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INTELLECTUAL PROPERTY PROTECTION AND THE LICENSING OF TECHNOLOGY TO DEVELOPING COUNTRIES

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Abstract

In this paper we study the influence of stronger intellectual property protection on technology transfer into developing countries via licensing. Using panel data for the post-TRIPs period 1995-2005, we find that stronger protection is associated with increased royalty and license fee payments by developing countries, implying greater technology transfer into these countries. This result is robust to the inclusion of country fixed effects, as well as alternative specifications of the model estimated. The strong overall statistical significance of the protection variable is found to be driven by the sub-index of coverage, which makes eminent sense in view of the substantial increase in the coverage of patentable subject matter by developing countries post-TRIPs. Other factors of importance are scale variables such as per capita income and population, as well as human capital and trade openness of the technology-importing countries. The economic significance of the protection variable also appears to be substantial, with changes in this variable accounting for technology inflows of about US $3.4 billion to US $5.5 billion (base year 2000) in the post-TRIPs sample period. These magnitudes comprise 3.5% to 5.7% of the total value of royalty and license fees over 1995-2005 (at 2000 prices). Overall, our results are noteworthy.

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1. Introduction

In the wake of the Trade Related Intellectual Property rights (TRIPs) agreement of 1994, there has been renewed interest in the influence of intellectual property rights on various economic phenomena, technology transfer being one of them. In fact, Maskus (2003) points out that Article 7 of the TRIPs agreement mandates that the agreement should also be a vehicle of technology transfer from the more advanced to the less advanced countries, thereby raising productivity and growth. The transfer of technology is a rather complex beast and occurs in several different ways – some indirect, such as international trade, foreign direct investment and the movement of personnel, and some direct, such as overseas research and development via affiliates, and licensing. This paper focuses on the influence of stronger property rights on the latter-most mode of technology transfer, namely the licensing of technology.

Technology transfer today is not quite the same phenomenon that it used to be in earlier centuries. With the passage of time, the predominant proportion of technology has come to be concentrated in the hands of multinational corporations, rather than individuals (Scherer and Ross 1990), and the licensing of technology has become an important vehicle of technology transfer between nations. According to World Bank data, the royalty and license fee payments by developing countries totalled almost $27 billion in 2007 (World Bank 2009). Survey evidence reveals, however, that owing to perceptions of weak intellectual property rights in a sample of developing countries, multinationals were hesitant about transferring their frontier technology to those countries (via wholly or partially-owned affiliates), as well as licensing it to unaffiliated firms in those countries (Lee and Mansfield 1996). The question then arises whether voluntary technology transfer[1] across countries – both in vintage and quantum – has been responsive to the instrument of intellectual property protection that developing countries have employed, albeit often selectively and idiosyncratically.

The existing empirical evidence is less than convincing in establishing a relationship between licensing and the strength of protection, despite claims to the contrary. Although Nicholson (2007) finds a positive significant relationship between the number of US firms engaged in licensing in 1995 and the strength of intellectual property protection in the recipient nations, he cautions that this must be interpreted as increasing the frequency and not the level of licensing activity. Even this result vanishes when he splits the sample of recipient countries into OECD and non-OECD groups. Branstetter, Fisman and Foley (2006) report weak results for the effect of stronger protection on intra-firm royalty payments – the index of protection dummy they use is statistically insignificant in four of the six regressions reported (see their Table III, p. 336), despite an enormous sample size.[2] Moreover, while their regressions reveal that the positive effect of stronger protection was significant for firms which had high patent use, this is only a statement that the protection variable was *relatively stronger* for the high-patent-use firms than for the low-patent-use firms, and does not imply that the effect of stronger protection was significant for either group of firms per se. Park and Lippoldt (2005), using firm-level panel data for the period 1992-1999, find the receipt of license fees by US firms to be strongly affected by intellectual property indices, except when the receipts are from unaffiliated sources. They do not, however, discuss the possibility of endogeneity bias. Fosfuri (2002) finds no significant relationship between licensing (as well as other modes of international technology transfer) in the chemical industry and the strength of intellectual property protection that countries provide.[3] Yang and Maskus (2001) present somewhat complex results – they find a *negative* relationship between intellectual property protection and licensing for indices of protection below a certain threshold, although above this threshold a positive relationship obtains. In either case, their results may be subject to endogeneity bias. Smith (2001) reports a weak, positive relationship between licensing abroad by US firms and stronger protection, but her results are based on a single cross-country cross-section for 1989, and she utilizes the Rapp and Rozek (1990) index of protection which is subjectively determined.[4] Ferrantino (1993) finds that the intellectual property protection variables he uses (essentially membership of intellectual property conventions, and duration of protection) are all insignificant in explaining the flows of royalties and license fees of US multinationals.[5] Taken together, these studies present mixed evidence at best, regarding the contention that stronger property rights encourage the licensing of technology, necessitating further research into this relationship; and that is the object of our study.[6]

In the literature reviewed above, some studies use a single cross-country cross-section of data, and hence the results would be subject to the usual shortcomings of such data, where the protection measures vary with other country characteristics. Since there is no time series variation, generalisations over time would also be suspect. We also noted that some studies used protection measures that have not been objectively computed (and are, in fact, available for just one time period). Such measures, based on individual perceptions, are surely likely to be subject to endogeneity bias. Most studies used either wholly or partially pre-TRIPs data, further bedevilling the issue of the exogeneity of the protection variable. Finally, none of the studies comment upon what aspect of intellectual property rights (coverage of protectable matter, duration of protection, possibility of revocation of protection once granted, availability of legal enforcement mechanisms, etc.) might be driving the overall result vis-à-vis the protection variable. Our study addresses each of these issues

We attempt to identify and measure the influence of stronger intellectual property protection in less-developed countries, on technology transfer into these countries, where the latter is captured in terms of royalty and license fee payments made by these nations. A distinguishing feature of our empirical strategy is that it draws on the fact that the developing countries strengthened their protection of intellectual property in the post-TRIPs period, *under pressure from the developed countries*, as discussed in detail in section 3.2 below. This strengthening, in other words, was not voluntary, and was therefore exogenous to the phenomenon of developing country technology inflows (and expectations thereof) over this period.[7] Therefore, variations in the strength of intellectual property protection granted by developing countries in the post-TRIPs period, should help identify their effect on variations in technology transfer into these countries.

Using panel data for the period 1995-2005, we find that stronger protection of intellectual property is associated with increased royalty and license fee payments by developing countries or greater technology transfer into these countries. Our results are found to be robust to the inclusion of country fixed effects, as well as alternative specifications of the model estimated. Re-estimation of the model using the component sub-indices of the protection variable, reveals that the overall statistical significance of the protection variable is driven by the sub-index of coverage. This is cogent in view of the substantial increase in coverage of the patentable subject matter by developing countries, subsequent to the TRIPs agreement. Other factors that may significantly influence technology transfer via licensing turn out to be the market-size/scale-of-activity variables such as per capita income and population, as well as human capital and trade openness of the technology-importing countries. The protection variable also appears to be strongly economically significant, with changes in this variable accounting for developing country technology inflows worth about US $3.4 billion to US $5.5 billion (base year 2000) in the post-TRIPs sample period. These magnitudes constitute about 3.5% to 5.7% of the total value of technology transfer into developing countries over the sample period.

