Probabilistic Patents, Alternative Damage Rules and Optimal Trade Policy

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March 15, 2016

Overview

Introduction

Patents are not ironclad

The number of patent disputes has grown dramatically in recent decades

Approximately 46% of all litigated patents are found to be invalid

Allison and Lemley (1998), Lanjouw and Schankerman(2002), Shapiro (2003), Weatherall and Webster (2014), ...

Introduction ...

Damage awards in patent litigation has two purposes

1. Deter infringement
2. Compensate the patent holder (i.e., the damaged party)

Introduction ...

Damage Rules:

1. Unjust Enrichment (UE) rule
2. Lost Profits (LP) rule

Introduction ...

Schankerman and Scotchmer (2001 RAND) – Vertical relationship

Anton and Yao(2003 JEMS, 2007 JLEO) – Non drastic innovation

Choi (2009, IEP) – Closed economy

Surveys: Lemley and Shapiro (2005, JEP) and Weatherall and Webster (2014, JES)

The Setup

Firm 1

- Product patent holder (or, Patentee of a specific technology)
- Located in country F
- Cost function: $C_1 = C_1(q_1)$

Firm 2

- Potential competitor/infringer
- Located in country H
- Cost function: $C_2 = C_2(q_2)$

The product is sold only in country H

Market demand function: $p = p(Q)$, $Q = q_1 + q_2$.

The Setup...

Assumptions

A1: $p'(Q) < 0$ and $p''(Q) \leq 0$.

A2: $C_i(0) = 0,\ 0 \leq C_1'(q_1) \leq C_2'(q_2)$ and $C_1''(q_1) = C_2''(q_2) = 0$.

The Setup...

No Infringement	Infringement
Firm 1 is the monopolist (π_1^M)	Cournot quantity competition

$$[\text{(A1) and (A2)}] \Rightarrow \pi_1(q_1, q_2) + \pi_2(q_1, q_2) < \pi_1^M$$

The Setup...

Enforcement of the IPR is uncertain

An act of patent infringement can be proved in the court of law with probability α $(0 < \alpha < 1)$, which is assumed to be common knowledge.

The Setup...

Damage Rules

Unjust Enrichment (UE) rule: $D^{UE} = \pi_2(q_1, q_2)$

Lost Profit (LP) rule: $D^{LP} = \pi_1^M - \pi_1(q_1, q_2)$

A general form of Damage Rule

$$D^{Gen} = \theta D^{UE} + (1-\theta) D^{LP}, \text{ where } 0 \leq \theta \leq 1.$$

$$\theta = 0 \Rightarrow D^{Gen} = D^{LP}$$
$$\theta = 1 \Rightarrow D^{Gen} = D^{UE}$$

Free Trade Regime

Firm 2 infringes the patent

Stages of the game

Stage 1: Firm 1 and Firm 2 engage in Cournot quantity competition in the product market.

Stage 2: Firm 1 files a lawsuit of patent infringement against firm 2, the court of law pronounces judgment and the dispute is settled in the court.

Free Trade Regime ...

Problem of firm 1

$$\begin{aligned}\underset{q_1}{\text{Max}}\ O_1 =& \pi_1(q_1, q_2) + \alpha D^{Gen} \\ =& (1 - \alpha + \alpha\theta)\pi_1(q_1, q_2) + \alpha\theta\pi_2(q_1, q_2) + \alpha(1 - \theta)\pi_1^M\end{aligned}$$

$\theta = 0$ (LP)

$$O_1 = (1-\alpha)\pi_1(q_1, q_2) + \alpha\pi_1^M \Rightarrow \underset{q_1}{ArgMax}\ O_1(q_1, q_2) = \underset{q_1}{\text{ArgMax}}\ \pi_1(q_1, q_2)$$

$\theta = 1$ (UE)

$$O_1 = \pi_1(q_1, q_2) + \alpha\pi_2(q_1, q_2) \Rightarrow \underset{q_1}{ArgMax}\ O_1(q_1, q_2) < \underset{q_1}{\text{ArgMax}}\ \pi_1(q_1, q_2)$$

Collusive Behavior

Free Trade Regime ...

