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Please cite this paper as:

Cavazos Cepeda, R., D. Lippoldt and J. Senft (2010), "Policy Complements to the Strengthening of IPRS in Developing Countries", *OECD Trade Policy Papers*, No. 104, OECD Publishing, Paris.
http://dx.doi.org/10.1787/5km7fmwz85d4-en

OECD Trade Policy Papers No. 104

Policy Complements to the Strengthening of IPRS in Developing Countries

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Unclassified **TAD/TC/WP(2010)12/FINAL**

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development **14-Sep-2010**

English - Or. English

TRADE AND AGRICULTURE DIRECTORATE
TRADE COMMITTEE

TAD/TC/WP(2010)12/FINAL
Unclassified

Working Party of the Trade Committee

POLICY COMPLEMENTS TO THE STRENGTHENING OF IPRS IN DEVELOPING COUNTRIES

OECD Trade Policy Working Paper No. 104

By Ricardo H. Cavazos Cepeda, Douglas C. Lippoldt and Jonathan Senft

JT03288208

English - Or. English

ABSTRACT

The past two decades have witnessed an active period of global reform with respect to policies concerning Intellectual Property Rights (IPRs). This paper examines – from an empirical, economic perspective – policies that complement the generally strengthened framework for IPRs in developing countries. The analytical approach involves three complementary levels of analysis: macro, micro and country case studies. Across all three approaches, the results point to a tendency for IPR reform to deliver positive economic results. Reforms concerning patent protection have tended to deliver the most substantial results, but the results for copyright reform and trademark reform were also positive and significant. Overall, the policy complements that were found to be most important in facilitating positive results were those related to inputs for innovative and productive processes and to the ability to conduct business. These include policies that influence the macro-environment for firms as well as the availability of resources (*e.g.* related to education), the legal and institutional conditions and the fiscal incentives.

Keywords: intellectual property rights, innovation, patents, copyright, trademarks, policy reform, economic development.

ACKNOWLEDGEMENTS

This study was prepared by Ricardo H. Cavazos Cepeda, Douglas C. Lippoldt and Jonathan Senft. The paper has benefited from helpful comments from Sib Hayer, Michael Hennon, Benjamin Mitra-Kahn, Michael Plummer, Jayashree Watal, BIAC and delegates to the Working Party of the Trade Committee. The authors gratefully acknowledge the contribution of Walter G. Park, American University, who kindly made available some of the underlying data utilised in this study including key indices of IPR protection.

The Working Party of the OECD Trade Committee agreed to make this paper more widely available via declassification under its responsibility.

The paper is available on the OECD website: http://www.oecd.org/trade .

TABLE OF CONTENTS

Figures

Tables

Boxes

POLICY COMPLEMENTS TO THE STRENGTHENING OF IPRS IN DEVELOPING COUNTRIES

Executive Summary

The past two decades have witnessed an active period of global reform with respect to policies concerning Intellectual Property Rights (IPRs). This paper examines – from an empirical, economic perspective – policies that complement the generally strengthened framework for IPRs in developing countries. The paper builds on earlier work on technology transfer and IPRs conducted under the auspices of the Working Party of the Trade Committee.

A literature review in the paper provides illustrations highlighting the generally positive relationship of IPR reform to trade, foreign direct investment (FDI), technology transfer and innovation. However, it also underscores evidence of some variation in the experience of countries (*e.g.* in relation to level of development) and firms (*e.g.* in relation to size). The existence of policy complements appears to be one dimension that influences the effectiveness of IPR reform and the economic outcomes. At various points, the literature alludes to policies that complement improved protection of IPRs. Examples include policies that influence the environment for doing business, investment in research and development (R&D), development of human capital and entrepreneurial education (*e.g.* concerning the economic potential of intellectual property).

The analytical approach laid out in the present paper delivers three complementary levels of analysis: macro, micro and country case studies. The purpose of approaching research and policy questions from multiple levels is that each level may provide a distinct set of information, thereby leading to combined insights that could not be obtained from a single point of view. From the macro approach, we aim to obtain information about the importance of institutional variables through consideration of developments over time in a panel of countries. From the micro approach, we aim to obtain information about firm-level incentives and how these incentives eventually transform into tangible resources for the firm. Finally, in the case studies we focus on a particular country's economic environment and its idiosyncrasies, in order to illustrate how these may affect the knowledge production and transfer processes. The overall objective is to identify and understand the complementary factors operating in conjunction with the protection of IPRs to deliver positive economic outcomes.

The timeframe for the macro- and micro-level analyses is 1990 to 2008 (2007 for the macro level analysis). This timeframe covers a particularly dynamic period for reform of IPR protection, including the advent of the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights as well as a time of substantially increased adherence to agreements administered by the World Intellectual Property Organisation, among other developments. Thus, it provides an excellent opportunity to consider factors associated with change in the strength of IPR protection.

The results of the macro-level assessment provide a clear indication of the inter-relationships between indicators of economic performance and protection of three main types of intellectual property (patents, copyright and neighbouring rights and trademark rights). Moreover, the significance of the results across the system of equations points to a virtuous circle, whereby improvements in the IPR environment are associated with improved economic performance – in particular with respect to FDI – and, in turn, further improvements in the IPR environment. Important policy complements are identified in the course of this

assessment, notably with respect to variables that affect the ability of firms to conduct business. These complements can be grouped under four headings: those affecting the macro-environment, resources, legal and institutional, and fiscal conditions (*i.e.* taxation). The association of these complements with desired economic outcomes varied somewhat across the groups and by type of IPR.

The results of the micro-level assessment were positive in certain cases, but were less consistent than was the case for the macro-level assessment. Nonetheless, there was some evidence that firms do capitalise on the improved IPR protection taking place in conjunction with complementary factors (*e.g.* opportunities for industry-university collaboration). The strongest results were obtained in the case of trademarks, whereby in certain specifications concerning complementary policies, trademark protection had a statistically significant association in relation to the export turnover, sales and total assets of the firms in the sample. We also found a positive influence of patent right protection on export turnover (*e.g.* sale) under certain specifications with respect to complementary policies. Finally, for copyrights we found a significant association in relation to export turnover. We hypothesize that future analysis based on a more disaggregated approach may yield even stronger results.

The macro- and micro-level analyses were supplemented by case studies on China, Bangladesh and the Lao People's Democratic Republic (PDR). The China and Lao PDR studies proceeded using primarily qualitative assessments based on interviews with business executives and other experts. The study of Bangladesh employed a more quantitative analytical approach. Bangladesh and the Lao PDR, both least developed countries, were compared and contrasted.

The results of the China study indicate that rather than considering the IPR regime in isolation, innovative firms tend to take into account a combination of complementary factors including the IPR regime, other aspects of the legal system, and additional elements affecting the operation of their businesses (*e.g.* availability of human capital). The complex nature of China's intellectual property environment, which includes an important cultural dimension, has important policy implications. First, while the legal aspects of IP protection have been increasingly formalized and centralized, regional variation – in particular local weakness in enforcement – remains to be addressed. Second, achieving an effective IP regime will require reform extending beyond legal structures to include other complementary policies such as those needed to assure appropriate access to financing and talent. There are also risks of economic distortion or discrimination in the Government's strategic approach to innovation. Finally, redoubled education and awareness-building may be required to challenge social misperceptions with respect to the abuse of IPRs. In sum, if the uncertainties of the current IP environment persist, then the economy may fall short of its potential as some firms may withdraw from innovative activities or divert energy into alternative approaches for IP protection.

The case studies of Bangladesh and the Lao PDR highlight the need to consider the particular economic conditions in Least Developed Countries (LDCs) in the implementation of a strengthened IPR regime. In poor economies lacking key complements such as adequate stocks of human capital, there are challenges in reaping benefits from strengthened IPR protection. The local economy may lack the capacity to absorb optimal amounts of transferred technology or generate much domestic innovation. Here, key complements to enhanced IPR policies will include policies to promote education and training, as well as investment in basic infrastructure. In terms of strategy, it should be noted that establishment of an appropriate economic framework can help the government to leverage its efforts by mobilising private sector resources via market mechanisms. Economic opportunity can provide a strong incentive to invest. Though still at an early stage, there is already some positive evidence in this regard from Bangladesh, which has seen some improvement in technology transfer via private sector channels following the limited reforms to date. Qualitative evidence from the Lao PDR indicates that this process may also be getting underway there as well. As both countries move to integrate more fully into the global economy and

develop economically, they will need to take further steps toward compliance with the requirements of the rules-based multilateral trading system.

In conclusion, across all three analytical approaches the results point to a tendency for IPR reform to deliver positive economic results. Reforms concerning patent protection have tended to deliver the most substantial results, but the results for copyright reform and trademark reform were also positive and significant. Overall, the policy complements that were found to be most important in facilitating positive results were those related to inputs for innovative and productive processes and to the ability to conduct business. These include policies that influence the macro-environment for firms as well as the availability of resources (*e.g.* related to education), the legal and institutional conditions and the fiscal incentives.

The importance of specific complements varies depending on a country's level of development and other dimensions. However, a cross-cutting theme is the importance of human capital. The knowledge and skills that people are able to put into action constitute a factor that fuels innovation and business, enabling countries to develop and capitalise on intellectual property. For all countries, investment in people appears to be one important factor in reaping the optimal benefits of IPR reform.

POLICY COMPLEMENTS TO THE STRENGTHENING OF IPRS IN DEVELOPING COUNTRIES

Introduction

1. The past two decades have witnessed an active period of global reform with respect to policies concerning Intellectual Property Rights (IPRs). This paper examines – from an empirical, economic perspective – policies that complement the generally strengthened framework for IPRs in developing countries. The paper builds on earlier work on technology transfer and IPRs (Park and Lippoldt, 2008) conducted under the auspices of the Working Party of the Trade Committee (WPTC).

2. A strengthened IPR framework[1] can create spillovers, incentivise innovation, increase trade and trade-related investment, and boost intellectual property-intensive economic activity. Trade and foreign direct investment (FDI) are fundamental factors in this process as they are two of the main market-mediated channels by which ideas and intangible assets are disseminated internationally (Maskus, 2004). They facilitate the gradual accumulation of knowledge capital in firms, sectors and economies.[2] Enhancement of IPR systems and complementary policies may help to improve competitiveness – at both the macro and the micro economic levels – via improved access to, and accumulation of, knowledge capital.

3. The approach laid out in this paper delivers three complementary levels of analysis: macro, micro and country case studies. The purpose of approaching research and policy questions from multiple levels is that each level may provide a distinct set of information, thereby leading to combined insights that could not be obtained from a single point of view. From the macro approach, we aim to obtain information about the importance of institutional variables through consideration of developments over time in a panel of countries. From the micro approach, we aim to obtain information about firm-level incentives and how these incentives eventually transform into tangible resources for the firm. Finally, in the case studies we focus on a particular country's economic environment and its idiosyncrasies, in order to illustrate how these may affect the knowledge production and transfer processes. The three analytical approaches in the context of this project are discussed in more detail in the following sections of this paper. The overall objective is to identify and understand the complementary factors operating in conjunction with protection of IPRs to deliver positive economic outcomes.

4. The paper is organised as follows. The main body of the paper begins with a review of the recent literature and key citations from earlier work. This is followed by a presentation of the basic framework for the model. The empirical results of the macro, micro and case study exercises are presented in the next three sections. This is followed by a conclusion that highlights the main findings. Two appendices present the tables and charts and the underlying technical considerations, respectively. A separate annex document presents a text with a detailed narrative discussion of the China case study.

Literature Review

5. The last twenty years have seen sweeping reforms in the legal regime governing intellectual property in many developing countries. The establishment of the World Trade Organisation (WTO) in 1995 was of particular importance from a trade perspective because it resulted in the inclusion of IPR issues within the

1 Expressions such as "strengthened protection of IPRs" or "IPR strength" are referenced and discussed at length in previous literature (*e.g.* see Maskus, 2000 and 2008), and in the next section of this paper.

2 For a detailed explanation about knowledge capital, see Romer (1986) and Grossman and Helpman (1990a, 1990b).

ambit of the rules-based multilateral trade system. The entry into force of the WTO Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) that year established minimum standards for IPR protection, which now cover the 153 WTO member countries, though subject to some special and differential treatment for certain groups of developing countries. Moreover, many countries have implemented bilateral and regional trade agreements securing additional IPR provisions that go beyond those found in the TRIPS Agreement (Fink and Reichenmiller, 2005). As the globalization process moves forward, reforming countries have also enacted rafts of other modernizing legislation in parallel to IPR reform, for example, with respect to education and promotion of human capital accumulation. The interaction and coherence of these policies must be taken into account, if policymakers are to optimise the outcomes.

6. This literature review is focused on research published in the interval since the previous paper in this line of work for the WPTC (*i.e.* Park and Lippoldt, 2008) and on illustrative examples from earlier work. In order to orient the reader, however, it begins with a discussion of what is meant by "strength" of IPR protection. For the purposes of the present paper, the qualification of the stringency of IPR protection in various countries as being "strong" or "weak" is made using scores from a set of indices developed by Walter Park *et al.* (1997 and 2008),[3] with separate indices covering patent rights, copyright and neighbouring rights, and trademark rights. Each of these indices reflects structured objective assessments of conditions based on laws on the books. The Patent Rights Index (also called the Ginarte-Park Index), in particular, is regularly cited in scholarly works and other publications concerning IPRs.[4]

7. There is now a substantial and growing body of research that considers the economic effects of strengthened protection of IPRs.[5] Economists recognize several mechanisms through which protection of IPRs can stimulate economic development and growth (Maskus, 2000) including via their incentive effects for innovation, investment and technology transfer. Thus, reform of IPR protection is often cited as one part of a general strategy for promoting economic development, in combination with other reforms (Park and Lippoldt, 2005).

8. Portions of the economic literature on IPR reform express some concerns in a development context, in particular with respect to access to technology, the ability for firms to "learn by doing", and costs of doing business. For example, some observers worry that either through competition or strategic behaviour by firms, "patent thickets" may arise blocking the ability of others to exploit new technologies or limiting innovation in related areas (*e.g.* Reichman, *et al*., 2005; Encaoua *et al*., 2003). Moreover, the limited availability of key complements, such as certain types of physical capital or technical expertise, is seen as potentially undermining the ability of some developing countries to take advantage of the opportunities provided by enhanced IPR protection. Thus, while patent reform is associated with increases in research and development (R&D) when adopted in the relatively advanced countries (Kyle and McGahan, 2009),

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3 For details see, Park (2008) and the following papers developed via a process supervised by the WPTC: Park and Lippoldt (2005) and Park and Lippoldt (2008). A related index provides a subjective assessment of enforcement effectiveness (Park and Lippoldt, 2005).

4 For examples of such citation of the Patent Rights Index, see Maskus (2008) or Lai, E. (2008), "Intellectual Property Protection in a Globalizing Era", *Economic Letter—Insights from the Federal Reserve Bank of Dallas*, Vol. 3, No. 3, available here (as of 2 May 2010): http://www.dallasfed.org/research/eclett/2008/el0803.html.
It should be noted that the Patent Rights Index co-exists with other tools to measure IPR protection including those developed by Mansfield (1994), Seyoum (1996), Ostergard (2000), Lesser (2002) and Hamdan-Livramento, 2009.

5 Park and Lippoldt (2008) include a succinct review of the recent literature in their study of technology transfer, highlighting some of the debates and critiques of IPR strengthening. More recently, Hassan *et al* (2010) present an extensive review of the literature covering on intellectual property and developing countries.

this is not always the case in less advanced countries. For example, the introduction of pharmaceutical patents in less developed countries has sometimes failed to elicit a local innovation similar response (Correa, 2005). Particularly for diseases that primarily affect the poorest countries, Kyle and McGahan suggest that alternative mechanisms for inducing R&D may be more appropriate than patents.[6]

9. Ilias and Fergusson (2009) point out in a report for the US Congressional Research Service that an adequate system of IPR protection can benefit both developed and developing countries; it can provide a financial incentive to innovate and to diffuse the associated innovation. However, this is not unconditional. Authorities in some countries may find specific patent provisions as burdensome. The authors note that, "While the United States and other developed countries advocate for [sic] strong patent protections in order to promote innovation, there is concern that such stringent protections may delay developing countries' access to generic drugs and increase prices." Here, complementary policies can play a role in combating such a possibility, for example by promoting competition and market openness.

10. As for factors that drive IPR reform, Kanwar and Evenson (2009) consider the possibility that countries with more technological development will have stronger IPR regimes. However, controlling for other factors, they find that there is at best weak evidence supporting such a claim. While it may be true that some developing nations offer weaker protection, these researchers conclude this may be primarily due to a lack of human or financial capital that limits the ability to add protection. Noting that previous studies tended to assume determination of the strength of IPR protection as exogenous, Eicher and Garcia-Penalosa (2007) developed an analysis that endogenizes the strength of rights to show how private incentives to protect IPRs may affect economic development. Their model explains endogenous differences in IPR protection on a country basis and compares IPR protection to private investment incentives. This comparison is relevant since protection of IPRs helps to reassure stakeholders that they will be able to appropriate economic benefits of their investment in innovative activity, which can be of high risk. In other words, those with a stake in intellectual property protection are found to drive the process of IPR reform.