Section 2 briefly discusses some related theory, and how it might inform the empirical exercise. Section 3 sketches out the empirical strategy adopted in this study. Section 4 discusses the data set, and the construction of the variables. Section 5 reports the detailed empirical results, and Section 6 briefly concludes.

2. Insights from Theory

Researchers point out that firms are often unwilling to license their technologies, because that might provide rivals a platform to develop something better (Scherer and Ross 1990). Evidence shows, that the incidence of licensing activity in an industry is negatively related to the ease with which technologies can be copied (Anand and Khanna 2000). In other words, the incidence of licensing by firms is likely to vary positively with the strength of protection, insofar as stronger protection limits imitation by the licensee and increases the profitability of licensing. By extension, nations that provide stronger protection are likely to be able to purchase more technology/licenses, ceteris paribus, than those providing relatively weaker protection, on account of this ‘economic returns effect’ (Yang and Maskus 2001).

On the other hand, stronger protection may slow down innovation and diminish the pool of technology available for transfer due to the 'monopoly power effect' (Yang and Maskus 2001), as well as when firms try to preserve market share (Correa 2003), and thereby reduce licensing activity over the longer run. Gallini and Winter (1985) argue that this effect is likely to be more nuanced, and stronger protection need not invariably create monopolies and limit the flow of information. Assuming that firms license their technology, they show that licensing encourages innovation when the licensor and licensee have similar production costs, but discourages innovation when their production costs diverge widely. To the extent that the former cost structure may obtain in certain industries in the North, licensing between Northern *innovating* firms in these industries may well result in a larger (not smaller) pool of technology available for transfer. This larger pool can then be licensed to Southern *producing* firms.

Dinopoulos and Segerstrom (2010) construct a dynamic North-South trade framework to show that stronger intellectual property rights in the South are consistent with a permanent increase in technology transfer to the South, *within* multinational firms. In general, however, the theoretical literature on licensing has few direct hypotheses to offer vis-à-vis the relationship of interest in this study, and even those theoretical results are obtained under rather restrictive conditions, limiting their general applicability. These concerns underline the necessity of empirical approaches to address the issue at hand, to which we now turn.

3. Empirical Strategy

3.1 *The Model Specification*

We hypothesize that technology transfer into developing countries (represented by royalty and license fees paid by these countries) is determined by the strength of intellectual property protection that these countries provide. Countries that provide stronger protection (as reflected by observable laws) may, reasonably, be expected to be the ones to which more technology is made available, resulting in larger royalty and license fee payments. Thus, royalty and license fee payments are made for the right to use various kinds of intellectual property such as patents, trademarks, copyrights, industrial designs, utility models, and technical instructions, and there exist a variety of arrangements to do so (Gutterman 1995).

As is well-understood, technology transfer is determined by other country-related, time-varying factors as well. Thus, the size and level of development of the economy (captured by per capita income and population), the capacity to absorb foreign technology (represented by the stock of human capital), trade openness of the economy, and economic freedom, are factors that vary across countries and over time, partially explaining the differences in technology transfer across these countries over any given time span. Omitting these factors, and concentrating solely on the protection variable, would yield biased estimates of the influence of the protection variable on technology transfer.

In addition to the above factors, countries also vary systematically in several other dimensions as well; differences that tend to persist, or are relatively unvarying, over long spans of time. This set of variables can be quite diverse, including (unobservable) factors pertaining to the enforcement of legislation (including intellectual property laws), factor endowments, attitudes to work, whether colonized in the 'recent past' (and hence characterized by certain long-term advantages or disadvantages) etc., and spelling them out in totality is not quite possible. Since they vary relatively little over long time intervals, they are picked up by country fixed effects. In our specific context, some of these differences might be less important than they might appear in theory, given that our sample pertains to developing countries only and is, hence, relatively homogeneous.

Then there are factors that are common across countries for a given time period, but change over time. The global financial and economic climate, the international financial architecture, global economic shocks etc., are factors that fall in this category. They may be presumed to impinge on different countries in similar fashion, but vary in intensity and prevalence over time for all of these countries.

In view of the diverse categories of factors relevant for the phenomenon of technology transfer, we may express the relationship of interest as follows:

$$RLF_{it} = \beta_1 IP_{it} + \beta_2 Z1_{it} + Z2_i + Z3_t + u_{it} \qquad (1)$$

where RLF_{it} refers to the (deflated) royalty and license fee payment by country *i* in year *t*, IP_{it} is the strength of intellectual property protection in country *i* in year *t*, as reflected by the pertinent observable legislation, $Z1_{it}$ represents the country-related, time varying factors, $Z2_i$ denotes the factors specific to country *i* that do not vary with time (including enforcement efficacy of intellectual property laws),[8] $Z3_t$ are the factors that affect all countries in question but may vary over time, and u_{it} is the random error term for country *i* in year *t*.

3.2 *A Case for the Exogeneity of the IP variable*

For this estimation to be convincing requires that the index of protection variable *IP* be exogenous, which would mean that the strength of intellectual property protection provided by the sample nations should not have been motivated by technology transfer into these nations. This is presumably true of the post-TRIPs period, wherein developing countries were forced to strengthen their protection of intellectual property as per the TRIPs agreement of 1994.[9] This strengthening of intellectual property protection was forced upon these countries by the developed nations, after prolonged negotiations ending in the World Trade Organization (WTO) agreement of 1994, of which the TRIPs agreement was a part. Thus, Drahos (2002) in his study of international intellectual property standard-setting observes that "… developing countries have comparatively little influence …", the major cause of which "lies in the continued use of webs of coercion by the US and EU, both of which remain united on the need for strong global standards of intellectual property protection".

By all accounts, the developing countries stiffly resisted having to strengthen their protection of intellectual property, partially evidenced by the fact that the Uruguay round of trade negotiations under the GATT dragged on for some eight years; for they feared decreased access to technology inflows via imitation, and higher prices of the products using protected technology, in particular pharmaceuticals and agriculture. To break this stand-off, certain developed countries used strong economic and diplomatic pressures to make the developing countries cede their position (Deere 2009, Drahos 2002, Watal 2001). Thus, right through the 1980s and early-1990s, the United States used various provisions of its 1974 Trade Act to push its intellectual property agenda in the GATT. Section 301 of the Trade Act allowed it to withdraw trade benefits and impose duties on imports from non-complying countries. Similarly, the Generalized System of Preferences (GSP) programme was amended to introduce 'adequate intellectual property protection' as one of the criteria necessary for eligibility of GSP treatment, i.e. preferential duty-free exports to the United States. Furthermore, the 'Special 301' provisions allowed it to place on the 'Watch List' or 'Priority Watch List' (for punitive action) countries that were in the vanguard of the resistance to the US proposals on intellectual property.

