	-	-	-
Early grant	718	0.22	0.00	2	-	-	-	-	-	-	-	-