Trade and IPR Reform

11. Strengthening of IPR protection has been shown to correlate with increased trade, though the literature is laced with nuance regarding specific conditions, variation and causality. Fink and Primo Braga (1999) set the tone early: they found that IPR protection is positively associated with international trade flows, in particular manufactured nonfuel imports (though these results did not hold for certain trade flows of high technology products). Using expanded data sets, a number of studies from the subsequent literature have also found a positive association of IPR protection, including with respect to trade flows of high technology products. For example, researchers examining Chinese trade patterns estimate that IPR stimulates China's imports, particularly for knowledge-intensive products (Awokuse and Yin, 2010).

12. Ivus (2008) argues that the TRIPS Agreement appears to have contributed to a significant increase in exports by developed countries' intellectual property (IP) intensive industries. These industries include pharmaceuticals, information and communication technologies and chemicals. Ivus maintains that the increase in IPR protection following the implementation of the TRIPS Agreement added about USD 50 billion (1994 USD) to the annual value of developed countries' exports in IP-intensive industries and that the increase in the value of these exports was driven primarily by quantity rather than price developments. Another study focusing on firm-level analysis highlights the inter-relationship of IPR reform in developed and developing countries (Liao and Wong, 2009). The study concludes that while developing countries

6 Ryan (2010) provides a counterpoint to this argument based on a case study of bio-medical innovation and patent reform in the State of Sao Paulo, Brazil. The author finds that patents provided incentives for innovation investments and facilitated the functioning of technology markets.

may entice technology transfer from the North by providing IPR protection for incoming products, there is a need for redoubled R&D efforts in developed countries to spur needed innovation. At the same time, developing countries also have a need to adopt policies that encourage R&D within their own borders as a complement to incoming technology, as part of an overall development strategy.

The Relationship of IPR Reform to FDI

13. The economic literature highlights a clear tendency for the strengthening of IPR protection in recent decades to be associated with increased inflows of FDI. An early paper in this regard was authored by Edwin Mansfield (1994), which sought to define how industry leaders considered IPR protection in investment decisions concerning developing countries and found a positive relationship. More recent studies on specific sectors or industries find that stronger IPRs in developing countries can be associated with increased technology-intensive FDI (Park and Lippoldt, 2008). While some countries with weak IPRs may nonetheless experience substantial inflows of FDI (*e.g.* by firms seeking to access a particular resource or sell into a large market for their product), it is clear that the weak IPRs tend to distort the nature of the FDI or limit the flows to less than would otherwise be the case. For example, the FDI may be for the purpose of establishing sales and distribution outlets rather than high-value production and research and development (R&D) facilities.

14. In another example, Branstetter *et al.* (2006) show that strengthened IPR protection not only improves the investment climate in the implementing countries, but also leads to increased FDI in the country producing the original innovation. They conclude that IPR reform in the "global South" may be associated with FDI increases in the "global North." As northern firms shift their production to southern affiliates, this FDI accelerates southern industrial development creating a cyclical feedback mechanism that also benefits the North. The study by Awokuse and Yin (2010) provides a concrete example concerning the relationship of IPR protection in China to FDI inflows. They conclude that, despite some shortcomings in implementation of IPR protection, IPR reforms in China have had a positive and significant effect on inward FDI. A further example of a positive association of IPR protection to FDI inflows may be found in the experience of Jordan, which saw upturns in FDI inflows following IPR and other reforms in the 1990s (Box 1).

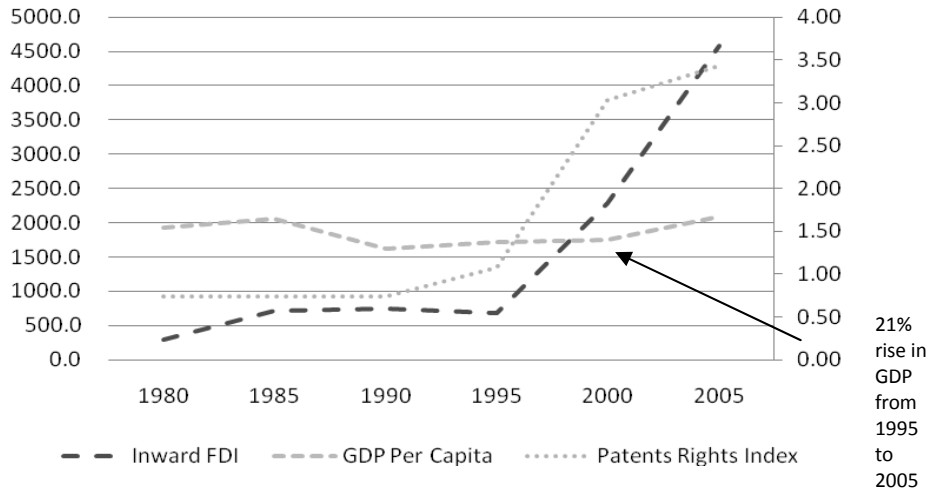
Box 1. 1995-2000: Jordan IPR Reforms Correlate with Gains in FDI and GDP

This box provides a brief overview of the illustrative case of Jordan. Jordan entered the World Trade Organization in 2000, which was an important milestone in a period of IPR reform that began in the 1990s and covered a broad range of IPR issues including with respect to copyrights, patents and trademarks (Nawafleh, 2010). The Patent Rights Index, for example, reflects the increased level of protection established in the years leading up to Jordan's accession to the WTO and adherence to TRIPS Agreement in 2000. Jordan subsequently completed a free trade agreement (FTA) with the United States in 2001, an agreement which included additional IPR commitments. In particular, this FTA required that Jordan ratify several treaties and implement subsequent laws, considered as strengthening IPR protection beyond levels required under the TRIPS Agreement. In 2001, Jordan ratified the WIPO Copyright Treaty, which entered into effect in 2004, and the WIPO Phonograms and Performers Treaty, which came into effect in May 2004. Jordan also signed the Patent Cooperation Treaty but had not yet ratified it as of February 2010.

The implementation of IPR reforms (including patent reform) correlated with positive economic developments. GDP rose from about USD 1.7 billion in 1995 to just under USD 2.1 billion in 2005, with the strongest gains between 2000 and 2005. The gain in GDP represents a *21%* rise during the years Jordan's IPR strength (Box Chart 1). Inward FDI also made strong gains (Adnan Al-Nuemat, 2009). While this positive association does not necessarily represent a causal relationship nor does it provide information on the importance of IPRs relative to other factors, it does nonetheless provide an indication that the stronger IPR protection can be associated with positive economic developments. (It is also worth noting the period before 1995, when FDI and IPR remained relatively flat while GDP dropped from USD 1.9 billion in 1980 to USD 1.7 billion in 1995 -- a fall of roughly 12%.)

Jordan's IPR and FDI rises also correlate (albeit roughly) with a decreasing dependence on foreign aid. According to OECD's Creditor Reporting System database, which records official donor activity, Jordan became less reliant on such aid in the late eighties and early nineties (excluding the Gulf War time frame) roughly five years before FDI and IPR reforms picked up.

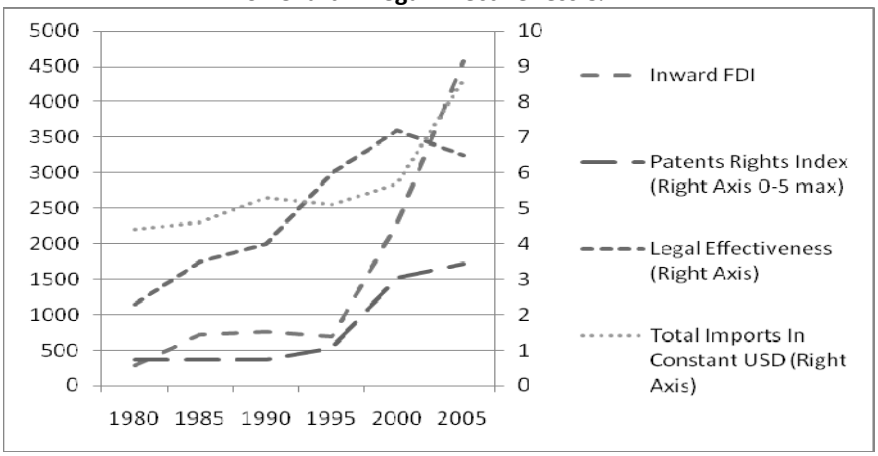
Box Chart 1. FDI, GDP & Patent Rights



(Note: GDP in real 2000 USD thousands and inward stock of FDI in real 2000 USD millions are shown on the left axis; the Patent Rights Index score on the right axis. The Patent Rights Index scores can range from 0 to 5.)

Legal Effectiveness also rose steadily between 1980 and 2005, but saw the sharpest gains between 1990 and 2005[7] (Box Chart 2). Legal Effectiveness is a composite score of judicial independence, impartial courts, security of property rights (tangible and intellectual), and integrity of the legal system. Total imports also rose along the same pattern. Once again, although this association does not demonstrate causality, it does provide an indication of a potential relationship among these factors. Particularly in the case of legal effectiveness, this may signal an important complementary policy development to IPR strengthening. In other words, IPR reform may function best in an environment whereby the overall legal system is functioning well.

Box Chart 2. Legal Effectiveness & FDI



Data Sources:
Patent Rights Index: Ginarte and Park (1997) and Park and Wagh (2002). http://www.oecdilibrary.org.
Index of Legal Effectiveness: Economic Freedom Network (EFN), 2006 Dataset: http://www.freetheworld.com/release.html.
Real GDP per capita (in real 2000 U.S. dollars) and Total Imports (Constant USD Billions): World Bank, World Development Indicators (WDI) 2007, CD-Rom.
Inward FDI Stock: United Nations Conference on Trade and Development (UNCTAD) Foreign Direct Investment Database (FDI-online). http://stats.unctad.org/fdi.

7 Index of Legal Effectiveness. Source: Economic Freedom Network (EFN), 2006 Dataset: http://www.freetheworld.com/release.html.

The Relationship of IPR Reform to Technology Transfer

15. Article 7 of the TRIPS Agreement provides that "the protection and enforcement of intellectual property rights should contribute to the transfer and dissemination of technology." Indeed, IPR strengthening in countries – particularly with respect to patents – is associated with increased technology transfer via trade and investment (Lippoldt, 2008). IPR reform is also associated with increased innovative activity as measured by domestic patent filings, albeit with some variation across countries and sectors.[8] Additional nuance can be found in the growing body of literature on this issue. Maskus (2004) notes that without protection from abuse of their newly developed technologies, firms may be less willing to reveal technical information associated with these innovations. The protection of patents and trade secrets provides necessary legal assurances for firms wishing to reveal proprietary characteristics of technologies to subsidiaries and licensees via contracts.

16. With respect to the literature on domestic innovation, Branstetter *et al*. (2006) find that royalty payments made by affiliates to parent firms for the use of intangible assets generally tend to increase as patent regimes are strengthened, in part due to technology transfer. They also find that IPR reform is associated with increased R&D spending by affiliates, a development that usually complements increased technology transfer and technology imports from the parent.

IPR Reform, Innovation and R&D

17. The provision of adequate protection for IPRs can help to stimulate local innovation, in some cases building on the transfer of technologies that provide inputs and spillovers (Park and Lippoldt, 2008).[9] In other words, local innovators are introduced to technologies first through the technology transfer that takes place in an environment where protection of IPRs is assured; then, they may build upon those ideas to create an evolved product or develop alternate approaches. Stronger IPR protection may also increase labour productivity and raise the return on innovation (Eicher and Garcia-Penalosa, 2007). For example, reform of protection may permit innovators and other rights holders to appropriate a bigger portion of the economic benefits from their innovations, which then provides incentives for greater research efforts. In another example of a patent policy reform, governments are taking action to stimulate innovation related to global challenges such as climate change by facilitating expedited access to patent protection for relevant innovations (Box 2).

18. While goods and services are the focus of much of the literature and recognized for their intrinsic utility, some economists are also looking into the dissemination of ideas (Romer, 2010). Ideas can be borne from the introduction of a new item or method, a phenomenon that economists admit can be difficult to quantify. But these ideas also promote economic development, including institutional reform and process modernization. For example, Romer points to the establishment of a common vocabulary for flight controllers and pilots as being one such idea that has clear economic benefits. Congestion pricing for high-

8 Patent filings are an incomplete indicator of R&D productivity. In some cases, for example, innovators may choose not to patent but rather to protect their innovations via trade secrecy or other means.

9 The strengthening of IPR protection in developing countries is sometimes criticised as raising the cost of technology acquisition, imitation and learning-by-doing (e.g., Correa, 2005). However, there are trade-offs; an environment with weak IPRs is not without costs. For example, such an environment weakens incentives for innovation, such that there is a cost to society at large. Where IPR protection is inadequate, local partners for imports, licensing and FDI may forego support from their foreign partners (e.g., due to the foreign partners' reluctance to transfer proprietary know how and technical support). There is also a potential loss of export markets whereby infringing exports from a producer in a country with weak IPR protection may be rejected by the market or subject to sanction. In addition, there is the basic cost of imitation (depending on the product this could be as high as 2/3 of the original producer's costs, though probably much less for some items such as intangible digital products).

traffic zones can be another. Such concepts are more abstract than tangible goods or services, but these and other ideas are sometimes embodied in innovations protected by IPR and included in the flow of technology transfer. Thus, they can have a role in innovation as it relates to economic development.

19. While such considerations are important at the national level, they also play a role in day-to-day business decisions at the firm level. Researchers recently found that stronger patent rights have been associated with faster company growth in IP-intensive industries like pharmaceuticals (Hu and Png, 2009). During the early nineties a one-standard-deviation increase in patent rights was associated with an increase in firm growth of 0.69% (an advantage amounting to nearly 1/5 of the average industry growth rate of 3.7%). The relationship of strengthened patent protection to business innovation incentives may be particularly strong when a patent corresponds to a single product and knowledge is not particularly cumulative (Hall, 2007). This is because patents amount to rights to exclude others temporarily from using an invention, thereby permitting innovators to earn rents or profits that are higher than those they would earn if there were immediate free entry into imitation of their invention.

20. On the other hand, some research suggests that not all firms are equally able to capitalise on the opportunities available as a consequence of IP reform. Small firms in developing countries may face a particular challenge in adapting to an environment of strengthened IPR protection. They are focused on day-to-day business demands, such as production and marketing. They tend to have relatively little initial knowledge of IPR issues, which are viewed as arcane and complex, and less ability to free resources to explore the possibilities afforded under the strengthened IP regimes. MacDonald and Turpin (2007) note that for smaller companies in developing South-East Asian countries, lawful imitation and copying can be seen as a more successful channel for evolving their technologies than licensing. Such firms may lack resources for in-house R&D and may find it too risky to outsource such R&D as that could entail leaks of company trade secrets. Also, small firms may be unable to mobilise resources to pursue and defend patents. Consequently, the analysis highlights a need for more user-friendly information about IPR protection that is tailored to the situation of small firms. This could be bundled with complementary policies such as business extension services in support of small business development.

21. Yang and Kuo (2008) note that stronger IPR protection can improve the export performance of firms benefitting from technology transfer. Their analysis indicates that by reducing a “Southern” firm's cost related to inward technology transfer, patent reforms could expand export opportunities. This suggests governments may have a deeper interest in facilitating such technology transfer, while pursuing complementary policies to reduce the cost of doing business.

Literature Review: Summing Up

22. The foregoing literature review has provided illustrations from the literature highlighting the generally positive relationship of IPR reform to trade, FDI, technology transfer and innovation. However, it has also revealed evidence of some variation in the experience of countries (*e.g.* in relation to level of development) and firms (*e.g.* in relation to size). The existence of policy complements appears to be one dimension that seems to influence the effectiveness of IPR reform and the economic outcomes. At various points, the literature alludes to policies that complement improved protection of IPRs. Examples include policies that influence the environment for doing business, investment in R&D, development of human capital and entrepreneurial education (*e.g.* with respect to the economic potential of IP).

Box 2. US, UK and Australia Implement Fast Track Policies for Green Patents

Innovative IPR policies are being implemented in at least three OECD countries' patent offices as part of the efforts to combat climate change. Australia, the United Kingdom and the United States have put in place procedures to accelerate the patent examination period to bring inventions related to climate change to the market faster than would otherwise be the case. Such innovations, for example, may help to reduce fossil fuel consumption by increasing energy supply from sun and wind power. By expediting the handling of the corresponding patent applications, these policies are intended to increase the incentives for action.

Generally, these programmes require inventors to show that their inventions enhance the quality of the environment by contributing to the restoration or maintenance of basic natural elements. For qualifying applications, the patent offices then make available fast track procedures. Under the US program, for example, applications pertaining to environmental quality, energy conservation, development of renewable energy, or greenhouse gas emission reduction will be advanced in the queue for examination. In the US, claims must be directed to a single invention that materially enhances the quality of the environment, or that materially contributes to (i) the discovery or development of renewable energy resources; (ii) the more efficient utilization and conservation of energy resources; or (iii) greenhouse gas emission reduction.[10] Applicants will also be considered if the inventions contribute to the development of renewable energy and the more-efficient utilization of energy resources. The USPTO claims the programme is expected to shorten the overall pendency time by as much as twelve months. Australia predicts its process could reduce the waiting time for applications to between four and eight weeks.[11] The UK office reports it could take nine months to get a patent granted under its scheme, compared with the current average time of two to three years.[12]

Although these fast-track procedures are operating in developed countries, to the extent that they succeed they may also have significant impacts on poor developing countries. This is because such countries may be the most harmed by climate change, according to experts at the World Bank and the OECD. Many in such countries live in physically exposed locations and economically precarious conditions, and their financial and institutional capacity to adapt is limited.[13]

Some observers have nonetheless expressed concerns about potential bias or distortions that could be caused by these measures. That is, the procedures place the government offices in the position of choosing which patents are eligible for a fast track and thus if an application is misjudged or submitted to the wrong queue, there may be a risk of giving some applicants an undue edge over competitors in terms of timeliness to market.[14] On the other hand, the patent offices are taking care to ensure that patent standards are maintained. The USPTO, for example, will not grant special lenience or an easier examination for patents under its Green Technology program, rather it will simply advance the place of these applications in the queue for consideration.

