International Trade, Economic Growth and Intellectual Property Rights: A Panel Data Study of Developed and Developing Countries

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Abstract

This paper examines the role of high-technology trade, IPRs and FDI in determining a country's rate of innovation and economic growth. The empirical analysis is conducted using a unique panel data set of 47 developed and developing countries from 1970 to 1990. The results suggest that: 1) high-technology imports are relevant in explaining domestic innovation both in developed and developing countries; 2) foreign technology has a stronger impact on per capita GDP growth than domestic technology; 3) IPRs affect the innovation rate, but this impact is more significant for developed countries; 4) the results regarding FDI are inconclusive.

JEL Classification: O3, O4, F1
Keywords: Trade and Technological Diffusion, Innovation, Intellectual Property Rights.

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1 Introduction

The benefits of international trade for economic growth and development are difficult to understate. Imports bring additional competition and variety to domestic markets, benefiting consumers, and exports enlarge markets for domestic production, benefiting businesses. Trade exposes domestic firms to the best practices of foreign firms and to the demands of discerning customers, encouraging greater efficiency. Trade gives firms access to improved capital inputs such as machine tools, boosting productivity and providing new opportunities for growth for developing countries. Until recently, the neoclassical growth model (Solow (1956), Swan(1956)) was the main theoretical framework used to explain economic growth. However, that framework does not offer a formal link between trade policies and long run growth.

The development of endogenous growth models (Romer (1990), Grossman and Helpman (1991), Rivera-Batiz and Romer (1991), Aghion and Howitt (1992)) provides such link and suggests different channels through which trade could affect economic growth. One idea is that imports may embody innovations that are not available in the local economy, and local researchers may gain insights from these innovations. Therefore, by providing access to foreign innovations, trade can promote technological diffusion and economic growth.

Previous research has shown a positive link between trade in physical goods and technological diffusion. Some of these studies have focused on general imports as a channel for technological diffusion (Coe and Helpman (1995), Coe, Helpman and Hoffmaister (1997), Eaton and Kortum (1996, 1997) and Keller (1997)). Other studies have looked at a more disaggregated measure of imports (Wang and Xu (1997), Connolly (1998) and Keller (1999)). However, most of these studies have focused on developed countries[1].

The motivation for this paper comes from the fact that many theoretical models suggest that technological diffusion among developed countries might differ from technological diffusion between developed and developing countries[2]. Additionally, in its 1998/99 Development Report, the World Bank emphasizes the importance of openness, stronger intellectual property rights (IPRs) and foreign direct investment (FDI) as important channels for acquiring imported knowledge, especially in developing countries. The investigation of these issues requires empirical work that includes both developed and developing economies, since policy recommendations that arise from this kind of analysis may have very different effects on these two groups of countries.

[1] Only Coe, Helpman and Hoffmaister (1997) and Connolly (1998) include developing countries in their sample.

[2] For example, Grossman and Helpman (1991), Segerstrom et al. (1990), Helpman (1993), Barro and Sala-i-Martin (1997), Chui, Levine and Pearlman (2001).

This paper conducts an empirical investigation of the role of trade in determining the rate of innovation and economic growth in developed and developing countries, and investigates the importance of IPRs and FDI in these processes. FDI has been identified in the literature as another important channel for technological diffusion (Grossman and Helpman, 1991; Helpman, 1993). Additionally, patent regimes could be an additional factor in the relationship between trade and growth. As suggested by Maskus and Penubarti (1995), returns to innovation could be influenced by variations in international patent laws, with a primary channel being decisions by firms to trade in different markets[3].

More specifically, this paper focuses on three main questions: 1) Does trade promote innovation and growth by providing access to foreign technology? 2) How important are FDI inflows and IPRs in these processes? and 3) Are the effects different for developed and developing countries? This study complements the literature by including a more representative sample of developing countries and by focusing on high-technology trade. The empirical analysis is conducted using a unique panel data set of 47 developed and developing countries from 1970 to 1990, in which patent data is used as a proxy for innovation. Various studies investigating the determinants of innovation and technological diffusion use micro data sets[4]. While these studies

[3] For more on the discussion on the link between trade and IPRs, see Segerstrom et al., 1990; Grossman and Helpman,1991; Helpman, 1993; Taylor, 1994.

[4] See, for example, Griliches(1984), Branstetter an Sakakibara (1998), Hall and Ziedonis (2001).

have produced important and interesting results, this paper uses data aggregated at the country level. This approach clearly leads to loss of some information, but generates the benefit of allowing me to focus on the dynamics of innovation and growth across countries and country groupings. By contrasting empirical specifications for innovation and per capita GDP growth, the results in this paper suggest that traditional growth regressions might not be able to capture the impact of factors like IPR protection. By estimating the regressions for separate groups of countries, the results also suggest that pooling together developed and developing countries in studies like this might lead to misleading conclusions, and consequently to inadequate policy recommendations.

This paper is organized as follows. Section 2 briefly reviews the empirical literature on the subject. Section 3 discusses the methodology implemented in the paper. Section 4 describes the data. Section 5 presents the empirical results and section 6 concludes this paper.

2 Previous empirical studies on trade and technological diffusion

Several empirical studies consider the possible link between trade in physical goods and technological diffusion. In general, the findings of these papers support the notion that trade contributes significantly to technological diffusion, although the precise mechanism through which trade promotes technological diffusion is not specified.

Most of these studies have focused on general imports as a channel for technological diffusion (Coe and Helpman 1995; Coe, Helpman and Hoffmaister 1997; Eaton and Kortum 1996, 1997; Keller 1997).

Coe and Helpman (1995), using a sample of 22 developed countries find that both the domestic and the foreign R&D capital stocks have significant effects on a country's total factor productivity (TFP), and that the effect of the foreign R&D stocks is greater the more open is the economy. However, using the Coe and Helpman (1995) data, Keller (1997) finds evidence of international R&D spillovers using randomly generated bilateral trade shares, and casts doubt on the importance of trade in goods as the channel for technological diffusion when considering similar, interrelated countries[5].

Coe, Helpman and Hoffmaister (1997) extend the Coe and Helpman type of analysis to 77 developing countries, although only foreign stocks of R&D expenditures are considered. They find that the TFP of developing nations increases with a greater import weighted foreign (developed-country) R&D capital stock, with increased openness to trade with developed nations and with greater secondary school enrollment.

