

The Impact of Product Market Characteristics on Firms' Strategies in Patent Litigation

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Patent litigation

“Intellectual property litigation reflects competition and conflict. Firms competing in research and production often infringe, or directly challenge, each other's patent rights. Firms face the decision to file a lawsuit and, following that, either to resolve their differences in pretrial settlement negotiations or to take the expensive route of going to trial. ”

- Lanjouw and Schankerman (2001)

- Facts of patent Litigation:
 - Large values involved
 - High ongoing litigation cost
 - Settlement is the most common way to resolve dispute

Our research questions

- How do product market characteristics impact patent litigation outcomes?
 - Product market characteristics:
 - The infringer's gain in profit relative to the infringed firm's loss of profits, as a result of the alleged infringement ("Gain-to-loss ratio", which captures the relations of the two firms' products)
 - Product market demand volatility (equivalent to firms' cash flow volatility)
 - Litigation outcomes: whether to settle, litigate or drop the lawsuit
 - Our angle: firms' abilities to finance litigation

- The economics of litigation and settlements.
 - e.g., Landes (1971), Ordover et al (1983), Bebchuck (1984), Lanjouw and Schankerman (2001), Crampes and Langinier (2002), Bessen and Meurer (2006), Spier (2007)
- The interaction of finance and patent litigation.
 - e.g., Cohen et al. (2016), Choi and Spier (2018), Lee et al. (2019), Mezzanotti (2019), Appel et al. (2019), Caskurlu (2019)
- Real options models on patent related decisions
 - e.g., Schwartz (2004), Marco (2005), Grundfest and Huang (2005), Jeon (2015)

Modelling choices

To model patent litigation from a finance perspective:

- 1 Both firms use profits from the product market to cover costs.
- 2 Ongoing cost during litigation vs. one time settlement cost.
- 3 Both firms have the option to drop the lawsuit, they can also settle before and after the lawsuit begins.
- 4 Firms exercise their options at thresholds on a common demand shock. They take each other's actions and future actions into consideration when making decisions. (A compound real options model as in Decamps et al. 2006)

Main findings

Through financing constraints, inter-firm characteristics affect litigation strategies greatly:

① The key determinant of possible settlements: **“Gain-to-loss ratio”**:

- $\Phi = \frac{\text{the alleged infringer's profit gain}}{\text{the infringed firm's loss of profit}}$ $\uparrow\uparrow \Rightarrow$ firms are likely to settle.

② The impact of **“Relative cost saving”**.

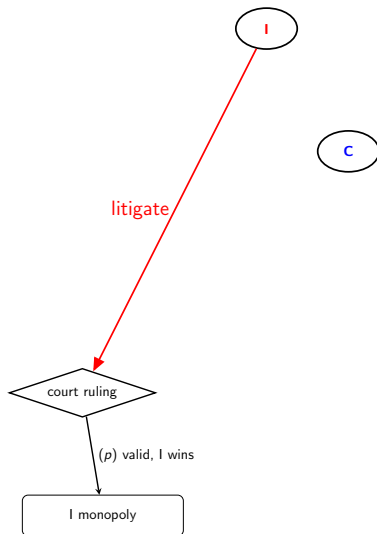
- $\Gamma = \frac{\text{alleged infringer's cost saving}}{\text{infringing firm's cost saving}}$ $\uparrow \Rightarrow$ alleged infringer's cost \uparrow
 - The more one firm is financially constrained relative to the other firm, the less likely that settlement between the two firms occurs
- ③ Overall, settlement is less likely for low gain-to-loss ratios, high probability of patent validity, and in more volatile product markets.