Presentation of the Model

23. The analysis for the present paper was based on a stylized model of the interaction of IPR protection with other complementary policy levers and other factors seen in relation to the economic indicators of particular interest. Such an approach can help to specify the relationships to be explored. The resulting system of equations can then be estimated econometrically.

24. Drawing on findings from the previous phase of the IPR research under the auspices of the WPTC and references from the literature, the Secretariat team developed a model with four equations. It includes three equations that consider three dependent variables of particular economic interest (FDI, R&D and knowledge creation) in relation to IPRs and other complementary factors. A fourth equation is included in

10 Federal Register / Vol. 74, No. 234 / Tuesday, December 8, 2009 / Notices

11 http://www.ipaustralia.gov.au/pdfs/news/MR_150909_fast_track_green_patents.pdf

12 http://www.ipo.gov.uk/press-release-20090512.htm

13 World Development Report 2010, World Bank; http://siteresources.worldbank.org/INTWDR2010/Resources/5287678-1226014527953/WDR10-Full-Text.pdf

14 Helpful legal analysis was provided by Benjamin S. Fernandez, attorney, Faegre & Benson (Denver).

order to highlight the relationship of IPR strength to various potential determinants. The model aims to consider various feedback effects that may exist. The system of equations is as follows:

FDI = f(IPR, GDP measures, macro-environment variables)

R&D = f(resources (human and physical capital), IPR, legal environment)

KC = f(FDI, R&D, IPR, legal environment)

IPR = f(FDI, R&D, WTO legal environment, other international institutional factors, domestic factors such as competition policy)

Whereby:

- **FDI** represents inflows of foreign direct investment;
- **IPR** represents a measure for intellectual property rights protection (in the context of the present analysis this refers especially to patent protection, but reference is also made to copyright and trademark protection);
- **GDP measures** represent one or more measures of income (*e.g.* GDP per capita);
- **Macro-environment variables** represent policy variables that have to do with institutions, the effectiveness of government, taxes, and how easy it is to do business in the country;
- **R&D** represents the investment in research and development;
- **WTO** represents one or more variables stating whether the country is a member of the World Trade Organization and the de facto obligation to assure availability of protection for intellectual property;
- **Legal environment** represents country regulations related to enforcement of the law (perceptions of corruption);
- **Resources (human and physical capital)** represent the inputs of production for both labour and capital;
- **KC** represents a measure for the accumulation of assets related to the creation of knowledge.

25. A system of equations is employed due to the endogenous nature of several of the explanatory variables, a situation which necessitates further consideration of the underlying determinants. In addition, examination of feedback mechanisms requires provision in the model for pathways for feedback relationships and various interrelated adjustments. In particular, the variables for FDI, IPR, R&D and KC all adjust internally within the system of equations. Notably, the fact that R&D and KC are also dependent variables reflects the possibility of a feedback mechanism that policies complementary to IPR protection may have in relation to these variables.

26. Measurement error was an important consideration in operationalising this framework for econometric analyses. The intangible nature of some of the variables meant there was a particular risk of such error as compared to tangible products. For example, knowledge creation and knowledge capital were difficult to measure. Some of the data sources, discussed below, do not directly provide information on such phenomena. The use of a system of equations is the recommended course of action by econometricians because it helps in minimizing measurement error.

27. As a concrete illustration of measurement challenges, one can consider the data employed in the firm-level analysis described below. The ORBIS database will be a key source for this exercise, but it does

not provide firm level information enabling a direct characterization of knowledge capital nor a distinction between investment in knowledge capital and investment in research and development. In previous literature, knowledge capital has been proxied as the ratio of innovation sales to total sales (Loof and Heshmati, 2002). However, the information on innovation sales is not available in the database. There are other alternatives: the candidate variables available to proxy for knowledge capital are *Intangible Fixed Assets* as proportion of *Total Fixed Assets* or as proportion of *Total Assets*. Unfortunately, these variables are associated with another potential confounding factor in that Intangible Assets could possibly contain "Goodwill." Goodwill in an accounting sense considers that an ongoing business may have some "intrinsic value" beyond its tangible assets. Such an asset, for example, might be reputation. Thus, care will be required to address such challenges or at least to identify them and ensure they are considered explicitly as the analysis advances.

28. As noted above, the analysis for the study was developed using macro, micro and case study approaches. The next subsection describes the scope of the analyses and then provides more detail on the methods to be employed under each analytical approach.

Scope

29. The scope for the macro and micro levels of the study highlights the development dimensions of the issue at hand. Particular focus was given to developing countries and efforts were made to include a large and representative sample of countries from Asia, Africa, Latin America and the Caribbean, as well as countries at different levels of development (*i.e.* those with low, medium and high incomes per capita). Advanced countries were considered for purposes of comparison.

30. The target timeframe for these sections of the study was 1990 to 2008 (2007 for the macro level analysis). This timeframe covers a particularly dynamic period for reform of IPR protection, including the advent of the WTO TRIPS Agreement as well as a time of substantially increased adherence to agreements administered by WIPO, among other developments. Thus, it provides an excellent opportunity to consider factors associated with change in the strength of IPR protection. The analysis proceeded based on a dynamic assessment of developments over time.

Macro Approach

31. In light of the conclusions from the literature review and the framework provided by our preliminary model, the macro analysis is structured to identify policies that accompany and complement the strengthened protection of IPRs, helping to incentivise innovation and increase trade and trade-related investment. Here, the focus is on economy-wide policies. As a first step, we augmented the dataset underlying the work by Park and Lippoldt (2008) with the Norris (2008) dataset containing data on social, economic and political characteristics of 191 nations with over 600 variables from 1971 to 2007. We also complemented this dataset with the datasets used by La Porta, Lopez de Silanes, Johnson, and Schleifer in several of their papers. By expanding the dataset we included different measures for infrastructure, both physical and human, and research and development capacity-building within countries, in particular developing countries. Since we were exploring the potential effects of those complementary policies that foster innovation or diffusion of innovation, we needed to look at the economic, political and social environments.

32. The macro approach tested the relationship of the following policies,[15] among other possibilities, in conjunction with strengthened IPR protection:

- **Macroeconomic stability** (especially in relation to inflation). In principle, countries that have a consistent monetary policy of controlling inflation may preserve the value of assets and therefore provide an appropriate climate for any type of investment including research and development (Rogoff, 1985; Barro, 1996).

- **Quality of governance and quality of government.** Responsible governments may be rewarded with relatively higher in-flows of foreign direct investment to the extent that they create an economic environment with less risk than would otherwise be the case. Basically, a "responsible" government is perceived as non-corrupt, transparent, non-discriminatory, open and stable (Barro 1996; La Porta, *et. al.* 2003 and 2008). This may encourage greater innovative activity as well.

- **Enforcement or rule of the law**. Countries that are perceived as having a clear, simple, effective and expeditious judicial system could display higher levels of investment. Firms may also conduct more R&D in these countries, for example, as this factor may facilitate their ability to appropriate the benefits of their innovative activity (Barro 1996; Djankov, *et. al.* 2002; La Porta, *et. al.* 2008).

- **The presence of bureaucratic obstacles to business practices and business establishment**. These bureaucratic obstacles proxy for transaction costs; their reduction may foster increases in the number of firms in domestic markets and, on occasion, the creation of new markets (Barro 1996; Djankov, *et. al.* 2002; Glaeser, *et. al.* 2004; La Porta, *et. al.* 2003).

- **The quality of the labour force.** Countries that possess a relatively more-educated labour force may be more attractive to foreign investors, for example by reducing the extend of necessary training expenditures and increasing the quality of inputs from local labour resources including potential innovation (Barro 1996; Glaeser, *et. al.* 2004).

- **The productivity of the labour force**. Innovative firms looking to do research and development may locate in countries where labour productivity is high compared to other countries. As the concentration of such activity increases, it is likely that unit labour costs will decrease (Barro 1996; Glaeser, *et. al.* 2004).

- **The quality of the infrastructure of the country**. The quality of the roads, telecommunications networks and ports, among other types of infrastructure, can reduce the cost of doing business (Barro 1996; Glaeser, *et. al.* 2004). In conjunction with adequate IPR protection, good infrastructure may be conducive to heightened levels of some types of economic activity (*e.g.* just-in-time manufacturing of IP-intensive components as inputs in global production chains).

Micro approach

33. The macro-level analysis was complemented by a micro-level analysis using firm-level data in order to gain insights into these developments from the perspective of the firm. Unlike the macro-level assessment, the micro approach relied on simple regression analysis, using a single equation to consider one dependent variable at a time rather than the system of equations described above. This approach was used to provide insights into specific elements of the aforementioned system of equations. But, in view of

[15] These hypotheses describe the basic relationships stemming from previous research and are now presented under a unified model. There are other hypotheses which could potentially be tested within this framework. We leave the inclusion of additional variables into the model as future extensions of this work.

the complexity of interpretation, it was preferable to proceed with a single equation approach for this exercise.

34. The broad objective of the micro approach was to explore the different motivations leading firms to innovate and how productive units utilise innovations. Two features are of particular interest. First, the analysis considered the feedback mechanism by which knowledge capital and productive capacity are enlarged thereby encouraging development and leveraging of intellectual property. In the modern economy, knowledge is at least as important an input as factors of production like labour, capital, and raw materials (Krugman and Obstfeld, 2009). Second, we sought to know the role of international trade and investment in disseminating this knowledge.

35. The micro-level analysis advanced based on the creation of a firm-level database with information coming from different sources, with the core information coming from the ORBIS database. The ORBIS database includes financial statement information on approximately 44,707,294 companies from all over the world from 1999 to 2008. It covers the 30 OECD countries in addition to several emerging economies.[16] A second source for data was the expanded database underlying Park and Lippoldt (2008) which contains information on measures of protection for Intellectual Property Rights for three different types of intellectual property: patents, copyrights and trademarks. Other sources of data which enriched this new database were the datasets compiled by López-de-Silanes, La Porta, Schleifer, *et al.* for several papers published in recognized economics and law journals.[17] The objective of combining these datasets with the firm-level information was to obtain proxies for the availability of inputs of production such as capital and labour, labour regulations, and other institutions and historical accidents related to development and relevant to firm-level incentives.[18]

36. Use of a simplified econometric framework went hand in hand with three further simplifying assumptions.[19] In particular, we assume that firms choose to use their IP, even though we cannot observe the actual outcome of this assumption. It is possible that firms choose not to disclose their latest technological advancement immediately after it is developed, but only some time afterwards. However, if the firm's goal is to maximize profits or maximize market share then it follows the firm would choose to employ all resources available to it, including the IP resources. Secondly, the point in the production process where the use of the IP is potentially more important, but is also unknown and unobservable. Due to data limitations, we must assume this lack of information is not critical to the results of the present

16 The emerging economies contained in the ORBIS database are the following: Argentina, Brazil, Chile, China, Hong Kong (China), India, Indonesia, Malaysia, Morocco, Russian Federation, Singapore, South Africa, Chinese Taipei, Thailand and Tunisia.

17 The draft working papers and datasets are available at http://mba.tuck.dartmouth.edu/pages/faculty/rafael.laporta/publications.html

18 Krugman and Obstfeld (2009) consider an historical accident to be any occurrence providing a country, industry or firm with a head start relative to other competitors.

19 In a future stage of the research, the following relationships could be examined in order to highlight important firm level factors including IPRs and their policy complements: 1) Firm size - Firm size may affect the likelihood of a firm innovating and increasing exports once IPRs are protected and regulation enforced. Public policy already influences firm size. For example, this can include policies with provisions that vary by firm size such as employment protection legislation or accounting and tax policies (with provisions that influence assets, employment, number of subsidiaries, and profits, among other aspects). Therefore, if firm size matters for increased innovation, reform of public policy may have a role in this regard.[19] (Bernard and Jensen, 1999, 2004; Bernard, *et. al.* 2003). 2) Firm location - Do firms in the same industry cluster together and therefore increase their innovation, generate greater profits and boost exports when IPRs are well protected? This could involve investigating potential economies of scale due to clustering and knowledge spillovers related to location (Bernard and Jensen, 1999, 2004; Bernard, *et. al.* 2003; Krugman and Obstfeld, 2009).

assessment. Finally, most of the indicators we have for IPR protection, in particular the patent, copyright and trademark indices developed by Park *et al*., represent a country's efforts to protect IPRs in terms of laws on the books. This presents an aggregation problem since firms operate in different sectors subjected to varying degrees of technological change and there is little variation within the Park et al indices according to the conditions in each sector.

Presentation of Results: Macro and Micro

37. The development process is difficult and for the majority of developing countries it is linked to FDI and international trade with developed countries. As noted in the literature review above, FDI has also long been considered an important channel for technology transfer. Among the possible mechanisms are knowledge spillovers, labour turnover, linkages and advanced specialized inputs. Currently, most of world trade has shifted to intermediate inputs and it has been argued that countries with higher growth rates and higher levels of R&D as a proportion of Gross Domestic Product produce intermediate goods of higher quality, which aids in producing more efficient capital goods and better final consumption goods.[20] This process allows developing countries to gradually close the gap between their current technology and the technological frontier, which increases the country's income and well-being.

38. The econometric model specified in this paper tries to address the aforementioned pattern and shed light into the development process. However, the analysis of IPR reform is not straightforward as for certain other types of policy because of the inter-related nature of IPR policy and other types of institutional change. The revision of IPR legislation may interact with other types of institutional change, and the effects of such change may take time to appear and the channels by which we can observe modifications may vary. Moreover, the growth process associated with R&D for new technologies can only be fully appreciated over the long-run. Adding to the difficulties, it is usually the case that acquiring technology involves making complementary investments. In Keller (1997), international trade is found to enable domestic firms to raise their productivity by importing specialized foreign intermediate goods. For this process to trigger domestic innovation, complementary investments have to take place. Therefore, identifying the characteristics of the environment that allow more R&D to occur is fundamental to ensuring an appropriate policy framework for development. If the current environment is not conducive for a country to engage in R&D on its own, then certain additional measures may need to be taken to modify these conditions in order to create an environment conducive towards R&D and thus economic growth.

39. The model has four equations addressing areas related to country and firm performance through the economic environment. Each one of the equations in the model attempts to capture the behaviour of a fundamental component related to the IP environment, technology research and transfer, and growth. For example, FDI captures the effects of technology transfer across countries; the level of R&D for new products captures the investment made in developing new technologies coupled with foreign ones brought from outside; service imports and licensing fees capture part of the confidence in the country's business environment; and finally, the IPR protection level captures the specific measure related to the reputation of the country's institutions enabling the environment to become conducive for growth. The key is to consider these variables jointly since policies intended to affect one of them directly may also affect the others indirectly.

40. A base specification for the model was estimated and then modified accordingly to test various policies affecting different areas of the IPR environment. Particular attention was paid to the evolution of inflows of FDI, the level of IPR protection (measured by the Patent Rights Index), the level of R&D in a country, and finally the amount of service imports going into countries. For example, one would not expect

[20] For more on this issue, see TAD/TC/WP(2010)14, "Have Changes In Factor Endowments Been Reflected In Trade Patterns And What Effect Has This Had On Relative Wages?", forthcoming.

an education policy to affect the inflow of FDI directly, but rather through R&D, which is affected by the IPR environment, which is affected by FDI.

Macro-level base models for patents, copyright and trademarks

41. The results[21] for the base model for patents are encouraging for a number of reasons (Tables 1 through 22). They suggest a positive and statistically significant relationship between the level of IPR protection and FDI (equation 1); the level of FDI and the level of IPR protection (equation 2); the level of IPR protection and the level of R&D done inside the country (equation 3); and the amount of service imports corresponding to license fees. We observe the feedback mechanism where a country that increased its protection of IPRs was rewarded by an increase in FDI; in this particular case, a 1% increase in the protection of IPRs measured by the Patent Rights Index was associated with a 2.8% increase in the inflow of FDI. Similarly, a 1% increase in the inflow of FDI implied on average an increase in IPR protection by 0.3%. Thus, we are looking at the virtuous cycle between IPR protection and FDI. In addition, we also capture the positive influence of IPRs on the level of R&D in a country, as shown by the sign and statistical significance of the parameter estimate of the Patent Rights Index in equation 3. For a 1% increase in the level of protection of IPRs there was on average a 0.7% increase in the domestic level of R&D. Finally, these positive results are compounded by the last equation where a 1% increase in the level of IPR protection was associated with an increase in service imports by 2%.

42. The results for the base model for copyrights are also encouraging and follow the same pattern as the ones for patents. We observe a positive relationship between the Copyright Index and FDI. For a 1% increase in copyright protection there was a 6.8% increase in FDI. Likewise for a 1% increase in FDI, there was on average a 0.075% increase in copyright protection by the host country. There appears to be a virtuous cycle related to FDI and protection of IP. When countries experienced a marginal increase in IPR protection, this drew a more than proportional amount of FDI; as they further increased the protection within the ranges covered in the time period of this study, they experienced further inflow of FDI. This positive relationship is again seen with respect to R&D, where a 1% increase in copyright protection was associated with a 3.3% increase in domestic R&D. In the case of copyright protection, we do not observe an increase in service imports in the form of licensing fees, as the parameter estimate was not statistically significant. Thus, there is no clear relationship in this instance.

