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INTELLECTUAL PROPERTY RIGHTS, HUMAN CAPITAL AND INNOVATION IN EMERGING AND DEVELOPING COUNTRIES

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ABSTRACT

The innovation literature suggests that the protection of Intellectual Property Rights (IPR) is a key determinant of innovation. Recent studies suggest that IPR protection stimulates innovation only under certain conditions. In this paper, we suppose that IPR have a positive impact on technological innovation only in countries with high levels of human capital. The objective of this study is to examine the relationship between intellectual property rights, human capital and technological innovation in the context of emerging and developing countries. To measure innovation, we use the number of patents granted to inventors in a country by the United States Patent and Trademark Office. IPR variable is the Ginarte and Park index, while the stock of human capital is measured by the percentage of the total enrollment among the school-aged population over 15 at the tertiary level. Panel Threshold Regression is applied to data of 46 developing countries for the period 1980-2009. The estimation results provide evidence for the existence of nonlinear relationship between intellectual property rights and innovation depending on human capital's initial level.

Contribution/Originality: This study is one of very few studies which have investigated the relationship between intellectual property rights, human capital and technological innovation in emerging and developing countries.

1. INTRODUCTION

The innovation literature suggests that the protection of Intellectual Property Rights (IPR) is a major motivation for innovation. Indeed, the patent affects innovation mainly through its effects on the imitation rate. According to Arrow (1962) the innovator's profits decrease because of the competition which is due to the imitation process. Thus, the imitation delay achieved through patent protection represents a stimulus for firms to invest in R&D. The protection of ideas through robust IPR ensures the return on investment and therefore encourages the generation of new knowledge.

Recent theoretical works suggest that IPR protection stimulates innovation only under certain conditions like a high level of human capital. Our study proposes to examine the effect of intellectual property rights on innovation. It attempts to answer to the following question: Does the effect of the IPR system on innovation depend on the level of human capital?

This question highlights the non-linear nature of the impact of IPR protection on innovation activity, that is, the possibility that the IPR system will have a different impact on innovation conditional on a threshold. We apply the Hansen (1999) threshold regression approach to a sample composed of 46 developing countries over six five-year periods.

This paper is structured as follows: in the second section, we will review some previous studies. The third section will focus on the research methodology. The fourth section will be devoted to the presentation and interpretation of the results. Finally, the fifth section will deal with the conclusion.

2. LITERATURE REVIEW

Many theoretical studies suggest that IPR protection stimulates innovation only under certain conditions. Maskus (2005)[1] points out that high levels of IPR should be introduced in markets where certain factors such as low barriers to entry, labor market flexibility and an international trading system are already present and developed at a certain level. Introduced differently, high levels of IPR protection may not have effects or even be associated with negative effects on the economy. Such prerequisites are not reachable in some developing countries. Siebeck, Evenson, Lesser, and Primo Braga (1990) noted that robust IPR do not promote R&D in developing countries because of several barriers such as low human capital, lack of physical capital, weak institutional systems and high economic uncertainty. Datta and Mohtadi (2006) have shown that the early stages of development that are associated with low levels of human capital are associated with great confidence in technological imitation. While at more advanced stages of development, skills enable the emergence of innovations.

The level of human capital represented by the level of education and skills of the population is considered as a key determinant of economic growth (Lucas, 1988). It is seen as an important source of competitive advantage for individuals, organizations and societies (Coleman, 1988; Gimeno, Folta, Cooper, & Woo, 1997). Qualified people have a great ability to learn new skills, to adapt to changing circumstances and to do things differently. In addition, well-qualified people generate knowledge that can be used to create and introduce an innovation.

The empirical literature highlights the positive role of human capital in shaping innovation (Furman, Porter, & Stern, 2002; Hall & Jones, 1999).

Empirical studies on the link between human capital, IPR and innovation are very limited. Qian (2007) has shown that the effect of IPR on innovation is accelerating in countries with the highest levels of economic development, education and economic freedom. Ortega and Lederman (2010) found in their empirical study that the IPR index influences research and development expenditures according to the level of human capital. The results of Mohtadi and Ruediger (2014) 'study indicate that the IPR system only stimulates economic growth when the level of human capital exceeds a certain threshold.

From the theoretical and empirical literature cited above, we will assume that intellectual property rights affect innovation in a non-monotonic way depending on human capital level.

Although both theoretical and empirical studies showing the importance of human capital in the relationship IPR / Innovation are very limited, its choice as a factor intervening in the relationship IPR-innovation aims on the one hand to allow a certain comparability of our results with those found by Qian (2007) and Ortega and Lederman (2010) and also reflects our ambition to test the hypothesis that economies, which are differentiated by their initial stock of human capital, may not converge and thus find themselves on different innovation paths.

3. METHODOLOGY

Our study is based on data for 46 developing countries in six five-year periods (1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004 and 2005-2009). The choice of our sample is based on limited existing data.

[1] See Mohtadi and Ruediger (2014).

3.1. Choice of Variables and Measuring Instruments

a. The Dependent Variable

Patenting is often considered a suitable proxy for the level of innovation (Furman et al., 2002; Griliches, 1990).

