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Title Page

Intellectual Property Rights and Innovation: A Panel Analysis

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ABSTRACT

We investigate the relationship between intellectual property rights (IPR) and innovation, for a panel of 48 countries between 1998-2011. Prior empirical studies mainly focus on strength of patent regulations largely ignoring the enforcement of such laws in practice. We employ a new index that accounts for the enforcement related component of the patent system and the Ginarte and Park (1997) index of patent regulatory strength. We thus include two crucial elements of a national patent system, the *de jure* position relating to book law and IPR regulations, and the *de facto* position relating to IPR enforcement. We consider nonlinearities between IPR and innovation, and we find that both nonlinearities and the enforcement aspect are significant in explaining the relationship between innovation and IPR systems.

Keywords: innovation, intellectual property rights, patent strength, patent enforcement

JEL codes: O3, O31, O34

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INTRODUCTION

It is a well-established stylised fact within the literature that national IPR systems perform an important role on the development of innovation internationally (Allred & Park, 2007; Kanwar & Evenson 2003). Innovations are regarded as non-rival goods and partially non-excludable goods. The use of an innovation by one producer does not exclude use by others. Innovators cannot completely prevent other producers from using an innovation without using proper licensing or other authorisation. Thus gains from innovation are difficult to appropriate and returns to investment become uncertain. In order to incentivize R&D spending and to encourage innovation activity, a suitable IP regime becomes essential to address such a market failure.

We examine the effect of the enforcement related component of intellectual property rights (IPR) systems on innovation. In the absence of available IPR enforcement related data, previous empirical studies in the literature use IPR regulation strength indices such as Ginarte and Park (1997) or counts of major IPR legislation reform events to approximate for the overall effect of national IPR systems (Allred & Park, 2007; Kanwar & Evenson, 2003). Enforcement is important because efficiency and effectiveness of administration and enforcement of IPR rights determines the actual strength of the overall IPR system (Maskus, 2000; Park, 2008). While a strong regulatory IPR framework may exist though enacted laws, these laws may not be effectively administered and enforced (Papageorgiadis et al. 2014).

We make two contributions to the literature. We proxy for strength of IPR enforcement by using the IPR index of Papageorgiadis et al. (2014). This applies transaction cost theory and constructs annual index scores by incorporating enforcement related dimensions of the IPR system. Thus we overcome data availability problems relating to IPR enforcement faced by previous studies. We find that the levels of IPR enforcement strength of a country's IPR system have a highly significant effect on national innovation. Our second contribution stems from use of indices for both IPR regulatory strength and IPR enforcement which allows us to more effectively proxy for the strength of the entire IPR system.

A number of theoretical R&D driven endogenous growth model studies expect a positive monotonic relationship between the extent of IPR system strength and innovation activity or innovation rate (Helpman 1993). The optimal IPR literature argues for the existence of an inverted U-shaped curve between the strength of IPR systems and innovation (O'Donoghue & Zweimuller, 2004). Empirical evidence suggests a negative or an inverted U-shaped relationship between strengthening IPR systems and innovation (Allred and Park 2007; Lerner 2009; Furukawa 2010; Gangopadhyay & Mondal 2012; Helpman 1993). Allred and Park (2007) find that strengthening levels of IPR regulation have a negative effect on the innovation output of developing countries. Hudson and Minea (2013) study this effect using the Ginarte and Park (1997) index together with the level of economic development and also find significant nonlinear effects. Furukawa (2010) argues that, with fairly high costs of innovation, both very weak and very strong IP systems lead to lower innovation, suggesting that in such cases a "moderate" approach is preferable. Strengthening of a weak IPR system incentivises innovation as it enables an IP owner to enhance their innovative activities and appropriate their investment in a safer environment. Strengthening of an already strong IPR system leads IP owners to lose the incentive to innovate and quickly commercialise their innovations due to the reduced level of competitive pressure and their increased market power (Park 2008).