43. The base model for trademarks displays relationships similar to those found in the two preceding base models. Whenever a country increased its trademark protection level by 1%, it recorded an increase of 3.8% increase in FDI. The feedback mechanism is present again, whereby a 1% increase in FDI was associated with an increase in the domestic level of trademark protection of 0.16%. Similarly, when trademark protection increased by 1% domestic, it was associated with an R&D increase of 1.4%. Unlike the situation for copyrights, in this case there is a statistically significant increase in service imports in the form of licensing fees and payments. A 1% increase in trademark protection was associated with a 2.9% increase in service imports.

44. The base models for the three included forms of IP (patents, copyrights, and trademarks) present broadly similar patterns. The statistical results suggest that for the period of the study, increases in the protection of the IPRs carried economic benefits in the form of higher inflows of FDI, increases in the levels of domestically conducted R&D, and increases in the level of service imports as measured by licensing fees. A feedback mechanism is observed whereby the inflows of FDI create incentives for countries to keep elevating their levels of IPR protection to continue receiving the benefits of even more FDI inflows. In the base specification, attention should also be paid to the legal institutions variable and its

[21] The estimation of this model was done through Two Stage Least Squares, as described in the Technical Appendix to this paper.

impact on R&D. Certainly, without protection, an economic agent could spend significant resources developing a novel idea that could be easily appropriated. This situation potentially leaves the economic agent without profits and with a considerable loss. Situations such as this inhibit future innovation and therefore should be avoided.

Results for the macro-level assessment of complementary policies

45. Within the macro-level assessment, a detailed examination of policy complements was carried out. Consideration of the coefficients for the control variables presented in Tables 1 through 22 provides insights into relevant complementary policies. The analysis of complementary policies meant looking into the characteristics of the IPR environment including variables related to the institutional, educational, social and political framework of the study countries. A large dataset was compiled to test and identify the impact of different complementary measures to IPR protection. There were four broad sets in which these variables were classified: macro-environment, resources, legal and institutional, and fiscal. The classifications were made somewhat arbitrarily, but they aim to group variables that impact the specified area of concern. The overarching framework considers that innovation results from the interaction of norms, markets, incentives, regulations, and infrastructure for the creation and use of technology. Education systems encourage skills and technical competence. Venture capital markets finance the investments of small companies in different sectors. Mass communication systems foster access to knowledge. These and other elements contribute to the skills, talents, capital, and competition that support innovation.

46. The variables grouped under the macro-environment set are related to the government's performance in running the macroeconomic aspect of the economy. As per the original scoping paper [TAD/TC/WP(2009)25/REV1], the variables tested were: corruption, the number of state owned enterprises in the economy, the average level of inflation, the number of bureaucratic delays, the risk of contract repudiation (another proxy for legal institutions), the government's effectiveness, the size of the unofficial economy, and labour informality.

47. The last two of the aforementioned variables (the size of the unofficial economy and labour informality) provided interesting results for copyrights and trademarks, but not for patents. The direction of the results was similar: a larger unofficial economy and more informal labour were associated with constrained inflows of FDI. In particular, the magnitude of the effect was for a 1% increase in the size of the unofficial economy to be associated with was a -0.03% and -0.01% decrease in FDI inflows in the case of copyrights and trademarks, respectively. The parameter estimates of these variables with respect to patents fall in the same direction as the ones mentioned already, but are not statistically significant. Overall, in this context, reducing the size of the unofficial economy and labour's informality tended to be associated with increased inflows of FDI, while having a positive effect on the level of R&D. These effects, through the feedback mechanism, were likely to be eventually reflected in higher future levels of IPR protection.

48. Additional variables falling in line with expectations were the number of state owned enterprises in the economy index, the risk of contract repudiation, and the indicator for government effectiveness. These variables proxy for the manner in which the government interacts with markets. The state owned enterprise index captures market competition, the risk of contract repudiation and the indicator for government effectiveness capture among other things the quality of public service provision and bureaucracy, the competence of civil servants, the independence of the civil service from political pressures, and the credibility of the government's commitment to policies. Even though, the parameter estimates associated with these variables were not statistically significant their sign suggests less government intervention in the form of state owned enterprises, lower risk of contract repudiation, and higher government effectiveness

may have had some relationship with increased FDI inflows which would in turn have an effect on the IPR environment.

49. Thus, a key finding is the degree of interrelatedness between domestic variables and FDI. In that same line of thought, recall that countries which have adopted relatively open trade regimes have often grown substantially faster than more protectionist countries. The present findings fit with similar conclusions by Branstetter and Saggi (2009) state that there appears to be a clear and positive relationship between the degree of IPR enforcement in developing countries and investment by US firms.

50. The variables grouped under the resources set have to do with the capacity building endowments available inside countries. We include these because they capture quality differences in the inputs required to manufacture higher-value intermediate goods or final consumption goods. In this category, we grouped human and physical capital variables. For example, this group included indicators for the size of the population, secondary school enrolment, literacy rates, infant mortality rates, physical infrastructure (index), unemployment protection laws and social security guarantees. As stated, these variables serve as proxies for the quality of the endowments available within countries.

51. The results for the resources set were robust and statistically significant for the infrastructure quality index for patents and trademarks. In the case of patents, a 1% increase in the quality of the infrastructure was associated with a 0.15% increase in R&D, which would then influence the level of IPR protection and affect FDI inflows. Recall, R&D spending is the main cause for technical change. Countries with positive and high levels of R&D will converge to parallel growth paths with similar positive growth rates while other countries will stagnate. Similarly, for trademarks a 1% increase in the quality of the infrastructure was associated with a 0.06% increase in R&D. Note the parameter estimate's magnitude is smaller relative to the one obtained for patents. One explanation may be that patents require more physical inputs than trademarks, being the most direct incentive for developing commercially useful new technologies and products. Finally, the infrastructure index's parameter estimate was positive but not statistically significant for the case of copyrights.

52. The social security index was another variable with important influence according to the statistical results for patents and copyrights. This index measures social security benefits as the average of: (1) old age, disability and death benefits; (2) sickness and health benefits; and (3) unemployment benefits. It attempts to capture one dimension related to the quality of the labour force within countries. The relationship postulated is a higher quality labour force will be more productive and better suited for complex activities such as research and development. A 1% increase in the social security index implies a 1.9% and a 0.8% increase in R&D in the case of patents and the case of copyrights, respectively. This variable also had a positive sign with respect to R&D in the case of trademarks, however, it was not statistically significant and should be interpreted with care.

53. The next set of variables was classed in the legal and institutional category. In the base specification, we already attempted to capture the legal institutions of the countries. In order to test other variables which attempt to capture in alternative ways the legal and institutional dimension of the environment, the base model was modified. This way of proceeding avoided situations where explanatory variables in the same regression model suffer from high correlation coefficients because they measure similar but not identical dimensions of the aspects of the countries' institutions. However, it is still necessary to test them because they could capture these different dimensions in better ways. Therefore, the legal institutions variable was removed from the base specification and tested subsequently.

54. Variables such as the enforceability of contracts, corruption within the country, the quality of the bureaucracy, citizen's perceptions of the judicial branch of government, and certain administrative impediments to start a business were tested. The variables measuring the enforceability of contracts and the

corruption within the country were the ones performing according to expectations. Results showed that great enforceability of contracts was associated with greater service imports, at least in the case of patents and copyrights. The magnitude of this increase is as follows: for a 1% increase in the enforceability of contracts, the associated increase in services imports was 0.27% for patents and 0.25% for copyrights. These results support the notion that patents are a direct incentive for developing commercially useful new technologies and products because they provide a legal foundation for that exchange. The parameter estimates for the case of trademarks were not statistically significant. The other variable which performed according to expectations was the corruption index. The impact of this variable is greater for patents than for copyrights or trademarks. In the case of patents a 1% decrease in the country's corruption implies an increase of 0.15% in R&D and a 0.03% increase in patent protection. For copyrights, a 1% decrease in corruption was associated with a 0.04% increase in copyright protection. For trademarks, a 1% decrease in corruption implies a 0.1% increase in R&D. Given the difficulties surrounding the measurement of institutions and the legal system, the other variables tested did not perform according to expectations. Obtaining a more accurate measure for these variables could be a topic for future investigation.

55. The last set of variables was composed of variables grouped under the fiscal dimension. They have to do with the tax burden imposed by countries on firms located within their borders. Analyzing this dimension is relevant because previous empirical studies document a negative relationship between FDI and host country tax rates. With regards to taxes, the parameter estimates confirmed empirical research in previous studies. The results imply that countries in which economic agents comply with paying their taxes see higher inflows of FDI and more service imports. On the other hand, countries where the tax level is higher see smaller inflows of FDI and smaller inflows of service imports. In particular, a 1% increase in compliance by economic agents with regards to paying taxes implies increases of 0.36% in FDI and 0.7% in service imports for the case of copyrights; increases of 0.64% in FDI and 0.87% in service imports for the case of trademarks; and for the case of patents an increase 0.46% in service imports, given that this variable's parameter with respect to FDI inflows was not statistically significant. With respect to the tax level, the results showed a negative relationship to both inflows of FDI and service imports. In particular, a 1% increase in the tax level implies lower FDI inflows (-3.6%) and lower service imports (-3.2%), for trademarks. It has the same relationship with copyrights, implying lower FDI inflows (-3.4%) and service imports (-4%). Finally for patents the effect is similar, however, only statistically significant for FDI inflows. A 1% increase in the tax level implies lower FDI inflows (-3.5%). The results for these variables underscore that they have a more than proportional association with FDI inflows and service imports. The results highlight the importance of a solid tax base in order to not curtail valuable resources coming from outside, which play an important role in development. FDI has the potential to offer two major sources of welfare gains: 1) it can lower prices by shifting production to lower cost locations; and 2) it has the potential to encourage industrial development by introducing new technologies.

56. Further, we tested an index capturing the frequency of price controls in the economy. In this sense our goal was to capture the flexibility in the ability of markets to adjust to changing conditions (an example would be entry and exit of firms). Unfortunately, this variable was not statistically significant.[22] (See also Box 3, which presents an additional assessment of policy considerations).

[22] There are reasons as to why market competition would be important with regards to innovation. For example, in early Schumpeterian models a higher degree of competition led to lower monopoly profits and thus a lower rate of innovation. With respect to product market competition, other studies have found that at least a little competition is always growth-enhancing. That is, starting from the minimal degree of product market competition and holding constant the case of imitation, a marginal increase in product market competition always raises the growth rate. On the other hand, with respect to imitation, these same studies found that a lot of imitation is always bad for growth. That is, as the ease of imitation goes to infinity the growth rate always falls to zero. Nonetheless, it has also been documented that the effect of product market competition on growth is monotonically positive, but sometimes it has an inverse "u" shape, whereas the effect of imitation on growth

Box 3. Interactions among policies

In addition to the results obtained from the system of equations, we test the relationship between several policy dimensions jointly with the Patent Rights Index (Tables 23 and 24). In other words, we ran regression analyses including interaction terms combining the indicator for the strength of patent rights with other economic parameters, as a way of testing which interactions were important for maximizing merchandise imports and FDI. The specification of the regression models for this exercise followed the econometric specifications in Park and Lippoldt (2008). We did so because the authors identified several institutions affecting the functioning of the country overall. These same institutions operate in the background in the IPR environment, and thus, should be tested in this setting.

There were only select cases in which we found statistically significant results in this supplementary exercise. However, the significance of particular indicators was more apparent when countries were disaggregated by income levels. The significant results were mostly linked to the effectiveness of the country's legal institutions interacting with the indicator for the strength of patent protection based on laws on the books. The more efficiently these institutions operate, the better the IPR environment will be preserved. At the end of the day, the incentive to innovate depends not on the rents of a successful innovator per se, but rather on the difference in rents between the successful innovator and the unsuccessful one. Therefore, a first outcome we can draw from these regressions is that the operation of patent rights in conjunction with the broader the legal institutions or the judicial branch in the country permit the successful innovator protect these incremental rents.

For middle income countries, we found that a 1% increase in the interaction term representing the combination of economic openness and patent protection was associated with a 3% increase in FDI. Similarly, conditional on being a LDC, having a better business environment with high levels of IPR protection implied a discrete change in FDI of approximately 24%. Looking at merchandise imports, the results show the importance of the legal system. For high income economies, a 1% increase in the indicator for the interaction of the functioning of legal systems and patent protection was associated with an 8% increase in merchandise imports. Additionally, conditional on the economy being a LDC, having a 1% better score for the functioning of the legal system and patent protection combined implied a 4% increase in merchandise imports. For LDCs, a 1% increase in the indicator for the property rights regime interacted with patent rights yielded an even larger implied increase in merchandise imports of approximately 17%.

The remaining statistical results were not conclusive in a statistical sense and thus we do not discuss them here. Note, the statistically significant results are consistently related to the factors which have the highest impact on the business environment, such as the legal system and the protection and preservation of property rights. Therefore, more research should be devoted to the accurate measurement of these variables, because these are the ones which create an enabling environment for firms to operate, stimulate economies and generate economic growth.

Summing up the macro-level assessment

57. The results of the macro-level assessment provide a clear indication of the inter-relationships of the variables indicating key dimensions of economic performance and those relating to protection of three main types of intellectual property (patents, copyright and neighbouring rights, and trademarks). Moreover, the significance of the results across the system of equations points to a virtuous circle, whereby improvements in the IPR environment are associated with improved economic performance – in particular with respect to FDI – and, in turn, further improvements in the IPR environment. Important policy complements are identified in the course of this assessment, notably with respect to variables that affect the ability to conduct business. These complements can be grouped under four headings: those affecting the macro-environment, resources, legal and institutional, and fiscal conditions. The association of these complements with desired economic outcomes varied somewhat across the groups and by type of IPR.

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usually is inverse "u" shaped but sometimes is monotonically negative. Growth is always enhanced by more competition because more competition raises the incentive for a firm to escape competition by innovating and a lot of imitation is bad for growth. Anti-trust policy addresses product market competition and patent legislation affects the ease of imitation these two institutions affect growth through their direct effect on the incentives to innovate in each industry and through their influence on the cross-country distribution of technological gaps.

Results of the micro-level assessment

58. As noted above, given difficulties in interpretation, the approach in this part of the research was simplified to obtain a first glimpse at the inner workings of the firm. Single equation regression models were developed and analyzed focusing on four different dependent variables, each individually in turn: export turnover, firm total sales, firm total assets, and firm total intangible fixed assets. The focus fell on them because the effect of IP and trade would likely appear in these indicators of firm performance. We analyze these separately for the cases of patents, copyrights and trademarks. The results are presented in Tables 25 to 29.

59. The selection of independent and control variables for inclusion in this exercise proceeded based on insights from the literature and previous iterations of the work in the WPTC. Among the variables included in the simple regression models were: inward FDI, the individual IPR index of concern (either Patent Rights, Copyright, or Trademark Rights), the level of GDP per capita, an indicator for openness, a measure for the business environment, a measure for the legal institutions within the country, a measure for property rights, and a measure for government effectiveness. These variables were part of all the models because they cover relevant dimension of the business environment. We then included other variables in addition in order to identify certain dimensions that could also exert influence in the outcome variables in question. These additional variables included a measure of cooperation between university research and industry, a measure for innovative capacity, a measure for the rule of law, a measure for regulatory quality, and a measure for political stability.

60. The results of the micro-level assessment were positive in certain cases, but less clear cut than was the case for the macro-level outcomes. Nonetheless, there was some evidence that firms do capitalise on improved IPR protection taking place in conjunction with complementary factors such as opportunities for industry-university collaboration. For example, when the model included the variable measuring the co-operation between industry and university research, the Trademark Index had a statistically significant association in relation to export turnover, sales and total assets. In the case when the mode included the variable intended to measure innovative capacity, one sees statistically significant results for the Trademark Index with respect to sales and total assets. For patents we observed a positive influence of the Patent Rights Index with respect to export turnover, but only when we included the university and industry cooperation variable and the innovation capacity variable. However, the parameter estimate for the Patent Rights Index was not statistically significant in the first case, so interpretation has to be done with care. For the innovation capacity variable an increase in 1% of the Patent Rights Index was associated with an increase in export turnover of approximately USD 270 000 per year. Finally, for copyrights we observed the same situation as for patents, export turnover was the only variable affected by the variable measuring cooperation between industry and universities. The other variables tested at this stage did not provide any

meaningful results in a statistical sense and therefore are not mentioned.[23] (Future research to expand the analysis based on a more disaggregated approach may yield stronger results.[24])

Case Studies

61. Case studies are included here in order to provide concrete illustrations of the economic implications of strengthened IPR protection in developing countries, to highlight specific contexts for the working of some of the aforementioned relationships with respect to IPR protection, and to help shed light on questions that may remain unclear from the macro and micro analyses (*e.g.* due to lack of data for certain indicators). Three case studies have been conducted with a view to obtaining contrasting examples, one from a large emerging economy – China – and two from least developed countries (LDCs) – Bangladesh and the Lao People's Democratic Republic (PDR). These case studies have been developed with support from consultants with particular country expertise in order to ensure country-specific features (*e.g.* institutions) are taken into account. The underlying paper for the China study is presented in the Annex to the present paper [TAD/TC/WP(2010)12/ANN].

