Repeated interaction in standard setting

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Standard setting and holdup

- The adoption of standards can be welfare enhancing for various reasons (network effects, duplication, coordination...)
- Standard setting organizations (SSOs) decide which technologies to include in a standard
- There is a concern that standardization may give rise to holdup:
  - In the absence of a standard, technology competition would hold license fees in check
  - The standard picks one technology to be the winner and eliminates alternatives; the associated patent becomes standard essential
  - This can lead to higher royalties and thus downstream prices than under *ex ante* licensing
- SSOs have responded by imposing FRAND commitments, but their effectiveness has been questioned

Two important features of standard setting

Repeated interaction

- Many standards evolve through several generations
- Example: mobile telephony, 2G/3G/4G...
- Often the same firms are involved in each generation

Complementarities

- Standards often combine several complementary technologies
- Demand for one contributor's licenses is decreasing in royalties of others
- (This is the source of the royalty stacking problem)

Main idea of the paper

- The combination of repeated standard-setting and complementarity between technologies may alleviate holdup:
  - Technology contributors have an interest in keeping royalty rates of other contributors low
  - They may be able to discipline contributors by excluding them from future generations of the standard
- We develop a stylized model of repeated standard setting: with some probability there will be another generation of the standard
- When can we sustain "fair, reasonable and non-discriminatory" (FRAND) royalties in equilibrium?
- How do procedural rules of SSO affect sustainability of FRAND royalties?

Outline

Technologies (1)

- Standard setting takes place in several rounds $t = 1, 2, \ldots$
- After each round, probability $\delta < 1$ of a new round occurring
- Two complementary technologies:
    - A: developed by a single innovator A
    - B: developed in two versions by innovators B_1 and B_2
- A and B_i's technologies are perfect complements (no stand-alone value) while B_1 and B_2's are substitutes
- All three innovators are infinitely lived and develop successive improvements of their technologies
- There is a perfectly competitive downstream sector with a continuum of downstream firms

Technologies (2)

- Two possible standards:
    - (A, B_1): leads to demand $Q = v_1 - p$
    - (A, B_2): leads to demand $Q = v_2 - p$

Assumption

(i) *The values (v_1 and v_2) are the same in every round $\rightarrow$ infinitely repeated game*

(ii) $v_1 > v_2 \geq 0$: B_1 *has the superior technology*

- Define $\bar{r} \equiv v_1 - v_2$ as the FRAND rate: equilibrium royalty rate under hypothetical *ex ante* licensing (Swanson & Baumol, 2005)

The standard-setting process

- In each round t the SSO issues a call for proposals
- B_1 and B_2 choose whether to submit a proposal for a standard (combining A's technology with their own)
- The SSO puts proposals to a sequential vote (random order)
- A, B_1, and B_2 each have one vote; downstream firms have $D \geq 1$ votes
- If a proposal receives a super-majority $\gamma > 1/2$, it is adopted and process stops
- If no proposal receives a super-majority:
  - With prob. α, tie-breaker whereby a proposal is adopted at random (prob. $1/2$ for each)
  - With prob. $1 - \alpha$, no standard is adopted (payoff zero)

Timing

In each round t:

1. The SSO adopts a standard $s \in \{1, 2, \varnothing\}$

2. A and selected B firm, B_s, simultaneously set royalties r_A and r_s

3. Downstream firms set prices and sell final product

Model
Analysis
Benchmark: a single round of standard setting
Repeated standard setting

Outline

1 Model

2 Analysis
- Benchmark: a single round of standard setting
- Repeated standard setting

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Outline

Hold up

Proposition

Suppose there is only one round. In any equilibrium, compared to hypothetical ex ante licensing ($\rightarrow$ FRAND):

- *the royalties charged by firm B_s and consumer prices are higher*
- *the profit of firm A is lower*

- Intuition: standard eliminates competition between B_1 and B_2
- That A would benefit from a lower royalty on B technology is due to complementarity

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Existence of an equilibrium with FRAND royalties

- Suppose now $\delta > 0$: repeated standard setting
- Players' strategies (voting, royalties) can be conditioned on the history of play

Proposition

If δ is sufficiently large, there exists an equilibrium in which
- *B_1's technology is adopted as the standard in every round and*
- *B_1 charges FRAND royalties ($r_1 = \bar{r}$),*

provided SSO rules permit effective punishment for deviations.

- Temptation for B_1 to deviate and charge $r_1 > \bar{r}$
- Must be dissuaded by threat of punishment: A votes against B_1 and in favor of B_2 for a number of rounds
- Effectiveness of punishment: likelihood of excluding B_1

Super-majority requirements

Proposition

A necessary condition for effective punishment is that the SSO's super-majority is sufficiently stringent: $\gamma > (1+D)/(3+D)$.