Eaton and Kortum (1996) develop a model of growth and technology diffusion

[5] Connolly (1998) suggests that this may be, at least in part, the result of the fact that in these papers only developed and relatively highly interactive countries are being considered. These results may be interpreted as suggesting that we should not focus narrowly on bilateral trade shares if the group of countries has a great deal of interaction amongst themselves.

which they fit to aggregate data from OECD countries. They estimate the model to explain international patterns of productivity and patenting and find that more than 50% of growth in each country in their sample derives from innovation in the United States, Germany, and Japan. Their results also indicate that imports are significant in explaining technological diffusion, however, geographical distance and human capital tend to play a much larger role in this process. Since they only consider technological diffusion between developed nations these results may underestimate the role that trade may play between developed and developing nations.

Eaton and Kortum (1997) develop a Ricardian model that explores the role of trade in spreading the benefits of innovation among OECD countries. They find that trade can serve as an important conduit for gains from improved technology. An improvement in a country's technology almost always benefits everyone. But the magnitude of the gains abroad approach those at home only in foreign countries enjoying proximity to the source. Otherwise, foreigners benefit by only a tenth as much as the innovating country.

Other studies have looked at a more disaggregated measure of imports. Wang and Xu (1997) investigate R&D spillovers through capital goods and FDI in industrialized countries. Connolly (1998) consider imports within certain specific Standard International Trade Classification (SITC) classes so as to separate out the effects of imports of goods that embody technology, from general openness effects. She finds that high technology imports from developed countries not only positively affect domestic innovation, but also lead to increased GDP growth as higher quality capital goods are used in domestic production. Even though her paper provides empirical analysis inclusive of some developing countries, there remains an under representation of less developed nations relative to developed nations. Keller (1999) examines the evidence on technology diffusion through trade in differentiated intermediate goods in eight OECD countries. He finds that, conditional on technology diffusion from domestic R&D, the import composition of a country matters, but only if it is strongly biased towards or away from technological leaders.

3 Methodology

The empirical specifications of the innovation and growth regressions are based on the theoretical models developed by Grossman and Helpman (1991) and Barro and Sala-i-Martin (1997). The empirical analysis uses a panel data set consisting of four separate five-year periods, 1970-74, 1975-79, 1980-84, 1985-89 for a cross-section of developed and developing countries. The panel regressions are estimated using country fixed effects. Due to the short length of the panel (four periods), some within-country effects might not be captured; therefore, I also estimate OLS regressions. All variables are used in natural logs and expressed in real terms.

3.1 Innovation Regression

Innovation in a given country is positively related to real import levels of capital goods from developed countries. As mentioned in the previous section, various studies suggest that the import composition of a country is important for domestic innovation. Coe and Helpman (1995) and Coe, Helpman and Hoffmaister (1997) suggest that a country should exhibit higher productivity levels if it imports to a large degree from countries that have accumulated high levels of technological knowledge. Keller (1999) argues that, conditional on technology diffusion from domestic R&D, the import composition of a country matters, but only if it is strongly biased towards or away from technological leaders.

As suggested in various studies in a volume edited by Griliches (1984), the stock of human capital and the level of R&D expenditures should also be positively correlated with the rate of innovation. In addition, factors that affect the profitability of innovation, such as the size of the market should contribute positively to innovative activities. Stern, Porter and Furman (2000) demonstrates that a production function for international patents depends on GDP per capita, which is used as a proxy for each individual country's knowledge stock.

The expected sign of the IPR variable is theoretically ambiguous. Helpman (1993), for example, argues that strenghtening of IPR protection in the South (which engages in imitation) could reduce global innovation (and welfare) in the long run[6].

Grossman and Helpman (1995) suggest that foreign direct investment (FDI) can potentially help disseminate technology to the host country. Finally, a country's ability to absorb foreign technology embodied in imports might depend on its level of infrastructure. Bardhan (1995), for example, argues that the flow of technology through FDI to a developing country is often constrained not so much by restrictive government policies in the host country as by its lack of infrastructure. Therefore, the innovation regression is:

$$
\begin{aligned}
(1)\ I_{it} &= \beta_0 + \beta_1 HK_{it} + \beta_2 HDC_{it} + \beta_3 R\&D_{it} \\
&\quad + \beta_4 GDP_{it} + \beta_5 IPR_{it} + \beta_6 FDI_{it} \\
&\quad + \beta_7 INF_{it} + \mu_{it}, \\
\mu_{it} &= \alpha_i + \varepsilon_{it},
\end{aligned}
$$

where I_i is the innovation rate in country i, HK_i is the level of human capital stock, and HDC_i is the real import level of high technology goods from developed countries. $R\&D_i$ is the level of R&D expenditures in country i. GDP_i is the real gross domestic product scaled by population, IPR_i is the Ginarte and Park (1997) patent protection index for country i, and FDI_i measures inflows of foreign direct investment into coun-

[6]Lai (1998) and Glass and Saggi (2002) also develop models that challenge the idea that stronger IPR protection in developing countries (the South) would always encourage innovation.

try i [7]. Finally INF_i is a measure of the country's infrastructure[8]. All variables are measured in natural logs. In the fixed effects regressions, α_i represents an individual effect which is unknown.

3.2 GDP Growth Regression

GDP growth depends positively not only on the stock of physical capital, but also on the quality of that capital. The GDP growth regressions consider domestic innovation, as well as foreign innovation. Growth of per capita high technology imports from developed countries is used as a proxy for the effect of foreign technology on domestic growth. I also include FDI and IPRs in the growth regression in order to examine if those variables have a direct effect on growth [9].

I use average annual data for four separate subperiods, 1970-74, 1975-79, 1980-84, and 1984-1989. For each subperiod, I consider the growth of real per capita GDP (γ_{Y_i}, in ln differences) as a function of the growth in the per capita physical capital

[7] Note that this specification assumes that FDI is exogenous with respect to the innovation rate.

[8] As explained in section 4, I use electricity production as a measure of a country's level of infrastructure.

[9] A number of interesting studies examine the relationship between property rights in general and economic growth (Torstensson 1994, Svensson 1994, Sachs-Warner 1995), as well as the specific relationship between intellectual property rights and economic growth (Gould and Gruben 1996, Park and Ginarte 1997, Thompson and Rushing 1999). The results in these studies are mixed and use various measures of general property rights and IPRs.

stock (γ_{K_i}), the innovation rate (I_i), the growth of real per capita import levels of high technology goods (γ_{HDC_i}), and foreign direct investment inflows (FDI_i). I also consider an alternative specification in which the level of intellectual property protection (IPR_i) is included in place of the innovation rate (equation 3).

$$(2)\ \gamma_{Y_{it}} = \beta_0 + \beta_1\gamma_{K_{it}} + \beta_2 I_{it} + \beta_3\gamma_{HDC_{it}} + \beta_4 FDI_{it} + \mu_{it},$$

$$(3)\ \gamma_{Y_{it}} = \beta_0 + \beta_1\gamma_{K_{it}} + \beta_2 IPR_{it} + \beta_3\gamma_{HDC_{it}} + \beta_4 FDI_{it} + \mu_{it},$$

$\mu_{it} = \alpha_i + \varepsilon_{it}$.

