Lobbying for international protection of intellectual property rights

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Abstract
Lobbying has been thoroughly analyzed in the context of trade protection, but there is little literature on lobbying for intellectual property rights (IPR), yet IPR is increasingly becoming the focus of international agreements. I propose a model that analyzes the effect of firm lobbying for IPR protection in an international setting in innovation-driven economies. In particular, I compare the IPR protection level and global social welfare between the case when countries set their IPR policies non-cooperatively and when they enter an international treaty, such as the TRIPS, TPP and TTIP. I find that lobbying necessarily leads to inefficient international agreements resulting in too much IPR protection and may even be welfare-reducing relative to no cooperation. I also show that international lobbying and high concentration of capital can further exacerbate this outcome. The model generates predictions consistent with patterns I find in the data concerning firms’ lobbying expenditures and the value of their international patent portfolios.

Keywords: Lobbying, Patents, Intellectual Property, Patent protection, Trade Agreements, TPP, TTIP

1. Introduction
Starting with the signing of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) in 1994 under the auspices of WTO, international protection of intellectual property rights has been the topic of a heated debate in academic and policy circles alike. Developing countries argue that it is mostly Western innovative economies that benefit from the high level of intellectual property rights (IPR) protection mandated by the
TRIPS at the expense of their poor citizens who pay high monopoly rents to foreign corporations. Faced with this political impasse, high-income countries have more recently turned their efforts to increased integration among themselves, as evidenced by the proposed Trans Pacific Partnership (TPP) and the Transatlantic Trade and Investment Partnership (TTIP).\footnote{TPP (signed on 4 February 2016) is an agreement among 12 Pacific Rim nations: USA, Canada, Japan, Australia, New Zealand, Chile, Brunei, Singapore, Malaysia, Mexico, Peru and Vietnam. TTIP is a proposed agreement between the US and the EU, still under negotiations at the time of writing this paper.} With the globalization of markets, the rise of the innovation economy premised on a strong patent system, and the reduction of tariffs and even non-tariff barriers to near-zero levels, protection of IPR is guaranteed to gain even more in importance in future trade negotiation agendas.

A crucial question for policymakers is whether cooperation in the area of IPR benefits the world as a whole and how those gains are distributed among the parties involved. The implementation of TRIPS spurred a rich theoretical and empirical literature on the economic implications of strengthening IPR in so called North-South models, where the North is modeled as the high-income country where innovation takes place, while the South only acquires the technologies developed in the North either through imitation or FDI\footnote{Depending on the model specifications, these papers arrive at mixed conclusions regarding the effect that strengthening IPR in the South would have on the Southern growth rate and therefore Southern welfare, starting from a non-cooperative equilibrium. For a detailed survey of the literature on North-South models, see Breitwiser and Foster (2012).}. However, the asymmetric framework of innovators vs. imitators inherent in these models is inappropriate if we want to analyze North-North type IPR agreements, like the TPP and TTIP. Moreover, this literature sets the government’s choice of policy to be exogenous, which is suitable for evaluation of the effects of TRIPS, but ideally we would want to endogenize policy choice so as to be able to analyze the outcome of strategic cooperation in a more general sense.

Notable exceptions from this pattern are Edwin L.-C. Lai and Larry D. Qiu, (2003) and Gene M. Grossman and Edwin L.-C. Lai (2004). Both papers model the simultaneous IPR policy choices by trade partners, whose asymmetry arises from different endowments rather than from imposing complete specialization into innovator vs. imitator country. They find that IPR agreements are Pareto-efficient but the winners (the innovation-intensive
economies) may need to compensate the less innovation-intensive economies in order to implement the agreement\textsuperscript{3}. This is because cooperation typically results in the internalization of externalities that countries impose on each other when they are not cooperating. IPR protection in one country benefits all firms, domestic and foreign, that are selling their products in that country and encourages investment in innovation, which in turn benefits both domestic and foreign consumers. The positive effect on foreign consumer surplus and foreign profits is ignored by the domestic country when setting its IPR protection non-cooperatively. It is a positive externality that results in an inefficiently low level of IPR protection. Cooperative agreements eliminate this externality, just as free trade agreements eliminate the terms-of-trade externality (Kyle Bagwell and Robert W. Staiger, 1997). Scholars and policymakers tend to ignore the difference in the source of the externality on the basis that both types of agreements are efficient and conflate them, as evidenced by the fact that a treaty like the TRIPS was on the WTO agenda at all. Similarly, proponents of TPP and TTIP, which concern largely investor property rights, dub them free trade agreements and by extension use well-established anti-protectionist logic to make their case for these treaties\textsuperscript{4}.

I show in this paper that the distinction between IPR and free trade agreements is crucial and in the presence of lobbying can overturn traditional results on the benefits of cooperation. In the current literature the closest benchmark we have in order to think about the impact of lobbying on trade agreements is the generalized approach of K. Bagwell and R.W. Staiger (1997, 2009). They analyze the case of two politically motivated governments with two perfectly competitive sectors that lobby for sector-specific import tariffs. They conclude that trade agreements improve global efficiency by mutual reduction of tariffs up to a certain level\textsuperscript{5}, thereby eliminating the terms-of-trade externality that countries impose on each other.

\textsuperscript{3}In Grossman and Lai (2004) compensation takes the form of transfer payments, whereas Lai and Qiu (2003) focus on market access in the form of lower tariffs for the good that is not patent-intensive.

\textsuperscript{4}See Gregory Mankiw "Economists Actually Agree on This: The Wisdom of Free Trade" (April, 2015), The New York Times

\textsuperscript{5}Trade agreements in the standard model can eliminate only the terms-of-trade component of the tariff, but not the "politically optimal" tariff component, which is due to the organized sectors lobbying for protection. In upcoming work, I describe a model in which trade agreements can also reduce the protectionist politically optimal tariffs.
when they don’t cooperate\textsuperscript{6}. Grossman and Helpman (1997) provide microfoundations for Bagwell-Staiger’s reduced form approach, but also allow for export subsidies to be used, which allows pro-export and import-competing lobbies to neutralize each other’s influence. The more similar the lobbies are in terms of strength, the more this lobbying inefficiency is neutralized, resulting in efficient trade agreements in the perfectly symmetric case.

Unlike trade agreements on tariffs, I show that cooperation in the form of IPR agreements is not always Pareto-improving. In fact, my model shows that lobbying will necessarily lead to inefficient agreements between countries with organized innovation-driven sectors (North-North agreements), resulting in supra-optimal levels of IPR protection that in some cases could make the world worse off than if countries didn’t cooperate at all. Intuitively, the lobbyists’ influence always works to push the equilibrium outcome towards more IPR protection, so when countries don’t cooperate and IPR protection is inefficiently low, lobbying brings it closer to the efficient level. However, when countries sign agreements to eliminate the externality, the effect of lobbies will be to increase IPR protection beyond the optimal level. The logic of Grossman and Helpman (1997) does not extend to lobbying for IPR protection, because the lobbies’ interests, rather than being opposed, are perfectly aligned with one another: because governments cannot discriminate on the basis of origin\textsuperscript{7}, increasing IPR protection in one country will benefit both domestic and foreign firms selling in that market. I also show that international lobbying, the proliferation of multinationals and higher knowledge capital concentration within countries and in countries where lobbies hold a lot of sway over the government can further increase the inefficiency of IPR agreements.

Similar results hold when we analyze the case of IPR agreements in the presence of organized imitation sectors that lobby to counter the influence of the innovation-oriented firms. This type of North-South agreements will be inefficient and supra-optimal under a weak sufficient condition\textsuperscript{8}, and like North-North agreements, they will not always be Pareto-improving relative

\textsuperscript{6}In a similar fashion for the case of imperfect competition, R. Ossa (2010) and J. Brander and B. Spencer (1992) show that trade agreements result in the elimination of tariffs that are due to delocation and profit-extracting externality respectively.

\textsuperscript{7}The principle of national treatment, a core principle of most international trade treaties including the WTO, states that the state must provide equal treatment to imported and locally produced goods.
My theoretical approach takes the lobbying framework from Grossman and Helpman (1992) and imposes it on the innovation economy model developed by Grossman and Lai (2004) with a few key modifications. Rather than assuming identical firms and an aggregate R&D sector, I consider heterogeneous firms, each with a different capacity to innovate which determines the number of goods that the firm invents every period. Patents, when fully enforced, provide firms with the exclusive right to produce and sell the product during the duration of the patent lifetime.

Lobbies too will be at the firm level, and firms will be allowed to lobby the national government for IP protection policies that affect all firms equally, namely patent enforcement and patent lifetime. Lobbying is modeled as a common agency game where firms post contribution schedules conditional on implementing desired policies, just like in Grossman and Helpman (1992). Conducting the analysis at the firm level, though not consequential for the welfare implications, will allow us to determine the lobbying contribution by each firm thus generating a testable prediction that I show holds in the data, as well as endogenize lobby formation both at the level of in-house firm lobbies and at the level of trade associations, unlike Grossman and Helpman (1992) where sectors were exogeneously assigned lobbies.

The role of lobbying by patent-holders is central for my conclusions, so it is worth taking the time to present some stylized facts to support the claim that corporate lobbying plays a crucial role in international negotiations in reality as well. From January 2012 to February 2014 during the negotiations for TTIP, the proposed trade agreement between the USA and the EU, 597 behind-closed-doors meetings in which TTIP was discussed took place between lobbyists and the EU Trade Commissioner, members of her Cabinet and the director general of DG Trade — almost twice a day on average. Of these, 88% were with business lobbyists. Of course, this statistic captures only a fraction of the full extent of lobbying as there are numerous other EU institutions and national governments where corporations could lobby.

8The sufficient condition states that the ratio of the government susceptibility to lobbying by imitators in the South relative to that by innovators in the North needs to be smaller than the patent premium under maximum IPR protection. In other words, the asymmetry in terms of political systems should be smaller than the asymmetry in terms of profits between innovators and imitators.

9Source: Corporate Europe Observatory
for particular TTIP provisions. In the US, the data is a lot more transparent because all firms are required by law to report all lobbying expenditures on a quarterly basis, provided they are above $12,500. Up until 2016, US companies spent an estimated total of $507 million on lobbying for TTIP or TTP-related issues.\textsuperscript{10} In 2015, the year when lobbying for TTIP/TTP was most intensive, estimated expenditures for this purpose totaled $148 million, which represents 4.6% of the total lobbying expenditures that year.

The TPP and TTIP are complex pieces of legislation and do not only contain provisions regarding IPR, so not all lobbying for these agreements can be considered as lobbying for IPR. Nevertheless, the final chapter on intellectual property of the TPP contains strong provisions that go beyond the TRIPS-plus aspects that the US had already negotiated on a bilateral basis with countries such as Australia, Chile, and Peru, and affect both scope, length and enforcement of patents, copyrights, trademarks and trade secrets.\textsuperscript{11} Moreover, legal mechanisms such as the investor-state dispute settlement further strengthen enforcement of the various protections envisioned in the treaty. A simple comparison between the top manufacturing sectors that lobbied for TPP/TTIP as a share of revenue and those with the highest patent premiums\textsuperscript{12}(Figure C1 in the appendix) — namely pharmaceuticals and biotechnology first and foremost, but also machinery, electronics equipment, and chemical manufacturing — reveals a high correlation of 0.74 and provides evidence that IPRs constitute a key concern for lobbyists.

Analysis of targeted lobbying expenditures at the firm level confirms the link between IPR and TPP/TTIP. I find that, controlling for firm size (revenue), firms with larger international patent portfolios lobbied more for these agreements during the negotiations phase, as the model predicts. In particular, a 1% increase in the value of the citation-GDP-weighted Pacific patent portfolio is associated with a 0.15% increase in TPP-related lobbying, whereas 1% increase in the value of the citation-GDP-weighted European patent portfolio is associated with a 0.08% increase in TTIP-related lobbying. Though modest, these point estimates are only 3 to 6 times smaller

\textsuperscript{10}Own calculations from data gathered by the Center for Responsive Politics. Details about the data and the methodology of calculation are given in the Appendix B1.

