INTERNATONAL JURISDICTION OVER STANDARD-ESSENTIAL PATENTS

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Abstract

A sizeable literature analyzes the appropriate interpretation of FRAND commitments for standard-essential patents. With few exceptions, the literature disregards international dimensions, despite the fact that most standards are used in international markets. This paper uses a simple economic setting to assess pros and cons of the main jurisdictional bases in international law—the Territoriality and Nationality Principles—when national regulatory authorities have conflicting views regarding the appropriate interpretation of FRAND commitments. The paper identifies situations where the bases can implement efficient outcomes, and where they fail. The paper also shows how non-discrimination obligations might improve upon the outcomes.

Contents

1 Introduction

Technical standards often require the use of "standard-essential" patents (SEPs). Holders of SEPs and potential implementers negotiate the terms at which the latter can use the patented technologies. But the negotiations can be constrained by commitments that SEP holders have made, as members of standard-setting or standard-developing organizations, to make their patents available to implementers on "fair, reasonable and non-discriminatory" (FRAND) terms, should their patents become standard-essential. These commitments are intended to limit SEP holders' ability to exploit the market power that the essentiality of their patents yields. The FRAND notion is very vague however, and conflicts often arise between SEP holders and potential implementers regarding the meaning of the concept in practice. These conflicts frequently cause SEP holders to seek legal injunctions against the use of their technologies, claiming that implementers are unwilling to negotiate and/or accept FRAND terms, or induce implementers to seek legal recourse against alleged unwillingness on part of SEP holders to license their technologies on FRAND terms.

Countries differ in their views on the legal nature of violations of FRAND commitments. In some countries, most notably the US, it is viewed primarily as a violation of private contract law. In other economies FRAND violations by SEP holders are viewed antitrust violations (abuse of dominance, or similar); for instance, the EU, China, South Korea and Taiwan have recently applied their competition laws to SEPs.[1,2]

National regulations of FRAND commitments are causing increasing tensions internationally, however. SEPs are very often of significant interest to more than one country, for instance, since products that draw on standards are traded internationally, or since SEP holders have different nationalities. There have been several cases recently where the international jurisdiction over FRAND commitments have been at issue. In these cases competition authorities have been alleged to pursue national objectives at the cost of the interests of other countries. For instance, China, Taiwan and South Korea have been criticized for using antitrust interventions against alleged violations of FRAND commitments as a form of industrial policy. In the words of Patrick Ventrell, US White House National Security Council spokesman:

> The United States government is concerned that China is using ... anti-monopoly law, to lower the value of foreign-owned patents and benefit Chinese firms employing foreign technology.[3]

Similar concerns have been addressed by legal scholars and practitioners. For example, Wong-Ervin et al. (2016) maintain that some competition authorities appear to enforce FRAND com-

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[1] See Hovenkamp (2020) for a recent legal analysis of the role for antitrust to regulate violations of FRAND commitments.

[2] For comprehensive summaries, see Padilla et al (2018) et Geradin (2020). The former study provides an overview of antitrust enforcement in the EU, the US, Japan, China, India and South Korea, with particular focus on SEPs. Geradin (2020) discusses where the EU stand on SEP licensing and its relationship with EU competition law.

[3] Reuters, Dec 16, 2014. www.reuters.com/article/us-qualcomm-china-antitrust-idUSKBN0JU0AK20141216.

mitments in order to benefit their local implementers or national champions. de Rassenfosse et al. (2018) find that China is less likely to accept applications for patent protection for foreign SEPs than for domestic SEPs. The notion that competition authorities sometimes use the enforcement of FRANDs commitments as means of achieving industrial policy objectives, is in line with the more general observation that there is a temptation for competition authorities in open economies to promote not only consumer welfare in the traditional sense, but also other objectives; see e.g. Mariniello et al. (2015).[4] Indeed, authorities might be legally required to treat foreign interests different from national interests; the fact that the US Sherman Act does not apply to export cartels is an example of this. Authorities might also be under domestic political pressure to favor domestic firms, or may be lobbied to do so by private parties.

When national regulatory authorities pursue different objectives, countries will typically have conflicting interests with regard to the choice of regulating authority. There is no multilateral agreement to turn to in this regard, and rarely any other agreement. But all countries are legally bound by *the default rules for international jurisdiction* in customary international law that apply absent international agreements. The respect for these principles, which have emerged as a result of systematic state practice, is of fundamental importance to the world economy (and to international relations generally). The principles are so deeply ingrained in international relations that it is easy to forget that they exist. For instance, we take for granted that countries normally only regulate their own territories, that stronger countries do not tax firms and workers in smaller countries, etc. But despite the general respect for the rules there are still conflicts regarding how they apply in particular circumstances.[5]

This paper   The purpose of this paper is analyze whether the application of the two main bases for jurisdiction that are identified in the rules—*the Territoriality and Nationality Principles*—will allocate jurisdiction regarding the enforcement of FRAND commitments across national authorities in an economically efficient manner, and if not, what pros and cons these rules have. This issue is of immediate policy interest. If the default rules can be shown to implement efficient outcomes, existing law is adequate from an economic perspective. The problem then, if any, is to ensure that countries comply with the law. On the other hand, if the rules cannot implement an efficient outcome, there is a need to look for alternative solutions, most likely in the form of international agreements.

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[4]This is not uncontested, however. For instance, Bradford et al (2017) examine the European Commission's response to the approximately 5 000 mergers reported to the Commission during 1990-2014. They find no evidence that the Commission has challenged non-EU mergers decisions to a larger extent than intra-EU mergers.

[5]One example is the very strong resistance in targeted countries against unilaterally imposed carbon-based tariffs on imports. At the core of this resistance is the notion that this is that such a measure amounts to extra-territorial regulation that violates national sovereignty, a notion which underlies the principles for jurisdiction. Another example is the conflict regarding the proposed EU taxation of mainly US digital firms.

Related literature To the best of our knowledge, this is the first paper to address the economic efficiency of the fundamental default rules for any application, and thus also in the context of SEPs. But there are obviously several related fields of literature. For instance, there is a very large economic literature on competition policy in international markets.[6] There is also a considerable law and economics literature on SEPs. The latter mainly addresses how to define or determine the "reasonable" part of the FRAND concept, and the circumstances under which SEP holders should be allowed to use injunctions against implementers for not agreeing to the requested terms for using the patented technologies.[7] The literature does occasionally point to problems stemming from multiple jurisdictions for FRAND enforcement. But the focus is then typically on the transaction costs that arise from differences in legal regimes, and the possibilities for SEP holders to select courts that are prone to grant injunctions (forum shopping); see respectively Wong-Ervin et al. (2016) and Erixon and Bauer (2017). These aspects are not considered here.

The framework to be employed The paper uses a highly stylized economic framework to capture basic sources of conflict of interest over the allocation of jurisdiction. It considers a product that is produced in one country and then exported to another country. The product builds on a standard that draws on two patents. The patents are essential in two respects: both patented technologies are required in order to manufacture and sell the product, and the two separate holders of the patents are bound by FRAND commitments to charge "reasonable" license fees. In each country a regulatory authority can intervene to enforce its view of the meaning of the FRAND commitments, by imposing a ceiling on the permissible license fee(s) for which it has jurisdiction.

The interaction takes place in three stages. The regulatory authorities first simultaneously lay down FRAND policies for the patent(s) for which they have jurisdiction. There are then simultaneous separate negotiations between the producer and each of the two SEP owners regarding the per unit royalty fees. These negotiations are interrelated, since the surplus that can be divided between each of the SEP holders and the producer, will be adversely affected by the license fee that they expect to be agreed upon between the producer and the other SEP holder. To formally capture this, the outcome is assumed to be a "Nash-in-Nash" equilibrium, as in Horn and Wolinsky (1988). In the final stage there is production and consumption in standard fashion.[8]

For each license fee, each authority trades off the implications of the fee for its commercial interests, against the implication for the revenue of the domestic SEP holder(s), if any. The authories'

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[6]Garcia et al (2018) is a recent contribution to the formal analysis of national competition policy enforcement in international markets. Mariniello et al (2015) discuss the consequences of regulatory capture among competition authorities for international economic integration.

[7]See e.g. Contreras (2019) for a survey of the literature on standard-setting organizations. Formal analyses of the FRAND notion are undertaken by e.g. Choi (2014), Froeb et al (2012), Langus et al (2013), and Lerner and Tirole (2015). Layne-Farrar (2017) provides an overview of the economic literature on SEPs. These papers do not focus on international/jurisdictional issues, however.

[8]Our model share certain basic features with the more elaborate dynamic model with endogenously determined research and development, inventor-producer bilateral bargaining, and subsequent Bertrand product market competition, developed by Spulber (2019).

concern for the latter is intended to capture their interest in providing incentives for innovation, without having to go into a dynamic setting. Hence, the authority in the importing country is concerned with the implications of the negotiated fees for consumer welfare and for the welfare of its SEP holder(s) if any, while the authority in the exporting country is concerned with the implications of the fees for its exporting firm, and for its SEP holder(s), if any. Each authority views a license fee to be "reasonable" if it does not exceed the authority's preferred level.

This economic structure is about as simple as it can be. But it seems to capture fundamental differences in the interests of countries with regard to the enforcement of FRAND commitments, where some countries are mainly concerned with consumer welfare and incentives for innovation, while for other countries the main interest is production. We might thus think of the importing country as the EU or the US, say, and the exporting country as say China or Korea. There are no doubt more intricate production and consumption patterns of interest for particular standards. But we believe that the present setting is natural as a starting point for an analysis of the implications of jurisdictional principles.

Findings   Absent jurisdictional rules, both authorities will want to regulate. They will then prefer to minimize the license fee for the respective foreign-owned SEP. For the patent-issuing country, this will enhance consumer welfare by reducing the equilibrium product price. For the producing country, minimizing the license fee for the SEP held by patent-issuing country will enhance the profit of its producer. Also, since the bargaining processes for the SEP licenses are interrelated, both countries prefer a minimal license fee for their respective foreign SEP to increase the surplus that is available for its domestic SEP holder to divide with the producer. The outcome yields inefficiently stringent regulation of the FRAND commitments absent observance of any jurisdictional principles.

We then consider the implications of allocating jurisdiction according to the Territoriality Principle and the Nationality Principle, respectively. It is shown that:

- The outcome with the Territoriality Principle converges toward the efficient outcome, as given by the outcome in an integrated economy, as the patent-issuing country becomes concerned only with *consumer* welfare. The Nationality Principles performs worse in this case, and might even reduce the joint welfare of the countries.

- The outcome with the Nationality Principle converges toward the efficient outcome as the concern for *license revenues* for SEP holders increasingly dominates the decision making by both regulatory authorities. The Territoriality Principle then performs worse.

