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Intellectual Property Rights and Innovation in Developing Countries

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. This paper studies the relations between intellectual property rights (IPRs) and innovation in developing countries. While weak IPRs facilitate the imitation of foreign technologies, stronger IPRs encourage domestic innovative activities. A model is developed to illustrate how this trade o¤ may a¤ect a developing country's choice of IPRs. It is shown that innovations in a developing country increase in its IPRs, and a country's IPRs can depend on its level of development in a non-monotonic way, ...rst decreasing and then increasing. We evaluate these theoretical results empirically, using a panel data set incs16uiypda .6(ri)-1o-
in developing countries, and suggests the presence of a U-shaped relationship between IPRs and economic development.

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The protection of intellectual property rights in developing countries has been a much debated issue in recent years. This debate is often placed in a North-South framework, where the predominant view is that southern developing countries tend to lose from protecting intellectual property rights (IPRs). The static and partial equilibrium reason for this loss is that IPRs protection will strengthen the market power of northern innovating firms and raise prices in developing countries (Chin and Grossman, 1988; Deardorff, 1992).[1] But even dynamic and general equilibrium factors are accounted for, the South need not fare better from tight IPRs, partly due to the adverse terms-of-trade effect and the possible slowing down of northern innovations over time (Helpman, 1993). In fact, Helpman concludes:

"Who benefits from tight intellectual property rights in less developed countries? My analysis suggests that if anyone benefits, it is not the South." (Helpman, 1993, pp. 1274).

There are, however, several arguments of why developing countries need to increase their protections of IPRs. First, as Diwan and Rodrik (1991) argue, northern and southern countries generally have different technology needs and, without the southern protection of IPRs, northern countries would not develop technologies largely needed by the South. Second, northern firms may react to the lack of IPRs in the

WTO negotiations, and the strengthening of IPRs has been raised as a condition for many developing countries' entry to the WTO (Maskus, 2000). Importantly, even these arguments for tight southern IPRs seem to suggest that, if not for strategic reactions or pressures from the North, the southern developing countries would have little incentive to protect IPRs.

The purpose of this paper is to offer an alternative perspective on the protection allows it to produce a product of a higher quality than that can be produced by the domestic firm. However, the domestic firm can raise its product quality by imitating the northern technology, and its ability to do so depends on the tightness of IPRs in this country. The local sector consists of two domestic firms, one of which has the ability to develop a patentable new technology that improves the product quality, while the other local firm can imitate the new technology. Increased protection of IPRs makes imitation in both sectors more difficult, but it has different effects on the country's welfare. In the importing sector, less imitation means lower product quality of the domestic firm and thus less competition for and higher price of the foreign firm. As a result, there is a reduction of consumer surplus and (domestic) social surplus. In the local sector, less imitation means more incentive for the domestic innovating firm to invest in a higher-quality technology (product), which leads to more efficient investment and to a higher social surplus. In a game where the government first chooses the level of IPRs, followed by investment of the domestic innovating firm and then by production in both sectors, we show that the optimal protection of IPRs balances this basic trade-off. In equilibrium, the incentive to innovate by the domestic firm increases in the tightness of IPRs. Furthermore, there exist plausible situations where, starting from a low level of development, increases in the level of development lowers IPRs initially but raises IPRs after a certain point. That is, a developing country's preferred levels of IPRs can exhibit a U-shaped curve with respect to its levels of economic development, given the advanced technologies of the North.

Although our model is highly stylized, we believe that the insights we try to illustrate are very general. We shall later discuss some of the possible extensions of the model, such as allowing foreign innovations to be endogenous, allowing different types of innovations, and allowing more general market conditions. But our basic idea and our main departure from the existing literature remains to emphasize that even without strategic actions or pressures from the North, there can be incentives for a developing country to protect IPRs, and these incentives tend to differ for different countries in the South. It should be emphsized that we are not the first to notice the relations between IPRs and the levels of economic development. In fact, the ex-

All ...rms in have constant unit cost $^{A} \in [0$].

