CENTRO STUDI LUCA D'AGLIANO

WWW.DAGLIANO.UNIMI.IT

CENTRO STUDI LUCA D'AGLIANO
DEVELOPMENT STUDIES WORKING PAPERS

N. 479

February 2022
This version: August 2024

Intellectual Property Institutions, Comparative Advantage, and Technology Transfer

Previous Title: "Institutions, Development, and Patterns of Trade"

Andrea Greppi *
Alireza Naghavi **

* OECD
** University of Bologna, Department of Economics

ISSN 2282-5452

Intellectual Property Institutions, Comparative Advantage, and Technology Transfer *

Andrea Greppi[†] Alireza Naghavi[‡]

Abstract

This study investigates how improved intellectual property rights (IPR) institutions can result in divergent trade patterns for economies in different stages of development but be beneficial through different mechanisms. While IPR protection is a determinant of comparative advantage for OECD countries, there is no immediate impact on the composition of exports in non-OECD countries. We use a panel and a staggered difference-in-difference framework to exploit information on differential timing of IPR reforms and show that IPRs only shift OECD countries' exports towards intellectual property (IP)-intensive sectors. We then highlight the role of technology transfer by showing that better IPR quality could nevertheless create a transition in less advanced economies towards a more IP-intensive export sector, if complemented by technology adoption.

JEL classifications: F13, F14, F63, O34, D23
Keywords: Intellectual property rights, Technology adoption, Comparative advantage, IP-intensity, Level of development

*We are grateful to Pol Antràs, Stefano Bolatto, Enrico Cantoni, Emanuele Forlani, Olena Ivus, Bohdan Kukharskyy, Antonio Minniti, Gianmarco Ottaviano, Alessandro Sforza, Tommaso Sonno, Farid Toubal, and Francesco Venturini for helpful comments. Declarations of interest: none.

[†]OECD. E-mail: andrea.greppi@oecd.org

[‡]Corresponding author: University of Bologna, Department of Economics, Piazza Scaravilli 2, Bologna 40126, Italy. E-mail: alireza.naghavi@unibo.it

1 Introduction

A worldwide wave of trade agreements and improvements in legal institutions has facilitated international transactions over the last decades (Antràs, 2016). The issue of intellectual property rights (IPRs) has in particular gained importance in both bilateral as well as multilateral trade talks. This has especially been true when parties at the talks include both advanced (OECD) and developing (non-OECD) economies and technology is at center stage. A proliferation of regional trade agreements with strict IPR provisions has fostered technology transfer from developed to developing countries (Jinji et al., 2023, 2024; Santacreu, 2023, 2024). Such agreements stimulate exports in IP-intensive industries (Maskus and Ridley, 2021), in a way that IPR enforcement can be perceived as a source of comparative advantage (Maskus and Yang, 2018).[1]

Protection of IPRs has been viewed as a key determinant of success in the race for latest technologies and efficient operation in IP-intensive sectors. The question we pose in this paper is whether this role of IPRs is universally applicable across all countries, or if its impact on comparative advantage depends on a country's stock of knowledge or absorptive capacity. Using the same premise, we are additionally interested in exploring the conditions under which IPRs could stimulate technology transfer and potentially lead to a reversal of comparative advantage in less advanced economies. To this end, we carry out a systematic investigation to explain the alternative patterns of specialization across countries as an outcome of the quality of IPR institutions. Our study sheds light on whether differences in production structure, stage of development, or technological capability play a role in deciding whether IPR institutions determine a country's comparative advantage. The findings reveal a remarkable contrast in the institutional source of comparative advantage between OECD and non-OECD countries. In the former, IPR protection drives comparative advantage in IP-intensive industries, whereas in the latter it can only have an impact when accompanied by technology adoption.

The first contribution of the analysis to the literature on the institutional sources of comparative advantage is to show that the quality of intangible property rights protection have diverse effects for countries at different levels of development. We make use of information on the timing of IPR reforms across countries in a staggered difference-in-difference framework to show the robustness of our results. The findings are consistent whether using the level of IPR protection in a panel or the IPR reform

[1] Previous related works have associated the quality of alternative institutions with comparative advantage, for example when contractual frictions create distortions in transactions between firms and their relation-specific input suppliers (Nunn, 2007; Levchenko, 2007).

year in difference-in-differences regressions, reinforcing our hypothesis on the effect of the quality of IPR institutions on trade patterns across countries and industries over time.

While the outcome may initially question the role of IPR policy as a tool to stimulate innovation in the developing world, We next highlight how improved quality of IPR institutions can benefit countries at various stages of development through different mechanisms, with trade serving as a moderating factor. These advantages are realized through the enhancement of comparative advantage in IP-intensive goods and the facilitation of technology transfer. To test this hypothesis, we exploit information on the adoption of different technologies to show how IPRs can align trade structure and technology transfer in a way that steers less advanced economies onto their path of development. While confirming our results on the role of IPR institutions on the comparative advantage of OECD countries, the findings suggest that IPRs, if accompanied by technology adoption, could work in redirecting the comparative advantage of non-OECD countries towards IP-intensive sectors. The results are strongly robust to alternative fixed effect combination. The analysis of technology adoption and its interaction with institutions can provide insights on when and how the less developed world can also reap the fruits of IPR protection.

The paper is organized as follows. The next section discusses the related literature. Section 3 presents the empirical specification and the data. Section 4 reports the baseline panel estimates and the difference-in-difference regressions using the IPR reform years. Section 5 proceeds to the argument of technology transfer and introduces the role of technology adoption for developing countries. Section 6 concludes.

2 Literature

With the world economy witnessing substantial changes in the structure of international trade, new sources of comparative advantage have come to light. A direction taken by literature seeks to establish that the standard determinants of trade patterns driven by Ricardian efficiency and Heckscher-Ohlin factors are themselves an outcome of deeper political and economic processes, broadly identified as the concept of "institutions". These studies emanate from the empirical methodology introduced in Rajan and Zingales (1998), interacting industry and country-specific characteristics to show for example that countries with more developed financial markets tend to export relatively more in industries that require large amounts of external finance (Beck, 2003). Some key contributions in this category highlight that countries with better rule of law specialize in the production of more institutionally dependent goods (Levchenko, 2007) and in goods with a higher share of relationship-specific inputs (Nunn, 2007; Ma et al., 2010), extended by Ferguson and Formai (2013) to encompass the role of firms' organizational form.[2]

A similar approach has been adopted to examine the role of IPRs in shaping the patterns of comparative advantage. Also drawing on variation in effective patent rights across countries and varied impact across industries within a country, Hu and Png (2013) finds that stronger patent rights are associated with faster growth in more patent-intensive industries. More recently, Maskus and Yang (2018) demonstrates the positive effect of domestic patent rights on export performance in high-R&D goods. Chen and Shao (2020) follows by showing that countries with more knowledge capital endowment have comparative advantage in products with longer life cycles, where innovation is harder, and this is enhanced by stronger IPR protection.

Other contributions that investigate the effect of IPR on production and export performance include Branstetter et al. (2011), who exploits IPR reforms that happened in the 80s and 90s and show that these episodes led to an increase in the number of product classes in which these countries export. Delgado et al. (2013) show that following the Trade-Related Aspects of Intellectual Property Rights agreements (TRIPS) the compliers experienced higher growth of export in IP-intensive industries. Briggs and Park (2014) analyzes the effect of patent protection on the outward orientation of firms and find that stronger patent rights encourage firms to commercialize and to export their innovations. Ivus and Park (2019) studies how national patent reforms in developing countries affect characteristics and dynamics of exports in these countries, providing also a micro-founded analysis of the behavior of firms.

There are also theoretical contributions that suggest how patent reforms do influence local productivity, innovating capacity and, as a consequence, should also affect the structure of export: several findings proved that stronger patent protection can encourage inward investments as a consequence of a diminished local imitation threat and reduced contracting costs (Lai, 1998; Yang and Maskus, 2001; Branstetter et al., 2007). In addition, through learning by doing from foreign FDI, firms may become sufficiently productive to innovate and export new products (He and Maskus, 2012).

[2] Other related papers using this technique look at factor proportions and trade (Romalis, 2004), credit constraints (Manova, 2008), gains from division of labor and specialization (Costinot, 2009), and flexibility of labor markets (Cuñat and Melitz, 2012). Chor (2010) provides a model of comparative advantage generated from the interaction of industry and country characteristics and tests the predictions in joint presence of several sources identified in the literature. See also Nunn and Trefler (2014) for an exhaustive literature review on institutions and comparative advantage.