- For intermediate cases neither jurisdictional base achieves full efficiency. The Territoriality Principle gives too weak enforcement of FRAND commitment(s) when the patent(s) is (are) owned by nationals of the country that has issued the patents, and too stringent enforcement when they are owned by foreign interests. The Nationality Principle gives too lenient enforcement for all patterns of ownership of the patents.

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Put differently, the analysis suggests that *the Territoriality Principle performs best when the regulatory authorities have a common interest in maintaining low license fees for both SEPs, and Nationality Principle when each authority prefers a high license fee for its domestically held SEP.*

These findings reflect a general weakness of these basic jurisdictional principles: adherence to the default rules does not remedy the *international externalities* that stem from countries' pursuit of nationally defined objectives. While the default rules designate a party (or possibly several parties) as legitimate regulator(s), only in extreme cases will the country or countries that have been awarded jurisdiction unilaterally behave in a jointly efficient fashion.

The inefficiency of the default rules seems to be worsened by another feature of the principles: they allow countries that are awarded jurisdiction to regulate the FRAND commitments by the two SEP holders in a *discriminatory fashion,* despite the fact that the efficient outcome requires equal treatment. The Territoriality Principles implies explicitly discriminatory regulation, since the regulating country prefers to treat SEP holders differently based on nationality. Discrimination is more subtle under the Nationality Principle, but the outcome can imply different regulatory treatment depending on SEP holders' territorial location. This raises the question of whether a prohibition of discriminatory regulation could improve the efficiency of the outcome. This question is not only of conceptual interest. There might already exist a legal constraint on discrimination: World Trade Organization members are legally bound to respect the *Agreement on Trade-Related Aspects of Intellectual Property Rights* (the TRIPs Agreement). It includes a National Treatment provision that requests that any protection that is awarded to intellectual property belonging to nationals must be awarded also to foreign-owned intellectual property. While untested in case law, it appears as if this provision could potentially be applicable to FRAND enforcement. Another reason for examining implications of non-discrimination obligations is that it seems highly plausible that such an obligation would be a central component of any future international agreement on the enforcement of FRAND commitments. The paper shows that:

- Territoriality Principle coupled with a National Treatment obligation can implement a jointly efficient outcome. This is more likely, the more the interests of the two regulatory authorities are aligned. But the imposition of the National Treatment obligation might also reduce joint welfare.

- Regulation based on the Nationality Principle will not be constrained by a National Treatment provision. However, a more general form of non-discrimination obligation, similar to the "consistency requirement" in WTO law, can have favorable impact. Broadly speaking, it would request that countries adopt the same regulation in different industries, regardless of differences in the country's commercial interests across industries.

Finally, it is also demonstrated why a National Treatment obligation can have beneficial effects also in case an extreme version of the Effects Principle is employed that gives jurisdiction over both SEPs to both countries.

The broader conclusion that emerges from the analysis is that *existing principles for jurisdiction in international law typically will typically not implement an efficient outcome when applied to SEPs in international markets.* Non-discrimination obligations can, but need not, improve the outcomes. These findings suggest the need for some form of international agreement, but also that it will not be easy to identify an implementable an agreement with desirable properties.

The structure of the paper The next section gives a brief description of the default rules for international jurisdiction. Section 3 lays out the simple economic market structure, and the negotiations over the license fees. Section 4 derives and compares the outcomes with the two main traditional bases for jurisdiction in the defaults rules: the Territoriality and Nationality Principles. Section 6 extends the analysis include non-discrimination obligations. Section 7 concludes.

2 The default rules for jurisdiction

There is no multilateral treaty on the allocation of jurisdiction for the enforcement of FRAND commitments, or for antitrust. All countries are therefore bound by the customary international law rules regarding jurisdiction, often referred to as the "default rules" for jurisdiction.[9],[10] These rules have emerged as custom from many years of interaction between states in a large number of different areas. A widely accepted interpretation of these rules is the series of *Restatements of Foreign Relations Law of the United States* by the American Law Institute (ALI).[11] In what follows, we will draw on the very recent Restatement ALI (2018) to briefly describe main features of current jurisdictional rules in customary international law.[12]

There are three forms of jurisdiction. Jurisdiction to *prescribe* gives a state authority to make laws that apply to *actors, acts* or *objects.* Jurisdiction to *adjudicate* allows a state to apply its laws. Jurisdiction to *enforce* allows a state to intervene to induce compliance with laws. These are clearly separate aspects of jurisdiction. But we will not distinguish between these aspects in what follows. We will instead assume that if a regulatory authority has jurisdiction to prescribe, it also has jurisdiction to adjudicate and enforce, this being the prime case of interest from an economic perspective.

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[9] Customary international law is formed when states act in a consistent fashion out of a sense of obligation. It applies to international relations in instances where there is no international treaty governing the relationship. The exception is if a country has persistently objected to a custom. But this does not appear to be of practical relevance to SEPs.

[10] The basic rules concerning jurisdiction were spelled out in the classic "Lotus judgment" in 1927 by the Permanent Court of International Justice (the predecessor of the International Court of Justice).

[11] ALI Restatements are meant to clarify the state of the law for the benefit of US courts, and are often used by courts as authoritative interpretations of the law. The latter stems from the thorough process through which the ALI memberership, comprising some 3 000 leading US legal scholars and professionals, scrutinize the development of the Restatements.

[12] See also Lundstedt (2016) for a comprehensive description and analysis of jurisdictional principles, in particular as they apply to intellectual property law.

In order for a state to have jurisdiction to prescribe there must be a "genuine connection" between the subject of the regulation and the state seeking to regulate. Such a connection might stem from one or several bases.[13] The oldest, most frequently used, and least controversial base is the territorial location of actors, acts and objects within its geographic territory—the *Territoriality Principle*. Another jurisdictional base with a long tradition is the nationality of these entities— the *Active-Nationality Principle*. A more controversial, but increasingly commonly used, base is the substantial effects that arise (or are intended to arise) within a state's territory—the *Effects Principle* (or Doctrine). This basis, which is often seen as a special case of the Territoriality Principle, is particularly commonly referred to in the area of antitrust. Yet another controversial but increasingly common justification for regulating conduct outside a state's territory is to protect domestic nationals against harm—the *Passive-Nationality Principle.*

The default rules can simultaneously give jurisdiction to more than one party. For instance, in the case of SEPs, the territorial applicability of a patent, and the nationality of the holder of the patent, might point in different directions with regard to which party should have jurisdiction. In the past there was a clear hierarchy in international law according to which the Territoriality Principle dominated both the Nationality and the Effects Principle; see the ALI (1987) Restatement. But the recent ALI (2018) Restatement unequivocally states that there is no hierarchy among the bases in international law, even if some bases are more controversial than others.

A possible solution in case of conflicting jurisdiction is *comity*, that is, that countries that would have jurisdiction defer other countries to exercise jurisdiction, if the latter have larger legitimate interests at stake.[14] There is no requirement in customary international law for states to do so. But countries nevertheless occasionally do this unilaterally through domestic laws and regulations that constrain the exercise of prescriptive jurisdiction. There are also some international comity agreements, the most well-known is probably the 1998 EU-US positive comity agreement, under which each side may request the other side to remedy anti-competitive behavior which originates in the other side's jurisdiction but affects the requesting party.

In what follows we will focus on the principles regarding territoriality and active nationality ("nationality" for short below) since these seem highly relevant to SEPs. We will also touch upon implications of the Effects Principle, but we will be briefer for reasons explained below.

3   The economy

A product is imported by country A from country B, where it is produced by a monopoly firm. The product is based on a standard that draws on two essential patents, denoted 1 and 2, with separate

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[13]ALI (2018) points to two additional bases: the protective principle, which is concerned with national security, and universal jurisdiction, which concerns interventions in the case of crimes against humanity etc. These are omitted since they seem irrelevant to the issues at stake in this paper.

[14]See Drahozal (2012) for a discussion of economic aspects of comity.

holders. The firm negotiates separately and simultaneously with each SEP holder the respective license fees r_1 and r_2 per unit sold of the final product in market A.

The patents are essential in two respects. First, the product cannot be produced without the use of both patents, and second, the standard has been developed with (FRAND) commitments by the patent holders to charge "reasonable" license fees. In each country there is a regulatory authority. Depending on their jurisdiction, the authorities can seek to enforce the FRAND commitments. There are three stages in the interaction for any given allocation of jurisdiction over the SEPs:

1. Each regulatory authority lays down a FRAND enforcement regulation that sets ceilings for license fees for which it has jurisdiction;

2. License fees are negotiated, respecting any FRAND regulations; and

3. Production and consumption takes place.

This sequence of events is intended to capture countries' long-run legislative decisions regarding their enforcement of FRAND commitments.

3.1   The product market

Let $D(p) \equiv \arg\max_c \tilde{U}(c) - pc$ be consumer demand in market A, where $\tilde{U}(c)$ is gross consumer welfare, p is the good price, and c is the level of consumption. For given license fees, the single producer maximizes its profit in standard fashion, by setting the price

$$P(\mathbf{r}) \equiv \arg\max_p \ (p - \sum r_i)D(p),$$

where $\mathbf{r}$ denotes the vector (r_1, r_2).[15] The firm's optimal price is assumed to increase less than proportionally in each of the fees. That is, with denoting partial derivatives with subscripts attached to function operators , and letting subscript i denote either of SEP 1 and 2, we assume that[16]

$$0 < P_i(\mathbf{r}) < 1 \tag{1}$$

The maximized profit and consumer welfare are

$$\begin{aligned}
\Pi(\mathbf{r}) &\equiv [P(\mathbf{r}) - \sum r_i]D(P(\mathbf{r})) \\
U(\mathbf{r}) &\equiv \tilde{U}(D(P(\mathbf{r}))) - P(\mathbf{r})D(P(\mathbf{r})),
\end{aligned}$$

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[15] We assume throughout that SOCs are fulfilled for any optimization problems we consider. These conditions are verified to hold in a fully parametric example in the Appendix.

[16] A sufficient but not necessary condition is that $D_{pp} \leq 0$:

$$P_i = \frac{1}{2 + (p - \sum r_1)\frac{D_{pp}}{D_p}}$$

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both of which fall in the level of the license fees: $\Pi_i = -D < 0$ and $U_i = -DP_i < 0$.