Problem of firm 2

$$\underset{q_2}{\text{Max}}\ O_2 = \pi_2(q_1, q_2) - \alpha D^{Gen}$$

$$= (1 - \alpha\theta)\pi_2(q_1, q_2) + \alpha(1 - \theta)\pi_1(q_1, q_2) - \alpha(1 - \theta)\pi_1^M$$

$\theta = 0$ (LP)

$O_2 = \pi_2(q_1, q_2) + \alpha\pi_1(q_1, q_2) - \alpha\pi_1^M$ **Collusive Behavior**

$\Rightarrow \underset{q_2}{ArgMax}\ O_2(q_1, q_2) < \underset{q_2}{\text{ArgMax}}\ \pi_2(q_1, q_2)$

$\theta = 1$ (UE)

$O_2 = (1 - \alpha)\pi_2(q_1, q_2) \Rightarrow \underset{q_2}{ArgMax}\ O_2(q_1, q_2) = \underset{q_2}{\text{ArgMax}}\ \pi_2(q_1, q_2)$

Free Trade Regime ...

LP Rule ($\theta = 0$)

- Firm 1 is non-collusive (Aggressive)
- Firm 2 is collusive

$\Rightarrow q_1^{LP} > q_1^{NoIPR}$, $q_2^{LP} < q_2^{NoIPR}$

UE Rule ($\theta = 1$)

- Firm 1 is collusive
- Firm 2 is non-collusive (Aggressive)

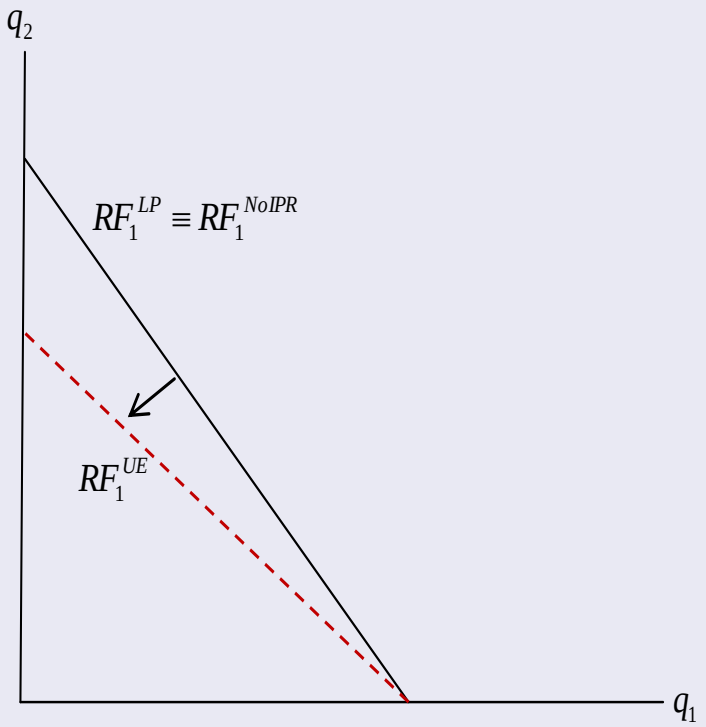
$\Rightarrow q_1^{UE} < q_1^{NoIPR}$, $q_2^{UE} > q_2^{NoIPR}$

Free Trade Regime ...

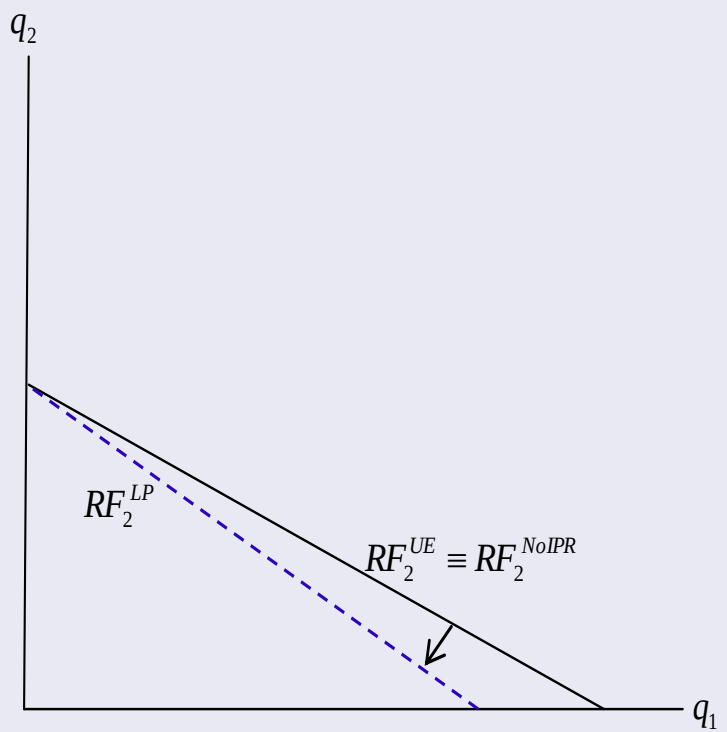
An Illustration:

Let $p = a - q_1 - q_2$ and $mc_1 = mc_2 = c$.

Firm 1



Firm 2



Free Trade Regime ...

Illustration (Contd..)

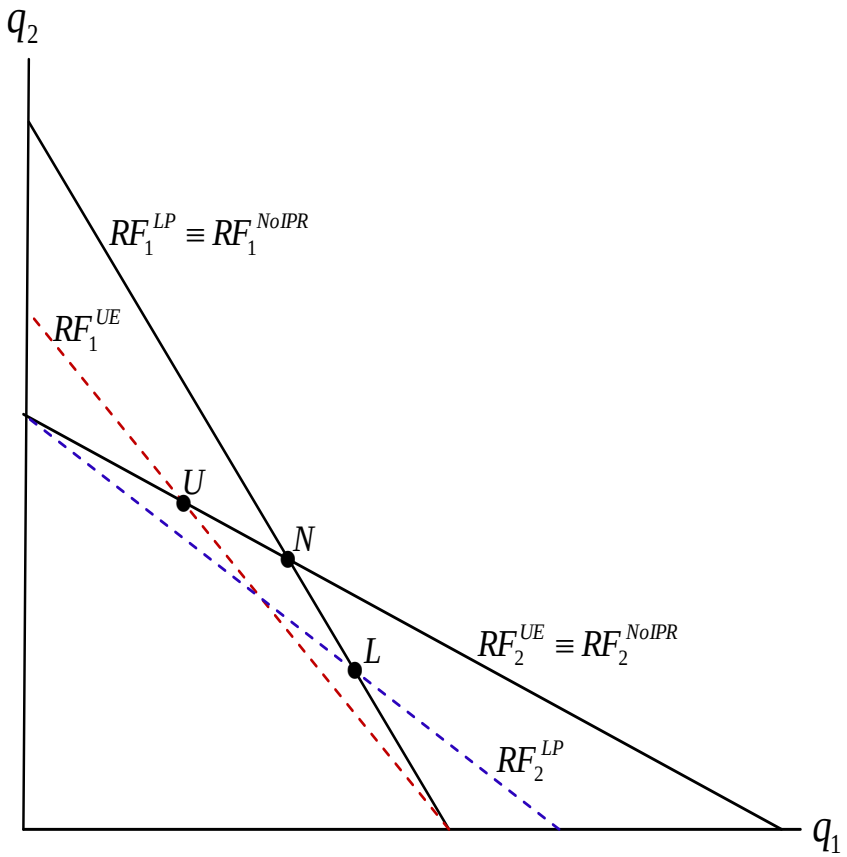


Figure: Equilibrium Analysis

Free Trade Regime ...

Lemma 1

$\frac{\partial q_1^F(\theta)}{\partial \theta} < 0$, $\frac{\partial q_2^F(\theta)}{\partial \theta} > 0$ *and* $\frac{\partial [q_1^F(\theta)+q_2^F(\theta)]}{\partial \theta} \geq 0 \, \forall \, \theta \in [0,1]$, *where the sign of equality holds in the case of* $C_1' = C_2'$.

It implies that

$q_{1,LP}^F > q_{1,UE}^F$, $q_{2,LP}^F < q_{2,UE}^F$ and $q_{1,LP}^F + q_{2,LP}^F \leq q_{1,UE}^F + q_{2,UE}^F$.

