Regulation & Governance

Regulation & Governance (2017) ••, ••–••   doi:10.1111/rego.12165

Does intellectual property lead to economic growth? Insights from a novel IP dataset

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Abstract
While policymakers often make bold claims as to the positive impact of intellectual property (IP) rights on both developed and developing country economies, the empirical literature is more ambiguous. IP rights have both incentive and inhibitory effects that are difficult to isolate in the abstract and are dependent on economic context. To unravel these contradictory effects, this article introduces an index that evaluates the strength of IP protection in 124 developing countries for the years 1995 to 2011. We illustrate the value of this index to economics study and show evidence that is consistent with IP leading to increased growth. Our results are further consistent with two causal pathways highlighted in the literature: that IP leads to greater levels of technology transfer and increased domestic inventive activity. Yet other aspects of our study fit uneasily with this simple story. For example, we find evidence suggesting that increased levels of growth lead to greater levels of IP protection, contradictory evidence in the literature linking IP with growth, a lack of evidence that increased levels of IP protection lead to actual use of the IP system, and problems with what IP indexes measure. Because of this, we suggest another – and so far undertheorized – explanation of the links between IP and growth: that IP may have few direct effects on growth and that any causality is a result of belief rather than actual deployment of IP.

Keywords: economic development, growth, index, intellectual property, international comparison.

1. Introduction

It is a matter of belief that higher levels of intellectual property (IP) protection in all but the poorest of countries increase wealth. As one author bluntly stated: "The bottom line is that decades of study and scores of researchers demonstrate that a robust intellectual property rights regime is beneficial to economic development" (Lybecker 2014). One can easily find, sometimes boldly and at other times with more subtlety, similar statements by the World Bank (1998, p. 145), the former Secretary General of the World Intellectual Property Organization (Idris 2003, p. 24), the United States (US) State Department (Field Jr. 2008, p. 3), the European Commission (2014, p. 11), and the Office of the United States Trade Representative (2015).

Despite the general belief that increased levels of IP protection leads to growth, there are reasons to question it.[1] Economic theorists generally recognize that IP has both an incentive (Chu *et al.* 2012) and an inhibitory effect (Maskus 2000b, p. 29). Which of these effects predominates depends on context and thus can only be determined empirically (Hudson & Minea 2013, p. 73). Empirical evidence is, however, not only mixed but the results of any one study frequently contradict those of others. While this may be partially explained by differences in methodology, scope, and objectives (López 2009, p. 6), these factors alone do not explain the stark differences between studies. In fact, as this article argues, higher levels of IP protection may be more influenced by politics (Briggs 2010, pp. 540–41) and wealth than vice versa. As Maskus notes, "the causation between [IP rights] and development operates in both directions" (2000a, p. 476).

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Accepted for publication 22 May 2017.

Cumulatively, these factors suggest that we ought to consider a complementary theory explaining the positive link between higher levels of IP protection and growth: that belief may play a larger role than either the literature or public policy has so far acknowledged. More precisely, they suggest that a strong belief in the capacity of IP to increase wealth may be sufficient, in itself, to lead to growth, even in the absence of direct reliance on IP rights in the target country. In this scenario, (mostly foreign) investors react to a country's increased levels of IP not to actually obtain IP rights there, but because increases in IP protection feed into their belief that the economy is likely to grow. According to this theory, it would thus be these political beliefs – suggested by Briggs (2010) and described in detail by Morin and Gold (2014) – rather than direct economic consequences of IP alone that lead to growth. This does not imply that IP has no direct effects. The evidence we put forward is consistent with the argument that a nation's IP system exercises a direct effect on the level of domestic invention, which in turn contributes to economic growth. However, this effect is moderate at best.

While it is impossible to "prove" a negative – that IP does not have the direct economic effect often claimed – a number of factors that we examine suggest that this indirect, placebo effect not only exists but may provide a useful complement (or substitute) for the direct effect of IP on investments and importation (Park & Ginarte 1997). In the sample studied, our results indicated that the placebo effect was approximately five times as strong as the direct effect of IP. The goal of this article is to provide good reasons for thinking that this placebo effect may help explain the empirical evidence rather than studies based solely on direct economic effects. We do not attempt to prove the negative but to suggest its consistency with our results and the literature.

To better understand our argument, a fuller appreciation of the literature on placebos – also known as self-fulfilling prophecies – is necessary, a subject to which we first briefly turn. We then examine the various factors that, despite it being a negative thesis, collectively suggest the viability of the placebo theory. These include a discussion of the empirical literature on IP and innovation, as well as on IP and growth. Following this discussion, we introduce our own empirical studies that rely on a new index to measure the strength of IP. While the results of these studies are consistent with the view that more protectionist IP does, indeed, have a positive effect on gross domestic product (GDP) per capita, this effect surprisingly occurs only in lower-middle income countries rather than in richer developing countries. We then examine one reason why empirical studies relating IP to either innovation or growth may lead to error: the use of formal IP indexes. Indeed, through the development and testing of a new IP index adjusted to the changing landscape since 1995 and collected annually, we have been able to capture some of the subtleties in the data that past indices have not. Finally, we examine the interrelationship between IP and GDP per capita in more detail, finding evidence that suggests that political influences may, in fact, be stronger than economic ones for all but domestic actors engaged in invention.

2. Of placebos and self-fulfilling prophecies

The underlying intuition of a placebo, or self-fulfilling prophecy, is well described by Merton as follows: "[A] *false* definition of the situation evoking behavior which makes the originally false conception come *true*" (1948, p. 195). The danger with these situations is that they lead to strong claims that are false. As Merton explains, "the prophet will cite the actual course of events as proof that he was right from the beginning" (1948, p. 195). In other words, the defining characteristic of a placebo is that it is the very consequences of the belief that make reality conform to the initial belief and that believers "fail to understand how their own belief has helped to construct that reality" (Biggs 2009, p. 295).

The economics literature has its own treatment of placebos and self-fulfilling prophecies. These arise in economies presenting multiple potential equilibria in which untested expectations non-trivially determine the equilibrium into which they eventually fall (Azariadis 1981; Krugman 1989, p. 654). These expectations "are unrelated to the preferences, endowments or production set of any individual, and yet come to influence the forecast and actions of economic decision-makers" (Azariadis & Guesnerie 1986, p. 725). We can regard economic outcomes as the sum of two distinct effects: (i) direct (structural) effects and (ii) indirect (behavioral) effects (Bulte *et al.* 2014, p. 15). A growth model with strong indirect effects would exhibit placebo characteristics. Where different groups of individuals hold beliefs based on distinct yet false conceptions – such as one group believing in the effect of sunspots and another in those of "moonspots" – each will find "factual" support for their beliefs, leading to increased faith (and, hence, stability) in the false belief (Guesnerie & Aziariadis 1982, pp. 803–805). A policymaker who knows that economic growth is driven by indirect, rather than direct, effects of IP has greater room to increase growth by exerting influence on individuals' beliefs and behavior rather than through increasing levels of IP protection. For example, she could focus on changing beliefs – through education – or on inducing the same behavior through other means at a lower cost.