As before, in the fixed effects regressions, α_i represents an individual effect which is unknown.

4 Data

Among the empirical studies that investigate the link between trade in physical goods and technological diffusion, very few have used data sets that include developing countries. In this paper, I have created a sample that consists of 19 developed and 28 developing countries. I have included all countries for which data was available. The list of countries used in the regressions is provided in Table 7.

Also, this paper focuses on high-technology imports as a channel for technological diffusion. High Technology Imports from Developed Countries (HDC) are defined as the real import level of high-technology goods from developed countries. This variable is created using data for imports of capital goods from developed nations from various issues of the Commodity Trade Statistics published by the United Nations. The commodity groups used in this measurement include Standard International Trade Classes 7, 86, and 89 (SITC, Rev.1)[10]. In order to express this variable in real terms, the data is deflated by the U.S. Producer Price Index (PPI) for capital equipment (IFS data -line 63bb- September 99 CD).

The proxy for innovation is defined as the number of U.S. patent applications by residents of a given country each year as reported by the U.S. Patent and Trademark Office. Because of the time gap between the application process and the issuing of a patent, the use of data on patent applications instead of granted patents provides a more timely account of innovative activity. As pointed by Stern, Porter and Furman (2000), patents are an imperfect measure for the total level of innovation in a given country[11]. For example, the propensity to apply for patent protection may reflect

[10] Class 7 includes machinery and transport equipment. Class 86 includes instruments (optical, medical and photographic), watches and clocks. And Class 89 includes "miscellaneous manufactured goods". This definition is similar to the one used in Connolly (1998).

[11] Griliches (1994) provides a discussion of the advantages and limitations of using patent data relative to other measures of innovation.

differences in countries' industrial composition as well as differences in countries' internal intellectual property institutions. They argue, however, that "patents are the most concrete and comparable measure of innovative output across countries and time" (p.18).

Data on FDI inflows comes from the World Development Indicators (1998). This variable is reported as net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. The data is reported in current U.S. dollars, so I use the U.S. CPI to deflate it. Note that this variable can assume negative values meaning that disinvestment has occurred. Therefore, FDI is the logarithm of the maximum of ln(FDI) and (1-D), where D is a dummy variable that equals one if FDI > 0 and zero, otherwise. This methodology implies that the logarithm of FDI is taken only if it is positive, otherwise the FDI variable is zero[12].

To control for varying levels of IPRs across countries, I use a time varying index of intellectual property rights protection developed by Ginarte and Park (1997) for 110 countries[13]. This index is based on five categories of patent laws: extent of coverage,

[12] There were a total of 16 observations for which dummies for negative FDI were included. See Battese (1997) for more details on this procedure.

[13] I would like to thank Prof. Walter Park for providing me with an eletronic version of this data.

membership in international patent agreements, provisions for loss of protection, enforcement mechanisms, and the duration of protection. The Park and Ginarte index has two main advantages over time-invariant indices of intellectual property rights [Rapp and Rozek (1990) and Mansfield (1994)]. First, it covers more countries and a larger time period than the other indices, since it follows these countries over five-year periods from 1960 to 1990. Second, the index considers broader categories of the patent system, consequently yielding greater variability in the measurement of IPRs across countries. Also, with fixed-effects estimators it is not always possible to recover estimates of time-invariant explanatory variables[14].

Data on R&D expenditures comes from the United Nations Statistical Yearbooks (various issues). The data is reported in current values and in local currency units; therefore, I have translated the data into constant U.S. dollars by using the CPI (for each country) and the official exchange rate, both reported by the World Bank Development Indicators (1998)[15].

[14] One of the drawbacks of this index is that it focuses on the legislation as presented in the books, but does not take into account its enforcement. Lesser (2001) tries to address this issue but he constructs an alternative measure of IPR protection for 1998 only.

[15] Evenson (1984) discusses some important caveats about using the R&D expenditures data reported in the UNESCO Statistical Yearbooks. For example, he argues that there is no ideal deflator for R&D spending in any single country or across countries. He therefore advises against drawing strong conclusions from cross-country comparisons. With that in mind, however, he acknowledges that this is the most comprehensive data set that is inclusive of developing countries.

Capital stock (KStock) data comes from Nehru and Dhareshwar (1998). They compile investment series from 1950 onward for as many countries as possible and aggregate these series according to a perpetual inventory method. Human capital stock (HKStock) data, defined as mean years of secondary education, also comes from Nehru and Dhareshwar (1998).

The proxy for infrastructure is electricity production (Elect). Data on electricity production (kwh) comes from the World Bank Development Indicators (1998). Electricity production is measured at the terminals of all alternator sets in a station. In addition to hydropower, coal, oil, gas, and nuclear power generation, it covers generation by geothermal, solar, wind, and tide and wave energy, as well as that from combustible renewables and waste. Production includes the output of electricity plants that are designed to produce electricity only as well as that of combined heat and power plants.

Finally, data on real GDP in constant dollars (expressed in 1987 international prices) comes from the World Bank Development Indicators (1998). To express this variable in per capita terms, I divide it by total population (also from the World Bank Development Indicators, 1998).

5 Empirical Results

5.1 Innovation Regressions

Tables 1 through 4 report the results for the innovation regression using OLS, fixed effects (FE) and time dummies. These regressions include up to 31 countries (18 developed and 13 developing) as reported in Table 7. The results in Table 1 (OLS regressions) show that the size of the market (real GDP_{pc}) has a positive impact on innovation. This variable exhibits positive and statistically significant coefficients in regressions (1) through (6). Following Stern, Porter and Furman (2000), we could also think about per capita GDP as a proxy for a country's individual stock of knowledge. Therefore, the higher the country's knowledge stock, the higher the innovation rate. High technology imports from developed countries (HDC) also have a positive effect on domestic innovation. This variable appears positive and statistically significant in all regressions in Table 1. As expected, human capital stock (HKStock) and R&D expenditures (R&Dexp) have a positive and statistically significant effect on domestic innovation in most OLS regressions[16]. The infrastructure measure, electricity production (Elect), is positive and significant in all regressions in which it is included. Domestic innovation also seems to respond to the level of IPR protection. This vari-

[16]Note that the regressions were also estimated using a per capita version of R&D expenditures, as well as without including data for the United States. The results are robust to these alternative specifications and are available upon request.

able exhibits positive coefficients in all regressions and is significant in regressions (1) and (2). Finally, FDI inflows are not siginificant in the OLS regressions[17]. This result is consistent with work by Connolly (1998), who also finds that foreign direct investment inflows do not contribute to domestic innovation, and work by Lichtenberg and van Pottelsberghe de la Potterie (1996), who find no relationship between FDI inflows and international R&D spillovers. Also Haddad and Harrison (1993) find no relationship between productivity growth of domestic firms and the presence of foreign firms.

