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April 2008

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Abstract

The purpose of this paper is to investigate the impact of the length of the grant lag under the early disclosure system in Japan. First, we measure the length of the grant lag. Second, we investigate whether reducing the grant lag significantly increases patent applications. We use data from 1985 to 2000 on 101 Japanese companies. The parameter for the grant lag was significantly negative in all equations. Therefore, reducing the grant lag increases patent applications. We also empirically investigated the determination of R&D. The grant lag significantly affects R&D.

JEL classification number: O31,O32,O33

Key word: Patent, Grant Lag, Patent Policy, R&D

1 Introduction

The purpose of this paper is to investigate the impact of the length of the grant lag (the length of time between the patent application and the granting of the patent (Johnson and Popp, 2003)) under the early disclosure system in Japan. First, we measure the length of the grant lag. Second, we investigate whether reducing the grant lag significantly increases patent applications.

Reducing the grant lag increases the international competitiveness of Japanese firms by increasing the number patents resulting from the stimulation of domestic research and development (R&D) under the early disclosure system (Japan Patent Office,2007). Therefore, the policy of reducing the grant lag is an important patent policy. In the US prior to December 2000, there was no early disclosure system and patent applications were not published before patents are granted. Without an early disclosure system, the substance of the patent is unknown before the granting of the patent. Furthermore, the grant lag is irrelevant because of the first-to-invent rule. However, in the US, the grant lag for patents is increasingly assuming importance because of the introduction of an early disclosure system.

There is little empirical work on the length of the grant lag. There are several theoretical studies of the early disclosure system (Aoki and Prusa, 1996, Aoki and Spiegel,1998 and Bloch and Markowitz,1996). Aoki and Prusa (1996) found that early disclosure reduces the quality of R&D. Aoki and Spiegel (1998) showed that early disclosure reduces patent applications. Hence, we infer that reducing the grant lag would increase patent applications because it corresponds to shortening disclosure.

In this paper, we show that reducing the grant lag increases patent applications. This happens because patent protection is stronger after patents have been granted and, hence, grant lags reduce incentives to make patent applications. Empirical work on patents in Japan is hampered by the lack of data on, for example, dates of patent applications and grants, numbers of citations, and claims. However, data from the Institute of Intellectual Property (IIP) are now available. The IIP patent data enable empirical study of patent policy.

Our paper is organized as follows. A description of the grant lag is presented in Section 2. Models, data, and estimation methods are described in Section 3. Empirical results are presented and discussed in Section 4. Conclusions are presented in Section 5.

2 The policy of reducing the grant lag

2.1 Japan

Recently, the Japan Patent Office employed several policies for the early determination of patent rights under policies of intellectual property rights. Moreover, early determination of patent rights is one aim of the "Strategic Council of Intellectual Property" of the Japanese Government. The Patent Law has been revised as follows. The duration for objections after the granting of patents was determined in 1996 and periods of request for substantive examinations were reduced in 2002. Furthermore, several improvement policies for examination efficiency, such as increasing the power of the examiner, specifying a duty of disclosure for prior art by applicants, and introducing the outscoring of prior art search, have been used.

[Figure 1]

The grant lag from 1985 to 2000 is shown in Figure 1[1]. The grant lag for the drugs is short and that for the electronics is long. In 1985, grant lags were similar between industries. For all industries, grant lags rose in the late 1980s and suddenly fell in the early 1990s. Grant lags differed between industries in the late 1990s. Since 2000, the grant lag has been 2.5 years for all industries.

[Figure 2]

The strength of patent protection in Japan is illustrated in Figure 2. Under the Japanese Patent Law, patent applications must be disclosed after 18 months. After disclosure, compensation payments can be demanded. Hence, the length of the period of examination does not affect the protection of the patent. However, the right to demand compensation payment does not effectively protect patents. There are a number of reasons for this. First, applicants cannot ask the courts for injunctions against third parties before patents are granted. Second, demands for compensation for implementation before registration of the establishment of the patent rights cannot be sustained when there are claim differences between application and grant. Third, applicants face huge costs for litigation proceedings and suits.

