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Patents, Competition Policy, and Growth

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I. INTRODUCTION

Many economic models deal with the concepts of static efficiency and distribution. To distribute resources efficiently, competition is one of the essential factors. Another important role of competition is to act as an engine of economic development through stimulating the creative initiative of entrepreneurs. The latter aspect has complex implications due to matters related to patents and competition policy. On the one

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hand, there is a positive correlation between competition and economic development (total factor productivity [TFP]).[1] On the other hand, there is an inverted U-shaped relationship between competition and patents.[2] The authors show that competition discourages laggard firms from innovating, but encourages neck-and-neck firms to innovate and leads to an inverted U-shaped relationship between the price cost margin and the number of patents produced.[3]

From the viewpoint of competition, there is room for consideration of whether patents have a positive relationship with economic development with or without competition policy. We study the relationships among patents, competition policy, and development by using country panel data and obtain several results regarding both old and new problems in industrial structure and institutions.

This Essay is comprised of eight parts: Part II is a brief description of competition and economic growth and its extensions, with a focus on *Competition and Innovation: An Inverted-U Relationship*, written by Philippe Aghion and co-authors.[4] Part III explains a model, and Part IV delineates the data. Part V shows the estimation results, Part VI describes the robustness check, and Part VII provides a discussion and caveats. Part VIII consists of concluding remarks.

II. RELATED STUDIES

In an influential paper, authors investigated the relationship between product market competition and innovation.[5] Using panel data, they found strong evidence of an inverted-U-shaped relationship and developed a model in which competition discourages laggard firms from innovating but encourages neck-and-neck firms to innovate.[6] Combined with the effect of competition on the equilibrium industry structure, these generate an inverted U.[7] Two additional predictions of the model, that the average technological distance between leaders and followers increases with competition and that the inverted U is steeper when industries are more neck-and-neck, are both supported by the U.K. patent and product cost margin data.[8]

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1. Stephen J. Nickell, *Competition and Corporate Performance*, 104 J. POL. ECON. 724, 724–46 (1996).
2. *See* Philippe Aghion et al., *Competition and Innovation: An Inverted-U Relationship*, 120 Q. J. ECON. 701, 701–28 (2005).
3. *Id.* at 715–16.
4. *Id.* at 701.
5. *Id.*
6. *Id.* at 715–16.
7. *Id.* at 716.
8. *Id.* at 717–19.

This concept has been previously pointed out, though only obscurely.[9] Nickell's investigations indicate first that there are some theoretical reasons for believing this hypothesis to be correct, but they are not overwhelming.[10] Furthermore, the existing empirical evidence regarding this question is weak. However, the results reported here, which are based on an analysis of around 670 U.K. companies, provide some support for this view. Nickel presents evidence that competition, as measured by increased numbers of competitors or by lower levels of rents, is associated with a significantly higher rate of TFP growth.[11]

There are three sources of evidence to advance the study put forth by Aghion.

- Firstly, we have access to a number of country-oriented studies. For instance, there are several direct extensions of these authors' articles, such as those from the European Union,[12] Romania,[13] Estonia,[14] Finland,[15] Japan,[16] Norway,[17] Bulgaria,[18] and the United States.[19]

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9. Nickell, *supra* note 1, at 730.

10. *Id.* at 741.

11. *Id.* at 738–40.

12. *See, e.g.*, Rachel Griffith et al., *Product Market Reform and Innovation in the EU*, 112 SCANDINAVIAN J. ECON. 389, 390–91 (2010); Niels Krap & Johannes Stephan, *The Relationship Between Knowledge Intensity and Market Concentration in European Industries: An Inverted U-Shape* 24 (Halle Inst. for Econ. Research., Discussion Paper No. 3, 2008) (Ger.); Michele Cincera & Olivia Galgau, *Impact of Market Entry and Exit on EU Productivity and Growth Performance* (Universite Libre de Bruxelles Institutional Repository, Working Paper No. 921, 2004) (Belg.).

13. *See, e.g.*, Alberto Bucci, *An Inverted-U Relationship Between Product Market Competition and Growth in an Extended Romerian Model*, 95 RIVISTI DI POLITICA ECONOMICA 177 (2005) (It.).

14. Priit Vahter, *Productivity in Estonian Enterprises: the Role of Innovation and Competition* 29 (Bank of Estonia, Working Paper No. 7, 2006).