Table 2 reports the results of FE estimation. They provide some corroboration for the importance of market size, IPR protection and infrastructure in affecting innovation. FDI inflows continue to exhibit no impact on the innovation rate and high technology imports from developed countries has positive coefficients but is not significant in any regression. R&D expenditures and the stock of human capital exhibit the wrong signs but appear significant only in regression (5), which includes electricity and no time dummies.

Tables 3 and 4 report the results for the OLS regressions when the sample is split between developed and developing countries. Market size and infrastructure continue to be important factors in explaining innovation in both sets of countries.

[17] The FDI variable was included separately in various regressions and it always appeared insignificant in the OLS regressions for the full sample of developed and developing countries.

High-technology imports from developed countries, human capital stock and R&D expenditures are relevant for both developed and developing countries. However, these variables seem to play a much bigger role in explaining innovation in developed countries and their effect is insignificant when a measure for infrastructure (elect) is introduced in the OLS regressions for developing countries only (Table 4).

The most interesting contrast between tables 3 and 4 is with respect to intellectual property protection. The results suggest that IPRs have a stronger impact on domestic innovation for developed countries. This variable is positive and statistically significant in all OLS regressions in Table 3 (developed countries); but negative and even significant in some regressions in Table 4 (developing countries). These results are in accordance with the results in Park and Ginarte (1997), who look at the effects of IPRs on physical and research capital investment for a cross-section sample of developed and developing countries. They find that IPRs explain only the physical and research capital investment behavior of the top 30 economies. IPRs are significant at only 24% significance level for the lesser developed countries' R&D. These results are also consistent with work by Stern, Porter and Furman (2000) who find that the extent of intellectual property protection is an important determinant of international patenting (patenting by foreign countries in the United States) in OECD countries[18].

[18] In fact, the results regarding developed countries only (Table 3) are consistent with Stern, Porter and Furman (2000) who investigate the determinants of international patenting (patenting by foreign countries in the United States) in 17 OECD countries. They find that international

The results for FDI inflows appear insignificant in the regressions for developing countries, but show negative and significant coefficients for developed countries.

Since data on R&D expenditures is limited for developing countries, I also estimated regressions without the R&D expenditues variable. I report these results in the appendix (Tables 1A through 4A). These regressions include up to 42 countries (18 developed and 24 developing) as reported on Table 7. Overall, the results continue to suggest that market size and infrastructure are the dominant factors in explaining domestic innovation, but human capital and high-technology imports also play a role. And they continue to show that IPRs have distinct effects on developed versus developing countries.

5.2 Growth Regressions

Tables 5 and 6 report the results for the growth regression. The results show that the growth in per capita physical capital stock (Kstock) has by far the greatest

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patenting depends on aggregate policy choices such as openness to international trade and the extent of intellectual property protection, R&D manpower and spending, and the share of research performed by the academic sector and the share funded by the private sector. They demonstrate that the production function for international patents depends on each individual country's knowledge stock (using either GDP per capita or the country-specific patent stock). Note that their measure of intellectual property protection is an average (1-10) Likert score variable from the IMD World Competitiveness Report.

effect on real per capita GDP growth. This variable has coefficients above 0.4 and is statistically significant in all regressions.

The second strongest impact comes from the growth of per capita high technology imports from developed countries (HDC), which can be interpreted as a proxy for foreign innovation. Domestic innovation appears significant in the FE regression for developed countries only (Table 6). These results suggest that foreign innovation is more important than domestic innovation in determining per capita GDP growth. These findings are consistent with the results in Eaton and Kortum (1996) and Connolly (1998). Eaton and Kortum (1996) suggest that, with the exception of the United States, the OECD countries derive almost all of their productivity from abroad.

Intellectual Property Rights (IPR) appear significant in the FE regression with all countries. This is consistent with Gould and Gruben (1996), who report a positive and significant effect of IPR protection on GDP growth using a measure of IPR protection based on that of Rapp and Rozek (1990).

Lastly, FDI inflows appear significant in the FE regression that includes developed countries only (Table 6). These results are consistent with the work of Borenzstein, De Gregorio and Lee (1995). They investigate the effects of FDI inflows on growth in a sample of 69 developing countries over the 1970-89 period and find that FDI stimulates economic growth but only for host economies that have reached a minimum threshold stock of human capital.

6 Conclusion

This paper examines the hypothesis that trade increases innovation and economic growth by facilitating access to foreign technology and it also investigates the importance of IPRs and FDI inflows in these processes. It complements the previous literature by focusing on high-technology trade and by considering a more representative sample of both developed and developing countries.

The results for the pooled sample suggest that market size, high technology imports from developed countries, the stock of human capital, the level of R&D expenditures, infrastructure, and the level of IPR protection are all important factors in explaining the rate of innovation. Additionally, a country's stock of physical capital is very relevant in explaining per capita GDP growth. And foreign technology (measured as the growth of per capita high technology imports) has a stronger impact on per capita GDP growth than domestic technology.

However, when the sample is split between developed and developing countries, the results suggest that the dynamics of innovation and growth differ across these two groups of countries. Market size and infrastructure are the dominant factors in explaining innovation in developing countries; while high technology imports, human capital, and R&D expenditures appear to have a stronger impact on developed countries.

The results regarding intellectual property protection are interesting. They suggest that IPRs have a stronger impact on domestic innovation for developed countries and might even negatively impact innovation in developing countries. These results may be indicative of the fact that most innovation in developing countries may actually be imitation or adaptive in nature. Therefore, providing stronger IPRs protects foreign firms at the expense of local firms. The policy implication here is not to discourage intellectual property protection in developing countries, but to generate incentives for its strengthening. Innovative activities and IPRs are complementary in nature; therefore, developed countries would benefit by supporting R&D activities in developing countries.

By contrasting empirical specifications for innovation and per capita GDP growth, the results in this paper suggest that traditional growth regressions might be unable to fully capture the impact of specific factors like IPR protection which might affect growth only indirectly. At a broader level, this paper highlights the importance of conducting studies that are inclusive of both developed and developing countries and suggests that pooling together developed and developing countries might lead to misleading conclusions, and consequently to inadequate policy recommendations.