Drahos (2002) notes that the European Union also enacted similar laws – for instance, the so-called Council Regulation 264/84 – which, however, were sparingly used against the developing countries, because the EU could not muster the adequate consensus. Commenting on the possibility of collapse of the GATT negotiations on intellectual property, the then United States trade representative is quoted by Drahos (2002) as saying that "… there are a number of consequences to failure. First will be an increase in bilateralism. For those of you who think bilateralism is a bad thing, a bad thing will have come about". This was nothing if not a veiled threat to the developing countries which had dug in their heels. The signing of the TRIPs agreement, and the subsequent strengthening of intellectual property rights by the developing countries was, thus, determined by exogenous pressure, and was not a result of actual or expected changes in technology inflows.

4. The Data Set and Variables

Data on royalty and license fees paid by countries were extracted from World Development Indicators (World Bank 2009), for the post-TRIPs years 1995, 2000 and 2005. Quinquennial data were used, because data on the causal variable of interest – the index of intellectual property protection – were available quinquennially (see below for details). The 'royalty and license fees payment' figures for each country were deflated by the corresponding *GDP* deflator (base year 2000), to derive the regressand. *RLF*.

The causal variable of interest, or the strength of intellectual property protection in the technology-importing developing countries, is measured by the Ginarte-Park index of patent rights, which is available only quinquennially (Ginarte and Park 1997; Park 2008). This index incorporates five important aspects of patent laws to manifest the strength of protection a nation provides. These criteria are the extent of coverage (or the matter that can be patented), duration of protection (or the number of years for which protection is available under the law), membership of international property rights covenants (such as the Paris convention, Berne convention and others), potential reasons for the revocation of patent rights once granted (for instance, through compulsory licensing on moral or health grounds), and enforcement mechanisms provided by law (such as preliminary injunctions, contributory infringement, and burden of proof reversal). For each of these five aspects a country receives a score ranging between 0 and 1, a larger score indicating stronger protection in that aspect. This yields five sub-indices – the index of coverage (*ICOV*), the index of duration (*IDUR*), the index of membership (*IMEM*), the index of potential revocation (*IREV*), and the index of enforcement (*IENF*) – which are aggregated to derive the overall index (*IP*). This overall index ranges from 0 to 5, with higher values indicating stronger patent protection.[10]

Several other country-related, time varying factors are relevant in the present context, factors that we represented by vector *Z1* in the equation specified above. The market size of the economy is one such factor. Thus, the larger the economy in terms of the goods and services it produces, the larger its technology needs and the larger, ceteris paribus, its demand for technology imports. The market size of the economy was captured by a country's per capita *GDP* at constant 2000 prices (*GDPPC*), and population (*POP*). These data were taken from the World Development Indicators (World Bank 2009).

The purchase of foreign technology, whether for production purposes or as an input into the domestic innovation process, will also depend on the importing country's capacity to absorb it (Nelson and Phelps 1966); and this capacity is likely to be determined by its human capital base. Thus, countries with relatively more human capital tend to innovate more (Romer 1990), requiring larger imports of complementary foreign-technology inputs. Further, given that in certain skills (e.g. communications) the returns are higher if others are also skilled, increases in human capital tend to induce higher rates of investment (Barro 1991), which might be associated with larger technology imports. Human capital (*HUMANK*) is defined as the average gross enrollment rate in secondary and tertiary education in the technology-importing developing countries, and these data were available from World Development Indicators (World Bank 2002, 2009).

How much technology is transferred across borders will also depend upon whether this is feasible or actively discouraged using various instruments. We capture this feasibility in terms of the openness of the economy to trade and investment from abroad. While none of the competing measures of openness available in the literature are entirely satisfactory, we use the 'freedom to trade' sub-index computed by Gwartney, Lawson and Norton (2008). This sub-index incorporates various aspects of trade openness such as taxes on international trade, regulatory trade barriers (including non-tariff barriers), black market exchange rates, as well as international capital market controls. We christen this sub-index the trade openness index (*TOI*), which ranges from 1 to 10, with higher values indicating freer trade.

The extent of economic freedom in a country would be another factor of relevance to the feasibility of technology imports. One would suppose that the more interventionist the government and the more controls it imposes on economic activity, the more difficult would be international transactions, including those relating to the purchase of technology. We compute the economic freedom index (*EFI*) as the average of four sub-indices constructed by Gwartney, Lawson and Norton (2008) – specifically, the magnitude of government taxes, expenditure and enterprises, the legal structure and security of property rights, the access to sound money, and the regulation of credit, labour and business. Thus, we adapt the Gwartney-Lawson-Norton index of freedom by dropping their fifth sub-index 'freedom to trade', which was used to construct the trade openness variable discussed above. This re-computed index varies from 1 to 10, with higher values implying greater economic freedom.

The descriptive statistics pertaining to the regressand and regressors discussed above are presented in Table 1. The table reveals that the average index of intellectual property protection for our sample countries rose substantially by more than 33% over the period 1995-2000, and by about 11% over the subsequent quinquennial period 2000-2005. At the same time, the average royalty and license fees payments by our sample of developing countries increased by a whopping 69% during the initial five-year period and a relatively smaller 43% over the subsequent five-year period. The percentage changes in the deflated average payments are not radically different. This observation, of course, does not establish any concrete relationship between these two variables, and for that we require more formal analysis.

5. Empirical Results

The correlation between the logarithm of *RLF*, the regressand, and the logarithm of *IP*, the causal variable, is a healthy 0.53, suggesting a positive relationship between technology transfer to developing countries and the strength of intellectual property protection; and this observation is supported by the scatter plot in Figure 1. With these preliminary observations, we proceed to the estimation results, where all variables are taken in logarithms.

