Incentives for process innovations under discrete structural alternatives of competition policy

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Toolkit of public policies to promote innovations

- Basic institutional conditions: intellectual property rights (IPR) or other institutional frameworks to reward an innovator
- Industrial (sectoral) policy: measures of state support to promote innovations in specific sectors or industries
- Competition policy: making competition more intense to provide strong incentives for innovations

Preliminary comments

- Discrete structural alternatives: different regimes of institutional settings; here – presence or absence of compulsory licensing
- Compulsory licensing is classified as a type of competition policy in the area of IPR-intensive goods and services
- Process innovations: solutions permitting to decrease costs of production, making production process cheaper
- Technological leadership: only one firm may invest in R&D
- Technological competition: all the firms may invest in R&D

The main question

- *How will different regimes of competition policy affect the incentives of potential innovators?*
- Different environments should be considered…

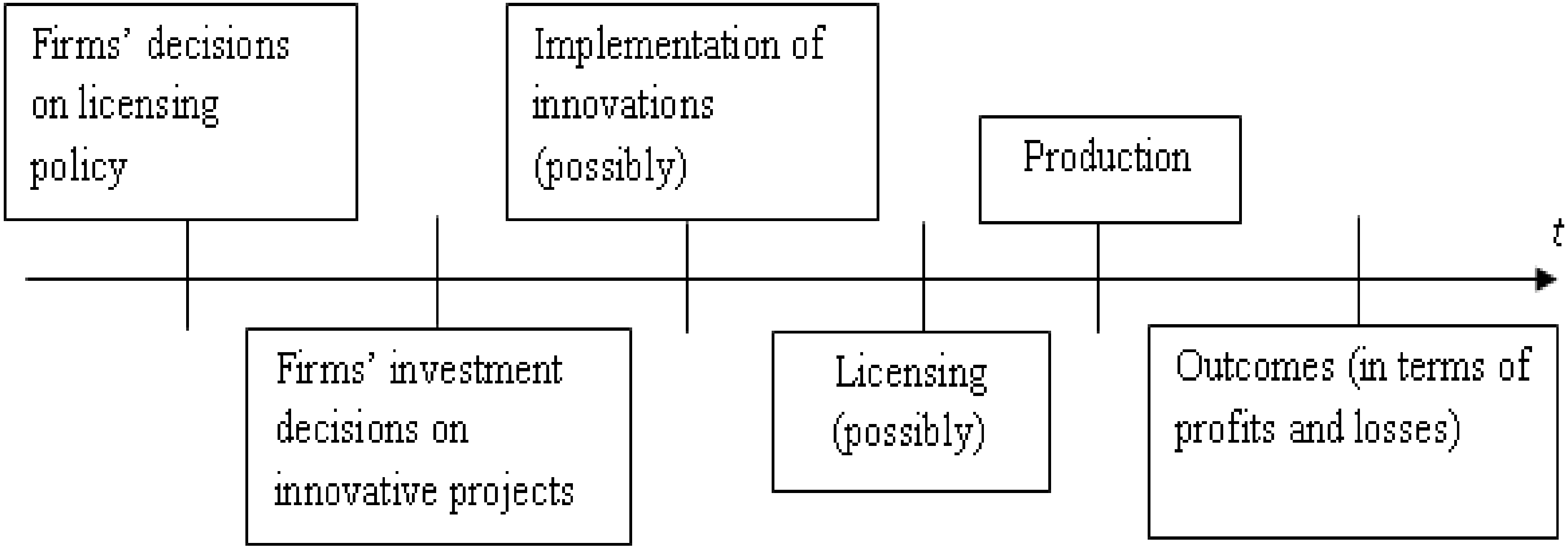
Literature

- Old discussion between positions articulated by Schumpeter (1942) and Arrow (1962): what market structure is better for innovations?
- Valuable additions by Gilbert and Newbery (1982); Reinganum (1983); Aghion, Griffith (2005); Gilbert (2006); Shapiro (2011) etc.
- Licensing as a tool to promote competition and innovation… or not: Katz, Shapiro (1985, 1986); Gallini (1984); Kamien, Oren, Tauman (1992); Tandon (1982); Acemoglu, Akcigit (2012); Seifert (2013) etc.
- On different licensing mechanisms: Yan et al. (2012); Fan et al. (2013) etc.

