MODELING THE ENFORCEMENT OF IPR THROUGH TRADE AGREEMENTS

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Abstract

We develop a modeling framework for ex-ante analysis of the economic effects of provisions of international trade agreements that protect and enforce intellectual property rights (IPR). The model focuses on the incentive compatibility of enforcement in the implementing country. Decisions to enforce IPR and the resulting effects on market prices and the profits of IP originators depend on the price responsiveness of demand in the market, total market size, the cost competitiveness of the IP owner relative to potential imitators, the costs of enforcing IPR, regulatory price caps in the market, the political economy weight assigned to repatriated monopoly profits, and the costs and productivity of efforts to innovate.

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1 Introduction

Recent U.S. trade agreements include provisions that strengthen the protection of intellectual property rights (IPR). For example, Chapter 20 of USMCA includes provisions that strengthen protection of trade secrets and regulatory data, patents, trademarks, geographical indicators, copyright provisions, and enforcement obligations.[1] This continues a trend toward stronger enforcement over the past 30 years.[2]

The economic effects of these IPR provisions depend on whether they are enforced. It can be difficult to effectively monitor enforcement efforts across borders, and there are concerns that enforcement falls short, even in countries that have entered into trade agreements with the United States. For example, U.S. Chamber of Commerce (2019) rates most U.S. trade agreement partner countries significantly lower than the United States in terms of IPR enforcement, and some even below China. U.S. Trade Representative (2019) placed Chile on its Priority Watch List and placed Canada, Colombia, Costa Rica, the Dominican Republic, Mexico and Peru on its Watch List based on specific concerns about the trade partners' enforcement of IPR.

To better understand enforcement decisions and the economic effects of IPR provisions in trade agreements, we develop an industry-specific modeling framework with enforcement effort that is shaped by economic incentives. We model the probability of IPR enforcement and the expected effects on market prices and the profits of IP originators. Our analysis is organized into two steps. First we model monopoly prices, quantities, and profits *assuming* complete enforcement of IPR in the implementing country. Then we model how enforcement efforts are shaped by incentives created by the international trade agreement. The modeling

[1] U.S. International Trade Commission (2019) compares IPR provisions in USMCA to their predecessors in NAFTA.

[2] U.S. International Trade Commission (2016) documents the evolution of IPR provisions in U.S. trade agreements, while Fink, Maskus and Qian (2016) discuss the trend toward strengthening the enforcement of IPR in non-U.S. trade agreements.

framework highlights economic questions related to IPR enforcement and identifies the data needed to answer them.

Decisions to enforce IPR and the resulting effects on prices and profits depend on the price responsiveness of demand in the market, total market size, the costs of enforcing IPR provisions, regulatory price caps, the political economy weight assigned to repatriated monopoly profits, and the costs and productivity of efforts to innovate. We extend the model to consider the effects of IPR protection on incentives to innovate.

The rest of the paper is organized into three sections. Section 2 introduces the monopoly model. Section 3 extends the model to consider the effect of IPR protection on innovation. Section 4 models enforcement. Section 5 discussed the joint determinants of expected economic effects. Section 6 concludes with a discussion of the challenges facing empirical application.

2 Monopoly Model

A first step in estimating the effects of IPR provisions is modeling the monopoly prices and profits generated by IPR protection, assuming enforcement. There is a large economics literature on this topic that considers various assumptions about the form of competition in the market, the ability to substitute to new products, and whether innovation is reflected in new products or new processes.[3] In this paper, we focus on a simple, tractable example with linear demand and perfect substitutes, though this part of the model could be much more complex to better fit a specific industry. Our model focuses on a single national market for a product with the following linear inverse demand curve:

$$p = \alpha \ - \beta \ q \tag{1}$$

[3]Maskus (2012) and Maxwell and Riker (2014) survey the economic literature on protecting IPR.

p_0 and q_0 are the initial price and quantity in the market. We assume that there is no IPR protection in the initial equilibrium. The initial market equilibrium is competitive, with p_0 equal to c_0, the marginal cost of imitators of the innovative product. The initial equilibrium quantity q_0 is equal to $\frac{\alpha}{\beta} - \frac{1}{\beta} p_0$.