5.1 *Does the level of protection explain the magnitude of technology transfer to developing countries?*

In presenting the random effects regression results in Table 2, we follow the well-established procedure of starting out with the ‘base model’, and proceeding to the ‘full model’. In all the reported regressions we find that the hypothesis that the regressand is randomly determined is strongly rejected, the associated *p*-values being 0 in all cases. The ‘base model’ results of column (1) show that the index of protection variable is positive and very strongly significant at the 1% level. These results, however, are likely to be subject to considerable omitted variable bias, and so we introduce the relevant control variables in the subsequent regressions. The addition of GDP per capita in the column (2) regression results in a considerable change in the coefficient of the *IP* variable. Both regressors exercise a positive and strongly significant influence on the dependent variable. Supplementing the demand side variable by population in the column (3) regression further reduces the magnitude of the coefficient of the *IP* variable. All three regressors are, however, found to exert a strongly positive effect on technology transfer. Inclusion of the human capital variable *ENROL* does not change the qualitative picture; the coefficient of the *IP* variable in column (4) remains positive and significant, although it settles around 0.9. The human capital variable is found to have a strongly positive effect on the dependent variable, as one would expect. The other variables also continue to have a positive and significant effect on the regressand. The trade openness index *TOI* included in the column (5) regression does not disturb the earlier results, and all regressors are found to be positive and strongly significant. Finally, the column (6) regression is also in line with the earlier results – the coefficient of the *IP* variable continues to be around 0.8, and all variables have a positive and strongly significant effect on the dependent variable, except the economic freedom index *EFI*, which is positive but statistically insignificant. An *F*-test reveals the joint insignificance of the year fixed effects, the associated *p*-value being 0.063, and these are therefore omitted from the ‘full’ regression As indicated at the bottom of the table, all regressions allow for clustering at the cross-section or country level.

Given the panel nature of our data, where the cross-section units may differ from each other on many counts other than explicitly accounted for by the control variables, one may want to repeat the above estimations using country fixed effects. The results of this exercise are presented in Table 3. Instead of discussing the results of each of the regressions individually, it would suffice to note that the index of protection variable *IP* is strongly significant right through, with its coefficient settling around 1.3 in the 'full' model. However, the only other variable that is statistically significant, and weakly so, is the trade openness index *TOI*; despite the fact that the hypothesis that all the regressors are jointly zero is strongly rejected for all the regressions. Once again, the year fixed effects are found to be jointly insignificant (*p*-value 0.066), and are omitted from the 'full' regression. Further, a Hausman specification test comparing the 'full' fixed effects regression (column 6, Table 3) with the 'full' random effects regression (column 6, Table 2) does not reject the null hypothesis that the difference in coefficients is systematically *in*significant, the associated *p*-value being 0.643.

One is not too surprised at the insignificance of the control variables in the Table 3 regressions, for the fixed effects estimator is a 'within-estimator', and totally ignores 'between-variation'. In our context, with data for only three time points, the latter is in fact the major source of variation. This, by itself, could be one reason for preferring the random effects results. Further, recall that the intellectual property protection variable was computed on the basis of a small number of factors relating to patent protection and, by definition, omits various other aspects of protection that may be important. To the extent that these omitted factors vary persistently across countries, fixed effects estimation implies that they are omitted from estimation, thereby weakening the signal to measurement error ratio. Moreover, as noted earlier, the case for fixed effects estimation is perhaps weaker in our context, because our sample is relatively homogeneous insofar as it comprises developing countries only. In any case, however, even the fixed effects results are found to be supportive of the significance of the *IP* variable vis-à-vis technology transfer into developing countries; and may be seen as a robustness check of sorts of the random effects results.

5.2 *Economic significance*

Although the random effects results appear relatively preferable on several grounds, we will use the coefficient estimates of the *IP* variable from both the random and fixed effects 'full' regressions [i.e. Table 2, column (6); and Table 3, column (6)], to determine the economic significance of the *IP* variable vis-à-vis technology transfer into developing countries. These coefficients were found to be about 0.8 and 1.3, respectively. This implies that a 1% change in the index of protection is likely to raise technology transfer by about 0.8% to 1.3% per period, post-TRIPs. Note that this effect (of a 1% change in the regressor leading to a certain percentage change in the regressand) is independent of the length of period, as long as both percentage changes refer to the same period. For the illustration below, therefore, we take it to hold for each year of a quinquennium. Given that the royalty and license fees paid by developing countries in 2000 (the mid-year of our sample period) was about $8.85 billion at 2000 prices, this translates to an increase in the value of technology transfer by about $71 million (using the random effects estimate) to about $115 million (using the fixed effects estimate) in the year 2000. Over the post-TRIPs sample period 1995-2005, the index of protection for our sample of developing countries increased from 2.080 to 3.068, or by about 47.5%. This implies that the value of technology transfer into developing countries on account of the strengthening of intellectual property rights was about US $3.4 billion to US $5.5 billion (base year 2000), in the post-TRIPs period 1995-2005. These flows constitute about 3.5% to 5.7% of the total value of technology transfer into developing countries (i.e. as a percentage of the total royalty and license fees paid, at 2000 prices), over the sample period 1995-2005. These are rather substantial figures, and strongly support the contention that changes in the strength of protection may have a very significant effect on technology transfer into developing countries. Furthermore, the actual inflows on account of the strengthening of intellectual property protection might be even higher, considering that the dependent variable may not have completely adjusted to the change in the causal variable over the period in question, and the full adjustment may become apparent only in the years to come.

5.3 *Some Robustness checks: Using alternative regressors*

In this section we discuss the results of some robustness checks conducted on the exercises reported in section 5.1 above. Columns (1) and (2) of Table 4 report the random and fixed effects estimation results, respectively, for the ‘full’ regressions, substituting manufacturing value added per capita (*MVAPC*) in lieu of *GDP* per capita (*GDPPC*). This may be defended on grounds that most technology transfer, particularly of the kind that requires royalty and license payments, occurs in the manufacturing sector. We find that this does not make any substantive difference to the results obtained in section 5.1 above. As before, the *IP* variable exhibits a strongly significant positive effect both in the random effects regression of column 1, as well as the fixed effects regression of column 2. Again, as for the control variables, barring the economic freedom variable *EFI* all the other regressors are strongly positive in the random effects regression of column 1, whereas in the fixed effects regression of column 2 only the manufacturing value added variable *MVAPC* is weakly significant.

Columns 3 and 4 of Table 4 present the random effects and fixed effects results, respectively, of the full model, replacing the human capital variable *ENROL* by the alternative literacy variable *LIT*. The results, again, are pretty much in line with those presented in section 5.1 above. The intellectual property protection variable *IP* is positive and strongly significant in both regressions. In the random effects regression of column (3), the economic activity variables *GDPPC* and *POP*, and the trade openness variable *TOI* are all strongly positively significant as well, whereas the literacy variable exhibits only a weak positive effect on the regressand. In the fixed effects regression of column (4), of the controls only the literacy and trade openness variables are weakly positively significant.

The economic significance of the *IP* variable is also roughly the same as what we demonstrated in section 5.2 above, because the coefficient of this variable is about 0.9 to 1.0 in the random effects specifications [of columns (1) and (3)], and about 1.2 to 1.3 in the fixed effects specifications [of columns (2) and (4)],

5.4 ***What Drives the Overall IP Result?: Disaggregating the IP index***

5.4.1 *Considering all the protection sub-indices together*

As explained in section 4 above, the index of protection variable *IP* has been computed using five sub-indices – the index of coverage *ICOV*, the index of duration *IDUR*, the index of membership *IMEM*, the index of revocation *IREV*, and the index of enforcement *IENF*. The question of interest then is whether all five of these sub-indices are driving the results that we found above vis-à-vis the index of protection variable *IP*, or whether only a sub-set of these indices is the motive force.