References

Aghion, P., Howitt, P., 1992. A Model of Growth through Creative Destruction. Econometrica 60, 323–351.

Bardhan, P., 1995. The Contributions of Endogenous Growth Theory to the Analysis of Development Problems: An Assessment, in: Berhman, J., Sirinivasan, T.N. (Eds.), Handbook of Development Economics, Vol.3. North-Holland, Amsterdam.

Barro, R., Sala-i-Martin, X., 1997. Technological Diffusion, Convergence and Growth. Journal of Economic Growth 2, March.

Battese, G. E., 1997. A Note on the Estimation of Cobb-Douglas Production Functions When Some Explanatory Variables Have Zero Values. Journal of Agricultural Economics 48, 250–252.

Borensztein, E. , De Gregorio, J. , Lee, J., 1995. How Does Foreign Direct Investment Affect Economic Growth? NBER Working Paper 5057.

Branstetter, L. , Sakakibara, M., 1998. Japanese Research Consortia: A Microeconomic Analysis of Industrial Policy. The Journal of Industrial Economics 46, 207–233.

Chui, M., Levine, P., Pearlman, J., 2001. Winners and Losers in a North-

South model of growth, innovation and product cycles. Journal of Development Economics 65, 333–365.

Coe, D., Helpman, E., 1995. International R&D Spillovers. European Economic Review 39, 859–887.

Coe, D.T., Helpman, E., Hoffmaister, A.W., 1997. North-South R&D Spillovers. Economic Journal 107, 134–149.

Connolly, M. P., 1998. The Dual Nature of Trade: Measuring its Impact on Imitation and Growth. Staff Reports, Federal Reserve Bank of New York 44.

Eaton, J., Kortum, S., 1996. Trade in Ideas, Patenting and Productivity in the OECD. Journal of International Economics 40, 251–278.

Eaton, J., Kortum, S. 1997. Technology and Bilateral Trade. NBER Working Paper 6253.

Evenson, R., 1984. International Invention: Implications for Technology Market Analysis, in: Griliches, Z. (Ed.), R&D, Patents and Productivity. University of Chicago Press, Chicago, Chapter 5.

Ginarte, C., Park,W., 1998. Determinants of Patent Rights: A Cross-National Study. Research Policy 26, 183–201.

Glass, A. J., Saggi, K., 2002. Intellectual Property Rights and Foreign Direct Investment. Journal of International Economics 56, 387–410.

Gould, D. M., Gruben, W. C., 1996. The Role of Intellectual Property Rights in Economic Growth. Journal of Development Economics 48, 323–350.

Griliches, Z., 1984. R&D, Patents and Productivity. University of Chicago Press, Chicago.

Griliches, Z., 1994. Productivity, R&D and the Data Constraint. American Economic Review 84, 1–23.

Grossman, G., Helpman, E., 1991. Innovation and Growth in the Global Economy. MIT Press, Cambridge, Massachusetts.

Haddad, M., Harrison, A. 1996. Are There Positive Spillovers from Direct Foreign Investment?: Evidence from Panel Data for Morocco. Journal of Development Economics 42, 51–74.

Hall, B. H., Ziedonis, R. H., 2001. The Patent Paradox Revised: An Empirical Study of Patenting in the US Semiconductor Industry, 1979-95. Rand Journal of Economics 32, 101–128.

Helpman, E., 1993. Innovation, Imitation and Intellectual Property Rights. Econometrica 61, 1247-1280.

IMF, 1999. International Financial Statistics. CD-rom, September.

Keely, L. C., Quah, D., 1998. Technology in Growth. CEPR Discussion Paper 391.

Keller, W., 1997. Are International R&D Spillovers Trade-Related? Analyzing Spillovers Among Randomly Matched Trade Partners. NBER Working Paper 6065.

Keller, W., 1999. How Trade Patterns and Technology Flows Affect Productivity Growth. NBER Working Paper 6690.

Lai, E. L. C., 1998. International Intellectual Property Rights Protection and the Rate of Product Innovation. Journal of Development Economics 55, 133-153.

Lesser, W., 2001. The Effects of TRIPs-Mandated Intellectual Property Rights on Economic Activities in Developing Countries. Mimeo.

Lichtenberg, F., van Pottelsberghe de la Potterie, 1996. International R&D Spillovers: A Re-Examination. NBER Working Paper 5668.

Mansfield, E., 1994. Intellectual Property Protection, Foreign Direct Investment, and Technology Transfer. International Finance Discussion Paper 19.

Maskus, K., Penubarti, M., 1995. How trade related are intellectual property rights? Journal of International Economics 39.

Nehru, V., Dhareshwar, A., 1998. A New Database on Physical Capital Stock. World Bank Research Paper.

Park,W., Ginarte, C., 1997. Intellectual Property Rights and Economic Growth. Contemporary Economic Policy 15, 51–61.

Rapp, R., Rozek, R., 1990. Benefits and Costs of Intellectual Property Protection in Developing Countries. Journal of World Trade 24, 74–102.

Rivera-Batiz, L.A., Romer, P., 1991. Economic Integration and Endogenous Growth. Quarterly Journal of Economics 106, 531–555.

Romer, P.M., 1990. Endogenous Technological Change. Journal of Political Economy 98.

Sachs, J. D., Warner, A. M., 1995. Economic Reform and the Process of Global Integration. Brookings Papers on Economic Activity, 1–95.

Segerstrom, P.S., Anant, T.C.A., Dinopoulos, D. 1990. A Schumpeterian Model of Product Life Cycle. American Economic Review 80, 1077–1091.

Solow, R., 1956. A Contribution to the Theory of Economic Growth. Quarterly Journal of Economics 70, 65–94.

Stern, Scott, Porter, M. E., Furman, J., 2000. The Determinants of National Innovative Capacity. NBER Working Paper 7876.

Svensson, J., 1994. Investment, Property Rights and Political Instability: Theory and Evidence. Institute for International Economic Studies, University of Stockholm,Seminar Paper 574.

Swan, T. W., 1956. Economic Growth and Capital Accumulation. Economic Record 32, 334–361.

Taylor, M.S., 1994. TRIPs, Trade and Growth. International Economic Review, 361–382.

Thompson, M. A., Rushing, F. W., 1999. An Empirical Analysis of the Impact of Patent Protection on Economic Growth: An Extension. Journal of Economic Development 24.

Torstensson, J., 1994. Property Rights and Economic Growth: An Empirical Study. Kyklos 47, 231–247.

United Nations. Commodity Trade Statistics. Annual issues (1960-1990).

UNESCO. Statistical Yearbooks, various issues.

