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An Empirical Analysis of the Impact of Patent Protection on Economic Growth: An Extension

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This research extends prior research (Thompson and Rushing (1996)) that explores the relationship between patent protection and economic growth. In comparison with the prior work, this research takes a more refined look at the linkages between the impact of patent protection on total factor productivity leading to economic growth. The research also considers the factors that explain the disparities that exist in patent protection levels across countries. The results of the study suggest that, in wealthier countries, patent protection shares a positive relationship with changes in total factor productivity and, in turn, total factor productivity positive influences the rate of economic growth.

I. Introduction

There exists a vast amount of literature that documents a significant degree of effort expended on attempting to sort out the explanations for disparities in cross country growth rates. This effort is ongoing and the literature continues to expand. Our understanding of the forces that explain economic growth is improving in part because of improved availability and quality of data and because we are developing a better understanding of the complex combination of these forces with each effort.

The research effort described in what follows attempts to build upon our understanding of the factors that contribute to economic growth and aid in explaining the differences in the rate of growth across countries. A typical model of the chain of events that results in economic growth suggests that investment in new processes/technology (innovations) results in increased factor productivity which in turn results in growth (increased GDP per capita). The standard "chain of events" has traditionally not identified the stimulus to investment that sets off the chain. The contribution of this effort is the incorporation of the change agents that provide a catalyst for investment leading to improved factor productivity and eventually economic expansion.

One point on which the majority of economists will agree is that entrepreneurial activity is a catalyst to investment (time and money) leading to innovation and growth. Furthermore, many economists, recognizing the role of self-interest, would agree that entrepreneurs expend effort in response to an anticipated reward. Baumol (1993), for example, focuses on the importance of payoffs in exchange for entrepreneurial effort. He states, "For a growth-conscious world,

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encouragement (in the form of appropriate rewards) of the productive entrepreneur may well prove a key enhancement of productivity and output."

It can be argued that intellectual property rights (IPRs) can act as an incentive resulting in the entrepreneurial actions that results in improvements in factor productivity and in turn a more rapid advancement of economic growth. IPRs may encourage entrepreneurial activity at a variety of levels by: 1) encouraging development of a new product or process with some assurance of a return on resources invested in the effort; 2) creating an incentive to take an innovation from others and finding an application within the economy; or 3) creating an environment increasing the likelihood that an entrepreneur will recognize an opportunity not seen by others and market it in a creative way.

In fact, Thompson and Rushing (1996), using data covering the period from 1970 to 1985, provide evidence to suggest that strong intellectual property rights laws and effective enforcement policies result in more rapid economic growth in countries with an initial level of GDP greater than or equal to $3,400 (1980$). This occurs presumably because protection from patents is the foundation for payoffs to entrepreneurs starting off the chain of events that leads to economic expansion.

Baumol (1993) sees entrepreneurship as an indirect entry into the chain of events leading to economic growth. He argues that innovation is impacted by "productive entrepreneurship" and that the degree of entrepreneurial effort is influenced by the relative size of the rewards associated with it. Petrakis (1997) indicates that the entrepreneur has traditionally been treated by economic theory as an independent factor of production akin to land, labor and capital. For example, Helpman (1997) states the following:

> "... evidence exists that inventive activities play a key role in modern economic growth. Education is of course very important, and so is capital accumulation. But they do not diminish the role of technological progress as a major force in expanding income per capita."

Baumol dismisses the idea that entrepreneurs are driven by unexplainable and non-identifiable forces that cannot be influenced. If Baumol's argument can be supported consideration can be given to policies that encourage and promote entrepreneurial effort.

Recent research investigating the contributions of IPRs to economic growth include both Gould and Gruben (1996) and Park and Ginarte (1997). Gould and Gruben's research provides evidence suggesting that IPRs are a significant determinant of economic growth. However, Gould and Gruben's work is representative of much of the previous work in this area that fails to explicitly account for the intermediate steps in the chain of events that hypothetically explain the connection between IPRs and economic growth. This chain of events includes the establishment and enforcement of IPRs that create the incentives leading to entrepreneurial pursuits (R&D, investment, innovations). The enhanced entrepreneurial activity results in increased capital accumulation and productivity with positive impacts on the rate of economic growth.

Park and Ginarte's (1997) work does consider some of the intermediate steps in the linkages between IPRs and economic growth. Their research suggests that IPRs stimulate factor accumulation that in turn is a determinant of economic growth.

The research described herein attempts to take a more refined look at the contribution of IPRs (in the form of patent protection) to factor productivity growth (as opposed to factor accumulation) which in turn stimulates economic growth, essentially seeking support for the hypothesis that factor productivity can be stimulated by innovative effort that has been positively influenced by intellectual property protection. The results from our initial analysis show that for higher-income countries, strong patent protection and enforcement do have a positive and significant impact on the growth of factor productivity. Further, we affirm that those countries with more rapid advances in factor productivity experience more rapid economic growth.