15. Juha Kilponen & Torsten Santavirta, *Competition and Innovation – Microeconometric Evidence Using Finnish Data*, *in* VATT RESEARCH REPORTS 2009, at 78 (Helsinki Gov't Inst. for Econ. Research, VATT Research Report, Publ'n No. 113, 2004).

16. David Flath, *Industrial Concentration, Price-cost Margins, and Innovation*, 23 JAPAN & WORLD ECON. 129, 137 (2011); Yosuke Okada, *Competition and Productivity in Japanese Manufacturing Industries* 20 (Nat'l Bureau of Econ. Research, Working Paper No. 11540, 2005).

17. Fulvio Castellaci, *How Does Competition Affect the Relationship Between Innovation and Productivity? Estimation of a CDM Model for Norway*, 3 (Univ. Lib. of Munich, Germany, Working Paper No. 27591, 2009).

18. Ralitza Dimova, *The Impact of Labour Reallocation and Competitive Pressure on TFP Growth: Firm-level Evidence from Crisis and Transition Ridden Bulgaria*, 22 INT'L REV. APPLIED ECON. 321–38 (2008).

19. Szabolcs Blazsek & Alvaro Escribano, *Knowledge Spillovers in U.S. Patents: A Dynamic Patent Intensity Model with Secret Common Innovation Factors*, 159 J. ECONOMETRICS, 14, 16 (2010).

- Secondly, a range of advanced theoretical analyses have been generated in response to their articles. There are the agency issues,[20] fraudulent behavior,[21] limited commitment,[22] strategic R&D investment and competitive toughness,[23] asymmetric oligopoly,[24] vertical integration,[25] minimum rivalry,[26] skill and wage inequality,[27] and entry effect.[28]
- Thirdly, there are many other related articles. We have drawn on numerous interesting articles concerning, for example, matters such as the experiment issue. As predicted by the inverted-U-shaped relationship theory, an increase in the number of firms from two to four reduces investments. However, a positive effect is results for a switch from Cournot to Bertrand, even though the theory predicts a negative effect in the four-player case.[29] We have also considered the competition policy issue.[30] In particular, Buccirossi's discussion paper shows the effectiveness of competition policy by estimating its impact on TFP growth for 22 industries in 12 Organisation for Economic Co-operation and Development (OECD) countries from

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20. Mark Rogers, *Competition, Agency and Productivity*, 11 INT'L J. ECON. BUS. 349, 350 (2004).

21. Rainer Andergassen, *Product Market Competition, Incentives and Fraudulent Behavior* 107 ECON. LETTERS 201, 201 (2010).

22. Ramon Marimon & Vincenzo Quadrini, *Competition, Innovation and Growth with Limited Commitment* 1 (Ctr. for Econ. Pol'y Research, Discussion Paper No. 5840, 2006) (U.K.).

23. Claude D'Aspremont et al., *Strategic R&D Investment, Competitive Toughness and Growth*, 6 INT'L J. ECON. THEORY 273 (2010).

24. Junichiro Ishida et al., *Market Competition, R&D and Firm Profits in Asymmetric Oligopoly* 1 *passim* (Inst. Soc. & Econ. Research, Discussion Paper No. 777, 2010) (Japan).

25. *See* Philippe Aghion et al., *Vertical Integration and Competition*, 96 AM. ECON. REV. 97 (2006).

26. Wendy Carlin et al., *A Minimum of Rivalry: Evidence from Transition Economies on the Importance of Competition for Innovation and Growth*, 3 Contributions to Econ. Analysis of Pol'y, No. 1, art. 17, 2004, at 1.

27. *See* Maria Guadalupe, *Product Market Competition, Returns to Skill, and Wage Inequality*, 25 J. LAB. ECON. 439 (2007).

28. *See* Philippe Aghion et al., *The Effects of Entry on Incumbent Innovation and Productivity*, 91 REV. ECON. & STAT. 20 (2009).

29. Donja Darai et al., *Competition and Innovation: An Experimental Investigation*, 13 EXPERIMENTAL ECON. 439, 453 (2010).