The theory has been supported by wide empirical evidence that links better IPR institutions with the attraction of FDI (Javorcik, 2004), promotion of knowledge spillovers from MNEs as a catalyst for quality improvements and efficiency gains (Branstetter, 2006), stimulation of innovation (Qian, 2007), and a boost for transfer of foreign technology to affiliates and encouraging domestic R&D (Branstetter et al., 2006, 2007). Strengthening IPRs could also simply promote technology diffusion to developing countries by increasing exports in patent-sensitive industries into those markets and facilitating access to new foreign technologies (Ivus, 2011, 2015). Looking at both cross section as well as firms' responses to six IPR reforms in a difference-in-differences framework, Lin and Lincoln (2017) further show that IPR protection attracts imports of high-tech goods from technologically advanced countries in a gravity equation framework.

We contribute to this literature by providing a systematic analysis of the effect of IPR institutions on OECD versus non-OECD countries, showing that IPRs are a determinant of comparative advantage only in the former group: an improvement of IPR protection policy directly increases IP-intensive exports for OECD economies. However, it is well-established that technology adoption in developing countries is a crucial phenomenon for long-run growth and development (Cirera et al., 2022). We thus provide evidence and spell out the mechanisms through which IPRs can also benefit non-OECD countries by inducing technology transfer. We collect data on the level of technology adoption from the Cross-Country Historical Adoption of Technology (CHAT) database (Comin and Hobijn, 2009) for each country in our panel setting and confirm that stronger IPR protection can indeed increase exports of IP-intensive goods from non-OECD countries if complemented by the adoption of new technologies. The data was constructed and initially used in a series of works, including Comin et al. (2008), Comin and Hobijn (2010), and Comin and Mestieri (2010).

3 Empirical Analysis

3.1 Methodology

As our baseline specification, we use a variant of a methodology first introduced by Rajan and Zingales (1998) and widely used in trade literature that uses an interaction term to capture the relative difference in export values across industries and countries, providing a complete map of specializations across countries. This approach is particularly appealing for our purpose because it allows to control for country and industry fixed effects that explain the total volumes of trade, and focus on the mix of exports in each country. As an example, assume that two countries are similar in every aspect but their IPR quality. A positive interaction term between a country's IPR institutions and the IP content of each sector would be evidence of comparative advantage because it suggests that countries with higher-quality IPRs tend to export relatively more in IP-intensive industries.[3]

We estimate the following panel specification:

$$\begin{aligned} exp_{i,c,t} = \alpha + \beta_1(IPint_i * IPR_{c,t}) + \beta_2(h_{i,t} * log(H_{c,t})) + \beta_3(k_{i,t} * log(K_{c,t})) \\ +\beta_4(RS_i * RL_{c,t}) + \beta_5 GDP_{c,t} + \beta_6 \upsilon_{c,t} + \beta_7 \nu_{i,t} + \delta_{i/c/t} + \epsilon_{i,c,t} \end{aligned} \quad (1)$$

where $exp_{i,c,t}$ in OLS regressions is the natural log and in PPML the level of export in industry i from country c to the rest of the world at time t, $IPR_{c,t}$ is a measure of the quality of protection of intangible capital in country c at time t, $IPint_i$ is a proxy for the contribution of IP to the production process of each industry i, RS_i is a measure of the importance of relationship-specific investments in industry i; $RL_{c,t}$ is a measure of the quality of contract enforcement in country c at time t; $H_{c,t}$ and $K_{c,t}$ denote the endowments of skilled labor and capital of country c at time t expressed in logs, and $h_{i,t}$ and $k_{i,t}$ are the skill and capital intensities of production in industry i at time t. We also control for a time-variant country variable, namely log of GDP per capita, $GDP_{c,t}$, that can explain changes in the overall volume of trade and level of development between countries over the years. Throughout the paper, we will refer to the term $IPint_i * IPR_{c,t}$ as IPR interaction. The same logic applies for the interpretation of the coefficients of other interaction terms in equation (1).

The use of a panel is important as the time dimension allows us to capture how global changes in IPRs have resulted in a systematic change in the export structure of a country over time. Our panel spans from 1989 to 2014 with 6 observations per industry-country at 5 years frequencies. The IPR index is available at 5 years frequency, from 1995 to 2010. We lag the institutional variables by four years with respect to trade flows to allow for some delay in the effect of IPR policy change on technological activity and trade structure. Same reasoning applies for contract enforcement.

[3] The underlying idea is that for each industry the dependence on a country variable, either a stock or an institutional quality, is a technological feature and so it is constant across countries; country features that satisfy better the needs of specific industries offer a more suitable environment for efficient operation of those industries. As a consequence, countries specialize in industries whose production needs are best matched with their factor endowments and institutional strengths.

The panel specification incorporates country (δ_c), industry (δ_i) and time (δ_t) fixed effects, that capture the overall level of trade and control for unobserved country, industry, and time characteristics. In this specification, the variation that we assess is within countries across industries and over time, net of industry-specific patterns and world-wide business cycle fluctuations. In addition, since trade is correlated within a country over time, we always cluster the standard errors at country level. The basic hypothesis we want to test is whether, other things equal, a country's export volumes in IP-intensive sectors increase with an improvement of IPR enforcement.

Finally, $\upsilon_{c,t}$ includes the country-year variables of the interaction terms as controls, namely the IPR index, rule of law, log of human capital and log of physical capital. In turn, $\nu_{i,t}$ represents the industry-year components of the interaction terms. These include IP-intensity and the fraction of relationship specific input that are industry specific, plus skill and capital intensity of production which are also time variant.

In the initial OLS estimations, we exclude from the analysis missing observations and those with a trade value equal 0. Restricting the focus on positive exports only implies that we implement an analysis conditional on a country exporting in an industry, and try to assess whether country characteristics explain the observed difference in trade performance across industries rather than the decision to enter and trade in an industry. Nevertheless, it is important to acknowledge the existence of a massive amount of zeros in trade flow data across countries or across countries and industries. We therefore opt for a Poisson pseudo-maximum likelihood (PPML) estimator throughout the paper to deal with the zero problem and use OLS for our robustness checks in the appendix.

3.2 Data

A key variable that lies at the center of our analysis is the data for the contribution of IP at industry level. We obtain this measure, $IPint_i$ from the report "Intellectual property rights intensive industries and economic performance in the European Union, Industry-Level Analysis Report, October 2016 Second edition" provided by EUIPO (European Union Intellectual Property Office). The intellectual property rights considered in the European report are trademarks and patents applied at EUIPO, EPO (European Patent office) and CPVO (Community Plant Variety Office) during 2006-2010 and subsequently granted. The unit of analysis of the report is at industry level, as defined by NACE 4-digit revision 2 classification and it provides the number of IP issued for 1000 employees. We take this measure as the importance of IP to the production process of each industry.[4] Table 1 provides a descriptive summary of this variable at industry level and a list of the three most and least IP-intensive industries.

Table 1: Intellectual Property Rights statistics

Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
trademark	7.55	6.54	0.47	38.80
patent	3.30	9.98	0	109.74
sum	10.85	12.99	0.47	116.92

Top Industries	N of IP
Manufacture of power driven hand tools	116.92
Manufacture of instruments and appliances for measuring and testing	70.89
Manufacture of basic pharmaceutical products	66.38

Lowest Industries	N of IP
Manufacture of ready-mixed concrete	0.47
Manufacture of prepared meals and dishes	0.88
Processing and preserving of poultry meat	1.06

All other data are from standard sources. Other industry variables are obtained from US manufacturing database maintained by the National Bureau of Economic Research and US Census Bureau's Center for Economic Studies. These variables are updated up to 2011 and are classified under the NAICS 1997 system, that we converted to NACE 4-digits.[5] We define capital intensity as one minus the share of total compensation in value added in each industry, whereas skill intensity is given by the share of non-production workers relative to overall employment multiplied by the share of labor compensation in value added. Regarding relation-specificiy (RS_i),

[4]A frequent critic for the use of industry data in this setting is that it uses information on one country and assumes that industry characteristic is constant across all other countries with the argument that technology is a structural feature and hence production requires the same process regardless of its location. Even if the data we use on IP-intensity is an average of all the EU countries (and so less prone to this critique), some caveats are worth mentioning. Our identification does not require that industries have exactly the same IP-intensity levels in every country, but it does rely on the ranking of sectors remaining relatively stable across countries.

[5]In order to convert all the industry variables according to the NACE 4-digits classification, we match NAICS 1997 to NAICS 2007 categories and then convert this system with NACE 4-digits through an official concordance table provided by Eurostat. All the concordance between different versions of the NAICS classification are available at: https://www.census.gov/eos/www/naics/concordances/concordances.htm. Conversion from NAICS2007 to NACE is available from the Eurostat web page RAMON - Reference and Management of Nomenclatures. When the issue was many to many or one to many, to be more conservative, we have dropped that industry.

Nunn's webpage directly provides the share of input that are relationship specific in each NAICS 1997 industry and, following the same procedure as previously described, we convert these data in NACE 4-digit classification. Throughout the paper, for each industry we consider the share of input that are neither reference priced nor sold in organized exchange as relationship-specific investment (Nunn, 2007).

