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ORIGINAL ARTICLE

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# All rights reserved: Copyright protection and multinational knowledge transfers

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**Abstract**

The copyright industry contributes to global knowledge transfers, rivaling the manufacturing industry. Creative works are media for conveying information. This paper studies the effects of copyright protection on the international licensing of US companies in the copyright-based industries. The results show that copyrights affect technological development in creative industries as well as beyond; for example, in supporting industries that produce complementary output. The empirical analysis considers firms' selection into licensing, based on the cost of transferring creative works to host markets. The volume and likelihood of licensing rise with copyright protection when creative works are in sufficiently high demand.

**KEYWORDS**
copyrights, firm-level data, information industries, international knowledge transfer

**JEL CLASSIFICATION**
O34, O30, F23

## 1 | INTRODUCTION

This paper studies the effects of copyright protection on the knowledge transfers of US multinational firms. The literature on intellectual property rights (IPRs) and multinational firms has thus far focused on patent protection and on companies in the manufacturing sector.[1] However, this overlooks the huge role that the copyright industry plays in the global flows of knowledge capital. In fact, as shown in Table 1, copyright-based industries—such as software, films, books, sound recordings, and the broadcasting and recording of live events—account for the largest share of US international licensing, ahead of the manufacturing industries as a whole. Despite this fact, studies on the impact of copyright protection on international knowledge transfers are absent.

This oversight likely reflects an assumption that technological innovation and national productivity growth are largely driven by patentable inventions (e.g., machinery and chemicals) and not by creative works (e.g., visual arts, music, and film). However, such a view is rather narrow. Certain copyrightable works directly affect innovation and production activities, such as software, journals, and databases. Moreover, spillover effects can arise between industries.

**Abbreviations:** BACI, Base Pour L'Analyse du Commerce International; BEA, Bureau of Economic Analysis; CEPII, Le Centre d'Études Prospectives et d'Informations Internationales; FDI, foreign direct investment; IPR, intellectual property rights; NAICS, North American Industry Classification System; R&D, research and development; TRIPS, Trade-related Aspects of Intellectual Property Rights; USDIA, U.S. Direct Investment Abroad; WIPO, World Intellectual Property Organization.

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**TABLE 1** International involvement of US firms, by industry type

| | Licensing Receipts | | Affiliated R&D | | FDI stock (Non-bank) | |
|---|---|---|---|---|---|---|
| | 2006 | 2015 | 2006 | 2014 | 2006 | 2015 |
| Billions (real 2005 dollars) | 81 | 104 | 29 | 44 | 1011 | 1376 |
| Copyright industries, share | 0.45 | 0.47 | 0.04 | 0.08 | 0.10 | 0.11 |
| Manufacturing industries, share | 0.39 | 0.37 | 0.82 | 0.62 | 0.42 | 0.38 |
| Unaffiliated parties, share | 0.34 | 0.38 | | | | |
| Non-G6 countries, share (across copyright industries) | 0.46 | 0.66 | 0.63 | 0.65 | 0.47 | 0.69 |

*Source*: www.bea.gov Interactive Tables (accessed September 2018). Licensing receipts are charges for the use of intellectual property. Manufacturing licensing is the licensing of *Industrial Processes*. FDI is the direct investment position abroad on a historical cost basis, converted to current value. Affiliate R&D is for majority-owned affiliates.

Growth in the demand for creative works, for instance, could influence the demand for goods and services produced by other industries, such as high-technology. These other industries support the traditional copyright industries in that they produce goods and services that can be used to enhance the value of creative works.[2] It follows that revisions to copyright protections carry important implications for both the copyright-based and related industries, making it imperative that we truly understand the effects of such policy changes. Like other forms of intellectual property, copyright issues are contentious, especially around issues of access to knowledge.

This paper studies the effects of changes in the strength of copyright protection across host countries on the international operations of multinational firms. Our focus is on the licensing strategies of US multinational firms in the copyright-based industries and the associated knowledge transfers, for which multinational firms have been a leading conduit.[3] We distinguish between the licensing of copyrighted works to affiliated and unaffiliated parties, isolate the distinct margins of the impact, and study the cross-industry impacts. The empirical results show that a strengthening of copyright protection in the host country increases the likelihood of knowledge transfer via affiliated licensing and decreases that via unaffiliated licensing, more so in industries with high sensitivity to copyright. The selection in terms of transfer is important to take into account when measuring the impact on the volume of licensing. When we correct for potential endogeneity in the transfer decision, we find that the volume of licensing no longer rises with a strengthening of copyrights across all copyright-based industries: it actually falls in industries that are below a critical level of sensitivity to copyright. The findings suggest that firms in industries with relatively large domestic markets profit from stronger copyrights by expanding their international knowledge transfers, while those with smaller domestic markets take advantage of greater market power and limit their transfers.

The empirical challenge is to credibly measure a causal effect of strengthening copyright protection on international licensing by accounting for two key econometric problems. The first is the issue of endogeneity in the national adoption of copyright laws. The literature argues that the adoption of IPRs post 1994 was exogenously imposed by the Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement, rather than endogenously chosen by countries in response to domestic innovation.[4] Nonetheless, the reforms of intellectual property systems could still have coincided with other domestic policy reforms intended to promote multinational activity. Second is the issue of endogeneity in the firm market choice. The strength of foreign copyright protection can influence the likelihood of a firm transferring its creative work to the local market (the extensive margin) and conditional on transfer, also determine the volume of knowledge transfer (the intensive margin).

We start with a simple model of a dominant foreign firm facing a local competitive fringe. The firm produces and owns the copyright for a creative work and would like to exploit its work commercially in the local market by means of licensing. The competitive fringe consists of the imitators that produce perfect substitutes of the original creative work. The firm's licensing strategy involves two interdependent decisions: the knowledge transfer decision (whether to establish the creative work in the foreign country) and the volume of licensing (how much of the work to transfer). The strength of copyright protection in the local market is a key factor in both decisions. The model generates two testable predictions. First conditional on transfer, strengthening copyright protection increases the volume of licensing relatively more for high-demand creative works. Intuitively, copyright protection limits the ability to copy and reduces the fringe supply. The market for the original creative work expands as a result while the firm's market power rises, particularly so for creative works with high consumer willingness-to-pay. The model further predicts that strengthening copyright

protection increases the likelihood of knowledge transfer relatively more for high-demand works licensed to affiliated parties. Two opposing forces are at play here: the firm's gross profit in the local market rises, but so too does its cost of transferring the work to the local market. The impact on the gross profit is strong when the consumer willingness-to-pay for the work is high, while the impact on the transfer cost is weak when the transfer is via licensing to affiliated parties.

Using firm-level data on the licensing of copyrighted works by US multinationals to affiliated and unaffiliated parties, we confirm the model's predictions. Our focus is on the differential effect of copyright protection in copyright-sensitive industries. We rely on cross-industry variation in industry market size to account for impacts common to all industries within a country and address unobserved country-level changes that might coincide with or drive the adoption of copyright laws. Our measure of industry market size is constructed using data on industry sales in the US market. This measure is exogenous to the strength of copyright protection in the host countries since it is based on US market conditions.

Another empirical challenge is to isolate the distinct margins of the impact. The model's key insight is that in order to transfer its creative work via licensing to the host country, the firm must first adapt the work to the local market. An important implication is that the cost of a work's adaptation only affects the likelihood that the firm will establish the work in the local market by means of licensing, while it does not affect the volume of licensing conditional on transfer. The (fixed) adaptation cost is high when the work requires costly transformation prior to the transfer in order to establish it successfully in the local market. Such transformation is often needed to ensure that the work is sufficiently differentiated from local works, which is a greater concern when the two countries have a high degree of similarity in the structure of creative industry output. In cultural product industries, a firm's competitive advantage rests not only on copyright protection but on differential property such as marketplace differentiation and positionality (Power, 2010). If a foreign market has high creative output similarity, there is less space for marketplace differentiation and positionality. Hence, it is more costly to adapt a product such that it can enjoy a unique, differentiated position in the marketplace, which is key for product survival.[5] Using data on bilateral exports of cultural and information goods, we calculate the degree of creative output similarity between the host country and the US and use the resulting measure (which varies by industry, country and time) as a proxy for the adaptation cost.[6]

Our paper contributes to an emerging literature studying the effects of copyright laws on knowledge diffusion. Using historical data, the literature has shown that copyright protection induces creativity but can also hinder the diffusion of works. Giorcelli and Moser (2020), for example, studied Italian operas in the early 1800s and found that Italian states that adopted copyright laws experienced greater and higher quality opera productions than those states that did not. Li et al. (2018) showed, using 19th century UK data, that an increase in the duration of copyright protection for the works of deceased authors significantly raised book prices. In a more recent context, Biasi and Moser (2021) showed that the granting of a temporary license to US publishers in the 1940s to republish German books facilitated access to scientific knowledge.

This paper is the first to study the implications of modern global copyright systems using firm-level panel data. Thus far, studies in the area have focused on a single country (Baker & Cunningham, 2006; Ku et al., 2009) or used aggregate data for a panel of countries (Png & Wang, 2009; Smith et al., 2009).[7] Using firm-level data allows us to uncover the impact of global copyright reforms on firm strategy and capture the impacts on both the knowledge transfer and the volume of licensing decisions at the micro level, which is important since these decisions are interdependent. We also depart from the literature by allowing for industry heterogeneity in the impact and exploring effects beyond the traditional copyright industries. Much of earlier research, by contrast, focused on one particular type of creative work (e.g., books, music, or films) and did not consider industries complementary to the copyright-based industries which produce goods and services that can enhance the value of creative works.[8] Lastly, earlier research has focused on the effects of piracy rather than on copyright protection per se.[9]

As noted earlier, to improve identification, we condition the impact of copyright protection on industry market size. This approach is inspired by and builds on recent empirical studies in the patent context that conditioned the impact of patent rights on a measure of industry patent sensitivity. In Bilir (2014), for example, the impact of patent rights depends on product life-cycle lengths; in Ivus et al. (2017), it depends on the underlying technological complexity of products.[10] Ivus and Park (2019) compare export outcomes in the treated group of products with the highest patent intensity versus the control group of products with low patent intensity, relying on the classification in Delgado et al. (2013). Hu and Png (2013) and Maskus et al. (2019) condition the impact of patent rights on industry patenting intensity, measured by the ratio of US patents granted to the industry's total sales. In all of these studies, the identifying assumption is that industry patent sensitivity is unrelated to the unobserved quality of a host's institutions or other

confounding factors. Our approach is similar, but its application to the copyright context and the conditioning measure used are new.[11]

The rest of the paper proceeds as follows. Section 2 provides a conceptual framework for thinking about the effects of copyright protection in the local market on the multinational firm's licensing strategy. Section 3 outlines our methodology, and Section 4 reviews our data. Section 5 presents our results, and Section 6 concludes.

## 2 | CONCEPTUAL FRAMEWORK

Assume the world is composed of two countries: home and host. A firm in the home country produces and owns the copyright for one creative work. It seeks to exploit its creative work commercially in the host country by means of licensing to its affiliates or to arms-length parties. Its strategy involves two interdependent decisions: the knowledge transfer decision (whether to establish the work in the host country by means of licensing) and the volume of licensing decision (how much knowledge to transfer via licensing). The strength of the host's copyright protection is a key factor in both decisions.

We model the market for a creative work in the host country as a dominant foreign firm facing a local competitive fringe.[12] The copyright owner—which by law, has exclusive rights to commercialize, distribute, perform the creative work, and make derivative works of it—is the dominant foreign firm, indexed by $O$. The imitators (or copiers) are the local competitive fringe, indexed by $R$. Entry into the fringe is free, and the copied works are perfect substitutes for the original works. Total demand for a creative work in the host's market is given by $P(a, Q)$, where $a$ is the demand parameter that captures consumers' willingness-to-pay for the work and $Q$ is the total market output. The demand parameter $a$ can vary across different types of creative works (films, databases, and software). This is important as it implies that the size of the fringe—and thus, the importance of copyright protection—can vary across copyright-based industries. The total market output is divided between the dominant firm and the competitive fringe as follows: $Q = q_O + q_R$, where $q_O$ is produced by the firm's licensed affiliates or unaffiliated parties in the host market, and $q_R$ is produced by the local fringe. The copied works are priced at marginal cost. The dominant firm acts as a monopolist over the *residual* demand, that is, the demand net of the fringe supply.