II. Data and Methodology

The data for this study cover the years from 1975 to 1990 for 55 countries both developing and developed. The data come from a variety of sources as indicated in the Appendix. The empirical model is a system of three equations and can be expressed as:

$$GR7590_i = f(GDP75_i,\ SEC75_i,\ POP75_i,\ TFP_i,\ GPOP_i,\ INV_i), \quad (1)$$

$$TFP_i = g(PAT_i,\ FREE_i,\ SEC75_i,\ GDP75_i,\ INV_i,\ PINSTAB_i), \quad (2)$$

$$PAT_i = r(GDP75_i,\ FREE_i,\ SEC75_i,\ PINSTAB_i), \quad (3)$$

where *GR*7590 is the growth rate of real *GDP* per capita from 1975 to 1990 for country *i*, *GDP*75 is per capita income in 1975 (in 1985 dollars), *SEC*75 is the percentage of secondary school attained in the population, *POP*75 is the 1975 population, *TFP* is the ratio of total factor productivity from 1971 to 1990, *GPOP* is the percent change in population from 1975 to 1990, *PAT* is an index of patent protection, *FREE* is a measure of free trade openness, *INV* is the average annual percent growth in gross domestic investment from 1980 to 1990, and *PINSTAB* is a measure of political instability.

Two of the variables bear special mention - *PAT* and *TFP*. *PAT* is an index of patent protection developed by Rapp and Rozek (1990). This index was constructed based on each country's adherence to the minimum standards for patent laws proposed by the U.S. Chamber of Commerce Intellectual Property Task Force. The index ranks the level of patent protection for each country on a scale of zero to five as follows:

0	No intellectual property protection laws
1	Inadequate protection, no laws forbidding piracy.
2	Seriously flawed laws
3	Flaws in laws, some enforcement
4	Generally good laws
5	Protection and enforcement fully consistent with the minimum standards proposed by the U.S. Chamber of Commerce

TFP (the ratio of total factor productivity-1990/1971) data come from Coe and Helpman (1994) and Coe, Helpman and Hoffmeister (1997). *TFP* is determined empirically as a function of research and development capital stock. In the 21 OECD countries plus Israel, *TFP* is a function of both the domestic and foreign R&D capital stocks. These countries accounted for 96 percent of total world R&D expenditures (Coe, Helpman, and Hoffmeister). In developing countries *TFP* is a function of foreign R&D capital stock under the assumption that domestic R&D capital stocks in these countries are negligible (given the high concentration of R&D expenditures in the developed countries). We would have preferred to estimate the impact of patent protection on R&D effort (a sign of entrepreneurial activity) directly and the resulting impact on factor productivity. However, as Coe, Helpman, and Hoffmeister point out, most of the developing countries display very small research efforts and for those that have significant amounts of R&D, data constraints make it difficult to build a good measure of R&D capital stocks.

We view the inclusion of Equation (3) as a contribution. Throughout the literature there are speculative statements regarding the explanations for the level of patent protection in a given country. These assertions can be viewed as hypothesis to be tested. There are essentially four hypotheses tested with Equation (3) represented by the four independent variables. The following *a priori* expectations on the relationship of the independent variables with *PAT* is described within the context of the stated hypotheses below.

Hypothesis 1

· Countries with restraints on free trade are less likely to have significant levels of patent protection. Gould and Gruben (1996) argue that there is some evidence to suggest that strong IPRs may not result in a stimulus to innovation in countries that are less open to trade. In fact, their own research suggests that IPRs have a slightly stronger effect on economic growth in relatively open economies. Gould and Gruben do not test the hypothesis as stated, however, Gould and Gruben cite both theoretical and empirical evidence that suggests that innovation is not stimulated in a closed regime due to a lack of competition from foreign concerns. In open regimes, domestic concerns potentially face competition from foreign concerns that are using the most modern technologies and processes available. If so, we expect that *FREE* has a positive sign.

Hypothesis 2

· Countries that lack an R&D infrastructure will not have high patent protection levels. Park and Ginarte (1997) indicate that it is unlikely that countries without an active and innovative R&D sector will see developing an IPR infrastructure as a high priority. Furthermore, Coe and Helpman (1994) point out that the majority of R&D takes place in the OECD countries (plus Israel), relatively high income countries. We therefore expect that *GDP*75 shares a positive relationship with *PAT*.

Hypothesis 3

· Countries with higher levels of political instability will not have high levels of patent protection. Thompson and Rushing (1996) have suggested that increasing the strength and enforcement of IPRs is not costless and may be viewed as granting an increase in monopoly power to developed countries at the expense of developing countries. As a result it is unlikely that we would see a high level of *PAT* in a country with low levels of political stability. The weak regime is not likely to establish improved IPRs as a high priority agenda item. We expect that the sign of the coefficient on *PINSTAB* will be negative as a result.