Rights to suspend infringements, rights to precaution to infringements, and rights to demand compensation for damages apply after registration of the establishment of the patent rights. Hence, patent protection is stronger following registration of the establishment of the patent rights. Therefore, increasing grant lags discourages patent applications.

[1] One can define the grant lag as the length of time between a request for substantive examination and the granting of a patent in Japan.

2.2 The US

As in Japan and the EU, the US has introduced an early disclosure system. Twenty-six Nobel laureates opposed its introduction in December 2000, arguing that early disclosure would reduce patent applications by eliminating incentives among small businesses and private investors to undertake R&D (Johnson and Popp,2003). When large firms infringe the patent rights of small-business and private inventors, it is not possible for the holders of these patent rights to recover fully damages because of the huge legal costs. Furthermore, the examination periods for new inventions can become excessive. Hence, there is a greater risk of infringement for new inventions (Johnson and Popp, 2003).

3 Empirical framework and data

3.1 The model

The purpose of this study is to test the effect of the length of grant lag on patent applications. We presume that the number of patent applications is affected by the length of the grant lag. Furthermore, R&D investment, sales, and dummy variables are incorporated into the estimation equation. Sales represent firm scale. Innovation activity may be affected by firm size (Cohen ,1995 and Schumpeter ,1942).

$$P(i,t) = \alpha_0 + \alpha_1 RD(i,t) + \alpha_2 S(i,t) + \alpha_3 GL(i,t) + \sum \beta_j D(j) + \mu(i) + \epsilon(i,t), \qquad (1)$$

In equation (1), $P(i,t)$ denotes the number of patent applications at time t in firm i, $RD(i,t)$ denotes real R&D investment at time t in firm i, $S(i,t)$ denotes sales at time t in firm i, $GL(i,t)$ denotes the grant lag at time t in firm i, and $D(j)$ is a dummy variable for industry j. Four industry dummy variables are incorporated: α_0, α_1,α_2,α_3,and β_j are parameters, $\mu(i)$ denotes the unobservable firm effect, and $\epsilon(i,t)$ is the disturbance term.

Our model is related to that of Griliches (1984). This equation is a general patent production function (Griliches,1984 and Jaffe ,1986) except for the inclusion of the length of the grant lag. This equation is the same as that used by Sakakibara and Branstetter (2001), except that they do not include the length of the grant lag.

Johnson and Popp (2003) assert that as scale decreases, the reaction against the length of the grant lag strengthens. Hence, we incorporate an interaction term between the grant lag and sales into equation (1), as follows:

$$P(i,t) = \alpha_0 + \alpha_1 RD(i,t) + \alpha_2 S(i,t) + \alpha_3 GL(i,t) + \alpha_4 S(i,t)GL(i,t) + \sum \beta_j D(j) + \mu(i) + \epsilon(i,t), \quad (2)$$

where $S(i,t)GL(i,t)$ is the interaction term between the grant lag and sales. We expect the sign of the coefficient on the interaction term to be positive. Furthermore, since 1988, more than one claim can be attached to a patent application. This means that one patent application may correspond to more than one innovation. Hence, to account for differences in claims, we construct another model in which the dependent variable represents claim-weighted patent applications.

3.2 The grant lag

Generally, the average grant lag is as follows (Johnson and Popp,2003):

$$GL(t) = \sum [g(t-i,t) \times i] \; / \; \sum g(t-i,t), \quad (3)$$

where $GL(t)$ denotes the average grant lag at time t and $g(t-i,t)$ denotes the number of patent grants at time t that is applied at time $t-i$[2]. However, the grant lag, as represented by equation (3), depends on the number of patent applications. This is because the number of patent grants depends on the number of patent applications. If patent applications are high, so are patent grants. Thus, the definition of the grant lag represented by equation (3), as proposed by Johnson and Popp (2003), is not ideal. Hence, we amend the equation for the average grant lag as follows:

$$GL(t) = \sum \frac{[g(t-i,t) \times i]}{a(t-i)} \; / \; \sum \frac{g(t-i,t)}{a(t-i)}, \quad (4)$$

where $a(t-i)$ denotes the number of patent applications at time $t-i$. In equation (4), the average grant lag is not affected by the number of patent applications; its effect is cancelled. We suggest that equation (4) is an appropriate representation of the grant lag[3].