\textsuperscript{11}Gina M. Vetere, Marty Hansen, Marney Cheek and Jay Smith "Whats New in the TPPs Intellectual Property Chapter", Global Policy Watch

\textsuperscript{12}Patent premium is defined as the proportional increment of the value of innovations by patenting them
than the coefficient on sales which is considered in the empirical literature to be the best predictor of lobbying expenditures. The estimates are robust to different measures of patent portfolio value. The details about the data can be found in the Appendix B1 and the results from the regression in Appendix B2.

The remainder of the paper proceeds as follows: I will first describe the benchmark case for the closed economy to describe and provide the basic intuition about the model. Then I will consider the non-cooperative case of two (or more) countries choosing their policies simultaneously, after the lobbies have posted their contribution schedules. Next I consider the case of cooperation in the form of international patent agreements and analyze the outcome vis-a-vis the non-cooperative and the efficient outcome. I identify the exact parameter range for which the non-cooperative outcome Pareto-dominates the cooperative outcome. Intuitively, the effect of lobbying under no cooperation needs to be strong enough to compensate for the negative effect on IPR due to free riding on the trading partner’s strong IP provision.

The model remains tractable without affecting the main conclusions even if we add extensions such as fixed lobbying costs, fixed patenting costs, multiple countries, Cournot competition (imitation sector), and international and collective lobbying. Some of these extensions are considered as I describe the model, others in separate subsections towards the end.

2. Theoretical Model

2.1. Innovation

I begin by analyzing the case of a single closed economy, whose insights will then be used in the next sections to address the question of two or more countries in an international setting in the non-cooperative and cooperative case respectively. I start by describing the framework of the innovation-driven economy from Grossman, Lai (2004), but instead of using an aggregate R&D like they do, I impose heterogeneity in the firms’ capacity for innovation.

The economy has two sectors: one that is perfectly competitive and produces a homogeneous good and another that is research-intensive and consists of a fixed number of firms, each producing a continuum of differentiated goods. Each differentiated good has a finite lifetime of $\bar{\tau}$ periods. During the good’s lifetime, it can be produced and consumed providing utility to consumers, after which the technology “expires” and it cannot be produced.
anymore. The homogeneous good, by contrast, does not provide utility to consumers and has infinite lifetime.

There are $M$ sophisticated consumers with identical preferences and we assume income is distributed such that each of them is able to consume all available varieties and then consumes the homogeneous good with the remainder of his budget. The number of sophisticated consumers is exogenous and is a fraction of the total population. This assumption can be justified if we suppose that the differentiated varieties don’t provide any utility to a consumer before a certain threshold level of consumption of the homogeneous good is reached. Thus, population size, total income and income distribution together determine the number of sophisticated consumers, which captures market size.\footnote{Alternatively, we can suppose that $M$ does reflect population size and every consumer is sophisticated, or rather the varieties are more akin to research-intensive necessities (like pharmaceuticals) than luxury goods. However, in this case $M$ will not vary with total income and any extra income that rich people earn will be spent on consumption of the homogeneous good which does not give any consumer surplus. At the expense of tractability, we could even assume two sectors - one producing luxuries that only consumers with high purchasing power could afford and the other producing necessities that every consumer needs.}

The representative sophisticated consumer maximizes a utility function discounted across time:

$$U(t) = \int_t^\infty u(z)e^{-\rho z}dz$$

where $u(z)$ is the $z^{th}$ period utility given by:

$$u(z) = y(z) + \sum_{j=0}^{n(z)} h[x(j, z)]$$

Here I denote the consumption of the homogeneous good at time $z$ as $y(z)$, and the consumption of variety $j$ at time $z$ as $x(j, z)$. $n(z)$ is the number of active differentiated varieties whose lifetime hasn’t expired by period $z$. These varieties generate consumer surplus via $h(x)$. We assume that $h'(x) > 0$, $h''(x) < 0$, $h'(0) = \infty$, and $x h''(x)/h'(x) < 1$ for all $x$, thus ensuring a positive demand for all varieties and finite prices charged by profit-maximizing firms. The consumer’s first-order condition (FOC) with respect to consumption of
variety j gives the individual (inverse) demand:

\[ h'[x(j, z)] = p(j, z) \]  

(3)

where \( p(j, z) \) is the price of variety j at period z.

On the supply side, goods are invented as a result of each firm’s own R&D capacity, represented by a privately owned fixed knowledge capital \( H_i \) and its associated R&D function. The number of newly invented varieties by firm i at time t is given by a CES function:

\[ \phi_i(t) = F_i(L_{Ri}(t)) = \left( b \left( \frac{L_{Ri}(t)}{l} \right)^{\frac{1}{1-\beta}} + (1 - b)H_i^{\beta} \right)^{1/\beta} \]  

(4)

Here \( L_{Ri} \) represents the amount of labor employed by the firm in R&D and \( l \) is the unit labor requirement in the perfectly competitive sector for the production of the homogeneous good. Here we assume \( \beta \leq 1/2 \) which Grossman and Lai show is a sufficient condition for the second-order condition to hold for any interior FOC solution for the patent policy. We also assume that there is enough labor in the economy to always produce the homogeneous good, so then FOC(y) will set the wage equal to the marginal product of labor, i.e. \( w = 1/l \).

Once a good is invented, the firm acquires a patent for it with a duration of \( \tau < \bar{\tau} \). During the duration of the patent, every period there is \( \omega \) chance that the patent holder’s exclusive right to sell the product will be enforced.\(^{14}\) Both \( \tau \) and \( \omega \) are policy choice variables to be decided by the government. If the patent is enforced during a given period, the firm will operate in a monopolistic regime able to set its price and reap profits. Conversely, there is a \( 1 - \omega \) chance that the patent won’t be enforced and the good will be sold in the competitive regime, where any firm may produce it at a price equal to its marginal cost: \( p_c = l \cdot w = 1 \).\(^{15}\) After the patent has expired and before the end of the good’s lifetime, it is always produced in the competitive regime.

\(^{14}\)Alternatively, \( \omega \) can be thought of as the share of the country’s territory in which the patent is enforced each period.

\(^{15}\)In the open economy version of the model, the imitator firms may compete with their cheap generic versions from abroad, so even if the country maintains a relatively high level of IPR protection where no domestic firm is allowed to produce a copied product, there could still be smuggled imports that patent enforcement would have to deal with.
Under the monopolistic regime, profit (per good per consumer) maximization for a monopoly yields:

$$\frac{p(x_m) - lw}{p(x_m)} = -\frac{x_m h''(x_m)}{h'(x_m)}$$  \(\text{(5)}\)

where \(x_m\) denotes the consumption per consumer this regime. The above equation determines \(x_m\), from where it is straightforward to derive the optimal (variable) profit per consumer \(\pi = (p_m - 1)x_m\) and the individual consumer surplus \(CS_m = h(x_m) - p_m x_m\). Similarly, in the competitive regime, firms earn zero profits and individual consumer surplus \(CS_c = h(x_c) - x_c\), where \(x_c\) is the individual consumption under perfect competition pinned down by the inverse demand \(h'(x_c) = p_c = 1\).

The labor market equilibrium condition states that the wage has to equal the marginal product of labor in both the manufacturing and the R&D sectors of each firm. If by \(v\) we denote the value of the patent, for the R&D sectors (for all \(i\)) the equilibrium condition is:

$$w = v F'_i(L_{Ri})$$  \(\text{(6)}\)

The value of the patent \(v\) equals the discounted expected profits throughout its duration:

$$v = \frac{\omega M \pi}{\rho} (1 - e^{-\rho \tau}) \equiv M \pi \Omega(\tau, \omega)$$  \(\text{(7)}\)

Notice that the value of \(\Omega(\tau, \omega)\) fully conveys the effect of government policies \((\tau, \omega)\) - they matter only insofar they affect the valuation of patents. In this sense patent length and patent enforcement are policy substitutes and only the overall level of IPR protection given by \(\Omega\) matters.

The equilibrium condition equating national savings \(S\) and national investment in R&D \((-w \sum L_{Ri} = wL_R\)) gives an expression for total expenditure \(E\) on goods as a function of national income \(I\) for every period:

$$E = I - S = (wL + \omega n(t) M \pi) - wL_R$$  \(\text{(8)}\)

As the derivation hitherto suggests, the equilibria of interest are stationary, in the sense that the rates of innovation \(\phi_i\) are constant over time.

\section*{2.2. Lobbying}

The political economy setup is motivated by the seminal model ”Protection for Sale” by Grossman and Helpman (1992). Like the original paper,
lobbies offer contribution schedules conditional on different policy outcomes to be implemented by the government. The government, or rather politicians, in turn maximize their own welfare, which is a weighted average of total contributions collected by lobbyists and the aggregate social welfare. However, instead of exogenously assigning lobbies at the level of industries like Grossman and Helpman (1992), we allow every firm to choose whether or not to lobby for IPR protection and determine its own contribution schedule, subject to a fixed cost of operating its in-house lobby paid in hired labor. Because of this fixed cost, only large enough firms will decide to lobby in equilibrium, which is consistent with what we observe in reality.

The process of lobbying consists of two phases. In the first phase, all firms simultaneously decide whether to lobby and if yes, they submit non-negative contribution schedules $C_i(\Omega)$ to the government: if the government implements policy $\Omega$, the politician will receive $\sum_i C_i(\Omega)$ worth of donations for his election campaign\textsuperscript{16}. $C_i(\Omega)$ is defined for all feasible $\Omega$. In the second phase, the government chooses policy $\Omega$ once and for all by maximizing:

$$G(\Omega) \equiv \sum_{i \in L} C_i(\Omega) + a W(\Omega)$$

where $a$ is the weight on the utilitarian social welfare $W$ discounted across time, and $L$ is the set of firms that will decide to lobby in equilibrium.

Notwithstanding any principal-agent considerations, the objective function of the firm’s lobby is given by the joint welfare of the firm’s owners. We assume that firm i’s owners constitute $\alpha_i$ share of the sophisticated consumers $M$ and contribute $\delta_i$ share of total labor employed $L$. We impose the restriction $\alpha_i < H_i/H$ which reflects the realistic fact that firm ownership is more concentrated than the distribution of consumer surplus in the economy. Firm i’s owners invest in R&D in firm i in the form of salaries for labor employed in research and hold the patent rights on all inventions that are produced as a result. Thus, like in reality, ownership is pre-requisite for investment, or conversely investment is means to ownership (equity finance). We assume that any individual can be (partial) owner of at most one firm. So whatever money is not re-invested in firm i by its owners must be money spent on purchasing goods: $E_i = \Pi_i + \delta_i w L - w L_{Ri}$, where $\Pi_i$ is the joint profit earned

\textsuperscript{16}Alternatively, this expenditure can be thought of as funds spent on lobbying for the particular policy issue in the firm’s favor, whereby money spent translates directly into additive influence on the politician’s preferences.
by firm i’s owners. Under these assumptions, the lobby discounted welfare of firm i at time $t=0$ is given by:

$$W_i(\Omega, t = 0) = PDV_0(E_i(\Omega) + \alpha_i CS(\Omega)) + \Lambda_i^0$$

(10)

In equation (10), $PDV_0$ is an operator expressing the present (at time $t=0$) discounted value of the terms in brackets: firm i’s owners’ expenditure on goods and their consumer surplus (as $\alpha_i$ share of overall consumer surplus CS), whereas $\Lambda_i^0$ denotes the welfare to be derived from patents that had been invented before time 0. By assumption, patent protection decided at $t=0$ applies only to patents awarded after this time. For goods invented beforehand, whatever IPR protection was in effect at the time of invention is applicable. For this reason, $\Lambda_i^0$ is a separate term independent of $\Omega$ and will not affect the optimization problem. Without loss of generality, we can also assume that firm owners are pure capital owners and don’t provide any labor i.e. $\delta_i=0$, because it won’t affect optimization.

Counting only the goods invented after $t=0$, in each period we calculate the number of goods that will be sold under a monopolistic regime (thus yielding $\pi$ and $CS_m$ to owners), and the number of goods sold under competitive regime (yielding $CS_c$ to owners), and then discount them across time applying (1). Substituting these results in (10), we get:

$$W_i(\Omega, 0) = \frac{\pi M_0 \phi_i(\Omega)}{\rho} - \frac{wL_R(\Omega)}{\rho} + \frac{\alpha_i M_0 \phi(\Omega)}{\rho} \left( CS_m + CS_c \frac{T - \Omega}{\Omega} \right) + \Lambda_i^0$$

(11)

Here, I define $T$ to be a discounting factor for the product lifetime equal to $\frac{1}{1-e^{-\rho \tau}}$.