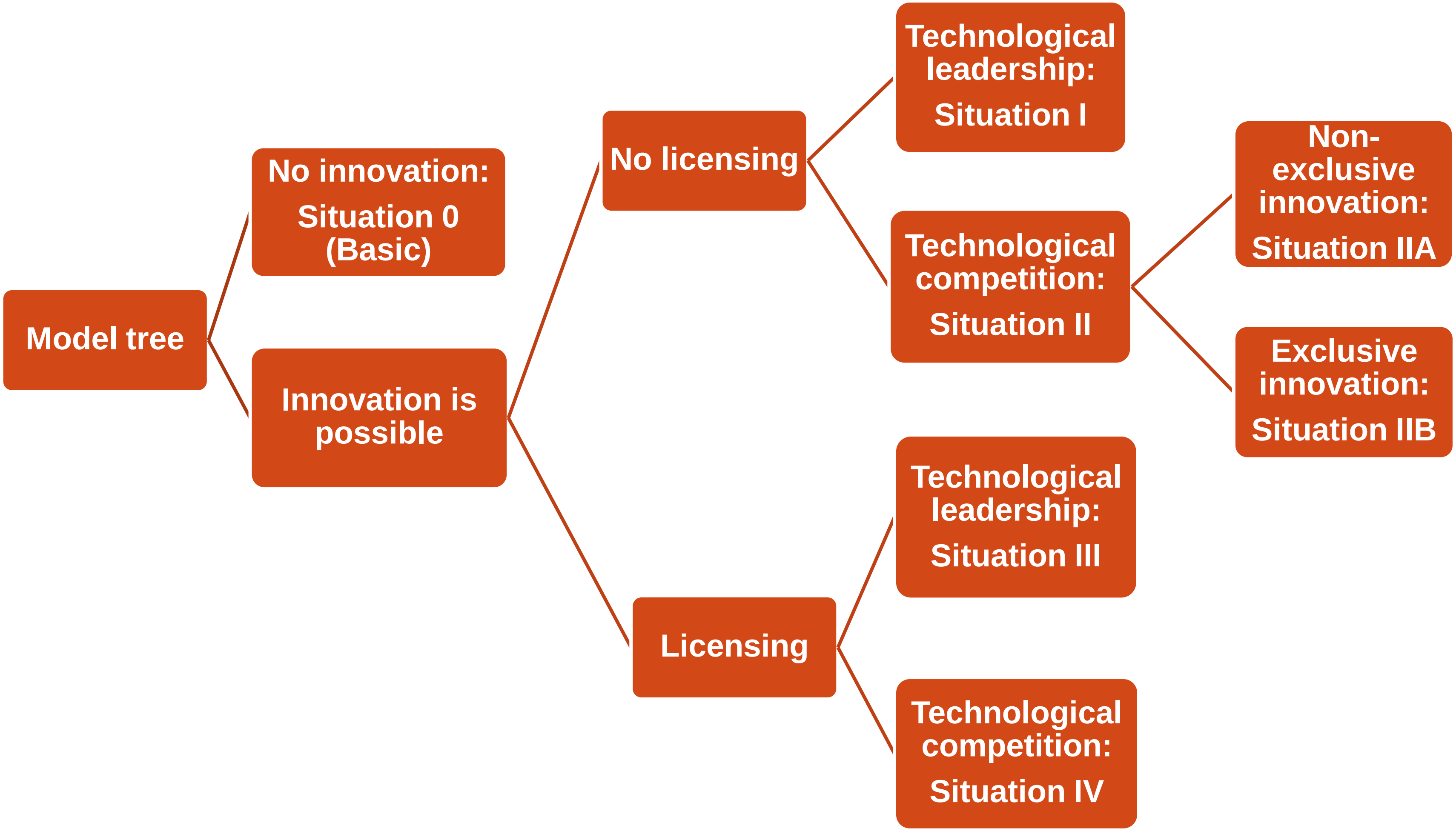
Model assumptions

- Intellectual property rights (IPR) may be sold and purchased by means of licensing;
- There is a market for IPR-based goods ("products");
- Two initially symmetric incumbents compete *a la Cournot* in this market;
- The entry to the market is closed;
- An incumbent may invest a fixed amount M in R&D in order to obtain a decrease in marginal costs of production from c to c';
- Market demand is specified by the equation $P = a\text{-}bQ$;
- Marginal costs of production equal c in the case without an innovation and c' in the case of the realization of innovation $(a > c, c > c', a > 0, b > 0, c > 0, c' > 0)$.