Game Tree

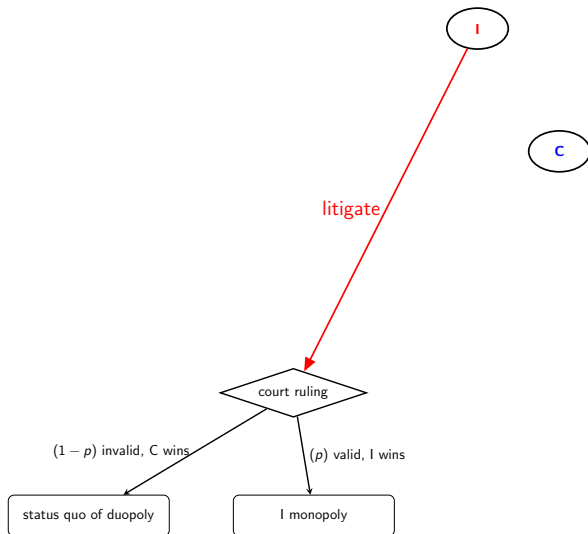
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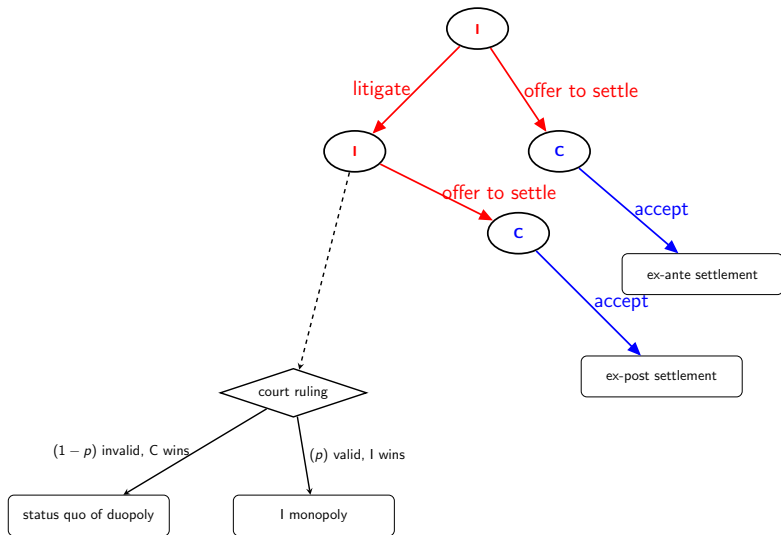
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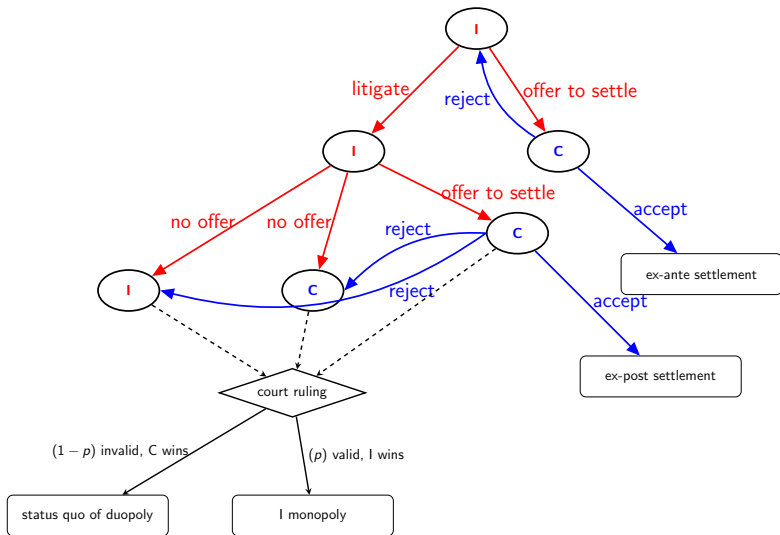
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