30. *See, e.g.*, Paolo Buccirossi et al., *Competition Policy and Productivity Growth: An Empirical Assessment* 2 (Düsseldorf Inst. for Competition Econ., Discussion Paper 22, 2011) (Ger.); Per-Johan Norbäck & Lars Persson, *Entrepreneurial Innovations, Competition and Competition Policy* (Research Inst. of Indus. Econ., Working Paper No. 670, 2006) (Swed.); Patrick McCloughan et al., *The Effectiveness of Competition Policy and the Price-Cost Margin: Evidence from Panel Data* (Econ. & Soc. Research Inst., Working Paper No. 209, 2007) (Ir.); Mattias Ganslandt, *Intellectual Property Rights and Competition Policy* (Research Inst. of Indus. Econ., Working Paper No. 726, 2008) (Swed.); Volker Grossmann & Thomas M. Steger, *Anti-Competitive Conduct, In-House R & D, and Growth*, 52 EUR. ECON. REV. 987 (2008).

1995 to 2005 and finds a robust, positive, significant effect of competition policy on the TFP.[31]

Our study is a mixture of the above three types. We extend the analysis of the relationship between patents and competition and think analytically regarding growth and competition policy. We focus on competition policy from the viewpoints of growth and patents by using a standard development model. Furthermore, our research includes non-OECD countries and long-term data. Thus, the findings of our research are more comprehensive and general.

III. THE MODEL

We use the Solow-Swan-type standard development economic model, as in the following:

$$Y_{it} = A_{it}K_{it}^{\alpha}L_{it}^{\beta} \quad i = 1,2,\ldots,N, \quad t = 1,2,\ldots, n \tag{1}$$

where Y_{it} is the GDP (gross domestic product) of a country, A_{it} is the technology level, K_{it} is the capital, L_{it} is the labor, i is the country index, and t is the year index. For the calculation, we take the logarithm of Equation (1) and add an error term to obtain the following statistical model equation:

$$\log(Y_{it}) = \log(A_{it}) + \beta_1\log(K_{it}) + \beta_2\log(L_{it}) + \varepsilon_{it}$$

We take two parameters regarding patents and competition policy. The parameter of a patent is usually a proxy of innovation as an index of technology development. The parameter of competition policy is a government intervention for the incentive structure of benefits and/or redistribution from the patent and development. Both parameters are included in Equation (1) with i and t; we can then obtain the following log linear equation with the parameters of competition policy and the square of competition policy:

$$\log(Y_{it}) = \log(A_{it}) + \beta_1\log(K_{it}) + \beta_2\log(L_{it}) + \beta_3\log(patent_{it}) + \beta_4 cp_{it} + \beta_5 cp_{it}^2 + \varepsilon_{it}$$

In this model, Y_{it}, K_{it}, L_{it}, $patent_{it}$, and cp_{it} are observable parameters. Therefore, constants ($\log(A_{it})$) and β_1-β_5 can be inferred. In particular, β_3 is the relationship between patents and growth, β_4 is the relationship between competition policy and growth, and β_5 is the relationship

31. Buccirossi et al., *supra* note 30, at 20.

between square of competition policy and growth.

IV. DATA

The proxy data of Y_{it}, K_{it}, and L_{it} are the GDP (constant local currency unit), capital (gross capital formation [of the constant local currency unit]), and the population of the country.[32] Data regarding patent grants and applications, which are shown as technology development ($patent_{it}$), consist of the number of patent grants and applications.[33] The data regarding competition or competition policy density, shown as cp_{it}, is the number of competition law enforcement bodies.[34] We screen the data to obtain more effective variables, and then, we have 31 countries covering a range of 40 years (1970–2009). These countries' descriptive statistics are shown in Table 1.

32. *See* UNITED NATIONS, NATIONAL ACCOUNTS MAIN AGGREGATES DATABASE, http://unstats.un.org/unsd/snaama/dnlList.asp (last visited Mar. 15, 2013). Also, data of other variables (consumption, exports, and imports) are drawn from this website.

33. *Statistics on Patents*, WORLD INTELLECTUAL PROPERTY ORGANIZATION, http://www.wipo.int/ipstats/en/statistics/patents/ (last visited Mar. 15, 2013).

34. *Member Directory*, INTERNATIONAL COMPETITION NETWORK, http://www.internationalcompetitionnetwork.org/members/member-directory.aspx (last visited Mar. 15, 2013).