Timeline of the model



Guide to the model situations



Situation 0 (basic): No innovation

- Equilibrium *a la Cournot*

$$q_1^0 = q_2^0 = \frac{a-c}{3b}; Q^0 = \frac{2(a-c)}{3b};$$

$$P^0 = \frac{a+2c}{3};$$

$$\pi_1^0 = \pi_2^0 = \frac{(a-c)^2}{9b}; \Pi^0 = \frac{2(a-c)^2}{9b};$$

$$CS^0 = \frac{2(a-c)^2}{9b}; TS^0 = \Pi^0 + CS^0 = \frac{4(a-c)^2}{9b},$$

where: q_1, q_2 - quantities produced by each of two firms (hereinafter the situations are denoted by the superscripts), Q – total quantity produced, P – market price, π_1 and π_2 – profits obtained by each of two firms, Π – total profit of both firms concerned, *CS* – consumer surplus, *TS* – total surplus.

Situation I: technological leadership without licensing

- The position of the leader improves, the follower lags behind, consumer surplus grows

$$q_1^I = \frac{a+c-2c'}{3b} > q_1^0; q_2^I = \frac{a+c'-2c}{3b} < q_2^0; Q^I = \frac{2a-c-c'}{3b} > Q^0;$$

$$P^I = \frac{a+c+c'}{3} < P^0;$$

$$\pi_1^I = \frac{(a+c-2c')^2}{9b} - M; \pi_2^I = \frac{(a+c'-2c)^2}{9b} < \pi_2^0;$$

$$CS^I = \frac{(2a-c-c')^2}{18b} > CS^0 = \frac{(2a-2c)^2}{18b}.$$

- But the investment decision depends on the level of *M*

Estimation of the readiness to innovate

- M is the cost of innovation
- M is the key parameter of the model; it determines maximal sums that potential innovators are ready to invest in R&D
- $\bar{M}$ is the threshold level, 'investment ceiling' for each situation
- In the Situation I (and further Situations) it is set by the inequality:

$$\pi_1^I > \pi_1^0$$

- In the Situation I:

$$\bar{M}^I = \frac{4(c - c')(a - c')}{9b}.$$

Situation II: technological competition without licensing

Let's assume that the innovation is non-exclusive, i. e. each firm can invest and use it independently of the other firm

		Strategies of the firm # 2	
		To invest in R&D	Not to invest in R&D
Strategies of the firm # 1	To invest in R&D	$\frac{(a-c^{'})^2}{9b}-M;\ \frac{(a-c^{'})^2}{9b}-M$	$\frac{(a+c-2c^{'})^2}{9b}-M;$ $\frac{(a-2c+c^{'})^2}{9b}$
	Not to invest in R&D	$\frac{(a-2c+c^{'})^2}{9b};\ \frac{(a+c-2c^{'})^2}{9b}-M$	$\frac{(a-c)^2}{9b};\ \frac{(a-c)^2}{9b}$

The result of the game will depend on the level of *M.*

Situation II: technological competition without licensing

If $M < \frac{4(c - c')(a - c)}{9b}$,

then non-investing strategies will be dominated

		Strategies of the firm # 2	
		To invest in R&D	Not to invest in R&D
Strategies of the firm # 1	To invest in R&D	$\frac{(a - c')^2}{9b} - M$; $\frac{(a - c')^2}{9b} - M$	$\frac{(a + c - 2c')^2}{9b} - M$; $\frac{(a - 2c + c')^2}{9b}$
	Not to invest in R&D	$\frac{(a - 2c + c')^2}{9b}$; $\frac{(a + c - 2c')^2}{9b} - M$	$\frac{(a - c)^2}{9b}$; $\frac{(a - c)^2}{9b}$

And both firms will invest in R&D.