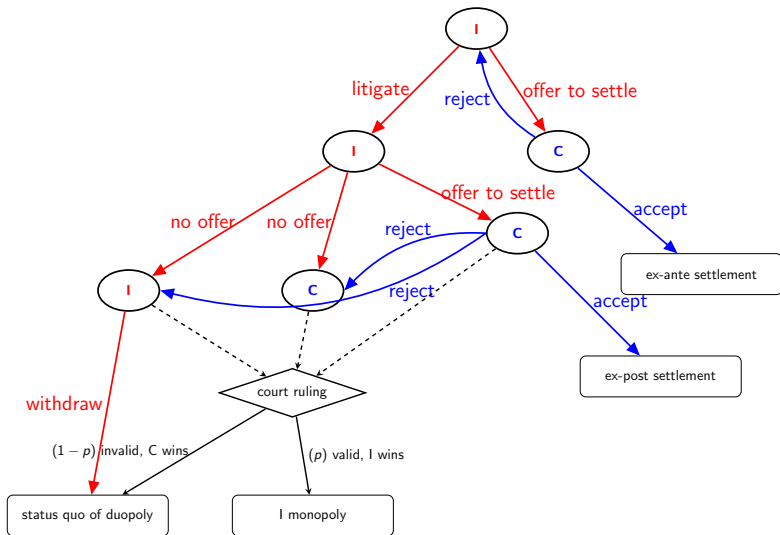
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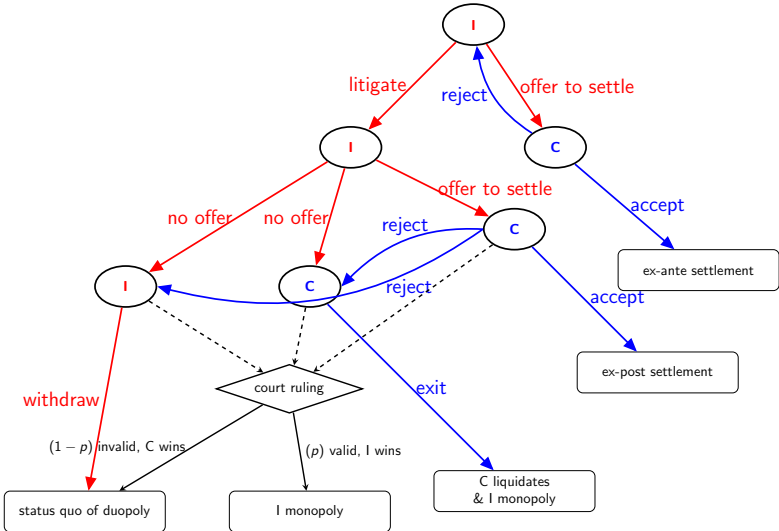
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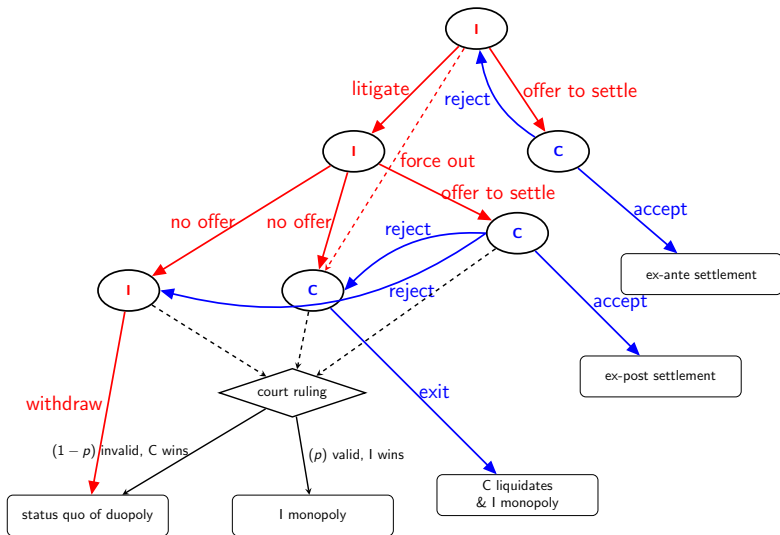
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