To address this issue, we first repeated the estimations using all five sub-indices underlying the protection variable, in place of variable *IP* itself, and these results are reported in Tables 5 and 6. From the random effects results reported in Table 5, we note that in the column 1 regression the index of coverage *ICOV* has a positive, strongly significant effect on the transfer of technology into developing countries. In addition, the index of enforcement *IENF* exercises a weak positive influence on the regressand, and so does the index of duration *IDUR*, albeit using a one-tail test. Of course, this regression is likely to be subject to omitted variable bias, to remedy which we add the control variables in the regressions presented in the adjoining columns. In the column 2 regression *ICOV* continues to exert a positive, though weakly significant influence on the dependent variable; and *IDUR* continues to be weakly positive using a one-tail test. The economic activity variable *GDP* per capita exhibits a very strong positive effect on technology transfer into developing countries. In the column 3 regression, *ICOV* is strongly positive, while *IDUR* is weakly positive using a one-tail test as before. Both *GDPPC* and *POP* are found to have positive and very strongly significant coefficients. The picture is unchanged in the column 4 regression, where the added regressor *ENROL* is also found to exert a strong positive effect on the *y*-variable. Adding the trade openness index in the column 5 regression does not alter the picture very much, except that *IDUR* is now no longer even weakly significant. Finally, adding the economic freedom index *EFI* in column 6 again does not alter anything much – the index of coverage *ICOV* is still strongly positive, both the economic activity variables *GDPPC* and *POP* are also positive and strongly significant, and so is the human capital variable *ENROL*, whereas the trade openness index *TOI* is only weakly positively related to the dependent variable. The year fixed effects are found to be jointly insignificant in the 'full' regression of column (6), with a *p*-value of 0.115, and are omitted from the regression. From this set of regressions, it appears that the statistical significance of the *IP* variable that we noted above is driven by the index of coverage *ICOV* for the most part, and perhaps by the index of duration *IDUR* to a small extent. This makes good sense, since in the post-TRIPs period the developing countries increased their levels of protection by expanding, for instance, the coverage of their protection laws to allow patents in the areas of pharmaceuticals and chemicals, as well as agriculture. Further, these countries also increased the duration of protection to a uniform 20 years, as per the TRIPs agreement.

Proceeding to the fixed effects results in Table 6, we note that the base regression of column (1) shows only *ICOV* to have a positive and strongly significant effect on the dependent variable, whereas *IDUR* is positive and only weakly significant using a one-tail test. The successive addition of the control variables *GDPPC*, *POP*, and *ENROL* in columns (2), (3) and (4) do not change this result. The further addition of *TOI* and *EFI* in columns (5) and (6) also produce results in line with those we found earlier – the index of coverage *ICOV* continues to be the only significant protection variable, and of the control variables, only *TOI* is weakly significant using a one-tail test. Once again, the year fixed effects in the full model are found to be statistically insignificant at the 5% level, the associated *p*-value being 0.082, and are dropped from the model estimated. Thus, the fixed effects results support the random effects results discussed in the previous paragraphs, in that the significance of the *IP* variable is driven by the index of coverage *ICOV*.

5.4.2 *Considering each of the protection sub-indices individually*

We repeat the regression exercises, now including each of the protection sub-indices individually, rather than all the sub-indices together as in the previous sub-section. Thus, for example, columns (1) and (2) of Table 7 report the random effects and fixed effects results, respectively, of the ‘full’ model, including only the index of coverage *ICOV* in lieu of the protection variable. Similarly, columns (3) and (4) report the random and fixed effects results including only the index of duration *IDUR* in lieu of the protection variable, and so on for the remaining columns in the Table..

From columns (1) and (2), we find that *ICOV* has a positive and strongly significant relationship with royalty and license fee payments or technology transfer into developing countries in the post-TRIPs period. Further, as in the case of the random effects regressions discussed in the previous sections, most of the control variables (barring the economic freedom index *EFI*) also exhibit a strong positive relationship with the regressand. In the fixed effects regression, however, only the trade openness index *TOI* has a mild positive effect on the dependent variable, as also the population variable *POP*, albeit using a one-tail test.

The results presented in the remaining columns reveal that none of the other protection sub-indices exercise a statistically significant influence on the dependent variable in either the random effects or the fixed effects regressions, in complete consonance with the results we found above in sub-section 5.4.1, where we included all the protection sub-indices together. In other words, once again we find that the significance of the *IP* variable appears to be driven by the significance of the *ICOV* variable.

6. Conclusions

The Trade Related Intellectual Property rights agreement of 1994 generated much interest in the influence that stronger protection is conjectured to have on various economic phenomena. In this paper we study the influence of stronger intellectual property protection on technology transfer into developing countries via licensing. Using panel data for the post-TRIPs period 1995-2005, we find that stronger protection is associated with increased royalty and license fee payments by developing countries, implying greater technology transfer into these countries. This result is robust to the inclusion of country fixed effects, as well as alternative specifications of the model estimated. Use of the component sub-indices constituting the protection variable in lieu of the (average) protection variable, reveals that the strong overall statistical significance of the protection variable is driven by the sub-index of coverage. This makes eminent sense in view of the substantial increase in coverage of the patentable subject matter by developing countries, subsequent to the TRIPs agreement. Other variables that one might consider with profit are the market-size/scale-of-activity variables such as per capita income and population, as well as human capital and trade openness of the technology-importing countries. The economic significance of the protection variable also appears to be substantial, with changes in this variable accounting for developing country technology inflows of about US $3.4 billion to US $5.5 billion (base year 2000) in the post-TRIPs sample period. These magnitudes comprise 3.5% to 5.7% of the total real value of developing country technology inflows over our sample period.

Overall, our results are noteworthy.

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Figure 1: Scatterplot of *Ln RLF* against *Ln IP*

