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Innovation, Intellectual Property Rights, and Economic Development: A Unified Empirical Investigation

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Summary. — Two important strands of literature investigate the way the effect of intellectual property rights (IPR) on innovation depends on either the initial IPR level or the level of economic development. We expand on this by studying their *joint* effect, in a single, unified, empirical framework. We find that the effect of IPR on innovation is more complex than previously thought, displaying important nonlinearities depending on the initial levels of both IPR and per capita GDP. The policy implications of this are examined and include the conclusion that a single global level of IPR is in general sub-optimal.

Key words — intellectual property rights, innovation, economic development, nonlinearities

1. INTRODUCTION

Among the different engines of economic growth, none has received as much attention as innovation. In recognition of the importance of innovation for promoting economic development, the World Trade Organization (WTO), along with other international institutions, emphasized several decades ago the crucial role of intellectual property rights (IPR) for enhancing innovation worldwide. Since then, the study of the relation between IPR and innovation has become a prominent topic in economic research. In an excellent recent survey, Park (2008a) identifies three main questions that have been addressed in the literature: (i) how do IPR affect the composition of technology transfer by mode of entry, (ii) does the impact of IPR on innovation vary by the stage of economic development, and (iii) do stronger IPR stimulate innovation?

The goal of the present contribution is to expand on these latter two issues in a *single*, *unified*, empirical analysis linking innovation, IPR and the level of economic development. To this end, we provide econometric estimations based on panel smooth threshold regressions (PSTR), a technique recently developed by Gonzalez, Terasvirta, and van Dijk (2005). Specifically we employ an identification procedure to search for endogenously estimated threshold effects of IPR on innovation, on a sample of both developed and developing countries. Contrary to previous studies that constrained the shape of the impact of IPR (and of the level of economic development) on innovation to simple polynomial forms, the identification procedure allows for a high complexity of the nonlinearities. In particular, since the transition between regimes is smooth, the innovation/IPR elasticity differs across countries and time-periods, with respect to the levels of both IPR and economic development. This is particularly important given the numerous structural reforms in many countries during the 90s. [1]

We find firstly that the influence of IPR on innovation is nonlinear, depending on the IPR level. We emphasize two types of nonlinearity. On the one hand, stronger IPR would increase innovation in countries with either relatively low or relatively high initial IPR, and decrease it in other countries. Secondly, we enlarge this analysis to allow for the presence of a measure for economic development, namely the per capita GDP level. The tests used in the identification procedure confirm that the level of per capita GDP also exerts a nonlinear influence on the innovation/IPR relationship.

Failing to account for both variables (IPR and per capita GDP) could produce biased evaluations of the effect of a worldwide IPR strengthening of innovation. For countries with low IPR levels, we find a family of curves, dependant on the per capita GDP level, between IPR and innovation. Such a result complicates the task of policymakers that aim at maximizing innovation, since the optimal IPR level is contingent on the level of economic development, which is of course endogenous. For countries with high IPR levels, we show that stronger IPR increase innovation, provided that the per capita GDP level is above a certain threshold. This has important policy implications. Firstly, the same level of IPR has a different impact on richer countries than poorer ones, as does strengthening IPR, and in addition, given positive adjustment costs a single minimum standard for IPR as in TRIPS is unlikely to be optimal either globally or for individual countries. Similarly fixed time adjustment periods are also unlikely to be satisfactory.

The paper is organized as follows. Section 2 reviews the literature. We then describe the PSTR methodology and present the dataset. In Sections 5 and 6, we present the results, then consider those results and finally conclude the paper.

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2. THE LITERATURE

Early influential theoretical contributions in the "optimal patent literature" (Cadot & Lippman, 1995; Horowitz & Lai, 1996; O'Donoghue & Zweimuller, 2004; Scotchmer & Green, 1990) find the existence of an inverted-U curve between the level of IPR and innovation, a result supported by more recent theoretical analysis (see, among others, Furukawa, 2007, 2010; Futagami & Iwaisako, 2007; Horii & Iwaisako, 2007).[2] Thus, the optimal, innovation-maximizing, IPR level should solve a trade-off between the positive (a higher ability to appropriate R&D investment-based profits, larger markups that are an incentive for further innovation, *etc*.) and negative (reduced competition from the higher blocking of rival entry, higher transaction costs for licensing, *etc*.) effects of tighter IPR. Based on these results, an important empirical literature has investigated the existence of an inverted-U curve between IPR and innovation. Kanwar and Evenson (2003) show not only that tighter IPR always enhance innovation (as in Schneider, 2005; Varsakelis, 2001), but also that the increase in innovation is amplified as the level of IPR increases, a result confirmed by Kanwar (2007). Allred and Park (2007) add to the complexity of the nonlinear relation between IPR and innovation by emphasizing a U-shaped curve. Hence, there is some disagreement on the nature, if any, of the relationship.[3]