Similarly, we calculate society’s welfare at time $t=0$ by adding up all expenditures on goods and the consumer surplus they generate, and by counting and discounting goods just like for the individual firm’s lobby.

$$W(\Omega, 0) = \Lambda^0 + \frac{w(L - L_R(\Omega))}{\rho} + \frac{M_0 \phi(\Omega)}{\rho} \left( \pi + CS_m + CS_c \frac{T - \Omega}{\Omega} \right)$$

(12)

To find the subgame perfect Nash equilibrium of this two-stage game, I follow the approach of Grossman and Helpman and apply Bernheim, Whinston (1986) theorem, which states the optimization conditions that support the SPNE equilibrium\textsuperscript{17}. Assuming that the contribution schedules are dif-

\textsuperscript{17}The theorem states that $\{\{C_i(\cdot)\}, \Omega_o\}$ is SPNE iff:
iferentiable at the optimum, it follows that $C'_i(\Omega_o) = W'_i(\Omega_o)$, which is known as local truthfulness. Substituting this result in the first order condition for (9), we get the expression:

$$\sum_{i \in L} W'_i(\Omega_o) + a W'(\Omega_o) = 0 \quad (13)$$

I substitute (11) and (12) in (13), take the derivatives with respect to $\Omega$ and substitute the following expressions:

$$w = \frac{vF'_i(L_{Ri})}{B_{Ri}(L_{Ri})}, \quad \frac{\partial v}{\partial \Omega} = M \pi$$

and

$$\frac{1}{\phi_i} \frac{\partial v}{\partial \Omega} = \left( - \frac{F'_i(L_{Ri})}{F_i(L_{Ri})} \right) \frac{\phi_i}{v} \equiv \gamma(\Omega) \frac{\phi_i}{v}.$$  

Rearranging the result gives us the following implicit formula for the optimal IPR protection:

$$CS_c - CS_m - \pi \frac{\zeta + a}{\alpha_L + a} = \gamma(\Omega) \left( CS_m + CS_c \frac{T^i - \Omega}{\Omega} \right) \quad (14)$$

Here $\zeta$ is defined as the share of firms in terms of knowledge capital that are lobbying in equilibrium$^{19}$. $\alpha_L$ is the share of sophisticated consumers comprised of the owners of lobbying firms. The variable $\gamma(\Omega)$ measures the responsiveness of innovation to IPR protection and under our CES assumption for R&D it is equal to $b(1-b)(1-\beta)/(1+b(1-b)(1-\beta))$, but it can be shown it is invariant across firms.

The optimization condition (14) reflects the fact that the government chooses the policy that balances between the static cost (dead-weight-loss) from a marginal increase in IPR on the left-hand side and the dynamic benefits of higher research output on the right-hand side. Grossman, Lai (2004) show in their appendix that if $\beta \leq 1/2$ then the right-hand side is decreasing in $\Omega$, so the second-order condition holds globally, which guarantees that the interior solution given by (14) is unique and is a (global) maximum.

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1. $C_i(\Omega)$ are feasible $\forall i$
2. $\Omega_o$ maximizes the government objective function $G(\Omega)$
3. $\Omega_o$ maximizes the joint gov+lobby objective function $G(\Omega) + (W_i(\Omega) - C_i(\Omega)) \forall i$
4. $\exists \Omega_i$, such that it maximizes $G(\Omega) - C_i(\Omega)$

18 This last derivative we obtain by differentiating (6) with respect to $v$ and substituting it in $\frac{\partial \phi_i}{\partial v} = F'_i(L_{Ri}) \frac{\partial L_{Ri}}{\partial v}$.

19 In fact, the derivation gives a different ratio - the share of new innovation coming from lobbying firms: $\sum_{i \in L} \phi_i$, but it can be shown that if the R&D function is CES as we assumed, that ratio also equals the share of knowledge capital owned by lobbying firms: $\sum_{i \in L} H_i$. 

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Simplifying even further, if we assume that $\beta = 0$ (the Cobb-Douglas case), $\gamma = b/(1-b)$ becomes independent of $\Omega$ and $M$, and consequently, the optimal $\Omega$ is not affected by the size of the market $M$.

In order to fully characterize the equilibrium, we also need the set of firms that will be lobbying which is also endogenous. In general, multiple subgame perfect Nash equilibria can exist, some of which may be inefficient. As in Bernheim and Whinston (1986) we restrict our focus on truthful equilibria, which arise when the contribution payment functions $C_i$ are globally truthful. A truthful contribution is a feasible (non-negative) contribution schedule that mirrors the curvature of the lobby’s utility. The lobby will get the same payment net of fixed lobby costs $f$ for all policies $\Omega$ that induce positive contributions $C_i > 0$. Thus, deciding the contribution schedule boils down to deciding by what scalar $B_i > 0$ the lobby wants to shift its utility. Mathematically, the truthful contributions can be written as:

$$C_i(\Omega) = \max\{W_i(\Omega) - B_i, 0\}$$

(15)

Focusing on truthful equilibria is less restrictive than it may seem. As Whinston and Bernheim show, the set of best-response strategies to any strategies played by the other lobbies contains a truthful contribution function, thus the lobby incurs no cost from playing a globally truthful strategy. Second, truthful equilibria implement Pareto-efficient outcomes. Third, only truthful equilibria are stable to non-binding communication among the players (i.e. they are "coalition proof").

In equilibrium, lobby $i$ will have increased the scalar $B_i$ until the government is indifferent (or rather marginally prefers) between choosing the optimal policy $\Omega_o$ and another policy $\Omega_{-i}$ that the government would choose when lobby $i$ would contribute 0, taking all other lobbies’ equilibrium contributions as given. Thus the lobby wishes to reduce its contribution as much as possible without inducing the government to deviate to another policy that it considers inferior. We can use the government indifference condition to back out the scalars $B_i$ for all $i$.

$$B_i = a(W(\Omega_o) - W(\Omega_{-i})) - \sum_{j \in L, j \neq i} W_j(\Omega_{-i}) + \sum_{j \in L} W_j(\Omega_o)$$

(16)

Finally, for all lobbies that contribute a positive amount as opposed to not lobbying at all, the following inequality that reflects this preference has to hold in equilibrium as well:

$$W_i(\Omega_{-i}) < B_i - f$$

(17)
Figure 1 depicts this equilibrium graphically for two firms. The curves $G_i G_i$ representing different combinations of policy $\Omega$ and payment $C_i$ are indifference curves for the government when the contribution schedule of the other firm is taken as given by lobby $i$. If lobby $i$ makes no contributions (corresponding to the x axis), the government will maximize its utility by choosing $\Omega_{-i}$. But the optimal policy $\Omega_o$ must also lie on this curve because of the government indifference condition discussed earlier. This is the condition that pins down the scalar $B_i$. The truthful contribution schedule is given by the positive portion of the $C_i(\Omega) - B_i$ curve (and it equals zero for negative values), so the government will maximize its utility at $\Omega_o$, the point where $C_i(\Omega)$ is tangent to the government indifference curve $G_i G_i$. Because the government indifference curve is given by $C_i(\Omega) = \text{const} - (W(\Omega) + \sum_{j \in L, j \neq i} C_j(\Omega))$, equation (13) guarantees that the tangency condition holds for all $i \in L$. Notice also that the positive portion of the truthful contribution schedule is an indifference curve for the lobby (because it guarantees the same utility $B_i - f$), so in other words the lobby has chosen a contribution schedule that maximizes its utility subject to keeping the government away from deviating. Finally, condition (17) which determines whether the firm will set up an in-house lobby is met only if the distance $d_i \equiv |W_i(\Omega_{-i}) - B_i|$ is larger than the fixed cost $f$.

It can be shown that $d_i$ is monotonically increasing in $H_i$ as expected\(^\text{20}\): Larger firms are more likely to establish in-house lobbies. It follows from this that if condition (17) fails for a firm with knowledge capital $H_i$ then it must also fail for all smaller firms. In equilibrium, there will be a cutoff $\bar{H}$ below which firms will find it too costly to establish lobbies. Unfortunately there is no explicit condition that pins down this cutoff, because it will depend among other things on the distribution of knowledge capital among the different firms. However, it can be easily found by backward reasoning: starting from a candidate equilibrium in which all firms lobby, we check if (17) holds for all $i \in L$ as assumed. If not, we discard the smallest firm from the set of lobbying firms until the assumption is met, thus producing the set of lobbying firms in equilibrium, since no firm has incentive to drop out nor to start lobbying.

If the fixed costs of lobbying are zero, all firms will lobby in equilibrium ($\zeta = 1$) and the resulting level of protection will be independent of the concentration of capital or whether they are organized in separate lobbies or

\(^{20}\)See Appendix 1 for proof.
a single trade association\textsuperscript{21}. This assumption, though somewhat unrealistic, makes finding the equilibrium more straightforward and does not affect the conclusions of the paper regarding welfare. Nevertheless, once fixed costs of lobbying are introduced, capital concentration starts to matter for the optimal policy because $\zeta$ is affected by the fixed cost. An industry with a low capital concentration will have many small firms unwilling to lobby, therefore producing a lower level of IPR protection $\Omega_0$. On the other hand, organizing

\textsuperscript{21}Curiously enough, simulations show that when capital is more concentrated (or when lobbying is conducted through an industry-wide association), the total contributions that the government receives are higher than if capital was less concentrated into a higher number of smaller firms. This might be one reason why firms prefer to lobby separately.
into a single industry-wide lobby will offer a major cost-saving advantage of paying the fixed cost only once, so smaller firms will now participate in the lobbying effort and the resulting policy $\Omega_o$ will be as high as in the case of zero fixed costs ($\zeta = 1$). Thus we can explain industry-wide lobby formation endogenously: firms will choose to lobby together when the cost savings achieved through lower fixed lobbying costs outweigh the increase in firm contributions that joint lobbying entails (see footnote) net of any coordination costs.

In the existing literature, firms are believed to lobby individually typically on policies that differentially affect them compared to other competitors, whereas when it comes to policies affecting all firms equally they tend to free ride on the lobbying efforts of larger competitors or decide to lobby through trade associations. Thus, if an industry is highly concentrated it should be able to overcome the free riding problem and form a trade association to collectively lobby the government. In this model, capital concentration will affect the level of IPR protection only insofar it determines which firms are profitable enough to afford an in-house lobby department, and has nothing to do with collective action failure.

Notice that even though the interests of the firms are perfectly aligned, free riding is not an issue in this model, because firms' lobbying efforts are complementary to one another. As in all common agency games, lobbies are able to device their contribution schedules such that each firm will want to contribute funds and induce the government to increase IPR protection further, given what other firms have already contributed. The only reason why it might decide not to lobby is because the fixed cost of setting up a lobby might be too prohibitive. M. Bombardini (2008) also shows that in the presence of fixed lobbying costs high capital concentration results in more lobbying and therefore more protection, however she analyzes the individual incentives of firms to participate in the joint lobbying effort without allowing them to lobby separately and assumes that all firms have to pay a fixed cost in order to join the industry lobby, so there is no cost-saving advantage. But if industry-wide lobbies are less cost-effective and there is no free rider problem that they could help solve, then firms would choose to lobby separately if allowed.

How does the equilibrium level of IPR protection $\Omega_o$ compare to the

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22 Olson (1971), Bergstrom et al. (1986), Gawande (1997), Bombardini (2012)
efficient level \( \Omega_{eff} \) that prevails when there is no lobbying? Setting \( a \to \infty \) in (14), equivalent to the government putting all weight on social welfare and none on lobby contributions, would give the first-order condition for \( \Omega_{eff} \), which differs from (14) in that the lobbying term \( \frac{\zeta + a}{\alpha_L + a} \equiv \theta \) disappears, yielding the result of Grossman and Lai (2004). Notice that because \( \alpha_i > H_i / H \) by assumption, \( \zeta > \alpha_L \) and therefore \( \theta > 1 \). Because the right-hand side of (14) is decreasing in \( \Omega \) and the lobbying term shifts down only the left-hand side, we can conclude that:

**Proposition 1:** Lobbying in a closed economy causes patent protection to be above the welfare-maximizing level \( \Omega_{eff} \).