- If $\gamma \leq (1+D)/(3+D)$, the votes of B_1 and the downstream firms are enough to adopt B_1, even if A and B_2 vote against
- Thus, B_1 cannot be punished, and FRAND royalties cannot be sustained

Tie-breaker use
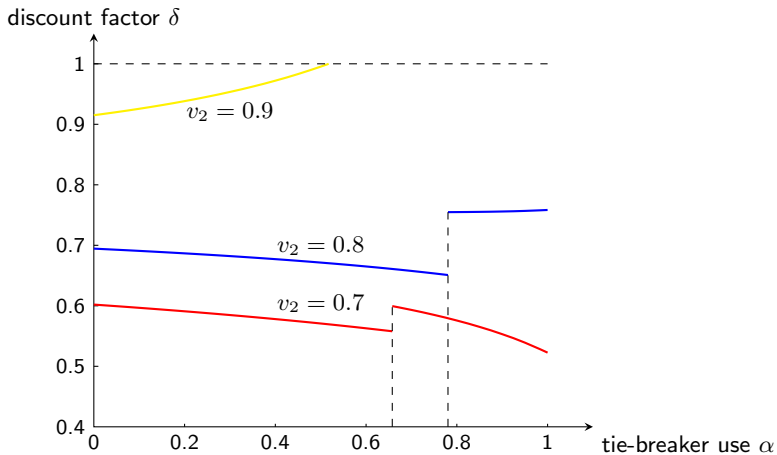The case of a single punishment period, for $v_1 = 1$

Figure : The critical discount factor δ^* as a function of α and v_2

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The effects of tie-breaker use depending on v_2

- Tie-breaker use has ambiguous effects on δ^*:
    - Not using a tie-breaker enhances effectiveness of punishment...
    - ...but also makes punishment more costly for A
- Case where v_2 is close to v_1 is noteworthy:
    - That's when the hold-up problem is most severe (FRAND rate is low)
    - In that case, an SSO rule that discards proposals which have not received a super-majority (no tie-breaker) makes FRAND royalties easiest to sustain

SSO rules in practice

Our results can provide a rationale for the prevalence of certain
procedural rules used by SSOs in practice:

- Super-majority requirements (Baron & Spulber, 2015)
- Rules to remove rejected proposals from consideration instead
  of entering them into a tie-breaker (Bonatti & Rantakari,
  2016)

Top 10 SEP holders for mobile communications standards

2G (GSM)[a]	2.5G (GPRS)[b]	3G (UMTS)[c]	4G (LTE)[d]
Nokia: 1456	Qualcomm: 517	Qualcomm: 2799	InterDigital: 808
Motorola: 1116	Ericsson: 514	InterDigital: 2337	Qualcomm: 524
Ericsson: 843	Motorola: 451	Motorola: 1961	Samsung: 322
InterDigital: 675	Siemens: 100	Nokia: 1631	Ericsson: 315
Qualcomm: 422		Philips: 529	Motorola: 293
Philips: 175		Siemens: 421	Huawei: 281
		Huawei: 380	ZTE: 235
Nokia Siemens Networks: 164		Ericsson: 349	NTT: 212
Alcatel: 88		NEC: 208	LG: 208
Siemens: 69		Nokia Siemens Networks: 180	Nokia: 197
Toshiba: 62			

Source: Disclosed Standard Essential Patents (dSEP) Database (Bekkers *et al.*, 2012).
[a]: ETSI project GSM.
[b]: ETSI project GPRS.
[c]: Includes ETSI projects UMTS, UMTS/CDMA, UMTS FDD, UMTS Release 99, UMTS Release 4, UMTS
Release 5, UMTS Release 6, UMTS Release 7, UMTS Release 8, UMTS Release 9, WCDMA, and TD-SCDMA.
[d]: Includes ETSI projects LTE, LTE Release 8, LTE Release 9, LTE Release 10, HSPA+, HSUPA, and E-UTRA.

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Conclusion

- Standard setting creates essentiality, which may lead to holdup
- However, when standards evolve through several generations, there is repeated interaction
- Contributors of complementary technology want to keep royalties low: prevent holdup
- They can discipline owners of standard-essential patents by threatening to exclude them from future rounds
- SSOs can support this through appropriate procedural rules:
  - super-majority requirements
  - rules governing the use of tie-breakers

- European Commission's horizontal guidelines:
  - Openness, transparency, non-discriminatory distribution of voting rights: in line with our results
  - "Objective criteria" = technological superiority? Would make punishment harder