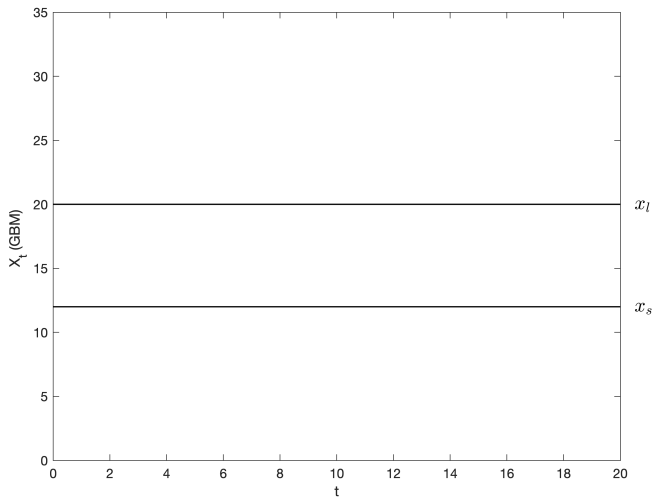
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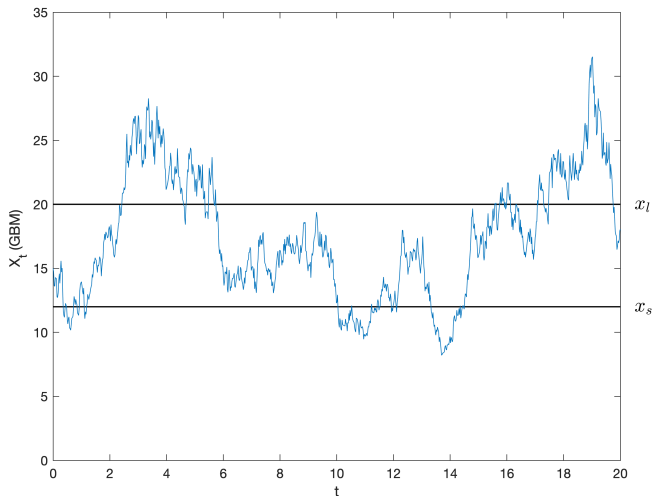
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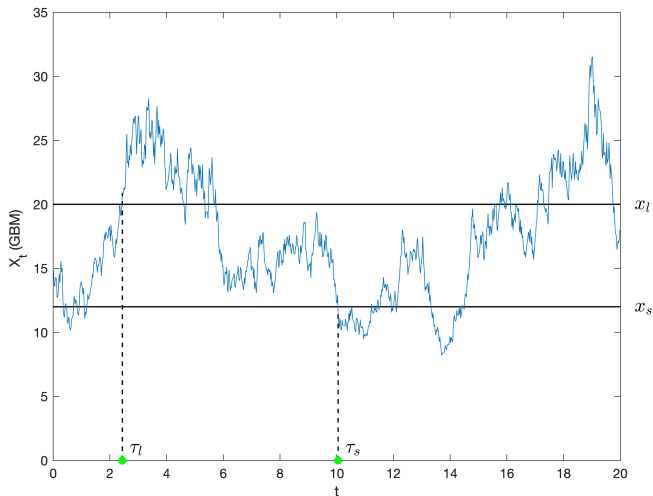
An illustration of threshold strategies - Example 1