Enforcement of the IPR generates monopoly profits for the IP originator. The marginal cost of the monopolist is equal to $c_m = \mu c_0$. If the monopolist has higher costs than potential imitators, then $\mu > 1$. The monopolist sets its price to equate its marginal revenue to its marginal cost. Equation (2) represents the monopolist's first order condition, assuming that the monopolist cannot price discriminate and there are not binding regulatory caps on prices in the market.

$$\alpha - 2 \beta q_m = c_m \tag{2}$$

Equation (1) and (2) jointly define the monopoly price if there are no price caps.

$$p_m = \alpha - \beta q_m = p_0 \left(\frac{1 + \frac{1}{\epsilon_0} + \mu}{2} \right) \tag{3}$$

The monopoly price, and therefore the percentage increase in market prices when IPR are enforced, is decreasing in the initial price elasticity of demand (ϵ_0) and increasing in the monopolist's relative marginal costs (μ).[4] If there is a binding price cap $\overline{p}$, then (2) and (3) do not hold. Instead, $p_m = \overline{p}$ and $q_m = \frac{\alpha}{\beta} - \frac{1}{\beta} \overline{p}$.

Equation (4) is the monopolist's variable profits if IPR are protected and prices are not capped.

$$\pi_m = (p_m - c_m) q_m = (p_0 q_0) \epsilon_0 \left(\frac{1 + \frac{1}{\epsilon_0} - \mu}{2} \right)^2 \tag{4}$$

[4]The absolute value of the initial price elasticity of demand, ϵ_0, is equal to $\frac{1}{\beta} \left(\frac{p_0}{q_0} \right)$.

The monopolist's profits are decreasing in the absolute value of the initial price elasticity of demand (ϵ_0) and the relative marginal cost of the monopolist (μ) and increasing in initial market size ($p_0\ q_0$).

Equation (5) is the loss of consumer surplus when IPR are protected.[5]

$$L = (p_m\ -\ p_0)\left(q_m\ +\ \frac{1}{2}(q_0\ -\ q_m)\right) = \frac{3}{2}\ \pi_m \tag{5}$$

The loss of consumer surplus is greater than the value of the monopolist's variable profits. If $\mu = 1$ (no difference in the marginal costs of the monopolist and its potential imitators), then the gap between L and π_m will only reflect the effect of market power. If $\mu > 1$, then the gap will also reflect a reduction in production efficiency. The loss of consumer surplus depends on the same factors that determine the monopolist's profits: L is decreasing in the absolute value of the initial price elasticity and the relative marginal cost of the monopolist and increasing in initial market size.

The implementing country might experience economic benefits from IPR enforcement that will offset part of the loss of consumer surplus, for example if a share of the monopoly profits are not repatriated to the IP-originating country and are spent in the implementing country. For example, non-repatriated profits might take the form of higher foreign affiliate wages that include a share of the monopoly rents, local tax revenues, or both.

3 Incentives to Innovate

IPR protection can create economic incentives for additional innovation.[6] Again, we focus on a simple, tractable example to illustrate these effects, though this part of the model could

[5]This calculation assumes that imitators would supply the market at p_0 absent IPR protection.

[6]These economic benefits for the IP-originating country are often called dynamic efficiencies. Fink et al. (2016) discusses the dynamic efficiency argument for protecting IPR.

also be much more complex depending on the application.[7] We assume that innovation is a costly and uncertain process. After incurring a fixed cost γ, a new product is invented with probability θ. Innovation does not displace existing products. Innovation will be profitable in expectation if the inequality in (6) holds.

$$\theta \ (\pi_m \ (1 \ - \ \omega) \ e \ + \ \pi_{row}) > \gamma \tag{6}$$

e is the probability that IPR will be protected, ω is the share of monopoly profits that are not repatriated to the IP-originating country (discussed at the end of Section 2), and π_{row} is the sum of repatriated monopoly profits from the rest of the world. We assume that attempts to innovate occur after the trade agreement has been signed but while there is still uncertainty about enforcement effort.