Yu (2007, p. 193) suggests that a self-fulfilling prophecy lay in China's decision to embrace higher levels of IP protection (facially, at least) in the late 1970s after it opened its markets to foreign trade. He argues that while this increased protection had no direct effect on growth, inevitably some sectors and regions would see economic growth after (but not causally related to) the change. Observers then wrongly attributed this growth to the direct effect of IP and called for even greater levels of IP protection. "And," Yu notes, "the cycle would repeat itself" (2007, p. 193).

Our theory generalizes and adds precision to Yu's suggestion. It holds that IP as written in formal laws – rather than how these laws operate in practice – has less of a direct role in influencing growth than thought. Instead, a group of foreign investors, believing (even if falsely) that IP always drives growth, invest in countries that adopt these laws without necessarily engaging the IP system itself (e.g. by actually obtaining, defending, and licensing IP rights). There are various reasons why such actors may hold these beliefs even in the absence of direct economic effects, ranging from the symbolic – higher levels of IP protection signal a pro-investor policy environment – to the mystical – that IP will inevitably lead the country to higher rates of growth. In the end, the result is the same: actors' faith in the growth effects of increased IP protection drives investment and thus leads to growth despite the absence of direct causality.

3. A survey of the theoretical and empirical literature on IP, innovation, and growth

An examination of the literature on IP, innovation, and growth suggests a plurality of views concerning the effects of IP on innovation. The literature holds that increased levels of IP protection have both positive and negative effects on innovation and growth (Andersen & Konzelmann 2008; Odagiri *et al.* 2010; Chu *et al.* 2016). Hall and Harhoff (2012, p. 8) explain that, while patent rights create incentives for research and development and diffusion, they impede the combination of new ideas and inventions and raise transaction costs. Because of these offsetting tendencies, they conclude, "the theoretical literature … produces ambiguous results with respect to incentives provided by patents" (Hall & Harhoff 2012, p. 9). Scholars have documented similar tendencies with respect to other forms of IP (Landes & Posner 2003, pp. 21–24).

For developing countries, this suggests that the direct effect of IP on growth is mediated by a number of factors, including the country's research and development capacity, per capita wealth, the nature and efficacy of its institutions, its stage of development, and economic volatility, to name a few (Maskus 2000b, 2000a; Forero-Pineda 2006; Odagiri *et al.* 2010, p. 16; Chu *et al.* 2012; Chu *et al.* 2014). A corollary is that there is no one optimum domestic level of IP protection across all countries; rather, the literature suggests that a country ought to vary its IP protection depending on its entire and fluid innovation ecosystem, including the factors just set out. The effect of this, as Hudson and Minea conclude, is that "we are no longer faced with an unchanging single optimal level of [IP] for each country, but one which evolves" (2013, p. 73).

Acknowledging that domestic optima for IP protection vary according to circumstance does not explain which elements in the ecosystem are most relevant in setting domestic IP protection. Maskus suggests that developing countries benefit more from increased levels of IP protection when they have "appropriate complementary endowments" such as greater investments in human capital, more open economies, and policies such as strong anti-trust laws (2000a, pp. 497–499). Hudson and Minea (2013, p. 73) find that initial levels of IP protection and GDP jointly influence a country's optimal IP levels. Sweet and Eterovic Magio (2015, p. 674) show that these optima depend on both levels of development and economic complexity. Kim *et al.* (2012, p. 374) point out that it is not the level of IP protection but the form protection takes that is most relevant.

Scholars suggest that IP likely contributes to growth through at least two distinct processes: by encouraging foreign right holders to export high technology goods into the domestic economy and by providing incentives to innovate domestically (Maskus & Penubarti 1995, p. 244; Maskus 2000a, p. 481, pp. 485–86; Fink & Maskus 2005, pp. 3–5, pp. 8–9; López 2009, p. 5; Ivus *et al.* 2015).

The first of these processes is based on the suggestion that greater levels of IP protection create a favorable environment for developing countries with embryonic innovative capacity to receive technology transfer through foreign IP-intensive goods (López 2009, p. 5). More advanced developing countries go beyond importation to innovating their own products and services:

> The evolutionary trajectory of some East Asian countries such as the Republic of Korea, illustrates how economies that begin copying and adapting foreign technologies may gradually generate endogenous innovation capabilities as their firms progressively become world-class innovators (López 2009, p. 5)

In these countries, higher levels of IP protection can act as an incentive for entrepreneurial activity by:

> 1) encouraging development of new products or processes with some assurance of a return on resources invested in the effort; 2) creating an incentive to take an innovation from others and finding an application within the economy; or 3) creating an environment increasing the likelihood that an entrepreneur will recognize an opportunity not seen by others and market it in a creative way. (Thompson & Rushing 1999, p. 68)

IP rights:

> [P]romote investments in knowledge creation and business innovation by establishing exclusive rights to use and sell newly developed technologies, goods, and services. Absent these rights, competitive rivals could appropriate economically valuable information without compensation. Under such circumstances, firms would be less willing to incur the costs of investing in research and commercialization activities. (Maskus 2000a, p. 473)

Given the unclear effects of increased levels of IP protection, as well as the importance of context, it is not surprising that the theoretical literature "does not deliver a clear message about the effectiveness of the patent system" (Hall & Harhoff 2012, p. 12) or, for that matter, IP in general. Neither, however, does the empirical literature. We summarize some of the leading recent studies on the effectiveness of the IP system in encouraging economic growth, both directly and indirectly, in Appendix A. When we compare these studies, we find, as set out in Table 1, deep contradictions between results that one cannot easily explain.

We acknowledge that the variances in outcomes of the studies that we examine in Table 1 may be the result of differences in the models and methods deployed. Further, we recognize that economies are multi-faceted, affected by complicated interactions and volatilities that can be difficult to capture in any statistical model.

Table 1 Summary of results of recent empirical studies

Effect of IP on…	Results
Innovation	Positive: • Kanwar and Evenson (2003) • Chen and Puttitanun (2005) • Schneider (2005) Negative: • Hudson and Minea (2013) • Lerner (2009) U-shaped according to level of development: • Kanwar and Evenson (2003) • Hudson and Minea (2013) • Chu *et al.* (2014)
GDP per capita (middle income countries)	Negative: • Kim *et al.* (2012) No relationship/undetermined: • Falvey *et al.* (2006)
GDP per capita (low income countries)	Positive: • Falvey *et al.* (2006) Negative: • Kim *et al.* (2012)

GDP, gross domestic product.

Nevertheless, even when one takes these differences into account, some further explanation is needed, given the stark contrast in results. We suggest four possibilities for this disparity. First, some studies may simply be wrong or incomplete. This may be because the models they used, the theories deployed, the indicators selected, or the data collected are inappropriate or outdated. Second, and relatedly, there simply may not have been enough studies conducted to develop a clear pattern of what is happening. Third, as theory predicts that the outcome of IP protection on growth will depend on other factors, we may be observing the effects of an unknown underlying effect.

Despite the merits of these three possibilities, we suggest that a fourth theory provides a more interesting explanation for future studies, that is, that quantitative studies to date have examined the wrong thing: the direct effect of IP on growth rather than the indirect effect of "atmospheric conditions" (Intarakumnerd & Charoenporn 2015), especially of the *belief* that higher levels of IP protection lead to growth. The differing results we see in the studies above arise, on this theory, from the inclusion of indicators unrelated to belief and the failure to include those that relate to it. If this turns out to be the case, then:

> [T]he main impediment to improving patent systems many not lie in gaining new insights, but in the political economy of patent systems and the vested, often diverging interests that many stakeholders have in the existing system. (Hall & Harhoff 2012, p. 36)

In this article, we explore this fourth explanation: that IP protection acts, at least in part, as a placebo on growth or, in other words, is a self-fulfilling prophecy. We first explain the results of our own empirical contributions to these questions using a new index of IP protection calibrated to the post-1995 world.