Situation II: technological competition without licensing

If $\frac{4(c-c')(a-c)}{9b} < M < \frac{4(c-c')(a-c')}{9b}$,

then there will be two Nash equilibria:

		Strategies of the firm # 2	
		To invest in R&D	Not to invest in R&D
Strategies of the firm # 1	To invest in R&D	$\frac{(a-c')^2}{9b} - M; \frac{(a-c')^2}{9b} - M$	$\frac{(a+c-2c')^2}{9b} - M; \frac{(a-2c+c')^2}{9b}$
	Not to invest in R&D	$\frac{(a-2c+c')^2}{9b}; \frac{(a+c-2c')^2}{9b} - M$	$\frac{(a-c)^2}{9b}; \frac{(a-c)^2}{9b}$

Only one firm will invest in R&D (but which one?), and innovation will be achieved, if firms do not choose prudent maximin strategies.

Situation II: technological competition without licensing

Finally, if $M > \frac{4(c-c')(a-c')}{9b}$,

then investing strategies will be dominated:

		Strategies of the firm # 2	
		To invest in R&D	Not to invest in R&D
Strategies of the firm # 1	To invest in R&D	$\frac{(a-c')^2}{9b} - M$; $\frac{(a-c')^2}{9b} - M$	$\frac{(a+c-2c')^2}{9b} - M$; $\frac{(a-2c+c')^2}{9b}$
	Not to invest in R&D	$\frac{(a-2c+c')^2}{9b}$; $\frac{(a+c-2c')^2}{9b} - M$	$\frac{(a-c)^2}{9b}$; $\frac{(a-c)^2}{9b}$

And nobody will invest.

Situation II: technological competition without licensing

Let's assume that the innovation is exclusive, i. e. only one firm wins "the race for innovation", and the second one then cannot use it; the probability of win is 0.5

		Strategies of the firm # 2	
		To invest	Not to invest
Strategies of the firm # 1	To invest	$\frac{5(c-c')^2+2(a-c)(a-c')}{18b}-M$; $\frac{5(c-c')^2+2(a-c)(a-c')}{18b}-M$	$\frac{(a+c-2c')^2}{9b}-M$; $\frac{(a-2c+c')^2}{9b}$
	Not to invest	$\frac{(a-2c+c')^2}{9b}$; $\frac{(a+c-2c')^2}{9b}-M$	$\frac{(a-c)^2}{9b}$; $\frac{(a-c)^2}{9b}$

The result of the game will depend on the level of *M* again.

Situation II: technological competition without licensing

If $M < \frac{(c-c')(2a-c-c')}{6b}$,

then non-investing strategies will be dominated

		Strategies of the firm # 2	
		To invest	Not to invest
Strategies of the firm # 1	To invest	$\frac{5(c-c')^2+2(a-c)(a-c')}{18b}-M$; $\frac{5(c-c')^2+2(a-c)(a-c')}{18b}-M$	$\frac{(a+c-2c')^2}{9b}-M$; $\frac{(a-2c+c')^2}{9b}$
	Not to invest	$\frac{(a-2c+c')^2}{9b}$; $\frac{(a+c-2c')^2}{9b}-M$	$\frac{(a-c)^2}{9b}$; $\frac{(a-c)^2}{9b}$

And both firms will invest in R&D.

Situation II: technological competition without licensing

If $\frac{(c-c')(2a-c-c')}{6b} < M < \frac{4(c-c')(a-c')}{9b}$,

then there will be two Nash equilibria:

		Strategies of the firm # 2	
		To invest	Not to invest
Strategies of the firm # 1	To invest	$\frac{5(c-c')^2+2(a-c)(a-c')}{18b}-M$; $\frac{5(c-c')^2+2(a-c)(a-c')}{18b}-M$	$\frac{(a+c-2c')^2}{9b}-M$; $\frac{(a-2c+c')^2}{9b}$
	Not to invest	$\frac{(a-2c+c')^2}{9b}$; $\frac{(a+c-2c')^2}{9b}-M$	$\frac{(a-c)^2}{9b}$; $\frac{(a-c)^2}{9b}$

Only one firm will invest in R&D (but which one?), and innovation will be achieved, if firms do not choose prudent maximin strategies.