Let $\Omega$ denote the strength of the host's copyright protection. The host's copyright protection has a twofold impact on the firm's licensing strategy: (i) it affects the fringe supply and with that, the firm's residual demand, and (ii) it determines the firm's cost of transferring its creative work to the host country. To model the first impact, we assume that the fringe's marginal cost is given by $c(q_R, \Omega)$, where $dc/d\Omega > 0$. Copyright systems vary in what is considered a legitimate use of copyrighted works. Under more flexible copyright systems, fair use or fair dealing provisions are more lenient, and a copyrighted material can be used more freely (i.e., without permission or purchase) for a greater variety of uses, such as education, journalism, or research. More stringent copyright systems, on the other hand, raise the level of originality and standards a work must meet in order not to infringe on existing copyrighted works. We assume that stronger copyright protection limits the ability to copy or imitate and so, increases the marginal cost for a given $q_R$. Stronger copyright enforcement also increases the cost of avoiding detection of copyright violations, particularly so when the level of output $q_R$ is high. Accordingly, as $q_R$ rises, the marginal cost rises at a faster rate when $\Omega$ is high. The copied works are priced at marginal cost: $P = c(q_R, \Omega)$. Inverting the marginal cost function, we obtain the fringe supply function: $q_R = q_R(P, \Omega)$, where $dq_R/d\Omega < 0$. Stronger copyright protection lowers the fringe output $q_R$ for a given price and also lowers $dq_R/dP$.

To model the second impact, we assume that in order to transfer its work to the host country, the firm must incur a fixed transfer cost $F_k$, where $k = u$ and $k = a$ for the transfer via unaffiliated and affiliated licensing respectively. The transfer cost has two components: the transaction cost $f_k^T(\Omega)$, which depends on the strength of the host's copyright protection, and the adaptation cost $f^A(\eta)$, which depends on the degree of creative output similarity between the host and home countries, $\eta$. Consider the transaction cost first. Foreign firms need to comply with local copyright regulations and obtain any necessary permissions to use existing copyrighted expressions or to grant others the same. Under more stringent copyright systems, compliance requirements and costs are greater, and owners of copyrighted works have greater scope to charge higher royalties and licensing fees for the use of their works. This raises the transactions costs of bargaining and negotiations in cross licensing agreements and collective licensing arrangements, particularly involving unrelated parties (Hall & Ziedonis, 2001). These costs apply not only to local users in the host country but also to multinational firms and their affiliates operating in the host market. Consequently, stronger copyright protection raises the cost of transferring the work to the host country, particularly

so when the transfer is via unaffiliated licensing: $df_u^T/d\Omega > df_a^T/d\Omega > 0$. The firm must also adapt its work to the host country market. While the work has already been created in the home country, introducing it to a new economic environment may still require additional cost (Glass & Saggi, 2002; Jensen & Scheraga, 1998). We assume the (fixed) adaptation cost is high when a creative work requires costly transformation prior to the transfer to ensure that it is successfully established and commercialized in the local market. Such transformation is often needed to ensure that the work is sufficiently differentiated from foreign expressions, which is a greater concern when the structure of creative industry output in the host country is similar to that in the home country. Accordingly, $df^A(\eta)/d\eta > 0$.

The model has two stages. In Stage I, the firm decides whether to establish its work in the host country by means of licensing. If the firm has decided to establish its work, then in Stage II it decides on the volume of licensing. We solve the model using backward induction.

In Stage II, the firm chooses $q_O$ to maximize its gross profit given by $\Pi(a, \Omega) = P(a, Q)q_O - C(q_O)$, where $C(q_O)$ is the total cost of producing $q_O$.[13] Differentiating $\Pi(a, \Omega)$ with respect to $q_O$ and setting the result to zero, we find that the profit maximizing output equates marginal revenue with marginal cost as follows:

$$P(a, Q) + \left(1 + \frac{dq_R}{dq_O}\right)\frac{dP}{dq_O}q_O = \frac{dC(q_O)}{dq_O}, \tag{1}$$

where $dq_R/dq_O < 0$, since $dP/dQ < 0$ from the market demand function and $dq_R/dP > 0$ from the fringe supply function. The negative relationship between the firm's output, $q_O$, and the fringe's output, $q_R$, reduces the firm's factor markup over marginal cost. In other words, the presence of the competitive fringe limits the firm's market power. The profit maximizing output that solves Equation (1) is given by $q_O^*(a, \Omega)$. At this output, the firm's profit maximizing price is $P^*(a, \Omega)$ and its long-run gross profit is $\Pi^*(a, \Omega)$.

The model predicts that stronger copyright protection in the host has an ambiguous impact on the firm's output: $dq_O^*/d\Omega \lessgtr 0$. An increase in $\Omega$ has two opposing impacts on the firm's marginal revenue and hence output, as in Maskus and Penubarti (1997). The first is the positive *market expansion* effect. Stronger copyright protection limits the ability to make copies and so the fringe supply $q_R$ falls for a given price. The residual demand curve shifts upward, and the market for the firm's work expands. The second is the negative *market power* effect. Stronger copyright protection increases the rate at which the fringe's marginal cost rises as $q_R$ rises and so lowers $dq_R/dP$. The term $dq_R/dq_O < 0$ in Equation (1) falls in absolute value, and the firm's market power rises as a result. At the same time, the impact on the firm's profit maximizing price is unambiguously positive: $dP^*/d\Omega > 0$. When the fringe supply falls as $\Omega$ rises, the firm's factor markup over its marginal cost rises. The positive impact of an increase in $\Omega$ on the firm's price is particularly high when the consumers' willingness-to-pay for the work, measured by the demand parameter $a$, is high. The impact on the firm's gross profit is also positive, $d\Pi^*/d\Omega > 0$, particularly so for creative works with a high demand parameter $a$. Hypothesis 1 summarizes the empirical implication for the impact of an increase in $\Omega$ on the intensive margin.

**Hypothesis 1** *Conditional on the firm's knowledge transfer decision, a strengthening of copyright protection in the host country will increase the volume of transfer via licensing relatively more for high-demand creative works.*

In Stage I, the firm makes the transfer decision. The firm will choose to establish its creative work in the host country by means of licensing if its gross profit exceeds the transfer cost, which requires the following:

$$\Pi^*(a, \Omega) - f_k^T(\Omega) - f^A(\eta) > 0. \tag{2}$$

This inequality holds when the degree of creative output similarity between the host and home countries ($\eta$) is sufficiently low, so that the adaptation cost $f^A(\eta)$ is low. But the impact of $\Omega$ on the firm's transfer decision is ambiguous, because both the firm's gross profit $\Pi^*(a, \Omega)$ and the transaction cost $f_k^T(\Omega)$ rise as $\Omega$ rises. The impact of $\Omega$ on $f_k^T(\Omega)$ is particularly strong when the transfer is via licensing to unaffiliated parties, as cross-licensing negotiations are naturally more difficult with arms-length parties. An increase in $\Omega$ will motivate the firm to establish its work in the host country only if its gross profit rises to a sufficient degree in response. This is more likely for high-demand creative works. We summarize the empirical implications for the impact of an increase in $\Omega$ on the extensive margin (the knowledge transfer decision) in Hypothesis 2.

**Hypothesis 2** *A strengthening of the host's copyright protection will increase the likelihood of knowledge transfer relatively more for high-demand creative works licensed to affiliated parties.*

An important implication of the inequality Equation (2) is that the adaptation cost $f^A(\eta)$ only affects the likelihood of the firm establishing its work in the host country by means of licensing, while it does not affect its volume of licensing conditional on transfer. In our two-country model, $f^A(\eta)$ varies across creative works, but in our empirical analysis, we allow the adaptation cost to vary across host countries as well to reflect differences across national cultures.

## 3 | EMPIRICAL FRAMEWORK

The unit of analysis is the US parent firm $i$ in industry $j$ which may transfer its proprietary knowledge to host country $h$ in year $t$. The basic model of knowledge transfer is as follows:

$$\ln(T_{iht}) = \alpha_i + \alpha_h + \alpha_t + (\beta_1 + \beta_2 M_j) \ln C_{ht} + \ln \boldsymbol{X}'_{ht}\gamma + \ln \boldsymbol{Z}'_{it}\varphi + \varepsilon_{iht}, \quad (3)$$

where $T_{iht}$ is the knowledge transfer via the licensing of copyrighted works. We consider licensing fees and royalty receipts from unaffiliated parties ($T^U_{iht}$) and from affiliates of a parent firm $i$ ($T^A_{iht}$). The independent variable $C_{ht}$ is the index of effective copyright protection (adjusted for enforcement) in host country $h$ at time $t$, and $M_j$ is the measure of industry sensitivity to copyright. Next, $\boldsymbol{X}_{ht}$ is the vector of time-varying host country controls, such as the level of real gross domestic product (GDP), hourly wages relative to the US, the quality of economic institutions, and the corporate income tax rate; and $\boldsymbol{Z}_{it}$ is the vector of time-varying firm controls, such as parent sales and affiliate sales. The controls $\alpha_i$, $\alpha_h$, and $\alpha_t$ are the firm, country, and year fixed effects. By separately controlling for $\alpha_i$, we allow $T_{iht}$ to differ across firms for reasons other than the strength of copyright protection. Last, $\varepsilon_{iht}$ is the stochastic error term.

We first estimate the model Equation (3) via ordinary least squares (OLS), taking the firms' transfer decision as given. This estimation disregards zero licensing flows in our data. But, if the occurrence of zeros is non-random, the approach may bias our results, as it does not account for the selection of firms into licensing. To address this concern, we then allow for the transfer decision to be endogenous and estimate the full model, where the volume of licensing equation is specified jointly with a selection equation determining the decision to license the knowledge to a particular foreign market. We use the two-step Heckman (1979) estimation procedure. Step 1 is the selection equation which models the likelihood that a parent firm $i$ will license to host country $h$ in year $t$. Step 2 is a linear regression equation which models the volume of licensing conditional on licensing. We estimate the selection equation using a probit model, in which we control for all of the variables in Equation (3), and also use a measure of the cost of adapting the works of industry $j$ in the host country $h$ in year $t$ as the exclusion restriction. Our theory predicts that the adaptation cost affects the firm's decision to establish its work in the host country by means of licensing but has no direct effect on its volume of licensing.

The model predicts that conditional on licensing, the impact of stronger copyright protection in the host country on the volume of licensing depends on the relative strength of the market expansion and the market power effects. The volume of licensing will rise (so that $\beta_1 + \beta_2 M_j > 0$) when the market expansion effect is relatively strong, but it may fall otherwise (so that $\beta_1 + \beta_2 M_j < 0$). Nonetheless according to Hypothesis 1, the volume of licensing will rise relatively more for high-demand (i.e., high-$M_j$) copyrighted works. This implies that $\beta_2 > 0$ when we measure the impact on the intensive margin. Hypothesis 2 further states that stronger copyright protection in the host will increase the likelihood of knowledge transfer relatively more for high-demand creative works licensed to affiliated parties. This implies that $\beta_2 > 0$ when we measure the impact on the extensive margin of affiliated licensing.

## 4 | DATA

Our data come primarily from a micro database of US parent companies with foreign direct investments (FDI) and operations around the world.[14] These data are collected by the US Bureau of Economic Analysis (BEA) in its benchmark and annual surveys of the operations of US multinational companies, its quarterly survey of direct transactions of US reporters with foreign affiliates, and its annual and quarterly surveys of US international services transactions. The BE-11 survey covers the operating data of parent and affiliate firms, and the BE-577 covers FDI and intra-firm licensing.

The BE-93, BE-25, and BE-125 surveys cover cross-border transactions for all US firms (including multinational companies), such as licensing by type of intangible asset. We matched these surveys using available bridges linking company codes on different surveys.

From 2006 on, we obtained all licensing data from the BE-125 survey. Prior to 2006, we obtained affiliate licensing data from the BE-577 survey. Prior to 2004, we obtained unaffiliated licensing data from the BE-93 survey. For 2004, we obtained unaffiliated licensing from the BE-25 survey.[15] Licensing receipts represent royalties and fees charged to licensees for the right to use, reproduce, or distribute specific kinds of intellectual property, such as industrial processes, franchises and trademarks, and copyrighted works, as well as outright sales of proprietary rights.[16]

The data are annual from 1994 to 2011 and cover 69 host countries and 25 industries. Together, the 69 countries account for over 97% of licensing fees and royalties received by US multinationals. Of the 25 industries in our sample, 16 are copyright-based and 9 are complementary, as listed in Appendix II. The copyright-based industries include: software publishers; motion picture and video industries; sound recording industries; satellite and wireless telecommunications; data processing and hosting; and other information industries with the North American Industry Classification System (NAICS) codes starting with 51. These industries have the highest copyright intensity (based on revenue) according to a USPTO (2012) report. The complementary industries, which should have a stake in copyrights, include: printing and related support; computer and peripheral equipment; communications equipment; audio and visual equipment; semiconductors and other electronic components; navigational, measuring, control instruments; magnetic and optical media; electrical equipment; and other electrical equipment and components. For each parent firm in the data, we have information on its industry and the top 10 industries to which it sells. We classify a parent firm as belonging to the complementary industry if a copyright-based industry is among its top 10 industries of sale (excluding, of course, parent firms that themselves belong to the copyright industry). In total, there are 227 parent firms in the copyright-based industries and 605 parent firms in the complementary industries in our sample.