4. Material and methods

As acknowledged above, while the effect of different levels of IP protection on an economy varies on the basis of multiple factors, our focus is on the long-term and general case. By examining the effects of IP protection across the gamut of developing countries over a long enough period of time, we smooth out difficulties posed by such factors as volatility and business cycles in individual economies.

4.1. A new Intellectual Property (IP) Index

We address the inconsistencies between previous studies by applying a new index of IP protection that specifically captures, on an annual basis, the type of IP changes common in the post-1995 world. This index, while building on the learning of previous indexes, overcomes their limitations. These include the fact that several older indexes consider data on four to five year averages, study only one type of IP right or one sector, and/or are limited as to the number of developing countries examined. In addition, these indexes rely on data covering years prior to the coming into force of the TRIPs Agreement and thus do not reflect changes instituted as a result of global IP reforms in the mid-1990s (WTO 1994). The most common of these indexes (Candelin-Palmqvist *et al.* 2012) is that developed by Ginarte and Park (1997), updated by Park (2008) and extended by Park and Lippoldt (2008) (collectively, "Ginarte-Park"). Other indexes include that of Rapp and Rozek (1990), Kondo (1995), Seyoum (1996), Sherwood (1997), Ostergard (2000), Campi and Nuvolari (2015), and Liu and La Croix (2015). Since 2004, the Global Competiveness Index (World Economic Forum 2016) includes a measure of the level of IP protection, but this is based on individual opinions, rather than specific elements of IP systems, and is limited in its time coverage.

The index we introduce measures the adoption of IP rules that go beyond the minimum standards set by TRIPs and that are specific to the more onerous US demands for increased IP protection. It is thus sensitive to changes in levels of IP protection since 1995. The **IP INDEX (IP)** scores countries on a 0–9 scale. The higher a country scores, the more it has aligned its IP rules with those of the US. We collected data for each year from 1995 to 2011, coinciding with the initial coming into force of the TRIPs agreement. The IP INDEX covers all developing countries with a population of more than one million and for which data was available. The result is 124 countries and a sample of 2143 country-years. These results, as well as the complete list of indicators, coding values, descriptive statistics, and data sources, are available in the appendices.[2]

All of the regressions that we used in our statistical models made use of fixed effects (on both country and year) estimation, which is an approach to analyzing panel data that better enables controlling for unobserved heterogeneity that varies across individual countries but remains constant across time periods. Doing so allows for our model to better isolate key relationships that may be masked by the presence of individual idiosyncrasies (e.g. unchanging characteristics unique to a given country) for which we would not otherwise account. We used the StataSE 13 program to perform all fixed effects analyses described in the article, and in all models, we used robust standard error estimates following the Huber/White method of estimation in order to correct for heteroscedasticity and to assure the stability of our results (Huber 1967; White 1980). All F-test results in respect of our models are statistically significant at 0.001.

4.2. Our models

We examined two routes through which the literature proposes that IP affects growth. The first is that stronger levels of IP protection facilitate the transfer of high technology goods into developing countries, thus increasing the stock of knowledge and raising productivity growth, ultimately leading to overall economic growth. The second is that stronger levels of IP protection encourage domestic innovation, which in turn increases the technological ability of developing countries, creating growth. Consistent with the earlier discussion, we would expect to see the importation pathway outlined in the first route occurring primarily in countries with low to middle levels of development; the second pathway ought to be more visible in middle income and upper-middle income countries.

To test our hypotheses, we split countries into categories based on World Bank income classifications to account for unobserved heterogeneity that may vary over time as countries attain various levels of development, which would not be otherwise captured by a fixed-effects approach. Considering that the vast majority of countries studied fall into the lower and upper middle income class, we introduced a further refinement that designated countries as above or below the median GDP per capita for their income classification in a given year (i.e. if a country was categorized as lower middle income in 1996 and fell above or below the median GDP per capita for lower middle income countries in 1996, it would be classified as LM+ or LM-, respectively). Each refined category was then run through our models individually to see how the relationships changed across income levels. For robustness, we analyzed the group of all developing countries, which includes all countries not designated as "High Income" by the World Bank.

In order to examine both the effects of increased IP protection on growth and to specifically investigate the two pathways suggested by the literature – that is, increased technology transfer and greater inventive activity – we introduced three variables. **LOG IP IMPORTS (M)** measures the annual importation of IP-intensive goods into the country. We include within this variable the total of manufactured imports, machinery and transport equipment, parts and components for electrical and electronic goods, chemicals and related products, and electronics excluding parts and components according to United Nations Conference on Trade and Development (UNCTAD) statistics. We transformed the import data logarithmically to account for skew. We used real GDP per capita (**GDP PER CAPITA [G]**) to measure economic growth.

For reasons of tractability and comparison, we focus on "technologically and economically significant inventions" to assess the impact of the IP system (Furman *et al.* 2002, p. 909). While Kim *et al.* properly note that much of the innovation in developing countries is "of the adaptive, imitative type" (2012, p. 358), we seek to determine the effect of the major categories of IP rights in inducing economic growth and thus must eliminate smaller units of invention from our study. Consistent with the literature (Furman *et al.* 2002; Chen & Puttitanun 2005; Qian 2007), we measured domestic levels of invention on the basis of the number of patent applications that nationals of the country filed with the United States Patent and Trademark Office (USPTO), which we transformed logarithmically to account for skew in a similar fashion to IP imports (**LOG USPTO APP [U]**). We selected filings at the USPTO so as to provide a consistent comparison between countries as opposed to more ad hoc and often changing practices in individual countries, and to accommodate patent propensity across countries (Furman *et al.* 2002).

We inserted LOG IP IMPORTS and LOG USPTO APP, representing the two routes linking IP and growth, into the model as mediator variables. Mediator variables serve as "the generative mechanism through which the focal independent variable is able to influence the dependent variable of interest" and mediation "is best done in the case of a strong relation between the predictor and the criterion variable" (Baron & Kenny 1986, pp. 1173, 1178). Put simply, the presence of a mediator variable provides insight into *how* a given relationship occurs. If we can show, for example, that LOG IP IMPORTS mediates the relationship between IP INDEX (the predictor variable) and GDP PER CAPITA (the dependent variable), this would provide consistency with the theory that IP leads to growth by increasing IP imports that, in turn, cause economic growth. A similar situation would occur between IP, domestic inventive activity, and growth.

According to Holmbeck (1997, p. 602), in addition to controlling for multicollinearity, one must meet four conditions in order to establish that a given variable mediates the relationship between a predictor and dependent variable:

1 The predictor variable must be significantly associated with the dependent variable;
2 The predictor variable must also be significantly associated with the mediator variable;
3 The mediator must be significantly associated with the dependent variable, after controlling for the predictor variable;
4 In step 3, the impact of the predictor variable on the dependent variable must be significantly lower than it is in step 1, which shows that the mediator variable explains a significant portion of the predictor's impact.