Moreover, the higher the share of \( \alpha_L \) consumers that lobbying firm owners represent, the more they internalize the dead-weight loss resulting from their lobbying activities, and the closer is \( \Omega_o \) to the efficient level.

2.3. **Global regime: non-cooperative case**

In this section, I extend the closed economy model to the non-cooperative case of two countries: USA (U) and EU (E), both with identical preferences, identical R&D innovation functions and identical lifetime of goods \( \bar{\tau} \). The countries differ by their market size \( M \), their labor endowments \( L \), the unit labor requirements \( l \), as well as the total stock and distribution of knowledge capital \( H \), which would result with different levels of IPR protection in autarky.

Consistent with how the real world works, we assume equal national treatment of patent applicants: A country affords the same patent protection to all patented goods sold within its borders regardless of their national origin. If there are no costs to patenting, firms will always apply for a patent to sell in both countries irrelevant of where the good was produced, so the value of all patents will be given similarly as in (7):

\[
v = \pi(M_E \Omega_E + M_U \Omega_U)
\]

As long as the homogeneous good is produced in both countries, the costs of production will be the same: \( l_U w_U = l_E w_E = 1 \), so location of production is irrelevant as well. It will be possible for firms to separate the innovation process from the production process and outsource production abroad (so trade costs won’t play a role).

The lobbying process is conducted in two phases as before. In the first phase, all firms set their contribution schedules simultaneously. In the second
phase, each government simultaneously decides the optimal $\Omega_U$ or $\Omega_E$ taking the other as given. Following Grossman, Helpman (1997), I assume that firms can only lobby their own domestic government for policies and that they don’t know the contribution schedule of the lobbies abroad. Therefore, they will be able to condition their strategies only on the policy outcome in the other country. Similarly, assume that the domestic government doesn’t know the foreign contribution schedules and vice-versa, therefore lobbies don’t set their contribution schedules strategically with respect to the foreign government’s decision. With these assumptions in place, we can define the Nash equilibrium for the non-cooperative two countries scenario as follows:

**Definition 1:** A Nash Equilibrium consists of two sets of contribution schedules $\{C^*_{U,i}(\Omega_U, \Omega_E)\}_i$ and $\{C^*_{E,i}(\Omega_E, \Omega_U)\}_i$, and a policy vector $[\Omega^*_U, \Omega^*_E]$ such that for each $J \in \{U, E\}$:

1. $\Omega^*_J$ maximizes the objective function $\sum_{i \in L_J} C^*_{J,i}(\Omega_U, \Omega_E) + a_J W_J(\Omega_U, \Omega_E)$, taking the other country’s $\Omega^*_{-J}$ as given.
2. For every lobby $i$ there is no other feasible alternative function $C^A_{J,i}$ and policy $\Omega^A_J$ that would give the lobby a strictly higher welfare, whereby $\Omega^A_J$ is the optimal response by government $J$, taking the other country’s $\Omega^*_{-J}$ as given.

Like for the case of the closed economy, the Bornheim-Whinston theorem applies and yields the first-order condition:

$$\sum_{i \in L_J} \frac{\partial W_{J,i}(\Omega_U, \Omega_E)}{\partial \Omega_J} + a_J \frac{\partial W_J(\Omega_U, \Omega_E)}{\partial \Omega_J} = 0 \quad (19)$$

Proceeding as before (counting goods, discounting, substituting partial derivatives and rearranging), we get expressions for the best response functions:

$$CS_c - CS_m - \pi \mu_J \frac{\zeta_j + a_J}{\alpha_J + a_J} = \gamma(\Omega_U, \Omega_E) \frac{M_J \Omega_J}{M_U \Omega_U + M_E \Omega_E} \left( CS_m + CS_c \frac{T - \Omega_J}{\Omega_J} \right) \quad (20)$$

Here, $\gamma$ is the same for both countries (because the R&D functions have identical CES specification), whereas I define $\mu_J$ as the share of innovation taking place in country $J$, which can be shown equals the share of knowledge capital that is found there: $\mu_J \equiv \frac{\phi J}{\phi S + \phi N} = \frac{H_J}{H_S + H_N}$. We also define $\nu_J$ as the market weighted share of IPR protection in country $J$: $\frac{M_J \Omega_J}{M_U \Omega_U + M_E \Omega_E}$.

Comparing (14) and (20), it can be concluded that ceteris paribus countries lower their IPR protection levels after opening up to trade, conditional
on maintaining the same set of lobbyists\textsuperscript{23}. Just as Grossman and Lai (2004) show, liberalization worsens IPR protection because countries benefit from each other’s R&D, so they have incentive to free ride and invest less in domestic innovation. But the presence of lobbying mitigates this incentive through two channels. First, the existence of the lobbying term \( \frac{\zeta J + a J}{\alpha J + a J} \equiv \theta_J \) causes higher levels of patent protection in that country compared to no lobbying, holding foreign patent policy constant. And second, opening up may intensify lobbying further, because firms that didn’t lobby under autarky because the fixed costs were too high may now find it profitable to do so because the value of their patents will have increased by being able to sell in both markets.

The Nash equilibrium will also be affected by lobbying. Limiting the analysis to the linear case when the innovation functions are Cobb-Douglas (\( \beta = 0 \)), we get explicit linear expressions for the best response functions given in (20)\textsuperscript{24}. The linear best response functions will be decreasing in the other player’s policy as long as the IPR protection policy doesn’t exceed the lifetime of the product \( \Omega < \bar{T} \), so the levels of protection in each country are strategic substitutes. The Nash equilibrium in this case is given by their intersecting point. As discussed, an increase in the lobbying term \( \theta_J \) (the presence of lobbying) would push the best response function of country \( J \) outward, thus leading to a new Nash equilibrium whereby the IPR protection in country \( J \) increases, but it decreases in the trading partner. Intuitively, foreigners free-ride on domestic lobbying efforts to strengthen patent protection.

If both \( \theta_E \) and \( \theta_U \) increase (evaluate the effect of lobbies in both countries simultaneously), we can derive a sufficient condition for the direction of

\textsuperscript{23}This effect can be immediately seen by noticing that in equilibrium the right-hand side of (20) which is decreasing in \( \Omega_J \) is further decreased by \( \nu_J \) compared to (14), whereas the left-hand side constant is shifted up by \( \mu_J \).

\textsuperscript{24}The explicit best response function for the US is:

\[
\Omega_U = \frac{\gamma C^S_c T}{(1 + \gamma)(C^S_c - C^S_m)} - \theta_U \pi \mu_U \frac{M_E}{M_U} \left( \frac{-(C^S_c - C^S_m - \pi \theta U \mu_U) M_E}{(1 + \gamma)(C^S_c - C^S_m) - \pi \theta U \mu_U} \frac{M_E}{M_U} \right)
\]

For the EU:

\[
\Omega_U = \frac{\gamma C^S_c T}{(C^S_c - C^S_m)} - \theta_E \pi \mu_E \frac{M_E}{M_U} + \Omega_E \frac{M_E}{M_U} \left( \frac{-(C^S_c - C^S_m)(1 + \gamma) - \pi \theta_E \mu_E) M_E}{(C^S_c - C^S_m) - \pi \theta_E \mu_E} \frac{M_E}{M_U} \right)
\]
change of NE policies. The joint effect of lobbying under no cooperation is represented graphically in Figure 2.

**Proposition 2:** For the Cobb-Douglas case, if $\Delta \theta_U \mu_U / M_U > \Delta \theta_E \mu_E / M_E$, then $\Omega^*_U$ must increase. If the opposite is true, then $\Omega^*_E$ must increase\(^{25}\).

Another sufficient condition, analogous to the one Grossman and Lai derive, can be used to explain differing levels of IPR protection.

**Proposition 3:** If $M_U > M_E$ and $\mu_U \theta_U > \mu_E \theta_E$, then $\Omega^*_U > \Omega^*_E$.\(^{26}\)

So knowledge capital stock and market size of sophisticated consumers determine which country will get a higher level of IPR protection in equilibrium, but the political system can magnify these asymmetries. The US may have higher level of protection (also) because US government is more susceptible to lobbying (low $a_U$), or because US society is highly unequal so US patent holders constitute a low percent of sophisticated consumers (low $a_U$),

\(^{25}\)The proof of Proposition 2 can be found in Appendix A2.

\(^{26}\)The proof of this proposition is the same as in Grossman, Lai (2004), just replacing $\mu_J \theta_J$ for $\mu_J$. 

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or because capital is more concentrated so higher share of firms participate in lobbying (high $\zeta_U$).

Grossman and Lai (2004) show that the Nash equilibrium level of IPR protection in the world is always sub-optimal from a global social planner’s perspective. With lobbying that doesn’t have to be the case, because lobbies push the NE in the direction of the efficient frontier, which consists of all linear combinations that maximize global welfare $[\Omega_E, \Omega_U]$ s.t. $M_E\Omega_E + M_U\Omega_U = \Omega_{eff} \equiv \text{argmax}\{W_E(\Omega) + W_U(\Omega)\}$. Solving this optimization problem as before yields an expression for the efficient world level of IPR protection $\Omega_{eff}$:

$$CS_c - CS_m - \pi = \gamma(\Omega_{eff}) \left( CS_m + CS_c \frac{MT - \Omega_{eff}}{\Omega_{eff}} \right)$$  \hspace{1cm} (23)

Whether the NE will be above or below the efficient global level of IPR protection will depend in general on the number of countries and active lobbies. If we restrict the choice of parameters to Nash equilibria that are interior solutions, i.e. all governments impose at least some IPR protection in the non-cooperative case, then:

**Proposition 4:** The NE world level of protection $\Omega_{NE} \equiv \sum M_j\Omega_j^*$ will be above the efficient level $\Omega_{eff}$ iff $\pi(\bar{\theta} - 1) > (CS_c - CS_m)(J - 1)$, where $\bar{\theta} \equiv \sum \theta_j\mu_j$ is the R&D-weighted average lobbying constant and J is the number of countries.

**Proof:** We sum up the first-order conditions (20) for all J countries to get:

$$J(CS_c - CS_m) - \pi \bar{\theta} = \gamma(\Omega_{NE}) \left( CS_m + CS_c \frac{MT - \Omega_{NE}}{\Omega_{NE}} \right)$$ \hspace{1cm} (24)

Comparing the expression for $\Omega_{NE}$ with the expression for $\Omega_{eff}$ from (23), notice that the right-hand sides are identical. So $\Omega_{NE} > \Omega_{eff}$ is true iff $\pi(\bar{\theta} - 1) > (CS_c - CS_m)(J - 1)$, or equivalently iff $\bar{\theta} > J + (J + 1)DWL/\pi$.

QED

The more countries there are, the higher the externality due to free-riding, so the less likely it is for $\Omega_{NE}$ to overshoot the efficient level. The term $DWL/\pi$ captures the extent to which society loses from IPR protection relative to the gain that patent holders get. If lobbying is strong enough and the loss to society small enough such that governments are susceptible to lobbying, then there will be over-protection of IPR at the global level. Then
lobbying will not only compensate for the free-riding externality that countries impose on each other in a non-cooperative environment, but it will in fact overshoot the world efficient level, so a Pareto-efficient agreement about IPR would have to lower global IPR protection and counter the influence of lobbies.

2.4. Global regime: cooperative IPR agreements

In this section I apply the model to the case of cooperative agreements between 2 countries regarding IPR protection. Cooperative agreements involve binding agreements whereby parties are allowed to compensate each other with transfer payments conditional on implementing the agreed policies. In the context of the IPR lobbying model discussed, the parties are the politicians in each country that are maximizing their objective functions which consist of the weighted social welfare, the contributions from the domestic lobbies and the transfer payment received from the trading partner. Therefore, a cooperative agreement will not yield an efficient outcome whereby world social welfare is maximized, but rather a politically efficient outcome, which is defined as follows.