3.2 License fee negotiations absent regulation

The firm negotiates the license terms simultaneously with the two SEP holders. The outcome of the bargaining is assumed to be a "Nash-in-Nash" equilibrium, as in Horn and Wolinsky (1988), with the status quo point $(0,0)$ since each patent is essential. Hence, the negotiation over license fee r_i maximizes $\Pi(r)L^i(\mathbf{r})$ with correct expectations concerning the fee r_j to be agreed upon in the other negotiation, with $L^i(\mathbf{r}) \equiv r_i D(P(r_i, r_j))$ denoting the license revenue received by the holder of SEP i. The associated first-order conditions for an interior solution to the negotiation over fee r_i, defines a function $N^i(r_j)$ that gives the negotiated fee r_i for any given r_j, if the outcome of the negotiation is not constrained by enforcement of FRAND commitments:

$$N^i(r_j) \equiv \arg \max_{r_i} \Pi(\mathbf{r})L^i(\mathbf{r}),$$

with the associated first-order condition for an interior solution

$$-Dr_i + (p - \sum r_i)[D + r_i D_p P_i] = 0. \tag{2}$$

We make three natural assumptions regarding the negotiations. The first is that the fee that is negotiated between one of the SEP holders and the firm, is lower the higher is the fee for the other SEP:

$$N_j^i < 0 \tag{3}$$

This is natural since a smaller r_j will give more surplus to be divided between the producer and SEP i holder, and part of this additional surplus will accrue to the holder of SEP i in the form of a higher r_i. Second, we assume that there is a unique equilibrium $r_1^0 = r_2^0 \equiv r^0$, given by

$$r_i^0 = N^i(r_j^0), \ i \neq j \tag{4}$$

for the unconstrained negotiations. Finally, in order have intuitively reasonable comparative statics properties, we assume that the interaction between the two bargaining processes is "stable" in the sense that the relative slope of the two functions in (4) is such that at $\mathbf{r}^0 \equiv (r^0, r^0)$,

$$N^j(N^i(r)) > r_j \text{ iff } r_j < r^0. \tag{5}$$

To see why this is assumed, suppose that the negotiated fee r_i, for given r_j, increases due to some exogenous change. In the "unstable" case, this will trigger a change in r_j that in equilibrium causes a *fall* in r_i despite the direct favorable impact of the exogenous change. Assumption (5) serves to remove this formal but counter-intuitive possibility.

4   Regulation

Expression (4) specifies the outcome for the case where the negotiations are unconstrained by regulatory interventions. We now turn to first stage, in which regulatory authorities can lay down their regulations of the FRAND commitments.

4.1   Regulatory authorities

Assume temporarily that all agents reside in one integrated economy. In this economy a regulatory authority enforces the FRAND commitments by the SEP holders in order to maximize its objective function

$$W(\mathbf{r}) \equiv U(\mathbf{r}) + \alpha \sum L^i(\mathbf{r}) + \gamma \Pi(\mathbf{r})$$

The parameter $\alpha > 0$ reflects the relative weight that is put on license revenues. The parameter $\gamma \geq 0$ captures the extent to which producer profits are considered as part of welfare, as a generator of income for share-holders, or as a source of tax revenue. With $\alpha = \gamma = 0$ the regulating authority would only be concerned with consumer welfare. If $\alpha = \gamma = 1$ the welfare function reduces to $W(\mathbf{r}) = \tilde{U}(\mathbf{r})$, that is, to the standard social welfare function for the case where there is no special benefit from having positive license fees. If $\alpha > 1$ the regulating authority hence puts an intrinsic value on license payments. We use this as a compact way of capturing beneficial effects of license fees on innovation, without having to bring in the complexities of a model of endogenous innovation. A more elaborate model of innovation does not seem to be of first-hand interest for the purpose of analyzing the impact of jurisdictional principles, since the issues to be discussed here will also arise in more complex settings. The function $W(\mathbf{r})$ thus captures in a very simple manner the main conflicting objectives with regard to the license fees for SEPs: the desire to keep license fees low to enhance consumer welfare, versus the desire to provide strong incentives for innovators.[17]

Let the pair of license fees that maximize joint welfare $W(\mathbf{r})$ be denoted $\mathbf{r}^J \equiv (r^J, r^J)$, with $r_1 = r_2$ due to symmetry. The optimal fee for patent i balances the positive effect on the revenue for the holder of SEP i, and the adverse effects of the fees on consumer surplus, on holder of SEP j, and possibly also on the profit of the producer (depending on whether $\gamma \geq 0$):

$$
\begin{aligned}
W_i(r, r) &= U_i + \alpha(L_i^i + L_i^j) + \gamma \Pi_i \\
&= -DP_i + \alpha[D + r_i D_p P_i + r_j D_p P_i]
\end{aligned}
$$

where the U_i, αL_i^j and $\gamma \Pi_i$ are all negative, and where αL_i^i is positive for small r_i.

We will use the license fees $\mathbf{r}^J = (r^J, r^J)$ that maximize the objective function for the integrated economy W as the benchmark for measuring the efficiency of the outcome with national regulatory

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[17] See Spulber (2019) for an analysis of SEPs with endogenously determined research and development.

authorities.[18] It is thus given by

$$
\begin{aligned}
W_i(\mathbf{r}^J) &= V_i^A(\mathbf{r}^J) + V_i^B(\mathbf{r}^J) && (6) \\
&= (\alpha - P_i - \gamma)D + 2\alpha r^J D_p P_i \\
&= 0
\end{aligned}
$$

We will focus on situations where the unconstrained jointly efficient regulation restricts the nego-tiated outcome, but still (mostly) allows for strictly positive fees for the SEPs; that is, we assume that[19]

$$(0,0) < \mathbf{r}^J < \mathbf{r}^0 \tag{7}$$

This is a natural assumption in that it excludes cases where the jointly efficient outcome is to deny the SEP holders any revenue ($\mathbf{r}^J = 0$), and or to leave the market unregulated ($\mathbf{r}^J \geq \mathbf{r}^0$). A strictly positive r^J requires that

$$W_i(0,0) = (\alpha - \gamma - P_i)D > 0$$

That is, the marginal benefit of introducing some license revenue for SEP i (αD) must exceed the marginal cost in terms of reduced consumer welfare ($-DP_i$), and reduced industry profit ($-\gamma D$).

We now divide this integrated economy into two countries such that consumption occurs only in country A and production only in country B, and the holder of SEP 1 is a country A national, while the holder of SEP 2 is a national of country B. There is a regulatory authority in each country, denoted RA in country and RB in country B. Their objectives are to maximize, respectively,

$$V^A(\mathbf{r}) \equiv U(\mathbf{r}) + \alpha L^1(\mathbf{r}) \text{ and } V^B(\mathbf{r}) \equiv \gamma \Pi(\mathbf{r}) + \alpha L^2(\mathbf{r}). \tag{8}$$

Observe that since the objectives of the national authorities add up to the objective of the authority in the integrated economy: $V^A(\mathbf{r}) + V^B(\mathbf{r}) = W(\mathbf{r})$, any deviation in the outcome with separate countries from the efficient outcome, is solely due to the international externalities from the national decision making. The international dimension drives a wedge between the interests of the national authorities, since each authority prefers the license revenue of the other country's SEP holder to be as small as possible:

$$V_2^A = -DP_2 + \alpha r_1 D_p P_2 < 0 \text{ and } V_1^B = -\gamma D + \alpha r_2 D_p P_1 < 0$$

To add some structure to the nature of this conflict, we assume that the authority in the patent-issuing country A, prefers a higher license fee for its domestically owned SEP, the lower is the license

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[18]This is not the first best outcome due to the monopoly distortion, and the policy instruments available to the authority that maximizes W.

[19]We let vector notation $\mathbf{r} < \mathbf{r}'$ denote $r_i < r_i'$, $i = 1, 2$, etc..

fee for the foreign owned SEP, that is, the license fees are strategic substitutes for RA:

$$V_{12}^A < 0. \tag{9}$$

4.2 The impact of regulatory interventions on negotiated license fees

Interventions by the regulatory authorities are constrained in two respects: First, authorities can only intervene with regard to patents for which they have *jurisdiction*. Second, to be consistent with restrained regulatory authority, the authorities can only intervene to limit the patent holders' exploitation of market power in the form of high fees for the patents, that is, they can only impose *upper limits on permitted license fees*. The authorities cannot implement higher fees than those negotiated between the producer and the respective patent holder. This seems descriptive of e.g. for antitrust interventions.

In case both authorities impose restrictions on a particular license fee, the SEP holder is assumed to comply with both determinations by respecting the more stringent of the two regulations. Formally, let m_i^A and m_i^B be the maximal fees allowed by the respective regulatory authority for SEP i. The maximal permitted fee for SEP i will then be $m_i \equiv \min(m_i^A, m_i^B)$. Let $\mathbf{m} \equiv (m_1, m_2)$ be the pair of most binding regulations.[20]

Four types of situations may arise as a result of the regulatory decisions.

(i) $\mathbf{m} < \mathbf{r}^0$: If both fees are regulated to levels below what would result without regulation—that is, $\mathbf{m} < \mathbf{r}^0$—both interventions will bind: $\mathbf{r} = \mathbf{m}$.

(ii) $\mathbf{m} \geq \mathbf{r}^0$: In the opposite case where neither of the interventions affects the negotiated outcomes—that is, $\mathbf{m} \geq \mathbf{r}^0$—the outcome is the pair of fees resulting from unconstrained negotiations: $\mathbf{r} = \mathbf{r}^0$.

(iii) $m_i < r^0$ and $m_j > N^j(0)$: One case with asymmetric regulation is where one of the constraints is lax enough not to bind regardless of the negotiated fee for the other SEP. In this case the implemented fee for the leniently treated SEP will be determined through an unregulated negotiation, but constrained by the expected outcome of the parallel negotiation. For instance, if $m_2 > N^2(0)$, the feasible outcomes are points $\mathbf{r} = (m_1, N^2(m_1))$ where $r_1 \in [0, r^0]$ is the implementable range of r_1 for RA.

(iv) $m_i < r^0$ and $r^0 < m_j < N^j(0)$: If $r^0 < m_2 < N^2(0)$ there will be a critical value of m_1 for any m_2, denoted $R^1(m_2)$, which is the level of m_1 that would induce the unconstrained negotiation

---

[20]If neither authority intervenes with regard to patent i we can set $m_i^A \geq N^i(0)$ and $m_i^B \geq N^i(0)$, since this is formally equivalent to a non-binding regulation.

over SEP 2 to result in the fee $r_2 = m_2$. That is, $N^2(R^1(r_2)) \equiv r_2$, and more generally $R^i(r_j)$ is given by

$$N^j(R^i(r_j)) \equiv r_j \tag{10}$$

If $m_1 \leq R^1(m_2)$, the implemented fee r_1 would be sufficiently low that the regulation $r_2 \leq m_2$ restricts the outcome of the negotiation over r_2. In this case the implemented outcome will be $\mathbf{r} = (m_1, m_2)$. If instead $R^1(m_2) < m_1 < r_1^0$, the outcome of an unconstrained negotiation regarding r_2 would be a lower fee than m_2, in which case the regulation $r_2 \leq m_2$ would not bind. The outcome in this case is $\mathbf{r} = (m_1, N^2(m_1))$.