To test whether these conditions were met in each group, we performed a series of multiple regressions in which we examined whether we could establish LOG IP IMPORTS and LOG USPTO APP as mediators. This involved first regressing GDP PER CAPITA on IP INDEX, then regressing each candidate mediator on IP INDEX, and finally regressing GDP PER CAPITA on IP INDEX alongside the proposed mediator. We lagged IP INDEX by two years to further emphasize directionality, as lagging further would unduly restrict our dataset and introduce additional confounding factors. In each regression, we included five standard control variables, approximating the various elements of growth set out by the Mankiw *et al.* (1992) variation on the Solow–Swan growth model (Solow 1956; Swan 1956): (i) human capital savings, measured as the gross enrolment ratio of the population at the tertiary level, regardless of age, expressed as a percentage of the official school-age population (**ENROLMENT [E]**);[3] (ii) average growth rate of the population (**POPULATION GROWTH [PG]**); (iii) physical capital savings, measured as the ratio of total gross domestic capital formation as a percentage of GDP (**GROSS CAPITAL FORMATION [GCF]**); (iv) economic freedom or the degree of market liberalization in a country (**ECONOMIC FREEDOM [EF]**); and (v) GDP per capita lagged by five years (**GDP LAG [GT-5]**), which we used in lieu of, but capturing the same effects as, initial GDP per capita.[4] We drew data from the World Bank's *World Development Indicators* (World Bank 2016), with the exception of economic freedom, which we obtained from the Heritage Foundation's Economic Freedom Index (Heritage Foundation 1995).

In accordance with the approach for determining mediator variables outlined above, we performed six different fixed effects regressions on each of our identified income categories, corresponding to Tables 2–7. The estimation equations are as follows, with the tilde accent referring to variables that have been demeaned using the *within* transformation:

$$\widetilde{G}_{it} = \beta_1\widetilde{IP}_{i(t-2)} + \beta_2\widetilde{E}_{it} + \beta_3\widetilde{PG}_{it} + \beta_4\widetilde{GCF}_{it} + \beta_5\widetilde{EF}_{it} + \beta_6\widetilde{G}_{i(t-5)} + \widetilde{\eta}_{it}$$

$$\widetilde{M}_{it} = \beta_1\widetilde{IP}_{i(t-2)} + \beta_2\widetilde{E}_{it} + \beta_3\widetilde{PG}_{it} + \beta_4\widetilde{GCF}_{it} + \beta_5\widetilde{EF}_{it} + \beta_6\widetilde{G}_{i(t-5)} + \widetilde{\eta}_{it}$$

$$\widetilde{G}_{it} = \beta_1\widetilde{IP}_{i(t-2)} + \beta_2\widetilde{M}_{it} + \beta_3\widetilde{E}_{it} + \beta_4\widetilde{PG}_{it} + \beta_5\widetilde{GCF}_{it} + \beta_6\widetilde{EF}_{it} + \beta_7\widetilde{G}_{i(t-5)} + \widetilde{\eta}_{it}$$

$$\widetilde{U}_{it} = \beta_1\widetilde{IP}_{i(t-2)} + \beta_2\widetilde{E}_{it} + \beta_3\widetilde{PG}_{it} + \beta_4\widetilde{GCF}_{it} + \beta_5\widetilde{EF}_{it} + \beta_6\widetilde{G}_{i(t-5)} + \widetilde{\eta}_{it}$$

$$\widetilde{G}_{it} = \beta_1\widetilde{IP}_{i(t-2)} + \beta_2\widetilde{U}_{it} + \beta_3\widetilde{E}_{it} + \beta_4\widetilde{PG}_{it} + \beta_5\widetilde{GCF}_{it} + \beta_6\widetilde{EF}_{it} + \beta_7\widetilde{G}_{i(t-5)} + \widetilde{\eta}_{it}$$

$$\widetilde{G}_{it} = \beta_1\widetilde{IP}_{i(t-2)} + \beta_2\widetilde{M}_{it} + \beta_3 U_{it} + \beta_4\widetilde{E}_{it} + \beta_5\widetilde{PG}_{it} + \beta_6\widetilde{GCF}_{it} + \beta_7\widetilde{EF}_{it} + \beta_8\widetilde{G}_{i(t-5)} + \widetilde{\eta}_{it}$$

In order to control for multicollinearity, we standardized all variables to have a mean of 0 and a standard deviation of 1, allowing us to examine the relative effect that each variable has on the relationships studied. After standardization, the coefficients represent the number of standard deviation changes expected in the response variable given a one standard deviation change in the predictor variable (Walker & Lev 1953). Some social scientists have criticized the coefficient standardization method because standard deviation is a characteristic of the sample and not the real population under study (Allison 1977). Because the variables in question here have been almost completely sampled (across nearly all developing countries and over a long time period) this is not a significant concern and thus we can more confidently rely on standardization.

We excluded income classes in the tables for which we obtained insignificant results in a given route from subsequent regressions in that route. We did this to simplify presentation of the results, as finding a mediator effect in that income class would be impossible. Note that results consistent with finding a mediator effect are presented in bold, while those inconsistent with such a finding are italicized. Complete results for all categories, including exact P values and F-tests, are included in Appendix B.

Our results are consistent not only with the proposition that higher levels of IP protection, as measured by the IP INDEX, correlate with economic growth, but that the two pathways – that increasing levels of IP protection lead to

Table 2 The total effect of IP on growth

Income Class	L-	L+	LM-	LM+	UM-	UM+	All Dev
Variable	GDPPC	GDPPC	GDPPC	GDPPC	GDPPC	GDPPC	GDPPC
IP INDEX (2-YEAR LAG)	*0.000573*	**0.00270***	**0.0105****	**0.0117*****	**0.0273***	**0.0224***	**0.0135*****
GDPPC (5-YEAR LAG)	0.539***	0.0767	0.342	0.115	0.509*	0.344	0.624***
ECONOMIC FREEDOM	0.00212*	0.00377**	0.00882*	0.00913	−0.0164	−0.00283	0.00627
ENROLMENT	0.00866**	0.0155***	0.0269**	0.0375***	0.0170*	0.0612***	0.0341***
POPULATION GROWTH	0.000274	−0.00450	−0.00345	−0.00588	−0.00884	−0.0217***	−0.00510
GROSS CAPITAL FORMATION	0.000478	0.000406	0.00475	0.0102**	0.0197*	0.0400**	0.00518
N	183	198	166	178	127	143	994
R^2	0.651	0.524	0.644	0.726	0.539	0.730	0.732

***$P < 0.001$;
**$0.001 < P < 0.01$;
*$0.01 < P < 0.05$. All models with fixed country and year effects; standardized coefficients reported. GDPPC, gross domestic product per capita; IP, intellectual property; L, lower; LM, lower-middle; UM, upper-middle.