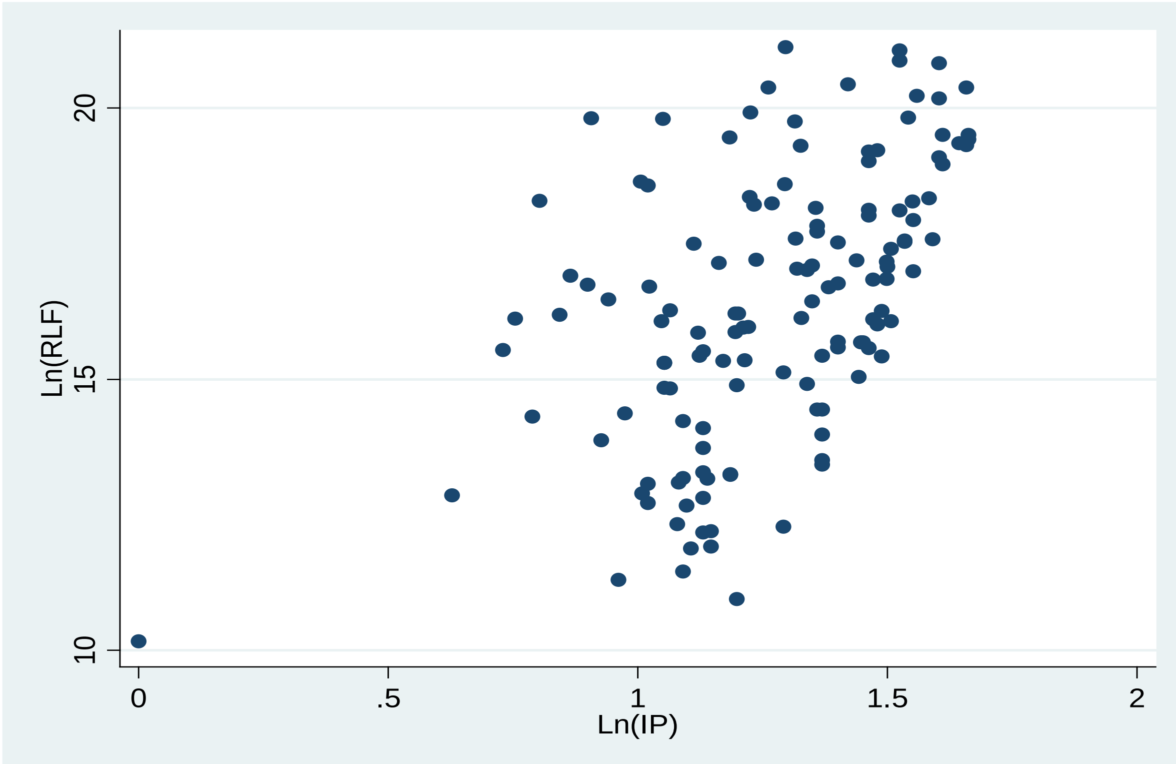

Table 1: Descriptive Statistics for the Data Set – Means and Standard Deviations

Variable*	1995	2000	2005	Full Period 1995-2005
Royalties and License Fee Payments	7.27e+07	1.23e+08	1.76e+08	1.24e+08
	(1.50e+08)	(2.54e+08)	(3.71e+08)	(2.75e+08)
Index of Protection	2.090	2.787	3.083	2.653
	(0.702)	(0.802)	(0.699)	(0.841)
Index of Coverage	0.367	0.556	0.606	0.509
	(0.183)	(0.230)	(0.198)	(0.228)
Index of Duration	0.892	0.948	0.971	0.937
	(0.177)	(0.096)	(0.075)	(0.127)
Index of Membership	0.387	0.524	0.573	0.495
	(0.183)	(0.187)	(0.203)	(0.206)
Index of Revocation	0.215	0.322	0.415	0.317
	(0.290)	(0.300)	(0.260)	(0.294)
Index of Enforcement	0.230	0.437	0.519	0.395
	0.308	(0.361)	(0.322)	(0.351)
GDP per capita	1940.053	2119.171	2326.721	2128.648
	(2292.635)	(2545.991)	(2730.092)	2515.330
Population	48368.940	53194.130	58049.180	53204.090
	(137647)	(150585)	(163937)	(150025)
GDP	6.23e+10	7.41e+10	8.89e+10	7.51e+10
	(1.21e+11)	(1.45e+11)	(1.72e+11)	(1.47e+11)
Enrollment	28.079	34.814	40.000	34.298
	(16.581)	(20.494)	(21.549)	(20.116)
Literacy	69.864	73.800	76.969	73.544
	(23.353)	(21.410)	(19.692)	(21.574)
Trade Openness Index	6.326	6.492	6.328	6.382
	(1.225)	(1.027)	0.850	(1.040)
Economic Freedom Index	5.523	6.061	6.320	5.968
	(1.286)	(1.180)	(0.954)	(1.188)

Notes: **Un*transformed variables. Standard deviations are in parentheses below the corresponding means.

Units of variables are: Royalty and License Fee Payments ($), Index of Protection (index), Index of Coverage (index), Index of Duration (index), Index of Membership (index), Index of revocation (index), Index of Enforcement (index), GDP per capita ($), Population ('000), GDP ($), Enrollment (%), Trade Openness Index (index), Economic Freedom Index (index).

The sample countries are: Angola, Argentina, Bangladesh, Benin, Bolivia, Botswana, Brazil, Cameroon, Chile, Colombia, Costa Rica, Cyprus, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Guyana, Honduras, India, Ivory Coast, Jamaica, Kenya, Madagascar, Malawi, Mali, Mexico, Morocco, Niger, Pakistan, Panama, Paraguay, Peru, Philippines, Rwanda, Senegal, South Africa, Tanzania, Thailand, Togo, Tunisia, Turkey, Uruguay, Venezuela, Zambia.

Table 2: The Effect of Intellectual Property Protection on Technology Transfer
Random Effects Regressions: Dependent Variable – Ln RLF

Regressor	(1)	(2)	(3)	(4)	(5)	(6)
Ln IP	2.562***	1.860***	1.345***	0.916*	0.800**	0.782**
	(0.330)	(0.339)	(0.395)	(0.476)	(0.381)	(0.393)
Ln GDPPC		1.115***	1.360***	0.901***	0.802***	0.807***
		(0.217)	(0.137)	(0.247)	(0.261)	(0.263)
Ln POP			0.877***	0.823***	0.887***	0.888***
			(0.146)	(0.126)	(0.121)	(0.123)
Ln ENROL				0.902**	0.839**	0.818**
				(0.390)	(0.375)	(0.384)
Ln TOI					2.019**	2.025**
					(0.884)	(0.896)
Ln EFI						0.094
						(0.374)
Intercept	13.124***	6.206***	–3.357*	–2.039	–5.318**	–5.464**
	(0.587)	(1.493)	(1.904)	(1.858)	(2.120)	(2.349)
Country fixed effects	No	No	No	No	No	No
HAC standard errors	Yes	Yes	Yes	Yes	Yes	Yes
P-value (all slopes 0)	0.000	0.000	0.000	0.000	0.000	0.000
P-value (year fixed effects 0)						0.063
Adjusted R^2	0.273	0.470	0.715	0.751	0.767	0.766
N	135	135	135	135	135	135

Note: Standard errors are reported in parentheses below the regression coefficients
HAC refers to heteroscedasticity and autocorrelation-consistent standard errors
***, **, and * denote significance at the 1%, 5% and 10% levels

Table 3: The Effect of Intellectual Property Protection on Technology Transfer
Fixed Effects Regressions: Dependent Variable – Ln RLF