[Table 1]

[Table 2]

[2] Equation (3) for the grant lag is not explicitly described by Johnson and Popp (2003). However, we base equation (3) on their study.

[3] We use data on the number of requests for substantive examination rather than data on patent applications.

The data on patents are from the IIP database. We use data from 1985 to 2000 on 101 Japanese companies in the drugs, chemicals, electronics, precision instruments, and transportation equipment. The number of requests for substantive examination and the number of patent grants are shown in Table 1. In the drugs, the ratio of patent grants to patent applications is high at 46%, and well above the industry mean of 26%.

Data on investment in R&D, Tobin's q and sales are obtained from the NEEDS database (Tokyo: Nihon Keizai Shimbunsya). The deflators used for R&D and output are from the Japan Industrial Productivity Database published by the Research Institute of the Economy, Trade and Industry. Details of the data used for Tobin's q are provided by Nakanishi and Yamada (2007). Basic statistics on our variables are shown in Table 2.

4 Results

4.1 Patent applications

[Table 3]

The estimation results for the patent applications function are shown in Table 3. The parameter for the grant lag is significantly negative in all equations that exclude the interaction term between the grant lag and sales. Therefore, reducing the grant lag increases patent applications. The parameter for the interaction term between the grant lag and sales is significantly positive in all equations that include this interaction term. Therefore, the impact of reducing the grant lag strengthens as scale decreases. Both the parameter for the grant lag and that for the interaction term between the grant lag and sales are significantly positive at the 10% level in all equations that include the interaction term between the grant lag and sales. The R&D parameters are all significantly positive. The sales parameters are positeve and significant in column (3) and (4). Therefore, the grant lag significantly affects patent applications.

Equations (1) and (2) are static and do not control for potential endogeneity. Therefore, we used the generalized method of moments (GMM) on the following first-differenced version of equation (2) that includes the lagged dependent variable:

$$\begin{aligned} DP(i,t) = \quad & \gamma \quad DP(i,t-1) + \alpha_1 DRD(i,t) + \alpha_2 DS(i,t) \\ & + \quad \alpha_3 DGL(i,t) + \alpha_4 D(S(i,t)GL(i,t)) + \epsilon(i,t), \end{aligned} \tag{5}$$

where D denotes the first-difference operator and γ is parameter.

[Table 4]

The GMM estimation results for patent applications are shown in Table 4. The parameters of all terms related to the grant lag are significantly negative. Moreover, the parameters for the interaction terms between the grant lag and sales are all significantly positive. The R&D parameters are all significantly positive. Although all the sales parameters are significant, the one in column (7) is positive. Therefore, the grant lag significantly affects patent applications. GMM estimation improves the results[4].

To account for patent citations, we classify patent applications into two types: (1) patent applications already cited; and (2) patent applications not previously cited(Trajtenberg ,1990, Hall, Jaffe and Trajtenberg ,2001, and Nakanishi and Yamada ,2007).

[Table 5]

The estimation results that incorporate the citation effect are shown in Table 5. The parameter for the grant lag is significantly negative in the regression for the number of applications cited. However, the parameter for the grant lag is not significantly negative in the regression for the number of applications not cited. The parameters for the other variables are significant in all models. Hence, the grant lag does not significantly affect patent applications without citation.

[Table 6]

We used the GMM estimator to estimate first-differenced versions of the equations for cited and noncited patents that include the lagged dependent variable. The GMM estimation results that incorporate the citation effect are shown in Table 6. The parameter for the grant lag is significantly negative in the regression for the number of applications cited. However, the parameter for the grant lag is negative but not significant in the regression for patent applications not cited. The parameters of all variables except sales are significant in all models. These estimates are similar to the panel estimates. Therefore, our results are robust. They confirm that the grant lag does not significantly affect patent applications without citation.