The possible outcomes can hence be summarized as follows:[21]

Lemma 1 *The negotiated fees* $\mathbf{r}$ *depend on the regulations m as follows:*

$$\mathbf{r(m)} \equiv \begin{cases} \mathbf{m} & \text{if} \quad \mathbf{m} < \mathbf{r}^0 \\ (m_i, \min(m_j, N^j(m_i))) & \text{if} \quad m_i < r_i^0 \text{ and } m_j > r_j^0 \\ \mathbf{r}^0 & \text{if} \quad \mathbf{m} > \mathbf{r}^0 \end{cases} \tag{11}$$

---

[21] Let gross consumer be $\tilde{U}(c) \equiv c - \frac{1}{2}c^2 + y$, where $0 < c < 1$ is consumption of the product of interest, and y is consumption of other products. The associated demand is $D(p) = 1 - p > 0$ for $p < 1$. For given license fees $r_i < \frac{1}{2}$, the optimal producer price is $P(\mathbf{r}) \equiv \arg\max_p (p - r_1 - r_2)(1 - p) = \frac{1}{2}(1 + r_1 + r_2)$ since the second-order condition (SOC) is always fulfilled. Also, $P_i = \frac{1}{2} < 1$, consistent with (1). The maximized profit and license revenues are

$$\Pi(\mathbf{r}) = \frac{1}{4}(1 - r_1 - r_2)^2 \text{ and } L^i(\mathbf{r}) = \frac{1}{2}r_i(1 - r_1 - r_2)$$

The negotiated license fees are given by the first-order conditions (FOCs) $\frac{d}{dr_i}[L^i(\mathbf{r})\Pi(\mathbf{r})] = 0$. Since $\max(r_1, r_2) = \frac{1}{4}$, the SOCs hold:

$$\frac{d^2}{dr_i^2}[L^i(\mathbf{r})\Pi(\mathbf{r})] = -\frac{3}{4}(1 - 2r_i - r_j)(1 - r_i - r_j) < 0$$

The FOCs define "best reply" functions for the two negotiations

$$N^i(r_j) = \frac{1}{4}(1 - r_j).$$

Hence, consistent with assumptions (3) and (5),

$$\left.\frac{dr_2}{dr_1}\right|_{N^1} = -4 < \left.\frac{dr_2}{dr_1}\right|_{N^2} = -\frac{1}{4} < 0,$$

The (symmetric) unregulated market outcome is given by $r = \frac{1}{4}(1 - r)$, and is hence $\mathbf{r}^0 = (\frac{1}{5}, \frac{1}{5})$. Since $1 - 2r_i - r_j$ is maximized for $r_i = r_j = \frac{1}{5}$, in which case it is negative, the SOC for the bargaining problem is fulfilled. To avoid less interesting corner solutions, we assume that $\alpha \in (\frac{1}{2}, \frac{3}{2})$, and we set $\gamma = 0$. With $W_{ii} = 1 - 4\alpha$, the SOC for the maximization of the integrated economy welfare is fulfilled. The solution to the FOC $W_i(r, r) = 0$ is

$$r^J = \frac{1}{4}\left(\frac{\alpha - \frac{1}{2}}{\alpha - \frac{1}{4}}\right) \begin{cases} > 0 \\ < \frac{1}{5} \end{cases}$$

Hence, $0 < r^J < r^0$ as assumed in (7). The assumed range of α also ensure that $V_{12}^A = \frac{1}{4}(1 - 2\alpha) < 0$, as assumed in (9).

4.3 Outcomes absent adherence to jurisdictional principles

If the regulatory authorities were to abstain from regulating the FRAND commitments, the license fees would be $\mathbf{r}^0 > 0$. But this will not be the outcome if the authorities see themselves free to regulate as they wish. Regardless of the pattern of ownership of the SEPs, each holder of SEPs will be the national of one of the countries, but not of the other. The interest of this second country is to minimize the fee for this SEP, either because this increases domestic consumer welfare, or the profits of the producer. With no rules on the allocation of jurisdiction, country i would therefore impose a regulation $m_j^{No} = 0$ on license fee r_j. Since this applies to both SEPs, the outcome absent regulation is $\mathbf{r} = \mathbf{m}^{No} = \mathbf{0}$ ("No" being a mnemo for "no jurisdictional rules").

Lemma 2 *Absent rules on jurisdiction, the equilibrium features zero license fees for both SEPs.*

Since we are assuming that $\mathbf{r}^J > 0$, there is too stringent regulation absent adherence to jurisdictional principles. We are now prepared to address our main issue, the virtues and vices of the jurisdictional bases in the default rules.

5 The performance of the two basic jurisdictional principles

Jurisdiction can be exercised with respect to acts, actors and the objects involved. The identification of the relevant acts, actors and objects can sometimes be difficult. But in the present case, it seems reasonable to see the relevant acts as the demands by the SEP holders regarding license fees, the actors as the SEP holders, and the objects as the SEPs. Jurisdiction over these entities can potentially derive from any or several of the three jurisdictional bases discussed above.

5.1 The Territoriality Principle

The main territorial dimension of acts is the location where they take place. This is of course a central determinant of jurisdiction incases of e.g. violent crimes. But in our setting it seems to be of less importance whether the negotiations regarding the SEP license fees physically take place in one country or the other, if this is at all possible to determine. Also, it is hard to see how the identity of the actors have any territorial significance beyond the location of the acts that they commit (and their nationality, which falls under another principle). The objects at issue, the SEPs, have clear territorial features however, since the patents apply to the territory of country A, and only to this territory. We thus presume that an application of the Territoriality Principle gives country A jurisdiction over both SEPs.

The regulation with jurisdiction allocated according to the Territoriality Principle will thus be given by the solution to RA's problem

$$\max_{m_1, m_2} \ V^A(\mathbf{r}(\mathbf{m}))$$

with $\mathbf{r}(m)$ defined in (11). RA incentives with respect to the license fee for the foreign-owned SEP 2 is clear: it will prefer r_2 to be as low as possible, since this will minimize the consumer price, and maximize the revenue available for SEP holder 1 to share with the foreign producer:

$$
\begin{aligned}
V_2^A &= U_2 + \alpha L_2^1 \\
&= -DP_2 + \alpha r_1 D_p P_2 < 0,
\end{aligned}
\tag{12}
$$

Since RA can implement $r_2 = 0$ without reducing its choice set with regard to r_1, it will do so by setting $m_2 = 0$.

RA has conflicting interests with regard to the license fee for SEP 1:

$$
V_1^A = -DP_1 + \alpha[D + r_1 D_p P_1] \gtrless 0
$$

Hence, an increase in r_1 drives up the product price and thereby reduces consumer welfare, $U_i < 0$. The resulting lower demand tends to reduce the license revenue. But a higher r_1 has the direct effect of increasing the revenue for SEP 1. But RA's most preferred fee for SEP 1 is strictly positive, since

$$
V_1^A(0,0) > V_1^A(r^J,0) > V_1^A(r^J,r^J) = -V_1^B(r^J,r^J) > 0
$$

where the first inequality follows from $r^J > 0$ and $V_{11} < 0$, the second inequality from $r^J > 0$ and $V_{12}^A < 0$, and the equality from the definition of r^J. The first-order condition for an interior m_1 is hence

$$
V_1^A(m_1,0) = -DP_1 + \alpha[D + m_1 D_p P_1] = 0
\tag{13}
$$

One possible outcome is that RA prefers to restrict the maximum FRAND-compatible license fee to $m_1' < r^0$, with $m_1' = r_1' > 0$ given by

$$
V_1^A(r_1',0) = 0.
\tag{14}
$$

This requires that $\alpha > P_1$. This most preferred outcome for RA will be implemented if $r_1' \leq N^1(0)$, since RA can then restrict the license fee to its most preferred level by setting $m_1' = r_1'$. The other possibility is that RA would prefer a license fee $r_1' > N^1(0)$. The implemented outcome will then be $N^1(0)$, since this is what will be negotiated given the constraint $m_2 = 0$. There is consequently in this case no point for RA to intervene regarding the FRAND commitment for SEP 1. Whether RA will prefer choose one or the other will depend on the relative weight it puts on license revenues relative to consumer welfare. Let α' be such that

$$
V_1^A(N^1(0),0;\alpha') \equiv 0
\tag{15}
$$

It follows from (2) that V_1^A increases in α. Hence, for $\alpha > a'$, RA prefers a license fee that exceeds

$N^1(0)$.

Lemma 3 *When SEP holder 1 is a country A national, and holder 2 is a national of country B, RA will regulate the FRAND commitments for the two SEPs such that:*
(i) $\mathbf{r} = (r_1', 0)$ *with* r_1' *given by (14) for* $\alpha < \alpha'$ *and* α' *given by (15); and*
(ii) $\mathbf{r} = (N^1(0), 0)$ *for* $\alpha \geq \alpha'$.

When deciding on its regulations, RA disregards the interests of country B. From the point of view of the integrated economy, it will therefore be too restrictive vis-à-vis the holder of SEP 2, since $r^J > 0$. But RA will be too lenient regarding the FRAND commitment by the holder of SEP 1. This is clearly the case if $m_1 = N^1(0)$, since $N^1(0) > r^J$. The same holds when $m_1 = r_1'$ as given by (14):

$$
\begin{aligned}
W_1(r_1', r^J) &= V_1^A(r_1', r^J) + V_1^B(r_1', r^J) \\
&< V_1^A(r_1', 0) + V_1^B(r_1', r^J) \\
&= V_1^B(r_1', r^J) < 0
\end{aligned}
$$

again using $V_{12}^A < 0$. Hence, $r_1' > r^J$ by $W_1(r_1', r^J) < 0$.

Proposition 1 *The Territoriality Principle implies that the patent-issuing country will be too lenient in its enforcement of the FRAND commitment for its domestically owned SEP, and too strict in the enforcement of the commitment of the foreign-owned SEP.*

5.2 The Nationality Principle

We next turn to the implications of the Nationality Principle. Acts do not seem to have nationality in any meaningful way, at least not here, so this will not serve as a basis for allocating jurisdiction. But actors obviously have nationality. The Nationality Principle would thus allocate jurisdiction for each of the SEPs to the home country of the respective holder. The objects in question, the patents, could possible be said to have nationality in that they are issued by country A. But it seems plausible that the nationality of the actors should dominate from point of view of the Nationality Principle. We will hence interpret this principle as giving regulatory authorities jurisdiction over their respective national SEP holders.

When each authority regulates only the FRAND commitment of its domestic SEP, the equilibrium regulation will be (m_1', m_2') given by

$$
\begin{aligned}
m_1' &= \arg\max_{m_1} V^A(m_1, m_2') \leq N^1(m_2') \\
m_2' &= \arg\max_{m_2} V^B(m_1', m_2) \leq N^2(m_1')
\end{aligned}
$$

16

The Nationality Principle hence creates a setting that differs in a fundamental way from the one derived from the Territoriality Principle, in that the implemented license fees will depend on decisions by *both* authorities. That is, the nationally pursued regulations will interact in certain situations to determine the outcome.