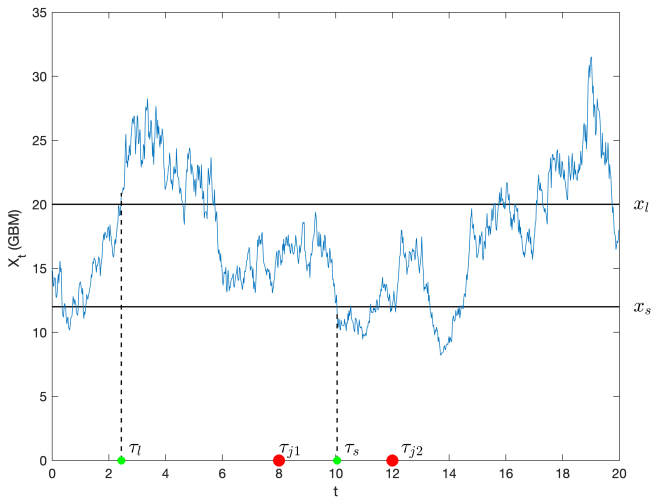
An illustration of threshold strategies - Example 1



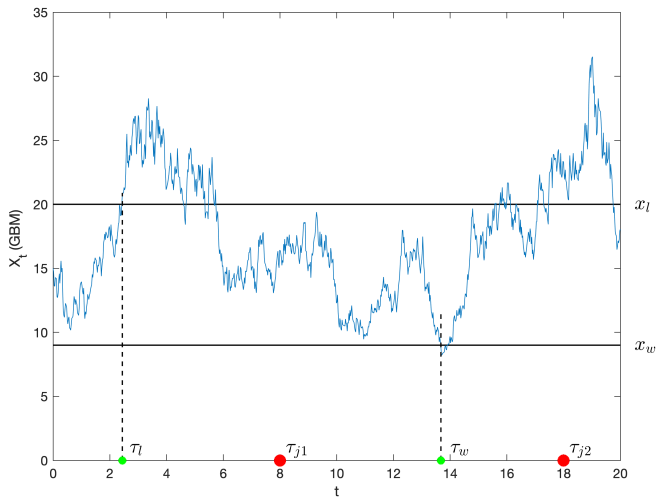
An illustration of threshold strategies - Example 1



An illustration of threshold strategies - Example 1



An illustration of threshold strategies - Example 2



General solutions for firm values: During litigation

- Firm value during litigation = expected discounted future operating cash flow
- present value of the litigation cost + **option value**
- During litigation, the firm values are

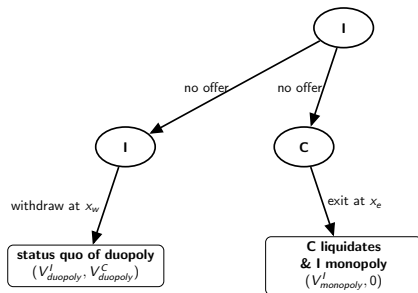
$$V_{dl}^I(x) = \left(\frac{\pi_2^I}{r - \mu} + p\delta(\pi_1 - \pi_2^I) \right) x - \frac{C_I^I}{r + \lambda} + B^I x^\beta, \quad (1)$$

$$V_{dl}^C(x) = \left(\frac{\pi_2^C}{r - \mu} + p\delta(0 - \pi_2^C) \right) x - \frac{C_I^C}{r + \lambda} + B^C x^\beta \quad (2)$$

where $\delta = \frac{1}{r - \mu} - \frac{1}{r + \lambda - \mu}$, $\beta = \frac{1}{2} - \frac{\mu}{\sigma^2} - \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2(r + \lambda)}{\sigma^2}} < 0$. B^i are the arbitrary constants to be determined by the options that the firms have during litigation.

During litigation

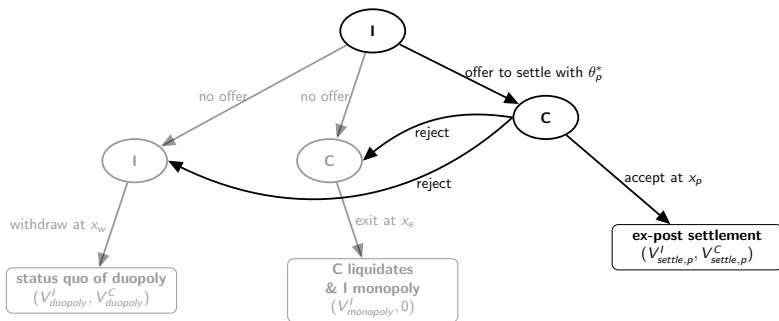
- (1) the option for I to withdraw; (2) the option for C to exit



- Thresholds are determined by the party who takes the action.
- Determine the order of withdraw vs. exit: reservation thresholds (Lambrecht, 2001).