Table 1: Descriptive Statistics

	(GDP) Avarage	(GDP) standard deviation	(CAP) Average	(CAP) standard deviation	(PP) Average	(PP) standard deviation	(PTG) Average	(PTG) standard deviation	(CP) Average	(CP) standard deviation
Austria	1.635.E+11	4.464.E+10	4.171.E+10	1.074.E+10	7.796.E+06	2.812.E+05	3,813	2,785	0.575	0.813
Belgium	2.015.E+11	5.074.E+10	4.640.E+10	1.397.E+10	1.001.E+07	2.705.E+05	4,474	5,648	1.1	0.304
Canada	8.168.E+11	2.669.E+11	1.672.E+11	7.583.E+10	2.751.E+07	3.587.E+06	17,582	5,853	1.625	0.49
Chile	3.113.E+13	1.743.E+13	6.730.E+12	5.002.E+12	1.320.E+07	2.321.E+06	533	261	0.4	0.778
Denmark	1.028.E+12	2.463.E+11	2.081.E+11	7.518.E+10	5.197.E+06	1.474.E+05	1,520	1,008	1.275	0.599
Egypt	1.383.E+11	7.576.E+10	5.864.E+10	3.282.E+10	5.731.E+07	1.458.E+07	339	142	0.125	0.335
Finland	1.032.E+11	3.190.E+10	2.365.E+10	6.092.E+09	4.976.E+06	2.175.E+05	1,929	537	0.95	0.932
France	1.153.E+12	2.914.E+11	2.500.E+11	6.298.E+10	5.805.E+07	3.511.E+06	19,053	9,650	2	0
Germany	1.641.E+12	3.981.E+11	3.454.E+11	6.602.E+10	8.001.E+07	1.844.E+06	17,658	3,726	2	0
Greece	1.159.E+11	3.195.E+10	2.850.E+10	7.903.E+09	1.015.E+07	7.777.E+05	1,464	1,653	1.55	0.783
Hungary	1.204.E+13	2.653.E+12	3.837.E+12	1.010.E+12	1.038.E+07	2.115.E+05	1,734	681	0.625	0.74
Iceland	5.345.E+11	1.972.E+11	1.349.E+11	6.705.E+10	2.549.E+05	3.210.E+04	47	34	0.125	0.335
Ireland	6.716.E+10	4.101.E+10	1.979.E+10	1.186.E+10	3.603.E+06	3.895.E+05	1,011	657	1.4	0.632
Israel	3.556.E+11	1.740.E+11	7.430.E+10	3.437.E+10	4.816.E+06	1.319.E+06	1,907	326	0.4	0.496
Japan	3.941.E+14	1.215.E+14	9.892.E+13	2.459.E+13	1.208.E+08	6.836.E+06	87,751	50,088	1.25	0.439
Luxembourg	1.487.E+10	7.470.E+09	3.446.E+09	1.966.E+09	3.975.E+05	4.374.E+04	750	901	1.15	0.362
Mexico	5.455.E+12	1.908.E+12	1.533.E+12	5.589.E+11	8.258.E+07	1.765.E+07	4,483	2,608	0.425	0.501
Monaco	2.056.E+09	6.157.E+08	5.402.E+08	1.328.E+08	2.885.E+04	2.989.E+03	47	32	0	0
Netherlands	3.161.E+11	9.398.E+10	7.229.E+10	2.160.E+10	1.493.E+07	1.050.E+06	2,870	1,846	1.3	0.464
New Zealand	9.730.E+10	2.666.E+10	2.157.E+10	8.779.E+09	3.496.E+06	4.218.E+05	2,971	1,489	0.6	0.496
Norway	1.099.E+12	3.868.E+11	2.771.E+11	8.182.E+10	4.279.E+06	2.544.E+05	2,255	349	0.425	0.501
Philippines	2.869.E+12	1.083.E+12	6.148.E+11	2.076.E+11	6.249.E+07	1.689.E+07	983	288	0	0
Portugal	9.208.E+10	3.040.E+10	2.378.E+10	1.025.E+10	9.896.E+06	5.530.E+05	1,167	923	0.775	0.733
Republic of Korea	4.359.E+14	2.941.E+14	1.298.E+14	9.321.E+13	4.160.E+07	5.197.E+06	22,939	32,878	0.725	0.452
Spain	4.880.E+11	1.634.E+11	1.526.E+11	6.746.E+10	3.895.E+07	2.781.E+06	5,769	4,758	1.125	0.966
Sri Lanka	1.109.E+12	5.866.E+11	3.770.E+11	1.795.E+11	1.682.E+07	2.290.E+06	137	103	0.175	0.385
Sweden	1.849.E+12	4.671.E+11	3.589.E+11	9.390.E+10	8.589.E+06	3.546.E+05	5,047	3,437	0.825	0.958
Switzerland	3.625.E+11	6.603.E+10	8.204.E+10	1.553.E+10	6.782.E+06	4.547.E+05	5,788	6,006	0.375	0.49
Turkey	5.272.E+10	2.429.E+10	6.476.E+10	3.864.E+10	5.570.E+07	1.169.E+07	653	397	0.325	0.474
UK	7.722.E+11	2.160.E+11	1.026.E+12	7.633.E+11	5.770.E+07	1.675.E+06	18,604	13,159	2.85	0.533
United States	7.300.E+12	2.543.E+12	1.400.E+12	6.308.E+11	2.572.E+08	3.263.E+07	103,192	40,578	3	0