**Definition 2:** A politically efficient (PE) bargaining outcome is:

\[
[\Omega_U, \Omega_E]_{PE} = \text{argmax} \Gamma \equiv a_UG_E(\Omega_U, \Omega_E) + a_EG_U(\Omega_U, \Omega_E)
\]  

(25)

where \(G_J \equiv \sum_{i \in L_J} C_i + a_J(W_J + R)\) for \(J \in \{U, E\}\).\(^{28}\)

We assume initially that firm owners constitute a negligent percent of sophisticated consumers, so \(\alpha_E = \alpha_U = 0\). This will simplify the analytics of finding the equilibrium bargaining outcome, because it implies that the lobbying contribution strategies do not have to be conditioned on transfers \(R\) (since society’s welfare which includes \(R\) will not enter the firm’s objective function). Later we can relax this assumption once we have shown that any

\(^{27}\)The compensatory payments do not have to be monetary in nature and can generally include concessions in any zero-sum policy area of interest to the signatory parties. For example, Lai and Qiu (2003) model this compensation in terms of market access for developing countries that export less research-intensive goods.

\(^{28}\)The reason (proof) for why definition 2 conforms with the concept of a cooperative agreement in an international setting as defined in the preceding paragraph is elaborated in Appendix 3. The proof basically shows that if the agreed upon policy vector doesn’t maximize \(\Gamma\), we can construct transfer payment \(R\) such that politicians in both countries gain by switching to \(\text{argmax} \Gamma\).
transfer payment can be replicated by choosing the appropriate vector of policies, holding \( \Gamma \) constant. Proceeding from definition 2, we introduce the definition for cooperative agreements on IPR:

**Definition 3:** An equilibrium IPR agreement is a set of contribution schedules \( \{ C_{U,i}^*(\Omega_U, \Omega_E) \}_{i} \) and \( \{ C_{E,i}^*(\Omega_E, \Omega_U) \}_{i} \), and a policy vector \( [\Omega_E^*, \Omega_U^*] \) such that for each country \( J \in \{ E, U \} \):

1. \( [\Omega_E^*, \Omega_U^*] \) maximizes \( \Gamma^* \), constructed using the sets of equilibrium contributions
2. For every lobby \( i \) there is no other feasible alternative function \( C_{J,i}^A \) and policy vector \( [\Omega_E^A, \Omega_U^A] \) that would give the lobby a strictly higher welfare, whereby \( [\Omega_E^A, \Omega_U^A] \) maximizes \( \Gamma_i^A \), constructed using \( C_{J,i}^A \) for the contribution of lobby \( i \) and equilibrium contributions (marked by \( * \)) for all other firm lobbies.

Comparing this definition with the benchmark scenario of a closed economy, we can see that the politically efficient bargaining outcome is analogous to the case of a single world government that decides on a two-dimensional policy vector by maximizing its objective function \( \Gamma \), which consists of appropriately weighted social welfares and contributions from all firm lobbies. Therefore, the approach to solving this problem is analogous to the approach of finding optimal policy in a closed economy discussed in the previous section, only taking into account the different weighting factors. Thus, assuming differentiability around the optimum and taking all steps as before, we write the first-order condition for the maximization problem in vector form\(^{29}\):

\[
a_U \sum_{i \in L_E} \nabla W_{E,i} + a_E \sum_{i \in L_U} \nabla W_{U,i} + a_U a_E (\nabla W_E + \nabla W_U) = 0 \quad (26)
\]

Substituting the derivative expressions as before and rearranging, we get the two first-order conditions for the optimal policy vector, which are identical due to the symmetry inherent in the objective function \( \Gamma \):

\[
CS_c - CS_m - \frac{\pi}{\gamma} \left( 1 + \frac{\mu_U \xi_U}{a_U} + \frac{\mu_E \xi_E}{a_E} \right) = \gamma(\Omega_U, \Omega_E) \left( CS_m + CS_c \frac{MT - (M_U \Omega_U + M_E \Omega_E)}{M_U \Omega_U + M_E \Omega_E} \right) \quad (27)
\]

\(^{29}\)The vector operator \( \nabla \) denotes the vector of partial derivatives of the function to which it is applied with respect to its arguments, in this case the decision variables \( \Omega_U \) and \( \Omega_E \).
We can conclude that this optimization problem doesn’t have a unique solution, however the optimal market size-weighted world level of IPR protection \( M_N \Omega_N + M_S \Omega_S \equiv \Omega \) is uniquely determined, because \( \gamma \) depends on the policies only through the value of the patent \( v = \pi \Omega \). We call this optimum the politically efficient world level of IPR protection \( \Omega_{PE} \). All linear combinations of policies which satisfy the solution of (26) are possible outcomes of an equilibrium agreement. Notice that if we vary \( \Omega_N \) and \( \Omega_S \) while keeping \( M_U \Omega_U + M_E \Omega_E = \Omega_{PE} \), lobbies’ payoffs will not be affected, but the individual countries’ social welfare obviously are, one at the expense of the other. This transfer of welfare mimics the payment transfers \( R \) that the governments exchange. Thus allowing transfer payments or not is irrelevant for the solution of the optimization problem. Adjusting innovation policies to the benefit of one country can substitute the monetary transfers with which the country is compensated by its trading partner in order to implement a politically efficient world level of IPR protection.

Comparing the politically efficient global level of IPR protection given by (27) with the socially efficient one given by (23), it is obvious that \( \Omega_{PE} > \Omega_{eff} \) due to the additional term \( 1 + \mu_U \zeta_U a_U + \mu_E \zeta_E a_E \) in the left-hand side in (27). In other words:

**Proposition 5:** International agreements on IPR protection in the presence of lobbying will always be inefficient (supra-optimal).

This conclusion about the effect of lobbying is different from the case of free trade agreements described by Grossman and Helpman (1997), where the politically efficient outcome of trade negotiations can neutralize the inefficiencies that each separate lobby causes, because their interests are opposed to one another, which renders trade agreements always preferable to no cooperation. Rather than neutralizing each others influence, in this model lobbies complement each other, because their interests are perfectly aligned. This allows for the possibility that a world with no cooperation on IPR may be better off (yielding higher global welfare) than one governed by IPR agreements.

Assume for simplicity that the R&D function is Cobb-Douglas \((\beta = 0)\), there are no lobbying costs \( (\zeta = 1) \) and denote the ratios \( \pi/(CS_c - CS_m) \) as \( p \in (0, 1) \) and \( (CS_c - CS_m)/CS_c \) as \( c \in (0, 1) \). Consider the case of \( J \) countries and restrict consideration to interior solutions for now\(^{30}\).

\(^{30}\)Interior solutions are \( \Omega_{PE} \in (0, M\bar{T}) \) and \( \Omega^N_j \in (0, \bar{T}) \) for \( \forall J \). This means that
Proposition 6: World welfare is higher under no cooperation than under IPR agreement, i.e. \( W(\Omega_{NE}) > W(\Omega_{PE}) \) if and only if the following holds:

\[
\left( 1 + \frac{J - 1}{1 - \bar{b} - p\bar{\theta}} \right)^{\frac{1}{1 - \bar{b}}} < 1 + \frac{J - 1}{1 - p\bar{\theta} + bp} \tag{28}
\]

This condition delimits a range of values for \( \bar{\theta} > \bar{\theta}_{min} \) for which Proposition 6 holds when the lobbyists’ influence is high enough.\(^{31}\) A smaller number of countries \( J \) (irrespective of the distribution of sophisticated consumers among them) or a smaller dead-weight loss relative to \((CS_c - CS_m)\) imply a smaller externality due to free-riding if not cooperating, so the more likely it is that the world economy is better off under no cooperation (lower \( \bar{\theta}_{min} \)). Similar inequalities hold in the case of corner solutions, some of which are derived in Appendix A5.

From (27), the ratio that determines the magnitude of the inefficiencies inherent in international IPR agreements is \( \frac{\mu J}{\xi J a_J} \). As expected, lower weights on social welfare by governments cause higher distortions, which are magnified by the share of innovation taking place in that country. Thus distribution of knowledge capital among countries matters, as does the distribution of knowledge capital among firms within countries, because it determines which firms will decide to lobby. Distortions will be the lowest if knowledge capital is more concentrated in countries whose governments are less susceptible to lobbying (higher \( a_J \)) and less concentrated within the countries themselves (lower \( \xi_J \)).

International agreements governing IPR protections most always require that countries signatories implement identical regulation, i.e. they strive to implement harmonized patent regimes at least on paper, because internal enforcement (proxied in the model by \( \omega \)) cannot be effectively enforced at the international level. However it is worth noting that, just as Grossman and Lai (2004) show for the benchmark case with no lobbies, harmonization is neither sufficient nor necessary condition for efficiency. In fact, the harmonized politically efficient level of IPR protection, which would be the no country wants to offer 0 IPR protection in the non-cooperative case, which typically holds in North-North environments when countries have similar research capacities. The parameter restrictions implied by this assumption are given by (A.7), (A.8) and (A.9).

\(^{31}\)The proof for this proposition can be found in Appendix A4
expected outcome of international negotiations in the presence of lobbying, will always be globally inefficient.

2.5. Extension: International lobbying

One of the assumptions of the model was that firms are only allowed to lobby with their respective domestic government. In reality, multinational firms are allowed to lobby foreign governments via their foreign subsidiaries, or even directly, subject to more stringent disclosure requirements (Foreign Agents Registration Act, 1938). Moreover, there has been a resurgence of international business associations, such as the Transatlantic Business Council, that lobby on agreements such as TPP and TTIP. We can extend this model in the simplest case scenario to analyze the effect of international lobbying in the cooperative case by allowing for foreign lobbying contributions and assuming equal fixed costs of lobbying across countries $f$. In this case, firms would decide to put all their lobbying effort in the country with the lower $a_f$, because it would result in maximum impact on $\Gamma$, the objective function of the hypothetical world government they are trying to influence. Solving the optimization problem with this new weight, gives the first-order condition for the world level of protection with international lobbying:

$$CS_c - CS_m - \pi \left(1 + \frac{\mu_E \zeta + \mu_U \zeta_U}{a_{\min}}\right) = \gamma(\Omega_U, \Omega_E) \left(CS_m + CS_c \frac{MT - (M_U \Omega_U + M_E \Omega_E)}{M_U \Omega_U + M_E \Omega_E}\right)$$

By comparing the left-hand sides of (27) and (29), it is obvious that by allocating their lobbying expenditures most efficiently, international lobbies cause cooperative agreements to result in even stronger over-protection of IPR, i.e. even more globally inefficient $\Omega_{PE}$.

The extent of international lobbying can also be determined by the extent to which firms establish multinational subsidiaries. Suppose there were trade costs per unit of good exported and a certain fixed cost of establishing offshore production operations in order to reach foreign destination markets. In this case, only the largest firms above a certain capital cutoff would have large enough trade volumes, so as to be profitable for them to offshore production and become multinationals. Further suppose that the fixed cost of lobbying the foreign government directly is prohibitively high, which can be justified by the higher regulatory and informational costs of hiring foreign lobbyists. However, if the multinational firms lobbies through its foreign subsidiary it would pay a lower fixed lobbying cost, just as the other foreign
firms. Then large multinational firms will be able to participate in foreign lobbying and thus they will lobby the government that is more susceptible to lobbying influence (lower $a_J$), while non-multinationals will only lobby their domestic government. It is easy to see that this setup will allow for trade agreements that are intermediate cases between the cooperative regime under no international lobbying, whose IPR outcome is given by (27), and the other extreme when all firms are allowed to lobby internationally given by (29). So the degree of global economic integration and proliferation of multinationals can strengthen the lobbyists' influence across borders, which renders IPR agreements even more inefficient. Notice that this reconfiguration of lobbying interests across borders can be a sufficient reason for a new strictly welfare-reducing IPR agreement to be signed among countries that have already signed an IPR agreement that eliminates the free-riding externalities that persist under no cooperation.