Innovation is more likely if innovation productivity, protected monopoly profits, and the share of profits that are repatriated are high, and it is less likely if innovation cost are high. If profits in the rest of the world are large relative to monopoly profits in the newly implementing country, then new IPR protection in the implementing country will not significantly affect the incentives to innovate.[8]

If (6) holds, then IPR protection would lead to the introduction of a new product with probability θ. In this case, the IPR protection would *not* reduce consumer surplus, since we are assuming that there is no comparable product available in the status quo that is displaced. In this case, there is a gain in consumer surplus that is due to the introduction of the new product. With linear demand, this gain in consumer surplus is equal to $\frac{1}{2} \ \pi_m$.

There are other scenarios in which IPR protection leads to the introduction of a new product into the market that would not be otherwise available. For example, in the phar-

[7]For example, incumbents and non-incumbents might have asymmetric incentives to innovate, and new products might add competition to the market without completely displacing the incumbent.

[8]For example, Park (2012) finds that the protection of IPR in developing countries does not have a strong positive effect on innovation in developed countries.

maceutical industry innovators' test data are submitted to regulators in the implementing country and international IPR provisions focus on prolonging the protection of these data from disclosure to imitators. Immediate generic imitation without the test data generally is not possible, so IPR protection increases consumer surplus by increasing product availability. (On the other hand, the scenario in Section 2 with a loss in consumer surplus is a better fit for copyrights on media content and other forms of IP where imitation is much easier and possibly immediate.)

4 Incentive Compatible Enforcement

The enforcement of IPR provisions is a sovereign decision of authorities within the implementing country, but the decision can be shaped by economic incentives created by an international trade agreement. An important second step in estimating the economic effects of IPR provisions is modeling the probability of enforcement. This starts with a careful review the language of the international agreement with respect to enforceability.[9] Is enforcement of the IPR provisions a requirement of the agreement or an aspirational goal of the parties? Are the burdens of proof for establishing violations appropriate? Are the procedures for dispute resolution adequate, or are there significant loopholes? Is effective monitoring possible? This type of textual analysis is outside of the scope of this paper, but it is a prerequisite to estimating the economic effects of the IPR provisions. If analysis of the text of the agreement suggests that the provisions are obligatory and enforceable, then we can move to the economic question: is enforcement of the IPR provisions incentive compatible?

A country without a history of strong IPR enforcement might be motivated to strengthen its enforcement in exchange for concessions it receives as part of an international trade

[9] U.S. International Trade Commission (2019) is an example of this type of analysis of the IPR provisions of a trade agreement.

agreement.[10] These concessions could compensate the IPR-implementing country for its loss of consumer surplus and its direct costs of IPR enforcement.[11] The concessions could be conditioned on enforcement of the IPR provisions.

In this section, we focus on a simple example based on a version of the textbook principal-agent model with moral hazard in Laffont and Martimort (2002). [12] We assume that enforcement is delegated by the IP-originating country to the IPR-implementing country. The IP-originating country is a risk-neutral principal, and the IPR-implementing country is an agent with limited liability. We assume that there are two possible enforcement outcomes, complete enforcement of IPR in the implementing country or no enforcement. The enforcement outcome is verifiable, but it is a noisy signal of the agent's enforcement effort.

The level of enforcement effort in the implementing country (represented by e) is normalized, so it ranges from zero to one.[13] The probability of complete enforcement is $f(e)$. This probability is equal to zero when there is no enforcement effort, increases in the level of effort, and approaches one as effort approaches its maximum. We assume that $f(e)$ is simply equal to e, following Laffont and Martimort (2002). The direct costs of enforcement are $\frac{1}{2}\ \lambda\ e^2$.