V. ESTIMATION RESULTS

Firstly, we check the results of a unit root test for the data, and none of the values reject the null hypothesis, except for PTG, so the result implies that each parameter may have an individual unit root. All of the probability values do reject the null hypothesis; each parameter is found to be in stationarity by taking the first difference as the I(1) parameter.

Secondly, we check the fixed or random effect model for the estimation result, and we select cross-section terms: none, period term fixed model based on the adjusted R-squared value, and Akaike Information Criteria by taking the redundant fixed effect test. Furthermore, according to the Hausman test, the null hypothesis (random effect) is rejected and is statistically significant. Therefore, we adopt the fixed effect model.

Thirdly, we check the endogenous problem by using the two-stage least squares method for the result in Table 2. We use the next period variables of each parameter, which does not affect the dependent variables at the period but does have strong links to the period's independent variables. We also arrange the other related variables.

Table 2: Pooled IV/Two-Stage Least Squares Method (First Difference)

Dependent Variable: DLOG(GDP)				
Variable	Pooled Least Squares	Pooled Least Squares	Pooled IV/Two-stage Least Squares	Pooled IV/Two-stage Least Squares
DLOG(CAP)	0.144 ***	0.149 ***	0.586 **	0.512 **
	(0.005)	(0.005)	(0.275)	(0.202)
DLOG(PP)	0.864 ***	0.854 ***	-2.094	-1.495
	(0.086)	(0.085)	(1.988)	(1.494)
DLOG(PTG)		0.001		0.001
		(0.002)		(0.029)
CP	0.003	0.003	-0.28	-0.226
	(0.002)	(0.002)	(0.203)	(0.157)
(CP*CP)	-0.002 ***	-0.002 ***	0.105	0.084
	(0.001)	(0.001)	(0.077)	(0.059)
C	0.02 ***	0.02 ***	0.116	0.097 *
	(0.002)	(0.001)	(0.072)	(0.056)
Adjusted R-squared	0.565	0.573		
Akaike info criterion	-4.936	-4.965		
Instrument specification: c dlog(cap(-1)) dlog(pp(-1)) dlog(ptg(-1)) cp(-1) dlog(ex(-1)) dlog(im(-				
*: p-value < 0.1, **: p-value <0.05, ***: p-value <0.01				
veriables explanation: DLOG(GDP): First difference of logarithm of GDP, DLOG(CAP): First difference CAP, DLOG(PP): First difference PP, DLOG(PTG): First difference PTG				

(Note: The upper values in the cell are estimated coefficients, and lower values in the parenthesis are standard errors.)

Our focus in this study is on the coefficients of patents, the coefficient of competition policy, and the square of the competition policy variables. The interesting result is that the coefficient of the square of competition policy (β_5 in the equation of the model) has a significant, negative impact on the growth. The coefficient of the square of competition policy has about -0.2% impact, according to the pooled ordinary least squares (OLS) methods, and the coefficient of competition policy has some positive effect but is not significant. In this result, the increasing competition enforcement leads to (i) firstly, positive impact, and (ii) secondly, negative impact on economic growth. It is a kind of inverted-U type result with regard to competition policy. Also, patents have a positive relationship with the growth, but little significance.

VI. Robustness Check

A. *Patent Application and Grant*

Though we use the data of the number of patents granted, but innovative conduct can be indicated by the number of patent applications rather than by the number of patents granted.

In this regard, we estimate the model with the number of patent applications, instead of the number of patents granted.