Table 1 shows the significant role that copyright-based industries play in international knowledge transfer, particularly by means of licensing to affiliated and unaffiliated parties.[17] Total licensing fees and royalty receipts, for example, have grown from 81 billion in 2006 to 104 billion in 2015, in real 2005 USD. The copyright-based industries accounted for the *leading* share of US international licensing (45%–47%), while the share of manufacturing industries is smaller (37%–39%). For affiliate R&D investment and the stock of (non-bank) FDI, by contrast, the share of copyright-based industries is relatively small (4%–8% and 10%–11%, respectively), but has also grown over time. Most of the international licensing of US firms occurred between parents and their affiliates, but unaffiliated parties still accounted for a significant share: 34% in 2006, which increased to 38% in 2015. When we further limit the data to the copyright-based industries, we find that countries outside of the large G6 countries[18] accounted for a large share of US multinational firm activity, especially so in more recent years. The share of US licensing received by non-G6 countries in the copyright-based industries, in particular, has increased from 46% in 2006 to 66% in 2015.

## 4.1 | National copyright protection

The strength of copyright laws and regulations in country $h$ at year $t$ is measured by the index of copyright protection developed in Park (2005) and Reynolds (2003). We update this index to 2011, so that it is available for each year from 1994 to 2011.[19] The index is constructed using four measures of copyright laws and regulations: duration and coverage of protection, limitations and exceptions (e.g., compulsory licensing, provisions on fair use and fair dealing), enforcement mechanisms, and membership in international copyright agreements.[20] For example, copyright protection is stronger if protection is over a longer period, covers more types of works, and has limited exceptions for private use, if strong enforcement mechanisms are widely available, and if the country adheres to various international agreements on copyrights. Each measure is assigned a value from 0 to 1 which equals the share of conditions a country satisfies. The overall score, which we denote by $CP_{ht}$, is a sum of these four values and so ranges from zero (lowest) to four (highest).

To address the concern that the index of copyright protection does not reflect enforcement practices, we follow Hu and Png (2013) and Maskus and Yang (2018) and interact $CP_{ht}$ with the *Fraser Institute* index of legal and property rights, denoted by $E_{ht}$. The index $E_{ht}$ is based on general property rights protection, judicial independence, and contract enforcement. Our variable $C_{ht} = CP_{ht} \times E_{ht}$ thus measures the effective strength of copyright protection and enforcement. We re-scaled the index $E_{ht}$ so that it is in the range of [0, 1] and thus the interaction adjusts the statutory score $CP_{ht}$ downward to account for imperfect enforcement practices.

Table 2 summarizes the index $C_{ht}$ for three 5-year periods: 1994–1999, 2000–2005, and 2006–2011. It is apparent that the mean index score has increased over the sample period, while the coefficient of variation has declined. Thus, copyright protection and enforcement has strengthened around the world since 1994 and at the same time has become more harmonized. This convergence is largely due to the recent global movement to strengthen IPRs in order to comply with the TRIPS Agreement. As developing countries increased their level of copyright protection and enforcement, the distribution of the index has become less positively skewed. During 1994–1999, by contrast, the median strength was far below the sample mean. Another development is the catch-up in copyright strength in the non-G6 countries to that in the G6 countries, as seen by the ratio of the mean index score of the G6 to that of the non-G6.

Figure 1 previews the shifts in US multinational knowledge transfers via the licensing of copyrighted works along two dimensions: over time (i.e., before and after the year of a major copyright reform in a country)[21] and across the copyright-based industries (i.e., below and above the median industry sales in the US market). The height of each bar is the multiple by which post-reform aggregate (firm) transfers are greater than pre-reform transfers for each of the two measures: unaffiliated and affiliated licensing. It is apparent that the multiple exceeds one for each industry group and outcome, implying that US firms' licensing fees and royalty receipts have risen following copyright reforms. The ratio is particularly high for the copyright-based industries with above median US sales, suggesting that these industries are impacted most by the copyright reforms. This provides support for our use of domestic sales data to measure industry sensitivity to copyright protection abroad.

**TABLE 2** Index of effective copyright protection

| | 1994–1999 | 2000–2005 | 2006–2011 |
|---|---|---|---|
| Mean | 1.27 | 1.56 | 1.83 |
| Std dev | 0.82 | 0.78 | 0.73 |
| Coef of variation | 0.64 | 0.50 | 0.40 |
| Skew | 0.69 | 0.36 | 0.14 |
| Min | 0.08 | 0.13 | 0.19 |
| Max | 3.21 | 3.27 | 3.38 |
| G6/Non-G6 | 1.97 | 1.78 | 1.52 |
| Number of reforming countries | 24 | 16 | 6 |

*Note*: Index of copyright protection is adjusted for enforcement. G6/Non-G6 is the ratio of the mean index score for G6 to that of non-G6 countries. Sample statistics are calculated across 69 countries.

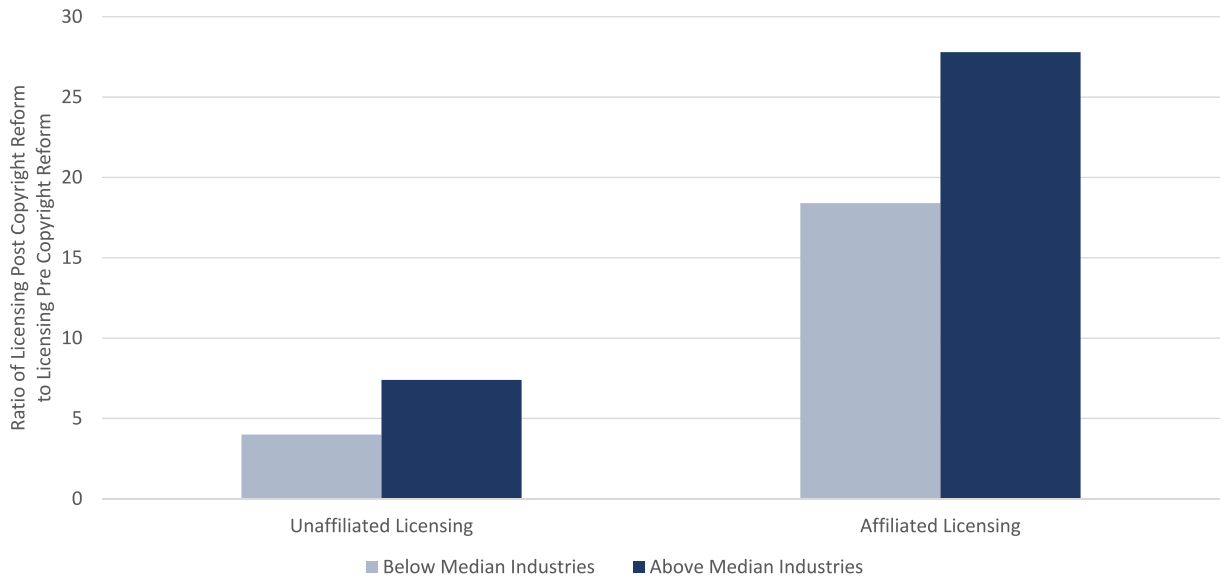


**FIGURE 1** Post-reform to pre-reform ratio, licensing income

## 4.2 | Industry market size

We construct our measure of industry market size for each copyright-based industry $j$ as follows:

$$M_j = S_j/\overline{S},$$

where $S_j$ is the total sales of industry $j$ in the US market during the sample period and $\overline{S}$ is the median $S_j$. In other words, $M_j$ measures the market size of a copyright-based industry, normalized by the industry-wide median sales.[22] Our underlying argument is that industries with large sales of copyrighted works are more sensitive to changes in copyright protection. This is consistent with our theoretical model, where the impact of copyright protection on the firm's profit is stronger for high-demand (high $a$) creative works. This is also consistent with some prior empirical work.[23] Furthermore, firms with large US market sales tend to have more investments in creative R&D, as a large market better enables the costs of R&D to be recouped, which gives reason for their sensitivity to copyright protection. To ensure that our measure $M_j$ is exogenous to a host's copyright protection, we construct it using data on US market sales.

To study the impact of copyright protection on the complementary industries, we measure $M_j$ using data on their global market sales that are classified as copyright-related, since data on their US market sales are not available.

We have also examined copyright registration data to confirm our identification of copyright sensitive industries. The quantity of registrations helps reveal the demand for protection on the part of creators, albeit imperfectly since copyright protection is automatic and registration is not required for protection.[24] Subject to this qualification, our classification of industries that are relatively more copyright sensitive is consistent with the number of registrations of *published* copyrighted works in the US by subject matter.[25] Table 3 summarizes the registration data for the years 1994, 2003, 2011, and 2014. In general, the matching is very similar: industries with greater domestic sales also have more copyright registrations. Software publishing is implied to be the leading sector in terms of the number of copyright registrations.

We later check the sensitivity of our estimation results to using an alternative measure of $M_j$, which we constructed using data on the R&D expenditures of parent companies in the US. Our use of this variable is analogous to the use of patents in prior work to measure the sensitivity to IPRs in manufacturing industries (e.g., Branstetter et al., 2006; Hu & Png, 2013). For copyrighted works, patenting standards typically do not apply; creators seek registrations, but copyright registrations are not needed to enjoy copyright protection. So instead, we examine R&D expenditures across copyright-based industries, since copyright-based industries with higher R&D should be relatively more sensitive to having their works protected. We find that the results remain similar, which confirms that our findings are not driven by our measure of industry sensitivity to copyright protection.

## 4.3 | Control variables

We control for the global sales of the parent firms and their affiliates, as these could explain the attractiveness of the firm's knowledge assets among licensees. Affiliate sales could also capture variations in the firm's share of the host market for creative products.[26] To control for the general market size and income of host countries, we use real GDP levels (in constant 2005 purchasing power parity dollars) from the *World Development Indicators*. The corporate income

**TABLE 3** Registrations of copyrighted works in the US

| Subject matter | 1994 | 2003 | 2011 | 2014 |
|---|---|---|---|---|
| Non-dramatic literary works (computers, monographs) | 121,323 | 141,279 | 180,076 | 132,718 |
| Other literary works (newspapers, serials) | 74,956 | 56,336 | 58,046 | 43,212 |
| Performing arts (including films) | 44,219 | 58,627 | 54,757 | 53,120 |
| Visual arts | 56,520 | 64,822 | 52,881 | 50,160 |
| Sound recordings | 14,052 | 22,798 | 30,192 | 20,194 |
| Total | 311,070 | 343,862 | 375,952 | 299,404 |

*Source*: US Copyright Office, *Fiscal Annual Reports*.

tax rate faced by the firm's affiliates in the host country is defined as the ratio of income taxes paid to the firm's pre-tax net income.[27] This measure is from the BEA data. We also control for relative hourly wages in all industries (in US dollars), since a relatively low cost of labor in foreign countries could motivate parent firms to establish foreign affiliates there. The relative wage variable is constructed as the ratio of the host's hourly wage to the US hourly wage. The hourly wage data are from the Occupational Wages around the World Database.[28] The quality of institutions data are from Kunčič (2014).[29] Adding this control mitigates the concern that our measure of copyright protection is picking up the effects of broader institutional changes correlated with the reforms of intellectual property systems. Later, to analyze data on industries which complement the copyright-based industries, we use an index of patent rights from Park (2008). The index is based on legislation and case laws which establish how such legislative provisions are interpreted and enforced. As with the index of copyright protection, we interact the index of patent rights with the *Fraser Institute* index of legal and property rights in order to account for imperfect enforcement practices. Following Ivus et al. (2017), we also take into consideration that the efficacy of patent rights is conditional on the technological complexity of products. Complex products have a natural advantage of being more difficult to misappropriate. Our industry measure of product complexity is a dummy variable which takes the value of one if an industry's product complexity is above the median and zero otherwise. We constructed this measure using data in Naghavi et al. (2015), which are based upon the factor content of tasks that require complex problem-solving skills.

### 4.4 | Exclusion restrictions

The methodology and data underlying the *Adaptation Cost*, the exclusion restriction for firms selecting into licensing in the copyright-based industries, are described in Appendix IV. The cost of adaptation, as constructed, varies by industry, host country, and time.

For firms in the complementary industries, the host country's *Patenting Cost* relative to GDP is used as the exclusion restriction for firms selecting into licensing. The data are from Park (2010) and include filing and maintenance fees. The measure has been found to be a significant exclusion restriction in Ivus et al.'s (2017) study on technology transfers.