Wang, J., Xu, B., 1997. Trade, FDI and R&D Spillovers in the OECD. University of Florida Working Paper.

World Bank, 1998. World Development Indicators, CD.

World Bank, 1998.Knowledge for Development. World Development Report.

Tables

Table 1: Innovation Regression (All Countries)						
Dep.: **LnInnov**	OLS (1)	OLS+ (2)	OLS (3)	OLS+ (4)	OLS (5)	OLS+ (6)
$LnGDP_{pc}$	0.51994 (4.12)*	0.47533 (3.97)*	0.78237 (6.59)*	0.72816 (6.44)*	0.81731 (6.35)*	0.82607 (6.90)*
LnHDC	1.02295 (9.41)*	1.02614 (9.94)*	0.28694 (1.82)***	0.32868 (2.18)**	0.39269 (2.10)**	0.36038 (2.05)**
LnHK Stock	0.71268 (3.12)*	0.91443 (4.10)*	0.27993 (1.32)	0.49087 (2.37)**	0.10581 (0.42)	0.30335 (1.28)
LnIPR	0.63199 (2.09)**	0.51032 (1.78)***	0.31225 (1.16)	0.22747 (0.89)	0.28738 (1.02)	0.13779 (0.52)
LnR&Dexp	0.05365 (3.41)*	0.05554 (3.73)*	0.02606 (1.80)***	0.02918 (2.12)**	0.02166 (1.44)	0.02350 (1.67)***
LnElect			0.74573 (5.84)*	0.70238 (5.75)*	0.75900 (5.50)*	0.73392 (5.69)*
LnFDI					-0.08145 (-0.96)	-0.05134 (-0.65)
Cons	-24.0631 (-11.03)*	-24.0099 (-11.58)*	-27.1997 (-13.79)*	-26.9336 (-14.37)*	-28.4912 (-12.63)*	-28.0255 (-13.32)*
Obs	109	109	109	109	101	101
R-sq	0.8851	0.8976	0.9130	0.9224	0.9132	0.9251

+ Time dummies are included in regressions 2, 4 and 6.
A dummy variable for negative FDI is included in all regressions.
t-statistics are in parentheses.
* Significant at 0.01 level.
** Significant at 0.05 level.
*** Significant at 0.10 level.

Table 2: Innovation Regression (All Countries)

Dep.: **LnInnov**	FE (1)	FE+ (2)	FE (3)	FE+ (4)	FE (5)	FE+ (6)
$LnGDP_{pc}$	0.62314 (1.55)	0.49105 (1.17)	0.43547 (1.06)	0.36682 (0.87)	1.44566 (3.00)*	0.12237 (2.42)**
LnHDC	0.16292 (1.27)	0.21165 (1.51)	0.15125 (1.19)	0.22348 (1.61)	0.11505 (0.93)	0.16398 (1.20)
LnHK Stock	0.02403 (0.15)	0.13065 (0.46)	-0.28940 (-1.21)	-0.05793 (-0.19)	-0.42926 (-1.66)***	-0.30069 (-0.89)
LnIPR	0.59605 (1.56)	0.68018 (1.70)***	0.70936 (1.85)***	0.82640 (2.05)**	0.30759 (0.80)	0.42138 (1.03)
LnR&Dexp	-0.02999 (-1.39)	-0.02153 (-0.98)	-0.02935 (-1.38)	-0.02251 (-1.04)	-0.03661 (-1.84)***	-0.03025 (-1.48)
LnElect			0.33621 (1.72)***	0.36028 (1.72)***	0.10486 (0.52)	0.12553 (0.58)
LnFDI					-0.03158 (-0.79)	-0.03676 (-0.90)
Cons	-4.2257 (-1.58)	-4.4041 (-1.33)	-10.7346 (-2.32)**	-12.6317 (-2.18)**	-11.5539 (-2.51)**	-11.4036 (-2.04)**
Obs	109	109	109	109	101	101
R-sq	0.7245	0.7742	0.8570	0.8867	0.7053	0.7534

+ Time dummies are included in regressions 2, 4 and 6.
t-statistics are in parentheses.
* Significant at 0.01 level.
** Significant at 0.05 level.
*** Significant at 0.10 level.

Table 3: Innovation Regression (Developed Countries)						
Dep.: **LnInnov**	OLS (1)	OLS+ (2)	OLS (3)	OLS+ (4)	OLS (5)	OLS+ (6)
$LnGDP_{pc}$	0.68124 (2.01)**	0.45063 (1.69)***	0.76490 (2.77)*	0.54973 (2.44)**	0.38795 (1.12)	0.96545 (0.34)
LnHDC	0.99777 (7.51)*	0.96976 (9.32)*	0.25370 (1.51)	0.41631 (2.99)*	0.62189 (2.58)**	0.75249 (3.90)*
LnHK Stock	0.90920 (3.30)*	1.29655 (5.84)*	0.39905 (1.66)*	0.84515 (4.09)*	0.45071 (1.68)***	0.82524 (3.70)*
LnIPR	1.42054 (1.93)***	2.27806 (3.79)*	1.75999 (2.92)*	2.39796 (4.73)*	2.11529 (3.26)*	2.78383 (5.14)*
LnR&Dexp	0.23975 (5.56)*	0.22894 (6.70)*	0.16292 (4.34)*	0.17348 (5.65)*	0.15447 (4.02)*	0.15080 (4.91)*
LnElect			0.73656 (5.78)*	0.54897 (5.12)*	0.73147 (5.33)*	0.62602 (5.62)*
LnFDI					-0.20099 (-1.88)***	-0.27345 (-3.15)*
Cons	-28.8191 (-7.64)*	-27.5693 (-9.27)*	-29.8229 (-9.69)*	-28.3951 (-11.33)*	-31.0152 (-9.38)*	-28.403 (-10.58)*
Obs	70	70	70	70	62	62
R-sq	0.8583	0.9145	0.9060	0.9395	0.9110	0.9441

+ Time dummies are included in regressions 2, 4 and 6.
t-statistics are in parentheses.
* Significant at 0.01 level.
** Significant at 0.05 level.
*** Significant at 0.10 level.