C is the value of concessions of the IP-originating country that are conditional. The concessions are subject to suspension if IPR provisions are not enforced. The expected value of concessions received by the implementing country is C times the probability of enforcement $f(e)$. The IP-originating country moves first and offers C, and then the implementing country decides whether to participate in the agreement. If it participates, it chooses its optimal

[10] Lai and Qui (2003) finds that stronger IPR protection in developing countries are typically exchanged for greater access to non-IP markets of trade partners. Maggi (2016) analyzes this type of issue linkage, though he focuses on noneconomic policies rather than IPR.

[11] If there are other benefits of enforcing IPR, these will reduce the amount of the compensating concessions.

[12] Again, this part of the model could be much more complex. For example, the model of enforcement could include different types of information asymmetries and a different set of potential actions tailored to the specific application. Enforcement decisions could be modeled as a repeated game, as in Maggi (2016).

[13] e is the ratio of expended effort to maximum possible effort.

enforcement effort e^*.

Equation (7) is the implementing country's objective function, assuming that the innovative product already exists in the IP-originating country, and so $\theta = 1$.

$$U(e, C) = C\ e\ +\ \omega\ \pi_m\ e\ -\ L\ e\ -\ \frac{1}{2}\ \lambda\ e^2 \tag{7}$$

The implementing country chooses e to maximize $U(e, C)$ given C. The implementing country's optimal, incentive compatible effort level e^* is determined by its first order condition with respect to e.

$$e^* = max\left(min\left(\frac{C\ +\ \omega\ \pi_m\ -\ L}{\lambda}, 1\right), 0\right) \tag{8}$$

Equation (9) is the IP-originating country's objective function.

$$V(e^*, C) = (\phi\ \pi_m\ \ (1\ -\ \omega) -\ C)\ \ e^* \tag{9}$$

The parameter $\phi \geq 1$ represents a political economy weight assigned to the monopoly profits repatriated to the IP-originating country. If ϕ is greater than one, then the IP-originating country values a dollar in repatriated IP monopoly profits more than a dollar in concessions. ϕ could reflect political interests tied to repatriated monopoly profits, a social value placed on law enforcement and protection of property rights in general, or both.

The IP-originating country chooses C to maximize $V(e^*, C)$ given the anticipated response e^* and subject to the participation constraint of the implementing country, $U(e^*(C), C) \geq 0$. The IP-originating country's optimal level of the concession, C^*, is determined by its first order condition with respect to C.

$$C^* = \frac{\phi\ \pi_m\ \ (1\ -\ \omega)\ -\omega\ \pi_m\ +\ L}{2} \tag{10}$$

As long as $V(e^*(C^*), C^*) \geq 0$, the IP-originating country will participate in the trade agreement. The implementing country will participate in the agreement as long as $U(e^*, C^*) \geq 0$.

Equation (11) is the reduced-form solution for the equilibrium probability of enforcement and enforcement effort.

$$e^* = \frac{\pi_m}{2\,\lambda}\left(\phi\ (1\ -\ \omega)\ +\ \omega\ -\ \frac{3}{2}\right) \tag{11}$$

e is increasing in monopoly profits π_m, decreasing in enforcement cost λ, increasing in the political economy weight on repatriated monopoly profits ϕ, and decreasing in the non-repatriated share ω as long as $\phi > 1$. e^* is below the first-best level of effort due to agency costs and moral hazard, as explained in Laffont and Martimort (2002).

Next, we consider the case where the IPR provisions lead to innovation and the introduction of a new product that would not have existed absent the provisions. As discussed in Section 3, there is a gain in consumer surplus G equal to $\frac{1}{2}\pi_m$ with probability θ if (6) is satisfied by the IPR provisions. In this case, (12) is the revised objective function of the agent, and (13) is the revised objective function of the principal.

$$U(e, C, x) = \left(\ C\ e\ +\ \omega\ \pi_m\ e\ + G\ e\ -\ \frac{1}{2}\ \lambda\ e^2\ \right)\ \theta \tag{12}$$

$$V(e^*, C) = (\phi\ \pi_m\ \ (1\ -\ \omega) -\ C)\ \ e^*\ \theta \tag{13}$$

Equation (14) is the optimal effort level as a function of the concession and the gain in consumer surplus.

$$e^{**} = max\left(min\left(\frac{C\ +\ \omega\ \pi_m\ +\ G}{\lambda}, 1\right), 0\right) \tag{14}$$

e^* does not depend on the probability of innovation θ. However, incentives to innovate still

increase equilibrium enforcement effort and the probability of enforcement ($e^{**} > e^{*}$), since they result in a gain in consumer surplus rather than a loss.