***China –Firms Deal With A Complex Intellectual Property Environment*[25]**

62. China has made progress in strengthening the protection of intellectual property and expanding its R&D base over the past two decades, as attested by indicators such as the Patent Rights Index[26] or statistics on Gross Expenditure on R&D (Figure 1). Meanwhile, in firms the understanding of intellectual property has gone beyond a mechanical interpretation of IPR law. Instead, with years of experience in innovation, imitation and knowledge management, firms have begun to realize that intellectual property protection is part of a complex business environment including various cultural, economic and strategic factors. In light of on-going developments in these areas related to IP, firms are not only adjusting their R&D strategies, but also their product and marketing strategies. This case study explores these issues based on numerous interviews with enterprise managers working in China.

63. China has developed into one of the most attractive investment destinations, not only for labour-intensive manufacturing but also for innovative and high-tech industries.[27] However, the uncertainty

23 We also ran separate single equation regression models interacting the Patent Rights Index with indicators for property rights, government effectiveness, doing business and legal institutions, respectively. The objective was to explore and test the joint variation between the variables currently included in the model and the Patents Rights Index. Expectations for these interaction variables were to find a positive correlation with the IPR indicator, as was the case for the macro-level results. Unfortunately, the parameter estimates for these variables exhibited mixed results since the interaction terms obtained the expected signs but each variable individually obtained an unexpected sign. Therefore, we do not show these results and more analysis should be done to verify their robustness. Recall the variation of these variables is at the country level and this could be creating an unexpected effect with the firm level data since there is heterogeneity in the firms' exposure to these variables.

24 Further research could usefully explore the importance of variation at the country level. The small impact of the regression coefficients could be verified in further analysis because the IPR indicators take this dimension into account.

25 This sub-section draws on a paper prepared for the OECD by Minyuan Zhao, University of Michigan. The full text is presented in the annex to the present paper, [TAD/TC/WP(2010)12/REV1/ANN].

26 This index is based on laws on the books and considers protection of patent rights in five areas: membership in international treaties, coverage of patentable subject matter, restrictions on patent protection, enforcement provisions, and duration of protection (Park, 2008).

27 For example, see A. T. Kearney (2007), *New Concerns in an Uncertain World: The 2007 A.T. Kearney FDI Confidence Index*, Global Business Policy Council.

around the protection of intellectual property is still an important deterrent for foreign as well as domestic firms engaging in R&D-related activities. Two unique features of the Chinese economy add to the challenge. First, culturally, there is a very positive view of efforts to learn a trade from others and bring it to perfection, an attitude with long historical roots. For example, Fernandez and Underwood (2006) recount stories of Chinese efforts to reproduce European products to perfection, as far back as the 1650s. In the 21st century, the "Tomato Garden" (a pirated version of Microsoft's Windows XP) and the HiPhone (a counterfeit version of Apple's iPhone) have large followings in China, not only because of their relatively low costs, but also because of the imitation skills embraced by large parts of Chinese society. Second, in the current political economic structure of China, policy-making at the level of the central government is not always effectively translated into enforcement at the local level (Lin *et al.*, 2009). This is partly an issue of incentives for local officials, for whom local economic growth in GDP is set as a criterion for compensation and promotion. Thus, in areas where firms maintain a heavy reliance on imitation, local officials have a strong incentive to employ a discretionary IPR policy, despite the numerous national campaigns to crack down on abuse (Lieberthal and Lieberthal, 2003). Authorities in areas with a high level of foreign investment are more aware of intellectual property issues and are usually more proactive in protecting intellectual property for the sake of local economic development (Ordish and Adcock, 2008).

64. In such an environment, the ability of firms to develop, protect and exploit IP may depend on internal strategies and the presence of certain complementary factors including size, financing, and supply of talent. First, the availability of some intellectual property protection strategies may depend on the scale of operations. Multinational enterprises (MNEs) may be able to resort to intellectual property segmentation strategies, whereby no unit or partner in China has access to all of the components necessary to exploit the intellectual property commercially. Similarly, MNEs or other large firms may be able to divide R&D tasks such that no one individual has access to the full set of critical intellectual property components. Moreover, such firms may be able to provide adequate compensation and incentives in order to retain critical talent (turnover being associated with intellectual property "leakage). Large firms find it much easier to identify and collaborate with reliable partners and suppliers. Small, private enterprises may have an advantage in their ability to control access to critical intellectual property (*e.g.* trade secrets) and also in flexibility to opportunistically capitalise on it, but also may find more constraints in financing R&D and retaining talent.

65. As more and more Chinese firms develop their R&D capacity and obtain their own intellectual property, the general public's perception of intellectual property is likely to change and a greater domestically-driven push for stronger intellectual property protection is expected. Although as of 2005 China only accounted for 0.8% of triadic patents (*i.e.* patents filed in Japan, the US and major European countries), China aims to increase R&D spending to 2.5% of GDP and join the top five countries receiving triadic patents by 2015.[28] To get ready for global competition, Chinese companies are also consciously building up their intellectual property portfolios. For example, in the automotive sector, access to technology, brand names and other intellectual property assets appears to have been a main motivation for Chinese efforts to acquire foreign producers.[29] This increased stakes in intellectual property are already contributing to a shift in the balance of domestic business perspectives on intellectual property. Yet, the technological capacity for abuse of intellectual property has also mounted and it remains a challenge for any firm to guard against imitation and ensure returns from R&D investments.

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28 Triadic patents are important indications of the quality of content since they represent novel ideas in the developed world. Moreover, because patents protect the owners' IP rights within the granting countries, applying for triadic patents is often an indication of future entry into these markets.

29 Examples of such takeover efforts include those of the Shanghai Automotive Industrial Corporation (SAIC) to acquire Britain's MG Rover, Beijing Automotive Industry Holding Group (BAIC) to purchase relevant assets from SAAB, and Geely Auto to acquire Volvo.

66. Rather than viewing intellectual property protection in China through a specific index, firms tend to look into a combination of complementary factors including the legal system and elements beyond. The multi-dimensional nature of China's intellectual property environment has important policy implications. First, while the legal side of intellectual property protection has been increasingly formalized and centralized, regional variation – in particular local weakness in enforcement – remains to be addressed. Second, achieving an effective IPR regime will require reform extending beyond legal structures to include other complementary policies such as those needed to assure appropriate access to capital and talent. There are also risks of distortion or discrimination in the Government's strategic approach to innovation; can one promote a healthy market for intellectual property while allowing government agencies to handpick "flagship" projects. Finally, redoubled education and awareness-building may be required to challenge social misperceptions with respect to the abuse of intellectual property. In sum, if the uncertainties of the current intellectual property environment persist, then the economy may fall short of its potential as some firms may withdraw from innovative activities or divert energy into alternative approaches for intellectual property protection (Zhao *et al.*, 2010).

Bangladesh and Lao People's Democratic Republic: Asian LDCs[30]

67. Despite their shared status as least developed countries (LDCs), Bangladesh and the Lao People's Democratic Republic (PDR) present economic contrasts. Bangladesh is a relatively large country and a member of WIPO and WTO; it is an active participant in certain global production networks, particularly with respect to textiles and clothing. The Lao PDR is a small country that has launched economic reforms in some areas, joined WIPO and is preparing to join the WTO; nonetheless, it remains less well integrated into the global economy.

68. The case study for Bangladesh considers the situation primarily using a quantitative empirical analysis, whereas due to data limitations a qualitative approach is used for analysis of the situation in the Lao PDR. The studies reveal continued low levels of effective protection for IPRs in both countries. Whereas the Patent Rights Index score for China in 2005 was above 4 on a scale of 5 (Figure 1), in the case of Bangladesh, the score was below 2 (Figure 2) indicating weakness in terms of laws on the books. The Lao PDR was not covered by the Patent Rights Index, but lagging IPR performance is evident from its slow progress in ratification of key international accords (*e.g.* it is not yet party to the TRIPS Agreement nor the Berne Convention for the Protection of Literary and Artistic Works) and from interviews with foreign investors operating there.

Bangladesh

69. Bangladesh is bordered by India and Myanmar and has a population of 156 million people, the 7th largest in the world (CIA World Fact Book 2009). The GDP growth rate has been in the range of 5 to 6% per year since 1995, despite the substantial continued role played by inefficient state-owned enterprises and the slow pace of economic reform. Although about two-thirds of Bangladeshis are farmers, more than three quarters of Bangladesh's export earnings come from the garment industry, which began attracting foreign investors in the 1980s due to availability of abundant cheap labour. A large part of the country's earnings also come from remittances sent by emigrants living in other countries.

70. Bangladesh, despite being a member of WTO, has made slow progress in adopting TRIPS requirements due in part to the transition measures available to LDCs. Some trade partners have reacted to the weak enforcement of IPR protection in Bangladesh; for example, the United States placed Bangladesh

30 This section draws heavily on a background report prepared by Thitima Puttitanun, San Diego State University, and consultant to the Secretariat.

on its 2008 IPR Watch List under the Special 301 process. The most cited areas of violation concern copyright and trademark abuse.

71. In the case of Bangladesh, regression analysis is conducted to determine the association of change in patent protection with illustrative indicators for economic inflows, technology transfer and innovation (Table 30). The analysis controls for other economic factors that may influence these flows. The dataset is aggregate ad the national level and covers the period from 1974 to 2007. Although there was only limited change in the patent laws during this period, regression analysis reveals that the change in Patent Rights Index scores was significantly associated (at the 99% confidence level) with improved FDI inflows, imports and patent registrations by foreign inventors. The control variables were not significant in any of these runs.

72. These developments provide an indication of a probable acceleration in technology transfer to Bangladesh following the modest patent reforms there to date.[31] A t the same time, the lack of a significant association between patent reform and patent filings by domestic innovators may signal a lack of capacity to innovate, use of alternative means to protect innovations (e.g. trade secrets) or a lack of interest due to weak incentives.[32]

73. In terms of complementary policies, further iterations of the regression analysis (not shown in the table) point to policies associated with economic freedom as being important for FDI and non-resident patenting. The economic freedom indicator in effect reflects policies to assure freedom in terms of personal choice, voluntary exchange coordinated by markets, freedom to enter and compete in markets, and protection of persons and their property from abuse. Such factors are critical in shaping economic incentives. Also, the coefficient for the rate of economic growth is significant in certain specifications, which provides investors with an indication of potential for expansion in future economic returns.

74. An enterprise study of Bangladesh (Gehl Sampath, 2007a, b) surveyed opinions from domestic firms of all sizes. They found that under current conditions in the country, IPR protection does not generally function as a direct incentive for innovation nor as an indirect incentive for enabling knowledge spillovers through technology transfer. The explanation may be that local firms do not have the ability to imitate. Rather, improved IPR is perceived as giving protection to foreign firms who sell their products in the local market. In addition, some firms may file for patent protections to prevent competitors from other countries taking advantage of a failure to protect in Bangladesh.

Lao PDR

75. The Lao PDR is a small landlocked country neighbouring Thailand, Burma (Myanmar), Vietnam, Cambodia and China. Since 1986, the Lao PDR's government has engaged in reforms to decentralise control, encourage private enterprise and open the country to FDI. This has contributed to an acceleration in growth, which has averaged about 6% per year since 1988 (with the exception of the Asian finance crisis in 1997). Despite this increased pace of growth, the Lao PDR remains poor. Infrastructure, particularly in rural areas, is underdeveloped. The country relies on international aid from the International Monetary

31 A separate regression analysis was run using a more general IPR indicator covering seven types of IP protection (Hamdan-Livramento's TRIPS Index, 2009), but the results were not statistically significant. Also at the disaggregate level (by industry and by country of origin), this broad indicator of IPR protection in Bangladesh did not appear to be significantly associated with FDI. Thus, it appears that to date legal changes in the patent regime have had a more potent effect than change in the general environment for IP.

32 Overall, although these findings should be interpreted with caution due to the small size of the sample, they help illustrate the investment and intellectual property environments in Bangladesh.

Fund (IMF), Asian Development Bank (ADB) and other international sources, to cover about 80% of its capital investment.[33]

76. In the case of the Lao PDR, the analysis proceeded using a qualitative approach based on in-depth interviews with a small sample of Thai participants active in the Laotian economy, supplemented by further material from the literature.[34] Lao international economic relations have been influenced in recent decades by Thailand, which has been a dominant investor in the Lao PDR since 1988. Between 1988 and 1994, Thai investment in the Lao PDR was over six times greater than that of the second largest investor, the United States (USD 554 million versus USD 86 million (Gunawardana and Sisombat, 2008). In 2004, Thailand accounted for 34% of all FDI flows into the Lao PDR. This dominant position of Thailand in the Lao economy is expected to continue for the foreseeable future due to its geographical proximity, cultural links and the existing close trade and investment ties.

77. At least among the small sample of investors interviewed for this study, the predominant view is that the weak IPR protection is not currently dissuasive to investment. This is in part due to the weak local imitative capacity in the areas of economic activity for these investors. In addition, some of these investors find protection due to the nature of their activities, which can be hard to imitate (*e.g.* construction). One respondent noted that some investors may accord low priority to IPR protection, because the emphasis now is on production for the domestic market (where local competition is weak) rather than export. However, all of the executives agree that the current level of IPR protection can potentially create problems for investors in the future. Even though firms in the Lao PDR generally may not have the technical capacity for imitative activity, there are imitated brand name products that enter the market from other countries, notably China. Such imported counterfeit products are available to customers in all of the main cities in Lao PDR. One executive suggested that poverty may contribute to the willingness of consumers to purchase such products.

78. Thus, the investors interviewed for this case study believe that stronger IPR laws will be needed to counter the growing influx of imported counterfeit and pirated goods, and to prepare for the day when domestic firms will have stronger technological capacity. The investors feel that upgrading the IPR system will help cultivate a better investment environment in the country. One respondent noted that the Lao government is interested in improving the IPR strength to meet WTO requirements, but requires foreign assistance in beefing up enforcement due to resource limitations.

79. In terms of complementary policies, the executives suggest that expansion of education and technical training are needed to enhance the stock of human capital. This factor is perceived as one of the most important for attracting greater inflows of FDI. One of the executives believes that as of now, the potential for Lao PDR to absorb technology from foreign investment is extremely low, due in part to the low educational level. Thus, it is a close complement to IPR strengthening. More broadly, one executive

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33 The Lao PDR is currently participating in the construction of two regional transportation routes: 1) the East-West Economic Corridor from Vietnam through Laos and Thailand and on to Myanmar (1450 kilometers), and 2) the North-South Economic Corridor that will connect China and Thailand via the Lao PDR. These routes are scheduled to open in 2012 and are expected to contribute to a substantial growth in trade.

34 The sample consisted of 6 investors (4 usable replies) and one reply from a Thai government representative: 1) Transportation, Mr. Suvit Perapate, TIFFAICD Co., Ltd., 180 employees, first investment in Lao PDR in 2010; 2) Construction, Mr. Kosol Wattayu, Hi-Steel Products Co.,Ltd., 300 employees, first investment in Lao PDR in 2007; 3) Construction, Mr. Montri Prokongsai, Chor Karncharng Co., Ltd., 1200 employees, first investment in Lao PDR in 2005; 4) Agriculture & Food, Mr. Tumnong Polthongmarg, CP (Lao) Co.,Ltd., 400 employees (in Lao PDR), first investment in Lao PDR in 2006; 5) Thai Trade Ambassador, in the Lao PDR, Mr. Chalermpol Pongshababnapa.

noted that the physical infrastructure could play an important role in promoting foreign investment. He believes that aid from other nations can help speed up this process.

Summing up – Bangladesh and the Lao PDR

80. The foregoing case studies highlight the need to consider the particular economic conditions in LDCs in the development of a strengthened IPR regime. In more advanced developing countries, there is evidence that the stronger IPR protection implemented in recent decades has tended to be associated with significantly larger inflows of FDI, imports and technology, as well as increased domestic innovation. However, in poor economies lacking key complements such as adequate stocks of human capital, there are challenges in reaping benefits from strengthened IPR protection. The local economy may lack the capacity to absorb optimal amounts of technology transfer or generate much domestic innovation. Here, key complements to enhanced IPR policies will include policies to promote education and training, as well as investment in basic infrastructure.

81. In terms of strategy, it should be noted that establishment of an appropriate economic framework can help the government to leverage its efforts by mobilising private sector resources via market mechanisms. Economic opportunity can provide a strong incentive to invest. Though still at an early stage, there is already some evidence in this regard from Bangladesh, which has seen some improvement in technology transfer via private sector channels following the limited reforms to date. Qualitative evidence from the Lao PDR indicates that this process may also be getting underway there as well.

82. The moves by Bangladesh and the Lao PDR to integrate more fully in the global economy also entail abiding by the rules of the multilateral trading system. For Bangladesh, as a WTO member, and the Lao PDR, as a candidate to join the WTO, compliance with the TRIPS Agreement standards is needed in order to benefit fully from economic integration and avoid costly sanction. At the same time, LDCs are accorded special flexibilities under TRIPS (*e.g.* with respect to the temporary waiver on implementation of full patent protection on pharmaceutical products) and there are other built in TRIPS flexibilities available to all WTO members (*e.g.* in defining the means to protect plant varieties). These flexibilities permit some adaptation of the TRIPS requirements to the resource limitations and needs of LDCs, a feature that can help to make compliance a more feasible objective. In addition, assistance in support of compliance is available from the WTO, WIPO and leading participants in the multilateral trading system (including governments and the private sector), among other sources.[35] Here it is useful to recall that steps towards TRIPS compliance are not simply a cost. In addition to the technology transfer benefits and incentives for domestic innovation discussed above, an appropriate IPR regime can provide benefits to the domestic economy in the near term – even in less developed countries – by enabling creative industries to leverage cultural expressions and some forms of traditional knowledge, for example, and thereby contribute to growth.