Table 3: Patent Application and Patent Grant, and Existence of Competition Law

Dependent Variable: DLOG(GDP)				
Variable	Method: Pooled Least Squares	Method: Pooled IV/Two-stage Least Squares	Method: Pooled Least Squares	Method: Pooled IV/Two-stage Least Squares
DLOG(CAP)	0.149 ***	0.512 **	0.148 ***	0.172 ***
	(0.005)	(0.202)	(0.005)	(0.008)
DLOG(PP)	0.854 ***	-1.495 ***	0.881 ***	0.731 ***
	(0.085)	(1.494)	(0.085)	(0.095)
DLOG(PTG)			0.001	0.01
			(0.002)	(0.007)
DLOG(PT)	0.001	0.001		
	(0.002)	(0.029)		
CP	0.003	-0.226		
	(0.002)	(0.157)		
(CP*CP)	-0.002 ***	0.084		
	(0.001)	(0.059)		
CPX			0	-0.005 **
			(0.001)	(0.002)
C	0.02 ***	0.097 *	0.019 ***	0.022 ***
	(0.001)	(0.056)	(0.001)	(0.002)
Adjusted R-squared	0.573		0.569	
Akaike info criterion	-4.965		-4.955	

(1) Instrument list: c dlog(cap(-1)) dlog(pp(-1)) dlog(ptg(-1)) cp(-1) dlog(ex(-1)) dlog(im(-1))
(2) Instrument list: c dlog(cap(-1)) dlog(pp(-1)) dlog(ptg(-1)) cp(-1) dlog(ex(-1)) dlog(im(-1))
(3) *: p-value < 0.1, **: p-value <0.05, ***: p-value <0.01.

The left two columns of Table 3 show the results, and our focus points are similar to the above main estimation. The coefficient of the competition policy is negative and significant. The coefficient of patent applications is negative and not significant. Not only in terms of the number of patents granted is the patent impact unclear, but also in terms of the number of patent applications.

B. *Existence of Competition Law*

The competition policy indicator of the regression, which is used to consider the relationships among patents, competition policy, and growth, is a core idea of this study. To verify whether the picture of competition policy is clear or not, according to the parameter, we address another variable as the competition policy indicator.

The new indicator is whether competition laws exist or not. Although this parameter is simpler than the parameter of the number of competition enforcement bodies, the variable may shed light on the impact of competition laws.

The result is given in the right two columns of Table 3. This is in almost the same direction as the main results. However, the significance of the coefficient is weaker than that of the parameter of the competition enforcement body. After the adjustment of the instruments' variables related to the parameter of competition laws, we can obtain a certain negative and significant coefficient for the competition law indicator. It is in the same direction as our main results.

C. *Effect on Consumption*

Recently, the idea that one of the goals of competition policy is consumer welfare has become widespread. Therefore, we checked the relationship among patents, competition policy, and consumption.

Table 4: Consumption, Patents, and Competition Policy

Dependent Variable: DLOG(CONS)		
Variable	Method: Pooled Least Squares	Method: Pooled IV/Two-stage Least Squares
DLOG(CAP)	0.117 ***	-0.153
	(0.008)	(0.686)
DLOG(PP)	0.971 ***	5.066
	(0.128)	(5.645)
DLOG(PTG)	0	-0.013
	(0.002)	(0.061)
CP	0.003	0.013
	(0.003)	(0.208)
(CP*CP)	-0.001 ***	0.039
	(0.001)	(0.068)
C	0.017	-0.092
	(0.002)	(0.149)
Adjusted R-squared	0.292	
Akaike info criterion	-4.152	

Instrument list: c dlog(cap(-1)) dlog(pp(-1)) dlog(ex(-1)) dlog(im(-1)) dlog(ptg(-1)) cp(-1)

*: p-value < 0.1, **: p-value <0.05, ***: p-value <0.01. The other caveats are the same as table 4.

The results are shown in Table 4. The coefficient of patents is positive and that of competition policy is negative. Neither is significant according to the pooled least squares method and the two-stage least squares method. It should be noted that the coefficient of competition policy has been changed from significant to not significant. On the other hand, the coefficient of patents is positive and not significant, which is the same as the situation of the total economic development (GDP).

From the viewpoint of our study, the result confirms that patents have a positive impact on growth in consumption, but also confirms that competition policy is not directly linked to total economic development. One potential path to economic growth via competition policy is increasing consumption.