Table 4: Innovation Regression (Developing Countries)						
Dep.: **LnInnov**	OLS (1)	OLS+ (2)	OLS (3)	OLS+ (4)	OLS (5)	OLS+ (6)
$LnGDP_{pc}$	0.51179 (2.77)*	0.64788 (3.33)*	0.61867 (3.83)*	0.86369 (5.50)*	0.66555 (3.38)*	0.97734 (5.22)*
LnHDC	0.65858 (4.56)*	0.66393 (4.63)*	-0.04106 (-0.18)	-0.25420 (-1.12)	-0.01378 (-0.05)	-0.19784 (-0.85)
LnHK Stock	0.67952 (1.88)***	1.04869 (2.58)**	0.28530 (0.87)	0.77527 (2.44)*	0.26896 (0.77)	0.77228 (2.38)**
LnIPR	0.11443 (0.35)	-0.10187 (-0.31)	-0.28212 (-0.95)	-0.71178 (-2.47)*	-0.32491 (-1.03)	-0.72017 (-2.49)*
LnR&Dexp	0.03298 (2.34)**	0.03439 (2.49)**	0.01313 (0.99)	0.01031 (0.87)	0.01284 (0.93)	0.00768 (0.65)
LnElect			0.67222 (3.59)*	0.84441 (4.64)*	0.69343 (3.54)*	0.83263 (4.52)*
LnFDI					-0.07000 (-0.59)	0.03568 (0.32)
Cons	-15.7071 (-5.02)*	-16.5637 (-5.35)*	-16.9987 (-6.28)*	-18.0374 (-7.49)*	-17.0652 (-5.40)*	-20.3713 (-7.22)*
Obs	39	39	39	39	39	39
R-sq	0.5735	0.5987	0.6865	0.7618	0.6695	0.7655

+ Time dummies are included in regressions 2, 4 and 6.
A dummy variables for negative FDI is included in all regressions.
t-statistics are in parentheses.
* Significant at 0.01 level.
** Significant at 0.05 level.
*** Significant at 0.10 level.

Table 5: Growth Regression						
Dep.:	All Countries		Developed		Developing	
Growth GDP_{pc}	OLS (1)	FE (2)	OLS (3)	FE (4)	Pooled (5)	FE (6)
$Kstock_{pc}$ Growth	0.48002 (8.92)*	0.47768 (5.49)*	0.50455 (6.38)*	0.55728 (5.14)*	0.44752 (5.93)*	0.44996 (3.47)*
HDC_{pc} Growth	0.05299 (5.59)*	0.05833 (5.64)*	0.05499 (5.62)*	0.05190 (4.33)*	0.05459 (3.93)*	0.05944 (3.90)*
LnIPR	0.00152 (0.58)	0.03116 (2.02)**	0.00267 (0.49)	0.01706 (0.98)	0.00249 (0.58)	0.03658 (1.49)
LnFDI	0.00079 (1.16)	-0.00049 (-0.26)	-0.00065 (-0.96)	0.00260 (1.10)	0.00214 (1.53)	-0.00091 (-0.32)
Cons	-0.01361 (-1.08)	-0.01351 (-0.35)	0.01385 (0.96)	-0.07148 (-1.59)	-0.03801 (-1.47)	-0.00179 (-0.03)
Obs	154	154	65	65	89	89
R-squared	0.5471	0.3286	0.5504	0.3594	0.5278	0.2516

A dummy variable for negative FDI is included in regressions 1, 2, 5 and 6.
t-statistics are in parentheses.
* Significant at 0.01 level.
** Significant at 0.05 level.
*** Significant at 0.10 level.

Table 6: Growth Regression						
Dep.:	All Countries		Developed		Developing	
Growth GDP_{pc}	OLS (1)	FE (2)	OLS (3)	FE (4)	OLS (5)	FE (6)
$Kstock_{pc}$ Growth	0.47219 (8.40)*	0.47774 (5.29)*	0.49886 (6.36)*	0.69471 (6.58)*	0.42963 (5.13)*	0.48182 (3.57)*
HDC_{pc} Growth	0.05426 (5.71)*	0.05773 (5.44)*	0.05475 (5.58)*	0.03902 (3.50)*	0.05572 (3.92)*	0.05836 (3.69)*
LnInnov	-0.00009 (-0.15)	0.00231 (0.55)	-0.00003 (-0.06)	0.01681 (3.25)*	-0.00120 (-0.64)	-0.00034 (-0.06)
LnFDI	0.00077 (0.79)	-0.00099 (-0.50)	-0.00053 (-0.69)	0.00368 (1.89)***	0.00242 (1.31)	-0.00251 (-0.85)
Cons	-0.01105 (-0.65)	0.01399 (0.35)	0.01503 (1.00)	-0.18650 (-3.45)*	-0.03921 (-1.24)	0.04891 (0.89)
Obs	146	146	65	65	81	81
R-squared	0.5515	0.5141	0.5487	0.0061	0.5294	0.4996

A dummy variable for negative FDI is included in regressions 1, 2, 5 and 6.
t-statistics are in parentheses.
* Significant at 0.01 level.
** Significant at 0.05 level.
*** Significant at 0.10 level.

<table>
<tr><th colspan="5">Table 7</th></tr>
<tr><th colspan="3">Innovation Regression</th><th colspan="2">Growth Regression</th></tr>
<tr><th>Developed Countries</th><th colspan="2">Developing Countries</th><th>Developed Countries</th><th>Developing Countries</th></tr>
<tr><td>Australia, Austria, Canada, Denmark, Finland, France, Greece, Ireland, Israel, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, United States</td><td><u>With R&Dexp</u>
Brazil, Chile, Costa Rica, Ecuador, El Salvador, Guatemala, India, Indonesia, Pakistan, Peru, Philippines, Thailand, Venezuela</td><td><u>Without R&Dexp</u>
Algeria,Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, India, Indonesia, Kenya, Malawi, Malaysia, Mexico, Pakistan, Paraguay, Peru, Philippines, Senegal, Thailand, Uruguay, Venezuela</td><td>Australia, Austria, Canada, Denmark, Finland, France, Greece, Ireland, Israel, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, United States</td><td>Algeria, Bolivia, Brazil, Cameroon, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Ghana, Guatemala, Honduras, India, Indonesia, Jamaica, Kenya, Malawi, Malaysia, Mexico, Pakistan, Paraguay, Peru, Philippines, Senegal, Sri Lanka, Thailand, Uruguay, Venezuela</td></tr>
</table>