4.2 R&D

We also empirically investigated the determination of R&D. The policy relating to the grant lag is a patent policy and therefore patent applications are affected by this patent policy. Essentially, the patent is the output

[4]The instrument set includes all lagged variables.

that is produced according to the patent production function. In particular, R&D is the most important factor in the patent production function. Hence, it is reasonable to suppose that R&D is stimulated by the length of the grant lag. Therefore, we must also investigate the determination of R&D empirically. The main R&D equation is

$$
\begin{aligned}
RD(i,t) = \quad & \alpha_0 \quad + \alpha_1 q(i,t) + \alpha_2 S(i,t) \\
+ \quad & \alpha_3 GL(i,t) + \alpha_4 S(i,t) GL(i,t) + \mu(i) + \epsilon(i,t).
\end{aligned} \tag{6}
$$

Furthermore, the high propensity to patent means that patents are valued and so we incorporate the propensity to patent. If the propensity to patent is high, the impact of the grant lag is strong. An interaction term between the propensity to patent and the grant lag is included in our model. Interaction terms between the propensity to patent, sales, and the grant lag are also included in our model. We expect the sign of the interaction term between the propensity to patent and the grant lag to be negative. We estimate the following R&D equation:

$$
\begin{aligned}
RD(i,t) = \quad & \alpha_0 \quad + \alpha_1 q(i,t) + \alpha_2 S(i,t) \\
+ \quad & \alpha_5 PT(i) GL(i,t) + \alpha_6 S(i,t) PT(i) GL(i,t) + \mu(i) + \epsilon(i,t),
\end{aligned} \tag{7}
$$

where $PT(i)$ is firm i's propensity to patent (Sakakibara and Branstetter,2001), and $q(i,t)$ denotes Tobin's q at time t in firm i. This model is identical to that of Sakakibara and Branstetter (2001), except for our inclusion of the grant lag.

[Table 7]

The estimation results for R&D determination are shown in Table 7. The parameter of the grant lag is significantly negative in all models except the one reported in column (13). The sales parameter is significant in all equations. However, the parameter on Tobin's q is not significant. Hence, the grant lag significantly affects R&D. Furthermore, the effects of scale, the propensity to patent, and the grant lag are confirmed empirically.

[Table 8]

Equation (6) has no dynamics and ignores endogeneity. Therefore, we used the GMM estimator to estimate a first-differenced version of equation (6) that includes the lagged dependent variable. The GMM estimation results for R&D are shown in Table 8. The parameter for the grant lag is significantly negative. The sales parameter is significant in all equations. However, the parameter for Tobin's q is not significant. The estimation results in Table 8 are similar to those in Table 7. Hence, the grant lag affects R&D.

5 Concluding Remarks

In this paper, we showed that reducing the grant lag increases patent applications. Having measured the length of the grant lag, we investigated whether reducing the grant lag contributed significantly to increasing patent applications. The parameter for the grant lag was significantly negative in all equations that excluded the interaction term between the grant lag and sales. Therefore, reducing the grant lag increases patent applications. The parameter for the interaction term between the grant lag and sales was significantly positive in all equations that included this interaction term. Therefore, the impact of reducing the grant lag strengthens as scale decreases. We used the generalized method of moments (GMM) estimator to estimate first-differenced versions of the equations that included lagged dependent variables. GMM improved the estimation results.

To account for patent citations, we classified patent applications into two types. The parameter for the grant lag was significantly negative in the regression for the number of applications cited. However, the parameter for the grant lag was not significantly negative in the regression for the number of applications not cited.

We also empirically investigated the determination of R&D. We also incorporated the propensity to patent. The parameter of the grant lag was significantly negative in most models. Hence, the grant lag significantly affects R&D. Furthermore, the effects of scale, the propensity to patent, and the grant lag were confirmed empirically.