## 5 | EMPIRICAL RESULTS

Table 4 shows the results of estimating Equation (3) for the two outcome variables: licensing fees and royalty receipts from unaffiliated parties and from affiliates. In columns (1)–(2), the model is estimated using OLS, taking the firms' knowledge transfer decision as given. It is apparent that the coefficient $\beta_1$ on the index of effective copyright protection ($\ln C_{ht}$) is negative but not statistically significant at the 10% level, while the coefficient $\beta_2$ on the interaction term between $\ln C_{ht}$ and the industry sensitivity to copyright protection ($M_j$) is positive and statistically significant at the 5% level for unaffiliated licensing and at the 1% level for affiliated licensing. The estimates of the elasticity of unaffiliated and affiliated licensing with respect to the index of effective copyright protection are equal to $0.205M_j$ and $0.457M_j$, respectively, and are positive for all values of $M_j$. Thus when we measure the impact on the intensive margin, a strengthening of a host's copyright protection increases the volume of licensing in all copyright-based industries, where industries with greater sensitivity to copyright (i.e., high-$M_j$ creative works) are impacted relatively more.

The results in columns (1)–(2) support Hypothesis 1, but they could suffer from a selection bias due to firms' endogenous selection of host countries. We have only measured the impact of copyright protection on firms that have already established their works in the local market. But, not all firms license to all countries. Some firms stay out of certain markets if, for example, the host market size is inadequate, the adaptation cost is too high, or the firm's creative expression is insufficiently differentiated from the expressions already established in the local market. In the presence of fixed costs of knowledge transfer via licensing, it is important to correct for potential endogeneity in the transfer decision. To do so, we estimate the equation for the volume of licensing jointly with a selection equation determining the decision to license the knowledge to a particular host country, using adaptation cost as the exclusion restriction. Again, the rationale for this is that firms typically adapt their creative work to the host country when entering into a licensing contract. The cost of doing so should affect the decision to license. We posit that the degree of differentiation needed to adapt the creative work to the foreign market is a function of the closeness or similarity in the composition of creative output between the foreign and the domestic countries. A US firm choosing to license to a foreign market faces

**TABLE 4** Knowledge transfer and copyright protection

| | | | Unaffiliated licensing | | Affiliated licensing | |
|---|---|---|---|---|---|---|
| | **Unaff licen (1)** | **Aff licen (2)** | **Step 2 (3)** | **Selection (4)** | **Step 2 (5)** | **Selection (6)** |
| Copyright protection | −0.129 | −0.607 | −0.438*** | −0.034 | −0.854*** | 0.161*** |
| | (0.289) | (0.372) | (0.086) | (0.040) | (0.167) | (0.062) |
| Copyright protection × industry sensitivity | 0.205** | 0.457*** | 0.261*** | −0.169*** | 0.508*** | 0.284*** |
| | (0.094) | (0.104) | (0.036) | (0.018) | (0.046) | (0.027) |
| GDP | 0.816** | 0.104 | 2.916*** | 0.879*** | −0.462* | 1.255*** |
| | (0.391) | (0.851) | (0.186) | (0.094) | (0.269) | (0.147) |
| Host wages | 0.332 | 0.043 | 0.586*** | 0.507*** | 0.254 | 0.804*** |
| | (0.274) | (0.468) | (0.144) | (0.062) | (0.231) | (0.100) |
| Income tax rate | −0.111 | 0.002 | 0.145** | −0.003 | −0.004 | −0.071 |
| | (0.080) | (0.072) | (0.062) | (0.033) | (0.080) | (0.050) |
| Institutional quality | 0.016 | 0.025 | 0.037 | 0.024* | −0.008 | 0.012 |
| | (0.049) | (0.081) | (0.027) | (0.014) | (0.036) | (0.021) |
| Parent sales | 0.014*** | −0.009** | −0.003 | −0.002 | −0.000 | 0.027*** |
| | (0.004) | (0.004) | (0.002) | (0.001) | (0.003) | (0.002) |
| Affiliate sales | 0.031*** | 0.053*** | | | | |
| | (0.009) | (0.015) | | | | |
| Adaptation cost | | | | −0.203*** | | −0.293*** |
| | | | | (0.052) | | (0.073) |
| Mills ratio: $\lambda$ | | | | 0.555*** | | 0.097 |
| | | | | (0.131) | | (0.102) |
| Constant | −23.734** | −0.634 | −76.289*** | −25.257*** | 11.167 | −35.689*** |
| | (11.574) | (24.917) | (5.189) | (2.563) | (7.405) | (4.045) |
| Observations | 7611 | 7611 | 39,454 | 39,454 | 39,454 | 39,454 |
| Adj $R$-squared | 0.778 | 0.492 | | | | |

*Note*: Standard errors in parentheses, clustered by country in columns (1)–(2). ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. All specifications include country, year, and firm fixed effects. All continuous variables are in natural logarithms.

a greater burden to differentiate its creative work when there exists a high degree of creative output similarity between the foreign country and the US.[30]

Columns (3)–(6) in Table 4 show the results. In columns (4) and (6), the outcome variable is equal to one if the flow of licensing (unaffiliated and affiliated, respectively) is non-zero. The coefficient on *Adaptation cost* is highly statistically significant in both columns, suggesting that adaptation cost is a relevant restriction.[31] Its negative sign implies that a higher adaptation cost reduces the likelihood of knowledge transfer via unaffiliated and affiliated licensing. Importantly, the data on unaffiliated licensing provide strong evidence of selection bias: the coefficient on the inverse Mills ratio, $\lambda$, is statistically different from zero at the 1% level in column (4). The positive coefficient on $\lambda$ indicates that the disturbances in the two equations (i.e., the licensing volume equation and the selection equation) are positively correlated, so that unobserved factors that make engaging in licensing more likely are associated with higher volumes of licensing.

At the same time, the evidence of selection bias for affiliated licensing is weak: the coefficient on $\lambda$ is statistically insignificant in column (6). This result suggests that firms that choose to license their works to affiliated parties do not differ in important unmeasured ways from firms that do not license to affiliated parties. One possible reason for the lack of a selection problem in this sample is that the multinational firms have other operations in conjunction with intra-

party licensing (e.g., sales, distribution, production, or R&D), which allow them to spread the costs of transfer among multiple activities and in doing so, lower the minimum level of profitability required to establish the works via affiliated licensing.

We turn now to the effects of copyright protection on the decision to license and the volume of licensing. First, on selection, the coefficients on $\ln C_{ht}$ and $\ln C_{ht} \times M_j$ in column (6) are positive ($\beta_1 = 0.161$ and $\beta_2 = 0.284$) and highly statistically significant. This implies that a strengthening of a host's copyright protection increases the likelihood of knowledge transfer via affiliated licensing, an impact which is particularly strong in industries with large market sizes. But, when we examine unaffiliated licensing at the extensive margin, we find no positive impact. In column (4), the respective coefficients are negative ($\beta_1 = -0.034$ and $\beta_2 = -0.169$), and the coefficient $\beta_2$ is highly statistically significant. Thus, the likelihood of knowledge transfer via unaffiliated licensing falls with the strengthening of a host's copyright protection, more so in industries with large market sizes. Overall, the results in columns (4) and (6) provide evidence in favor of Hypothesis 2. Higher transactions costs of striking unaffiliated licensing agreements tilt firms toward affiliated licensing transactions. Figure 2 corroborates this finding by showing that, although the counts of both affiliated and unaffiliated licensing rise following copyright reforms, the increase is greater for affiliated licensing. The ratio of affiliated to unaffiliated licensing counts rises after copyright reforms especially in industries with above median domestic sales.

Next, the results for the volume of licensing conditional on licensing (Step 2) are in columns (3) and (5). We find that selection in terms of knowledge transfer has an important effect on the elasticity of the volume of licensing with respect to $C_{ht}$. The coefficient $\beta_1$ was not statistically significant at the 10% level in columns (1)–(2), where we did not account for selection, but it is negative and highly statistically significant now. Thus, a key impact of selection is that not all industries expand their licensing volumes in response to a strengthening of copyright protection in the host country. The volume of licensing rises in copyright-based industries with a large market but falls in copyright-based industries with a small market. More precisely, the estimates of the elasticity of unaffiliated and affiliated licensing with respect to $C_{ht}$ are equal to $-0.438 + 0.261M_j$ and $-0.854 + 0.508M_j$, respectively. Thus, $M_j = 1.68$ is the threshold value of $M_j$ for both types of licensing. Since the value of $M_j$ is normalized, the results imply that in industries with a domestic market size that is at least 1.68 times the median, a strengthening of a host's copyright protection creates a positive market

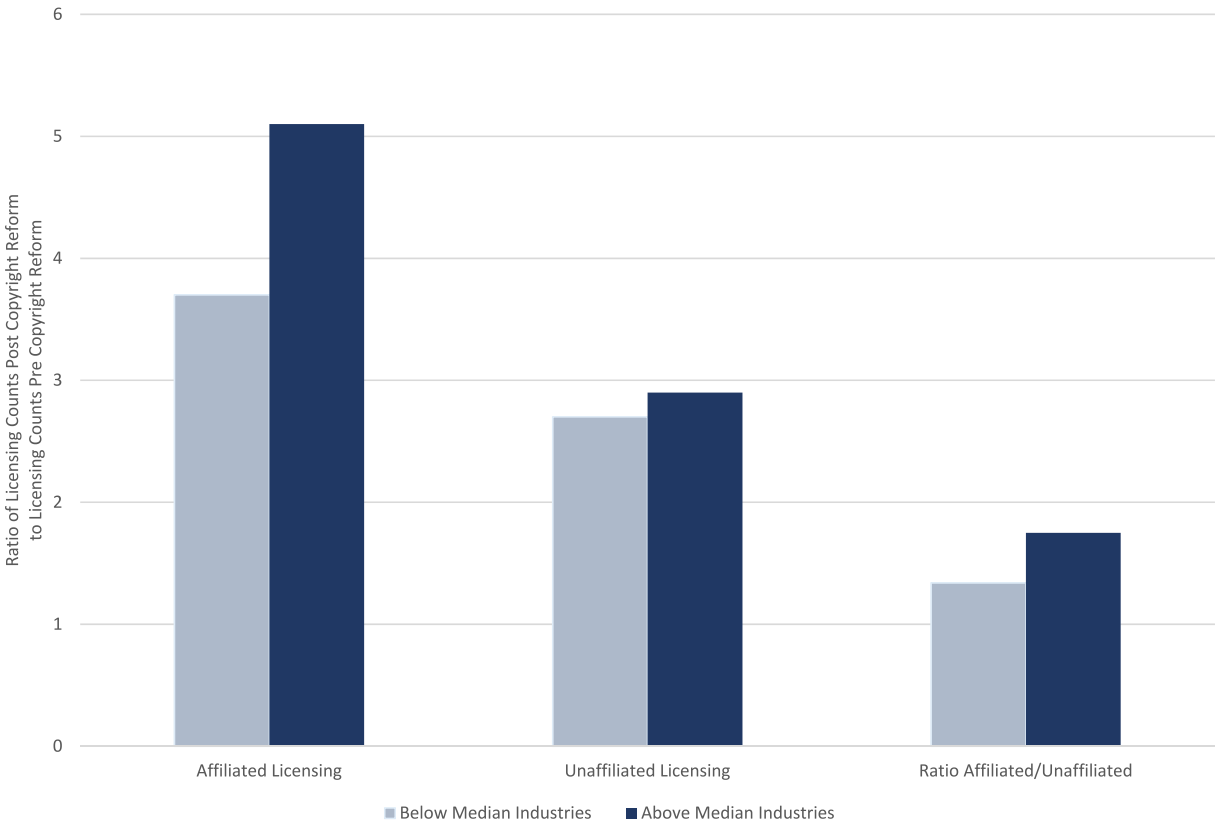


**FIGURE 2** Post-reform to pre-reform ratio, licensing counts

expansion effect. This typically applies to the software, cable, and radio and TV programming industries in our sample. For the remaining industries, the effect is negative, suggesting that a strengthening of the host's copyright protection has a market power effect. From our model, the market power effect arises when stronger copyrights serve primarily to raise rents and enable firms to exploit their creative works with reduced output and licensing.[32]

In line with Hypothesis 1, we find that at the intensive margin, the impact of a host's copyright protection on the volume of (affiliated and unaffiliated) licensing rises with greater industry sensitivity to copyright. This is true even when we allow for potential endogeneity in the knowledge transfer decision. In fact, our estimate of the differential industry impact remains robust: the coefficient $\beta_2$ only rises slightly in columns (3) and (5), as compared to columns (1) and (2).[33]

The policy implication here is that for some firms in the US copyright-based industries, a more flexible copyright system abroad would facilitate more knowledge transfers. This would call for levels of protection differentiated by industry, accounting for market size and the relative vulnerability to copyright misappropriation. Indeed previous studies have demonstrated cases for copyright flexibility in the film, music, and book industries. As discussed earlier, Biasi and Moser (2021) showed how a relaxation of copyrights can facilitate access to knowledge. Li et al. (2018) question the marginal contribution of increased copyright length on stimulating new books. Likewise, Png and Wang (2009) find that the extension of the copyright term in the European Union had no discernible impact on movie production. Heald (2009) finds that the lack of copyright protection need not result in the under-exploitation of musical works. While these are select examples, they reinforce our finding that for some industries a less stringent copyright regime can be more conducive to knowledge transfer and sharing.