Data on capital stocks and GDP per capita are from IMF and converted in 2011 US dollars; data on human capital stocks are from Penn tables Feenstra et al. (2015) and are defined as the average years of schooling for the population aged 25 or above. As a primary measure of rule of law, RL_c, we use Kaufmann et al. (2009) to follow more closely Nunn (2007). It is a weighted average of a number of variables that measure individuals' perceptions of the effectiveness and predictability of the judiciary and the enforcement of contracts in each country. Since the previous variable starts from 2000, when we need older values of rule of law, we use an alternative commonly used proxy from Gwartney et al. (2008).

Data on IP enforcement quality are from Park (2008), an updated version of Ginarte and Park (1997) index, the most widely used proxy in the IPR literature. The index is updated every 5 years and ranges from 0 to 5. It is the unweighted sum of five separate scores that can take value up to one and each of them consists of several binary conditions which, if satisfied, indicate a stronger level of protection in that category. The five variables include several conditions to account for the degree of coverage (inventions that are patentable), membership in international treaties (i.e. Paris treaty, Patent cooperation treaty), duration of protection, absence of risks of forfeiting the patent rights (for example, due to compulsory licensing or revocation of patents), and enforcement of patent rights in case of an infringement. We also use a reform dummy that takes into consideration significant shifts in one or more of these categories comparable to a change of at least a half standard deviation in the Park (2008) index of patent rights (Ivus and Park, 2019).

In table 2, we report the mean values and correlation between these variables. It is straightforward to see that the country level variables are highly correlated, but industry characteristics much less: the industry-country match can generate comparative advantage because institutional and endowment conditions affect production in different industries in alternative ways depending on characteristics of the industry.

Trade flows disaggregated at HS12 6-digit level are provided by COMTRADE and available from 1989 to 2014; also in this case, data were converted to match NACE 4-digits system.[6] Overall, we have data for 82 countries, 33 OECD members and 49

[6] We match this classification with NACE system through a concordance table provided by ISTAT (Italian statistical Office). Every time the cross-walk from HS to NACE is not unique, we

non-OECD members, as specified in the Appendix.

Table 2: Means and correlations of stocks and industry variables

Country Variables	**mean**		**correlations**		
IPR 2010	3.58	1.00			
Human capital	2.14	0.817	1.00		
Physical capital	4.10	0.763	0.775	1.00	
Rule of law	0.31	0.754	0.690	0.765	1.00
Industry Variables	**mean**		**correlations**		
IP int.	9.84	1.00			
Skill int.	0.81	0.031	1.00		
Cap. int.	0.72	0.189	-0.686	1.00	
Relat. Specific	0.47	0.160	0.552	-0.367	1.00

Information on technological dynamics within countries can be obtained from the CHAT dataset Comin and Hobijn (2009) by observing the level of adoption of different technologies by each country over time. Data on technology adoption is available for over 100 technologies across 150 countries. For the period under study, we look at available data on the adoption of 83 technologies. The technologies fall under 8 larger categories of agriculture, finance, health, steel, telecommunications, textiles, tourism, and transportation. Our aim is to investigate how our key independent variable — the interaction between the IPR regime and industry IP-intensity — interacts with the stock of various technologies available in a country within our panel. The CHAT dataset provides two measures of technology adoption at the intensive and the extensive margin. In our context, we use the latter as a binary variable, assigning a value of one to a particular technology if it has been adopted in a country at a given point in time. We then measure the proportion of globally available technologies that have been adopted in a country at each year of our panel.

4 Results

4.1 Baseline panel estimates

The baseline panel results are reported in table 3. Column (1) shows the preliminary OLS regression result for all countries. We include standard factor endowments as well as the interaction of relation-specificity with contract enforcement from Nunn

exclude the trade flow in that industry, but the number of excluded HS industries remain negligible.

(2007), control for GDP per capita, and consider country, industry, and year fixed effects. Countries with better IPR protection and rule of law export relatively more in industries highly intensive in IP and in industries with a relatively higher share of relationship specific investments, respectively. The results also hint at the growing link between institutions and comparative advantage along with the classic factors of human and physical capital.[7] Confirming Maskus and Yang (2018), the protection of IPR appears to be an effective tool in increasing innovation and R&D, thus leading to specialization in sectors in which IP play a substantial role in the production process.

In columns (2)-(3) we split the sample between OECD and non-OECD countries to account for differences in production structures, organizations, innovating capabilities and the stage of development. Only OECD countries that are on average more developed and technologically advanced form their comparative advantage based on institutions. Non-OECD countries, with less advanced production processes that involve tangible assets, seem to determine their specialization with property right protection and Nunn's channel of comparative advantage.[8]

Interestingly, when we repeat the regressions using a PPML estimator in columns (4)-(6), IPR institutions no longer play a role in determining comparative advantage when considering *all* countries. Yet, improvements of the protection of intellectual capital over time continues to show a systematic effect on trade structure for developed countries, leading to more exports in IP-intensive sectors. Such impact cannot be observed for less-advanced developing economies, which instead tend to rely on the classic form of comparative advantage based on physical and human capital endowment. We continue with the PPML estimations throughout the rest of the analysis as it is the preferred method in terms of reliability given our context and the nature of data.

Our analysis helps better understand the impact of IPR reforms or other determinants of trade by considering how institutions can have different consequences depending on the existing environment (Maskus and Ridley, 2016; Campi and Dueñas, 2019). Our baseline comparative study essentially shows that the impact of institutions on the composition of trade, and therefore the source of comparative advantage, varies with country-specific characteristics. To sum up the initial results, production of IP-intensive goods are influenced by even the smallest differences in IPR levels of

[7] The mitigating role observed for physical capital is also in line with related literature such as Levchenko (2007) or Maskus and Yang (2018).

[8] Maskus and Yang (2018) also shows that the effect of IPRs depends on the income level of countries. Introducing a triple interaction multiplying the baseline IPR interaction with an indicator dummy, they show that the impact is stronger for richer countries.

Table 3: Baseline results

	OLS			PPML		
Variable	Whole sample	OECD	non-OECD	Whole sample	OECD	non-OECD
IPR interaction: $IPint_i * IPR_c$	0.0047***	0.008***	0.002	0.0011	0.0149***	0.0063
	(0.001)	(0.002)	(0.001)	(0.005)	(0.005)	(0.004)
Skill interaction: $h_i * log(H_c)$	4.0529***	9.1075***	1.2288	6.8121*	10.6078*	10.8504**
	(1.368)	(2.555)	(1.679)	(3.925)	(5.948)	(5.326)
Capital interaction: $k_i * log(K_c)$	-0.4172*	-1.1287	0.0548	1.2398***	-0.0667	2.2973***
	(0.217)	(0.974)	(0.276)	(0.469)	(0.855)	(0.413)
Nunn interaction: $RS_i * RL_c$	0.2944***	0.0035	0.1743	0.4156**	-0.1230	0.0776
	(0.077)	(0.145)	(0.121)	(0.164)	(0.198)	(0.212)
GDP: $log(GDP_{c,t})$	0.8001***	0.7121	0.7415**	0.9838***	1.6350***	0.3205
	(0.301)	(0.671)	(0.329)	(0.311)	(0.438)	(0.389)
Observations:	40354	16404	23950	44644	16515	28129
R-squared:	0.784	0.766	0.683	-	-	-
Pseudo R-squared:	-	-	-	0.882	0.880	0.880
Cluster Country level:	Yes	Yes	Yes	Yes	Yes	Yes
Country FE:	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes	Yes	Yes	Yes
Year FE:	Yes	Yes	Yes	Yes	Yes	Yes
Controls:	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the natural log of exports in industry i by country c to all other countries in the first 3 columns and level of export in the last 3 columns. The first 3 columns report results of an OLS estimation, while the last 3 columns of a PPML estimation. The specifications include component of all interaction terms as controls. GDP per capita, physical capital, and human capital are expressed in logs. A constant term is included but not reported. Standard errors clustered at the exporting country level are reported in brackets. *, **, and *** indicate significance at the 10, 5, and 1 percent level.

OECD countries endowed with intellectual capital. This implies that the protection of intangible capital is an essential tool to stimulate innovation and increase the efficiency of producing R&D-intensive goods by preventing imitation. The result is in line with Qian (2007) that shows how IPR improvements foster innovation activities in the pharmaceutical sector conditional on a minimum level of development and human capital.

4.2 IPR reforms

A potential concern that invites caution when interpreting the results is the possibility that causality runs from trade flows to IPR quality. If so, the previous results would be generated by countries that specialize in IP-intensive industries having greater incentives to develop and maintain an effective system to protect intellectual capital. As the variable of interest here is not at the country level, e.g. GDP, but at the disaggregated industry level, it appears less likely that a single industry can affect the institutional quality at country level. Recall also that we lag the IPR interaction term by four years with respect to trade flows that we study throughout our analysis.