Acknowledgments

We are indebted to SBI Intechstra Co., Ltd. for their helpful suggestions and comments. A early version of this article was presented at the Workshops of R&D Stretegy and Patents at Hamamatsu Concorde Hotel. We thank N.Doi, T.Shinkai, T.Nakamura, X,Zhang, M,Okamura, T,Matsumura, G,Clarkson, S,Tanaka, H,Kinokuni, T,Ohkawa and other participants. Needless to say, any remaining errors are those of the author.

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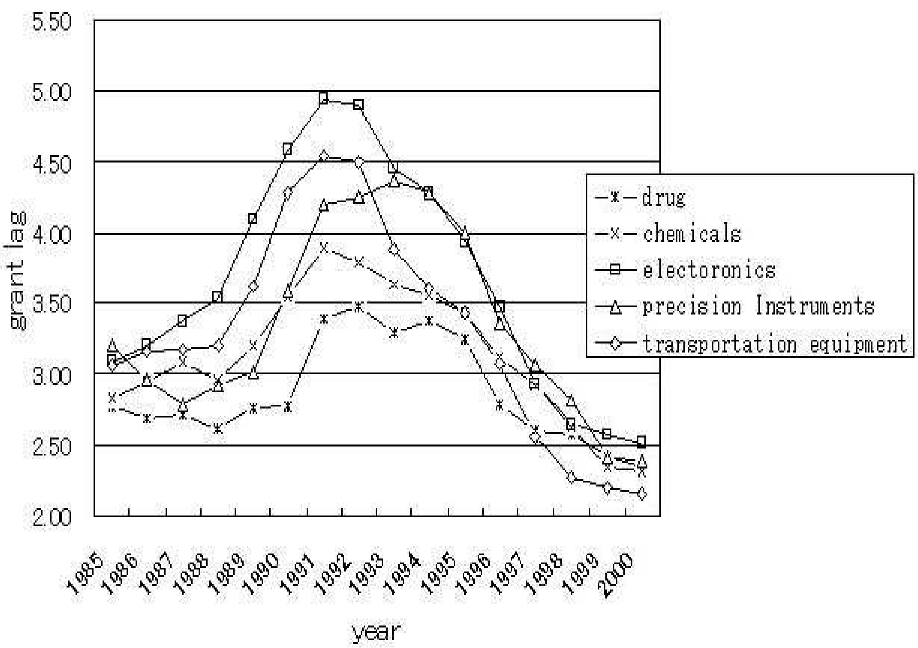