During litigation

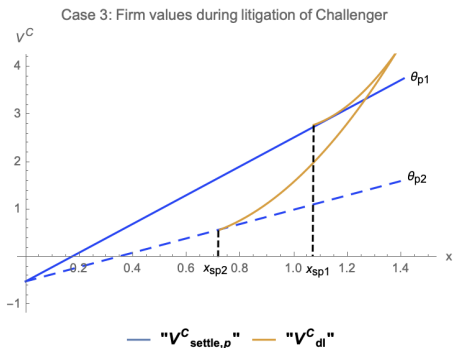
- The option of ex-post settlement:



- I proposes a royalty rate; C determines the settlement threshold (Lukas and Welling, 2012)

During litigation: ex-post settlement

- Challenger decides the settlement threshold x_{sp} at any θ_p
- Incumbent offers the settlement royalty level θ_p^* at x_{sp}
- $\theta_{p1} < \theta_{p2} \Rightarrow x_{sp1} > x_{sp2}$



Model solution: during litigation

- Case 1: I withdraws first
 - Case 2: C exits first
- } No-settlement
- Case 3: ex-post settlement
 - maximize C's value with settlement option given $\theta_P \Rightarrow$ settlement threshold
 - maximize I's value with settlement option: \Rightarrow

$$\theta_P^* = p\omega \left(1 - \frac{1}{\frac{\beta_\lambda}{\beta_\lambda - 1} + \frac{1}{\Gamma}} \right) + \frac{p\omega}{\Phi} \left(\frac{1}{\frac{\beta_\lambda}{\beta_\lambda - 1} + \frac{1}{\Gamma}} \right) = (1 - g)p\omega + g \frac{p\omega}{\Phi}$$

- the gain-to-loss ratio $\Phi = \frac{\Pi_2^C}{\Pi_1 - \pi_2^I}$, $\Phi \uparrow \rightarrow \theta_P^* \downarrow$
 - the relative cost saving $\Gamma = \frac{H_L^C - C_S^C}{H_L^I - C_S^I}$, $\Gamma \uparrow \rightarrow \theta_P^* \uparrow$
 - $\omega = \delta(r - \mu) = \frac{\lambda}{r - \mu + \lambda}$ and $g(\Gamma) = \frac{1}{\frac{\beta_\lambda}{\beta_\lambda - 1} + \frac{1}{\Gamma}}$
- Settlement is feasible when it is better than no-settlement for both C and I \Rightarrow feasible range for the royalty rate.

General solutions for firm values: Before litigation

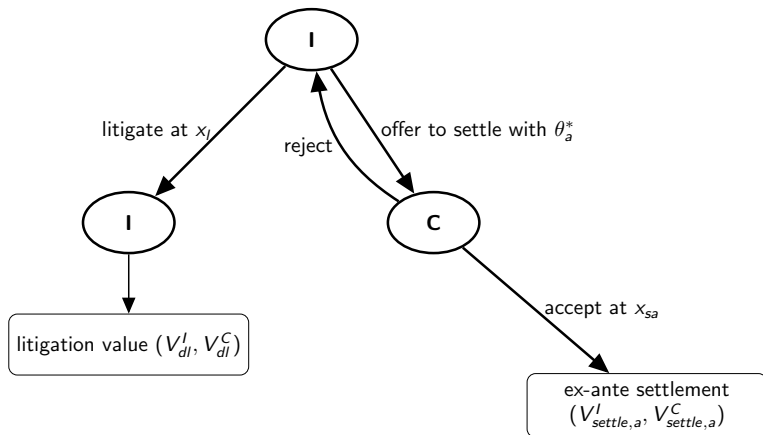
- Firm value before litigation = expected discounted future operating cash flow + option value
- After infringement and before litigation or ex-ante settlement

$$V_{bl}^I(x) = \frac{\pi_2^I x}{r - \mu} + A^I x^\alpha, \quad (3)$$

$$V_{bl}^C(x) = \frac{\pi_2^C x}{r - \mu} + A^C x^\alpha, \quad (4)$$

where $\alpha = \frac{1}{2} - \frac{\mu}{\sigma^2} + \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2r}{\sigma^2}} > 1$, and the arbitrary constants A^i are determined by the ex-ante settlement option or the litigation option.