Hypothesis 4

· Finally, it is our assertion that countries with low levels of educational attainment would not realize significant benefits from improvements in patent protection (the coefficient on *SEC*75 should have a positive sign). Active R&D efforts are unlikely to take place in countries with low level of education.

Equation (1) is a standard growth equation common to the literature with the exception of the inclusion of the *TFP* variable. Regarding Equation (2), our expectation is that countries displaying the most rapid advances in *TFP* will be those with greater levels of *PAT* and *INV*.

The system of equations is estimated by Seemingly Unrelated Regressions allowing for capitalization on the interrelationships that exist among the equations.[1] The results of regressions are provided in Tables 1 and 2. As a follow up to the work by Thompson and Rushing (1996) regressions were conducted on the full sample, a sample including high-income countries (*GDP*75 > \$4,000 in 1985\$) and a sample of the low-income countries (*GDP*75 < \$4,000 in 1985\$). This split is roughly compatible with the results of the switching regression conducted by Thompson and Rushing that determined a structural change in the coefficient on the patent protection variable in a standard growth equation takes place at a level of initial wealth of \$3,400 in GDP per capita in 1980 dollars.

III. Results

The results from the estimation of Equation (1) indicate that increases in total factor productivity have a positive and statistically significant impact on economic growth. This is true for the full sample and in the high-income, low-income samples. The same is true for the percentage increase in gross domestic investment and its impact on the rate of economic growth.

1. We also estimated the equations using both two stage and three stage least squares. All estimated coefficients found to be statistically significant using SUR were also statistically significant using the alternative estimation methods. Also, the signs on those statistically significant coefficients remained the same.

Table 1 Growth Regressions Dependent Variable GR7590

Independent Variable	Full Sample	*GDP*75 > $4,000	*GDP*75 < $4,000
*GDP*75	-.0002 (2.57)	-.0004 (2.57)	-.0002 (.51)
*SEC*75	.004 (.23)	.009 (.45)	.04 (.79)
*POP*75	.00000006 (.02)	.000004 (.7)	.0000009 (.31)
GPOP	-.04 (2.01)	-.001 (.03)	-.05 (1.28)
TFP	3.6 (4.5)	2.77 (1.97)	4.93 (4.05)
INV	.24 (4.47)	.34 (3.39)	.24 (3.24)
Constant	-.26 (.2)	1.15 (.5)	-1.83 (.84)
R^2	.57	.62	.62
N	55	26	29

Note: Absolute values of t-statistics appear in parentheses. Estimation is by Seemingly Unrelated Regression (equations were jointly determined with equations in Table 2).

Table 2

Dependent Variable - *TFP*				Dependent Variable - *PAT*			
Independent Variable	Full Sample	*GDP*75 > $4,000	*GDP*75 < $4,000	Independent Variable	Full Sample	*GDP*75 > $4,000	*GDP*75 < $4,000
PAT	.016 (.39)	.17 (2.1)	-.02 (.35)	*FREE*	8.09 (4.28)	6.66 (3.88)	10.9 (2.71)
FREE	-.19 (.3)	-.81 (1.09)	-.83 (.71)	*GDP*75	.0002 (2.99)	.0002 (3.89)	-.0003 (1.44)
SEC75	.006 (1.82)	.009 (2.81)	-.002 (2.5)	*SEC*75	.015 (1.35)	.0026 (.28)	.06 (1.99)
GDP75	-.00001 (.9)	-.00007 (2.5)	-.00005 (.86)	*PINSTAB*	.58 (.95)	1.1 (.46)	.36 (.47)
INV	.005 (.51)	.01 (062)	-.003 (.33)	Constant	.1 (.23)	.09 (.14)	.08 (.89)
PINSTAB	-.32 (1.82)	.05 (.07)	-.27 (1.34)				
Constant	1.17 (9.69)	1.05 (3.98)	1.51 (6.73)				
R^2	.16	.47	.20	R^2	.62	.67	.38
N	55	26	29	*N*	55	26	29

Note: Absolute values of t-statistics appear in parentheses. Estimation is by Seemingly Unrelated Regression (equations were jointly determined with equations in Table 1).

The results from Equation (2) shed light on the factors that influence change in total factor productivity. For the full sample, patent protection appears to be statistically insignificant as a determinant of total factor productivity (*TFP*). However, if we limit the sample to the high-income countries, patent protection does in fact have a positive and significant impact on *TFP*. *PAT* does not have a statistically significant relationship with *TFP* in the low-income countries. These results are similar to the findings of Thompson and Rushing (1996).