Regressor	(1)	(2)	(3)	(4)	(5)	(6)
Ln IP	2.157***	1.960***	1.451***	1.380***	1.218**	1.271**
	(0.321)	(0.365)	(0.460)	(0.474)	(0.486)	(0.497)
Ln GDPPC		0.553	–0.101	–0.238	–0.672	–0.848
		(0.643)	(0.796)	(0.868)	(0.907)	(1.067)
Ln POP			1.882	1.464	1.749	1.640
			(1.245)	(1.215)	(1.368)	(1.330)
Ln ENROL				0.376	0.447	0.384
				(0.565)	(0.597)	(0.617)
Ln TOI					1.908*	1.896*
					(1.121)	(1.102)
Ln EFI						0.426
						(0.756)
Intercept	13.637***	10.014**	–2.996	0.874	–2.385	–0.751
	(0.406)	(4.312)	(9.799)	(10.514)	(11.884)	(11.897)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
HAC standard errors	Yes	Yes	Yes	Yes	Yes	Yes
P-value (all slopes 0)	0.000	0.000	0.000	0.000	0.000	0.000
P-value (year fixed effects 0)						0.066
Adjusted R^2	0.273	0.466	0.168	0.205	0.120	0.064
N	135	135	135	135	135	135

Note: Standard errors are reported in parentheses below the regression coefficients
HAC refers to heteroscedasticity and autocorrelation-consistent standard errors
***, **, and * denote significance at the 1%, 5% and 10% levels

Table 4: The Effect of Intellectual Property Protection on Technology Transfer
Some Robustness Checks: Dependent Variable – Ln RLF

Regressor	(1a) Random effects	(1b) Fixed effects	(2a) Random effects	(2b) Fixed effects
Ln IP	1.017**	1.181**	0.943***	1.342***
	(0.412)	(0.538)	(0.357)	(0.463)
Ln MVAPC	0.678***	1.009*		
	(0.213)	(0.514)		
Ln GDPPC			1.053***	–0.720
			(0.216)	(1.096)
Ln POP	0.734***	1.158	0.936***	1.147
	(0.134)	(1.187)	(0.127)	(1.423)
Ln ENROL	0.824**	0.260		
	(0.366)	(0.570)		
Ln LIT			0.851*	1.425*
			(0.479)	(0.808)
Ln TOI	1.785*	1.441	1.924**	1.731*
	(0.942)	(1.152)	(0.854)	(1.052)
Ln EFI	–0.117	–0.045	0.358	0.412
	(0.453)	(0.825)	(0.468)	(0.797)
Intercept	–5.819**	–11.719	–9.097***	–1.415
	(2.393)	(10.463)	(2.114)	(11.496)
Country fixed effects	No	Yes	No	Yes
HAC standard errors	Yes	Yes	Yes	Yes
P-value (all slopes 0)	0.000	0.000	0.000	0.000
Adjusted R^2	0.753	0.536	0.742	0.115
N	135	135	135	135

Note: Standard errors are reported in parentheses below the regression coefficients
HAC refers to heteroscedasticity and autocorrelation-consistent standard errors
***, **, and * denote significance at the 1%, 5% and 10% levels

Table 5: The Effect of Intellectual Property Protection (All Components) on Technology Transfer
Random Effects Regressions: Dependent Variable – Ln RLF

Regressor	(1)	(2)	(3)	(4)	(5)	(6)
Ln ICOV	3.701**	2.824*	2.813**	2.599**	2.459**	2.461**
	(1.600)	(1.626)	(1.371)	(1.190)	(1.090)	(1.077)
Ln IDUR	2.203	2.198	2.142	2.116	1.057	1.056
	(1.559)	(1.467)	(1.639)	(1.612)	(1.480)	(1.492)
Ln IMEM	–0.812	–0.613	–1.003	–0.968	–0.909	–0.901
	(1.222)	(1.064)	(0.900)	(0.832)	(0.825)	(0.851)
Ln IREV	0.249	–0.188	–0.360	–0.657	–0.300	–0.293
	(0.595)	(0.595)	(0.556)	(0.557)	(0.557)	(0.556)
Ln ENF	0.895*	0.578	0.107	–0.223	–0.158	–0.160
	(0.492)	(0.523)	(0.465)	(0.474)	(0.461)	(0.467)
Ln GDPPC		1.079***	1.342***	0.865***	0.782***	0.782***
		(0.214)	(0.142)	(0.238)	(0.260)	(0.263)
Ln POP			0.892***	0.840***	0.893***	0.893***
			(0.166)	(0.138)	(0.138)	(0.139)
Ln ENROL				0.974***	0.877**	0.880**
				(0.374)	(0.369)	(0.386)
Ln TOI					1.748*	1.745*
					(0.912)	(0.924)
Ln EFI						–0.026
						(0.328)
Intercept	13.425***	6.349***	–3.756	–2.850	–5.051**	–5.005**
	(1.061)	(1.666)	(2.397)	(2.190)	(2.246)	(2.388)
Country fixed effects	No	No	No	No	No	No
HAC standard errors	Yes	Yes	Yes	Yes	Yes	Yes
P-value (all slopes 0)	0.000	0.000	0.000	0.000	0.000	0.000
P-value (year fixed effects 0)						0.115
Adjusted R^2	0.307	0.480	0.728	0.771	0.780	0.778
N	135	135	135	135	135	135

Note: Standard errors are reported in parentheses below the regression coefficients
HAC refers to heteroscedasticity and autocorrelation-consistent standard errors
***, **, and * denote significance at the 1%, 5% and 10% levels

Table 6: The Effect of Intellectual Property Protection (All Components) on Technology Transfer
Fixed Effects Regressions: Dependent Variable – Ln RLF

Regressor	(1)	(2)	(3)	(4)	(5)	(6)
Ln ICOV	3.421**	3.295*	2.947*	2.853*	2.620*	2.593*
	(1.613)	(1.772)	(1.639)	(1.595)	(1.458)	(1.435)
Ln IDUR	1.837	1.773	1.837	1.842	0.727	0.715
	(1.268)	(1.268)	(1.291)	(1.310)	(1.492)	(1.476)
Ln IMEM	–0.354	–0.461	–0.650	–0.557	–0.373	–0.349
	(1.213)	(1.167)	(1.160)	(1.183)	(1.113)	(1.109)
Ln IREV	0.753	0.742	0.208	0.146	0.340	0.379
	(0.634)	(0.631)	(0.686)	(0.722)	(0.711)	(0.724)
Ln ENF	–0.157	–0.196	–0.296	–0.313	–0.061	–0.005
	(0.541)	(0.524)	(0.507)	(0.504)	(0.467)	(0.482)
Ln GDPPC		0.390	–0.274	–0.378	–0.814	–0.957
		(0.767)	(0.918)	(0.982)	(0.991)	(1.125)
Ln POP			2.019	1.772	1.795	1.693
			(1.289)	(1.378)	(1.426)	(1.378)
Ln ENROL				0.244	0.300	0.249
				(0.541)	(0.577)	(0.611)
Ln TOI					1.781	1.804
					(1.157)	(1.143)
Ln EFI						0.335
						(0.708)
Intercept	13.788***	11.207**	–3.358	–1.035	–1.023	0.427
	(0.731)	(5.108)	(10.184)	(11.798)	(12.145)	(12.121)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
HAC standard errors	Yes	Yes	Yes	Yes	Yes	Yes
P-value (all slopes 0)	0.000	0.000	0.000	0.000	0.000	0.000
P-value (year fixed effects 0)						0.082
Adjusted R^2	0.190	0.372	0.105	0.109	0.044	0.001
N	135	135	135	135	135	135