Related works, e.g. Ivus (2010), Delgado et al. (2013), and Maskus and Ridley (2016), further suggest that the TRIPS agreement has exogenously imposed the enforcement and the timing of new global standards of IPR protection. The agreement established a transition period for compliance based on each country's level of development. Developing countries were given until 2005, while least developed countries had until 2013 to implement the TRIPS provisions. While considering post-TRIPS IPR levels as exogenous may seem adequate for developing countries, it seems less reasonable for developed countries, who were the advocates of the agreement. Looking at it from a different angle, countries suffering from fewer exports may be more likely to endogenously reform IPRs in order to grow exports. Previous research like Acemoglu et al. (2005) has for example pointed toward total trade volumes affecting the development of political, economic, and legal institutions. We try to address the reverse causality issue regarding IPR institutions, exploiting a series of IPR reforms in a difference in difference setup. We then propose alternative methods of addressing the reverse causality concerns on comparative advantage affecting institutions in sections A.3 and A.4 of the Appendix, using IPR reforms and historical IPR levels in 1960 as instruments for today's IPR values.

The literature on IPR has extensively used a series of reforms that drastically changed the legal systems surrounding the protection of IPRs. As described in the data section, these events have been carefully analyzed by Park (2008), who have studied the evolution of the legal systems across countries and identified specific episodes of significant changes in the legal framework protecting IPRs. The time span of these reforms have been expanded and documented in Ivus et al. (2017) and employed in subsequent works such as Ivus and Park (2019). In short, a patent reform enables inventors to acquire patent rights, enforce them, and avoid wavering of their patent rights.

For the purpose of this section, we move to an unbalanced panel setting, where we follow the export performance of each country in a given industry over time. We build upon several contributions (Branstetter et al., 2006; Manova, 2008; Delgado et al., 2013) and recent improvements on the event study design (Borusyak and Jaravel, 2017; De Chaisemartin and d'Haultfoeuille, 2022), and implement a staggered diff-in-diff approach (Clarke and Tapia-Schythe, 2021) to assess how IPR changes affect a country's pattern of trade. This is essential as different countries implement IPR reforms in different years and the time-varying treatment effects can generate a severe bias.[9] We estimate the following regression:

$$\begin{aligned} exp_{i,c,t} = \alpha + \sum_{m=1}^{6} \gamma_m (Lead\ m)_{c,t} + \sum_{n=2}^{6} \delta_n (Lag\ n)_{c,t} + \beta_1 (IPint_i * reform_{c,t}) + \beta_2 (h_{i,t} * H_{c,t}) \\ + \beta_3 * (k_{i,t} * K_{c,t}) + \beta_4 * (RS_i * RL_{c,t}) + \beta_5 * GDP_{c,t} + \beta_6 \upsilon_{c,t} + \beta_7 \nu_{i,t} + \beta_i + \beta_c + \beta_t + \epsilon_{i,c,t}, \end{aligned} \tag{2}$$

where we now consider yearly observations from 1989 to 2015; reform is a binary variable equal to 1 in the year of reform and all years afterwards, and 0 otherwise. Since we are dealing with a time-varying country measure, its effect is not absorbed by country or year fixed effects. Standard errors continue to be clustered at country level to allow for correlation over time in the export patterns of a country. Finally, all direct effects of the country and industry variables in the interaction terms — although not the primary focus of our analysis — are included in all regressions in $\upsilon_{c,t}$ and $\nu_{i,t}$ respectively, except where they are absorbed by fixed effects.

The specification takes into account that reforms occurred at different points of time in each country, and that some countries are never treated. Leads and lags are binary variables indicating the the number of periods away from the event of interest in the respective country. M and N leads and lags are included respectively.[10] The first lead ($m = 1$) is omitted to capture the baseline difference between countries where the reform does and does not occur. Countries in which the event never occurs act as pure controls. These observations have 0s in all lead and lag terms, and act as the counterfactual on which the estimation of impacts is based. The main effect of

[9] This approach ensures that already-treated groups are not counted as comparisons.

[10] The choice of using 6 leads and lags is robust to alternative thresholds.

Table 4: IPR reforms in a staggered diff-in-diff setting

Variable	All Sample	OECD	non-OECD
IPR interaction: $IPint_i * IPR_c$	0.0042***	0.0072***	0.0010
	(0.001)	(0.002)	(0.002)
Skill interaction: $h_i * log(H_c)$	1.0163	0.2126	-0.4078
	(0.764)	(0.849)	(0.958)
Capital interaction: $k_i * log(K_c)$	-0.1444	0.0776	0.0419
	(0.169)	(0.182)	(0.241)
Nunn interaction: $RS_i * RL_c$	0.3785***	0.3459***	0.2431**
	(0.061)	(0.099)	(0.091)
GDP: $log(GDP_{c,t})$	0.9390***	1.3055**	0.6707**
	(0.258)	(0.530)	(0.286)
Observations:	172024	69307	102717
R-squared:	0.782	0.757	0.690
Country FE:	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes
Year FE:	Yes	Yes	Yes
N. lags & leads:	6	6	6
Controls:	Yes	Yes	Yes

The dependent variable is the natural log of exports in industry i by country c to all other countries in year t. It is a panel exercise with yearly observations, running from 1989 to 2015. The specification includes 12 time dummies, 6 leads and 6 lags with respect to the year of the reform. The specifications include component of all interaction terms as controls. GDP per capita, physical capital, and human capital are expressed in logs. A constant term is included but not reported. In brackets, t-values are reported. In all regressions, standard errors are clustered at country level. *, ** and *** indicate significance at the 10, 5 and 1 percent level.

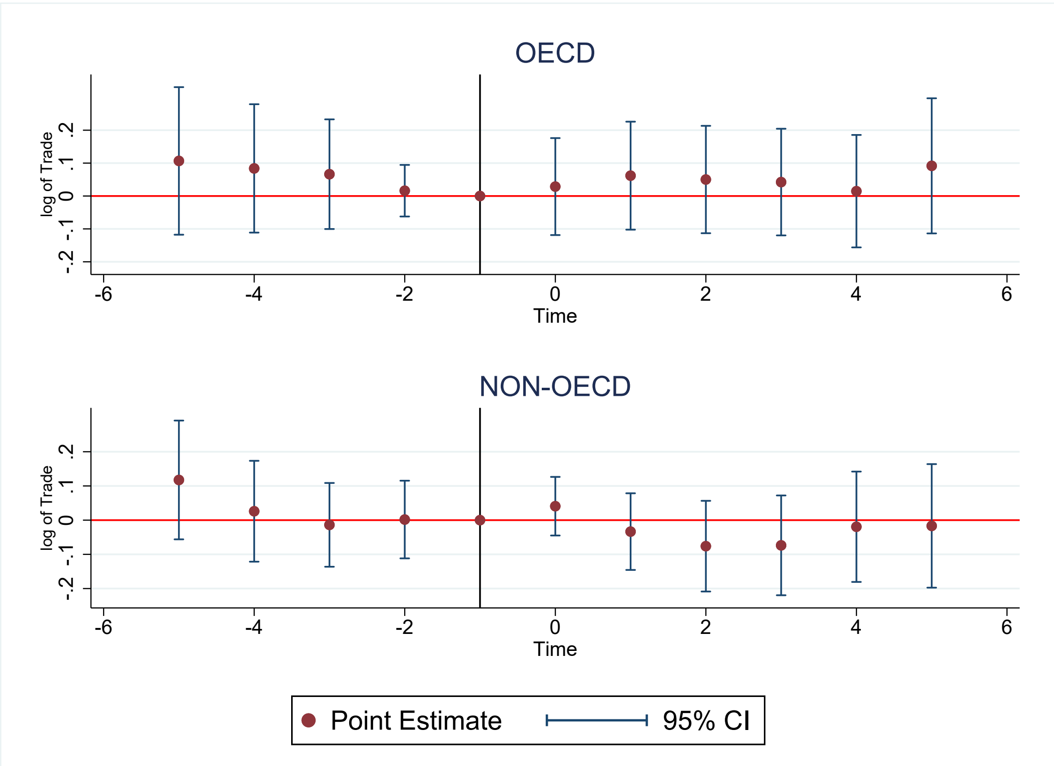

Figure 1: Effect of IPR reform on *total* volume of Trade

a legal reform is thus identified purely from the within-country variation over time and it is captured by the series of leads and lags.

The coefficient of interest is β_1, which expresses the differential impact of IPR reforms across industries depending on their IP-intensity. We expect the reform to have a stronger impact on the trade performance of IP-intensive sectors compared to less IP-intensive sectors, since the former are more directly affected by the consequences of the reform. In this dynamic analysis, the identification of our main interaction of interest, and similarly for other interaction terms, comes from the combination of cross-countries and time-series variation in IPR protection status across countries and cross-industry variation in IP-intensity.