Table 3 The effect of IP on inward technology transfer

Income Class	L+	LM-	LM+	UM-	UM+	All Dev
Variables	LOG IP IMPORTS	LOG IP IMPORTS	LOG IP IMPORTS	LOG IP IMPORTS	LOG IP IMPORTS	LOG IP IMPORTS
IP INDEX (2-YEAR LAG)	*0.0643*	**0.176*****	**0.0967*****	**0.228***	*0.0112*	**0.139*****
GDPPC (5-YEAR LAG)	4.470	6.136***	2.346**	0.574	1.268***	0.603
ECONOMIC FREEDOM	0.102	0.0540	0.0381	−0.163	0.0808	0.131**
ENROLMENT	0.415**	0.326***	0.163***	0.0873	0.138**	0.174***
POPULATION GROWTH	−0.554**	0.0342	−0.0188	−0.0811**	−0.0243	−0.0224
GROSS CAPITAL FORMATION	0.0629**	0.0541	0.139***	0.0836	0.00115	0.0965***
N	183	198	169	178	128	144
R^2	0.652	0.503	0.615	0.650	0.395	0.711

***$P < 0.001$;
**$0.001 < P < 0.01$;
*$0.01 < P < 0.05$. All models with fixed country and year effects; standardized coefficients reported. GDP, gross domestic product; IP, intellectual property; L, lower; LM, lower-middle; UM, upper-middle.

greater levels of technology transfer and also result in higher domestic inventive activity – hold true. More interestingly, these effects center on lower-middle income countries and fall away both for lower and higher income countries. In particular, we found the strongest significance of the correlation between the level of IP protection and growth through these pathways in both lower lower-middle and upper lower-middle countries, with significance falling in both upper lower-income and lower upper-middle income countries. Results were not significant in lower lower-income and upper upper-middle income countries.

When we turn to the two routes through which theory predicts IP acts, we find similar results. First, Tables 3 and 2.3 show that for all lower-middle income countries, higher levels of IP protection significantly and positively correlate with greater technology transfer which, in turn, correlate significantly and positively with growth even when we control for IP. Second, Tables 5 and 6 demonstrate that greater IP protection correlates significantly and positively with increased domestic inventive activity in lower lower-middle income countries, which correlates significantly and positively with growth in those countries, again controlling for IP. As these tables illustrate, both LOG IP IMPORTS and LOG USPTO APP satisfy the conditions for mediating the relationship between IP INDEX and GDP PER CAPITA. These effects remain even when we include both mediators in the model, as in Table 7.

Table 4 The effect of IP on growth with inward technology transfer as mediator

Income Class	LM-	LM+	UM-	All Dev
Variables	GDPPC	GDPPC	GDPPC	GDPPC
IP INDEX (2-YEAR LAG)	**0.00433***	**0.00623****	**0.00755**	**0.0108****
LOG IP IMPORTS	**0.0351*****	**0.0566*****	**0.0870***	**0.0199**
GDPPC (5-YEAR LAG)	0.131	−0.0177	0.459**	0.612***
ECONOMIC FREEDOM	0.00713*	0.00697	−0.00223	0.00369
ENROLMENT	0.0157*	0.0283***	0.00939	0.0306***
POPULATION GROWTH	−0.00487	−0.00481	−0.00179	−0.00466
GROSS CAPITAL FORMATION	0.00274	0.00233	0.0124	0.00325
N	166	178	127	994
R2	0.752	0.789	0.687	0.739

***$P < 0.001$;
**$0.001 < P < 0.01$;
*$0.01 < P < 0.05$. All models with fixed country and year effects; standardized coefficients reported. GDPPC, gross domestic product per capita; IP, intellectual property; LM, lower-middle; UM, upper-middle.

Table 5 The effect of IP on domestic inventive activity

Income Class	L+	LM-	LM+	UM-	UM+	All Dev
Variables	LOG USPTO APPS	LOG USPTO APPS	LOG USPTO APPS	LOG USPTO APPS	LOG USPTO APPS	LOG USPTO APPS
IP INDEX (2-YEAR LAG)	*0.0555*	**0.302****	*0.0445*	*0.0954*	*0.0181*	**0.0807***
GDPPC (5-YEAR LAG)	4.089	5.927	2.184	4.552*	2.188***	2.519***
ECONOMIC FREEDOM	0.0291	−0.121	0.262*	−0.0733	0.138	0.0158
ENROLMENT	0.275	0.126	0.110*	0.183	0.0958	0.132***
POPULATION GROWTH	−0.0936	−0.0928	−0.000127	−0.182*	0.0626	−0.0539
GROSS CAPITAL FORMATION	0.0347	0.102	0.0417	0.0796	−0.0283	0.0426
N	198	169	178	128	144	999
R^2	0.095	0.251	0.134	0.288	0.508	0.266

***$P < 0.001$;
**$0.001 < P < 0.01$;
*$0.01 < P < 0.05$. All models with fixed country and year effects; standardized coefficients reported. GDPPC, gross domestic product per capita; IP, intellectual property; L, lower; LM, lower-middle; UM, upper-middle; USPTO, United States Patent and Trademark Office.

Table 7 reveals a more intriguing fact: given our use of standardized variables, we can see that the effect of IP on growth through inward technology transfer is just over five times as strong as the effect of IP on growth through domestic inventive activity in lower lower-middle income countries. That is, while we find support for both causal mechanisms, the more important effect of IP is on foreign actors who decide to transfer technology to the country rather than on domestic actors engaging in innovative activities themselves.

Our results contrast with those of previous studies in several ways. Appendix A provides a detailed comparison with those studies. We highlight here a couple of significant differences. First, our finding that higher levels of IP correlate best with growth in lower-middle income countries is opposite to the findings of certain studies (Falvey *et al.* 2006; Kim *et al.* 2012), adding to the inconsistency of results that already exists. Second, whereas the literature suggests that technology transfer leads eventually to inventive activity (López 2009, p. 5), our data suggests that such a relationship may not in fact exist: that inventive activity occurs at the lower end of lower-middle income countries whereas technology transfer occurs at both lower and higher lower-middle income countries.

The literature suggests possible explanations for these observations. These include the suggestion that it is differences in trade policy, not degree of economic development, that influence the impact of IP protection on growth

Table 6 The effect of IP on growth with domestic inventive activity as mediator

Income Class	LM-	All Dev
Variable	GDPPC	GDPPC
IP INDEX (2-YEAR LAG)	**0.00799****	**0.0132*****
LOG USPTO APPS	**0.00849***	**0.00430**
GDPPC (5-YEAR LAG)	0.287	0.613***
ECONOMIC FREEDOM	0.00964*	0.00619
ENROLMENT	0.0255***	0.0335***
POPULATION GROWTH	−0.00250	−0.00486
GROSS CAPITAL FORMATION	0.00399	0.00500
N	166	994
R2	0.687	0.733

***$P < 0.001$;
**$0.001 < P < 0.01$;
*$0.01 < P < 0.05$. All models with fixed country and year effects; standardized coefficients reported. GDPPC, gross domestic product per capita; IP, intellectual property; LM, lower-middle.

Table 7 The effect of IP on growth with both mediators

Income Class	LM-	LM+	UM-	All Dev
Variables	GDPPC	GDPPC	GDPPC	GDPPC
IP INDEX (2-YEAR LAG)	**0.00306**	**0.00602****	**0.00689**	*0.0106***
LOG IP IMPORTS	**0.0320*****	**0.0564*****	**0.0874***	*0.0193*
LOG USPTO APPS	**0.00611***	*0.00515*	*0.00592*	*0.00246*
GDPPC (5-YEAR LAG)	0.109	−0.0284	0.432**	0.606***
ECONOMIC FREEDOM	0.00787**	0.00563	−0.00173	0.00372
ENROLMENT	0.0157*	0.0278***	0.00827	0.0304***
POPULATION GROWTH	−0.00407	−0.00481	−0.000681	−0.00453
GROSS CAPITAL FORMATION	0.00237	0.00215	0.0119	0.00321
N	166	178	127	994
R2	0.774	0.793	0.690	0.739

***$P < 0.001$;
**$0.001 < P < 0.01$;
*$0.01 < P < 0.05$. All models with fixed country and year effects; standardized coefficients reported. GDPPC, gross domestic product per capita; IP, intellectual property; LM, lower-middle; UM, upper-middle.