## 5.1 | Sensitivity analysis

In this section, we check the sensitivity of our results. We consider alternative exclusion restrictions in Table 5, a different measure of industry sensitivity to copyright in Table 6, and examine whether our results are driven by G6 countries in Table 7. Our findings remain qualitatively similar and still support Hypotheses 1 and 2.

In Table 5, we first interact *Adaptation cost* with *Linguistic similarity* and include this variable as an additional exclusion restriction. *Linguistic similarity* measures the likelihood that two persons from a pair of countries (one of which is the US in our data) can find a common language.[34] Language can affect the cost of adaptation, as copyrighted works often need to be translated in order to be adapted to local culture. Columns (1)–(4) show the results. In column (2), the coefficient on *Adaptation cost* × *Linguistic similarity* is positive and highly statistically significant. As expected, greater linguistic similarity facilitates adaptation. The adaptation cost does not reduce the likelihood of unaffiliated licensing by as much when the host country offers greater linguistic similarity. The coefficient on $\lambda$ is also positive and highly statistically significant, which confirms our earlier finding that selection bias is a serious concern for unaffiliated licensing. But, for affiliated licensing, the evidence of selection bias is again weak: the coefficient on $\lambda$ is only marginally statistically significant in column (4), although the coefficient on *Adaptation cost* × *Linguistic similarity* is also not statistically different from zero at the 10% level. From columns (1) and (3), the estimates of the elasticity of unaffiliated and affiliated licensing with respect to $C_{ht}$ are respectively given by $-0.430 + 0.269M_j$ and $-0.854 + 0.508M_j$, with the threshold values of $M_j$ equal to 1.6 and 1.68. These estimates are very close to those implied by the results in Table 4, confirming our finding that the volume of licensing rises (due to the market expansion effect) in copyright-based industries with high sensitivity to copyright but falls (due to the market power effect) in copyright-based industries with low sensitivity to copyright. Next in columns (5)–(8), we interact the linguistic index with year indicator variables and use these interaction terms as exclusion restrictions. The interaction terms are jointly statistically significant, as evidenced by the $\chi^2$ test statistic reported at the bottom of columns (6) and (8). The coefficient on $\lambda$ is highly statistically significant in column (6) and is not statistically significant at the 10% level in column (8). Thus again, we find strong evidence of selection bias for unaffiliated licensing, but not for affiliated licensing. The coefficients on $\beta_1$ and $\beta_2$ in columns (5) and (7) are close to those in columns (1) and (3), which confirms our estimates of the impact at the intensive margin.

In Table 6, we construct a measure of industry sensitivity to copyright, $M_j$, using data on the R&D expenditures of parent companies in the US. The results are consistent with those in Table 4, and support Hypothesis 2 as well. From columns (4) and (6), we find that a strengthening of the host's copyright protection increases the likelihood of knowledge transfer via affiliated licensing and decreases the likelihood of knowledge transfer via unaffiliated licensing, more so in industries with high sensitivity to copyright. When we account for potential endogeneity in the transfer

**TABLE 5** Alternative exclusion restrictions

| | Unaffiliated licensing | | Affiliated licensing | | Unaffiliated licensing | | Affiliated licensing | |
|---|---|---|---|---|---|---|---|---|
| | Step 2 (1) | Selection (2) | Step 2 (3) | Selection (4) | Step 2 (5) | Selection (6) | Step 2 (7) | Selection (8) |
| Copyright protection | −0.430*** | −0.032 | −0.854*** | 0.160*** | −0.441*** | −0.041 | −0.854*** | 0.137** |
| | (0.086) | (0.040) | (0.167) | (0.062) | (0.087) | (0.040) | (0.167) | (0.062) |
| Copyright protection × industry sensitivity | 0.269*** | −0.171*** | 0.508*** | 0.285*** | 0.258*** | −0.168*** | 0.506*** | 0.293*** |
| | (0.035) | (0.018) | (0.046) | (0.027) | (0.036) | (0.018) | (0.046) | (0.027) |
| Adaptation cost | | −0.245*** | | −0.272*** | | | | |
| | | (0.053) | | (0.075) | | | | |
| Adaptation cost × Linguistic similarity | | 0.420*** | | −0.187 | | | | |
| | | (0.108) | | (0.158) | | | | |
| Linguistic similarity | | | | | | −0.499 | | −0.775 |
| | | | | | | (0.367) | | (0.538) |
| Linguistic similarity × Year indicators | | | | | | Yes | | Yes |
| Mills ratio: $\lambda$ | | 0.450*** | | 0.101 | | 0.604*** | | 0.084 |
| | | (0.130) | | (0.102) | | (0.131) | | (0.102) |
| Constant | −74.657*** | −25.535*** | 11.108 | −35.500*** | −77.081*** | −25.378*** | 11.395 | −34.489*** |
| | (5.171) | (2.565) | (7.406) | (4.048) | (5.197) | (2.410) | (7.396) | (3.875) |
| Observations | 39,454 | 39,454 | 39,454 | 39,454 | 39,454 | 39,454 | 39,454 | 39,454 |
| $\chi^2(34)$ | | | | | | 2101.9*** | | 1745.0*** |

*Note*: Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. All specifications include country, year, and firm fixed effects, and control for GDP, host wages, income tax rate, institutional quality, and parent sales. $\chi^2(34)$ reports the test statistic for the $H_0$ that the coefficients on *Linguistic similarity* × *Year indicators* are jointly equal to zero.

**TABLE 6** Alternative measure of industry sensitivity to copyright

| | | | Unaffiliated licensing | | Affiliated licensing | |
|---|---|---|---|---|---|---|
| | Unaff licen (1) | Aff licen (2) | Step 2 (3) | Selection (4) | Step 2 (5) | Selection (6) |
| Copyright protection | 0.022 | −0.286 | −0.102 | −0.186*** | −0.434*** | 0.404*** |
| | (0.261) | (0.330) | (0.075) | (0.031) | (0.163) | (0.053) |
| Copyright protection × industry sensitivity (R&D) | 0.040** | 0.097*** | 0.015** | −0.033*** | 0.050*** | 0.044*** |
| | (0.020) | (0.023) | (0.007) | (0.003) | (0.010) | (0.006) |
| Adaptation cost | | | | −0.198*** | | −0.317*** |
| | | | | (0.052) | | (0.073) |
| Mills ratio: $\lambda$ | | | | 0.604*** | | 0.038 |
| | | | | (0.132) | | (0.102) |
| Constant | −23.137** | 0.617 | −78.907*** | −25.077*** | 13.159* | −35.545*** |
| | (11.494) | (25.220) | (5.202) | (2.563) | (7.431) | (4.028) |
| Observations | 7611 | 7611 | 39,454 | 39,454 | 39,454 | 39,454 |
| Adj. *R*-squared | 0.778 | 0.493 | | | | |

*Note*: Standard errors in parentheses, clustered by country in columns (1)–(2). ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. All specifications include country, year, and firm fixed effects, and control for GDP, host wages, income tax rate, institutional quality, parent and affiliate sales.

**TABLE 7** Knowledge transfer and copyright protection, Non-G6 sample

| | | | Unaffiliated licensing | | Affiliated licensing | |
|---|---|---|---|---|---|---|
| | Unaff licen (1) | Aff licen (2) | Step 2 (3) | Selection (4) | Step 2 (5) | Selection (6) |
| Copyright protection | −0.035 | −1.025** | −0.359*** | 0.055 | −1.055*** | −0.015 |
| | (0.189) | (0.405) | (0.087) | (0.042) | (0.174) | (0.074) |
| Copyright protection × industry sensitivity | 0.241** | 0.642*** | 0.285*** | −0.185*** | 0.604*** | 0.267*** |
| | (0.095) | (0.112) | (0.037) | (0.019) | (0.049) | (0.031) |
| Adaptation cost | | | | −0.198*** | | −0.308*** |
| | | | | (0.054) | | (0.080) |
| Mills ratio: $\lambda$ | | | | 0.137 | | 0.095 |
| | | | | (0.127) | | (0.124) |
| Constant | −11.281 | 16.466 | −46.298*** | −18.846*** | 12.099 | −28.801*** |
| | (9.717) | (32.383) | (5.132) | (2.752) | (8.046) | (4.790) |
| Observations | 4484 | 4484 | 33,282 | 33,282 | 33,282 | 33,282 |
| Adj. $R$-squared | 0.822 | 0.497 | | | | |

*Note*: Standard errors in parentheses, clustered by country in columns (1)–(2). ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. All specifications include country, year, and firm fixed effects, and control for GDP, host wages, income tax rate, institutional quality, parent and affiliate sales.

decision in columns (3) and (5), we find that the volume of unaffiliated licensing rises with stronger copyright protection in all copyright-based industries, but the volume of affiliated licensing only rises in copyright-based industries with high enough R&D expenditures (e.g., software and data processing). The threshold value of $M_j$ is equal to 8.86 (=0.434/0.050), which implies that the volume of affiliated licensing rises in industries with more than eight times the R&D of the median industry.

In Table 7, we exclude the G6 countries (Canada, France, Germany, Italy, Japan, and the UK) from our sample and re-estimate the equations. These six nations are among the leading economies with which the US engages in knowledge trade[35] and so it is important to check that their presence in the sample does not drive our results. It is apparent that the results in Table 7 are qualitatively similar to those in Table 4. From columns (3) and (5), the threshold values of $M_j$ are equal to 1.26 and 1.75, respectively. The threshold value of 1.75 for affiliated licensing is close to the value of 1.68 from Table 4. But, for unaffiliated licensing, the threshold value is noticeably lower (1.26 vs. 1.68). This result implies that across the non-G6 countries, stronger copyright protection promotes knowledge transfer via unaffiliated licensing in a wider range of copyright-based industries. One possible explanation is that non-G6 countries tend to have more flexible copyright protection, which reduces the firms' transaction costs in knowledge transfer.

## 5.2 | Additional impacts

One concern with the above results remains: the observed increase in the volume of affiliated licensing, for example, could have been driven by an increase in the price, rather than quantity, of creative works. That is, a strengthening of copyright protection in the host countries could have primarily enabled the parent companies to better exploit their market power and raise licensing fees. In that case, we cannot argue, based on our results so far, that stronger copyright protection enhances local access to creative knowledge from the US. In Table 8, we analyze two auxiliary outcomes associated with knowledge transfers: the R&D performed by the affiliates of a parent company firm $i$ in the host country $h$ in year $t$; and the number of parent firms that engage in FDI. To the extent that increased licensing is associated with substantive knowledge transfers, we should observe affiliates investing in and creating local knowledge, instead of relying solely on the parent firm's R&D, and we might also observe the parent companies expanding their production and distribution facilities via FDI.

**TABLE 8** Additional outcome measures

| | | Affiliated R&D | | | FDI episodes |
|---|---|---|---|---|---|
| | Affil. R&D (1) | Step 2 (2) | Selection (3) | FDI episodes (4) | Non-G6 (5) |
| Copyright protection | −0.836*** | −0.544*** | −0.490*** | −0.418* | 0.138 |
| | (0.242) | (0.162) | (0.073) | (0.223) | (0.228) |
| Copyright protection × industry sensitivity | 0.308** | 0.310*** | 0.280*** | 0.720*** | 0.412*** |
| | (0.149) | (0.068) | (0.028) | (0.119) | (0.131) |
| Adaptation cost | | | 0.207** | | |
| | | | (0.085) | | |
| Mills ratio: $\lambda$ | | | 0.082 | | |
| | | | (0.132) | | |
| Constant | −13.646 | −11.485 | −17.441*** | −29.651* | −34.447** |
| | (14.774) | (8.986) | (3.985) | (16.467) | (16.438) |
| Firm fixed effects | Yes | Yes | Yes | | |
| Industry fixed effects | | | | Yes | Yes |
| Observations | 7611 | 39,454 | 39,454 | 3461 | 2696 |
| Adj. *R*-squared | 0.442 | | | 0.676 | 0.396 |

*Note*: Standard errors in parentheses, clustered by country in columns (1), (4), (5). PPML estimates are in columns (4)–(5). ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. All specifications include country and year fixed effects, and control for GDP, host wages, income tax rate, institutional quality, parent and affiliate sales.

Columns (1)–(3) in Table 8 focus on the R&D of affiliates. It is apparent that the coefficient $\beta_1$ is negative and highly statistically significant while the coefficient $\beta_2$ is positive and statistically significant at the 5% level in all three columns. Thus in industries with high sensitivity to copyright, a strengthening of the host's copyright protection increases both the likelihood of affiliate R&D as well as the affiliates' total expenditure on R&D. From column (2), the threshold value of $M_j$ is equal to 1.75. This estimate implies that affiliate R&D expands in the software and cable industries (for which $M_j > 1.75$) but contracts in the other copyright-based industries in our sample. Affiliate R&D would contract if stronger copyright regimes increase the cost of conducting R&D through, say, higher licensing fees or reductions in copyright exceptions to using proprietary expressions.