Table 4 reports the results and shows that deep and exogenous legal change in the protection of IP only increased exports in sectors intensive in IP assets for OECD countries. Controlling for leads and lags 6 years with respect to the reform does not affect the significance of our key IPR interaction variable. The relationship between IPR reforms and the overall volumes of trade is reported graphically in Figure 1 and does not illustrate any pre- or post-reform trends. This confirms our findings that reforms resulted in a shift of exports towards more IP-intensive sectors in OECD countries, but were not sufficient to trigger such improvements in non-OECD countries.

5 Technology Transfer

In the previous section we showed that the upgrading of IPR standards have not been effective in reshaping the export structure of developing countries towards more technology intensive goods. We now examine whether strengthening IPR protection in developing countries has encouraged international knowledge spillovers through trade and foreign direct investment. We study the implications of the harmonization of global IPR standards, and whether they have been beneficial in nurturing technological capability in developing countries. Specifically, we study how the link between IPR and trade structure in innovation-oriented economies vis-à-vis those with lagging technologies differs but may converge over time.

A strong motivation that has led to significant improvements of IPR policies, especially in developing countries, is the idea that stronger and more effective enforcement of IPRs would contribute to the transfer of technology, thereby fostering technological progress in developing countries. Taking what we have observed so far in previous sections as face value, this policy choice has not led these countries to systematically specialize in IP-intensive industries. However, IPR protection may have helped less advanced countries to increase their inflow of advanced technologies through imports, thus leading to a mutual advantage both for IP producers in developed countries and for the recipients of new technologies in the developing world. This is only a part of the broader target set by the WTO when introducing the TRIPS agreement, with the ultimate goal being to create a new environment in which developing countries could start producing and specializing in more advanced industries.

To form a better understanding of the long-run effects of the global harmonization of IPR standards that took place in the last decades, in this section we revisit our baseline panel specification and make use of the CHAT dataset on technology adoption (Comin and Hobijn, 2009) to see how it interacts with improvements in IPR policy to determine the composition of exports. We do this exercise for both OECD and non-OECD countries to reveal the potential role of technology adoption on the impact of IPR institutions on comparative advantage. To be more explicit, we look at how changes in IPR institutions alongside technology adoption have over time affected the patterns of trade.

We build a proxy of technology adoption, called $tech_{c,t}$ at the extensive margin in each country up to the period for which data is available (year 2000) by measuring the proportion of technologies adopted in a country at any point of time (ratio of technologies adopted over total number of technologies available worldwide). To this end, we use a panel from 1989 to 2000 with 3 observations per industry-country at 5 years frequencies and estimate a specification similar to equation (1), which now also interacts the IPR interaction term with the ratio of adopted technologies in each country:

$$\begin{aligned} exp_{i,c,t} = \alpha + \beta_1(IPint_i * IPR_{c,t}) + \beta_2(IPint_i * IPR_{c,t} * tech_{c,t}) + \beta_3(h_{i,t} * log(H_{c,t})) \\ +\beta_4(k_{i,t} * log(K_{c,t})) + \beta_5 * (RS_i * RL_{c,t}) + \beta_6 * GDP_{c,t} + +\beta_7\upsilon_{c,t} + \beta_8\nu_{i,t} + \delta_{i/c/t} + \epsilon_{i,c,t} \end{aligned} \tag{3}$$

The coefficient of the triple interaction term can reveal whether and to what extent being complemented by the adoption of new technologies and building absorptive capacity can be decisive in the effect of IPR protection on trade structure for each country group. The results are reported in table 5 for both OECD and non-OECD countries using PPML estimations for alternative fixed effect models, with robustness standard errors clustered at country level.

Columns (1)-(2) replicate our baseline specification and show the significant effect of IPR institutions in the comparative advantage of OECD countries irrespective of the level of technology adoption. IPRs continue to play no direct role in non-OECD

Table 5: The role of technology adoption

Variable	OECD	non-OECD	OECD	non-OECD	OECD	non-OECD	OECD	non-OECD
IPR interaction: $IPint_i * IPR_c$	0.0161**	-0.0045	0.0053***	-0.0625***	0.0161**	-0.0033	0.0198*	-0.0004
	(0.007)	(0.010)	(0.002)	(0.022)	(0.006)	(0.010)	(0.010)	(0.012)
IPR triple int: $IPint_i * IPR_c * tech_{c,t}$	-0.0030	0.0906***	0.0008	0.2749***	-0.0032	0.0848***	-0.0028	0.1168**
	(0.003)	(0.030)	(0.001)	(0.099)	(0.003)	(0.029)	(0.003)	(0.050)
Skill interaction: $h_i * log(H_c)$	2.6202	12.9349***	7.5497*	-2.63	2.346	12.6574**	2.4886	14.51111**
	(4.870)	(4.897)	(3.927)	(2.564)	(5.067)	(5.044)	(4.897)	(6.070)
Capital interaction: $k_i * log(K_c)$	-0.9311	2.2815***	1.3193	-1.4796**	-0.9383	2.4341***	-1.0661	2.2765***
	(1.047)	(0.305)	(1.168)	(0.702)	(1.076)	(0.307)	(1.053)	(0.321)
Nunn interaction: $RS_i * RL_c$	0.2629	0.5157**	0.5856***	0.2643*	0.274	0.5306**	0.2743	0.506**
	(0.230)	(0.203)	(0.150)	(0.150)	(0.238)	(0.211)	(0.256)	(0.215)
GDP: $log(GDP_{c,t})$	-0.1476	3.778***	0.1351	3.0441***			-0.1622	3.8045***
	(1.095)	(1.352)	(1.097)	(1.069)			(1.091)	(1.264)
Observations:	7410	12350	7220	11068	7410	12350	7410	12350
Pseudo R-Square:	0.872	0.851	0.990	0.985	0.878	0.856	0.874	0.857
Cluster Country level:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE:	Yes	Yes	No	No	No	No	Yes	Yes
Industry FE:	Yes	Yes	No	No	Yes	Yes	No	No
Year FE:	Yes	Yes	Yes	Yes	No	No	No	No
Country-Industry FE:	No	No	Yes	Yes	No	No	No	No
Country-Year FE:	No	No	No	No	Yes	Yes	No	No
Industry-Year FE:	No	No	No	No	No	No	Yes	Yes
Controls:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the volume of exports in industry i by country c to all other countries. The table shows the results of a PPML estimation. The specifications include component of all interaction terms as controls (note that, depending on the fixed effect specified, some components cannot be computed). GDP per capita, physical capital, and human capital are expressed in logs. A constant term is included but not reported. Standard errors clustered at the exporting country level are reported in brackets. *, ** and *** indicate significance at the 10, 5 and 1 percent level.

countries, but the results are striking and uncover a positive and significant effect of the interaction of our variable of interest with technology adoption. If improved IPR quality is accompanied by technology adoption in developing countries, it can also eventually shift their exports towards more IP-intensive industries. This is an important result and not only highlight the critical role of absorptive capacity to reap the fruit of better IPR protection, but also suggests that the latter can be a driver of development in non-OECD countries if complemented by technology transfer. We therefore observe that policies aimed at strengthening IPR standards have indeed triggered some improvement in the export performance of IP-intensive sectors in developing countries as long as they go hand in hand with the intermediary channel of technology transfer.

In columns (3)-(4), we consider year and country-industry fixed effect. The identification now comes from time-variation within country-industry pairs net of world-wide business cycle fluctuations: we now track the performance of each industry in each country and we look at its within variation over time, controlling also for aggregate time fluctuations. This specification allows to control for unobserved specificities that systematically affect the performance of an industry in a country. For this reason, it enables also to partially detect the concern of reverse causality. Namely, in this comparative advantage study, reverse causality would be interpreted as the presence of an industry, with already high levels of export, that pushes for IPR reforms. Essentially, we are now controlling for whether, following any improvement in IPR, there has been a systematic increase in exports — net of year-specific dynamics — that is greater for industries with higher IP intensity compared to the average for the same industry within the same country.

In columns (5)-(6), we use industry and time-country fixed effects to explain variations in our dependent variable by exploiting differences across industries within each country and year, while accounting for common industry performance across countries and years. This approach helps better control for unobserved country-specific trends. In this specification, the GDP variable is omitted.

Finally, in columns (7)-(8), we use country and time-industry fixed effects to exploit variation across countries for each industry-year pairs, controlling for country-specific characteristics that may affect systematically the level of trade for a country in all industries and across time. This allows unobserved industry characteristics to be time-varying, capturing different trends across industries over the years. In particular, the specification accounts for the fact that industries follow different paths over time, and that economies have become more knowledge-oriented, increasing the importance of IP-intensive industries on average for all countries over time.[11]

One can relate the results to the inflow of technologies through IPR-induced imports building technological capability that may, over the years, spur industrial development. To consider a possible channel through which technology adoption takes place, in Appendix A.2 we use available cross-sectional data on bilateral trade flows between country pairs, considering the IPR quality of both exporting and importing countries to see how they interact to contribute to attracting technology-intensive goods. This allows us to see whether the patterns of trade of an exporting country may also be influenced by IPRs in the importing country. The results suggest that IPR institutions increase trade in IP-intensive sectors from OECD to non-OECD countries. This reveals a complementarity between the role of IPRs in determining OECD exports and non-OECD imports of technology-intensive goods. Domestic IPRs lead OECD countries to specialize in IP-intensive industries and destination IPRs direct the trade of these goods towards non-OECD locations with strong IPR institutions.