Sector also has two ...rms, and , both of which are domestic ...rms. Firm $'$ product has quality (;) where ≥ 0 is 's investment in quality improvement, and $\forall$ $_{z}($;) 0 $_{z}(\infty$) = 0 $_{zz}($) 0 $_{\mu}($;) 0 and $_{z\mu}($;) 0 Firm can also produce in with product quality $^{M}($;) = (;) $-$ ( )((;) $-$) where, $\forall$ 0 $\leq$ (0) ———

The optimal (;) thus satis…es

$$(\ ) \ _z (\ (\ ; \ ) ; \ ) \leq 1 \quad \text{where the equality holds if} \quad (\ ; \ ) \quad 0 \qquad (3)$$

Since (0) $\frac{}{\mathrm{v}_z \quad \mu}$ by assumption we have (0) $_z$(0;) 1 Hence (;) 0 and condition (3) holds in equality. Since $_{zz}$(;) ((9)

(i) The optimal $( )$ satisfies

$$- {}^F ( ) \, '(( )) + [\quad _z ((( ););) - 1] \, ^- (( );) \quad \begin{cases} \leq 0 & ( ) \quad 1 \\ \geq 0 & ( ) \quad 0 \end{cases} \tag{5}$$

where

$$0 \quad ( ) \quad 1 \text{ if } {}^F ( ) \, '(( )) = [\quad _z ((( ););) - 1] \, ^- (( );)$$

(ii) Suppose that $( )$ is unique and $0 \quad ( ) \quad 1$ Then,

$$'( ) \quad \begin{matrix} 0 & {}^F \, '( ) \, '(( )) & [\quad _z ((( ););) - 1] \, ^-_\mu (( );) \\ 0 & {}^F \, '( ) \, '(( )) & [\quad _z ((( ););) - 1] \, ^-_\mu (( );) \end{matrix} \tag{6}$$

The result in (i) follows dire16.1(i)-5.3(6-1.0y)-298.8(f)11.2(r)0.3(om)-287.1ihe K-1.0uhn-Tcker ...rs

To show (ii),eoiceha

$$\frac{[\quad _z ((( ););) - 1] \, ^- (( );) - {}^F ( ) \, '(( ))}{} \quad 0$$

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$$\frac{[\quad _z ((( ););) - 1] \, ^- (( );) - {}^F ( ) \, '(( ))}{}$$

$$= [\quad _z ((( ););) - 1] \, ^-_\mu (( );) - {}^F \, '( ) \, '(( ))$$

The conclsin i6) hen follws. ■

An increase in a¤ecs through hewoermsn eeft sidef (5).he ...rst term represens e reductin in consumer surplus in . A higher make it mre di¢ult for a domstic ...rm to imitate the more advancedoreign ...rm's technlogy, rcing th competition rsing th equilibru prfhe foreign ...rm This e¤ect reduces The sende representshe net bene...t from qualit irovement by ...rm in wh--11.2iichs welfare imp--11.2irvin. T choic(of) balnce thi trd¤.

To see how ( ) will behave, we can consider F ′( ) ′(( )) as the imitation e¤ect of increasing A higher makes an increase in more costly in sector since the potential bene…t of imitation in is higher. On the other hand,

5:) ; [z ((( ) ;) ;) − 1] −µ (( ) ;)

measures the innovation e¤ect of increasing in Sector B A higher increases z ((( ) ;) ;) and − (( ) ;) which makes it more desirable to increase Starting from low level74e161Tfl74e161Tfl74e161Tfl74e160.486rf87TD0.0428Tc(2/TT21Tf1.1848-0.008;TD-

From

$$^{F} \quad (\;) \quad ' (\quad ^{*}) = [\quad _{z} (\quad (\quad ^{*}; \quad) ; \quad) - 1] \quad ^{-} (\quad ^{*}; \quad)$$

we have

$$\frac{1}{3}(1 + 2 \;) \frac{1}{1 + } = 2 \frac{1}{1 - } \frac{1}{1 + \frac{- \; \mu}{- \mu}} - 1 \quad \frac{1}{1 - }$$

and thus

$$(\;) = \frac{2}{3} \quad - \frac{1}{3} \quad + \frac{2}{3}$$

The ( ) is U-shaped here, decreasing for – and increasing for – Figure 1 shows the curve of ( ) from this example.ple3Tf7s analysis. We can extend the model in many directions without altering the insights of our analysis. For instance, our results would not change if there are more than one imitating domestic …rm in sector for a small developing country.