DATA AND VARIABLES

Our panel covers forty-eight countries (see appendix Table 1), from 1998 to 2011. Data is obtained from the World Development Indicators (World Bank) and the OECD. Following convention, our dependent variable is the logarithm of patents filed which is proxy for innovation (Table 2). Independent variables include log of per capita GDP in constant US dollars (measure for level of economic development), log of high technology exports in constant dollars (to proxy technological sophistication), health expenditure per capita (proxy for availability of public goods and infrastructure), researchers engaged in R&D (capturing innovation skills and capabilities), log of net FDI inflows in current dollars (proxy for availability of capital and technology inflows), openness (ratio of trade to GDP), government stability (an index) and log of population (size of market and economies of scale).

Ginarte and Park (1997) index (GPI) is widely used to measure the strength of IPR regimes (updated by Park 2008). It is the unweighted sum of scores for five individual constructs including coverage (inventions that can be patented), membership of countries in international treaties related to IPRs, duration of protection for IP, enforcement mechanisms available and restrictions imposed on IP rights.

Table 2: Variable names

Variable code	**Variable name**
lpatents	log of patents
gpi	Ginarte and Park index (0-5)
pi	Papageorgiadis et al. index (0-10)
gdpcpc	GDP per capita, constant USD
open	(Exports+Imports)/GDP [constant USD]
pop	Population
govstability	Government stability index
healthexppc	Health expenditure, per capita constant USD
hitechrx	High tech exports, real USD
fdinetinf	FDI net inflows, current USD
resrd	Researchers engaged in R&D per million

l denotes logarithm of variable

Papageorgiadis et al.'s (2014) index quantifies transaction costs faced by patent owners when engaging with the enforcement related elements of a national patent system. It employs three transaction cost constructs, namely a) monitoring costs relating to effectiveness, efficiency and commitment of public authorities e.g. customs and police forces that enforce the rights of patent owners, b) property rights protection costs relating to efficiency, effectiveness and evenhandedness of judicial enforcement, and c) servicing costs relating to quality of patent administration by e.g. national IP offices. Longitudinal secondary data is used to calculate index scores for each of the three transaction cost constructs after which annual scores are extracted for 48 countries (1998-2011).

METHODOLOGY AND RESULTS

An established model used for analysing the relationship between IPR and innovation (Hudson & Minea, 2013; Kanwar, 2007; Kanwar & Evenson, 2003; Sweet & Maggio, 2015) is the following:

$$\ln P_{it} = \beta_0 + \beta_1 IPRINDEX_{it} + \phi_{it} Z_{it} + \varepsilon_{it} \quad (1)$$

where $IPRINDEX_{it}$ is a suitable index of IPR strength, Z_{it} is a vector of suitable that explain patent creation and patent related activity, as captured by P_{it}. We include squared terms for both IPR indices in order to allow for nonlinearities and to relax monotonicity assumptions following Furukawa (2010) and Sweet & Maggio (2015).

Empirical Results

There are well known nonlinearities in innovation models involving IPR indices such as gpi (see Hudson and Minea, 2013: 69). We take into account possible nonlinearities between IPR and innovation and relax the monotonicity assumption by including including two squared terms for both indices used to proxy for the different elements of national IPR systems. By doing so we correct for a possible omitted variables bias as well as specification bias, given the theoretical justification provided for relaxing the monotonicity (e.g. Furukawa 2010 and Sweet and Maggio 2015). Innovation maximising levels of IPR protection can lead to a trade-off between positive effects of stricter IPR regimes such as greater levels of appropriations from innovation based profits, leading to higher profits which stimulate further investment in innovation activity as well as negative effects such as lower levels of competition due to barriers to entry and higher transactions costs.