6 Conclusion

Recent contributions in trade literature have emphasized the role of institutions as a source of comparative advantage. We provide an empirical assessment of how IPR institutions shape the patterns of specialization depending on the level of economic development. Splitting the sample between OECD and non-OECD countries, we find that IPR institutions drive exports in IP-intensive industries in advanced economies. This finding is consistent with the evidence that developed countries possess the initial intellectual capital necessary to engage in innovation activities. We then test the validity of our results using IPR reforms in a staggered difference-in-difference framework in order to exploit different timing of reforms across countries and help mitigate reverse causality concerns. In summary, our preliminary evidence suggests that IPR reforms only have a systematic impact on trade pattern for OECD countries.

We then investigate further to examine whether improvements of IPR protection in developing countries can be beneficial through other channels. We find that better IPR protection can stimulate imports of new technologies into developing countries and serve as a crucial step to build technological capability and eventually generate new patterns of specialization. To this end, we make use of information about the timing of the adoption of different technologies and its interaction with IPR policy

[11] Also, by considering the concern that the importance of IPR may change faster for some industries, this specification controls for the possibility that IP-intensity has not been constant over time, since it captures any unobserved heterogeneity in each year for each industry across countries.

improvements in determining patterns of trade. While technology adoption has no additional effects on the persistent role of IPR institutions in already technologically advanced economies, improved IPR protection tends to be important for redirecting the developing world's exports to IP-intensive sectors if accompanied by an inward transfer of new technologies. Progresses made in the IPR regime of developing countries could be a driver of technology diffusion and a first step towards specialization in IP-intensive sectors. The findings highlight the importance of technology transfer for less advance economies to make an upgrading of IPR standards meaningful in terms of trade and growth. An avenue of future research is to investigate further such reversal in the source of comparative advantage, by studying circumstances under which technology adoption occurs and IPR reforms could explicitly induce domestic innovation and R&D in developing countries.

References

Acemoglu, D., Johnson, S., and Robinson, J. (2005). The rise of europe: Atlantic trade, institutional change, and economic growth. *American Economic Review*, 95(3):546–579.

Antràs, P. (2016). *Global Production: Firms, Contracts, and Trade Structure*. Princeton University Press, Princeton, NJ.

Beck, T. (2003). Financial dependence and international trade. *Review of International Economics*, 11(2):296–316.

Borusyak, K. and Jaravel, X. (2017). Consistency and inference in bartik research designs. Technical report, Technical Report, Working paper 2017. 187 and,"Revisiting event study designs.

Branstetter, L. (2006). Is foreign direct investment a channel of knowledge spillovers? evidence from japan's fdi in the united states. *Journal of International Economics*, 68(2):325–344.

Branstetter, L., Fisman, R., Foley, C. F., and Saggi, K. (2007). Intellectual property rights, imitation, and foreign direct investment: Theory and evidence. Technical report, National Bureau of Economic Research.

Branstetter, L., Fisman, R., Foley, C. F., and Saggi, K. (2011). Does intellectual property rights reform spur industrial development? *Journal of International Economics*, 83(1):27–36.

Branstetter, L. G., Fisman, R., and Foley, C. F. (2006). Do stronger intellectual property rights increase international technology transfer? empirical evidence from us firm-level panel data. *Quarterly Journal of Economics*, 121(1):321–349.

Briggs, K. and Park, W. G. (2014). There will be exports and licensing: The effects of patent rights and innovation on firm sales. *Journal of International Trade & Economic Development*, 23(8):1112–1144.

Cai, J. and Stoyanov, A. (2016). Population aging and comparative advantage. *Journal of International Economics*, 102:1–21.

Campi, M. and Dueñas, M. (2019). Intellectual property rights, trade agreements, and international trade. *Research Policy*, 48(3):531–545.

Chen, X. and Shao, Y. (2020). Product life-cycle, knowledge capital, and comparative advantage. *Review of international economics*, 28(1):252–278.

Chen, Y. and Puttitanun, T. (2005). Intellectual property rights and innovation in developing countries. *Journal of Development Economics*, 78(2):474–493.

Chor, D. (2010). Unpacking sources of comparative advantage: A quantitative approach. *Journal of International Economics*, 82(2):152–167.

Cirera, X., Comin, D., and Cruz, M. (2022). *Bridging the technological divide: Technology adoption by firms in developing countries.* World Bank Publications.

Clarke, D. and Tapia-Schythe, K. (2021). Implementing the panel event study. *The Stata Journal*, 21(4):853–884.

Comin, D. and Hobijn, B. (2010). An exploration of technology diffusion. *American Economic Review*, 100:2031–2059.

Comin, D., Hobijn, B., and Rovito, E. (2008). Technology usage lags. *Journal ofEconomic Growth*, 13:237–256.

Comin, D. and Mestieri, M. (2010). An intensive exploration of technology diffusion. Technical report, NBER Working Paper Nr. 16379, National Bureau of Economic Research, Cambridge, MA.

Comin, D. A. and Hobijn, B. (2009). The chat dataset. NBER Working Paper No. 15319, National Bureau of Economic Research, Cambridge, MA.

Costinot, A. (2009). On the origins of comparative advantage. *Journal of International Economics*, 77(2):255–264.

Cuñat, A. and Melitz, M. J. (2012). Volatility, labor market flexibility, and the pattern of comparative advantage. *Journal of the European Economic Association*, 10(2):225–254.

De Chaisemartin, C. and d'Haultfoeuille, X. (2022). Difference-in-differences estimators of intertemporal treatment effects. Technical report, National Bureau of Economic Research.

Delgado, M., Kyle, M., and McGahan, A. M. (2013). Intellectual property protection and the geography of trade. *Journal of Industrial Economics*, 61(3):733–762.

Feenstra, R. C., Inklaar, R., and Timmer, M. P. (2015). The next generation of the penn world table. *American Economic Review*, 105(10):3150–82.

Ferguson, S. and Formai, S. (2013). Institution-driven comparative advantage and organizational choice. *Journal of International Economics*, 90:193–200.

Ginarte, J. C. and Park, W. G. (1997). Determinants of patent rights: A cross-national study. *Research Policy*, 26(3):283–301.

Gwartney, J., Lawson, R., and Norton, S. (2008). *Economic freedom of the world: 2008 annual report*. Fraser Institute.

He, Y. and Maskus, K. E. (2012). Southern innovation and reverse knowledge spillovers: a dynamic fdi model. *International Economic Review*, 53(1):279–302.

Hu, A. G. and Png, I. P. (2013). Patent rights and economic growth: evidence from cross-country panels of manufacturing industries. *Oxford Economic Papers*, 65(3):675–698.

Ivus, O. (2010). Do stronger patent rights raise high-tech exports to the developing world? *Journal of International Economics*, 81(1):38–47.

Ivus, O. (2011). Trade-related intellectual property rights: industry variation and technology diffusion. *Canadian Journal of Economics*, 44(1):201–226.

Ivus, O. (2015). Does stronger patent protection increase export variety? evidence from us product-level data. *Journal of International Business Studies*, 46(6):724–731.

Ivus, O. and Park, W. (2019). Patent reforms and exporter behaviour: Firm-level evidence from developing countries. *Journal of the Japanese and International Economies*, 51:129–147.

Ivus, O., Saggi, K., and Park, W. (2017). Patent protection and the composition of multinational activity: evidence from us multinational firms. *Journal of International Business Studies*, 48(7):808–836.

Javorcik, B. S. (2004). The composition of foreign direct investment and protection of intellectual property rights: Evidence from transition economies. *European Economic Review*, 48:39–62.

Jinji, N., Yukiko, S., Zhang, X., and Haruna, S. (2024). Gravity for cross-border licensing and the impact of deep trade agreements: Theory and evidence. *Canadian Journal of Economics*. forthcoming.

Jinji, N., Zhang, X., and Haruna, S. (2023). Do deeper regional trade agreements enhance international technology spillovers? *World Economy*, 42(8):2326–2363.

Kaufmann, D., Kraay, A., and Mastruzzi, M. (2009). *Governance matters VIII: Aggregate and individual governance indicators 1996-2008*. World Bank.

Lai, E. L.-C. (1998). International intellectual property rights protection and the rate of product innovation. *Journal of Development economics*, 55(1):133–153.

Levchenko, A. A. (2007). Institutional quality and international trade. *Review of Economic Studies*, 74(3):791–819.