Situation II: technological competition without licensing

Finally, if $M > \frac{4(c-c')(a-c')}{9b}$,

then investing strategies will be dominated:

		Strategies of the firm # 2	
		To invest	Not to invest
Strategies of the firm # 1	To invest	$\frac{5(c-c')^2+2(a-c)(a-c')}{18b}-M;$ $\frac{5(c-c')^2+2(a-c)(a-c')}{18b}-M$	$\frac{(a+c-2c')^2}{9b}-M;$ $\frac{(a-2c+c')^2}{9b}$
	Not to invest	$\frac{(a-2c+c')^2}{9b}; \frac{(a+c-2c')^2}{9b}-M$	$\frac{(a-c)^2}{9b}; \frac{(a-c)^2}{9b}$

And nobody will invest.

Situation II: technological competition without licensing

- Technological competition leads to the emergence of the “grey zone”: the most expensive R&D projects, which are not realized under technological leadership, still are not realized under technological competition; but even cheaper projects may be rejected under technological competition because of a possible dissipation of an innovator’s rent
- If participants have some instruments of coordination, investments are more likely to be realized under technological competition – and that is the task of reasonable competition policy
- The scope of the “grey zone” depends on the character of innovation (exclusive/non-exclusive), benefits from innovation and parameters of demand

Situation III: technological leadership with licensing

- Here we consider only exclusive innovations (but it does not matter under technological leadership)
- We assume that the state imposes compulsory licensing but gives to firms an opportunity to arrange for fees on their own
- There is a fixed fee *F* for a license. *F* is set accordingly to the arrangement between the leader and the follower, or it is set by the state

Situation III: market outcomes in the case of licensing

$$q_1^{III} = \frac{a - c'}{3b};\ q_2^{III} = \frac{a - c'}{3b};\ Q^{III} = \frac{2(a - c')}{3b};$$

$$P^{III} = \frac{a + 2c'}{3};$$

$$\pi_1^{III} = \frac{(a - c')^2}{9b} - M + F;\ \pi_2^{III} = \frac{(a - c')^2}{9b} - F;\ \Pi^{III} = \frac{2(a - c')^2}{9b} - M.$$

$$CS^{III} = \frac{2(a - c')^2}{9b};\ TS^{III} = \frac{4(a - c')^2}{9b} - M.$$

- Consumer surplus is bigger than it is under technological leadership without licensing, quantity produced is higher, price is lower
- But will the licensing arrangement take place on a voluntary basis?
- Yes, if total profits are higher (the condition is: $2a + 3c' - 5c > 0$)

Situation III: technological leadership with licensing

- If the condition of higher profits under licensing is met, then there exists the "mutually agreeable" range for *F*:

$$F \in \left(\frac{(c-c')(2a+c-3c')}{9b}; \frac{4(c-c')(a-c)}{9b} \right)$$

- Here each value of *F* satisfies both firms making them to arrange for licensing, if the leader invests in R&D
- The condition for leader's investment in R&D:

$$\bar{M}^{III} = \frac{(c-c')(2a-c-c')}{9b} + F.$$

- $\bar{M}^{III} > \bar{M}^{I}$, if *F* is in the "mutually agreeable" range

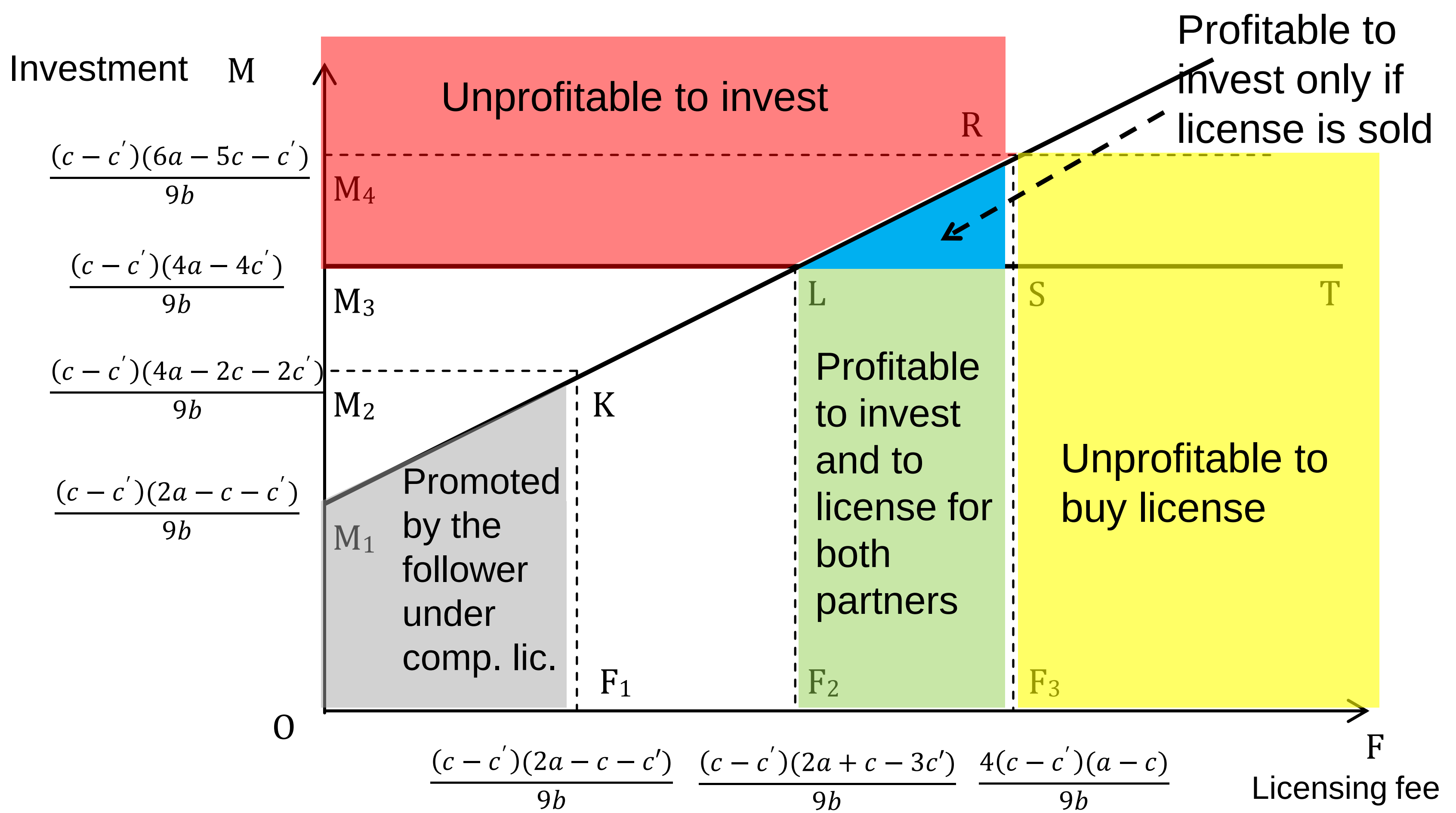
Situation III: compulsory licensing and opportunistic behaviour

- Licensing seemingly provides increase in social welfare and innovative activity (if certain market conditions are satisfied)
- However, if the follower can block the innovation under the regime of compulsory licensing by rejecting licensing offer, she will do it until the fee will be considerably lower:

$$F < \frac{(c - c')(2a - c - c')}{9b}.$$

- This will happen because the absence of innovation (if it can be blocked) may be more profitable for the follower than the purchase of license

Situation III: technological leadership with licensing



Remedies against the follower's opportunism

- Almost the same effect will take place in the Situation IV (technological competition with licensing)
- To control licensing fees in order to prevent their artificial lowering
- To ensure the realization of R&D projects (using state guarantees and other form of support) in order to make the follower believe that the innovation with licensing is the only feasible alternative

Main findings and conclusions

- Technological competition may dissipate the innovator's expected rent and lead to the rejection of R&D projects, if any mechanisms of coordination between producers are absent (compared to technological leadership)
- Licensing generally leads to the improvement of social welfare (if certain objective conditions are met) and may even incentivize innovative activities. However, compulsory licensing may be used opportunistically to block feasible projects

Thank you!