(Gould & Gruben 1997). Alternatively, differences in the dominant industries and their respective reliance on levels of IP protection between the countries studied may mask relationships that are only apparent if an industry-specific approach to this analysis were taken. In our view, however, these alternatives only seem to add to the general confusion in the literature, rather than resolve it. Instead, we see these results as consistent with the suggestion that the mechanisms of technology transfer and of domestic inventive activity may not, in fact, be linked at all. We will discuss this further, but our argument is that growth through the former route is more heavily based on belief than that of the latter.

5. The role of perception in measuring IP

5.1. The problem with IP indexes

A problem inherent in all IP indexes, including the one we introduced above, is that none measure the *actual* (functional) level of IP protection, but only the perceived level of protection, which may be quite different. There are two reasons for this.

First, apart from Sherwood (1997) and efforts to assess the quality of IP systems (de Saint-Georges & van Pottelsberghe de la Potterie 2013), all indexes assume that the level of IP protection is nothing more or less than what legislation says it is. As IP legislation is written in a broad and inclusive manner, it necessarily leaves interpretation of often vague standards to courts and tribunals. Thus, it is IP offices, courts, and tribunals, not legislation, that usually determine the meaning of such fundamental concepts as invention, novelty, inventive step and industrial application in patent law, originality in copyright law, and confusion in trademark law. An index based on the law as written in legislation – for convenience, formal IP – will be incomplete at best and misleading at worst (Arora 2009, p. 46).

Even if one could overcome this exclusive reliance on formal IP – Sherwood (1997) only succeeds by heavily restricting his sample in time and space and by using idiosyncratic measures that cannot be replicated – there remains significant uncertainty. Consider, for example, two countries possessing identical laws allowing for the grant of compulsory licenses. Neither country has ever, within the period examined by the study, granted one of those licenses. In this example, not only the law but also the actual practice of the law are identical; nevertheless, the two countries may have very different reasons for this. For example, one country's (e.g. Canada since the early 1990s) policymakers may simply not believe in compulsory licensing to ensure access and thus never grant them. The other country may so clearly communicate its willingness to issue such a license that no rational patentee would undertake an action that would cause the country to do so (e.g. France in respect of genetic testing) (Gold & Carbone 2010). Therefore, while simply looking at formal IP is inadequate, so too would be looking at the law in practice.

Second, none of the indexes take into account the actual *use* of the IP system in a country. Thus, a country with laws that provide the highest levels of protection (measured according to one's preferred index) but that has not issued any patents or trademarks – we leave aside copyrights as they need not be registered – will score higher than a country with lower levels of protection but in which IP is more actively sought and traded. Without taking into account the actual use of IP systems, none of the indexes measure the direct and actual effects of IP on a given economy.

While IP indexes do not actually measure IP as it functions directly in the economy, they do capture something. We suggest that they measure the beliefs that actors within a country hold based on assumptions of how IP functions. (This is most explicit in the Global Competitiveness Index [World Economic Forum 2016] but is true for all of them.) It is these beliefs that drive actors to invest, or not, whether in a form related to goods subject to IP – licensing, foreign direct investment, or investments leading to invention – or otherwise. That is, actors who take notice of IP will be more likely to invest in some form in a country with a higher IP score than another if those actors believe that IP leads to growth. We return to this belief in the next section. For now, we simply point out that the empirical studies carried out to date, including our own, are consistent with there being a link between a belief in the effect of higher levels of IP protection and growth.

To obtain an understanding of how IP may directly affect a country's economy, we introduce an additional indicator: **LOG PCT DESTINATION**. The Patent Cooperation Treaty (PCT) allows inventors to apply for a patent through an international mechanism. Once the preliminary examination is complete, the applicant designates countries in which she would like to obtain patent protection. These are called designated countries. LOG PCT DESTINATION is the logarithmically transformed measure of the number of times in a year that a country has been designated under this regime, regardless of invention origin. While LOG PCT DESTINATION is far from perfect – not all patent filings will result in a patent, not all patents are granted through the PCT, and patents do not comprise all IP – the indicator nevertheless provides a good measure of patents held in a country. That is, it measures the propensity of (mostly foreign) actors to file for patents in the country.

Unlike a country's level of domestic patents or the number of patents filed in the US (which only apply to use within the US), LOG PCT DESTINATION is a measure of the *actual usage* of the country's patent system in the sense that actors rely on the actual level of IP protection provided by that country. As such, it captures the direct effect of patents on that country's growth. If IP (more narrowly, patents) in the country actually causes growth through its direct effects, we would expect to find a correlation between LOG PCT DESTINATION and GDP PER CAPITA.

As Table 8 indicates, we find no significant correlation between PCT DESTINATION and GDP PER CAPITA in developing countries. Although the availability of PCT DESTINATION data limits our sample size, the IP INDEX remains a consistently significant lagged predictor of GDP PER CAPITA even with this more limited data set. Models in which both the IP INDEX and PCT DESTINATION are present indicate a significant effect of the IP INDEX and an insignificant lagged effect of PCT DESTINATION. This absence of significance of the correlation between PCT DESTINATION, which measures actual IP usage, and GDP PER CAPITA is surprising because, as noted in the introduction, a positive correlation between IP and growth is an article of faith.

Table 8 Models comparing the lagged effects of the IP INDEX and LOG PCT DESTINATION on GDP PER CAPITA in 2005 USD with a dataset limited to data points with available PCT data

Variable	GDPPC	GDPPC	GDPPC
GDPPC (5-YEAR LAG)	0.661***	0.662***	0.731***
LOG PCT DESTINATION (5-YEAR LAG)	0.002		0.002
IP INDEX (5-YEAR LAG)	0.037***	0.037***	
ECONOMIC FREEDOM	0.009	0.009	0.016
ENROLMENT	0.159***	0.159***	0.154***
POPULATION GROWTH	0.423	−0.010	−0.005
GROSS CAPITAL FORMATION	0.014*	0.014*	0.013
N	540	540	540
R2	0.990	0.990	0.990

***$P < 0.001$;
**$0.001 < P < 0.01$;
*$0.01 < P < 0.05$. All models with fixed country and year effects; standardized coefficients reported. GDPPC, gross domestic product per capita; IP, intellectual property; PCT, Patent Cooperation Treaty.

5.2. Direct versus indirect effect of IP

Armed with the above analysis, we can hypothesize why it is that different studies examining the effect of the level of IP protection on innovation and growth have led to the contradictory results we witnessed earlier. As suggested, what previous studies have measured is how actors behave in response to their beliefs about how the relative strength of formal IP regimes affects growth. These studies do not examine the direct effect of IP as it is actually practiced in the economy. As actors alter their behavior in response to their beliefs, IP has an indirect impact on growth regardless of whether anything concrete has, in fact, directly affected the economy. For example, actors may decide to transfer technology into the country without seeking IP, they may buy high technology goods in foreign markets and bring them into the country, or they may enter into contracts with local businesses without actually registering any IP. In other words, the actual decision to invest in a country is multifactorial and, in large part, is not *directly* related to the country's formal levels of IP protection. Thus, as the models involving PCT DESTINATION suggest, it does not matter how strong IP law is in practice, as it is a superficial understanding of domestic IP that induces belief. Given this, while a higher IP score on existing indexes may render actors more willing to consider investing in a country, there are many additional and confounding factors that have not been taken into account in the literature. Because these factors are missing, we should not be surprised that the results show so little consistency.