2.6. Extension: Patenting costs

So far we assumed that patents are automatically granted at no cost in all countries for all inventions, which caused the value of the patent to be independent of the firm which produced it. In order to make the model more realistic and more applicable for empirical testing, we consider an extension where firms pay fixed costs of patenting every period, very much like the annual renewal costs that firms pay in reality. The costs could be firm-country specific in general, depending on the firm's history of business and legal operations in the particular country.\(^{32}\) For simplicity, we focus on the Cobb-Douglas case ($\beta = 0$) and we'll assume two types of firms: a set of firms D that face prohibitive costs of patenting abroad and therefore choose only to patent the invention in the domestic market, and a set of firms X that also choose to patent and export the good abroad where they face no patenting costs. The share of X-firms in economy J in terms of knowledge capital is given by $\eta_J$, so the share of D-firms is $1 - \eta_J$. It follows that D-firms and X-firms will hold patents with different values $v_D = \pi M_J \Omega_J$ and $v_X = \pi (M_U \Omega_U + M_E \Omega_E)$ respectively. Because exporters have more valuable

\(^{32}\)Alternatively, we can motivate this variation in patenting decisions more realistically by assuming that the patenting costs are the same for all firms, however the product varieties that the firms invent are "bundled" into goods that then get sold to market, provided that the profits from that "bundled" good are worth its patenting costs in a particular country.
patents, the marginal product of labor employed in R&D is higher, so they will choose to employ more labor and consequently produce more patents $\phi_i$.

It can be shown that firms with international patent portfolios (X-type) will contribute more in the cooperative equilibrium than D-type firms with identical knowledge capital stock because they have a higher potential return on each dollar spent lobbying. More formally:

**Proposition 7:** Assume two identical firms with knowledge capital $H_i$ and $\alpha_i = 0$, of which one has prohibitive patenting costs abroad (D-type) and the other has 0 patenting costs abroad (X-type firm). Further assume that their CES research output function is Cobb-Douglas: $\beta = 0$. Then in the equilibrium of lobbying for IPR agreements, their contributions satisfy $C_X > C_D$.\(^{33}\)

This prediction is consistent with firm-level lobbying data, namely that lobbying expenditures for TPP and TTIP increased with the value of the firm’s international patent portfolio in the relevant jurisdictions, conditional on firm total sales. The details about the data collection and analysis can be found in Appendix B1 and Appendix B2.

2.7. Extension: Cournot competition and North-South agreements

The setup so far assumed that in each innovation-driven economy profit-making firms lobby for more IPR protection, whereas goods are produced competitively (or imported from abroad) at zero profit whenever the patent is not enforced. This framework is most appropriate for analyzing North-North type of IPR agreements. To analyze North-South type of agreements, whereby the Southern economy is based on imitating patented products, we consider a version of the model with identical setup, except that rather than perfect competition, sophisticated goods are produced costlessly under Cournot competition by identical imitator firms whenever the patent is not enforced. The number of firms $N$ allowed to imitate will be given exogenously given for each country. Each imitator firm will be able to imitate all goods (including foreign) whose patent is not being enforced in the current period\(^{34}\). In general each country could have an innovation and imitation sector\(^{35}\), but the South, naturally, will contain more imitator firms than the North, whereas the North will dominate the South in terms of knowledge

\(^{33}\)The proof is given in Appendix 6.

\(^{34}\)This assumption of unlimited capacity for imitation will be key for the influence of imitators on the equilibrium outcome relative to innovators.
capital stock. A Cournot competitive regime generates positive profit for the imitators, which gives them a stake in the IPR outcomes and a motivation to engage in lobbying, but with interests opposed to those of the innovator firms.

Given product demand (3) and the number of imitators \( N \), we can solve for the Cournot regime (indexed by \( C \)): imitator firms will earn a joint profit of 
\[
\pi_C = x_C (p_C - 1) \quad \text{per good and individual consumer surplus}
\]
\[
CS_C = h(x_C) - x_C, \quad \text{where} \quad x_C \quad \text{is the individual consumption under Cournot competition pinned down by} \quad x_C = \frac{N(1 - h'(x_C))}{h''(x_C)}.
\]

Counting the non-enforced yet-to-be-invented goods and discounting across time, we can write the discounted welfare at time \( t=0 \) of a given imitator firm whose owners constitute a negligible share of sophisticated consumers as:
\[
\tilde{W}_i(\Omega, 0) = \frac{\pi_C M (T - \Omega) \phi(\Omega)}{N \rho} + \hat{\Lambda}_i^0
\]

(30)

For simplicity, assume that the fixed lobbying cost \( f=0 \), so that all firms, both innovators and imitators, lobby in equilibrium. Solving the same as before for the closed economy case, we get an expression for the resulting level of IPR protection \( \Omega \):
\[
CS_C - CS_m - (\pi_m - \pi_C)\theta = \gamma(\Omega) \left( CS_m + (CS_C + \pi_C \theta) \frac{T - \Omega}{\Omega} \right)
\]

(31)

As before, lobbying in a closed economy will unambiguously result in supra-optimal level of IPR protection, because the lobbying term \( \theta = \frac{1 + a}{a} > 1 \) will decrease the left-hand side of (31) and will increase its right-hand side.

In the global cooperative regime, the politically efficient level of world IPR protection \( \Omega_{PE} \) can be calculated following the same procedure as earlier to get:
\[
CS_C - CS_m - (\pi_m \bar{\theta} - \pi_C \tilde{\theta}) = \gamma \left( CS_m + (CS_C + \pi_C \tilde{\theta}) \frac{T M - \Omega_{PE}}{\Omega_{PE}} \right)
\]

(32)

Here, \( \bar{\theta} \) is the capital-weighted average of the lobbying terms, whereas \( \tilde{\theta} \equiv \sum J \frac{N_j}{N} \theta_j \) is the lobbying average weighted by the number of imitator firms.

---

\(^{35}\) Without loss of generality, we could even assume some overlap between the innovation and the imitation sector, i.e. some firms would be able to both innovate and imitate, but for simplicity, for now assume the sectors are separate.

\(^{36}\) This assumption is not consequential for the results, but simplifies the algebra.
in each country. If imitator firms are concentrated in countries that are very susceptible to lobbying (high $\theta_J$), whereas knowledge capital is concentrated in countries with low $\theta_J$, then it could happen in principle that the political influence of imitators dominates over the influence of innovators to such a large extent that $\Omega_{PE}$ overshoots the efficient level. Nevertheless, we can specify a sufficient condition for which IPR agreements will be globally inefficient resulting in too much protection.

**Proposition 8:** If $\pi_m(\bar{\theta} - 1) > (\bar{\theta} - 1)\pi_C$ holds\(^{37}\), then $\Omega_{PE} > \Omega_{eff}$.\(^{38}\)

An analogous version of Proposition 6 will hold for North-South agreements as well.\(^{39}\) As before, assume for simplicity that the R&D function is Cobb-Douglas ($\beta = 0$), there are no lobbying costs ($\zeta = 1$), $\alpha_L = 0$ and denote the ratios $\pi_m/(CSC - CMS) \equiv p_m$, $\pi_C/(CSC - CMS) \equiv p_c$ and $(CSC - CMS)/CSC \equiv c \in (0, 1)$. For the case of interior solutions:

**Proposition 9:** World welfare is higher under no cooperation than under IPR agreement, i.e. $W(\Omega_{NE}) > W(\Omega_{PE})$ if and only if the following parameter restriction holds:

$$\left(1 + \frac{J - 1}{\frac{1 + p_c \bar{\theta}}{1 - b} - p_m \bar{\theta}}\right)^{\frac{1}{1-b}} < 1 + \frac{J - 1}{\frac{1 + p_c \bar{\theta}}{1 - b} - \frac{b(1 + p_c - (1-b)p_m)(1 + p_c \bar{\theta})}{(1-b)(1+p_c)}}$$

(33)

Due to the complicated nature of this expression, not much can be learned it, however it guarantees the fact that there exists a parameter range for which no cooperation is preferable to an agreement on IPR. To summarize, even for North-South models in which imitators earn profits and can lobby for less IPR protection, modified versions of the welfare implications still hold: IPR agreements will be inefficient provided that the asymmetry in institutions and endowments is not larger than the asymmetry in profits (expressed through the sufficient condition in Preposition 7) and IPR agreements will not be Pareto-improving provided that the conditions in Preposition 8 are true.

\(^{37}\)For the most extreme case of two completely specialized countries, an innovating North (N) and an imitating South (S), the sufficient condition becomes $\pi_m a_N > \pi_C a_S$. Also note that the ratio $\frac{\pi_m}{\pi_C}$ is the patent premium under maximum IPR protection $\Omega = \bar{T}$.

\(^{38}\)This can be easily seen by comparing the social planner’s IPR level (given by setting $\theta \rightarrow 1$ in (31)) and the politically efficient IPR level in (32). The sufficient condition ensures that the left-hand side of (32) is smaller, which guarantees that $\Omega_{PE} > \Omega_{eff}$.

\(^{39}\)The proof for Proposition 9 is analogous to the proof for Proposition 6.
3. Conclusion

This paper is the first in the literature to develop a highly tractable general equilibrium model in order to analyze the effect of lobbying for IPR protection during international negotiations for IPR-related trade agreements. The analysis showed that these agreements have different welfare implications than traditional trade agreements regulating tariffs. While trade agreements about tariffs can sometimes be inefficient but are always desirable because they make the world better off than no cooperation, by contrast, IPR agreements among innovating economies are always inefficient and can sometimes make the world worse off than if there was no agreement at all in place. I also showed that under the realistic assumption of fixed lobbying costs, high capital concentration increases the inefficiency of IPR agreements, as does international lobbying.

These are not merely theoretical assumptions of the model, but rather salient features of the global trade order. Given the dominant influence of corporate lobbying during the trade negotiations for TPP and TTIP, as well as the widely recognized increase in capital concentration on a global scale, policymakers and academics have a good reason to be increasingly skeptical about the benefits of IPR agreements from pure efficiency considerations. At the very least, it is necessary to differentiate conceptually between trade agreements on tariffs and IPR trade agreements and stop using the standard anti-protectionist argumentation to push for international cooperation in this area, because as we saw it is not always Pareto-improving relative to no cooperation.

Even though it is difficult to observe in reality the exact conditions under which IPR agreements reduce global efficiency, the analysis shows that it is more likely to happen if there are fewer countries involved or if the deadweight loss is small relative to the loss in consumer surplus, which is more consistent with goods with highly inelastic demands. The TTIP seems to fit this description well, since it involves only two parties, the USA and the EU, and it targets largely pharmaceutical products with highly inelastic demands, judging by the industries’ lobbying efforts. As for the political factors, the more susceptible governments are to lobbying, the more firms establish an international presence and the more concentrated firm ownership becomes, the more likely it is that countries might be better off without an agreement on IPR. It is worthy to note that all these institutional factors have been on the rise globally in recent years.
If policymakers insist on the efficiency gains from implementing IPR agreements, they should either reverse these political trends or completely insulate trade negotiations from lobbyist influence. If they fail to do so, then the public might be right to view these agreements with a healthy dose of skepticism, and this assessment holds without even considering the other types of inefficiencies associated with the patent system and the distributional impact of strengthening IPR through cooperation, which would evidently benefit R&D-oriented corporations at the expense of consumers without a proper compensation scheme.

To properly analyze the distributional effects of IPR agreements a more sophisticated model is needed that would explicitly model consumers’ income and therefore purchasing power. Another avenue for future research on the topic are empirical tests. Even though it is difficult to devise a direct test of the theory, researchers could try to measure the welfare effect of TPP and TRIPS, after a sufficient time from their implementation has passed. If a negative effect on consumer welfare is found, this model would provide a convincing explanation.

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40See Baker (2005) for an overview.
References


Appendix A. Proofs

Appendix A.1. Monotonicity of $d_i$

**Proof:** We want to show that if $H_1 > H_2$ then $d_1 > d_2$. Substituting the expression (16) for $B_i$ in the definition of $d_i = B_i - W_i(\Omega_{-i}) > 0$ we get:

$$d_i = a\Delta W(\Omega_o; \Omega_{-i}) + \sum_{i \in L} \Delta W_i(\Omega_o; \Omega_{-i})$$  \hspace{1cm} (A.1)

where the notation $\Delta W(\Omega_o; \Omega_{-i}) = W(\Omega_o) - W(\Omega_{-i})$ is used. Take two firms that differ only marginally in the knowledge capital stock, so $H_1 = H_2 + dH$
for a an infinitesimally small positive \(dH\). Because the solution to (14) is continuous and positively correlated with \(\zeta\), it follows that \(\Omega_{-2} = \Omega_{-1} + d\Omega\). Using expression (A.1), we can write the difference \(d_1 - d_2\) as:

\[
d_1 - d_2 = a\Delta W(\Omega_{-2}; \Omega_{-1}) + \sum_{i \in L} \Delta W_i(\Omega_{-2}; \Omega_{-1})
\] (A.2)

Dividing this expression by \(d\Omega\) yields an equation in terms of the first-order differentials evaluated at \(\Omega_{-1}\):

\[
\frac{d_1 - d_2}{d\Omega} = aW'(\Omega_{-1}) + \sum_{i \in L} W_i'(\Omega_{-1}) > 0
\]

This expression is exactly the same as the first-order condition (13), but is evaluated at \(\Omega_{-1} < \Omega_o\) (below the global maximum), therefore it must be positive. Thus, \(d_1 - d_2\) must be positive as well.