Conclusion

83. This paper considers the wave of IPR reform that has rolled out globally over the past two decades. Building on earlier work on technology transfer and IPRs conducted under the auspices of the Working Party of the Trade Committee, the analytical approach laid out in the paper employs three complementary levels of analysis (macro, micro and country case studies) to examine the economic implications of this IPR reform and variation in associated economic performance. In considering this variation, the analysis looks at the policy complements that may have been associated with positive economic outcomes or that may have influenced further IPR reform.

35 For example, see the information on technical co-operation that is posted on the WTO web site: http://www.wto.org/english/tratop_e/trips_e/intel9_e.htm).

84. Under each approach, the analysis has found a tendency for IPR reform to deliver positive economic results. Reforms concerning patent protection have tended to deliver the most substantial results, but the results for copyright reform and trademark reform were also positive and significant. Overall, the policy complements that were found to be most important in facilitating positive results were those related to inputs for innovative and productive processes and to the ability to conduct business. These include policies that influence the macro-environment for firms as well as the available resources (*e.g.* related to education), legal and institutional conditions, and fiscal incentives.

85. The importance of specific complements varies depending on a country's level of development and other dimensions. However, a cross-cutting theme is the importance of human capital. The knowledge and skills that people are able to put into action constitute a factor that fuels innovation and business, enabling countries to develop and capitalise on intellectual property. For all countries, investment in people appears to be one important factor in reaping the optimal benefits of IPR reform.

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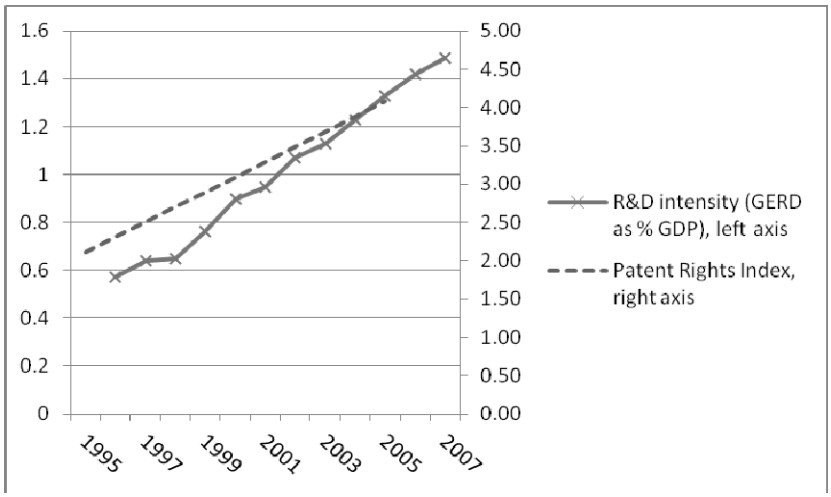
APPENDIX: FIGURES AND TABLES

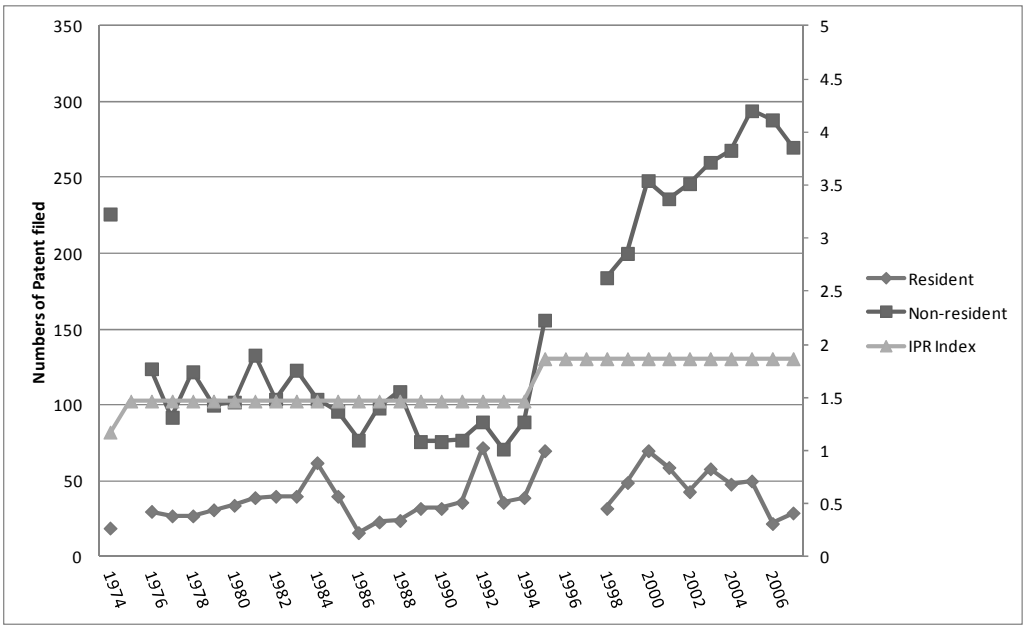
Figure 1. China, Selected Innovation Indicators, 1995-2007



Notes: 1) The Patent Rights Index scores refer to 1995, 2000 and 2005; the intervening years are interpolated. 2) GERD = Gross expenditure on research and development.

Sources: OECD (2008) and Park (2008).

Figure 2. Bangladesh: Patent Applications and the Patent Rights Index, 1974-2007



Source: WIPO statistics Database for Resident and Non-resident Patent Applications; Park (2008) for the patent rights index.

Table 1. Base Model for Patents

VARIABLES	Log of FDI	Log Patent index	Log Research and Development	Log Knowledge Capital
Log Patent Index	2.819***		0.751*	2.046**
	(0.764)		(0.435)	(0.793)
Log Per Capita GDP	0.0757			
	(0.103)			
Log of Free Trade	-0.320			
	(0.596)			
Unofficial Economy	0.210			
	(0.430)			
Log Legal Institutions	-0.0785		1.355***	-1.810**
	(0.487)		(0.370)	(0.913)
Government Effectiveness (dummy)	0.318	-0.0118		
	(0.247)	(0.0430)		
Log Doing Business	-0.00506			
	(0.0863)			
Log Research and Development		8.88e-05		1.474***
		(0.0434)		(0.279)
Log of FDI		0.301***		
		(0.0337)		
Log of Research Quality		-0.601***	0.0735	
		(0.226)	(0.869)	
Log University		0.229	1.899**	
		(0.183)	(0.812)	
Percent of Secondary Enrollment			0.00289	
			(0.00412)	
Log of Population			-0.0518	
			(0.0778)	
Constant	6.135***	-1.213***	-6.365***	6.876***
	(1.249)	(0.262)	(0.712)	(2.163)
Observations	113	113	113	113
R-squared	0.433	-0.213	0.764	0.493

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 2. Base Model for Copyright

VARIABLES	Log of FDI	Log Copyright Index	Log Research and Development	Log Knowledge Capital
Log Copyright Index	6.826*		3.312***	1.966
	(3.939)		(0.596)	(1.882)
Log Per Capita GDP	0.143			
	(0.442)			
Log of Free Trade	1.758			
	(1.615)			
Labour Informality	0.264			
	(0.864)			
Log Legal Institutions	-1.834*		1.088***	-3.066***
	(0.954)		(0.314)	(1.074)
Government Effectiveness (dummy)	0.429	-0.0547**		
	(0.410)	(0.0260)		
Log Doing Business	-0.0461			
	(0.247)			
Log Research and Development		0.127***		2.052***
		(0.0279)		(0.334)
Log of FDI		0.0727***		
		(0.0179)		
Log of Research Quality		0.0145	-0.374	
		(0.149)	(0.709)	
Log University		-0.279**	2.162***	
		(0.135)	(0.635)	
Percent of Secondary Enrollment			0.000845	
			(0.00228)	
Log of Population			-0.0301	
			(0.0586)	
Constant	11.26	-0.757***	-3.071***	12.88***
	(8.518)	(0.161)	(0.639)	(2.179)
Observations	108	108	108	108
R-squared	-0.476	-0.054	0.522	0.375

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 3. Base Model for Trademarks

VARIABLES	Log of FDI	Log Trademark Index	Log Research and Development	Log Knowledge Capital
Log Trademark Index	3.784***		1.436***	2.973***
	(0.720)		(0.270)	(0.949)
Log Per Capita GDP	0.0276			
	(0.142)			
Log of Free Trade	0.635			
	(0.952)			
Unofficial Economy	-0.0659			
	(0.845)			
Log Legal Institutions	-1.726**		1.378***	-1.367
	(0.677)		(0.297)	(1.038)
Government Effectiveness (dummy)	0.911***	-0.185***		
	(0.250)	(0.0440)		
Log Doing Business	-0.155			
	(0.155)			
Log Research and Development		0.271***		1.381***
		(0.0558)		(0.313)
Log of FDI		0.165***		
		(0.0278)		
Log of Research Quality		0.0209	-0.532	
		(0.311)	(0.739)	
Log University		-0.666**	2.632***	
		(0.307)	(0.666)	
Percent of Secondary Enrollment			-0.00113	
			(0.00223)	
Log of Population			0.00422	
			(0.0470)	
Constant	13.62***	-1.143***	-4.587***	10.05***
	(2.750)	(0.308)	(0.481)	(1.969)
Observations	92	92	92	92
R-squared	0.152	-0.654	0.801	0.362

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 4. Copyright Index and the Unofficial Economy

VARIABLES	Log of FDI	Log Copyright Index	Log Research and Development	Log Knowledge Capital
Log Copyright Index	-0.652		2.647***	2.336
	(2.288)		(0.681)	(1.625)
Log Per Capita GDP	0.332			
	(0.298)			
Log of Free Trade	0.835			
	(1.107)			
Unofficial Economy	-0.0322***			
	(0.00999)			
Log Legal Institutions	-0.960		0.791**	-1.481
	(0.734)		(0.336)	(1.029)
Government Effectiveness (dummy)	0.713**	-0.0339		
	(0.309)	(0.0356)		
Log Doing Business	0.236			
	(0.188)			
Log Research and Development		0.169***		1.584***
		(0.0415)		(0.336)
Log of FDI		0.0746**		
		(0.0297)		
Log of Research Quality		-0.440	0.628	
		(0.286)	(0.928)	
Log University		-0.0863	1.515*	
		(0.274)	(0.817)	
Percent of Secondary Enrollment			0.000403	
			(0.00251)	
Log of population			-0.116	
			(0.0854)	
Constant	6.652	-0.399	-2.964***	10.15***
	(5.213)	(0.344)	(0.680)	(2.030)
Observations	99	99	99	99
R-squared	0.489	0.025	0.599	0.410

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 5. Copyright Index and Labour Informality

VARIABLES	Log of FDI	Log Copyright Index	Log Research and Development	Log Knowledge Capital
Log Copyright Index	1.723**		0.849**	4.308***
	(0.738)		(0.362)	(1.096)
Log Per Capita GDP	0.451**			
	(0.201)			
Log of Free Trade	-1.674*			
	(0.977)			
Labour Informality	-0.0213**			
	(0.0102)			
Log Legal Institutions	0.892		1.195***	0.813
	(0.682)		(0.411)	(1.546)
Government Effectiveness (dummy)	-0.0207	-0.0991		
	(0.305)	(0.0816)		
Log Doing Business	0.134			
	(0.183)			
Log Research and Development		0.0923		0.679
		(0.109)		(0.476)
Log of FDI		0.146**		
		(0.0606)		
Log of Research Quality		-0.820**	2.140***	
		(0.408)	(0.816)	
Log University		0.480	-0.131	
		(0.411)	(0.734)	
Percent of Secondary Enrollment			0.00150	
			(0.00273)	
Log of population			-0.353***	
			(0.109)	
Constant	9.328***	-1.311	-3.584***	6.472**
	(2.735)	(0.808)	(0.736)	(2.771)
Observations	47	47	47	47
R-squared	0.654	0.107	0.895	0.364

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 6. Trademark Index and the Unofficial Economy

VARIABLES	Log of FDI	Log Trademark Index	Log Research and Development	Log Knowledge Capital
Log Trademark Index	2.276***		1.187***	0.378
	(0.638)		(0.246)	(0.850)
Log Per Capita GDP	0.0817			
	(0.177)			
Log of Free Trade	1.166			
	(1.158)			
Unofficial Economy	-0.0189**			
	(0.00951)			
Log Legal Institutions	-1.004		1.027***	-1.411
	(0.774)		(0.305)	(1.104)
Government Effectiveness (dummy)	0.522*	-0.129**		
	(0.288)	(0.0598)		
Log Doing Business	-0.209			
	(0.174)			
Log Research and Development		0.297***		1.779***
		(0.0806)		(0.342)
Log of FDI		0.142***		
		(0.0331)		
Log of Research Quality		-0.563	0.869	
		(0.453)	(0.698)	
Log University		-0.410	1.593***	
		(0.409)	(0.601)	
Percent of Secondary Enrollment			-0.00217	
			(0.00228)	
Log of Population			-0.120**	
			(0.0539)	
Constant	11.05***	-0.475	-4.057***	9.022***
	(3.288)	(0.486)	(0.469)	(2.073)
Observations	84	84	84	84
R-squared	0.363	-0.435	0.804	0.445

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 7. Trademark Index and Labour Informality

VARIABLES	Log of FDI	Log Trademark Index	Log Research and Development	Log Knowledge Capital
Log Trademark Index	-0.681		-0.265	0.738
	(0.582)		(0.303)	(0.607)
Log Per Capita GDP	1.034***			
	(0.223)			
Log of Free Trade	-0.621			
	(1.496)			
Labour Informality	-0.0406***			
	(0.0129)			
Log Legal Institutions	-0.840		0.613	-0.661
	(0.829)		(0.440)	(1.040)
Government Effectiveness (dummy)	-0.0149	0.00680		
	(0.347)	(0.123)		
Log Doing Business	0.376*			
	(0.215)			
Log Research and Development		0.0919		1.391***
		(0.136)		(0.301)
Log of FDI		0.0644		
		(0.0721)		
Log of Research Quality		-0.330	3.824***	
		(0.783)	(1.020)	
Log University		-0.0169	-1.227	
		(0.701)	(0.788)	
Percent of Secondary Enrollment			0.000851	
			(0.00235)	
Log of Population			-0.587***	
			(0.116)	
Constant	3.873	-0.699	-2.892***	8.059***
	(3.743)	(0.920)	(0.716)	(1.942)
Observations	40	40	40	40
R-squared	0.739	0.158	0.906	0.649

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 8. Infrastructure Quality Index and Patent Index

VARIABLES	Log of FDI	Log Patent Index	Log Research and Development	Log Knowledge Capital
Log Patent Index	2.589***		0.376	2.160***
	(0.884)		(0.434)	(0.624)
Log Per Capita GDP	-0.0541			
	(0.174)			
Log of Free Trade	-0.465			
	(0.939)			
Log Legal Institutions	0.000921		0.794**	-0.689
	(0.574)		(0.341)	(0.796)
Government Effectiveness (dummy)	0.410*	-0.0662		
	(0.238)	(0.0491)		
Log Doing Business	-0.0254			
	(0.110)			
Log Research and Development		0.102*		1.077***
		(0.0560)		(0.249)
Log of FDI		0.308***		
		(0.0370)		
Log of Research Quality		-1.177***	2.371***	
		(0.333)	(0.809)	
Log University		0.699**	-0.602	
		(0.277)	(0.688)	
Percent of Secondary Enrollment			-0.000268	
			(0.00323)	
Log of Population			-0.177***	
			(0.0630)	
Infrastructure Quality Index			0.151***	
			(0.0573)	
Constant	8.336***	-1.084***	-4.914***	4.942***
	(2.115)	(0.399)	(0.720)	(1.738)
Observations	88	88	88	88
R-squared	0.348	-0.066	0.797	0.368

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 9. Infrastructure Quality Index and Trademark Index

VARIABLES	Log of FDI	Log Trademark Index	Log Research and Development	Log Knowledge Capital
Log Trademark Index	2.818***		0.860***	1.539**
	(0.513)		(0.270)	(0.745)
Log Per Capita GDP	-0.111			
	(0.160)			
Log of Free Trade	0.373			
	(1.029)			
Log Legal Institutions	-0.236		0.804**	-0.343
	(0.624)		(0.321)	(1.006)
Government Effectiveness (dummy)	0.505*	-0.194***		
	(0.264)	(0.0670)		
Log Doing Business	-0.216			
	(0.148)			
Log Research and Development		0.299***		1.214***
		(0.0984)		(0.332)
Log of FDI		0.227***		
		(0.0509)		
Log of Research Quality		-0.734	2.106**	
		(0.624)	(0.846)	
Log University		-0.0953	0.177	
		(0.476)	(0.736)	
Percent of Secondary Enrollment			-0.00253	
			(0.00274)	
Log of Population			-0.142**	
			(0.0567)	
Infrastructure Quality Index			0.0682*	
			(0.0399)	
Constant	13.01***	-1.513***	-3.995***	7.759***
	(3.016)	(0.528)	(0.509)	(1.847)
Observations	75	75	75	75
R-squared	0.185	-0.547	0.822	0.384

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 10. Social Security Index and Patent Index