Lin, J. X. and Lincoln, W. F. (2017). Pirate's treasure. *Journal of International Economics*, 109:235–245.

Ma, Y., Qu, B., and Zhang, Y. (2010). Judicial quality, contract intensity and trade: Firm-level evidence from developing and transition countries. *Journal of Comparative Economics*, 38(2):146–159.

Manova, K. (2008). Credit constraints, equity market liberalizations and international trade. *Journal of International Economics*, 76(1):33–47.

Maskus, K. E. and Ridley, W. (2016). Intellectual property-related preferential trade agreements and the composition of trade. Robert Schuman Centre for Advanced Studies Research Papers, Nr. 35.

Maskus, K. E. and Ridley, W. (2021). How preferential trade agreements with strong intellectual property provisions affect trade. World Bank Policy Research Working Paper No. 9659, The World Bank, Washington, DC.

Maskus, K. E. and Yang, L. (2018). Domestic patent rights, access to technologies and the structure of exports. *Canadian Journal of Economics/Revue Canadienne d'Économique*, 51(2):483–509.

Nunn, N. (2007). Relationship-specificity, incomplete contracts, and the pattern of trade. *Quarterly Journal of Economics*, 122(2):569–600.

Nunn, N. and Trefler, D. (2014). Domestic institutions as a source of comparative advantage. In *Handbook of International Economics*, volume 4, pages 263–315. Elsevier.

Park, W. G. (2008). International patent protection: 1960–2005. *Research Policy*, 37(4):761–766.

Qian, Y. (2007). Do national patent laws stimulate domestic innovation in a global patenting environment? a cross-country analysis of pharmaceutical patent protection, 1978–2002. *Review of Economics and Statistics*, 89(3):436–453.

Rajan, R. and Zingales, L. (1998). Financial dependence and growth. *American Economic Review*, 88(3):559–86.

Romalis, J. (2004). Factor proportions and the structure of commodity trade. *American Economic Review*, 94(1):67–97.

Santacreu, A. M. (2023). International technology licensing, intellectual property rights, and tax havens. *Review of Economics and Statistics*. forthcoming.

Santacreu, A. M. (2024). Dynamic gains from trade agreements with intellectual property provisions. *Journal of Political Economy*. forthcoming.

Shin, W., Lee, K., and Park, W. G. (2016). When an importer's protection of ipr interacts with an exporter's level of technology: Comparing the impacts on the exports of the north and south. *World Economy*, 39(6):772–802.

Yang, G. and Maskus, K. E. (2001). Intellectual property rights, licensing, and innovation in an endogenous product-cycle model. *Journal of International Economics*, 53(1):169–187.

A Appendix

A.1 List of Countries and the Year of IPR Reform

OECD countries	non-OECD countries
Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, South Korea, Slovakia, Spain, Sweden, Switzerland, Turkey, USA, United Kingdom	Algeria, Angola, Argentina, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cameroon, China Colombia, Congo, Costa Rica, Cyprus, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Fiji, Guatemala, Honduras, India, Jamaica, Jordan, Madagascar, Malawi, Malaysia, Malta, Mauritius, Nepal, Nicaragua, Pakistan, Panama, Paraguay, Peru, Russia, Rwanda, Singapore, South Africa, Sri Lanka, Tunisia, Uganda, Ukraine, Tanzania, Uruguay, Vietnam, Zambia, Zimbabwe

A.2 Bilateral Trade Flows

In this section we look at the other direction of trade and assess how import patterns could also be affected by IPR quality and be associated with technology transfer. We employ data on bilateral trade flows, which allows us to augment the baseline exercise with gravity controls and reassess our findings.[12] More importantly, a bilateral framework makes it possible to conduct a deeper comparative analysis by further breaking up trade patterns for different countries and exploiting information on both sides of trade. In particular, we compare the exporting behavior of an OECD country with respect to a non-OECD country, and take the analysis at a more disaggregate level by observing whether or not the importing country belongs to OECD.

We run the following regression:

$$\begin{aligned} exp_{i,c,p} = \alpha + \beta_1(IPint_i * IPR_c) + \beta_2(IPint_i * IPR_c * IPR_p) \\ +\beta_3(h_i * log(H_c)) + \beta_4(k_i * log(K_c)) + \beta_5 * (RL_c * RS_i) + \delta_i + \delta_c + \delta_p + \delta_{c,p} + \epsilon_{i,c,p}, \end{aligned} \tag{4}$$

where $exp_{i,c,p}$ here represents the natural log of exports in industry i from country c to its partner p. Due to data limitations, this exercise is performed in a cross-section framework, hence ignoring the time dimension. We however augment the baseline specification to include importer country fixed effects δ_p and also country pair-wise fixed effects $\delta_{c,p}$ that should incorporate all the standard gravity controls. We continue to cluster standard errors at exporter (country) level. Our strategy is related to Shin et al. (2016), who finds that as importing countries adopt a more stringent IPR regime, the impact on the bilateral exports of the partner nation is negatively related to the level of technology of the exporting country.[13]

The bilateral analysis is a key tool for the question at hand because IPR institutions could play a role on both sides of a trade transaction by affecting the pattern of trade both for the origin and the destination country. It allows us to combine these predictions in a more comprehensive manner as it allows us to directly assess the impact of IPR institution of an importing country on the export patterns of its trading partner. We would expect more trade in IP-intensive industries not only with higher IPR quality of the exporting country, but also that of the importing country since in some cases better institutions serve as an important tool to attract intangible capital. We therefore introduce a triple interaction $IPint_i * IPR_c * IPR_p$

[12] See Chor (2010) and Cai and Stoyanov (2016) for examples of a bilateral set-up of our original baseline framework of comparative advantage.

[13] They argue that IPR acts as an export barrier to trade, especially discouraging exports from developing countries that are in a catching-up phase.

in our specification that takes into account also the IPR strength in the importing country and tells us whether or not the effect of the baseline IPR interaction is stronger for higher quality IPRs in the destination.

The results are reported in table A.2.1 and are consistent with all our previous findings regarding the impact of IPRS on export structure being evident only for OECD countries, controlling also for importer country fixed effects and pair-wise country fixed effects. Our main interest lies in the sign of the triple interaction, to highlight the effect of IPR quality of the importing country on the export pattern of other countries. The composition of imports is affected by IPR policy in a developing country because multinational firms, particularly technology-oriented ones with high risk of imitation, require their intangible capital to be safeguarded before entering that market. This is especially true when flows to a developing country originate from a developed country as these transactions on average involve a higher content of technology, the stronger is the IPR regime in the exporting country. Nevertheless, importing country IPRs also shift the balance of trade between non-OECD countries toward more IP-intensive transactions. As expected, the triple interaction terms in which the importing country is a developed nation are not different from zero as entering these markets is not perceived as a threat for foreign firms due to their already strong IPR institutions.

The findings show that the quality of IPR institutions has opposite effects on the pattern of trade based on the stage of development: for developed countries it helps boost R&D, innovation and the production in IP-intensive industries, thus leading to more export in these sectors; for developing countries it attracts imports of IP-intensive goods. In other words, what we found to be a source of comparative advantage for OECD countries also explains an opposite trade pattern in non-OECD countries: IPR protection stimulates trade in IP-intensive industries from developed to developing countries.

This analysis sheds light on the positive effects of IPR improvements on trade in IP-intensive industries both for developed and developing countries, in one case affecting export patterns and in the other through imports. it suggests that stricter enforcement of IPR across developing countries can be beneficial by attracting more technologies into these countries. We saw in section 5 that the resulting technology transfer can help its recipients build the necessary absorptive capacity and eventually shift their comparative advantage to innovative activities.

Table A.2.1: Bilateral Trade Flow analysis

Variable	(I) O-O	(II) O-NO	(III) NO-O	(IV) NO-NO
IPR interaction: $IPint_i * IPR_c$	0.0234***	0.0211***	0.0077	0.0034
	(0.008)	(0.005)	(0.006)	(0.003)
$IPint_i * IPR_c * IPR_p$	0.0004	0.0010***	0.0005	0.0011**
	(0.0002)	(0.0002)	(0.001)	(0.0004)
Skill interaction: $h_i * log(H_c)$	11.80**	12.99**	2.96*	3.99**
	(4.686)	(4.740)	(2.861)	(2.725)
Capital interaction: $k_i * log(K_c)$	0.1834	-0.285	1.073*	0.6197
	(0.996)	(1.028)	(0.566)	(0.515)
Nunn interaction: $RS_i * RL_c$	-0.4555	0.1345	1.1391***	0.7380***
	(0.372)	(0.288)	(0.318)	(0.279)
Observations:	67641	83040	44237	47081
R-squared:	0.650	0.580	0.507	0.469
Exporting Country FE:	Yes	Yes	Yes	Yes
Importing Country FE:	Yes	Yes	Yes	Yes
Pair-wise Country FE:	Yes	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes	Yes

The dependent variable is the natural log of export in industry i from country c to country i. In all regressions, standard errors are clustered at industry-exporter country level and are reported in brackets. Each column refers to a different sample, identified in the first row. O refers to OECD countries, NO to non-OECD; the first letter(s) identifies the exporting country, the second letter(s) the importing country. GDP per capita, physical capital, and human capital are expressed in logs. A constant term is included but not reported. *, ** and *** indicate significance at the 10, 5 and 1 percent level.