It is also noteworthy that the coefficient on *Adaptation cost* is positive and statistically significant at the 5% level in the affiliate R&D regression in column (3) of Table 8, whereas it was negative and highly statistically significant in the affiliate licensing regression in column (4) of Table 4. One possible explanation for this difference is that licensing involves the transfer of already produced (in the US) creative works, while affiliate R&D is performed to create new works in the host country, utilizing local inputs and infrastructure. Similarity in the structure of creative output in this case helps lower the affiliates' cost of using local inputs to develop indigenous creative work.

Columns (4)–(5) in Table 8 focus on FDI episodes, measured as the number of parent companies that engage in new FDI. Here, we provide evidence regarding the impact of copyright protection on knowledge transfer via FDI at the extensive margin. Since the FDI episodes variable is discrete, the model is estimated using the non-linear Poisson pseudo-maximum-likelihood (PPML) estimator proposed by Silva and Tenreyro (2006). We work with the full sample of countries in column (4) and limit the sample to non-G6 countries in column (5). It is apparent that in both columns, the coefficient $\beta_1$ is not statistically different from zero at the 5% level, while the coefficient $\beta_2$ is positive and highly statistically significant. Thus, consistent with our affiliate licensing results above, we find that stronger copyright protection in the host country encourages entry via FDI, particularly so in industries with greater sensitivity to copyright. The differential industry impact (as measured by $\beta_2$) is stronger in the full sample of countries. One possible reason is that in the G6 economies, firms from relatively small copyright industries face higher barriers to knowledge transfer and more formidable competition in the wake of copyright reforms and strengthening.

## 5.3 | Complementary industries

We turn our attention now to industries outside the copyright-based industries; namely, the complementary industries. These are industries (primarily manufacturing) which produce goods and services that either enhance the consumption of creative works or act as inputs into the production of creative works. The motivation here is to demonstrate that copyright reforms contribute to creating incentives for firms in these complementary industries to transfer technologies and conduct creative work in the host market, controlling for other factors. To the extent that copyright reforms expand the host market for copyrighted works, firms in these other industries should observe profitable opportunities for producing and selling goods and services that complement goods from the copyright industries.

Table 9 shows potentially why firms in the complementary industry could profit from the impact of copyright reforms on the copyright industry, and explains how we identified a complementary industry. For each industry shown, we examine the top 10 industries in which parent companies had their largest sales. For most industries, the largest industry of sale is their own industry. But, the demands for their products can go beyond their own industries; for example, aircraft manufacturers produce goods and services for military defense. Likewise, firms in the complementary industries produce goods for the copyright-based industries, as well as creative works themselves. For example, more than 40% of firms in the Printing & Related Supplies reported that a copyright-based industry accounted for the second largest industry of sale. Nearly 48% of the Communications Equipment firms reported a copyright industry as the second largest industry of sale, and even some of them (1.3%) listed it as the first largest. All of the firms in the Magnetic and optical media industry reported that a copyright industry was the second largest industry of sale. As a result of these cross-industry linkages, changes in the sales of copyright-based industries due to copyright reform could spur a change in the demand for the products in the complementary industries. Thus, what constitutes a complementary industry here is an industry (outside the copyright-based industries) that lists a copyright-based industry among its top 10 industry of sale.

Table 10 further illustrates interdependence between the copyright-based and the complementary industries. For each industry group, the table shows the number of affiliates and FDI stock that parent companies have outside their main industry, before and after a copyright reform. While most US parent companies primarily invest in the same industries abroad as they do in the US, they do own and operate affiliates outside their core industry. Firms in the complementary industries could invest in the copyright-based industries, and vice versa. Following copyright reforms during the period of 1994–2011, the parent companies in the complementary industries nearly quadrupled the number of their affiliates in the copyright-based industries across 41 host countries and nearly tripled their stock of FDI held in foreign affiliates in the copyright-based industries. At the same time, the parent companies in the copyright-based industries more than doubled their number of affiliates in the complementary industries across 21 host countries and increased 1.5 times their stock of FDI held in foreign affiliates in the complementary industries. These cross-industry linkages exist because parent companies find benefit in internalizing some resources from other industries for the purposes of production, sales, or distribution.

**TABLE 9** Copyright-based industry in top 10 industries of sales, % of firms

| Complementary industry | NAICS | *N* | 1st | 2nd | 3rd | 4th | 5th | 6th–10th |
|---|---|---|---|---|---|---|---|---|
| Printing & related supplies | 3231 | 38 | | 41.6% | 22.1% | 5.2% | 3.9% | 10.4% |
| Computers & peripherals | 3341 | 99 | | 9.0% | 10.1% | 5.5% | 1.0% | 1.5% |
| Communications equipment | 3342 | 76 | 1.3% | 47.7% | 10.5% | 1.3% | | 8.5% |
| Audio & visual equipment | 3343 | 15 | | 24.1% | 37.9% | 17.2% | | |
| Semiconductors | 3344 | 158 | | 4.4% | 1.3% | 1.3% | 0.6% | 3.1% |
| Navigation & control instruments | 3345 | 110 | | 4.1% | 7.7% | 1.4% | 3.2% | 6.8% |
| Magnetic & optical media | 3346 | 6 | | 100% | | | | |
| Electrical equipment | 3353 | 24 | | 4.3% | 8.5% | | | 18.8% |
| Other elec. equip. & components | 3359 | 79 | | 4.4% | | 2.6% | 1.3% | |

*Note*: Percentage of firms reporting a copyright-based industry as first, second, third ... largest industry of sale. *N* = number of US parent companies. Sample period: 1994–2011.

Table 11 shows the results of estimating Equation (3) for the sample of firms in the complementary industries. The focus is on three outcome variables: unaffiliated licensing, affiliated licensing, and affiliate R&D. The key variables of interest are the *Copyright reform* dummy variable by itself and its interaction with the measure of industry sensitivity to copyright protection, namely $M_j$, the industry's normalized global sales to the copyright-based industries.[36] Since the complementary industries belong to the manufacturing sector, where patenting is generally widespread and patent protection is important, we also control for the index of patent rights (adjusted for enforcement) and its interaction with a measure of product complexity. Controlling for patent rights serves to ensure that the strength of patent protection in host countries does not confound our estimate of the impact of copyright reforms, while the interaction with product

**TABLE 10** Cross-industry impacts

| **Parents in the copyright-based industries** | | |
|---|---|---|
| | **Number of affiliates in the complementary industries** | **FDI stock (relative to pre-reform) in the complementary industries** |
| Pre-reform | 87 | 1 |
| Post-reform | 188 | 1.5 |
| **Parents in the complementary industries** | | |
| | **Number of affiliates in the copyright industries** | **FDI stock (relative to pre-reform) in the copyright industries** |
| Pre-reform | 101 | 1 |
| Post-reform | 356 | 2.8 |

*Note*: Post-reform FDI Stock is normalized by pre-reform values.

**TABLE 11** Knowledge transfer and copyright reform, complementary industries

| | | | | **Unaffiliated licensing** | | **Affiliated licensing** | | **Affiliated R&D** | |
|---|---|---|---|---|---|---|---|---|---|
| | **Unaff licen (1)** | **Aff licen (2)** | **Aff R&D (3)** | **Step 2 (4)** | **Selection (5)** | **Step 2 (6)** | **Selection (7)** | **Step 2 (8)** | **Selection (9)** |
| Copyright reform | −0.255** | −0.231*** | −0.417* | −0.230*** | 0.065 | −0.232*** | 0.092* | −0.293* | 0.108** |
| | (0.099) | (0.087) | (0.221) | (0.052) | (0.052) | (0.085) | (0.053) | (0.160) | (0.053) |
| Copyright reform × industry sensitivity | 0.215*** | 0.203*** | 0.331*** | 0.201*** | −0.022 | 0.213*** | −0.016 | 0.277*** | −0.045 |
| | (0.079) | (0.036) | (0.124) | (0.028) | (0.028) | (0.046) | (0.028) | (0.087) | (0.028) |
| Patent rights index | −0.209** | 0.361** | 0.057 | 0.159** | 0.812*** | 1.071*** | 0.837*** | 1.500*** | 0.853*** |
| | (0.085) | (0.177) | (0.317) | (0.079) | (0.069) | (0.128) | (0.070) | (0.249) | (0.070) |
| Patent rights index × product complexity | 0.302*** | −0.196** | 0.690*** | 0.259*** | −0.246*** | −0.373*** | −0.287*** | 0.109 | −0.305*** |
| | (0.100) | (0.077) | (0.201) | (0.038) | (0.037) | (0.062) | (0.038) | (0.119) | (0.038) |
| Patent costs/GDP | | | | | −0.243*** | | −0.164*** | | −0.213*** |
| | | | | | (0.053) | | (0.054) | | (0.054) |
| Mills ratio: $\lambda$ | | | | | 0.850*** | | 1.921*** | | 2.839*** |
| | | | | | (0.080) | | (0.132) | | (0.278) |
| Constant | −7.129** | 4.696 | 2.123 | −19.348*** | −29.660*** | −32.822*** | −32.974*** | −64.294*** | −32.082*** |
| | (3.074) | (4.791) | (14.012) | (2.862) | (2.860) | (4.827) | (2.927) | (9.324) | (2.912) |
| Observations | 25,527 | 25,527 | 25,527 | 63,052 | 63,052 | 63,052 | 63,052 | 63,052 | 63,052 |
| Adj. *R*-squared | 0.408 | 0.281 | 0.373 | | | | | | |

*Note*: Standard errors in parentheses, clustered by country in columns (1)–(3). ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. All specifications include country and year fixed effects, and control for GDP, host wages, income tax rate, institutional quality, parent and affiliate sales.

complexity is important since product complexity enhances appropriability and can serve as a technological impediment to imitation. In the selection models in columns (5), (7), and (9), we use the cost of patenting relative to a country's market size as the exclusion restriction. Firms that license abroad typically file for patent protection first in order to protect what they are licensing to others. In other words, patenting cost affects firms' *decisions* to protect and market an asset, but it should not have a direct effect on the extent of firms' activity with the asset once they acquire the protection. We find that the coefficient on *Patent costs/GDP* is negative and highly statistically significant in all three columns, which implies that the cost of patenting is an appropriate exclusion restriction. The coefficient on the inverse Mills ratio, $\lambda$ is also highly statistically significant, which provides strong evidence of selection bias for all three outcomes.

The first three columns show estimates under the assumption of exogenous location. Copyright reform and its interaction with industry sensitivity have the expected signs and are statistically significant. When we control for firm selection in columns (4), (6), and (8), we find that the coefficient $\beta_2$ is positive and highly statistically significant in all three columns, while $\beta_1$ is negative and highly statistically significant in columns (4) and (6) and marginally statistically significant in column (8). The results in columns (4) and (6) imply that the threshold values of $M_j$ are equal to 1.14 and 1.08, for the volume of unaffiliated and affiliated licensing respectively. The complementary industries that exceed these thresholds are computer and peripheral equipment, communications equipment, and audio and video equipment. Firms in these industries increase the transfer of knowledge to host countries following copyright reforms. But for firms in the other complementary industries, the transfer of knowledge falls after the reforms, which would be the case if, for example, more stringent copyright limitations and exceptions increased the cost of using creative expressions in these industries.

Patent protection is also an important determinant of licensing and R&D in the complementary industries. The coefficient on the *Patent rights index* is positive and statistically significant at the 5% level in columns (4), (6) and (8). Further, the coefficient on the *Patent rights index* interacted with *Product complexity* is negative and highly statistically significant in the affiliated licensing regression in column (6), which supports the argument that product complexity provides a natural barrier to imitation and in doing so, reduces the dependence of firms on patent protection. But in the unaffiliated licensing regression in column (4), the coefficient on *Patent rights index* × *Product complexity* is positive and highly statistically significant. This is consistent with the finding in Ivus et al. (2017) that product complexity encourages multinational firms to shift to arms-length licensing following patent reforms. Last, from columns (8) and (9), we find that stronger patent rights promote affiliate R&D, but product complexity matters only to the selection into R&D.

## 6 | CONCLUSION

It has been nearly 25 years since the adoption of the *World Intellectual Property Organization (WIPO) Copyright Treaty* of 1996, and its implementation in the US as the *Digital Millennium Copyright Act* – two initial responses to the dawning information age. Since 2000, copyright laws around the world have been updated, often through multilateral and regional trade agreements, to address new technologies and their implications for trade in copyrighted works. With core copyright-based industries accounting for nearly 7% of GDP in the US in 2017 and comparable shares in other countries,[37] the stakes are high and yet studies on the effects of these policy updates have been quite limited.