A Nash equilibrium can be of three different types.[22]

Neither license fees is regulated   When neither fee is subject to binding regulation, the outcome is $\mathbf{r} = \mathbf{r}^0$. Setting $\mathbf{m} \geq \mathbf{r}^0$ will be individually rational for the authorities if

$$V_1^A(\mathbf{r}^0) \geq 0 \text{ and } V_2^B(\mathbf{r}^0) \geq 0.$$

Such a situation can arise if α is large enough that both regulatory authority prefer such high licenses fee that they cannot be implemented through the negotiations between the producer and the SEP holders. This type of equilibrium is compatible with the assumption $0 < \mathbf{r}^J < \mathbf{r}^0$ since

$$
\begin{aligned}
W_1(\mathbf{r}^0) &= V_1^A(\mathbf{r}^0) + V_1^B(\mathbf{r}^0) < V_1^A(\mathbf{r}^0) \\
W_2(\mathbf{r}^0) &= V_2^A(\mathbf{r}^0) + V_2^B(\mathbf{r}^0) < V_2^B(\mathbf{r}^0)
\end{aligned}
$$

So the national authorities will allow for higher license fees than the regulated fees in the integrated economy.

Both fees are regulated   Both fees will be regulated if the authorities choose $\mathbf{m}'$ with the property that $m_i' < N^i(m_j')$. In this case the fees will be given by

$$
\begin{aligned}
V_1^A(\mathbf{r}(\mathbf{m}')) &= U_1 + \alpha L_1^1 = 0 \\
V_2^B(\mathbf{r}(\mathbf{m}')) &= \gamma \Pi_2 + \alpha L_2^2 = 0
\end{aligned}
$$

This outcome requires that α is large enough to make both authorities prefer strictly positive fees, but low enough that the implementation constraints are not violated.

In this case, both equilibrium fees would again be higher than in the integrated economy:

$$
\begin{aligned}
W_1(\mathbf{r}(\mathbf{m}')) &= V_1^B < 0 \\
W_2(\mathbf{r}(\mathbf{m}')) &= V_2^A < 0
\end{aligned}
$$

Note that this type of equilibrium can have the feature that even though both FRAND regulations are binding, one of regulations is more lenient than the level that the license fee would have

---

[22] One potential symmetric Nash equilibrium would be that both authorities set their respective fee to its minimum level, $m_1^A = m_2^B = 0$, so $\mathbf{r} = (0,0)$. This requires that α is sufficiently small that $V_1^A(0,0) < 0$ and $V_2^B(0,0) < 0$. But this outcome is not compatible with the assumption that the jointly optimal outcome is strictly positive, $\mathbf{r}^J > 0$.

absent regulation: $m_i < r^0 < m_j$. The reason is that when $m_i < r^0$, there will be more surplus for the parties to divide in the negotiation over SEP j. This implies that the unconstrained negotiation over r_j would yield $N^j(m_i) > r^0$. Hence, if $r^0 < m_j < N^j(m_i)$, the outcome in this negotiation is restricted to m_j, implying both restrictions are binding.

One fee is regulated but not the other The third possibility is that license fee i is regulated, but not fee j. The resulting fees will then be $r_i < r^0 < r_j$, with the fees being on the boundary of the set of implementable license fees: $r_j = N^j(r_i)$. For this to occur there must be sufficient asymmetry between the objectives of the two authorities. For instance, this can arise if RA mostly cares about consumer welfare, while RB is mainly concerned with the revenue of its license holder. This can be the outcome if α is small, and γ sufficiently smaller than α; the role of the countries will be reversed if γ is large. Assume e.g. that RB sets $m_2 \geq N^2(0)$. The optimal regulation for RA would then be the m_1' that solves

$$m_1' = \arg \max_{m_1 \leq r^0} V^A(m_1, N^2(m_1))$$

The interior solution m_1' to RA's problem is given by the solution to the FOC

$$V_1^A(m_1, N^2(m_1)) + V_2^A(m_1, N^2(m_1))N_1^2(m_1) = 0 \tag{16}$$

Note that this equilibrium has a novel feature in that RA's problem now has a flavor of Stackelberg leader problem, although decisions (the choice of the level of FRAND regulations) are still made simultaneously: RA now effectively determines *both* license fees: $r_1 = m_1$ and $r_2 = N^2(m_1)$. The higher is m_1, the higher the negotiated r_1 (up to $N^1(m_2)$), and the lower will be the negotiated r_2. The reason is the combination of the fact that RB here effectively leaves regulation to RA, and the interrelationship of the two bargaining problems regarding the license fees. RA will hence balance the implication of its choice of m_1 for r_1 against the effect on r_2. The latter effect will tend to lead to a less restrictive regulation of the license fee for SEP 1.

We assumed so far that $m_2 \geq N^2(0)$. But m_2 will of course be chosen by RB. For $(m_1', N^2(m_1'))$ to be a Nash equilibrium, it must be optimal for RB not to set $m_2 < N^2(m_1')$, that is, it is required that[23]

$$V_2^B(m_1', N^2(m_1')) \geq 0. \tag{17}$$

---

[23]We here assume that RB sets $m_2 \geq N^2(0)$, but what is required for the Nash equilibrium is the less stringent $m_2 \geq N^2(m_1')$. However, if RB prefers $m_2 < N^2(m_1')$, the above type of equilibrium will not arise. It will then instead be given by $(R^1(m_2), m_2)$ with $m_2 > r^0$ given by

$$V_2^B(R^1(m_2), m_2) = 0,$$

implying that both negotiated license fees are regulated.

Observation 1 *When each authority regulates the FRAND commitment for its domestically held SEP only, and the authorities have asymmetric preferences regarding the optimal patent fees for their respective SEPs, the authority with a preference for a lower fee can use a lenient enforcement of its domestic FRAND commitment as a strategic device to reduce the negotiated fee for the foreign-owned SEP.*

Turning to the efficiency of the FRAND regulations in this case, it is clear that $m'_2 > r^0 > r^J = m^J$. The enforcement regarding SEP 1 will also be too lenient, given m'_2:

$$
\begin{aligned}
W_1(m'_1, m'_2) &= V_1^A + V_1^B \\
&= -V_2^A N_1^2 + V_1^B < 0
\end{aligned}
$$

by (16), $V_1^B < 0$, and $N_1^2 < 0$.

We can thus summarize our findings regarding the efficiency of the Nationality Principle as follows:

Proposition 2 *With the Nationality Principle each regulatory authority will enforce the FRAND commitment of its domestic SEP holder too leniently, resulting in too lenient enforcement of both FRAND commitments.*

Note that the strategic incentive that is highlighted in Observation 1 can be sufficiently strong that the authority it optimal for the authority to allow for such a high fee for its domestically held SEP, that it cannot be implemented through the bargaining between the producer and the license holder. In this case there is no interior solution to (16), in which case the Nationality Principle would yield the same outcome as if neither party enforced FRAND commitments.

5.3 The relative performance of the two jurisdictional bases

We have argued that in the present setting, the Territoriality Principle gives exclusive jurisdiction over the SEPs to the country where the patents are issued (country A). This will result in too lenient regulation of this country's domestically owned SEP, and too strict regulation of the foreign-owned SEP. The Nationality Principle, by instead allocating jurisdiction based on the SEP holders nationality, results in too lenient regulation of both SEPs. There is hence a clear pattern for the inefficiencies arising with these jurisdictional principles:

Observation 2 *Regulating countries will seek to impose too lenient enforcement of domestically owned SEPs, and too stringent regulation of foreign-owned SEPs.*

Consequently, neither jurisdictional base will persistently implement the efficient outcome for the integrated economy. However, for each of the jurisdictional bases, there is a situation where it implements an efficient outcome, despite unilateral decision making.

First, the Territoriality Principle gives country A jurisdiction over both SEPs and as a result leads to the maximization of V^A only. It follows from (??) and (??) that $m_1^{TP} > r^J$. But assumed that $\gamma = 0$, so that RB's only concern is the with license revenue for the holder of SEP 2. m_1^{TP} and r^J will then both converge to 0 at $\alpha = P_i(0,0)$. That is, the outcome with the Territoriality Principle and the jointly efficient solution converge as α becomes small, at a corner solution.[24] In this case, the Nationality Principle will still implement a large r_2^{NP} since RB is only concerned with the license revenue. The Nationality Principle hence performs worse than the Territoriality Principle. What more, in this case it will be *directly harmful,* relative to letting both authorities regulate both FRAND commitments, to restrain regulation by imposing the Nationality Principle, since this would imply maximally restrictive regulations.

Second, if instead that the regulatory authorities are effectively only concerned the license revenues of their respective SEP holders (i.e., α is large), the interests of the authorities would be in direct conflict, since a higher license fee for one SEP reduces the negotiated fee for the other fee. Allocating jurisdiction to RA only, as prescribed by the Territoriality Principle, will then severely harm authority RB, since RA will set $m_2 = 0$. In this case the Nationality Principle performs better, since each authority can ensure a positive license fee for its domestically held SEP. Since both regulatory authorities disregard the adverse external effects of a high license fee for their respective domestically held SEP, the fees will be too high: $r_i^{NP} > r^J$. But as α increases, the regulation will eventually become ineffective, $r_i^{NP} = r^0$. As α increases further, $\mathbf{r}^J$ will converge toward $\mathbf{r}^{NP} = \mathbf{r}^0$.

In sum:

Proposition 3 *With split ownership of the SEPs:*
(i)   As α approaches $P_i(0,0)$, the license fees with the Territoriality Principle converge to the efficient outcome, while the Nationality Principles yields lower welfare than if both countries disregard jurisdictional rules.
(ii) As α gets large, the license fees with the Nationality Principle converges to the efficient outcome, and it dominates the Territoriality Principle.

The Territoriality Principle leads to the maximization of V^A only. The Nationality Principle instead allows both objective functions to be maximized, but it has the disadvantage of causing each of the maximizations be done with respect to one of the fees only. Hence, neither principle can implement full efficiency in general. The Proposition illustrates two very different reasons for why unilateral decision making can still lead to a jointly efficient outcome.

One reason is that a regulating authority has command over all regulation, and behaves *as if internalizing* the external effects of its decisions. This is what occurs in the case above where α gets small, and the Territoriality Principle applies. When α gets small, the two authorities' interests tend to become aligned, since the prime objective for RA—consumer surplus—and the prime objective

---

[24]If $0 < \gamma < \alpha$, $r^J = 0$ for $m_1^{TP} > 0$. But as α converges to $P_i(0,0)$, m_1^{TP} converge to 0.

for RB—producer profit—both benefit from low fees. Hence, letting RA regulate both fees, as prescribed by the Territoriality Principle, will not be very harmful to RB.