Note: Standard errors are reported in parentheses below the regression coefficients
HAC refers to heteroscedasticity and autocorrelation-consistent standard errors
***, **, and * denote significance at the 1%, 5% and 10% levels

Table 7: The Effect of Intellectual Property Protection (Individual Components) on Technology Transfer
Random and Fixed Effects Regressions: Dependent Variable – Ln RLF

Regressor	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)
Ln ICOV	1.936***	2.515**								
	(0.739)	(1.038)								
Ln IDUR			1.504	1.277						
			(1.010)	(1.324)						
Ln IMEM					0.362	0.791				
					(0.682)	(0.840)				
Ln IREV							0.252	0.613		
							(0.438)	(0.685)		
Ln IENF									0.332	0.554
									(0.391)	(0.411)
Ln GDPPC	0.774***	–1.094	0.828***	–0.391	0.819***	–0.675	0.817***	–0.353	0.816***	–0.664
	(0.257)	(1.179)	(0.260)	(1.116)	(0.254)	(1.124)	(0.257)	(1.144)	(0.255)	(1.098)
Ln POP	0.885***	1.926	0.906***	2.529*	0.909***	2.403*	0.919***	2.304	0.900***	2.416*
	(1.301)	(1.312)	(0.117)	(1.410)	(0.117)	(1.453)	(0.117)	(1.470)	(0.116)	1.373
Ln ENROL	0.830**	0.361	0.930***	0.535	0.933***	0.624	0.914**	0.493	0.873**	0.511
	(0.354)	(0.570)	(0.344)	(0.649)	(0.338)	(0.643)	(0.357)	(0.688)	(0.375)	(0.650)
Ln TOI	2.006**	2.021*	1.890*	1.768	2.140**	2.165*	2.197**	2.099*	2.183**	2.289**
	(0.881)	(1.065)	0.976	(1.391)	(0.957)	(1.162)	(0.943)	(1.152)	(0.949)	(1.134)
Ln EFI	–0.029	0.289	0.203	0.243	0.240	0.265	0.263	0.302	0.281	0.366
	(0.302)	(0.687)	(0.405)	(0.772)	(0.434)	(0.770)	(0.398)	(0.794)	(0.398)	(0.797)
Intercept	–4.761*	–1.087	–6.113***	–11.694	–5.776**	–9.024	–5.864**	–9.688	–5.575**	–9.143
	(2.388)	(12.498)	(2.273)	(11.571)	(2.450)	(12.750)	(2.425)	(11.824)	(2.460)	(11.571)
Contry fixed effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
HAC standard errors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
P-value (all slopes 0)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Adjusted R^2	0.778	0.027	0.767	0.161	0.763	0.120	0.762	0.180	0.763	0.122
N	135	135	135	135	135	135	135	135	135	135

Note: Standard errors are reported in parentheses below the regression coefficients
HAC refers to heteroscedasticity and autocorrelation-consistent standard errors
***, **, and * denote significance at the 1%, 5% and 10% levels

Notes

[1] We refer to the phenomenon of technology transfer sanctioned by the owner as *voluntary technology transfer*, as opposed to *involuntary technology transfer* that may occur, for example, via imitation.

[2] The protection dummy is insignificant in equations (2), (3), (5) and (6), in their Table III, p. 336.

[3] Of course, whether this result would generalise to other industries is a moot point.

[4] The Rapp and Rozek (1990) index of protection is based on a comparison of individual countries' patent laws with the guidelines proposed by the US Chamber of Commerce's Intellectual Property Task Force.

[5] Although Ferrantino (1993) reports that the interaction effects of the 'patent duration' variable with the 'membership' variables are significant, all this implies is that the effect of patent duration on the regressand(s) differs significantly between countries that are members of intellectual property agreements and those that are not. This does not imply the significance per se of any of the intellectual property variables themselves.

[6] The strength of property rights might also influence the vintage of the technology transferred across countries, but we are not aware of any research that formally studies this link, probably due to lack of appropriate data, as is true of the present study.

Another important issue is that of intellectual property rights and the mode of technology transfer. There is a sizeable literature that delves into questions of substitution between the alternative modes of technology transfer such as foreign direct investment, exports and licensing, in response to a strengthening of property rights (see, for instance, Sinha 2006, Viswasrao 1994). This issue lies beyond the scope of our paper.

[7] Ivus (2010) observes that the erstwhile colonial status of Southern countries could be useful in isolating the effect of intellectual property protection – in her case, on high-technology exports into developing countries. She notes that in the pre-TRIPs period Southern countries that were colonies of Britain and France strengthened the protection of intellectual property considerably more than other Southern countries; whereas in the post-TRIPs period the reverse appears to have happened. We would like to caution that this observation may be sample-specific, i.e. it may depend upon the specific set of countries and years in one's sample, which may vary with the phenomenon (exports, or foreign direct investment, or licensing, etc.) that one may be investigating. Thus, using the Ginarte-Park index of patent rights (Ginarte and Park 1997; Park 2008) she observes that in the period 1990-2005, the 'non-colony' developing countries increased their protection by 50% more than the 'erstwhile-colonies'. By contrast, for our sample of countries, and for the period 1995-2005 (since TRIPs was signed in 1994), the former set of countries increased their protection by only17% more than the latter. In other words, her methodology may not be generalisable.

[8] Obviously, which set of factors can be represented by this variable will partly depend upon the length of the time period in question. Since our empirical analysis pertains to the relatively short post-TRIPs period, we may be justified in treating country-level enforcement mechanisms as relatively unvarying over this time span.

[9] Although this had to be undertaken within the implementation period of 10 years, starting January 1995, in actual fact countries made temporary provisions for stronger protection fairly quickly, till such time as they could formally amend their protection laws.

[10] Three other indices of the strength of protection are available in the literature. The index from Rapp and Rozek (1990), based on the perceptions of the US Chamber of Commerce's

intellectual property task force, was mentioned in footnote 4 above. Mansfield (1993) computes an index based on the perceptions of a sample of R&D managers in US firms, about the strength of protection in a set of mostly developing countries. The World Economic Forum (various years) provides an index based on the perceptions of various individuals, regarding the strength of intellectual property protection in their specific countries. All these indices are highly subjective in nature, and the first two are available for single cross-sections only. For these reasons, they are inappropriate for our use.