This paper is the first to study the effects of copyright protection on the international licensing of US companies in copyright-based industries using firm-level data. We started with a simple model of a dominant foreign firm facing a local competitive fringe. In the model, a firm's selection into licensing depends on the fixed cost of transferring its creative work to a host market; a strengthening of copyright protection in a host country increases the firm's gross profit but also increases the transfer cost. The model generated two testable predictions. First, conditional on transfer, strengthening copyright protection increases the volume of licensing relatively more in industries facing high demand for creative works. Second, strengthening copyright protection increases the likelihood of knowledge transfer relatively more for high-demand works licensed to affiliated parties, given the rise in transfer costs, thereby keeping such transfers within firm boundaries.

We then took the model's predictions to the data. The data showed that the selection in terms of transfer is important to take into account when measuring the impact of copyright protection in the host country on the volume of unaffiliated licensing, suggesting that firms that choose to license their works to unaffiliated parties differ in important unmeasured ways from firms that do not license to unaffiliated parties. This is possible given that entering into licensing agreements with unaffiliated parties typically involves substantial upfront adaptation and transactions costs.

When we take the firms' knowledge transfer decisions as given, we find that stronger copyright protection in the host countries promotes unaffiliated licensing in all copyright-based industries. But when potential endogeneity in the transfer decision is accounted for, the impact of copyright protection on the volume of unaffiliated licensing rises (from negative to positive) with industry sensitivity to copyright. The impact on the volume of affiliated licensing rises with industry sensitivity to copyright, although the evidence of selection bias for affiliated licensing is weak. At the extensive margin, a strengthening of the host's copyright protection increases the likelihood of knowledge transfer via affiliated licensing and decreases the likelihood of knowledge transfer via unaffiliated licensing, more so in industries with high sensitivity to copyright. Our results are robust to using alternative exclusion restrictions and a different measure of industry sensitivity to copyright, and are not driven by the presence of G6 countries in our sample. We also find that copyright protection affects other outcomes associated with knowledge transfers, such as FDI episodes and affiliate R&D, and has a significant effect too on industries that produce output complementary to creative works.

Our results have two key implications. First, copyright systems can contribute to technological development. Copyrighted works include, among other things, software programs, databases, documentaries, films, books, periodicals, and journals, which add to the stock of knowledge and serve as inputs into scientific research. The global diffusion of these works is best enhanced when copyright protection is industry-specific, stronger in certain industries and more flexible in others. Knowledge transfers, especially when they occur outside firm boundaries via unaffiliated licensing, can potentially improve access to technology for local indigenous agents. Second, the effects of copyright reforms are not limited to the traditional copyright industries, but extend to supporting industries (such as computers, communications, and electronics), which produce capital goods or conduct innovations useful for the production or consumption of creative works. The impact of copyright protection on complementary industries imparts a broader sense of how copyright systems can contribute to industrial development.

For future work, a natural extension would be to examine *user rights*. Copyright systems require a balancing of interests between copyright owners and users. Indeed, copyright statutes typically feature detailed provisions on copyright limitations and exceptions. Yet existing economics research on copyrights—limited as it is—has been heavily skewed toward research on "rights" rather than "exceptions". Limitations and exceptions may also add economic value, by enhancing the value of creative works and spurring transformative works by users. They can also help reduce the transaction costs of licensing and negotiating rights, and thereby reduce the cost of creative activity, as well as alleviate the market power of copyright holders.

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## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the US Bureau of Economic Analysis (BEA), Department of Commerce. Restrictions apply to the availability of these data, which were accessed on-site under arrangements that maintain legal confidentiality requirements.

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## ENDNOTES

[1] See Bilir (2014), Branstetter et al. (2006), Ivus et al. (2017), and Park and Lippoldt (2005).

[2] Examples of technologies that complement creative works are: sound systems, 3D video, pixel imaging, Bluetooth, computers and peripherals, television, audio-books, DVD/Blu-ray, mobile devices, virtual reality (VR), and WiFi networks. Examples of products that serve

as inputs into creative works are: infrastructure for delivering creative services (e.g., satellite transmissions, broadband systems) and innovative components and other accessories used to produce creative works (e.g., animation tools, photography equipment, graphics processing units (GPU), and data storage). A strong demand for the output of the copyright industry may translate into a strong demand for the output of these complementary industries and motivate innovators in the latter group to target their innovations for the former.

[3] See Berry and Kaul (2015) and Zeile (2014).

[4] See for example, Branstetter et al. (2006), Delgado et al. (2013), and Ivus and Park (2019).

[5] From Power (2010): "Products that cannot deliver at least the vestige of difference will ultimately get involved in the race to the bottom."

[6] The export data help us capture similarity in production, business factors such as the competitive environment, and technological infrastructure, rather than similarity in consumer tastes.

[7] Baker and Cunningham (2006) shows that court rulings favorable to copyright holders can boost their company stock prices. Ku et al. (2009) finds that copyrights weakly stimulate innovation, as measured by copyright registrations. Handke (2011) surveys the economic literature on copyrights.

[8] Complementarities have been observed previously. Lerner (2011), for example, finds that copyright protection can affect venture capital investments in the cloud computing industry in the European Union. Smith et al. (2009) find that strong copyright laws are associated with increased investments in copyright-related infrastructure, which embodies or disseminates creative works (e.g., personal computers, servers, and bandwidth).

[9] Danaher and Smith (2014) estimates the impacts of piracy on the sales of copyright owners. Telang and Waldfogel (2018) study the near decline of the Bollywood movie industry due to piracy. Copyright reforms in India in the early 2000s helped the movie industry recover, and were associated with an increase in shopping mall and theater investments. While our paper can relate to this strand of the literature, we should note that piracy is not simply a measure of the inverse of copyright strength or enforcement. Piracy is also a function of poverty, social, and cultural factors (Marron & Steel, 2000). Furthermore, we will also discuss copyright flexibility, which permits legitimate uses of copyrighted works and should not be conflated with piracy.

[10] Bilir (2014) argues that firms with short life-cycle products are less sensitive to patent protection because their technologies may become obsolete before imitation can occur. In Ivus et al. (2017), technological complexity acts as a natural barrier to imitation and decreases the hazard rate by which innovations are imitated; in doing so, it strengthens the appropriability regime and reduces the firm's reliance on a host's patent rights.

[11] The two contexts differ for one key reason: unlike patent protection, copyright protection is automatic. To obtain patent protection, inventors must apply for a patent; but in the case of copyrights, creators are not required to register their works, as protection is given by default. Should the creator choose to relinquish some of the rights provided by copyright, she may apply a *Creative Commons* license to the work. This difference matters for the choice of a conditioning variable, as it implies that a measure based on the number of copyright registrations, for example, would not be a fully reliable measure of industry sensitivity to copyrights.

[12] This conceptual framework builds on Feinberg and Rousslang (1990) and Landes and Posner (2003). Maskus and Penubarti (1997) adopt a similar framework to study the effects of patent protection on international trade.

[13] Copyright works typically have a long life (e.g., the life of the author plus 50 or 70 years more). We ignore time discounting for simplicity.

[14] We list our variables and data sources in Appendix I.

[15] We interpolated unaffiliated licensing for 2005 by averaging firm level data for 2004 and 2006.

[16] A more recent BE-125 survey reclassifies these transactions under new categories, such as R&D services, computer services, audio-visual services, and the capital account. See https://apps.bea.gov/scb/2020/07-july/0720-annual-international-transactions.htm.

[17] The table is based on data published at www.bea.gov.

[18] The G6 are Canada, France, Germany, Italy, Japan, and the UK.

[19] See http://fs2.american.edu/wgp/www/intlcopyright.xlsx. Details on the construction of the index are in Appendix III.

[20] The main source of information about copyright laws and regulations is the World Intellectual Property Organization (WIPO)'s LEX website http://www.wipo.int/wipolex/en/index.jsp?tab=3 and case law commentaries in Geller and Bently (2013).

[21] When selecting the year of a major reform, we considered only the most significant shifts in the copyright laws or regulations in country $h$ during our sample period.

[22] We focus on the fairly long period to smooth out cyclical effects, and work with total industry sales, rather than industry mean firm sales, because the distribution of sales is highly skewed and the mean firm might not be a proper measure of market size. The normalization is for ease of identifying industries below or above the normalized median value of one.

[23] As De Vany and Walls (2007) note, pirates tend to target goods which are high in demand. Thus high sales industries should be relatively more sensitive to copyright protection.

[24] One would expect owners of high value works, though, to select into registering their works. The advantages are to better seek statutory damages for infringement or to enlist the aid of customs against importations that violate copyrights.

[25] Publication refers to "the distribution of works to the public for sale, other transfer of ownership, or by rental, lease, or lending." The subject matter is broadly defined and in some cases combines several copyright-based industries (e.g., the non-dramatic literary works subject matter combines monographs and computer software).

[26] Affiliate sales are not included in the selection models since they are not available for firms that have not entered into a host market.

[27] Specifically for each host country, the income taxes of the parent's affiliates were aggregated and then divided by the aggregate pre-tax net incomes of these affiliates. The median ratio is used to represent the corporate income tax rate for that country. Net income is defined as gross income minus total costs and expenses. The tax base uses net, rather than gross, income to obtain a measure of taxable income. Countries vary in terms of their statutory tax rates and regulations on tax deductions, so that gross income would not consistently measure what is taxable.

[28] The OWW database offers several options. We chose the country-specific calibration method, which refers to how the wage dataset was cleaned up (e.g., by making the wage figures consistent with country-specific figures on GDP per capita). We also selected the lexicographic method of treating differences in the reporting of data on hours worked and wages. This method assigns hours worked first by city, then by gender, then by pay concept, and so forth. These options are recommended for providing the largest sample. Details are discussed in Oostendorp (2012).

[29] The measure combines the information of several institutional indices from the Heritage Foundation, the Wall Street Journal, Freedom House, Fraser Institute, World Bank World Governance Indicators, and so forth.

[30] In the cultural and creative fields, marketplace differentiation and positionality are important because consumers face endless substitution possibilities. In the music industry, for example, the same product (from a well-known artist) can be consumed in many different formats sourced in many different places: a CD, a ring tone, a digital download or streaming, and concerts. In addition to product-specific characteristics, difference is also defined by firm-managed characteristics, such as reputation, brands, iconic status, and web communication and content. Companies must seek differentiation advantages as many firm-managed characteristics, such as information competences and capabilities, can easily be replicated by rivals. See Power (2010), Riquelme (2002), Yamin and Sinkovics (2006), and Yip and Dempster (2005).

[31] We also checked to make sure that the adaptation cost does not explain the volume of licensing. If we include this variable in columns (1) and (2), the t-statistics associated with its coefficient are −0.007 and 1.32 respectively.

[32] Our data further show that firms in copyright-based industries with lower home market sales invest less in R&D.

[33] To address the incidental parameter problem, we also re-estimated the models with industry fixed effects. The results are qualitatively similar and are available from the authors upon request.

[34] Linguistic similarity between two countries is given by $L = \sum_n s_n s_n^*$, where $s_n$ and $s_n^*$ are the percentage shares of language $n$ in the two countries, and $L$ varies from zero to 10,000.

[35] In our sample, the G6 along with Ireland, Netherlands, and Australia are the leading recipients of licensing from US copyright-based industries. Furthermore, according to United Nations statistics, the G6 countries are among the leading exporters and importers of creative goods, outside of the US and China (including Hong Kong). See https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx: tables on values and shares of creative goods exports and imports, 2002–2011.

[36] As the copyright index has some collinearity with the patent rights index, we use the copyright reform dummy as introduced in Figures 1 and 2.

[37] See International Intellectual Property Alliance, *Copyright Industries in the US Economy*: *The 2018 Report* and WIPO (2014).

[38] For instance, the home country only exports products in classes 1 to $k$, while the foreign country only exports products in classes $k + 1$ to $m$, where $k < m$.

[39] This corresponds to the index of adaptation, $\eta$, discussed in Section 2.

[40] https://unstats.un.org/unsd/iiss/The-UNESCO-Framework-for-Cultural-Statistics-FCS.ashx.

[41] We included goods that serve as tools and infrastructure for the production and distribution of content. The *Business Software Alliance* also uses shipments of personal computers to track installations of software programs. See bsa.org/files/reports/IPR_GlobalStudy2003.pdf.