Table 3 shows us that both the strength of IPR regulations (gpi) and IPR enforcement (pi) have a significant effect on innovation and show the expected positive sign indicating a positive relationship between IPR and innovation. As the enforcement of IPR rises, so does innovative activity within a country. This is in line both with theory and consistent with prior empirical work (Kanwar & Evenson, 2003; Minea & Hudson, 2013; Sweet & Maggio 2015). Our study makes a contribution by empirically addressing the crucial importance of the IP enforcement aspect, which is positive and significant, which underlines the importance of adequately considering the IPR system as a whole. To our knowledge, prior empirical studies do not take IPR enforcement levels into account.

Table 3: Main Results

	OLS	Fixed Effects (FE)	Random Effects (RE)
	lpatents	lpatents	lpatents
gpi	3.032***	1.140**	1.771***
	[0.0001]	[0.0195]	[0.0001]
pi	-0.400*	-0.625***	-0.552**
	[0.0736]	[0.0071]	[0.0116]
gpi2	-0.483***	-0.214***	-0.310***
	[0.0000]	[0.0030]	[0.0000]
pi2	0.0533***	0.0457**	0.0443***
	[0.0009]	[0.0137]	[0.0093]
lgdpcpc	0.628***	1.994***	1.106***
	[0.0045]	[0.0000]	[0.0000]
open	0.234*	-0.819***	-0.297*
	[0.0664]	[0.0001]	[0.0587]
lpop	1.394***	3.366***	1.245***
	[0.0000]	[0.0003]	[0.0000]
govstability	-0.0194	0.0154	0.0149
	[0.5989]	[0.3838]	[0.3987]
lhealthexppc	-0.188	-0.310***	-0.229**
	[0.2233]	[0.0049]	[0.0108]
lhitechrx	0.0672	-0.104	-0.0167
	[0.2030]	[0.2181]	[0.8042]
lfdinetinf	-0.119**	-0.0129	-0.00524
	[0.0222]	[0.6350]	[0.8447]
lresrd	0.394***	0.200	0.351***
	[0.0000]	[0.1936]	[0.0020]
_cons	-25.77***	-63.37***	-24.06***
	[0.0000]	[0.0001]	[0.0000]
N	352	352	352
R^2	0.7666	0.2410	

p-values in brackets
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The Hausman Test and tests proposed by Arellano (1993) and Wooldridge (2002) (see Table 4) clearly indicate that the FE model is preferred. The proxy for economic development, real GDP per capita, is significant for OLS, RE and FE models. GDP per capita, openness and population are significant for OLS, RE and FE models and have the expected signs. The squared IPR indices capture nonlinearities and indicate a possible inverted U-shared relationship between IPR regimes and innovation, as theorised in the literature (Furukawa, 2010; Hudson & Minea, 2013). For the FE model, the sign for gpi is as expected (indicating that as the regulative strength of IPR rises, so does innovation), while the sign for pi is negative which is plausible. As IPR enforcement falls, there is a greater incentive to protect IP by making further applications for patents to protect IP. As real GDP per capita increases, so do patents obtained, given greater effective demand and a larger market. The same conclusion can be made for population that acts as a proxy for market size and shows the expected sign. Health expenditures per capita are significant for the FE model, while hitexhrx, resrd and govstability are insignificant.

Table 4

Hausman Test

Ho: Difference in coefficients not systematic		
chi2(11)	=	27.83
Prob>chi2	=	0.0059

Arellano 1993 and Wooldridge 2002 Tests

Test of over identifying restrictions: fixed vs random effects
Sargan-Hansen statistic 33.682 Chi-sq(12) p-value = 0.0008

CONCLUSION

This paper makes two contributions to the literature. First, we address a research gap in prior empirical work that largely ignores the role of the enforcement element of IP systems in relation to innovation and mainly focuses on the strength of patent regulations. We effectively account for the enforcement related aspects of IPR systems and thus address an important limitation of prior work. Our second contribution arises from our use of an appropriately specified model which allows us to account for potential nonlinearities within the relationship between innovation and IPR regimes. We find that both nonlinearities and the enforcement aspect of IPR systems are significant in explaining the relationship between innovation and IPR systems.

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