VII. DISCUSSION

The main results of our estimation are that (i) patents have a positive and insignificant effect on economic development, and that (ii) competition policy has a significant inverted-U-type positive and negative effect on economic development. These two relationships are robust in terms of a number of alternative specifications, including identifying the other types of variables. The results and previous studies lend themselves to four interpretations.

First, the relationship between patents and growth is not a simple one, such as a linear relationship. Aghion pointed out that competition has two effects: the "escape-competition effect,"[35] which is the fact that the model of competition may increase the incremental profit from innovation, and the "Schumpeterian effect,"[36] which is the fact that the model of competition may reduce innovation incentives for laggards. Aghion states that the balance creates an inverted-U shaped relationship between patents and the price-cost margin.[37] On the other hand, Nickel shows that the relationship between competition and growth is a form of direct proportion.[38] Therefore, the relationship between patents and growth via competition is not a simple one. We assume that there is some positive relationship among them, but that the real effect is rather difficult to identify through the competition policy as well as competition itself. This is the reason the effect on the relationship between patents and the economic development of patents is unclear.

Second, patent policy is quite unstable. The number of patents fluctuates at the mercy of a number of pro-patent policies or other patent policies. For example, Figure-1 shows Ireland's patent number history. In 1992, Ireland amended the country's patent laws. Therefore, the single peak of the history is in the graph. Another example is shown in Figure-2, which presents Japan's patent number history. In 1996, there is the greatest single peak because that year brought procedural changes to the patent process. This type of swing in the numbers is quite a bit more than that of any of the other variables. The change in patent policy leads to the change in the number of patents, and almost all of the swing is a temporary issue with little impact on the trend of economic development.

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35. Aghion et al., *supra* note 2, at 720–21.
36. *Id.*
37. *Id.*
38. Nickell, *supra* note 1, at 741.

Figure-1: Patent Grant Number of Ireland

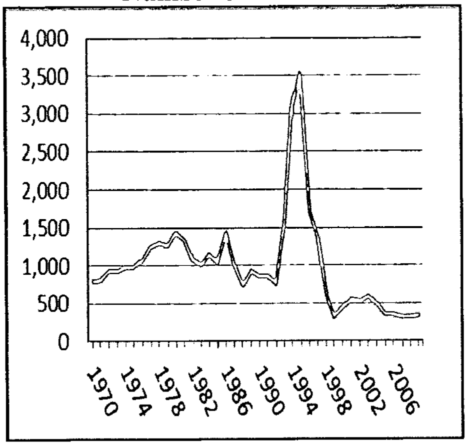
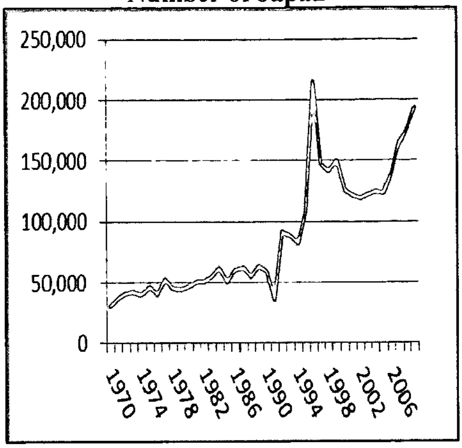


Figure-2: Patent Grant Number of Japan



Third, the relationship between competition policy and the competition results themselves is not simple. The index of competition policy enforcement is not directly linked to competition in the market. If a market is too competitive, it is not necessary for a competition authority to take strong enforcement measures. This situation is apparently not a positive competition policy. In contrast, if there are a number of anticompetitive pressures in a market, then a competition authority should take artificially aggressive measures. Thus, aggressive measures of competition policy do not always reflect a sound, competitive market. That is, there is not a positive relationship between competition policy and growth in a patent situation.

Fourth, the nature of competition policy is complex. Competition policy aims to create, maintain, and strengthen sound competition. However, it is difficult to create competition, including patent competition, itself. Therefore, a direct method of competition policy is to remove anti-competitive conduct, such as cartels and monopolization. After excluding anticompetitive conduct, incentives for development generate competition in the market. According to this scenario, competition policy is indirectly linked with growth; growth can have a positive effect on competition, though not through competition policy.