In our study, international patents (PAT) are defined as the number of patents granted to inventors in a country by the United States Patent and Trademark Office (USPTO) in a given period (Source: USPTO)[2].

b. Explanatory Variables

The present paper considers two explanatory variables of interest: the index of intellectual property rights and the level of human capital. Three control variables are introduced in the model: economic development level, institutional framework and sources of foreign knowledge.

3.1.1. The Index of Intellectual Property Rights

The variable IPR is the Ginarte and Park (GP) index developed by Park and Ginarte (1997)[3] which represents a measure of intellectual property protection often used in empirical studies. The authors examined patent rights in more than 100 countries by considering five aspects: 1) duration of protection, 2) extent of coverage, 3) membership in international patent agreements, 4) provisions for loss of protection; and 5) enforcement measures. The GP index of patent right is between 0 and 5, a high number reflects a higher level of protection. It is available for five-year periods. Since it is a quinquennially index, we have collected the other variables in every 5 years for the 1980–2009 period.

3.1.2. Human Capital

In this study, the stock of human capital will be measured by the percentage of the total enrollment among the school-aged population over 15 at the tertiary level (TER). Data are from Barro and Lee dataset[4].

3.1.3. The Level of Economic Development

To measure the level of economic development, we use real GDP per capita. The data on PPP converted GDP per capita, at 2005 constant prices come from Heston, Summers, and Aten (2012) Penn World Table 7.1.

3.1.4. Economic Freedom

In this paper the variable EFI refers to the economic freedom index[5] which takes a value ranging from 0 to 10.

3.1.5. Sources of Foreign Knowledge

As part of this work, we will introduce the FDI variable which represents the share of FDI inflows in GDP, and the variable TRD which represents the volume of international trade and is equal to the share of imports and exports in GDP (Source: World Development Indicators of the World Bank).

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[2] Patent data is collected from the USPTO website, by visiting: http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_allh.htm

[3] GP index data are obtained by contacting the author Walter G. Park.

[4] Source : www.barrolee.com/data/dataexp.htm

[5] Source: www.freetheworld.com

Table-1. Summary statistics.

Variable	Average	Standard Deviation	Minimum	Maximum
PAT	5.73	15.36	0	150.2
IPR	2.11	0.86	0.2	4.275
TER	6.72	5.35	0.1	27.2
GDP	4166.34	2840.46	363.47	15029.7
EFI	5.66	1.02	2.3	7.66
FDI	2.07	2.6	-4.17	20.9
TRD	70.64	38.59	12.87	226.87

3.2. Descriptive Statistics

Table 1 provides the descriptive statistics on the number of patents granted by the USPTO as well as the explanatory variables (IPR, TER, GDP, EFI, FDI, TRD) for the 1980-2009 period.

3.3. Overview of the Threshold Effect Model

Non linear effects can be demonstrated using a Panel Threshold Regression (PTR) developed initially by Hansen. (1996); Hansen (1999). We will use the modelling of endogenous thresholds initially developed by Hansen (1996). It consists of estimating the following relation:

$$Y_{it} = \alpha_i + \beta X_{it} + \delta c_{it} {*} I(d_{it} \leq \gamma) + \theta c_{it} {*} I(d_{it} > \gamma) + \varepsilon_{it} \qquad (1)$$

In equation (1), Y_{it} is the dependant variable (number of patents). c is the variable IPR. d is the threshold variable. It is the variable TER. X_{it} represents a vector of control variables. γ is the common threshold for all countries. I (.) is an indicator function that is equal to 1 if the condition in parentheses is true and 0 otherwise. δ and θ are the marginal effects that may be different depending on the level of human capital.

The specification (1) highlights two regimes: a first regime for which the variable d_{it} is less than or equal to the threshold γ and a second regime for which the variable d_{it} is greater than the threshold γ. Indeed, the variable relative to IPR protection level is assumed to be negative below the γ threshold and positive beyond of this threshold. Our equation can be rewritten as follows:

$$\begin{cases} Y_{it} = \alpha_i + \beta X_{it} + \delta c_{it} + \varepsilon_{it} & \text{if } d_{it} \leq \gamma \qquad (2) \\ Y_{it} = \alpha_i + \beta X_{it} + \theta c_{it} + \varepsilon_{it} & \text{if } d_{it} > \gamma \qquad (3) \end{cases}$$

In equations (2) and (3), the index i (i = 1 ……… N) is relative to the individuals (the countries in our case). The index t (t = 1 ……… T) represents the observation period. α_i is the country specific effects that we consider as fixed effects. The error term ε_{it} is independent and identically distributed with zero mean and finite variance o^2.

Like previous studies, and in order to improve the normality of the variables, all variables have been transformed into natural logarithms.

4. PRESENTATION AND INTERPRETATION OF THE RESULTS

Before presenting findings, we proceed to analyse the independence of the explanatory variables. This is the multi collinearity test. To check the condition of absence of multi-collinearity, we use the simple correlation matrix and assume a limit of 0.7. According to the correlation matrix, strongest correlation is found between GDP per capita and human capital stock (the correlation coefficient is equal to 0.62). Thus, the condition of absence of multi-collinearity between variables is verified.