The other reason why unilateral decision making leads to an efficient outcome is that *the decisions are constrained,* so that there is no interior solution to the parties unilateral decision problems. When the authorities are concerned with their respective domestic license fees only, they do not behave as if they were re will not be any implicit internalization of external effects with the Nationality Principle. The reason why there is a convergence with the efficient outcome is instead that the authorities reach a limit for how high fees that they can implement.

Observation 3 *The Territoriality Principle performs best when the regulatory authorities have a common interest in maintaining low license fees for both SEPs, and Nationality Principle when each authority prefers a high license fee for its domestically held SEP.*

5.3.1 The international pattern of ownership of the SEPs

The framework above assumed that there is one SEP holder in each country. This seems to capture the essential aspect of what is the most common setting for SEPs affecting international markets, where SEP ownerships are split among countries. But there can of course also be the more extreme cases where all SEP holders are nationals of the same country. The statements in Propositions 1 and 2 continue to hold for these settings as well.

To see why, consider first the Territoriality Principle. When neither of the SEP holders is a national of country A, the objective of the country A regulatory authority is simply to maximize consumer surplus: $V^A(\mathbf{r}) \equiv U(\mathbf{r})$. This is achieved by restricting the license fees as much as possible. Hence, the optimal regulation for RA is in this case $m_1 = m_2 = 0$. Since the jointly optimal levels are strictly positive, this regulation is too strict.

When instead both SEP holders are country A nationals, RA will take their revenues as well into account:

$$V^A(\mathbf{r}) \equiv U(\mathbf{r}) + \alpha \sum L^i(\mathbf{r}) \tag{18}$$

RA will prefer $\hat{\mathbf{r}} = (\hat{r}, \hat{r})$ given by $V_i^A(\hat{\mathbf{r}}) = 0$. RA will thus choose the regulation $\mathbf{m} = \hat{\mathbf{r}}$, provided that $\hat{\mathbf{r}} \leq \mathbf{r}^0$ so that $\hat{\mathbf{r}}$ can be implemented. Since RA will now allow for a strictly positive fee for SEP 2, it follows from $V_{12}^A < 0$ that $m_1 = m_2$ will be more stringent than what RA imposes on SEP 1 when the SEP holder 2 is a national of country B. The assumption that the jointly efficient fee $\mathbf{r}^J$ is interior $(0 < \mathbf{r}^J < \mathbf{r}^0)$, and thus here given by

$$V_i^A(\mathbf{r}^J) + \gamma \Pi_i(\mathbf{r}^J) = 0,$$

implies that $V_i^A(\mathbf{r}^J) > 0$. That is, the optimal regulation for RA is $\mathbf{r}^J < \mathbf{m} = \hat{\mathbf{r}} \leq \mathbf{r}^0$.

It follows that Proposition 1 holds for these more extreme settings as well, when slightly reworded to reflect the number of SEP holders for the patent-issuing country.

Now turn to the Nationality Principle. When both SEP holders are nationals of country A, country A will have full jurisdiction. The outcome will be the same as with the Territoriality Principle, since RA maximizes the objective function (18) in both cases. This implies too lenient treatment of both FRAND commitments, since RA will disregard the implications for the profits of the producers. If instead both SEP holders are nationals of country B, country B has full jurisdiction according to the Nationality Principle. RB will then be too lenient, since it does not take into account the negative effect of the fees on consumers in country A. Hence, Proposition 2 continue to hold, slightly reworded.

The findings above are thus robust to these other ownership patterns. But note though that the pattern of ownership of the SEPs still has two qualitatively different implications for the outcome:

Observation 4 *The pattern of ownership affects:*
(i) the allocation of jurisdiction that stems from the Nationality Principle; and
(ii) for each allocation of jurisdiction, also the objective function(s) of the regulating authority(-ies).

5.3.2 Overlapping jurisdiction

In the above we considered implications of the two main jurisdictional bases, one base at the time. As mentioned above, the more recent interpretation in international law regarding jurisdictional rules does not impose a hierarchy among the different bases. This implies that it is possible for several countries to simultaneously claim jurisdiction over acts, persons or objects, with reference to different principles. Such overlapping jurisdiction has become even more likely with the increased emphasis on the Effects Principle (see below)

To see some implications of such overlapping jurisdiction, consider a setting where ownership of the SEPs is split among the countries, and where both the Territoriality and the Nationality Principles are applicable. Country A can thus claim jurisdiction over the FRAND commitments for both SEPs based on the Territoriality Principle, and country B can argue it has jurisdiction over the FRAND commitment by the SEP holder 2, based on the Nationality Principle. The outcome will be the same as with the Territoriality Principle: there will then be overlapping jurisdiction for SEP 2, but the more stringent regulation will prevail. So the outcome will be $m_2 = 0$ and m_1 will be given by (13), as when RA is the sole regulator.

If both SEPs are instead owned by country A, the Nationality Principle does not have a bite, so the outcome with both principles being applicable is the same as with the Territoriality Principle. If both SEP holders are instead nationals of country B, both regulatory authorities have jurisdiction over both FRAND commitments. Hence, the outcome is maximal stringency for both FRAND commitments, as with the Territoriality Principle in this case: $m_1 = m_2 = 0$.

Observation 5 *Allowing for overlapping jurisdiction based on the Territoriality and Nationality Principles is either inconsequential or reduces joint welfare.*

6 Non-discrimination obligations

Several of the equilibria that were derived above feature some form of *differential enforcement* of the FRAND commitments for the SEP holders. At the same time, in the setting were are considering, efficiency requires that the license fees are identical, due to the completely symmetric way in which they affect the producer, and joint welfare. It is therefore natural to wonder whether the outcome would be better if some form of non-discrimination requirement were imposed.

For a non-discrimination obligation to have a bite, three conditions must be simultaneously fulfilled:

- the SEP holders have *different nationalities*, or they would not be treated differently;

- a regulating authority must regulate *more than one* SEPs*; and

- this authority somehow treats a foreign-owned patent *less favorably* than a patent with a domestic holder.

Such situations can arise in some but not all of the settings considered above.[25] There are in trade law two concepts that could be of relevance, either as the law already stands, or as natural obligations to include in any agreement on FRAND enforcement. As will be shown, these concepts provide mechanisms that can improve the properties of the Territoriality and Nationality Principles, and is also of the Effects Principle, which will be briefly examined.

6.1 The Territoriality Principle with a National Treatment obligation

The Territoriality Principles implies the regulating patent-issuing country will want to discriminate based in the *nationality* of the SEP holders. Differential enforcement of the FRAND commitments might not be legal, however. Virtually all countries are members of the World Trade Organization (WTO), and as such are legally bound to respect the *Agreement on Trade-Related Aspects of Intellectual Property Rights* (the TRIPs Agreement). The first part of the National Treatment (NT) provision in Art. 3 TRIPs states:

> Each Members shall accord to the nationals of other Members treatment no less favorably than that it accords it own nationals with regard to the protection of intellectual property, subject to the exceptions already provided in [various conventions].

NT provisions regarding intellectual property rights are also almost invariably included in other major trade agreements. Hence, countries are typically legally bound not to discriminate between

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[25]Since we are assuming that CA sets a more stringent restriction on the license fee for the foreign SEP absent a National Treatment obligation, we disregard that National Treatment provisions normally are in the form of weak inequalities, such as "treatment no less favorable than...".

domestic and foreign SEP holders. The TRIPs agreement has not been invoked in FRAND cases, so there is no case law on its applicability. We therefore do not claim that it is applicable. But it seems reasonable that more stringent treatment of a foreign-owned than a otherwise completely symmetric domestically-owned SEP could amount to "less favorable treatment" of the foreign-owned intellectual property right. It also seems plausible that a main component of any international agreement on FRAND enforcement would be some form of NT provision.

Consider the case where the ownership of the SEPs is split between the countries, and where jurisdiction is allocated to RA according to the Territoriality Provision. Absent the NT obligation, RA would choose $m_2' = 0$ and $m_1' < r^0$ given by (14). The difference in the regulated levels would thus be $m_1 - m_2 = m_1' > 0$. To see the effect of NT, and consider an NT obligation that requests RA to reduce this gap with a *marginal* amount.[26] To abide by the NT rule, RA could either reduce m_1, increase m_2, or some combination of the two. A reduction change in m_1 will not have any first-order effect at $(m_1', 0)$ since $V_1^A(m_1', 0) = 0$. But increasing m_2 will have a negative first-order effect equal to $(-D + \alpha r' D_p) P_2 < 0$. Hence, RA's optimal adjustment to a slightly binding NT rule would be to reduce m_1, while maintaining m_2 constant. A marginally binding NT obligation will be desirable from a joint efficiency perspective, due to the reduction in r_1:

$$W_1 = V_1^B < 0$$

Faced with the imposition of a *strict* NT rule, requesting equal regulation of the two FRAND commitments, RA in principle has two options. One option is to regulate both commitments. This requires equal treatment: $m_1 = m_2 = m''$. If if $\alpha > 2P_i(0,0)$ there will be an interior solution to RA's problem, given by the solution to

$$V_1^A(m'', m'') + V_2^A(m'', m'') = -2DP_i + \alpha[D + 2m''D_pP_i] \tag{19}$$
$$= 0,$$

In the opposite case RA will prefer the corner solution $m_1'' = m_2'' = 0$. The other option for RA would be to abstain from regulating the FRAND commitment for SEP 2, which would then remain unregulated. RA would then set the m_1' that solves

$$V_1^A(m_1', N^2(m_1')) + V_2^A(m_1', N^2(m_1'))N_1^2(m_1') = 0 \tag{20}$$

in awareness of the fact that the choice of m_1 will affect also r_2. This second option is relatively more attractive for RA, the more weight it puts the license revenue of SEP 1, since it allows RA to be less restrictive vis-à-vis the holder of SEP 1. We cannot rule out either option as the inferior choice for RA.

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[26] Horn (2006), ...(2008), and Horn, Maggi and Staiger (2011) examine basic aspects of National Treatment provisions embedded in the traditional enviroment, trade agreements.

The welfare implications of the strict NT obligation are ambiguous in general, and depend on the extent to which the interests of RA are aligned with those of RB. On the one hand, it can yield the fully efficient outcome. To see this, note that at an interior solution $m_1 = m_2 = m''$, as defined in (19),

$$\frac{d}{dm}W(m'', m'') = -2\gamma D + \alpha D + 2\alpha m'' D_p P_i$$
$$= 2(P_i - \gamma)D$$

using the FOC for m'' above. The Territoriality Principle coupled with strict NT will hence lead to too lenient enforcement of the FRAND commitments if $P_i < \gamma$, and to too restrictive enforcement in the opposite case. In particular, if $P_i = \gamma$, RA will behave is if it were maximizing joint welfare. Intuitively, when RA imposes a uniform regulation on both FRAND commitments it will implicitly take full account of the effects on the license revenue for SEP 2 since it will be the same as that for SEP 1 due to the symmetry of the setting. What will matter to whether there is too lenient or stringent enforcement is the extent to which RA's concern for consumer welfare matches RB's concern for producer welfare. The implication for RA of a marginal increase in $m_1 = m_2$ that stems from reduce consumer welfare is $-2DP_i$, and the implication for RB's interest in profits of its producer is $-2\gamma D$. Hence, when $P_i = \gamma$, RA's marginal incentives are perfectly aligned with those of RB, and the efficient regulation is imposed.