The results imply that competition policy has several targets, such as competition itself and consumer welfare. If so, our analysis of the relationship among patents, competition policy, and growth has some difficulty due to the bilateral character of competition policy. One side of the dual nature of competition policy is to level the playing field so that the clear winner can reap the rewards. If this incentive structure can function well, then a firm that earns competitive leverage has a strong incentive to obtain a patent because it creates a legal monopolistic tool for innovation, which means dynamic welfare maximization. The other side of the nature of competition policy is achieving consumer welfare maximization, which means static efficiency. The competition authority enacts its enforcement by striking a balance between dynamic and static efficiency. In this regard, the relationship between competition policy and economic development is not only positive.

The last but significant point to consider in the analysis of innovation and competition is to check the structural breakpoint. Correa[39] points out that the findings of Aghion, including the inverted-U type relationship, do not hold if the breakpoint is taken into consideration.[40] The analysis reveals the structural break in the early 1980s and also finds that there is a positive innovation-competition relationship in the first period and no relationship in the second period.

To check the structural break in the dataset of this analysis, we conduct the ols-based CUSUM test (the cumulative sum of the recursive residuals).[41] Then, we find 22 cases among the 31 countries that have a structural breakpoint; some are in 1990s, and some are in the 2000s. Therefore, it is not easy to discover the meaningful relationship, such as an inverted-u type relationship, via this analysis. We can say that there is some positive impact among innovation, competition, and growth, but it is a very ambiguous relationship.

In the legal aspect of patents and competition policy, we already have the basic principle; antitrust and intellectual property policy are complements in that both seek to create a set of incentives to encourage an innovative, vigorously competitive marketplace that enhances efficiency and improves consumer welfare.[42] Based on this principle and this Essay's results, two things are identified as the policy implications: keeping stable innovative policy in patents and competition, and maintaining consumer welfare in mind. The former is that we already share both policy goals but fluctuated policy instability leads to ambiguous effects in innovation driven through economic growth. Therefore, it is necessary to take the stable, elaborated measures for patents and antitrust. The latter comes to the bilateral characters of the competition policy and economic growth. There is an inverted-U shape relationship between competition policy and economic growth, which is why it is so important that our basic line of consumer welfare

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39. *See* Juan A. Correa, *Innovation and Competition: An Unstable Relationship*, 27 J. APPLIED ECONOMETRICS 160, 160 (2012).

40. *Id.*

41. R.L. Brown et al., *Techniques for Testing the Constancy of Regression Relationships Over Time*, 37 J. ROYAL STAT. SOC'Y SERIES B (METHODOLOGICAL) 149, 151 (1975).

42. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, ANTITRUST GUIDELINES FOR THE LICENSING OF INTELLECTUAL PROPERTY § 1.0 (1995), *available at* http://www.justice.gov/atr/public/guidelines/0558.pdf ("The intellectual property laws and the antitrust laws share the common purpose of promoting innovation and enhancing consumer welfare.").

standard is not blurred by the competition policy.

VIII. CONCLUDING REMARKS

This Essay explores the relationships among patents, competition policy, and economic growth. Many previous articles show that the relationship between patents and growth is positive, and several papers describe the fact that competition policy and growth have some positive correlation. We integrate these observations into one relationship and estimate the coefficient of the relationship.

There are two interesting results: patents have an ambiguous effect on growth, and competition policy has a positive and negative impact on growth. These results are robust in terms of several other variables. We suggest some reasons for these results, but they will be presented in a future article. Nevertheless, this study sheds light on relationships among patents, competition policy, and economic growth. The contribution of this study is in pointing out the ambiguity of the effect of patents on growth and the inverted-U-type positive and negative impact of competition policy on growth, but the result must be handled with careful consideration of the structural break point. To ensure that the policy implication is in line with these results, it is significant for us to take two simple but standard strategies: keeping stable innovative policy in patents and competition, and maintaining consumer welfare in mind.

For future work, it is worth performing industry-level or firm-level analysis. There is room for an aggregate level analysis in this study, such as the situation is different industry by industry or firm by firm. Another type of analysis worth considering is to find the mechanism of the relationship among patents, competition policy, and economic growth theoretically. For example, Aghion and Schankerman examine welfare effects and political economy of competition-enhancing policies in detail. Norbäck and Persson analyze the relationship among innovation, competition, and competition policy theoretically. Further research in this direction is desirable.