VARIABLES	Log of FDI	Log Patent Index	Log Research and Development	Log Knowledge Capital
Log Patent Index	2.417***		0.856**	2.827***
	(0.754)		(0.403)	(0.691)
Log Per Capita GDP	0.0715			
	(0.138)			
Log of Free Trade	-0.186			
	(0.713)			
Log Legal Institutions	0.187		1.107***	-0.0229
	(0.578)		(0.357)	(0.786)
Government Effectiveness (dummy)	0.401*	-0.0267		
	(0.233)	(0.0517)		
Log Doing Business	0.0431			
	(0.0984)			
Log Research and Development		-0.0640		0.852***
		(0.0590)		(0.247)
Log of FDI		0.349***		
		(0.0484)		
Log of Research Quality		-0.591**	1.406	
		(0.280)	(0.864)	
Log University		0.410	0.816	
		(0.253)	(0.778)	
Percent of Secondary Enrollment			-0.00520	
			(0.00419)	
Log of Population			-0.108	
			(0.0794)	
Social Security Laws Index			1.867***	
			(0.461)	
Constant	6.120***	-1.996***	-6.777***	2.574
	(1.521)	(0.451)	(0.759)	(1.827)
Observations	103	103	103	103
R-squared	0.419	-0.424	0.792	0.519

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 11. Social Security Index and Copyright Index

VARIABLES	Log of FDI	Log Copyright Index	Log Research and Development	Log Knowledge Capital
Log Copyright Index	2.431		2.609***	4.872***
	(2.077)		(0.713)	(1.574)
Log Per Capita GDP	0.148			
	(0.277)			
Log of Free Trade	0.376			
	(1.000)			
Log Legal Institutions	-0.423		0.941***	-0.134
	(0.683)		(0.327)	(0.989)
Government Effectiveness (dummy)	0.688**	-0.0619*		
	(0.281)	(0.0346)		
Log Doing Business	0.0861			
	(0.172)			
Log Research and Development		0.132***		0.916***
		(0.0409)		(0.321)
Log of FDI		0.101***		
		(0.0311)		
Log of Research Quality		-0.225	0.251	
		(0.270)	(0.919)	
Log University		-0.0724	1.512*	
		(0.255)	(0.809)	
Percent of Secondary Enrollment			-0.000454	
			(0.00285)	
Log of Population			-0.0944	
			(0.0913)	
Social Security Laws Index			0.805*	
			(0.416)	
Constant	9.226*	-0.987***	-3.258***	8.572***
	(4.788)	(0.330)	(0.698)	(1.964)
Observations	99	99	99	99
R-squared	0.306	-0.038	0.625	0.288

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 12. Enforceability of Contracts and Patent Index

VARIABLES	Log of FDI	Log Patent Index	Log Research and Development	Log Knowledge Capital
Log Research and Development		0.188***		0.650***
		(0.0541)		(0.200)
Log FDI		0.193***		
		(0.0322)		
Log Research Quality		-2.030***	6.453***	
		(0.348)	(0.891)	
Log University Research		1.340***	-3.360***	
		(0.355)	(0.933)	
Government Effectiveness	0.394*	0.00396		
	(0.222)	(0.0554)		
Enforceability of Contracts		0.00605	-0.0153	0.279**
		(0.0351)	(0.0882)	(0.141)
Frequency of Price Controls		-0.0222*		
		(0.0132)		
Log Patent Index	1.564		2.009***	1.568**
	(1.178)		(0.409)	(0.679)
Log GDP Per Capita	0.126			
	(0.215)			
Log Free Trade	0.0754			
	(1.293)			
Log Doing Business	-0.0218			
	(0.127)			
Log Secondary School Enrollment			-0.00543*	
			(0.00293)	
Log Population			-0.219***	
			(0.0541)	
Constant	6.934**	0.558	-6.189***	2.576**
	(2.705)	(0.379)	(0.598)	(1.049)
Observations	87	87	87	87
R-squared	0.447	0.455	0.742	0.505

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 13. Enforceability of Contracts and Copyright Index

VARIABLES	Log of FDI	Log Copyright Index	Log Research and Development	Log Knowledge Capital
Log Research and Development		0.284***		1.023***
		(0.0525)		(0.218)
Log FDI		0.0216		
		(0.0264)		
Log Research Quality		-1.737***	4.674***	
		(0.356)	(0.842)	
Log University Research		0.617*	-1.192	
		(0.366)	(0.924)	
Government Effectiveness	0.430*	0.0386		
	(0.240)	(0.0490)		
Enforceability of Contracts		0.0236	-0.0755	0.254*
		(0.0348)	(0.0982)	(0.147)
Frequency of Price Controls		-0.0138		
		(0.00996)		
Log Copyright Index	-2.352*		2.627***	0.223
	(1.217)		(0.523)	(1.099)
Log GDP Per Capita	0.757***			
	(0.218)			
Log Free Trade	0.596			
	(0.900)			
Log Doing Business	0.234			
	(0.171)			
Log Secondary School Enrollment			-0.000435	
			(0.00186)	
Log Population			-0.108	
			(0.0659)	
Constant	0.371	0.999***	-3.302***	4.963***
	(3.425)	(0.352)	(0.526)	(1.147)
Observations	84	84	84	84
R-squared	0.431	0.140	0.649	0.527

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 14. Corruption Index and Patent Index

VARIABLES	Log of FDI	Log Patent Index	Log Research and Development	Log Knowledge Capital
Log Research and Development		0.0165		1.023***
		(0.0563)		(0.258)
Log FDI		0.260***		
		(0.0370)		
Log Research Quality		-1.011***	2.072*	
		(0.265)	(1.088)	
Log University Research		0.436*	0.0504	
		(0.255)	(1.059)	
Government effectiveness	0.554***	-0.0164		
	(0.199)	(0.0579)		
Corruption Index		0.0339*	0.154**	0.00760
		(0.0203)	(0.0636)	(0.126)
Frequency of Price Controls		0.000542		
		(0.0118)		
Log Patent Index	2.097***		1.082*	2.229***
	(0.740)		(0.582)	(0.777)
Log GDP Per Capita	0.0463			
	(0.144)			
Log Free Trade	-0.219			
	(0.773)			
Log Doing Business	-0.00557			
	(0.109)			
Log Secondary School Enrollment			-5.49e-05	
			(0.00482)	
Log Population			-0.0973	
			(0.0816)	
Constant	7.139***	-0.722	-5.336***	3.184***
	(1.602)	(0.441)	(0.818)	(1.206)
Observations	106	106	106	106
R-squared	0.495	0.250	0.749	0.568

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 15. Corruption Index and Copyright Index

VARIABLES	Log of FDI	Log Copyright Index	Log Research and Development	Log Knowledge Capital
Log Research and Development		0.198***		1.492***
		(0.0513)		(0.284)
Log FDI		-0.0780**		
		(0.0344)		
Log Research Quality		-0.567**	1.298	
		(0.249)	(0.929)	
Log University Research		-0.118	1.173	
		(0.260)	(0.842)	
Government Effectiveness	1.076***	0.00767		
	(0.234)	(0.0570)		
Corruption Index		0.0448**	0.0679	0.0927
		(0.0217)	(0.0971)	(0.161)
Frequency of Price Controls		0.00707		
		(0.0131)		
Log Copyright Index	-1.305		1.395	-2.255
	(1.253)		(0.999)	(1.552)
Log GDP Per Capita	0.228			
	(0.193)			
Log Free Trade	-1.182			
	(0.918)			
Log Doing Business	0.0783			
	(0.152)			
Log Secondary School Enrollment			0.00468	
			(0.00319)	
Log Population			-0.172*	
			(0.100)	
Constant	8.747***	1.037**	-3.241***	4.543***
	(3.027)	(0.415)	(0.660)	(1.610)
Observations	102	102	102	102
R-squared	0.438	0.120	0.717	0.497

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 16. Corruption Index and Trademark Index

VARIABLES	Log of FDI	Log Trademark Index	Log Research and Development	Log Knowledge Capital
Log Research and Development		0.348***		1.115***
		(0.0633)		(0.286)
Log FDI		0.128***		
		(0.0277)		
Log Research Quality		-0.445	1.031	
		(0.350)	(0.855)	
Log University Research		-0.479	1.486*	
		(0.342)	(0.845)	
Government Effectiveness	0.503**	-0.105*		
	(0.219)	(0.0541)		
Corruption Index		-0.0267	0.104*	0.0955
		(0.0225)	(0.0590)	(0.128)
Frequency of Price Controls		-0.00475		
		(0.0102)		
Log Trademark Index	3.550***		1.613***	1.825*
	(0.657)		(0.315)	(0.961)
Log GDP Per Capita	-0.154			
	(0.164)			
Log Free Trade	0.365			
	(0.987)			
Log Doing Business	-0.329**			
	(0.158)			
Log Secondary School Enrollment			-3.50e-05	
			(0.00276)	
Log Population			-0.0581	
			(0.0492)	
Constant	13.44***	-0.197	-3.242***	6.276***
	(2.955)	(0.412)	(0.514)	(1.039)
Observations	87	87	87	87
R-squared	0.314	-0.323	0.754	0.537

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 17. Tax Compliance and Patent Index

VARIABLES	Log of FDI	Log Patent Index	Log Research and Development	Log Knowledge Capital
Log Patent Index	2.920***		0.913***	2.514***
	(1.023)		(0.333)	(0.782)
Log Per Capita GDP	-0.207			
	(0.189)			
Log of Free Trade	0.815			
	(1.285)			
Log Legal Institutions	-0.744		0.933***	-1.434
	(0.673)		(0.352)	(1.022)
Government Effectiveness (dummy)	0.285	0.000201		
	(0.251)	(0.0481)		
Log Doing Business	-0.0695			
	(0.128)			
Tax Compliance	0.0870	0.0582	-0.341***	0.465**
	(0.181)	(0.0395)	(0.0729)	(0.213)
Log Research and Development		0.209***		0.660**
		(0.0608)		(0.264)
Log of FDI		0.211***		
		(0.0279)		
Log of Research Quality		-1.259***	3.453***	
		(0.330)	(0.735)	
Log University		0.451*	-0.187	
		(0.247)	(0.631)	
Percent of Secondary Enrollment			-0.000437	
			(0.00315)	
Log of Population			-0.119*	
			(0.0644)	
Constant	8.178***	0.147	-6.254***	4.396**
	(2.780)	(0.403)	(0.638)	(1.841)
Observations	79	79	79	79
R-squared	0.145	0.156	0.817	0.235

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 18. Tax Compliance and Copyright Index

VARIABLES	Log of FDI	Log Copyright Index	Log Research and Development	Log Knowledge Capital
Log Copyright Index	3.416***		2.174***	3.599**
	(1.211)		(0.439)	(1.518)
Log Per Capita GDP	-0.102			
	(0.192)			
Log of Free Trade	1.947**			
	(0.972)			
Log Legal Institutions	-1.447*		0.920***	-1.736
	(0.777)		(0.318)	(1.190)
Government Effectiveness (dummy)	0.284	-0.0579		
	(0.280)	(0.0428)		
Log Doing Business	-0.0228			
	(0.147)			
Tax Compliance	0.360*	0.00553	-0.151*	0.714***
	(0.211)	(0.0373)	(0.0808)	(0.225)
Log Research and Development		0.261***		0.617
		(0.0553)		(0.375)
Log of FDI		0.0697***		
		(0.0240)		
Log of Research Quality		-0.402	1.278*	
		(0.330)	(0.737)	
Log University		-0.0705	0.713	
		(0.262)	(0.603)	
Percent of Secondary Enrollment			8.55e-05	
			(0.00242)	
Log of population			-0.0732	
			(0.0654)	
Constant	10.63***	-0.440	-2.924***	9.101***
	(2.805)	(0.378)	(0.662)	(2.134)
Observations	76	76	76	76
R-squared	0.006	0.114	0.709	0.187

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 19. Tax Compliance and Trademark Index

VARIABLES	Log of FDI	Log Trademark Index	Log Research and Development	Log Knowledge Capital
Log Trademark Index	2.683***		1.427***	2.210**
	(0.715)		(0.274)	(1.012)
Log Per Capita GDP	-0.262			
	(0.181)			
Log of Free Trade	2.223**			
	(1.119)			
Log Legal Institutions	-0.863		0.641**	-0.663
	(0.800)		(0.288)	(1.070)
Government Effectiveness (dummy)	0.150	-0.0609		
	(0.283)	(0.0507)		
Log Doing Business	-0.121			
	(0.177)			
Tax Compliance	0.642***	-0.0695	-0.0517	0.878***
	(0.232)	(0.0557)	(0.0997)	(0.267)
Log Research and Development		0.401***		0.465
		(0.0796)		(0.349)
Log of FDI		0.100***		
		(0.0282)		
Log of Research Quality		-0.764	2.158**	
		(0.600)	(0.914)	
Log University		-0.278	0.762	
		(0.436)	(0.754)	
Percent of Secondary Enrollment			-0.00268	
			(0.00272)	
Log of Population			-0.0845	
			(0.0524)	
Constant	9.914***	0.182	-3.883***	6.027***
	(3.266)	(0.462)	(0.603)	(1.880)
Observations	70	70	70	70
R-squared	0.100	-0.136	0.767	0.295

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 20. Tax Levels and Patent Index

VARIABLES	Log of FDI	Log Patent Index	Log Research and Development	Log Knowledge Capital
Log Patent Index	2.795***		0.403	1.424**
	(0.943)		(0.347)	(0.638)
Log Per Capita GDP	-0.111			
	(0.146)			
Log of Free Trade	-0.925			
	(0.637)			
Log Legal Institutions	0.544		1.584***	-2.338**
	(1.010)		(0.327)	(1.149)
Government Effectiveness (dummy)	0.454	-0.00383		
	(0.364)	(0.0561)		
Log Doing Business	-0.0594			
	(0.0952)			
Tax level	-3.493***	1.141***	-1.013**	-1.543
	(0.905)	(0.313)	(0.411)	(1.191)
Log Research and Development		0.0454		1.654***
		(0.0614)		(0.304)
Log of FDI		0.307***		
		(0.0456)		
Log of Research Quality		-1.151***	1.259**	
		(0.357)	(0.601)	
Log University		0.373	0.790	
		(0.256)	(0.521)	
Percent of Secondary Enrollment			-0.00102	
			(0.00287)	
Log of Population			-0.257***	
			(0.0601)	
Constant	10.45***	-1.374***	-4.841***	10.03***
	(2.221)	(0.475)	(0.666)	(2.266)
Observations	88	88	88	88
R-squared	0.529	0.097	0.855	0.553

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 21. Tax Levels and Copyright Index

VARIABLES	Log of FDI	Log Copyright Index	Log Research and Development	Log Knowledge Capital
Log Copyright Index	3.078**		3.717***	-3.436*
	(1.381)		(0.435)	(1.790)
Log Per Capita GDP	-0.207			
	(0.180)			
Log of Free Trade	-0.988			
	(0.829)			
Log Legal Institutions	-0.836		0.475**	-0.259
	(0.786)		(0.235)	(1.355)
Government Effectiveness (dummy)	1.018***	-0.0399*		
	(0.266)	(0.0203)		
Log Doing Business	-0.198			
	(0.137)			
Tax Level	-3.481***	0.0242	0.734	-4.030**
	(1.082)	(0.229)	(0.655)	(1.575)
Log Research and Development		0.247***		1.778***
		(0.0336)		(0.445)
Log of FDI		0.0558***		
		(0.0190)		
Log of Research Quality		-0.245	0.745	
		(0.233)	(0.625)	
Log University		-0.454**	1.601***	
		(0.197)	(0.540)	
Percent of Secondary Enrollment			-0.00226	
			(0.00141)	
Log of population			-0.0126	
			(0.0357)	
Constant	18.90***	0.0124	-2.844***	7.823***
	(3.285)	(0.321)	(0.571)	(2.392)
Observations	87	87	87	87
R-squared	0.330	-0.087	0.491	0.380

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 22. Tax Levels and Trademark Index

VARIABLES	Log of FDI	Log Trademark Index	Log Research and Development	Log Knowledge Capital
Log Trademark Index	2.539***		1.407***	-0.949
	(0.573)		(0.202)	(0.766)
Log Per Capita GDP	-0.376**			
	(0.167)			
Log of Free Trade	0.394			
	(1.141)			
Log Legal Institutions	0.0559		1.097***	-1.282
	(0.765)		(0.296)	(1.263)
Government Effectiveness (dummy)	0.797***	-0.177**		
	(0.238)	(0.0691)		
Log Doing Business	-0.401***			
	(0.137)			
Tax Level	-3.687***	0.265	0.0603	-3.208**
	(1.073)	(0.379)	(0.412)	(1.262)
Log Research and Development		0.391***		1.827***
		(0.0749)		(0.349)
Log of FDI		0.138***		
		(0.0491)		
Log of Research Quality		-0.194	0.132	
		(0.469)	(0.530)	
Log University		-0.968**	2.100***	
		(0.433)	(0.497)	
Percent of Secondary Enrollment			-0.000990	
			(0.00185)	
Log of Population			-0.135***	
			(0.0469)	
Constant	17.06***	-0.339	-3.811***	10.24***
	(3.245)	(0.618)	(0.444)	(2.176)
Observations	75	75	75	75
R-squared	0.410	-0.393	0.833	0.625

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 23. Policy Interactions and FDI, by Country Income Group