4.1. Analysis of Simple Correlations

We begin our analysis by examining simple correlations. The matrix of simple correlations allows us to examine the correlation coefficients in order to study the null hypothesis of the absence of correlation between two variables. Table 2 summarizes the results found.

Table-2. Simple correlations between the dependent variable and the explanatory variables.

Explanatory variables	Predicted sign	Correlation
IPR	+ / -	0.189***
TER	+	0.372***
GDP	+	0.405***
EFI	+	0.242***
FDI	+	0.137**
TRD	+	-0.148**

Note: ** and ***: significant correlations at 5% and 1% thresholds.

The analysis of simple correlations shows that the variable intellectual property rights (IPR) is positively and significantly associated with the innovation level. As expected, correlation coefficients for the variables TER, GDP, EFI and FDI are positive and significant. However, the variable relative to international trade is negatively and significantly associated with the number of US patents.

4.2. Estimation Results of Threshold Model

To determine the number of thresholds, the model (1) was estimated by least squares allowing one, two and three thresholds. We find that the two tests (F1 for a single threshold and F2 for double thresholds) are insignificant with p-value equal to 0.24 and 0.63 respectively. In contrast, the test F3 for triple thresholds is significant at 5% with p-value equal to 0.03. We conclude that there are three thresholds in the regression relationship. Threshold values are 1.5; 8.9 and 10.1. Thus, the four classes of countries indicated by the estimated points are those with “a low level”, “a relatively low level”, “a relatively high level” and “a high level” of initial human capital stock.

Table 3 shows the percentage of countries that belong to the four regimes for the entire period. We note that during the (1980-2009) period, the countries belonging to the first class represent about 13% of our sample, the countries of the second class 56%, while the third class represents the lowest part (8%) and the fourth class comprises 23% of all countries in our sample.

Table-3. Percentage of countries in each regime.

Class of countries	Percentage of countries (1980-2009)
TER <= 1.5	13%
1.5<TER <= 8.9	56%
8.9 <TER <= 10.1	8%
TER > 10.1	23%

Table-4. Results of the specification (1).

Independent variables	Coef.	SD (OLS)	T(OLS)	SD (White)	T(White)
TER	0.10	0.13	0.76	0.107	0.93
GDP	1.32	0.32	4.12***	0.29	4.55***
EFI	0.01	0.27	0.03	0.16	0.06
FDI	0.17	0.12	1.41	0.07	2.42**
TRD	0.02	0.09	0.22	0.07	0.28
IPR I (TER <= 1.5)	0.71	0.32	2.21**	0.25	2.84***
IPR I (1.5<TER <= 8.9)	0.32	0.22	1.45	0.12	2.66***
IPR I (8.9 <TER <= 10.1)	0.98	0.28	3.5***	0.19	5.15***
IPR I (TER > 10.1)	0.12	0.25	0.48	0.15	0.8

From the Table 4, we confirm the non-linear effects that exist in the IPR / innovation relationship as a function of the human capital stock. In fact, going from one regime to another, we notice that the patent law index does not influence the level of innovation in the same way. In the first three regimes, the impact is positive and significant. It is in the third class of countries with a relatively high initial stock of human capital that the coefficient relative to the GP index is the highest. It is almost one and a half times greater than that of the first regime, three times higher than that of the second and eight times higher than that of the fourth regime. In the latter regime, the impact becomes insignificant, indicating that there is a maximum threshold above which any increase in the stock of human capital plays no incentive role in the IPR-innovation relationship. Our results corroborate the results of Qian (2007).

The human capital stock variable is not significant. These results support the arguments of Ortega and Lederman (2010). The authors stress that developing countries with low levels of IPR can accumulate human capital without increasing their level of innovation. To create innovation, the simultaneous presence of a stock of human capital and a security system of intellectual property is necessary. In fact, Ortega and Lederman (2010) predicts that without a minimum degree of IPR protection, additional education leads more to imitation rather than innovation.

For the other control variables, the results are similar to the previous model. Real GDP per capita and foreign direct investment has a positive and significant impact on innovation. On the other hand, the index of economic freedom and the rate of international trade are not significant.

5. CONCLUSION

The purpose of this paper was to test the impact of intellectual property rights protection on technological innovation on a range of developing countries.

The previous literature has allowed us to argue that the IPR protection - innovation relationship may be a non-linear relationship depending on the initial level of human capital.

To test this relation, we used (Hansen, 1999) threshold panel model. The application of this model to 46 developing countries during the period 1980-2009 shows that in this relationship, there are non-linear effects associated with the level of human capital.

The findings show that human capital does not directly stimulate innovation. In fact, it plays an indirect role through its effect on the IPR-innovation relationship. Our results affirm the complementarity between intellectual property rights and human capital in the creation of innovation. In this study, we have shown that economies that are differentiated by their initial stock of human capital, may not converge and thus find themselves on different paths of innovation.

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