The positive correlations between LOG USPTO APPS and GDP PER CAPITA observed in Table 6, suggest that IP has some direct effect on growth. As we previously noted, LOG USPTO APPS captures inventive activity taking place inside the country. Table 5 suggests that formal IP, measured by the IP INDEX, correlates with increased domestic inventive activity. One would expect that nationals would be more aware of the subtleties of the national patent system than foreigners. Given this, there is reason to believe that nationals invent in response to the inducement that the actual IP system (and not simply its apparent form) provides. This inducement occurs at two levels: the direct effect of the national IP system and by the opportunity to obtain IP protection in foreign markets. Because US IP protection affects all countries in our sample equally, we can credit any increased inventive activity we witness in a country to local IP law. It thus seems likely that domestic IP as practiced (rather than its form) is a direct driver for domestic invention.

What emerges from the above discussion is that IP acts both directly and indirectly on the economy to increase economic growth. Specifically, it acts directly on local actors who are deciding whether to engage in inventive activity; it acts in a significant manner indirectly on foreign actors who invest in the country.

There is, of course, the possibility that the lack of correlation between LOG PCT DESTINATION and GDP PER CAPITA can be explained within existing growth models in a way that assumes that IP directly drives growth. However, such an explanation would likely require additional assumptions about how IP functions in the economy and (currently unknown) confounding conditions, making them quite complex. On the other hand, the placebo theory we put forward provides a simple explanation for the lack of significant correlation: that IP drives growth through largely indirect, rather than direct, means.

6. The virtuous cycle of growth and IP

Causation between a country's IP levels and level of economic development "operates in both directions" (Maskus 2000a, p. 476). Morin and Gold (2014) documented how social and political mechanisms serve to increase a country's level of IP protection, often despite the economic interests of that country. They show how, between 1995 and 2008, a combination of coercion and socialization from the US as well as regional competition led countries to increase the level of formal IP protection available in those countries. They also found a link between growth and IP levels. The direct effect of IP on development remains, however, for reasons discussed earlier, more difficult to establish. What the literature has not yet examined is, even if causation runs both ways, which arm of the causal chain – from growth to IP or IP to growth – is stronger?

The causation puzzle becomes more complex when we take into account that the literature bases its assessments on IP indexes that measure not IP as it operates in practice but formal IP. More precisely, the literature assesses causality based on actors' beliefs and the behaviors that follow those beliefs rather than on the direct causal of effect of IP itself on growth. Understood in this light, the study by Morin and Gold (2014) can better be described as demonstrating that politics cause countries to adopt formal changes to IP laws that appeal to (mostly foreign) actors, with or without those changes having any direct economic effect on the country. Similarly, the other studies examined earlier show – to the extent they are consistent with one another – that increases in formal IP levels lead actors to invest in a country, although not necessarily by obtaining or deploying IP rights. Thus, to the extent that a virtuous cycle emerges, it may be a cycle in which politics leads to a political construct manifested as formal IP, that political construct induces investment (even if not directly related to IP), and investment invigorates political pressure to increase IP protection, as Yu suggests occurred in China (2007, p. 193).

In order to better understand the mutual effects of increasing formal IP and growth, we examine two questions. First, through a cross-lagged analysis of the IP INDEX and GDP, we ask whether, as predicted, increases in one correlate with increases in the other and, relatedly, how strong are those effects. Second, we revisit the regressions we presented earlier to determine the magnitude of the effect of increases in formal IP on domestic innovation and on the importation of high technology goods. In answering these two questions, we develop a sense of the relative strength of IP on growth and growth on IP.

While we considered using instrumental variable analyses to narrow our causal conclusions, we were unable to identify a sufficiently sound instrument within the context of our generalized growth model. The conflicting theoretical and empirical characterizations of the relationship between GDP and IP render it difficult to identify strong instruments, as there is no consensus concerning the detailed understanding of the mechanisms driving the regressor of interest (Angrist & Krueger 2001). Further, as one usually derives instrumental variables from natural experiment approaches, they are inappropriate here because of the infrequency of policy changes.

Unlike simple cross-sectional regressions, which would have permitted us only to say whether two variables are correlated, a cross-lagged model provides us with greater insight into causality as a result of two factors. First, it allows us to separate the effects of variable X on variable Y from the effect of variable Y on variable X. Second, it looks for the effect after the cause, which can allow for stronger causal inference (Berrington *et al.* 2006). The model works by regressing each variable at each time step by the other variable at the previous time step and that same variable at the previous time step. We show the results of a five-year time lag.

Our cross-lagged regression in Table 9 shows that each of the IP INDEX and GDP PER CAPITA correlate with later changes in the other on a five-year time scale. Using a standardization procedure to transform the coefficients of our linear models, we can compare the relative reciprocal cross-lagged effects of these two variables (Selig & Little 2012). This allows us to state that GDP appears to have approximately 15 times the impact on the IP INDEX than the reverse.

The simplicity of the cross-lagged model design means that there is potential for spurious correlations. If an excluded third variable, Z, drives both the IP INDEX and GDP PER CAPITA, their disturbance terms will be correlated (Berrington *et al.* 2006). Such a correlation therefore points to a potential spurious correlation and casts doubt on the presence of a causal relationship. Here, we find that the disturbance terms of the two models are in fact correlated (significance level of $P < 0.01$). It is therefore possible that one or more extraneous factors drive both increased IP protection and wealth, and that these effects are partially responsible for the perceived virtuous cycle. Following Morin and Gold (2014), we suggest that some of these factors are political in nature.

Table 9 Cross-lagged reciprocal relationships between the IP Index and real GDP per capita in 2005 USD

Variable	GDPPC	GDPPC	IP INDEX
GDPPC (5-YEAR LAG)	0.617***	0.670***	0.542***
IP INDEX (5-YEAR LAG)	0.036***	0.036***	0.196***
ECONOMIC FREEDOM		0.012	
ENROLMENT		0.150***	
POPULATION GROWTH		−0.010**	
GROSS CAPITAL FORMATION		0.017*	
N	1222	842	1222
R^2	0.9851	0.9904	0.8884

***$P < 0.001$;
**$0.001 < P < 0.01$;
*$0.01 < P < 0.05$. All models with fixed country and year effects; standardized coefficients reported. GDPPC, gross domestic product per capita; IP, intellectual property.

We had hypothesized that increased IP protection acts both directly and indirectly on economic growth. We specifically posited that IP acts directly on growth by inducing domestic inventive activity whereas it acts indirectly – through belief – on actors engaged with transferring technology to the country. Our cross-lagged models in Table 10 provide additional support for this hypothesis. While in Tables 3 and 4 we demonstrated that IP protection correlated with inward technology transfer and inventive activity across all developing countries, respectively, Table 10 suggests that only the link from IP to domestic invention is causal as we found no significant relationship when we lagged the IP INDEX on LOG IP IMPORTS on either a simple or full model. That is, some other factor is accounting for the change in both IP INDEX and LOG IP IMPORTS. On the other hand, when we lagged IP INDEX by five years, it was highly predictive of LOG USPTO APP, indicating direct causality.