VARIABLES	Log of FDI High	Log of FDI Medium	Log of FDI Low
Log Patent Index	-325.3***	0.119	-53.14
	(63.55)	(7.192)	(113.8)
Log GDP per capita	-17.56***	0.630*	6.443
	(2.767)	(0.348)	(7.931)
Log Free Trade	3.605	-2.018	8.641**
	(11.71)	(1.711)	(4.336)
Log Doing Business	-6.691*	1.243*	-19.55*
	(3.745)	(0.684)	(10.52)
Log WEF IPR indicator	-94.27**	0.493	24.42*
	(37.20)	(2.199)	(13.83)
Log Legal Institutions	-23.53	-0.315	1.896
	(14.59)	(1.060)	(6.163)
Log Property Rights	85.57**	1.749	-28.90
	(38.27)	(2.998)	(18.90)
Government Effectiveness	5.454*	-0.738	-7.520
	(2.976)	(0.678)	(4.663)
GDP per cap * Patent Index	132.7***	-0.0895	-31.52
	(17.93)	(2.397)	(55.57)
Free Trade * Patent Index	-4.022	3.005*	-8.057
	(8.342)	(1.541)	(6.074)
Doing Business * Patent Index	4.491*	-0.534	24.87**
	(2.455)	(0.470)	(11.22)
WEF IPR * Patent Index	67.73***	0.995	-34.27**
	(22.17)	(1.968)	(14.65)
Legal Inst. * Patent Index	14.82	-0.411	-0.725
	(10.13)	(1.205)	(7.569)
Property Rights * Patent Index	-65.01***	-1.641	34.28*
	(21.91)	(2.646)	(20.49)
Gov. Effec. * Patent Index	-3.768*	0.997	9.772*
	(2.120)	(0.636)	(5.265)
Constant	233.6***	-1.745	54.02
	(76.83)	(7.693)	(76.74)
Observations	75	181	34
Number of country groups	23	56	12

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 24. Policy Interactions and Merchandise Imports, by Country Income Group

VARIABLES	Log Merchandise Imports	Log Merchandise Imports	Log Merchandise Imports
	High	Medium	Low
Log Patent Index	-91.77**	1.396	-58.89
	(42.26)	(2.082)	(38.57)
Log GDP Per Capita	-5.978**	1.407***	2.594
	(2.388)	(0.166)	(2.111)
Log Free Trade	2.896	-0.929	-5.880*
	(3.780)	(0.618)	(3.402)
Log Doing Business	-0.328	0.357	-6.129
	(1.530)	(0.355)	(4.086)
Log WEF IPR Indicator	-10.52	0.580	6.117
	(13.91)	(1.865)	(3.987)
Log Legal Institutions	-12.70**	0.407	-3.116**
	(5.981)	(0.317)	(1.342)
Log Property Rights	24.50	0.353	-11.69*
	(17.05)	(1.978)	(6.961)
Government Effectiveness	3.229**	-0.208	2.549
	(1.611)	(0.255)	(2.277)
GDP Per Cap * Patent Index	48.11***	-1.655**	-5.397
	(15.30)	(0.775)	(14.13)
Free Trade * Patent Index	-2.918	1.061*	7.990
	(2.730)	(0.570)	(4.970)
Doing Business * Patent Index	0.328	0.251	6.803
	(1.023)	(0.175)	(4.517)
WEF IPR * Patent Index	14.75*	1.047	-8.953*
	(8.891)	(0.894)	(4.689)
Legal Inst. * Patent Index	7.726*	-0.954***	3.851**
	(3.951)	(0.304)	(1.732)
Property Rights * Patent Index	-27.74**	-0.421	17.37**
	(11.75)	(1.033)	(8.469)
Gov. Effec. * Patent Index	-2.186**	0.418*	-3.490
	(1.099)	(0.245)	(2.734)
Constant	72.55*	10.68***	61.72**
	(41.54)	(3.033)	(27.37)
Observations	77	182	34
Number of country groups	23	56	12

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 25. Firm Level Outcomes, Patent Index, and University Industry Cooperation

VARIABLES	Export Turnover	Sales	Total Assets	Intangible Assets
Log FDI	-2.206***	0.886	0.914	0.911*
	(0.393)	(0.591)	(0.681)	(0.495)
Log Patent Index	4.210	-7.091***	-6.276**	-6.531***
	(4.725)	(2.719)	(3.162)	(2.471)
Log GDP Per Capita	0.0465	-1.322	-1.916	-0.247
	(1.440)	(4.588)	(5.708)	(2.187)
Log Free Trade	-4.356	6.613	6.225	6.108*
	(3.260)	(5.985)	(7.003)	(3.561)
Log Doing Business	0.465	-0.280	-0.541	-0.248
	(0.520)	(1.845)	(2.350)	(0.742)
Log Legal Institutions	-13.81***	1.375	0.537	2.016
	(5.238)	(2.403)	(2.712)	(1.500)
Log Property Rights	37.54	-4.255	-1.825	-2.649
	(39.06)	(7.731)	(9.361)	(3.878)
Government Effectiveness	-4.671***	1.003	1.033	0.567
	(1.060)	(0.831)	(0.863)	(1.188)
Log University Industry Cooperation	28.37***	-0.896	-0.919	-4.937*
	(8.899)	(5.587)	(6.908)	(2.948)
Constant	-39.18	13.70	16.95	2.914
	(36.82)	(16.79)	(20.38)	(8.552)
Observations	174964	4474811	4640435	1645572
Number of country groups	7	84	84	78
R-squared overall	0.143	0.0254	0.0118	0.00308

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 26. Firm Level Data, Trademark Index, and University Industry Cooperation

VARIABLES	Export Turnover	Sales	Total Assets	Intangible Assets
Log FDI	-4.365***	0.557	0.649	0.841
	(1.081)	(0.640)	(0.755)	(0.521)
Log Trademark Index	75.42**	6.355***	6.989***	1.780
	(30.18)	(1.563)	(2.160)	(3.311)
Log GDP Per Capita	5.661***	-2.438	-3.116	-2.066
	(1.130)	(3.988)	(5.296)	(2.223)
Log Free Trade	-15.53***	3.713	3.846	5.299
	(5.449)	(6.090)	(7.607)	(3.814)
Log Doing Business	-13.01**	-1.220	-1.596	-1.438
	(5.113)	(1.789)	(2.415)	(0.963)
Log Legal Institutions	-63.27***	1.104	0.326	2.352
	(22.66)	(2.919)	(3.123)	(1.829)
Log Property Rights	-146.1***	-2.957	-0.932	-1.620
	(43.60)	(8.296)	(10.37)	(5.381)
Government Effectiveness	8.648*	0.763	0.804	0.0711
	(5.239)	(1.100)	(1.117)	(1.424)
Log University Industry Cooperation	53.45***	-1.775	-2.084	-2.994
	(3.869)	(4.879)	(5.950)	(3.740)
Constant	395.9***	29.11	34.20	12.89
	(145.1)	(20.66)	(24.81)	(13.16)
Observations	174964	4421516	4586431	1642657
Number of country groups	7	61	61	59
R-squared overall	0.144	0.0506	0.0552	0.0553

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 27. Firm Level Data, Copyright Index, and University Industry Cooperation

VARIABLES	Export Turnover	Sales	Total Assets	Intangible Assets
Log FDI	0.603***	0.809	0.915	0.786**
	(0.221)	(0.498)	(0.637)	(0.369)
Log Copyright Index	144.8***	-16.39**	-17.83**	0.744
	(10.58)	(7.165)	(7.314)	(8.121)
Log GDP Per Capita	-20.71***	0.416	0.00724	-1.785
	(1.516)	(3.591)	(4.526)	(2.705)
Log Free Trade	-53.18***	7.517	8.124	4.750
	(4.074)	(4.748)	(6.501)	(3.274)
Log Doing Business	7.260***	-0.632	-0.886	-0.957
	(0.465)	(1.401)	(1.889)	(0.698)
Log Legal Institutions	72.10***	1.030	0.155	2.427*
	(6.871)	(2.067)	(2.236)	(1.274)
Log Property Rights	-73.14***	-9.119	-7.292	-0.342
	(10.41)	(7.017)	(7.716)	(4.984)
Government Effectiveness	-9.788***	0.964	1.032*	0.0554
	(0.515)	(0.638)	(0.625)	(0.930)
Log University Industry Cooperation	96.17***	-5.042	-5.362	-3.412
	(4.904)	(5.664)	(6.788)	(3.988)
Constant	180.4***	-4.058	-3.425	8.223
	(18.90)	(19.03)	(20.21)	(17.00)
Observations	174964	4474537	4640156	1645414
Number of country groups	7	77	77	73
R-squared overall	0.146	0.119	0.122	0.0579

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 28. Firm Level Data, Patent Index, and Innovation Capacity

VARIABLES	Export Turnover	Sales	Total Assets	Intangible Assets
Log FDI	-4.522***	0.884	0.911	0.903*
	(1.217)	(0.595)	(0.683)	(0.493)
Log Patent Index	12.52**	-7.092***	-6.276**	-6.541***
	(5.184)	(2.720)	(3.163)	(2.474)
Log GDP Per Capita	-2.833**	-1.302	-1.899	-0.186
	(1.314)	(4.625)	(5.733)	(2.183)
Log Free Trade	-16.68***	6.589	6.206	6.046*
	(5.659)	(6.014)	(7.023)	(3.530)
Log Doing Business	-5.529*	-0.377	-0.630	-0.173
	(2.920)	(1.912)	(2.418)	(0.773)
Log Legal Institutions	-55.89***	1.382	0.542	2.026
	(19.08)	(2.410)	(2.717)	(1.498)
Log Property Rights	46.06	-2.352	-0.0536	-0.0304
	(46.03)	(5.420)	(6.492)	(3.058)
Government Effectiveness	2.481	1.001	1.032	0.567
	(3.255)	(0.832)	(0.863)	(1.188)
Innovation Capacity	28.39**	-3.467	-3.287	-7.845**
	(13.35)	(7.649)	(9.591)	(3.298)
Constant	105.7	14.38	17.56	2.368
	(99.26)	(17.51)	(21.19)	(8.589)
Observations	174964	4474811	4640435	1645572
Number of country groups	7	84	84	78
R-squared overall	0.142	0.00946	0.00485	0.0169

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 29. Firm Level Data, Trademark Index, and Innovation Capacity

VARIABLES	Export Turnover	Sales	Total Assets	Intangible Assets
Log FDI	15.20	0.555	0.646	0.835
	(11.06)	(0.640)	(0.754)	(0.518)
Log Trademark Index	-321.6*	6.356***	6.986***	1.763
	(172.7)	(1.564)	(2.159)	(3.305)
Log GDP Per Capita	-16.62**	-2.421	-3.099	-2.018
	(7.822)	(3.993)	(5.292)	(2.205)
Log Free Trade	79.17	3.692	3.825	5.243
	(50.43)	(6.090)	(7.600)	(3.790)
Log Doing Business	77.23*	-1.319	-1.704	-1.482
	(45.24)	(1.783)	(2.432)	(0.915)
Log Legal Institutions	332.7	1.110	0.331	2.362
	(215.3)	(2.921)	(3.124)	(1.829)
Log Property Rights	804.7*	-0.334	1.961	1.484
	(411.6)	(7.243)	(8.931)	(4.501)
Government Effectiveness	-79.79*	0.761	0.803	0.0703
	(43.79)	(1.101)	(1.118)	(1.423)
Innovation Capacity	-96.10	-5.113	-5.731	-6.882**
	(73.06)	(5.282)	(6.496)	(3.181)
Constant	-2,351*	29.90	35.04	13.43
	(1,342)	(20.78)	(25.13)	(13.04)
Observations	174964	4421516	4586431	1642657
Number of country groups	7	61	61	59
R-squared overall	0.143	0.0514	0.0506	0.0372

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Table 30. Bangladesh: Patent Protection and Indicators of Technology Transfer, 1974 – 2007

Variable	FDI	Imports	Non-resident Patent Applications	Resident Patent Applications
Patent Rights Index	14.424***	0.986***	3.212***	2.057
	(4.322)	(0.332)	(0.630)	(1.338)
Real GDP per capita	11.853	3.826	2.730	-11.047
	(21.961)	(3.489)	(3.121)	(8.389)
Growth rate	0.119	0.0004	-0.005	0.070
	(0.109)	(0.018)	(0.026)	(0.062)
Economic freedom	9.326	-0.516	-0.704	-2.300
	(6.046)	(0.562)	(0.683)	(2.141)
Population (a proxy for market size)	-5.431	10.974	1.265	-20.403
	(58.725)	(10.681)	(8.705)	(23.145)
Market openness	1.184	-	-0.072	0.079
	(1.480)		(0.310)	(0.525)
Observations	30	34	30	30
Adjusted R-squared	0.9222	0.9581	0.9329	0.3512

Notes: 1) Each regression includes a time trend and a constant term. All variables except GDP growth rate and time trend are in natural log format. Robust regression is used in this table. The robust standard errors are in parentheses. ***, **, and * denote 1%, 5%, and 10% levels of significance, respectively. 2) The Economic Freedom index includes the following main components of freedom: personal choice, voluntary exchange coordinated by markets, freedom to enter and compete in markets, and protection of persons and their property from abuse by others. 3) Market openness refers to trade as a share of real GDP.

Sources: Patent Rights Index (Park, 2008); FDI, imports, real GDP per capita, growth rate and population (World Bank, World Development Indicators, WDI); Economic freedom (Economic Freedom of the World Report, 2009); market openness (Penn-World dataset, table 6.3, via NBER on-line); patent applications (WDI and WIPO Statistical Database). Calculations by Thitima Puttitanun, consultant to the Secretariat.

TECHNICAL APPENDIX: EXPLANATION OF THE TSLS ESTIMATOR

1. The Instrumental Variables (IV) estimator is used in this paper's regression model because of the reverse causality between the variables. This approach enables us to obtain a consistent estimator of the unknown coefficients of the population regression function.

The IV Model and Assumptions

2. We examine the population regression model relating the dependent variable Y_i and regressor X_i

$$Y_i = \beta_0 + \beta_1 X_i + u_i, i = 1,...., n$$

where u_i is the error term representing omitted factors that determine Y_i. If X_i and u_i are correlated, then the OLS estimator is inconsistent. The instrumental variables estimator uses an additional variable known as an instrument to isolate that part of X that is uncorrelated with u_i.

- Key Definitions:

  Endogenous variable: the variable which is correlated with the error term

  Exogenous variable: the variable which is not correlated with the error term

  Two conditions for a valid instrument: Instrument Relevance and Instrument Exogeneity

  Instrument Relevance $corr\ (Z_i, X_i) \neq 0$

  Instrument Exogeneity $corr\ (Z_i, u_i) = 0$

3. If an instrument is relevant, then the variation in the instrument is related to the variation in X_i. If an instrument is also exogenous, then the part of the variation of X_i captured by the instrumental variable is exogenous. If an instrument is relevant and exogenous it captures the variation in X and this variation is exogenous. The exogenous variation is then used to estimate the population coefficient β_1.

The Two Stage Least Squares (TSLS) Estimator

4. If the instrument Z satisfies the conditions for relevance and exogeneity, then the parameter β_1 can be estimated using a IV estimator called Two Stage Least Squares. The First Stage of the estimation links the endogenous variables to the instrument. It decomposes X into two components: one which may be correlated with the regression error term, and the other that will not be correlated with the regression error term. The Second Stage uses the second component to estimate the parameters of interest.

5. Assume the following population regression function linking X and Z

$$X_i = \pi_0 + \pi_1 Z_i + v_i$$

where π_0 and π_1 are the intercept and the slope coefficients, respectively, and v_i is an error term. The key decomposition lies in obtaining the predicted values from this equation, i.e. the values coming from $\pi_0 + \pi_1 Z_i$. The predicted values from this equation (such as $\hat{X}_i$) are going to be uncorrelated with u_i from the model because Z_i is exogenous. The TSLS process uses the predicted values from the regression equation of X_i on Z_i and disregards v_i. However, π_0 and π_1 must be calculated to obtain the predicted values of X_i. OLS is applied to this first stage regression and then calculated to predict value as the following:

$$\hat{X}_i = \hat{\pi}_0 + \hat{\pi}_1 Z_i$$

6. Once these predicted values are complete, they can be used in lieu of the original data in the model that were associated with the reverse causality problem. Therefore we have the following:

$$Y_i = \beta_0 + \beta_1 \hat{X}_i + u_i, i = 1,...., n$$

Now $\hat{\beta}_0$ and $\hat{\beta}_1$ are the TSLS Estimators.

The Sampling Distribution of the TSLS Estimator

7. The TSLS Estimator is as follows:

$$\begin{aligned}\hat{\beta}_1^{TSLS} &= \frac{s_{ZY}}{\hat{\pi}_1 s_Z^2} \\ &= \frac{s_{ZY}}{\left(\frac{s_{ZX}}{s_Z^2}\right) s_Z^2} \\ &= \frac{s_{ZY}}{s_{ZX}}\end{aligned}$$

For statistical inference purposes the sampling distribution of $\hat{\beta}_1^{TSLS}$ must be scrutinized. In large samples averages of random variables are normally distributed. The $\hat{\beta}_1^{TSLS}$ sampling distribution is approximately normal, as follows: $\hat{\beta}_1^{TSLS} \sim N\left(\beta_1, \sigma^2_{\hat{\beta}_1^{TSLS}}\right)$, where $\sigma^2_{\hat{\beta}_1^{TSLS}} = \frac{1}{n} \cdot \frac{\text{var}[(Z_i - \mu_z)u_i]}{[\text{cov}(Z_i, X_i)]^2}$. Inference and hypotheses tests concerning β_1 can be performed because it is distributed asymptotically normal. Likewise a 95% confidence interval can be calculated in the usual manner: $\hat{\beta}_1^{TSLS} \pm 1.96 * SE\left(\hat{\beta}_1^{TSLS}\right)$.