**Appendix A.2. Proof of Proposition 1**

If \(\Delta \theta_U \mu_U / M_U > \Delta \theta_E \mu_E / M_E\) then \(\Omega_U^*\) must increase. If the opposite it true, then \(\Omega_E^*\) must increase.

**Proof:** Using the linear best response functions (21) and (22), we calculate the Nash equilibrium to be:

\[
\Omega_U^* = CS_c T \gamma \left( (CS_c - CS_m)(1 + \gamma - \frac{M_E}{M_U}) + \pi(\theta_U \mu_U \frac{M_E}{M_U} - \mu_E \theta_E) \right) (A.4)
\]

\[
\Omega_E^* = CS_c T \gamma \left( (CS_c - CS_m)(1 + \gamma - \frac{M_U}{M_E}) + \pi(\mu_E \theta_E \frac{M_U}{M_E} - \theta_U \mu_U) \right) (A.5)
\]

If both lobbying terms \(\theta_U\) and \(\theta_E\) increase due to the formation/strengthening of lobbying, then \(\bar{\theta}\) must increase as well, so the denominator in both countries will decrease. If \(\Delta \theta_U \mu_U / M_U > \Delta \theta_E \mu_E / M_E\) holds, then the numerator in (A.4) will increase, so \(\Omega_U^*\) will unambiguously increase as well. Whereas if the opposite inequality is true, the numerator in (A.5) will increase, resulting in an unambiguous increase in \(\Omega_E^*\).

**Appendix A.3. Motivation for Definition 2**

A politically efficient (PE) bargaining outcome is:

\[
[\Omega_U, \Omega_E]_{PE} = \text{argmax } \Gamma \equiv a_U G_E(\Omega_U, \Omega_E) + a_E G_U(\Omega_U, \Omega_E)
\]

(A.6)
where $G_J \equiv \sum_{i \in L_J} C_i + a_J(W_J + R)$ for $J \in \{U, E\}$.

**Proof by contradiction:** We aim to show that the politically efficient bargaining outcome with transfers maximizes the objective function $\Gamma$. Suppose that it doesn’t, i.e. there exists another vector $[\Omega_U, \Omega_E]^A$ that maximizes $\Gamma$. This discrepancy can be decomposed as $\Delta \Gamma = a_U \Delta G_E + a_E \Delta G_U > 0$. If both terms are positive, then both governments would gain from agreeing to implement $[\Omega_U, \Omega_E]^A$ and no transfers are needed. If one term is negative the other must be positive, so the government that would gain from switching to $[\Omega_U, \Omega_E]^A$ (for example, the USA) is able to construct a transfer payment $R$ just below $\frac{\Delta G_U}{a_U}$ (which is marginally smaller than the US net gain) in order to compensate the EU. So the EU government objective function increases by $a_E R \rightarrow a_E \frac{\Delta G_U}{a_U}$, which will outweigh the loss experienced due to a different policy regime $\Delta G_E > -\frac{a_E \Delta G_U}{a_U}$. So we can construct a transfer payment, such that both governments (politicians) would gain from switching to $[\Omega_U, \Omega_E]^A$, therefore an agreement that doesn’t maximize $\Gamma$ cannot be a politically efficient bargaining outcome.

**Appendix A.4. Proof of Proposition 6**

Assume $\beta = 0$, $f = 0$ and define $p \equiv \pi/(CS_c - CS_m)$ and $c \equiv (CS_c - CS_m)/CS_c$. Consider only interior solutions for $\Omega_{PE} \in (0, MT)$ and $\Omega_{JNE} \in (0, \bar{T})$ for all $J$. Then:

$W(\Omega_{NE}) > W(\Omega_{PE})$ if and only if $\left(1 + \frac{J-1}{1+\theta}\right)^{\frac{1}{1+\theta}} < 1 + \frac{J-1}{1+\theta+b\theta}$. 

**Proof:** If $\Omega_{NE}$ and $\Omega_{PE}$ are interior, they can be determined by the expressions (25) and (24). Because the $R&D$ function is Cobb-Douglas, and therefore $\gamma = b/(1-b)$, we get closed form expressions for the resulting patent protection levels $\Omega_{PE}$ from (25) and for $\Omega_{NE}$ from (24). We write out the components of $W(\Omega_{NE}) > W(\Omega_{PE})$ using (12), and substitute for $\Omega_{PE}$ and $\Omega_{NE}$, while setting $\zeta = 1$ because there are no lobbying costs by assumption. Finally, after canceling some terms and rearranging we get the required inequality.

For the two-country case ($J=2$), the Nash equilibrium interior solution is given by solving the system of best-response equations (21) and (22). The (interior) politically efficient level of IPR $\Omega_{PE}$ is given by (25). Denote by $m$ the ratio $\frac{M_U}{M_E}$. Then, the parameter restrictions implied by the assumption of interior solutions $0 < \Omega_{E}^{NE} < \bar{T}$, $0 < \Omega_{U}^{NE} < \bar{T}$ and $\Omega_{PE} < MT$ are the
following:

\[ 0 < p(\theta_E \mu_m - \theta_U \mu_U) + \frac{1}{1 - b} - m < c\left(\frac{2 - b}{1 - b} - p\bar{\theta}\right) \quad (A.7) \]

\[ 0 < p(\theta_U \mu_U \frac{1}{m} - \theta_E \mu_E) + \frac{1}{1 - b} - \frac{1}{m} < c\left(\frac{2 - b}{1 - b} - p\bar{\theta}\right) \quad (A.8) \]

\[ \bar{\theta} < \frac{c - b}{(1 - b)cp} \quad (A.9) \]

The existence of a range of parameters such that Proposition 6 holds is also confirmed by running simulations with different parameter choices. The more similar the countries are, the more likely they are to fall within the valid parameter range for interior solutions.

**Appendix A.5. Proposition 6 for corner solutions**

Assume \( J = 2 \), \( \beta = 0 \), \( f = 0 \) and define \( p \equiv \pi/(CS_c - CS_m) \), \( c \equiv (CS_c - CS_m)/CS_c \) and \( m \equiv \frac{M_U}{M_E} \).

(i) Consider the case when \( \Omega^{NE} \) is a corner solution with complete free riding by one of the countries and \( \Omega^{PE} \in (0, M\bar{T}) \) interior. Without loss of generality assume that \( \Omega^{NE} \in (0, \bar{T}) \) and \( \Omega^{NE} = 0 \). Then \( W(\Omega^{NE}) > W(\Omega^{PE}) \) if and only if:

\[ \left(\frac{(1 + \frac{1}{m})(\frac{1}{1 - b} - p\mu_U\theta_U)}{\frac{1}{1 - b} - p\bar{\theta}}\right)^{\frac{1}{1 - b}} < \frac{(1 + \frac{1}{m})(\frac{1}{1 - b} - p\mu_U\theta_U) - \frac{b}{1 - b} + pb}{1 - p\bar{\theta} + bp} \quad (A.10) \]

**Proof:** Substituting \( \Omega^{NE} = 0 \) in (20) for \( J = U \), we get the NE world level of protection \( \Omega^{NE} = M_U\Omega^{NE}_U \). The rest of the derivation is similar as in Appendix A.4: We write out the components of \( W(\Omega^{NE}) > W(\Omega^{PE}) \) using (12) and substitute for \( \Omega^{PE} \) from (25) and \( \Omega^{NE} \), while setting \( \zeta = 1 \) because there are no lobbying costs by assumption. Finally, after canceling some terms and rearranging we get the above inequality (A.10). The parameter restrictions corresponding to this type of corner solutions are given by (A.8), (A.9) and (A.11):

\[ p(\theta_E \mu_E m - \theta_U \mu_U) + \frac{1}{1 - b} - m < 0 \quad (A.11) \]

(ii) Consider the case when \( \Omega^{NE} \) is interior and \( \Omega^{PE} = M\bar{T} \) is corner solution, describing the situation when the returns to innovation or the strength
of lobbying are so large that the countries agree to offer maximum possible IPR protection. Then \( W(\Omega_{NE}) > W(\Omega_{PE}) \) if and only if:

\[
\left( \frac{c}{b} (2 - b - p(1 - b)\bar{\theta}) \right)^{\frac{1}{1-b}} < \frac{2 - p\bar{\theta} + pb}{b\left( \frac{1}{c(1-b)} - \frac{1}{1-b} + p \right)}
\]

(A.12)

**Proof:** We write out the components of \( W(\Omega_{NE}) > W(MT) \) using (12) and substitute for \( \Omega_{NE} \) from (24), while setting \( \zeta = 1 \) because there are no lobbying costs by assumption. After some algebraic manipulation we get the above inequality. The parameter restrictions corresponding to this type of corner solutions are given by (A.7), (A.8) and (A.13):

\[
\bar{\theta} > \frac{c - b}{(1 - b)cp}
\]

(A.13)

**Appendix A.6. Proof of Proposition 7**

A firm that has an international patent portfolio (X type) will lobby more for a cooperative IPR agreement than an identical firm (same \( H_i \)) with only domestic patent portfolio (D type).

**Proof:** We want to show that the difference between the equilibrium contributions \( C_X(H_i) \) and \( C_D(H_i) \) is positive. Assume that both firms \( D_i \) and \( X_i \) are in the EU and both are lobbying in equilibrium. Substituting expression (16) in (15) for the case of a single world government maximizing \( \Gamma \), we get that the contributions of each firm can be written as:

\[
C_{Xi} = a_E \Delta W(\Omega_{-Xi}, \Omega_{PE}) + \sum_{j \in L_{E,j} \neq Xi} \Delta W_{E,j}(\Omega_{-Xi}, \Omega_{PE}) + \frac{a_E}{a_U} \sum_{j \in L_{U}} \Delta W_{U,j}(\Omega_{-Xi}, \Omega_{PE})
\]

(A.14)

\[
C_{Di} = a_E \Delta W(\Omega_{-Di}, \Omega_{PE}) + \sum_{j \in L_{E,j} \neq Di} \Delta W_{E,j}(\Omega_{-Di}, \Omega_{PE}) + \frac{a_E}{a_U} \sum_{j \in L_{U}} \Delta W_{U,j}(\Omega_{-Di}, \Omega_{PE})
\]

(A.15)

where the notation \( \Delta W_i(\Omega_j, \Omega_k) = W_i(\Omega_j) - W_i(\Omega_k) \) and each \( \Omega \) is the world level of patent protection under the indexed regime: \( PE \) being a cooperative regime with all firms lobbying and \( -Di \) a cooperative regime without the firm \( D_i \) participating in lobbying.

Substituting the expressions for D and X-type of firms in (26) for the cooperative case and solving as before gives us the following first order con-
dition for the EU and a symmetric one for the USA:

\[
\begin{align*}
(M + \mu_U \eta_U)\Delta S - \pi(M + \mu_U \eta_U + \frac{\mu_U \eta_U}{a_U}) &= \\
= \gamma \left( (M \eta_E + \mu_U \eta_U)(CS_M + CS_C \frac{MT - \Omega}{\Omega}) + \mu_U (1 - \eta_E)(CS_M + CS_C \frac{\bar{T} - \Omega_E}{\Omega_E}) \right)
\end{align*}
\]

(A.16)

Here \(\zeta_J\) is the share of lobbying firms in country \(J\), \(\zeta_J^\eta\) is the share of exporting firms in country \(J\) that lobby (as a share of all firms in \(J\) in terms of capital), and \(\mu_J < 1\) is the share of total world knowledge capital allocated in \(J\). If we substituted for \(\eta_J = 1\) (all firms export at no cost), we’d get the same expression as in the benchmark cooperative case (27). Unlike before, now we have an asymmetric system of equations that jointly gives the politically efficient policy vector. Notice that \(\Omega_{-Xi} < \Omega_{-Di} < \Omega_{PE}\), because if firm \(Xi\) doesn’t lobby both \(\zeta_E\) and \(\zeta_E^\eta\) are reduced by \(H_i\), whereas if firm \(Di\) abstains only \(\zeta_E\) is affected, resulting in a higher level of protection when the economically weaker firm \(Di\) is absent.