Our theoretical model yields two testable implications:

1. Domestic innovations in a country increase in its protection of IPRs (i.e., $-(\ ;\ )\quad 0$) and in its level of development (i.e., $\mu(\ ;\ )\quad 0$).[5]
2. It is possible that a country's level of IPRs …rst decreases and then increases in its level of development.

We next study the empirical evidence on these two implications.

In this section, we …rst describe the data to be used for our empirical analysis. We then discuss our econometric model. Results of the econometric analysis are presented at the end of the section.

The data used in this paper are collected from various sources. Most of the data are

technology, and thus domestic firms can benefit more from imitation, suggesting lower IPRs. The sign of WTO dummy variable is expected to be positive since TRIPS[6] require WTO members to increase their IPRs standards. The sign of EDU could be positive, if we believe that a more educated society will respect more for knowledge and thus for IPRs. A Hausman test for random effect supports the fixed-effect model for equation (i) at 5% level of significance.

For equation (ii), the dependent variable, IN, is a count variable involving non-negative integers. Therefore, either a fixed-effect count model or a random-effect count model should be used. The Hausman tests support the fixed-effect model at 5% level of significance. To take into account the count dependent variables, we follow the approach of Hausman, Hall, and Griliches(1984). They specified a Poisson regression to model the probability that the number of patent applications will occur the negative binomial model. In the negative binomial regression model, mean is replaced with the random variable :

$$_i = \exp \quad _j \quad _{ji} +$$

(IPRs as dependent variable)

Intercept	2.271* (0.720)
GDPCAP	-0.502* (0.186)
GDPCAPSQ	0.033* (0.013)
EDU	0.031 (0.026)
EF	0.177* (0.047)
TRADE	0.018 (0.041)
WTO	0.008 (0.036)
n	272

Estimated coe¢ cients are shown together with the standard errors in parentheses. * denotes 5% level of signi…cance.

From Table 2, GDPCAP and GDPCAPSQ have the signs that con…rm the U-shaped relationship between GDPCAP and IPRs. This suggests that countries tend to weaken their patent laws as GDPCAP begin to rise and then strengthen them after a certain point[9]. Based on the results, the curve reaches its minimum at log(GDP per capita) = 7.606, which translates into a per capita GDP of $2010.22 in 1995 value. This GDP per capita level is well below the GDPCAP mean in our data set, suggesting that for many developing countries increases in GDP per capita increase IPRs. Similar to the …ndings in Ginarte and Park(1997) and Maskus(2000), the

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results here suggest that market freedom increases a country's protection of IPRs, and that the EDU and TRADE variables have positive signs but are insigni…cant. The WTO variable is insigni…cant even though it has the positive sign. This could be due to the fact that our data started in 1975, far before the enforcement of TRIPS.