More generally, coupling the Territoriality Principle with a strictly binding NT obligation hence normally has ambiguous implications for joint welfare. Indeed, it is even possible that this will reduce welfare relative to just imposing the Territoriality Principle.

Proposition 4 *If the SEP holders have different nationality, and jurisdiction is determined according to the Territoriality Principle:*
(i) Imposition of a marginally binding NT provision will improve joint welfare.
(ii) Imposing a strictly binding NT obligation can implement full efficiency, but can also reduce joint welfare.

6.2 The Nationality Principle with a consistency obligation

The Nationality Principle only gives the regulatory authorities jurisdiction over the enforcement of FRAND commitments of their domestic SEPs. Hence, since commitments regarding foreign SEPs are not regulated, there cannot be less favorable treatment in the standard sense, and an NT obligation will not have any bite. However, if the setting is extended to include more than one industry, a natural rationale for differential treatment arises also with the Nationality Principle. To illustrate, assume now that there are two industries, where an industry X is identical to the one examined above, and where industry Y is a mirror image of X with the roles of the countries reversed. Hence, each country is the producer of one product and the consumer of another product.

The two industries are economically separate. Production in industry X draws on two SEPs, the country A-owned X1 and the country B-owned X2, and production in industry Y uses the country A-owned Y1 and the country B-owned Y2.

If these two industries were both part of an the integrated economy, the regulatory authority in this economy would treat all FRAND commitments identically due the complete symmetry of the setting. But when this integrated economy is split into two mirror images, the national regulatory authorities will typically want to treat their two national SEP holders differently, *depending on whether the SEP is used in the export or import industry.* There would then again be differential treatment of SEP holders that stem from the international dimension. This would not be *de jure* discriminatory, since it would not constitute differential treatment of SEP holders according to nationality. But it could potentially be perceived as *de facto* discriminatory treatment.

For instance, suppose that authority RA imposes a more lenient regulation of the FRAND commitment for SEP Y1 in its export sector, than on the commitment for SEP X1 in its import sector, in order to protect domestic consumers in the latter. RA would then be discriminating in the sense that it would be treating its domestic SEPs differently depending on how the costs are and benefits of the regulation are distributed internationally. This will not be efficient, as we have seen.

The WTO Agreement includes in one of its special agreements a requirement to treat risks from e.g. foodstuffs in a *consistent manner* across different situations:

> ...each Members shall avoid arbitrary or unjustifiable distinctions in the levels [of risk] it considers to be appropriate in different situations, if such distinctions result in discrimination or a disguised protection of international trade...[27]

The idea is hence that the regulatory regime should not vary across regulatory issues in order to promote trade interests.

Applying a similar type of consistency requirement to the present setting, consider the implication of imposing an obligation on the countries to enforce FRAND commitments in the same manner regardless of the sector where they are used. RA will then impose a regulation $m_{X1}^A = m_{Y1}^A = m^A$ that for $m_{X2}^B = m_{Y2}^B = m^B$ solves

$$\max_{m^A} U^X(m^A, m^B) + \alpha L^{X1}(m^A, m^B) + \alpha L^{1Y}(m^A, m^B) + \gamma \Pi^Y(m^A, m^B)$$

where the first two terms is the welfare derived from the X industry, and the second two terms that derived from the other industry. RB would solve the corresponding problem. Note that due to the assumed full symmetry of the setting, the regulatory authorities would now effectively maximize joint welfare. The outcome would then be *fully efficient*, as in the integrated economy.

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[27]Art. 5.5 of *The Agreement on the Application of Sanitary and Phytosanitary Measures.*

Intuitively, absent the consistency requirement, the two industries are economically separate, implying that the authorities decision problem for one industry is fully separate from that for the other industry. But the NT obligation bundles the two decision problems. Of course, each authority still disregards the impact of its decision for the other country. But with the obligation each authority will take into account the effects of its decision both with regard to the industry where it is an importer and where it is an exporter. When the countries are mirror images each regulatory authority will effectively maximize welfare with respect to the instrument it controls for an economy that is a replica of the other country. Full efficiency requires of course that the countries are mirror images. But the mechanism will be at play also in more asymmetric settings, although there full efficiency will not be achieved.

Proposition 5 *The Nationality Principle when supported by a consistency requirement that prevents differential treatment of FRAND commitments in different industries can implement the jointly efficient outcome if countries are symmetric.*

6.3 The Effects Principle with a National Treatment obligation

The Territoriality and Nationality Principles are the two classic bases for jurisdiction. But the Effects Principle has recently become important, not least in the area of antitrust, as discussed above. It gives countries jurisdiction to regulate when they are exposed to substantial effects from abroad. It is not clear how to capture "substantial" formally, however, which is why we have refrained from analyzing it above. It would not be meaningful to award jurisdiction solely based on the existence of effects, since in an economic system "everything depends on everything" normally.

We will nevertheless assume that the Effects Principle gives both countries jurisdiction over the enforcement of FRAND commitments for both SEPs, for two reasons. Most importantly, this interpretation of the Effects Principle helps illuminate a subtle implication of the National Treatment obligations that will likely be at play also with more refined interpretations of the principle. The second reason is that in the type of setting considered here, both countries would in practice probably claim jurisdiction. Country A would argue that the objective for the regulation of FRAND commitments, in particular if undertaken through antitrust, is consumer protection, and that the substantial effects from violations of FRAND commitments therefore appear in country A, and that it consequently should have sole jurisdiction. But country B would point to the importance of the SEPs for its export industry, and claim that FRAND enforcement is not of concern only for ultimate consumption; indeed, countries such as China, South Korea and Taiwan appear to have argued along the latter line in actual cases. Both countries could therefore plausibly see themselves exposed to sufficiently substantial effects to claim jurisdiction.

The outcome absent a National Treatment obligation is easily seen. When both countries exercise jurisdiction over both FRAND commitments, each authority will prefer the license fee for any foreign-owned SEP to be as low as possible. Since the more stringent of the regulations bind when

they are overlapping, the implemented outcome is clear: $\mathbf{r} = (m_1^B, m_2^A) = (0,0)$. Note, however, that even if the equilibrium regulations treat both SEP holders identically, each authority imposes a more stringent regulation the other country's SEP than on its domestic SEP—both countries hence have discriminatory regulations, but the same regulation is imposed on both SEP holders.

Observation 6 *When the Effects Principle yields overlapping jurisdictions, the separate regulations will be discriminatory, but the policy treatment will be the same for the SEP holders.*

Consider then the imposition of a strict NT obligation that requires each authority to impose the same regulation on both SEPs; the two authorities hence set m^A and m^B, respectively. The lower of m^A and m^B will be the binding regulation for both SEPs, provided that it is low enough to be implementable through the license fee negotiations. RA's optimal regulation is given by an identical expression to (19). Evaluating such an expression at RA's optimal regulation absent the NT obligation, m_1':

$$
\begin{aligned}
\frac{d}{dm}V^A &= V_1^A(m_1', m_1') + V_2^A(m_1', m_1') \\
&< V_1^A(m_1', 0) + V_2^A(m_1', m_1') \\
&= V_2^A(m_1', m_1') < 0
\end{aligned}
$$

where the inequality follows from $V_{12}^A < 0$. The NT obligation will hence induce RA to prefer more stringent FRAND enforcement for its domestically owned SEP, and less stringent regulation of the SEP with a country B holder. The same considerations apply to RB.

To see the implications of the NT obligation for aggregate welfare, assume RA prefers the more stringent regulation, $m^A < m^B$. It must then be that

$$
\begin{aligned}
\frac{d}{dm}W(m^A, m^A) &= \frac{d}{dm}[V^A(m,m) + V^B(m,m)] \\
&= \frac{d}{dm}V^B(m^A, m^A) > 0,
\end{aligned}
$$

where the inequality sign follows from the assumption that $m^A < m^B$, and that m^B is optimal for RB. The same reasoning applies in case $m^A > m^B$.

That is:

Proposition 6 *If the Effects Principle awards both countries jurisdiction over both FRAND commitments:*
(i)   License fees will be regulated to minimal levels absent a National Treatment obligation.
(ii)   With a National Treatment obligation regulations will be more lenient, but still be too restrictive, and joint welfare will be higher.

7 Concluding discussion

International law requires countries to respect the default rules for jurisdiction absent international agreements. These rules are crucial in almost every area of international interaction, including in the economic sphere. But the rules have still been subject little (if any) systematic economic analysis, to the best of our knowledge. The purpose of this paper has been to initiate the study of the ability of these rules to address international externality problems that arise from unilateral enforcement of FRAND commitments.

The paper is based on the notion that countries that are engaged in different parts of global production chains, will have different interests with regard to enforcement of FRAND commitments for SEPs. Countries can therefore differ in their trade-offs between making patented technologies available to implementers at low cost, and providing incentives for innovators to developed new technologies. The purpose of the paper is analyze how the two main jurisdictional principles, based on respectively territoriality and nationality, perform in various settings.

Broadly speaking, the findings suggest that the default rules should not be expected to fully address the inefficiencies that arise due to the unilateral regulation. These rules allocate jurisdiction, but *do not address the source of the externality problems*: the unilateral decision making regarding enforcement of FRAND commitments. Another weakness of the rules is that they *allow countries to purse discriminatory regulation*, despite this being inefficient. The paper identifies several mechanisms through which non-discrimination obligations might improve matters. But the findings nevertheless suggest that even when extended in this way, existing law does not suffice to resolve the problems regarding national enforcement of FRAND commitments in an economically efficient manner. This suggests the need for some form of internationally negotiated solution.

International comity agreements constitute steps toward more cooperative regulation. There are a few examples of such agreements in other areas of competition law. However, apart from the inherent problem of determining which party has the "greater interest," comity agreements have the drawback of allocating jurisdiction to the party with the larger *unilateral* interest, not to the party that will implement the jointly more efficient outcome. There are therefore limits to the extent to which such agreements can improve upon the outcome.

A more direct way of addressing the problem would be to negotiate an international agreement on principles for how to determine what constitutes reasonable license fees. As mentioned above, non-discrimination would presumably be a central component of such an agreement. While inspiration can be taken from existing clauses in other international economic integration agreements, such provision(s) would have to adopted to the specific issues at hand in the case of enforcement of FRAND commitments, as was seen above. It seems unlikely however that the major economies could reach such an agreement anytime soon, with their widely different views on how to enforce these commitments, and their different commercial interests. It thus looks like the world will be stuck with the current type of conflicts for the foreseeable future.