We turn now to the second point, namely the possible influence of the level of economic development on the relationship between IPR and innovation. Compared to the optimal patent literature, this point has generated even more controversy, especially since the adoption of the TRIPS agreement in the mid 90's, which has been criticized for favoring developed over developing countries, by implementing stronger IPR worldwide. The potential conflicting effects of tighter IPR for the industrialized ("North"), compared to developing ("South") countries, go back at least to a strand of several influential theoretical papers from the beginning of the 1990's (see, Chin & Grossman, 1991; Deardorff, 1992; Diwan & Rodrik, 1991; Helpman, 1993).[4] For example, Chin and Grossman (1991) show that, while industrialized countries benefit from rising IPR, developing countries may find themselves penalized, especially since higher IPR may result in higher monopoly prices and lower welfare. Consequently, they conclude that a worldwide IPR tightening should go along with some compensation mechanism, in the form of a transfer from North to South countries. Similar conclusions are reached by the above-mentioned papers,[5] although the underlying mechanisms delimitating "good" *versus* "bad" effects of tighter IPR in developing countries may be different, and depend on: the imitation cost of innovations by the South countries for Deardorff (1991) or Glass and Saggi (2002), trade (linked to FDI) and absorption capacities (particularly regarding the existence of a sufficient stock of human capital) for Maskus and Penubarti (1995), Lai (1998) and Grossman and Lai (2004), or a Chamberlain-based horizontal differentiation in the variety of products for Diwan and Rodrik (1991) and Lai and Qiu (2003).[6]

The empirical attempts to estimate the effect of the level of economic development on the relation between IPR and innovation can be classified into roughly three categories. First, several studies estimate the innovation/IPR elasticity in groups of countries defined using an *ex-ante* classification. Schneider (2005) shows that IPR have a positive effect on innovation in developed countries and a negative effect in developing countries. This result was partially questioned by Allred and Park (2007) who fail to find any significant effect for developing countries, but a U-shaped curve in developed countries. However, these papers can be criticized (a) for using an *ex-ante* distinction between developing and developed countries, and (b) for not allowing a direct role of the level of economic development on the innovation/IPR elasticity.[7] A second group of papers deals precisely with the first of these problems. Ginarte and Park (1997) and Park and Ginarte (1997) highlight different effects of IPR on innovation for countries below and respectively above the median value of the GDP level. However, there are no tests that discuss the robustness of this exogenously determined threshold,[8] and the innovation/IPR elasticity is constant within groups (no explicit influence of the level of economic development).

Finally, several papers aim at illustrating a direct effect of the level of economic development on the link between IPR and innovation (the critique (b) above). Among them, Chen and Puttitanun (2005) outline a nonlinear dependence of the innovation/IPR relation on the GDP level, within a sample of developing countries. However, the authors use a simple first-order polynomial interaction term (between IPR and the GDP level) to account for the nonlinear influence of GDP, which suffers from the usual limitations (for example, an *ex-ante* specification of the shape of the relation, no tests for higher-order polynomials,[9] *etc*.), and their analysis focuses exclusively on developing countries.

3. METHODOLOGY

The Panel Smooth Threshold Regression (PSTR) model, recently developed by Gonzalez *et al*. (2005), can be seen as an upgrading of two existing techniques. Firstly, a generalization to panel data of thresholds with smooth transition used in time series (Chan & Tong, 1986). Secondly, a generalization to smooth transitions of panel threshold models (PTR) with brutal transitions. In the following, we present the PSTR method from the latter perspective. PTR models were introduced by Hansen (1999), as a tool to estimate threshold effects on panel data. Assuming a panel model with $i = \overline{1,N}$ countries and $t = \overline{1,T}$ years, the simplest PTR model with one threshold is

$$\begin{cases} INNOV_{it} = \alpha_i + \beta_1 IPR_{it} + \beta_2 IPR_{it}\Gamma(Q_{it};\overline{Q}) + \sum_{j=1}^{J}\phi^j Z_{it}^j + \varepsilon_{it} \\ \Gamma(.) = \begin{cases} 0, & \text{if } Q_{it} < \overline{Q} \\ 1, & \text{if } Q_{it} \geqslant \overline{Q} \end{cases} \end{cases}, \tag{1}$$

where α_i are country fixed effects, Z_{it}^j stands for additional explanatory variables and ε_{it} is an error term. The impact of IPR on innovation (*INNOV*) depends nonlinearly on the values of the transition variable Q with respect to the threshold $\overline{Q}$: $dINNOV/dIPR = \beta_1$ if $Q_{it} < \overline{Q}$ (regime 1) and $dINNOV/dIPR = \beta_1 + \beta_2$ if $Q_{it} \geqslant \overline{Q}$ (regime 2).

The PTR model suffers from two important shortcomings. Firstly, the presence of a brutal transition between regimes. This is rather problematic in general, and particularly for our analysis, since it would be hard to justify such large structural differences in the impact of IPR on innovation in countries with fairly close IPR or per capita GDP levels. Secondly, even in the presence of multiple thresholds, the PTR model still allows for only a limited number of regimes, which may be considered as unrealistic when one deals with panel data with (i) an important time dimension (in our analysis, 30 years), and (ii) potential heterogeneity among countries. The PSTR technique overcomes these problems.

We assume the following basic PSTR model