A.3 Instrumental Variable I: IPR Reforms

Here, we exploit the major IPR reforms used in the paper as instruments for IPR quality. What is essential for us is that these episodes can be used as instruments because they can be considered as exogenous events and provide a random variation in today's IPR levels. To conduct this exercise, we consider a panel set-up from 1989 to 2014 with five-year intervals for each industry-country observation. This choice was driven by the fact that the Park index is updated every 5 years. We introduce a dummy for IPR reform that is equal to one starting from the first interval after which the reform occurred onwards.[14] It is a time-varying country variable that explains part of the variation in trade volume across time. Also in this case, we allow lags for changes in the IPR protection system to have some effects on the trade structure because trade flows of 1989 are regressed on IPR reform of 1985 and so on. In addition, since we are working with a dynamic specification, we include the log of GDP in the regression. To control for serial correlation in the export performance of an industry in a given country, we cluster at country-industry level.[15]

In the first stage, we regress our variable of interest, IPR interaction, on the dummy IPR reform interacted with IP-intensity at industry level, including again the variables described in the baseline specification (equation 1) plus year fixed effect since we now have a time dimension available. The instrument, which exploits the different timing of reforms across countries, is highly significant and strongly related to IPR values. We then use the predicted values from this first stage, $I\tilde{P}R$ interaction, as explanatory variable in the second stage. The IV is relevant, as highlighted by the statistics at the bottom of table A.3.1, which are all above the critical values. The test for weak instrument rejects the null hypothesis and so we can conclude that reforms are a strong instrument.[16] The results in table A.3.1 show that also the instrumental approach confirms our main hypothesis about the importance of IPR institutions as a key determinant of comparative advantage only for OECD countries. Overall, we believe that the emergence of a consistent and stable pattern mitigates the concerns on reverse causality.[17]

[14]For example, all the countries that experienced a reform between 1982 and 1985 will have the dummy IPR reform equal one from 1985 onwards, and all the countries that underwent a reform between 1986 and 1990 will have the dummy IPR reform equal to one from 1990.

[15]The results are unaffected when using robust standard errors and clustering at the level of the exporting country.

[16]To implement the instrumental variable approach, the Stata routine ivregress 2sls has been applied, In addition, the post-estimation commands first and weakivtest have been used to compute the statistics in the second part of table A.3.1.

[17]In addition, we have implemented two further exercises. In Appendix **??** we use IPR quality level in 1960 to instrument today's IPR values. Also, we replicated both the exercises reported in this section using a series of reforms identified by Branstetter (2006), confirming the results

Table A.3.1: IV Estimation

Second Stage	All Sample	OECD	NON-OECD
$IPR\ reform_{c,t}$	-0.0177	0.0164	-0.0318
	(0.061)	(0.082)	(0.104)
IPR interaction: $IPint_i * IPR\ reform_{c,t}$	0.0026***	0.0068***	-0.0001
	(0.001)	(0.001)	(0.002)
Skill interaction: $h_{i,t} * log(H_{c,t})$	3.7787***	9.3724***	0.8539
	(1.426)	(2.638)	(1.712)
Capital interaction: $k_{i,t} * log(K_{c,t})$	-0.4263*	-1.2209	0.0673
	(0.229)	(0.969)	(0.293)
Nunn interaction: $RS_i * RL_{c,t}$	0.2912***	-0.0021	0.1801
	(0.080)	(0.154)	(0.121)
GDP: $log(GDP_{c,t})$	0.8002***	0.6699	0.7323**
	(0.306)	(0.730)	(0.330)
Observations:	38942	15834	23108
R-squared:	0.779	0.756	0.687
Country FE:	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes
Year FE:	Yes	Yes	Yes
Controls:	Yes	Yes	Yes
First stage:			
$IPR_c \cdot IPint_i$:	1.4622***	1.384***	1.256***
	(0.075)	(0.128)	(0.101)
Weak IV test:	367.85	96.72	40.85

The dependent variable in the second stage is the natural log of exports in industry i from country c to all other countries. It is an unbalanced panel exercise with five observations for each country-industry, running from 1989 to 2014. The first stage dependent variable is the interaction term between IP-intensity at industry level and IPR reform dummy. Then, we use the predicted values, $\tilde{IPR}$ interaction, in the second stage. The bottom part of the table reports the coefficient of the IV from the first stage, together with the values of the F-test resulting from the first stage and the endogeneity test. All explanatory variables in the second stage are also included in the first stage, but to conserve space we only report the first stage coefficients for the instrumental variable. The specifications include component of all interaction terms as controls. GDP per capita, physical capital, and human capital are expressed in logs. A constant term is included but not reported. In all regressions, standard errors are clustered at country-industry level. In the IV exercise with IPR reforms, there are six observations for each industry-country variable, from 1989 to 2014 with five years of frequency. *, ** and *** indicate significance at the 10, 5 and 1 percent level.

A.4 Instrumental Variable II: Historical IPR Data

We propose a further IV strategy to address the concern on reverse causality. We move to a cross-sectional analysis using the most recent year available - 2010 - in order to exploit historical IPR protection values as instruments to today's values. Because each country's quality of IPR in 1960 is pre-determined and unaffected by trade flows in 2014, it can be a candidate to isolate exogenous variation in today's quality of IPR institutions. At the same time, the instrument is highly related to our potentially endogenous variable, given the persistency in the quality of institutions across countries. In particular, we regress $IPR_{c,1960} \cdot IPint_i$ on $IPR_{c,2010} \cdot IPint_i$, and used the predicted values $I\tilde{P}R$ as main explanatory variable for the second stage. All additional variables specified in equation 1 (adapted to a cross-sectional setting) are included in the first and second stage.[18] The instrument is relevant when we look at the all sample and for OECD countries, as highlighted by the statistics at the bottom of table A.4.1, which are all above the critical values, suggesting that old IPR values are a valid instrument for developed countries. The IV coefficient is positive and statistically significant for the all sample and OECD countries, providing support for the importance of IPR institution in shaping comparative advantage and mitigating the potential positive feedback effect that trade might have on IPR enforcement.

obtained using the reforms identified by Park (2008). We decided to focus on the reforms identified in the latter source because it provides information on a much larger set of countries, allowing for a separate analysis between OECD and NON OECD countries, which is the main interest of the paper.

[18] In this way we control for possible influences that IPR protection in 1960 could have had on trade values other than through its direct effect on IPR protection level in 2010. In fact, a possible concern for the validity of this instrument is that IPR quality in 1960 may also affect comparative advantage through channels other than IPR quality in 2010, not satisfying the exclusion restriction. For example, IPR in 1960 can be related to other country characteristics, such as GDP, that may have a direct impact on trade flows, see Ginarte and Park (1997) and Chen and Puttitanun (2005).

Table A.4.1: IV Estimation

Second Stage	All Sample	OECD	NON-OECD
$\tilde{IPR}$ interaction: $IPint_i * IPR_c$	0.0138***	0.0268**	0.0352
	(0.003)	(0.010)	(0.030)
Skill interaction: $h_i * log(H_c)$	0.5790	9.4987**	-2.6936
	(1.343)	(3.763)	(1.784)
Capital interaction: $k_i * log(K_c)$	-0.3508*	0.0453	-0.2906
	(0.190)	(0.676)	(0.406)
Nunn interaction: $RS_i * RL_c$	0.1632	-0.8349**	-0.1167
	(0.148)	(0.364)	(0.198)
Observations:	6818	2459	4359
R-squared:	0.775	0.758	0.645
Country FE:	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes
Year FE:	Yes	Yes	Yes
First stage:			
$IPR_{c,1960} \cdot IPint_i$:	0.61443***	0.33323***	0.1489
	(0.06923)	(0.0398)	(0.12407)
Weak IV test:			
Effective F-statistic	80	75	1.5

The dependent variable in the second stage is the natural log of exports in industry i from country c to all other countries. The first stage dependent variable is the interaction term between IP-intensity at industry level and IPR protection quality in 1960. Then, we use the predicted values, $\tilde{IPR}$ interaction, in the second stage. The bottom part of the table reports the coefficient of the IV from the first stage, together with the values of the F-test resulting from the first stage and the endogeneity test. All explanatory variables in the second stage are also included in the first stage, but to conserve space we only report the first stage coefficients for the instrumental variable. GDP per capita, physical capital, and human capital are expressed in logs. A constant term is included but not reported. *, ** and *** indicate significance at the 10, 5 and 1 percent level.