Regarding the results for Equation (3), in all three samples, the greater the degree of free trade openness, the greater the level of *PAT.* This seems to confirm that hypothesis 1 is true - Gould and Gruben's (1996) previously untested assertion. Regarding hypothesis 2, the coefficients on *GDP*75 suggest that low income countries do not place a great deal of emphasis on patent protection. This coefficient is positive and significant for the full and high-income samples, not so for the low-income sample. There is no statistical support for hypothesis 3. Political instability does not appear to be a significant factor explaining differences in *PAT.* Many of the countries in the sample do not suffer from instability and for those that have, the variability is small across countries. Hypothesis 4 asserts that patent protection will be highest in countries with higher levels of educational attainment. For the low-income countries, the initial level of quality of human capital (*SEC*75) appears to have a positive impact on patent protection levels. This supports the notion that benefits are anticipated from patent protection with higher levels of educational attainment in low-income countries.

IV. Conclusions

This paper has attempted to test four assertions by researchers investigating the role of IPRs in economic growth. We have introduced into the model of analysis of economic growth an equation that tests the relationship between patent protection and openness of trade, level of GDP per capita, political instability an educational attainment. The empirical analysis here seems to confirm what previous researchers speculated:

1. The greater the degree of open trade the greater the observed level of patent protection (Gould and Gruben - 1996).

2. Countries that have not developed a significant R&D infrastructure (low-income countries) have not placed emphasis on strong patent protection and vice versa (Park and Ginarte - 1997, Thompson and Rushing - 1996).

3. Low-income countries with low educational attainment levels are not likely to have high patent protection levels since the ability to capitalize on the rewards is not present to a large degree.

4. The degree of political instability does not appear to share a statistically significant relationship with the level of patent protection (Thompson and Rushing - 1996).

The finding in number 4 is not surprising in view of the fact that most of the 55 countries in the data set had relative political stability. Those countries that experienced some instability were in small in number and there was only a small amount of variation across countries.

What this study has not done is enlighten the reader with respect to the relationship between IPRs, the entrepreneur, innovation and economic growth. The link seems extremely important, and yet we have not been able to test the hypothesis of Baumol (1993) and Rushing and Thompson (1996) with regard to linkages in the action chain. Perhaps the direction to explore is the relationship between patents (as a proxy for all IPRs), new business start-ups, and economic growth. The new business start-ups could be a manifestation of the entrepreneurial actions. If the start-ups were for primarily technology based firms, the data should make the patent proxy more powerful. Although this approach may have promise in the developed economic with good R&D infrastructures and economic data, it will probably not be a feasible approach for a broad based sample of countries utilized in the studies cited in this paper.

Appendix

Data Sources

*GR*7590, *GPOP* :	Calculated by the author's using data from Summers and Heston, "Penn World Tables, Mark 5.6" available at www.nber.org.
*GDP*75, *POP*75 :	Summers and Heston, "Penn World Tables, Mark 5.6" available at www.nber.org.
*SEC*75, *FREE*, *PINSTAB* :	Barro and Lee (1993)
INV :	The World Bank, "World Development Indicators" (1997)
TFP :	Coe and Helpman (1994) and Coe, Helpman and Hoffmeister (1997)
PAT :	Rapp and Rozek (1990)

References

Barro, R.J., and J.W. Lee (1993), "International Comparisons of Educational Attainment," NBER Working Paper, Cambridge, MA.

Baumol, W.J. (1993), *Entrepreneurship, Management, and the Structure of Payoff*, MIT Press, Cambridge, MA.

Coe, D.T., E. Helpman, and A.W. Hoffmeister (1997), "North-South R&D Spillovers," *The Economic Journal*, 107, 134-149.

Coe, D.T., and E. Helpman (1995), "International R&D Spillovers," *European Economic Review*, 39, 589-887.

Gould, D.M., and W.C. Gruben (1996), "The Role of Intellectual Property Rights in Economic Growth," *Journal of Economic Development*, 48, 323-350.

Helpman, E. (1997), "R&D and Productivity: The International Connection," NBER Working Paper 6101, Cambridge, MA.

Park, W.G., and J.C. Ginarte (1997), "Intellectual Property Rights and Economic Growth," *Contemporary Economic Policy*, 51-61.

Petrakis, P.E. (1997), "Entrepreneurship and Growth: Creative and Equilibrating Events," *Small Business Economics*, 9, 383-402.

Rapp, R.T., and R.P. Rozek (1990), "Benefits and Costs of Intellectual Property Protection in Developing Countries," *Journal of World Trade*, 24(5), 75-102.

Rushing, F.W., and M.A. Thompson (1996), "Intellectual Property Protection, Entrepreneurship and Growth," *Journal of Enterprising Culture*, 4(3), 267-285.

The World Bank (1997), "World Development Indicators," Washington, D.C.

Thompson, M.A., and F.W. Rushing (1996), "An Empirical Analysis of the Impact of Patent Protection on Economic Growth," *Journal of Economic Development*, 21(2), 61-79.