Lemma 2

$\frac{dO_1^F(\theta)}{d\theta} < 0$ *and* $\frac{dO_2^F(\theta)}{d\theta} > 0$, $\forall \, \theta \in [0,1]$.

It implies that $O_{1,LP}^F > O_{1,UE}^F$ and $O_{2,LP}^F < O_{2,UE}^F$.

Free Trade Regime ...

Will there be infringement?

Yes, if $O_2^F > 0 \Rightarrow \alpha < \frac{\pi_2^F}{(\pi_1^M - \pi_1^F) - \theta(\pi_1^M - \pi_1^F - \pi_2^F)} = \bar{\alpha}(\theta)$.

- $\bar{\alpha}(\theta) > 0$ and $\frac{\partial \bar{\alpha}(\theta)}{\partial \theta} > 0$
- $\bar{\alpha}(1) = 1$. So, $O_2^F > 0 \ \forall \ \alpha \in [0, 1]$. Under *UE* rule, firm 2 will always Infringe.
- $\bar{\alpha}(0) < 1$, since $\pi_1^F + \pi_2^F < \pi_1^M$. Under *LP* rule infringement may or may not occur.
  - If $\alpha < \bar{\alpha}(0)$, infringement occurs.
  - If $\alpha \geq \bar{\alpha}(0)$, infringement is deterred.

Free Trade Regime ...

Proposition 1

In the regime of free trade, the patentee prefers the 'lost profit' damage rule the most, while the infringer prefers the 'unjust enrichment' damage rule the most, over any convex combination of the 'lost profit' damage rule and the 'unjust enrichment' damage rule.

Free Trade Regime ...

Consumers' Surplus and Social Welfare of Country H:

$$CS^F(\theta) = \int_0^{Q^F(\theta)} p(Q)dQ - p(Q^F(\theta))Q^F(\theta)$$

$$SW^F(\theta) = CS^F(\theta) + O_2^F(\theta)$$

Lemma 3

$\frac{dCS^F(\theta)}{d\theta} \geq 0$, *where the sign of equality holds in the case of* $C_1' = C_2'$, *and* $\frac{dSW^F(\theta)}{d\theta} > 0, \forall\, \theta \in [0,1]$.

It implies that $CS^F_{LP} \leq CS^F_{UE}$ and $SW^F_{LP} < SW^F_{UE}$.

Free Trade Regime ...

Proposition 2

In the regime of free trade, given the choice, **the government of the home country would always enforce the 'unjust enrichment' damage rule** to be followed in the court of law, which best protects interests of consumers and the infringer at the cost of the patentee.

Trade Policy Intervention

\# Unilateral trade policy intervention by the importing country H

Let t be the per unit tariff on imports. $t > 0$ $(t = 0)$ $t < 0$

Trade Policy Intervention ...

Stages of the game

Stage 1: The government of country H imposes per unit import tariff t.

Stage 2: Firm 2 decides whether to infringe the patent or not. If infringement does not take place, firm 1 produces monopoly output and the game ends. Otherwise, if firm 2 infringes the patent, Cournot quantity competition between firm 1 and firm 2 takes place in the product market.

Stage 3: Firm 1 files a lawsuit of patent infringement against firm 2, the court of law pronounces judgment and the dispute is settled in the court.

Trade Policy Intervention ...

No Infringement: Firm 1 is the Monopolist

$$\underset{q_1}{\text{Max}}\ \tilde{\pi}_1 = p(q_1)q_1 - C_1(q_1) - tq_1$$

$\frac{\partial q_1^M(t)}{\partial t} = \frac{1}{p''(q_1)q_1 + p'} < 0$

$$\underset{t}{\text{Max}}\ SW = \int_0^{q_1} p(q_1)dq_1 - p(q_1)q_1 + tq_1$$

$$\text{subject to the constraint } q_1 = q_1^M(t)$$

$t^{M,R} > 0$

Trade Policy Intervention ...