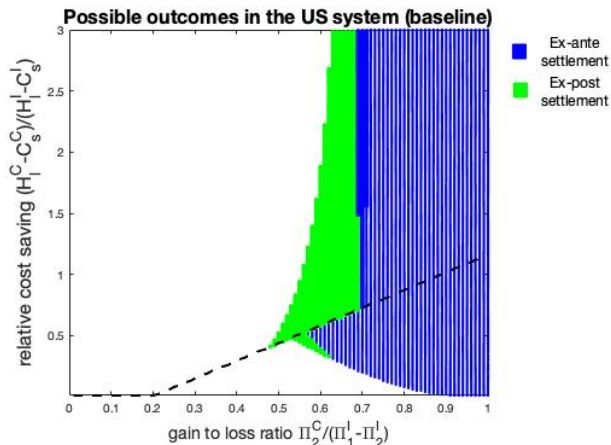
Before litigation



Model solution: before litigation

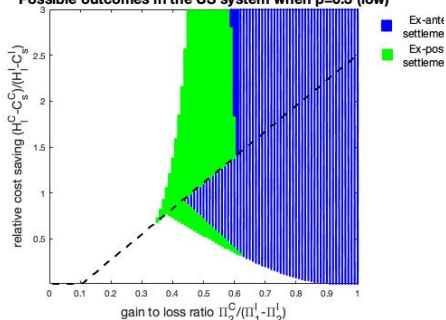
- Case 1: I litigates (affected by what happens during litigation)
- Case 2: ex-ante settlement:
 - C waits until the litigation threshold before agreeing to settle ex-ante.
 - may only occur if it worthwhile for both parties
 - For the challenger: $\Rightarrow \theta_a^{Cmax}$
 - For the incumbent: $\Rightarrow \theta_a^{Imin}$
 - ex-ante settlement is feasible if $\theta_a^{Imin} \leq \theta_a^{Cmax}$.
 - $\theta_a^* = \theta_a^{Cmax}$

Possible outcomes in patent infringement

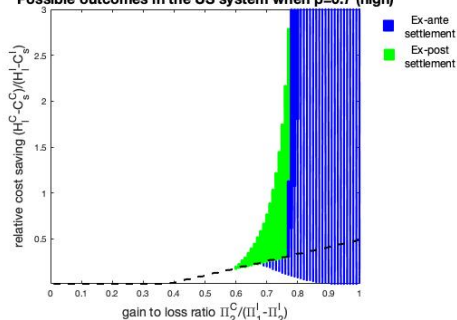


The effect of probability of patent validity

Possible outcomes in the US system when $p=0.3$ (low)

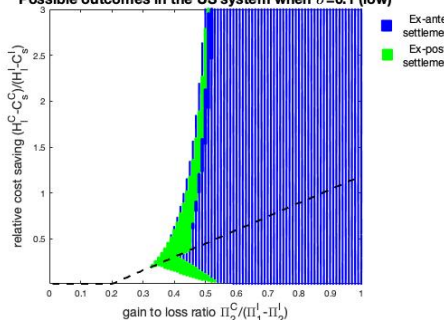


Possible outcomes in the US system when $p=0.7$ (high)

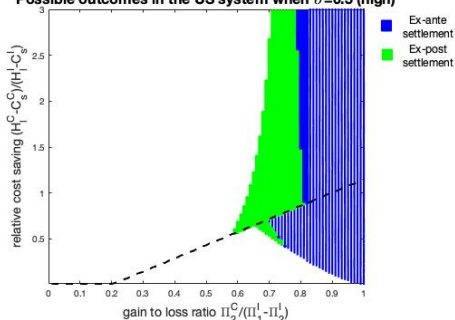


The effect of product market volatility

Possible outcomes in the US system when $\sigma=0.1$ (low)



Possible outcomes in the US system when $\sigma=0.5$ (high)



Contribution

- One of the first studies to examine the impact of firm's financial constraints on patent litigation outcomes.
- We establish the importance of product market characteristics (such as demand volatility and the relation between the plaintiff's and the defendant's products and profits) in determining the likelihood and terms of settlement.
- We model patent litigation as a strategic dynamic game in the real options framework, and consider the possibility of the challenger's exit during litigation.

Thank you!