Using (A.14) and (A.15), we can write:

\[
\begin{align*}
C_{Xi} - C_{Di} &= a_E \Delta W_{Di} \Omega_{-Di}, \Omega_{-Xi}) + \sum_{j \in L_E} \Delta W_{E,j} \Omega_{-Di}, \Omega_{-Xi}) + \\
& \quad + \frac{a_E}{a_U} \sum_{j \in L_U} \Delta W_{U,j} \Omega_{-Di}, \Omega_{-Xi}) + \Delta W_{Di} \Omega_{PE}, \Omega_{-Xi}) + \Delta W_{Xi} \Omega_{PE}, \Omega_{-Xi})
\end{align*}
\]

(A.17)

Notice that the term \(a_E \Delta W_{Di} \Omega_{-Di}, \Omega_{-Xi}) + \sum_{j \in L_E} \Delta W_{E,j} \Omega_{-Di}, \Omega_{-Xi}) + \frac{a_E}{a_U} \sum_{j \in L_U} \Delta W_{U,j} \Omega_{-Di}, \Omega_{-Xi}) = \Gamma(\Omega_{-Di}) - \Gamma(\Omega_{-Xi}) > 0\) because \(\Gamma(\Omega)\) is evaluated below the unique global maximum and \(\Omega_{-Xi} < \Omega_{-Di}\). Thus to prove the proposition it suffices to show that the remaining term of (A.17): \(\Delta W_{Di} \Omega_{PE}, \Omega_{-Xi}) + \Delta W_{Xi} \Omega_{PE}, \Omega_{-Xi})\) is positive. Using (11), we substitute for the individual firm owners’ welfares in terms of the different world levels of patent protection \(\Omega\) so we get:

\[
\begin{align*}
(b_{-Xi}^{1/\pi} - b_{-Di}^{1/\pi})H_i \pi \left( (\Omega_{PE})^{1/\pi} - (\nu_{Di}^{PE} \Omega_{PE})^{1/\pi} \right) + (b_{-Xi}^{1/\pi} - b_{-Di}^{1/\pi})H_i \pi \left( (\nu_{Di}^{PE} \Omega_{-Di})^{1/\pi} - (\Omega_{-Xi})^{1/\pi} \right)
\end{align*}
\]

(A.18)

The expression \((b_{-Xi}^{1/\pi} - b_{-Di}^{1/\pi}) > 0\) and \(\nu_{Di}^{PE} \in (0, 1)\) is the market-weighted share of world patent protection afforded in the EU under the specified set
of lobbying firms $L$. Because $f(x) = x\frac{1}{1-x}$ is an increasing function, the first term $(\Omega_{PE})^{\frac{1}{1-x}} - (\nu_E^{PE}\Omega_{PE})^{\frac{1}{1-x}}$ is clearly positive.

If we solved (A.16) for $\Omega$ and substituted it in the expression for $\nu_E$, we’d get that:

$$\nu_E = \frac{C_E}{A_E - A_U B + C_E + C_U B + \sqrt{(A_E - A_U B - C_E + C_U B)^2 + 4C_E C_U B}}$$

$$A_E \equiv \frac{1}{2} \left( M C S_c \tilde{T}(\mu_U \eta_U + \mu_E \eta_E) - \frac{\Delta CS}{\gamma} (\mu_E + \mu_U \eta_U) + \frac{\pi}{\gamma} (\mu_E + \mu_U \eta_U + \frac{\mu_E \zeta_E}{a_E} + \frac{\mu_U \zeta_U}{a_U}) \right)$$

$$B \equiv \frac{\mu_E + \mu_U \eta_U}{\mu_U + \mu_E \eta_E} ; \quad C_E \equiv C S_c \tilde{T} \mu_E (1 - \eta_E) M_E \quad (A.19)$$

From (A.19) we can conclude that $\nu_E^{PE} < \nu_E^{Di}$, because $\nu_E$ is inversely related to $\zeta_E$ via $A_E$ and because $S_E^{PE} = \zeta_E^{Di} + \frac{M}{H_E}$, whereas $A_U$ will not be affected if firm $Di$ doesn’t lobby. Therefore, for the negative contribution from the second term we have: $(\nu_E^{Di} - \Omega_{-Di})^{\frac{1}{1-x}} - (\Omega_{-Xi})^{\frac{1}{1-x}} > (\nu_E^{Di} - \Omega_{-Di})^{\frac{1}{1-x}} - (\Omega_{-Di})^{\frac{1}{1-x}}$, which in absolute terms is smaller than the positive contribution from the PE-term, because $\Omega_{-Di} < \Omega_{PE}$. Thus the whole term (A.18) is positive, which is sufficient to conclude that (A.17) is positive as well and $C_{Xi} > C_{Di}$.

Appendix B. Data

Appendix B.1. Data description

I gather and match cross-sectional data at the consolidated (parent) firm level from three sources: firm sales data from the Compustat (North America) database, lobbying expenditure data compiled by the Center for Responsive Politics\(^{41}\) and data on patent applications and grants from the PATSTAT database\(^{42}\). The sample is limited to publicly traded companies in the US. Country-level data for GDP was sourced from the World Bank, whereas country-level indices of patent protection were calculated using the methodology of Juan C. Ginarte and Walter G. Park (1997)\(^{43}\).

\(^{41}\)The data is available for public use on the CRP’s website OpenSecrets.org

\(^{42}\)Full name: EPO Worldwide Patent Statistical Database created and managed by the European Patent Office

\(^{43}\)The most recently available Ginarte-Park indexes from 2010 are used.
To construct the patent portfolios for the firms in our sample we use the 2015 Autumn edition of PATSTAT which contains data at the level of individual patent applications (including grants and citations) from over 100 national and international patent offices. We limit our interest only to jurisdictions associated with the countries involved in the TPP and TTIP negotiations. Because multiple patent publications across different jurisdictions can be associated with a single patented invention, we consider an innovation to be defined at the extended (INPADOC) patent family level. We discard patents for which the (latest) application was filed before 1997 and thus will have expired in 2017, the expected year of entry into force of TPP. We proxy for the number of citations at the INPADOC family level by taking the maximum number of citations among the DOCDB patent families associated with each INPADOC family. We later use the number of citations to construct citation-weighted patent portfolios that capture the quality dimension of different patent inventions.

To match the data across the different datasets first we apply the same name cleaning and standardization algorithm to all variables containing firm names. Next we assign patent inventions (INPADOC families) to the firms contained in the Compustat database by matching on the set of firm patent applicants associated with that invention. If multiple such parent company matches are found, we consider for valid the firm with the most recent fiscal report, implying it is still active and hasn’t been acquired by another firm. If no Compustat firm entry matches any of the patent applicants, then most likely all patent applicants are subsidiaries, so we find additional matches by using the company hierarchy implied by the INPADOC family structure:

44 Namely: the US Patent Office, the European Patent Office, the national patent offices of the countries members of EPO, and the patent offices of Japan, Australia, Canada, Chile, Brunei, New Zealand, Peru, Malaysia, Mexico, Singapore and Vietnam

45 A single INPADOC family contains all documents directly or indirectly linked to one specific priority patent document. Thus any member shares at least one priority with at least one other member.

46 We construct the parent-subsidiary correspondence for each Compustat firm entry as follows: We assume that an unmatched patent applicant is a subsidiary of a matched patent applicant if they can be found within the same INPADOC family. If there are multiple parents implied per subsidiary, we take for valid the parent that (in order of application of criterion): a) has a more recent fiscal filing, b) appears as a match with highest frequency, and c) has the largest total number of implied subsidiaries. We assign manually the parents for the few remaining ambiguous matches. Note that this method of matching
We assign the remaining patent inventions to Compustat parent entries whose subsidiaries show up as patent applicants. If multiple subsidiaries within an INPADOC family match to conflicting Compustat entries, we consider for valid the match whose parent firm filed the most recent fiscal report. If this criterion doesn’t give a unique match, we consider for valid the one that appears as a patent applicant with highest frequency.

Once we have matched every invention to a firm, we can construct a variety of weighted patent portfolio variables for each firm. These portfolios are defined across three criteria:

- The entity we choose to count: number of patent applications, number of granted patent applications, number of citation-weighted patents (each citation counts as 1) or number of duration-weighted patents (each remaining year of patent lifetime counts as 1)

- The selection of jurisdictions: only USA (domestic), only EPO, TPP participants, European national patent offices, EPO+Pacific countries (international portfolio) or all jurisdictions

- The choice of weights for each jurisdiction (country): GDP-share in world GDP (2014) or the product of GDP-shares and the Ginarte-Park indices of patent protection (2010)

The Center for Responsive politics has assembled individual firm lobbying expenditure data, which US firms are required by law\textsuperscript{47} to report to the Senate’s Office for Public Records on a quarterly basis. Reports can either be self-filed or submitted by hired lobbying firms. Each quarterly report, in addition to the total amount of lobbying expenses\textsuperscript{48}, contains a detailed checklist of pre-defined issue areas for which the firm lobbied any branch of the government, as well as a more detailed description of the issues discussed for each checked issue. Unfortunately, lobbying expenses are not broken down by issue, so we proxy the amount of TPP/TTIP-related expenditures by multiplying the total quarterly amount with the fraction of the number

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\textsuperscript{47}Lobbying Disclosure Act (1995)
\textsuperscript{48}Expenses are rounded to the nearest $10,000 and the firm is not required to submit a report if the total expenses are below $12,000 for self-filers and $3,000 for lobbying firms.
of reported issues from the checklist whose detailed issue description contains any TPP/TTIP-related words or phrases. To fit the framework of the model, the lobbying data is aggregated across time into a single period (q3:2007-q4:2015) during which negotiations for TPP and TTIP take place.

My method of estimating the TPP/TTIP-related lobbying expenditures presents an obvious limitation of the data, because our implicit assumption that lobbying efforts are spread equally across issues may not be justified. An additional limitation comes from the fact that a significant share of lobbying expenditures happens through trade associations, who do not disclose the sources of their finances. However, if it is the case that companies’ financial contributions in trade associations are in proportion to their individual lobbying expenditures, this limitation will not bias the resulting estimates.

Appendix B.2. Regression

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Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

49 Besides the obvious ”TTP”, ”TTIP” and their variations, we consider as related also bills granting fast-track trade promotion authority to the President, whose purpose was the smooth passing of the above agreements, namely: ”H.R.1295”, ”S.995”, ”H.R.1895”, ”H.R.2146”, ”Trade promotion authority”, ”Trade Priorities and Accountability Act” and their variations.
I run the following firm-level cross-sectional reduced form regression

\[ \log(\text{LobbyExp})_i = \alpha_0 + \alpha_1 \log(\text{Sales})_i + \alpha_2 \log(\sum_{J \in \text{TPP}} s^\text{GDP} \text{Citations}_i,J) + \epsilon_i \]  

(B.1)

The dependent variable is lobbying expenditures on TPP and TTIP-related issues, on the left and right half of the table respectively. The international portfolio includes the jurisdictions J of the countries signatories of the respective agreement. The patent stocks are weighted by the number of citations and then by \( s^\text{GDP}_J \) - the share of GDP of country J in world GDP. The coefficients on the portfolios are positive and significant as the theory predicts.

Appendix C. Figures

Figure C.3: Correlation between the estimated lobbying expenditures on TPP and TTIP as a share of total sales and the patent premiums at the sectoral level. The correlation coefficient is 0.74. Patent premium estimates are from Arora et al. (2008) and it is defined as the proportional increment of the value of innovations by patenting them. The data on lobbying expenditure is described in Appendix B1.