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A For Reviewers

This following analysis with a fully parametric version of the model.is not intended for publication, only to verify that the scenarios that are examined in the main text can arise with standard assumptions.

The market outcome for given r   Let gross consumer be

$$\tilde{U}(c) \equiv c - \frac{1}{2}c^2 + y,$$

where $0 < c < 1$ is consumption of the product of interest, and y is consumption of other products. The associated demand is $D(p) = 1 - p > 0$ for $p < 1$. For given license fees $r_i < \frac{1}{2}$, the optimal producer price is given by

$$P(\mathbf{r}) = \frac{1}{2}\left(1 + r_1 + r_2\right).$$

since the second-order condition (SOC) is fulfilled. Hence, $P_i = \frac{1}{2}$, consistent with (1). The relevant part of the maximized consumer welfare, the maximized profit, and the license revenues, are

$$U(\mathbf{r}) = \frac{1}{8}\left(1 - r_1 + r_2\right)^2, \quad \Pi(\mathbf{r}) = \frac{1}{4}\left(1 - r_1 - r_2\right)^2, \quad L^i(\mathbf{r}) = \frac{1}{2}r_i\left(1 - r_1 - r_2\right)$$

Properties (3) and (5)   The negotiated license fees are given by the first-order conditions (FOCs)

$$\frac{d}{dr_i}[L^i(\mathbf{r})\Pi(\mathbf{r})] = 0$$

It is verified below that the following SOCs hold:

$$\frac{d^2}{dr_i^2}[L^i(\mathbf{r})\Pi(\mathbf{r})] = -\frac{3}{4}\left(1 - 2r_i - r_j\right)\left(1 - r_i - r_j\right) < 0$$

The FOCs define "best reply" functions for the two negotiations

$$N^i(r_j) = \frac{1}{4}(1 - r_j).$$

Hence, consistent with assumptions (3) and (5),

$$\left.\frac{dr_2}{dr_1}\right|_{N^1} = -4 < \left.\frac{dr_2}{dr_1}\right|_{N^2} = -\frac{1}{4} < 0,$$

The (symmetric) unregulated market outcome is given by $r = \frac{1}{4}(1 - r)$, and is hence $\mathbf{r}^0 = (\frac{1}{5}, \frac{1}{5})$. Since $1 - 2r_i - r_j$ is maximized for $r_i = r_j = \frac{1}{5}$, in which case it is negative, the SOC for the

bargaining problem is fulfilled. It yields the joint welfare level

$$W^0 = \frac{3}{25}\alpha + \frac{9}{200}$$

If instead absent jurisdictional principles, both authorities regulate both SEPs, the outcome is $(0,0)$, with resulting welfare $W^{Over} = \frac{1}{8}$.

Properties (7) and (9) To avoid less interesting corner solutions, we assume that $\alpha \in (\frac{1}{2}, \frac{3}{2})$, and we set $\gamma = 0$. With $W_{ii} = 1 - 4\alpha$, the SOC for the maximization of the integrated economy welfare is fulfilled. The solution to the FOC $W_i(r, r) = 0$ is

$$r^J = \frac{1}{4}(\frac{\alpha - \frac{1}{2}}{\alpha - \frac{1}{4}}) \begin{cases} > 0 \\ < \frac{1}{5} \end{cases}$$

Hence, $0 < r^J < r^0$ as assumed in (7).The maximal joint welfare level is:

$$W^J = \frac{\alpha^2}{8\alpha - 2}$$

The assumed range of α also ensure that $V_{12}^A = \frac{1}{4}(1 - 2\alpha) < 0$, as assumed in (9).

NT can reduce welfare when the Territoriality Principle is employed Assume SEP holder 1 (2) resides in country A (B). When RA has exclusive jurisdiction over both licenses, it will set $m_2 = 0$ regardless of r_1.

$$V_2^A = -\frac{1}{4}(1 - r_1 - r_2 + 2\alpha r_1) < 0$$

V^A is strictly concave in r_1 since $V_{11}^A = \frac{1}{4} - \alpha$. The interior solution to the FOC with respect to r_1 is

$$r_1 = \frac{1}{2}\frac{\alpha - \frac{1}{2}}{\alpha - \frac{1}{4}} \begin{cases} < \frac{1}{2} \\ > 0 \end{cases}.$$

RA cannot implement a higher r_1 than what the negotiation gives, which for $m_2 = 0$ is $N^1(0) = \frac{1}{4}$. Hence, the critical value of α for which the implementation constraint starts to bite is given by

$$\frac{1}{2}\frac{\alpha - \frac{1}{2}}{\alpha - \frac{1}{4}} = \frac{1}{4},$$

or $\alpha = \frac{3}{4}$. The outcome is thus

$$m_1^{TP} = \begin{cases} \frac{1}{2}\frac{\alpha - \frac{1}{2}}{\alpha - \frac{1}{4}} & \text{if} \quad \frac{1}{2} < \alpha \leq \frac{3}{4}, \\ \frac{1}{4} & \text{if} \quad \frac{3}{4} < \alpha < \frac{3}{2}, \end{cases}$$
$$m_2^{TP} = 0.$$

where $m_1^{TP} > r^0 > m_2^{TP}$ is consistent with Proposition 1, and the resulting joint welfare is

$$W^{TP} = \begin{cases} \frac{\alpha^2}{8\alpha - 2} & \text{if} \quad \frac{1}{2} < \alpha \leq \frac{3}{4}, \\ \frac{3}{32}\alpha + \frac{9}{128} & \text{if} \quad \frac{3}{4} < \alpha < \frac{3}{2}. \end{cases}$$

Now consider strict NT. RA then has two options. One is to regulate FRAND commitments for both SEPs, constrained by strict National Treatment to set $r_1 = r_2 = 0$. $V^A(r, r)$ is strictly concave in r:

$$\frac{d^2}{dr^2}V^A(r, r) = 1 - 2\alpha < 0$$

Maximizing $V^A(r, r)$ over r yields the interior solution

$$r^{NT} = \frac{\alpha - 1}{4\alpha - 2}.$$

However, this is negative for $\frac{1}{2} < \alpha \leq 1$, so equilibrium regulations are

$$m^{NT} = \begin{cases} 0 & \text{if} \quad \frac{1}{2} < \alpha \leq 1 \\ \frac{\alpha - 1}{4\alpha - 2} & \text{if} \quad 1 < \alpha \leq \frac{3}{2} \end{cases}$$

with resulting RA welfare

$$V^A(m^{NT}, m^{NT}) = \begin{cases} \frac{1}{8} & \text{if} \quad \frac{1}{2} < \alpha \leq 1 \\ \frac{1}{8}\frac{\alpha^2}{2\alpha - 1} & \text{if} \quad 1 < \alpha \leq \frac{3}{2} \end{cases}$$

and joint welfare

$$W^{NT}(m^{NT}, m^{NT}) = \begin{cases} \frac{1}{8} & \text{if} \quad \frac{1}{2} < \alpha \leq 1 \\ \frac{1}{8}\frac{(4\alpha - 3)\alpha^2}{(2\alpha - 1)^2} & \text{if} \quad 1 < \alpha \leq \frac{3}{2} \end{cases}$$

The other option is to only regulate SEP 1. The equilibrium $\hat{m}_1^{NT}$ would then be given by

$$V_1^A(m_1, N^2(m_1)) + V_2^A(m_1, N^2(m_1))N_1^2(m_1) = 0$$

The SOC is fulfilled:

$$\frac{d^2}{dm_1^2}V^A(m_1, N^2(m_1)) = \frac{9}{64} - \frac{3}{4}\alpha < 0$$

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The interior solution to the FOC is

$$\frac{8\alpha - 3}{16\alpha - 3} > \frac{1}{5} = r^0$$

Since RA cannot achieve a higher r_1 than r^0, the outcome is $\hat{m}_1 = r_2 = \frac{1}{5}$. Since this yields RA the welfare level

$$V^A(\hat{m}_1^{NT}, N^2(\hat{m}_1^{NT})) = \frac{3}{50}\alpha + \frac{9}{200}$$

this option is netiher more attractive for RA than regulating both SEPs for $\alpha < 1$, since

$$\frac{3}{50}\alpha + \frac{9}{200} < \frac{1}{8},$$

nor when $1 < \alpha < \frac{3}{2}$, since

$$\frac{3}{50}\alpha + \frac{9}{200} < \frac{1}{8}\frac{\alpha^2}{2\alpha - 1}$$

Hence, with strict NT RA will regulate both FRAND commitments.

$W^{NT} < W^{TP}$ for each of the ranges $\frac{1}{2} < \alpha \le \frac{3}{4}$, $\frac{3}{4} < \alpha \le 1$, and $1 < \alpha < \frac{3}{2}$. Hence, strict NT reduces joint welfare for all α with the Territoriality Principle with $\gamma = 0$. This verifies the claim in Proposition 4 that the imposition of strict NT can reduce welfare in this case.

INTE HA MED I PAPPRET:

Proposition 2 Each country's authority regulates the FRAND commitment for its domestically held SEP only. V^B is strictly concave in r_2 since $V_{22}^B = -\alpha$. With

$$V_2^B = -\frac{1}{2}\alpha(r_1 + 2r_2 - 1) > 0$$

for all feasible fees, RB effectively will not regulate. Hence, the SOC condition for RA's problem is fulfilled:

$$\frac{d^2}{dm_1^2}V^A(m_1, N^2(m_1)) = \frac{9}{64} - \frac{3}{4}\alpha < 0$$

The interior solution to RA's FOC is

$$m_1 = \frac{8\alpha - 3}{16\alpha - 3} > r^0$$

which is too high to be implemented. Hence, neither authority will intervene: $r_1^{NP} = r_2^{NP} = \frac{1}{5} > r^J$ is consistent with Proposition 2. The resulting joint welfare is

$$W^{NP} = \frac{3}{25}\alpha + \frac{9}{200} = W^0$$

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Proposition ?? Comparing the outcomes with the Territoriality and Nationality Principles we can infer the following:

- $W^{TP} = W^{J}$ for $\frac{1}{2} < \alpha \le \frac{3}{4}$.

- $W^{TP} > W^{NP}$ iff $\frac{3}{4} < \alpha < \frac{3}{40}\sqrt{41} + \frac{27}{40} \approx 1.16 < \frac{3}{2}$.

- $W^{NP} < W^{Over}$ iff $\frac{1}{2} < \alpha < \frac{2}{3}$.

- $W^{J} > \max[W^{TP}, W^{NP}]$ for $\frac{3}{4} < \alpha < \frac{3}{2}$.

- $\alpha \to \frac{3}{2}$ implies that $W^{0} = W^{NP} \to W^{J}$.

These findings are consistent with Observation **??**.