Equation (15) is the reduced-form solution for the equilibrium concession C^{**}.

$$C^{**} = \frac{\phi\ \pi_m\ (1\ -\ \omega)\ -\omega\ \pi_m\ -\ G}{2} \tag{15}$$

Again, there is a gain in consumer surplus rather than a loss, so a lower valued concession is needed to ensure the participation of the implementing country. ($C^{**} < C^{*}$). Finally, (16) is the reduced-form solution for the equilibrium enforcement probability.

$$e^{**} = \frac{\pi_m}{2\ \lambda}\left(\phi\ (1\ -\ \omega)\ +\ \omega\ +\ \frac{1}{2}\right) \tag{16}$$

5 Expected Economic Effects

The expected economic effects of the IPR provisions are the product of the conditional effects on prices, profits, and consumer surplus (in Section 2), the probability of innovation (in Section 3), and the probability of enforcement (in Section 4). The first depends on the initial price elasticity of demand, the initial market size, the relative marginal cost of the monopolist, and regulatory price caps. The second also depends on the costs and productivity of efforts to innovate, and the non-repatriated share of monopoly profits. The third depends on all of these factors *through monopoly profits* and also on the political economy weight on repatriated monopoly profits, the repatriated share of the monopoly profits, and the costs of enforcing IPR.

6 Discussion and Conclusions

The model estimates the economic effects of provisions in trade agreements that strengthen and enforce IPR. It focuses on how a suspension of concessions linked to inadequate enforcement of IPR provisions can ensure that the implementing country has sufficient incentive to enforce the provisions. The probability that IPR provisions will be enforced and the expected economic effects on consumers and IP originators depend on the price responsiveness of demand in the market, total market size, the cost competitiveness of the IP owner relative to potential imitators, costs of enforcing the provisions, regulatory price caps, the political economy weight assigned to repatriated monopoly profits, and the costs and productivity of efforts to innovate.

The modeling framework provides a tractable set of structural equations that address the issue of enforcement of IPR provisions in a simple way. These equations define the data needed to model enforcement and the resulting economic effects in specific industries and countries. But is it practical? The inputs of the model are the initial market price and quantity p_0 and q_0, the initial price elasticity of demand ϵ_0, the relative marginal cost of the monopolist μ, the enforcement cost elasticity λ, regulatory price caps, and the political economy weight ϕ. When we allow for an effect on innovation, the inputs also include the share of monopoly profits that are repatriated $1 - \omega$, and the costs and productivity of efforts to innovate θ and γ. (The monopoly outcomes p_m, q_m, and π_m, enforcement effort e, concession C, and the innovation effort are all outputs of the model, not inputs.) In many empirical applications, it will be very difficult to quantify these model inputs, especially the political economy weights and the costs of enforcement and innovation. Still, the modeling framework can be used to focus data collection efforts on relevant economic factors. The feasibility of an empirical application will depend on the available of these specific data.

The modeling framework is a starting point for building more complex models customized

for specific applications. As Fink et al. (2016) points out, the economic effects of enforcing IPR will differ significantly across industries, national markets, and types of intellectual property. The enforcement framework could also be applied to estimate the effects of other behind-the-border provisions in international trade agreements, including environmental regulations, though the economic setting will need to be modified and the data requirements will change with each application. For example, in an application to environmental provisions, the benefits to the principal would include the social value of environmental protection and the gain in cost competitiveness relative to producers in the implementing country, and the model would require information about environmental compliance costs as well as costs of enforcing the provisions.

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