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## SUPPORTING INFORMATION

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## APPENDIX

### I | Data description

| Variable | Description and source |
|---|---|
| Affiliated licensing | Royalties and licensing receipts from affiliated parties.<br>Source: BEA *Quarterly Survey of Transactions in Selected Services and Intellectual Property with Foreign Persons* BE-125 for 2006–2011; *Quarterly Survey of Direct Transactions of US. reporters with Foreign Affiliates* BE-577 for 1994–2005. |
| Unaffiliated licensing | Royalties and licensing receipts from unaffiliated parties.<br>Source: BEA Survey BE-125 for 2006–2011; *Quarterly Survey of Transactions between US and Unaffiliated Foreign Persons in Selected Services and in Assets BE-25 for* 2004; *Annual Survey of Royalties, Licensing Fees, and Other Receipts and Payments for Intangible Rights between US and Unaffiliated Foreign Persons* BE-93 for 1994–2003. The remaining period (2005) has interpolated data. |
| Stock of foreign direct investment | Owner's equity plus intercompany debt receivables less intercompany debt payables.<br>Source: BEA Survey BE-577. |
| Parent R&D and sales | R&D performed by parent company; parent's total and US sales.<br>Source: BEA *Annual Surveys of USDIA* (BE-11), *Benchmark Surveys of USDIA* (BE-10) |
| Affiliate R&D and sales | R&D performed by affiliates; affiliate total sales.<br>Source: BEA *Annual Surveys of USDIA* (BE-11), *Benchmark Surveys of USDIA* (BE-10) |
| Industry of sale | Top 10 largest sales of parent company by industry.<br>Source: BEA *Annual Surveys of USDIA* (BE-11), *Benchmark Surveys of USDIA* (BE-10) |
| Income taxes, net income | Income taxes and net income of foreign affiliates.<br>Source: BEA *Annual Surveys of USDIA* (BE-11), *Benchmark Surveys of USDIA* (BE-10) |
| Copyright protection | Index of the strength of copyright protection, updated to 2011.<br>Source: Park (2005) and Reynolds (2003) |
| Patent protection | Index of the strength of patent rights, updated to 2011. Source: Park (2008) |

(Continued)

| Variable | Description and source |
|---|---|
| Patenting cost | Cost of procurement and maintenance. Source: Park (2010) |
| Index of legal and property rights | The index is based on integrity of the legal system, contract enforcement, judicial independence, impartiality of courts, and general property rights<br>Source: Economic Freedom of the World, *Fraser Institute* |
| Hourly wages | Hourly wages (in USD) in total industries; country-specific calibration and lexicographic weighting. Source: Occupational Wages Around the World (OWW) database |
| GDP | GDP in constant 2005 dollars. Source: World Bank *World Development Indicators* |
| Quality of institutions | Based on financial and business freedom; regulation of credit, labor, and business; capital controls and foreign ownership. Source: Kunčič (2014) |
| Product complexity | Binary measure of the complexity of tasks involved in a product's manufacturing: = 1 if complexity is above the median and = 0 otherwise. Source: Based on Naghavi et al. (2015) |
| Bilateral exports | Cultural and information goods. Source: CEPII BACI database http://www.cepii.fr |
| Linguistic similarity | Measures the likelihood that two persons from a pair of different countries can find a language in common. Source: Boisso and Ferrantino (2014), Katzner (2002) |

## II | Country and industry coverage

| | | | | | |
|---|---|---|---|---|---|
| Argentina | Australia | Austria | Belgium | Bolivia | Brazil |
| Bulgaria | Canada | Chile | China | Colombia | Cyprus |
| Czech Rep. | Denmark | Dominic. Rep. | Egypt | Finland | France |
| Germany | Ghana | Greece | Guatemala | Haiti | Honduras |
| Hong Kong | Hungary | India | Indonesia | Ireland | Israel |
| Italy | Jamaica | Japan | Korea, Rep. | Luxembourg | Malaysia |
| Mauritius | Mexico | Morocco | Netherlands | New Zealand | Nicaragua |
| Nigeria | Norway | Pakistan | Panama | Peru | Philippines |
| Poland | Portugal | Romania | Russia | Saudi Arabia | Singapore |
| Slovakia | South Africa | Spain | Sri Lanka | Sweden | Switzerland |
| Taiwan | Thailand | Trinidad & Tob. | Turkey | Ukraine | United Kingdom |
| Uruguay | Venezuela | Vietnam | | | |

| NAICS | Copyright industries |
|---|---|
| 5111 | Newspaper, periodicals, books, and directories |
| 5112 | Software publishers |
| 5121 | Motion picture and video industries |
| 5122 | Sound recording industries |
| 5151 | Radio and television broadcasting |
| 5152 | Cable and other subscription programming |
| 5161 | Internet publishers |
| 5171 | Wired telecommunications carriers |
| 5172 | Wireless telecommunications (excluding satellite) |
| 5173 | Telecommunications re-sellers |
| 5174 | Satellite telecommunications |
| 5175 | Cable distribution |
| 5179 | Other telecommunications |
| 5181 | Internet service providers, web search portals |
| 5182 | Data processing & hosting |
| 5191 | Other information services |

| NAICS | Complementary industries |
|---|---|
| 3231 | Printing & related support |
| 3341 | Computer and peripheral equipment |
| 3342 | Communications equipment |
| 3343 | Audio and video equipment |
| 3344 | Semiconductors, other electronic components |
| 3345 | Navigational, measuring, control instruments |
| 3346 | Making, reproducing magnetic/optical media |
| 3353 | Electrical equipment |
| 3359 | Other electrical equipment and components |

## III | Construction of the index of copyright protection

**Duration by coverage** ($\frac{x}{70 \text{ years}}$):
General
Performance
Sound
Films
Broadcasting
Computer Sub-score: _____

**Limitations and exceptions:**
Collective licensing
Private use
Compulsory licensing Sub-score: _____

**Enforcement:**
Criminal
Preliminary injunction
Seizure/destruction
Anti-circumvention Sub-score: _____

**Agreements:**
Berne Convention
Universal Copyright Convention (1952, 1971) Sub-score: _____
Rome Convention
Geneva Phonograms Convention
Brussels or Satellites Convention
TRIPS Agreement
WIPO Copyright Treaty
WIPO Performances and Phonograms Treaty Sub-score: _____

Overall Score: _____

*Note*: Two important principles guided the construction of the index. First, it was not necessary to cover every statute, regulation, or case related to copyrights, only to maximize data variability to the extent possible. For example, if a provision has existed since 1924 and applied to all forms of copyrightable works, accounting for it would not increase the variation in the index. Second, some statutes or cases may not be relevant to determining the strength of copyright protection; for example, works for hire or joint authorship statutes and cases have more to do with ownership and distributional issues.

## Duration by coverage

Duration varies by type of copyright, whether general or neighboring rights. Though many countries provide for a maximum of 50 years for the protection of neighboring rights, the index sets 70 years as the standard. A country that protects all works for 70 years receives a score of one for duration.

## Limitations and exceptions

In the category dealing with public use of copyrighted works, there are three sub-components, each worth 1/3. For example, collective licensing is assumed to contribute to the strength of the owner's protection through efficiencies in collective negotiations. The availability of collective licensing gives a country 1/3. Many regimes also provide for fair use or fair dealing, which also addresses the transactions costs of licensing, among other factors. However, from the standpoint of copyright strength, the more restrictive private use is the stronger the protection. Countries with very limited exceptions (say strictly for teaching and research) and that prohibit personal use without permission earn 1/3. Countries that do not mention private use in their laws and/or permit a variety of private uses without permission earn zero. Countries that provide private use and permit some enumerated list earn 1/6. Lastly, countries that do not provide for the compulsory licensing of copyright works, say for local translation, earn 1/3.

## Enforcement

This cluster has four sub-components, each worth 1/4. A country scores 1 overall for this component if it provides criminal penalties (in addition to civil remedies) as a deterrent against infringement, provides for preliminary injunctions while a case is pending or in process, allows authorities to seize and destroy infringing goods, and prohibits devices that can circumvent copy protection.

## Agreements

A country scores 1 for the international agreements component if it is a signatory to all of the agreements listed, as this would signal its commitment to copyright protection for nationals and foreigners. The *Berne Convention* is the first international copyright agreement that protects literary and artistic works. The *Universal Copyright Convention* is administered by the United Nations Educational, Scientific, and Cultural Organization (UNESCO), and provides for national treatment. The *Rome Convention* deals with neighboring rights. The *Geneva Phonograms Convention* deals with sound recordings. The *Brussels or Satellites Convention* deals with the re-transmission of satellite broadcasts. The TRIPS Agreement provides for enforcement and dispute settlement procedures. Last, the WIPO *Copyright Treaty* and the WIPO *Performances and Phonograms Treaty* address copyrights and modern technologies (digital and communication).

## IV | Construction of the adaptation cost measure

We measure the degree of creative output similarity between the foreign country and the US, and use this measure as a proxy for the cost of adapting the work in the foreign market. To construct this measure, we use data on bilateral exports of cultural and information goods and compute the *angle* between the vectors of export shares.

Let the distribution of cultural/information goods exports of the home country be given by $f = (f_1, f_2, ..., f_m)$, where $f_z \geq 0$ is the export share of the $z^{th}$ good, $m$ is the total number of classes of cultural/information goods, and $\sum_{z=1}^{m} f_z = 1$. The respective distribution for the foreign country is given by $f^* = (f_1^*, f_2^*, ..., f_m^*)$, where $f_z^* \geq 0$ and $\sum_{z=1}^{m} f_z^* = 1$. The angle $\theta$ between $f$ and $f^*$ is then as follows:

$$\cos(\theta) = \frac{\mathbf{f} \cdot \mathbf{f}^*}{\|\mathbf{f}\| \|\mathbf{f}^*\|} = \frac{\sum_{z=1}^{m} f_z f_z^*}{\sqrt{\sum_{z=1}^{m} (f_z)^2} \sqrt{\sum_{z=1}^{m} (f_z^*)^2}},$$

where $0 \leqslant \cos(\theta) \leqslant 1$. At one extreme, $\cos(\theta) = 0$ if the two vectors are orthogonal ($\theta = 90°$), which means there is no overlap in the distribution of exports.[38] At the other extreme, $\cos(\theta) = 1$ if there is perfect overlap ($f_z = f_z^*$ and $\theta = 0°$).

We use $\cos(\theta)$ as a measure of the adaptation cost.[39] We construct this measure for each copyright-based industry $j$ in host country $h$ in year $t$, using annual data on bilateral trade flows at the product level. The data come from the *Recherche et Expertise sur L'économie Mondiale (CEPII)* BACI database, which in turn builds on the UN *Comtrade* database. The products in our export data are organized by the Harmonized System codes, and we match these codes to the NAICS industry codes in our licensing data, following the 2009 UNESCO framework for cultural statistics.[40]

The table below provides sample descriptions of export classes[41]:

| Industry (NAICS) | Sample products |
|---|---|
| Books, etc. (5111) | Printed reading books, dictionaries, encyclopedias, brochures, newspapers, journals, periodicals |
| Software publishers (5112) | Interactive media, analog and hybrid computers, digital computers, data storage, video games |
| Motion picture and video (5121) | Cinematographic film, video recording, reproducing apparatus, photographic plates & film, microfilms |
| Sound recording (5122) | Musical boxes, recordings, instruments, magnetic discs, magnetic tapes, accessories |
| Radio and TV (5151) | Television cameras, television receivers, radio receivables, radio telephony, reception apparatus |
| Cable distribution (5152, 5175) | Transmission apparatus, audio-visual parts and accessories, image projections |

(Continues)

(Continued)

| Industry (NAICS) | Sample products |
|---|---|
| Telecommunications (5161–5174, 5179) | Telephone sets, telephonic and telegraphic switching apparatus, aerials and reflectors, optical fibers and cables |
| Data processing (5181–5182) | Automatic data processing machines and units, accounting machines |
| Other information services (5191) | Materials for libraries and archives and news syndicates, maps & charts |

The following table summarizes the adaptation cost measure, $\cos(\theta)$, for select regions and industries. For a given industry, the structure of creative output in the US is similar to that in the G6 and Europe, economies in which US firms face relatively greater costs of establishing marketplace differentiation and positionality. In Africa and the Middle East, by contrast, creative output similarity and adaptation costs are lower. Across industries, the creative output similarity is relatively high in the newspaper, periodicals, books, and directories (5111) and software (5112) industries, and relatively low in the motion picture and video (5121), sound recording (5122), and radio and television broadcasting (5151) industries.

| Region/industry | Books etc. (5111) | Software (5112) | Motion pic. (5121) | Sound rec. (5122) | Radio TV (5151) |
|---|---|---|---|---|---|
| G6 | 0.98 | 0.91 | 0.77 | 0.86 | 0.57 |
| Europe (excluding G6) | 0.90 | 0.81 | 0.84 | 0.91 | 0.40 |
| Africa | 0.76 | 0.65 | 0.64 | 0.47 | 0.28 |
| Asia (excluding G6) | 0.81 | 0.77 | 0.81 | 0.53 | 0.32 |
| Latin America and the Caribbean | 0.85 | 0.74 | 0.68 | 0.67 | 0.32 |
| Middle East | 0.80 | 0.67 | 0.64 | 0.66 | 0.33 |
| Oceania | 0.89 | 0.76 | 0.76 | 0.84 | 0.43 |

*Note*: G6 comprises Canada, France, Germany, Italy, Japan, and UK. NAICS codes are in parentheses.