Infringement: Cournot Duopoly

$\frac{\partial q_1^R(t;\theta)}{\partial t} < 0$, $\frac{\partial q_2^R(t;\theta)}{\partial t} > 0$ and $\frac{\partial [q_1^R(t;\theta)+q_1^R(t;\theta)]}{\partial t} < 0$

$$\underset{t}{Max}\ SW = [\int_0^Q p(Q)dQ - p(Q)Q] + \tilde{O}_2(q_1, q_2, t; \theta) + tq_1,$$

subject to the constraints

$q_1 = q_1^R(t;\theta)$ and $q_2 = q_2^R(t;\theta)$.

$\frac{\partial t^R(\theta)}{\partial \theta} \neq 0$

Trade Policy Intervention ...

An Example

$p = A - q_1 - q_2$ and $mc_1 = mc_2 = 0$

$q_1^R(t;\theta) > 0$ and $q_2^R(t;\theta) > 0$, if $\underline{t} < t < \bar{t}$; where $\underline{t} < 0$ and $\bar{t} > 0$

$$t^R(\theta) = \frac{A(1-\alpha)\left(3 - 5\alpha\theta + \alpha^2\theta\right)}{(1-\alpha+\alpha\theta)\left(9 - \alpha - 10\alpha\theta + 2\alpha^2\theta\right)}; \quad \underline{t} < t^R(\theta) < \bar{t}$$

Trade Policy Intervention ...

- $$t^R(\theta) < 0, \text{ if } \frac{1}{2}\left(5-\sqrt{13}\right) < \alpha < 1 \text{ and } \frac{3}{(5-\alpha)\alpha} < \theta \leq 1$$
$$\geq 0, \text{ otherwise}$$

- If $\alpha = 0$ (No IPR), $t^R(\theta) > 0$

- $\frac{\partial t^R(\theta)}{\partial \theta} < 0$ for all $\alpha \in (0,1)$ and $\theta \in [0,1]$.

Optimal rate of import tariff crucially depends on both the strength of the patent and the type of the damage rule in place.

Trade Policy Intervention ...

Proposition 3

In the case of linear demand function and symmetric firms with constant marginal cost of production, the following is true.

(a) If the patent is strong ($\hat{\alpha} < \alpha < 1$), it is optimal for the importing country to impose a tariff on imports under 'lost profit' damage rule, but import subsidization is optimal under 'unjust enrichment' damage rule.

(b) If the patent is weak ($0 \leq \alpha < \hat{\alpha}$), imposition of import tariff is optimal regardless of the damage rule, but 'lost profit' damage rule calls for a higher rate of import tariff than that under 'unjust enrichment' damage rule.

Trade Policy Intervention ...

Intuitions

a) UE rule ($\theta = 1$):
Foreign firm $\mapsto$ collusive, but domestic firm $\mapsto$ aggressive

b) LP rule ($\theta = 0$):
Foreign firm $\mapsto$ aggressive, but domestic firm $\mapsto$ collusive

[Higher θ] $\longrightarrow$ [Foreign firm more collusive, but domestic firm more aggressive]

$\uparrow t \longrightarrow \downarrow q_1, \uparrow q_2, \downarrow (q_1 + q_2), \downarrow CS, \downarrow \pi_1, \uparrow \pi_2, \uparrow TR$

$\theta = 0$: $SW = CS + (\pi_2 + \alpha\pi_1 - \alpha\pi_1^M) + TR$

$\theta = 1$: $SW = CS + (1 - \alpha)\pi_2 + TR$

Trade Policy Intervention ...

$q^R_{1,UE} > q^R_{1,LP}$ and $q^R_{2,UE} > q^R_{2,LP} \Rightarrow CS^R_{UE} > CS^R_{LP}$

$t^R_{UE} < t^R_{LP}$ and $T^R_{UE} < T^R_{LP}$

$O^R_{1,UE} > O^R_{1,LP}$, but $O^R_{2,UE} < O^R_{2,LP}$

$SW^R_{UE} < SW^R_{LP}$.

Trade Policy Intervention ...

Proposition 4

In the regime of trade policy intervention, when the demand function is linear and firms have the same constant marginal cost of production, given the choice **the government of the home country would always enforce the 'lost profit' damage rule to be followed in the court of law**, which best protects interests of the infringer at the cost of both consumers and the patentee.

Other issues:

Out-of-court settlement .... Bargaining

Licensing

Alternative trade patterns

Thank You