We noted earlier that in lower lower-middle income countries (the only segment in which we found both routes to be positive and significant) the effect of IP on growth through technology transfer was just over five times as strong as that of IP on growth through domestic inventive activity. Given only the latter appears to be directly causative of growth, it would seem that the bulk of the correlation between IP protection and growth is indirect.

The results presented in this section are consistent with the placebo theory that states that a *belief* in the positive effects of increases in levels of IP protection on growth drive both formal IP and investments made in an economy. Lower-middle income countries would be particularly subject to the effects of this belief as they would be sufficiently developed to attract the attention of outside actors but not have the resources internally, as would more developed countries, to resist pressures and construct alternative narratives and policies surrounding IP.

Table 10 Models comparing the lagged effects of IP on inward technology transfer and on domestic inventive activity across all developing countries

Variable	LOG IP IMPORTS	LOG IP IMPORTS	LOG USPTO APP	LOG USPTO APP
LOG IP IMPORTS (5-YEAR LAG)	0.105***	0.050		
LOG USPTO APP (5-YEAR LAG)			0.202***	0.194***
IP INDEX (5-YEAR LAG)	0.012	0.010	0.063***	0.067***
ECONOMIC FREEDOM		0.097***		0.070*
ENROLMENT		−0.007		0.107***
POPULATION GROWTH		0.024		−0.063*
GROSS CAPITAL FORMATION		0.026**		0.003
N	1288	845	1288	848
R^2	0.9827	0.9855	0.9589	0.9581

***$P < 0.001$;
**$0.001 < P < 0.01$;
*$0.01 < P < 0.05$. All models with fixed country and year effects; standardized coefficients reported. GDP, gross domestic product; IP, intellectual property; USPTO, United States Patent and Trademark Office.

Those same results point to a direct effect of IP on domestic innovation in lower lower-middle income countries. At first blush, one explanation for this effect may be that while lower income countries simply do not generally have the human, financial, and physical resources to support invention, upper lower-middle income and wealthier countries likely have better means to encourage invention, such as through direct financial support, investments in infrastructure, availability of public research institutes, and better resourced universities to carry on inventive activity. That is, IP may play a role in between those countries with few resources and those with a more substantial innovation ecosystem.

7. Conclusion

While the assumption that higher levels of IP protection lead to increased growth is strong, empirical support is equivocal and contradictory. Much of the problem relates to the fact that we measure a country's IP protection according to its explicit IP laws – or formal IP – rather than on IP as actually practiced in the country.

To get a better handle on the actual effects of IP on growth, we deployed a variety of approaches. We demonstrated that existing theory and empirical studies provide no clear guidance as to when and if increases in IP protection lead to growth. We introduced a new index of IP rights – the IP INDEX – that, while still measuring formal IP, better reflects developments in IP law since 1995 compared to previous indexes. In regression analyses, we found that increased levels of formal IP lead to economic growth in lower lower-middle income countries by encouraging both greater levels of IP-rich imports and by boosting domestic levels of inventive activity. We also found that, in higher lower-middle income countries, greater levels of IP protection encourage IP-rich imports but not domestic invention. We further documented that each of IP-rich imports and domestic invention contribute to economic growth. We found no other similar significant correlations in other income groups.

We supplemented these more traditional analyses with two others. First, we unpacked the direct effect of levels of IP protection on growth by introducing a novel measure of the volume of patent rights in a country, PCT DESTINATION, and found no significant correlation between the deployment of IP and growth. We also examined more closely the effects of greater formal IP levels on both domestic invention and IP-rich imports, finding that the latter contributes more than five times as much to growth as the former. Nevertheless, the evidence from our cross-lagged models indicate that the link between levels of IP protection and high technology imports is not causative but indirect, meaning that most of the impact of IP on growth is similarly indirect. Finally, we examined and compared the effect of increased formal IP levels on growth and vice versa. We found that growth has a greater effect on IP than IP on growth, further supporting the idea that politics and belief, rather than direct economic effect, explain the virtuous cycle between IP and growth.

We do not claim that, taken individual or collectively, the above arguments prove that IP protection does not lead directly to growth. What we show is that a focus exclusively on direct effects may be incomplete and require some complex adjustment to explain our results. The placebo theory is simple: politics and belief account for higher levels of formal IP and growth based on the *faith* that IP drives growth. This does not discount the direct effect of IP on growth that we found in lower lower-middle income countries through its encouragement of inventive activity.

Our results suggest that we need to take the placebo theory seriously. Faith-based reasoning led the Inquisition to hold fast to a complex and convoluted Ptolemaic model of the universe rather than accept the simpler explanation proffered by Copernicus (Hellman 1998). That is, faith is not necessarily true no matter how firmly held. We should therefore ask, at the very least, whether our faith in IP should give way to a simpler explanation: that IP predominantly acts as a placebo.

Acknowledgments

We gratefully acknowledge our funders: the PACEOMICS project funded by Genome Canada, Genome Alberta, Genome Quebec, the Canadian Institutes for Health Research, Alberta Innovates - Health Solutions, and the Social Sciences and Humanities Research Council. We would also like to thank, Michael Shortt, Doron Lurie, Liam Harris, Claudette van Zyl, Nadir Pracha, and a large group of students who carefully coded intellectual property laws from around the world for their research assistance. The authors would like to thank Nancy Gallini, Walter Park, and Joel Blit for their comments on earlier drafts.

Notes

1 For purposes of this article, IP includes all formal systems of protection such as patents, trademarks, and copyright, but not informal regimes such as trade secrets.
2 See Appendix B for the definition and coding scheme for the IP Index and see Appendix C for descriptive statistics detailing the distribution of IP Index scores by country and by year.
3 Note that there is only relatively poor data for tertiary enrolment, which restricts the number of observations included in our model. However, there does not appear to be a proxy for human capital with more complete data, particularly for the developing world. A version of our model that does not control for tertiary enrolment, and thus with more observations included, gave results consistent with those below and can be found in Appendix B.
4 We chose to use GDP per capita lagged by five years instead of the value of GDP per capita in 1995 because initial GDP per capita is constant over time and therefore would have been omitted by Stata in a fixed effects model in order to control for heterogeneity.

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Supporting information

Additional Supporting Information may be found online in the supporting information tab for this article.

Data S1 APPENDIX A. Summary of empirical studies on intellectual property (IP), innovation, and growth
Data S2 APPENDIX B. Variable definitions and data sources
Data S3 Appendix C – Descriptive statistics for the Intellectual Property (IP) Index
Figure C-1 Graphical representation of developing countries colored according to their IP Index scores for 2011, the most recent time period collected.
Figure C-2 A histogram representing the frequency of Intellectual Property (IP) Index scores of developing countries in 2011, the most recent time period for which data was collected. The mean and median of the distribution are indicated.
Figure C-3 The values of the Intellectual Property (IP) Index for developing countries in a given year are plotted to demonstrate trends over time. Darker shading represents a greater number of countries with that IP Index score in that year. The red line tracks the change in mean score over time.