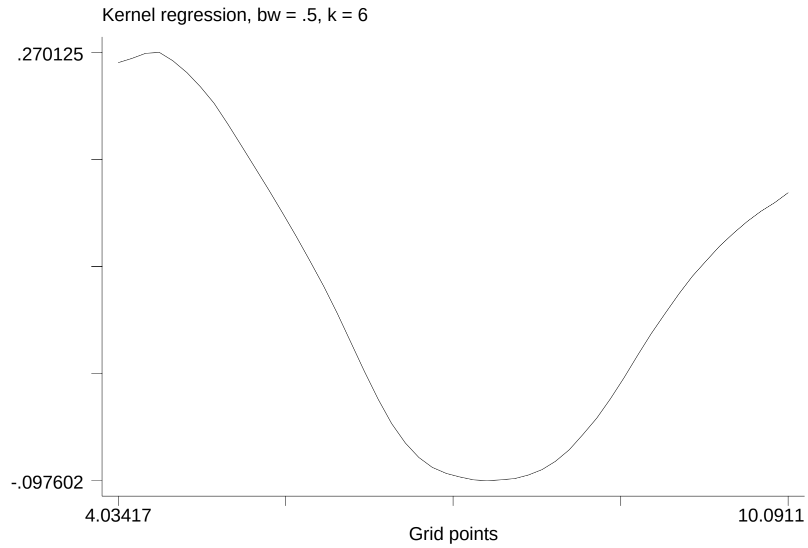
Intercept	-9.455* (3.126)
IPRs	4.998* (2.380)
GDPCAP	0.541* (0.185)
EDU	-0.130 (0.187)
EF	-0.681 (0.511)
POP	0.208 (0.135)
n	167
Log-Likelihood	-534.328

Estimated coe¢ cients are shown together with the standard errors in parentheses. * denotes 5% level of signi…cance.

Table 3 reports the impacts of various variables on domestic innovation, measured

Figure 2

Semiparametric estimates of the e¤ect of GDP per capita on IPRs



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Since a key …nding here is the U-shaped relationship between IPRs and GDP per capita, we are interested in how robust this result is. An alternative approach is to a parametric stance about other variables[11]. Using the Guassian kernel function, a semiparametric estimate of the e¤ect of GDP per capita on IPRs, controlling for other variables, is shown in Figure 2. As we can see from Figure 2, this relationship between GDP per capita and IPRs indeed appears to be U-shaped.

The empirical results support the implications of our theoretical model: $-$(;) 0 μ(;) 0; and ( ) is U-shaped, suggesting that the imitation e¤ect indeed dominates when foreign technologies/markets versus the bene…ts from imitation. In this paper, we have focused on a di¤erent trade-o¤: the need to facilitate imitation and the need to provide incentives for domestic innovative activities. We believe that the bene…ts from IPRs to a developing country are actually much more than encouraging domestic innovation in the narrow sense. As Stiglitz(1989) has suggested, the lack of a functioning market system could be the biggest obstacle to the development of

[1] Besley, T. (1995): "Property Rights and Investment Incentives: Theory and Evidence from Ghana," Journal of Political Economy, Vol. 103, pp. 903-937.

[2] Chin, J.C. and Grossman, G.M. (1990): "Intellectual property Rights and North-south Trade," In: Jones, R.W., Krueger, A.O. (Eds.), The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin. Blackwell, Cambridge, MA.

[3] Crosby, Mark (2000): "Patents, Innovation and Growth," The Economic Record, Vol.76, No.234, pp.255.262.

[4] Deardor¤, Alan V. (1992): "Welfare E¤ects of Global Patent Protection," Economica, Vol.59, pp.35-51.

[5] Deolalikar, Anil B. and Roller, Lars-Hendrik (1989): "Patenting by Manufacturing Firms in India: Its Production and Impact," Journal of Industrial Economics, Vol.37, Issue 3, pp.303-314.

[6] Diwan, Ishac and Rodrik, Dani (1991):"Patents, Appropriate Technology, and North-South Trade," Journal of International Economics, Vol.30, pp.27-48.

[7] DiNardo, John and Tobias, Justin L. (2001): "Nonparametric Density and Regression Estimation," Journal of Economic Perspectives, Vol.15, No.4, pp.11-28.

[8] Gould, David M. and Gruben, William C. (1997): "The Role of Intellectual Property Rights in Economic Growth," In: Dev Gupta, Satya and Choudhry, Nanda K. (Eds.), Dynamics of Globalization and Development, Kluwer Academic Publishers.

[9] Gwartney, James and Lawson, Robert (1997): Economic Freedom of the World 1997, Annual Report, Canadian Catoguing in Publication Data.

[20] Taylor, M. Scott (1993): "TRIPS, trade, and technology transfer,"