Figure 1: Grant Lag

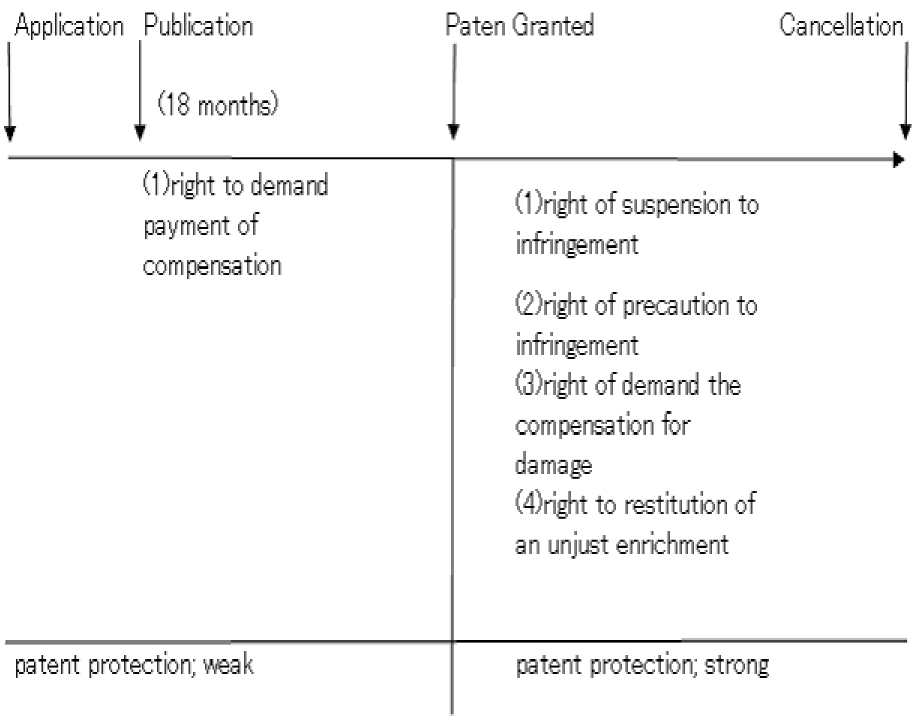

Figure 2: Patent Protection

Table 1: Summary Statistics for Patents

Sector	*Number of Firms*	*Applications*	*Requests*	*Grants*	*Request / Applications*	*Grants / Requests*	*Grants / Applications*
Drugs	11	14366	8039	6633	0.56	0.83	0.46
Chemicals	34	333173	140522	91254	0.42	0.65	0.27
Precision Instruments	34	1737427	813280	433652	0.47	0.53	0.25
Transportation Equipment	7	86535	29438	15629	0.34	0.53	0.18
Electronics	15	230835	117451	72839	0.51	0.62	0.32
Total	101	2402336	1108730	620007	0.46	0.56	0.26

Table 2: Summary Statistics of Sample Firms Observations

variable	*Mean*	*Max.*	*Min.*	*SD*
$Applications$	1547	19900	13	2883
$Claim - weighted\ Applications$	6378	143245	43	14634
$R\&D(¥M)$	31599	423878	18	60522
$Sales(¥M)$	572170	7669141	12214	861889
$Grant\ Lag(year)$	3.60	10.57	2.45	0.71

Table 3: Patent Applications and Grant Lag

Dependent Variable	*Applications*		*Claim-weighted Applications*	
	fixed effect	*fixed effect*	*fixed effect*	*fixed effect*
	(1)	*(2)*	*(3)*	*(4)*
$Constant$	4.26	6.31	-11.1	-7.94
	(0.55)	(1.60)	(0.82)	(2.50)
$R\&D$	0.09	0.09	0.17	0.16
	(0.03)	(0.03)	(0.05)	(0.05)
$Sales$	-0.02	-0.19	1.25	1.00
	(0.05)	(0.13)	(0.08)	(0.20)
$Grant\ Lag$	-0.27	-1.82	-0.29	-2.76
	(0.11)	(1.15)	(0.17)	(1.82)
$Grant\ Lag \times Sales$		0.13		0.20
		(0.09)		(0.15)
$D(Drugs = 1)$	2.31	2.32	0.46	0.46
	(0.13)	(0.13)	(0.21)	(0.21)
$D(Chemicals = 1)$	1.30	1.25	3.04	2.98
	(0.14)	(0.14)	(0.22)	(0.22)
$D(Electronics = 1)$	1.00	0.98	2.96	2.93
	(0.16)	(0.16)	(0.26)	(0.26)
$D(Precision$	1.79	1.78	0.95	0.94
$Instruments = 1)$	(0.15)	(0.15)	(0.24)	(0.24)
$Samples$	1083	1083	1215	1215

Note: Standard errors in parentheses.

Table 4: Patent Applications and Grant Lag

Dependent Variable	*Applications*		*Claim-weighted Applications*	
	GMM	*GMM*	*GMM*	*GMM*
	(5)	*(6)*	*(7)*	*(8)*
$Application_{t-1}$	0.606	0.612		
	(0.004)	(0.004)		
$Claim-weightedApplications_{t-1}$			0.886	0.886
			(0.003)	(0.004)
$R\&D_t$	0.076	0.075	0.077	0.073
	(0.009)	(0.007)	(0.011)	(0.011)
$Sales_t$	-0.126	-0.222	0.037	-0.355
	(0.014)	(0.029)	(0.006)	(0.042)
$Grant\ Lag_t$	-0.337	-1.261	-0.106	-3.842
	(0.017)	(0.308)	(0.013)	(0.266)
$Grant\ Lag_t \times Sales_t$		0.073		0.298
		(0.024)		(0.022)
$P-value$	0.43	0.42	0.42	0.44
$Samples$	1102	1102	1102	1102

Note: All variables in first differences; Standard errors in parentheses.