Appendix

Table 1A: Innovation Regression (All Countries)- Without R&D Expenditures						
Dep.: **LnInnov**	OLS (1)	OLS+ (2)	OLS (3)	OLS+ (4)	OLS (5)	OLS+ (6)
$LnGDP_{pc}$	0.64932 (4.69)*	0.59080 (4.32)*	0.88853 (7.58)*	0.83455 (7.35)*	0.91824 (7.37)*	0.90418 (7.64)*
LnHDC	1.01123 (11.26)*	0.99137 (11.24)*	0.19074 (1.56)	0.16183 (1.37)	0.20727 (1.47)	0.15730 (1.16)
LnHK Stock	0.62937 (3.59)*	0.84273 (4.53)*	0.01648 (0.10)	0.26357 (1.49)	-0.05623 (-0.31)	0.20141 (1.09)
LnIPR	0.16931 (0.60)	0.11984 (0.43)	0.07163 (0.30)	-0.01615 (-0.07)	0.03423 (0.14)	-0.10420 (-0.44)
LnElect			0.86771 (8.38)*	0.87236 (8.68)*	0.87655 (8.02)*	0.89078 (8.50)*
LnFDI					-0.02222 (-0.28)	-0.02635 (-0.35)
Cons	-23.7244 (-13.41)*	-23.0579 (-13.19)*	-28.3420 (-18.13)*	-27.6883 (-18.24)*	-28.7016 (-17.32)*	-28.0066 (-17.61)*
Obs	153	153	152	152	144	144
R-sq	0.8496	0.8564	0.8970	0.9055	0.8954	0.9058

+ Time dummies are included in regressions 2, 4 and 6.
A dummy variable for negative FDI is included in all regressions.
t-statistics are in parentheses.
* Significant at 0.01 level.
** Significant at 0.05 level.
*** Significant at 0.10 level.

Table 2A:Innovation Regression (All Countries)- Without R&D Expenditures						
Dep.: **LnInnov**	FE (1)	FE+ (2)	FE (3)	FE+ (4)	FE (5)	FE+ (6)
$LnGDP_{pc}$	0.63370 (1.41)	0.66106 (1.49)	0.29593 (0.69)	0.37002 (0.88)	0.65099 (1.36)	0.74803 (1.59)
LnHDC	0.24804 (1.78)***	0.25189 (1.72)***	0.30284 (2.31)**	0.31631 (2.30)**	0.30875 (2.17)**	0.30544 (2.10)**
LnHK Stock	0.05034 (0.33)	0.30775 (1.15)	-0.44790 (-2.37)**	-0.04745 (-0.18)	-0.48858 (-2.35)**	-0.06142 (-0.22)
LnIPR	0.60100 (1.59)	0.8416 (2.16)**	0.62375 (1.76)***	0.91092 (2.50)**	0.43815 (1.15)	0.74117 (1.90)***
LnElect			0.46207 (3.97)*	0.47362 (4.01)*	0.40717 (3.31)*	0.41550 (3.33)*
LnFDI					-0.06025 (-1.34)	-0.04988 (-1.10)
Cons	-7.2937 (-2.68)*	-7.7566 (-2.59)**	-16.9687 (-4.80)*	-18.3844 (-4.77)*	-17.3404 (-4.67)*	-18.6777 (-4.61)*
Obs	153	153	152	152	144	144
R-sq	0.7815	0.7830	0.8574	0.8842	0.8684	0.8773

+ Time dummies are included in regressions 2, 4 and 6.
t-statistics are in parentheses.
* Significant at 0.01 level.
** Significant at 0.05 level.
*** Significant at 0.10 level.

Table 3A:Innovation Regression (Developed Countries)- Without R&D Expenditures						
Dep.: **LnInnov**	OLS (1)	OLS+ (2)	OLS (3)	OLS+ (4)	OLS (5)	OLS+ (6)
$LnGDP_{pc}$	0.80044 (2.02)**	0.60949 (1.80)***	0.84914 (2.81)*	0.69175 (2.59)**	0.44213 (1.19)	0.26635 (0.82)
LnHDC	1.11451 (7.12)*	1.08867 (8.15)*	0.10966 (0.59)	0.25848 (1.54)	0.46376 (1.74)***	0.58230 (2.53)**
LnHK Stock	0.37939 (1.25)	0.81740 (3.04)*	-0.06805 (-0.28)	0.33288 (1.48)	-0.13836 (-0.54)	0.25222 (1.07)
LnIPR	3.08528 (3.79)*	3.90574 (5.44)*	2.8695 (4.63)*	3.53966 (6.24)*	3.27290 (4.89)*	3.86370 (6.43)*
LnElect			0.94289 (7.05)*	0.78017 (6.37)*	0.97224 (6.85)*	0.85946 (6.86)*
LnFDI					-0.21751 (-1.86)***	-0.26529 (-2.59)**
Cons	-30.7315 (-6.99)*	-30.1650 (-7.99)*	-31.0682 (-9.28)*	-30.3678 (-10.23)*	-32.2860 (-8.95)*	-30.7985 (-9.79)*
Obs	72	72	72	72	64	64
R-sq	0.7968	0.8543	0.8823	0.9099	0.8880	0.9178

+ Time dummies are included in regressions 2, 4 and 6.
t-statistics are in parentheses.
* Significant at 0.01 level.
** Significant at 0.05 level.
*** Significant at 0.10 level.

Table 4A: Innovation Regression (Developing Countries)- Without R&D Expenditures						
Dep.: **LnInnov**	OLS (1)	OLS+ (2)	OLS (3)	OLS+ (4)	OLS (5)	OLS+ (6)
$LnGDP_{pc}$	0.28886 (1.62)	0.31141 (1.73)***	0.39473 (2.82)*	0.47144 (3.55)*	0.27282 (1.72)***	0.41335 (2.66)*
LnHDC	0.67634 (6.58)*	0.65559 (6.32)*	-0.09878 (-0.77)	-0.20527 (-1.64)	-0.20674 (-1.45)	-0.26787 (-1.96)***
LnHK Stock	0.48923 (2.56)**	0.64732 (2.93)*	-0.30903 (-1.58)	-0.04694 (-0.23)	-0.28502 (-1.46)	-0.04041 (-0.20)
LnIPR	-0.41114 (-1.49)	-0.48137 (-1.71)***	-0.33959 (-1.57)	-0.52295 (-2.51)**	-0.24301 (-1.10)	-0.46396 (-2.11)**
LnElect			0.84255 (7.64)*	0.92405 (8.56)*	0.81755 (7.39)*	0.90270 (8.20)*
LnFDI					0.15035 (1.68)***	0.10216 (1.19)
Cons	-14.1357 (-6.06)*	-13.8330 (-5.89)*	-18.4763 (-9.87)*	-18.8082 (-10.61)*	-17.6399 (-9.01)*	-18.5093 (-9.81)*
Obs	81	81	80	80	80	80
R-sq	0.4436	0.4437	0.6671	0.7084	0.6714	0.7438

+ Time dummies are included in regressions 2, 4 and 6.
A dummy variables for negative FDI is included in all regressions.
t-statistics are in parentheses.
* Significant at 0.01 level.
** Significant at 0.05 level.
*** Significant at 0.10 level.