Table 5: Patent Applications and Grant Lag

Dependent Variable	*Claim-weighted Applications*	
	fixed effect with cited	*fixed effect without cited*
	(9)	*(10)*
$Constant$	-4.05	-14.02
	(0.97)	(1.28)
$R\&D$	0.24	0.18
	(0.06)	(0.08)
$Sales$	0.52	1.38
	(0.10)	(0.13)
$Grant\ Lag$	-0.57	0.24
	(0.19)	(0.25)
$D(Chemicals = 1)$	1.74	0.13
	(0.22)	(0.29)
$D(Electronics = 1)$	2.88	3.27
	(0.23)	(0.31)
$D(Precision$	2.50	3.53
$Instruments = 1)$	(0.38)	(0.50)
$D(Transportation$	1.88	1.05
$Equipment = 1)$	(0.27)	(0.36)
$Samples$	807	807

Note: Standard errors in parentheses.

Table 6: Patent Applications and Grant Lag

Dependent Variable	*Claim-weighted Applications*	
	GMM	*GMM*
	with cited	*without cited*
	(11)	*(12)*
$Claim-weightedApplications_{t-1}$	0.51	0.93
	(0.002)	(0.001)
$R\&D_t$	0.25	0.19
	(0.005)	(0.008)
$Sales_t$	-0.03	0.02
	(0.008)	(0.011)
$Grant\ Lag_t$	-1.42	0.01
	(0.024)	(0.013)
$p-value$	0.37	0.49
$Samples$	665	665

Note: All variables in first differences; Standard errors in parentheses.

Table 7: R&D and Grant Lag

Dependent Variable	*R&D*		
	fixed effect	*fixed effect*	*fixed effect*
	without Propensity to Patent		*with Propensity to Patent*
	(13)	*(14)*	*(15)*
$Constant$	-2.73	-0.10	1.16
	(0.47)	(1.44)	(1.25)
q	-0.02	-0.02	-0.01
	(0.02)	(0.02)	(0.02)
$Sales$	1.03	0.82	0.71
	(0.03)	(0.11)	(0.10)
$Grant\ Lag$	0.05	-1.98	
	(0.10)	(1.05)	
$Grant\ Lag \times Sales$		0.16	
		(0.09)	
$Grant\ Lag \times$			-7.78
$Propensity\ to\ Patent$			(2.34)
$Grant\ Lag \times Sales \times$			0.64
$Propensity\ to\ Patent$			(0.19)
$D(Chemicals = 1)$	-1.05	-1.04	-1.06
	(0.12)	(0.12)	(0.12)
$D(Electronics = 1)$	-0.73	-0.77	-0.74
	(0.13)	(0.13)	(0.16)
$D(Precision$	-1.46	-1.46	-1.39
$Instruments = 1)$	(0.15)	(0.15)	(0.16)
$D(Transportation$	-2.92	-2.92	-2.76
$Equipment = 1)$	(0.11)	(0.11)	(0.14)
$Samples$	1261	1261	1261

Note: Standard errors in parentheses.

Table 8: R&D and Grant Lag

Dependent Variable	*R&D*
	GMM
	(16)
$R\&D_{t-1}$	0.029
	(0.029)
q_{t-1}	0.001
	(0.017)
$Sales_{t-1}$	0.384
	(0.203)
$Grant\ Lag \times$	-13.517
$Propensity\ to\ Patent$	(4.723)
$Grant\ Lag\ \times\ Sales \times$	1.045
$Propensity\ to\ Patent$	(0.370)
$p-value$	0.036
$Samples$	1100.00

Note: All variabless in first differences; Standard errors in parentheses.