

# INCENTIVES FOR PROCESS INNOVATIONS UNDER DISCRETE STRUCTURAL ALTERNATIVES OF COMPETITION POLICY

Andrey Shastitko & Alexander Kurdin  
(RANEPA, MSU)

22, April, 2015

Athens University of Economics and Business

# The main background idea

2

- Contemporary nations with dominating material culture values have almost no chances to be successful if they fail to create sustainable mechanisms of economic development
- No innovations = no economic development
- ... And think about North's idea on Second Economic Revolution (North, 1981): fast increase of resourcing population due to development of IPR related to production.

# Toolkit of public policies to promote innovations

3

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

# The problem focusing: preliminary comments

4

- 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 firms may invest in R&D

# The main question

5

- ***How will different regimes of competition policy affect the incentives of potential innovators?***
  - To answer this question different environments should be considered...
- “It is not that we don't have a model of market structure and R&D, but rather that we have many models and it is important to know which model is appropriate for each market context” (Gilbert, 2006)*

# Literature

6

- 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.

# The Model assumptions-1

7

- 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;

# The Model assumptions-2

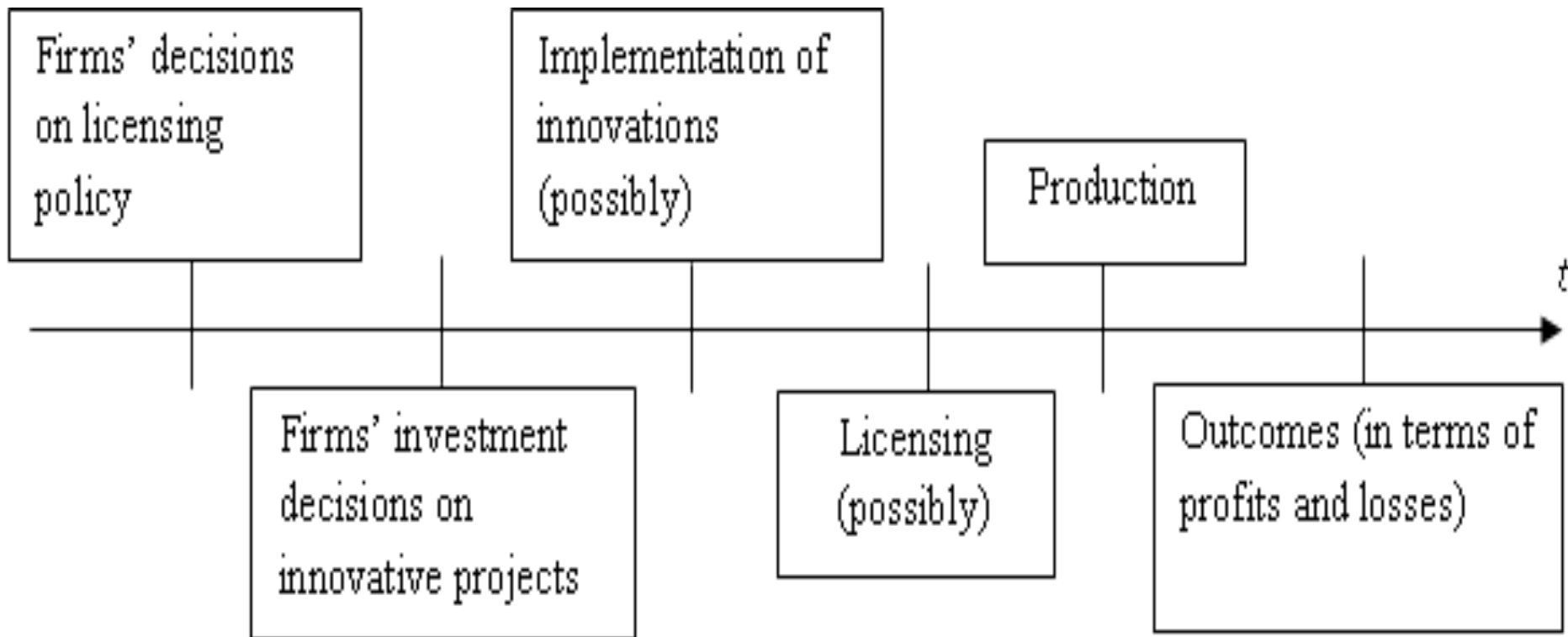
8

- 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  $c'$ ;
- Reverse market demand function is specified by the equation  $P = a - bQ$ ;
- Marginal costs of production equal  $c$  in the case without an innovation and  $c'$  in the case of the realization of innovation ( $a > c, c > c', a > 0, b > 0, c > 0, c' > 0$ ).



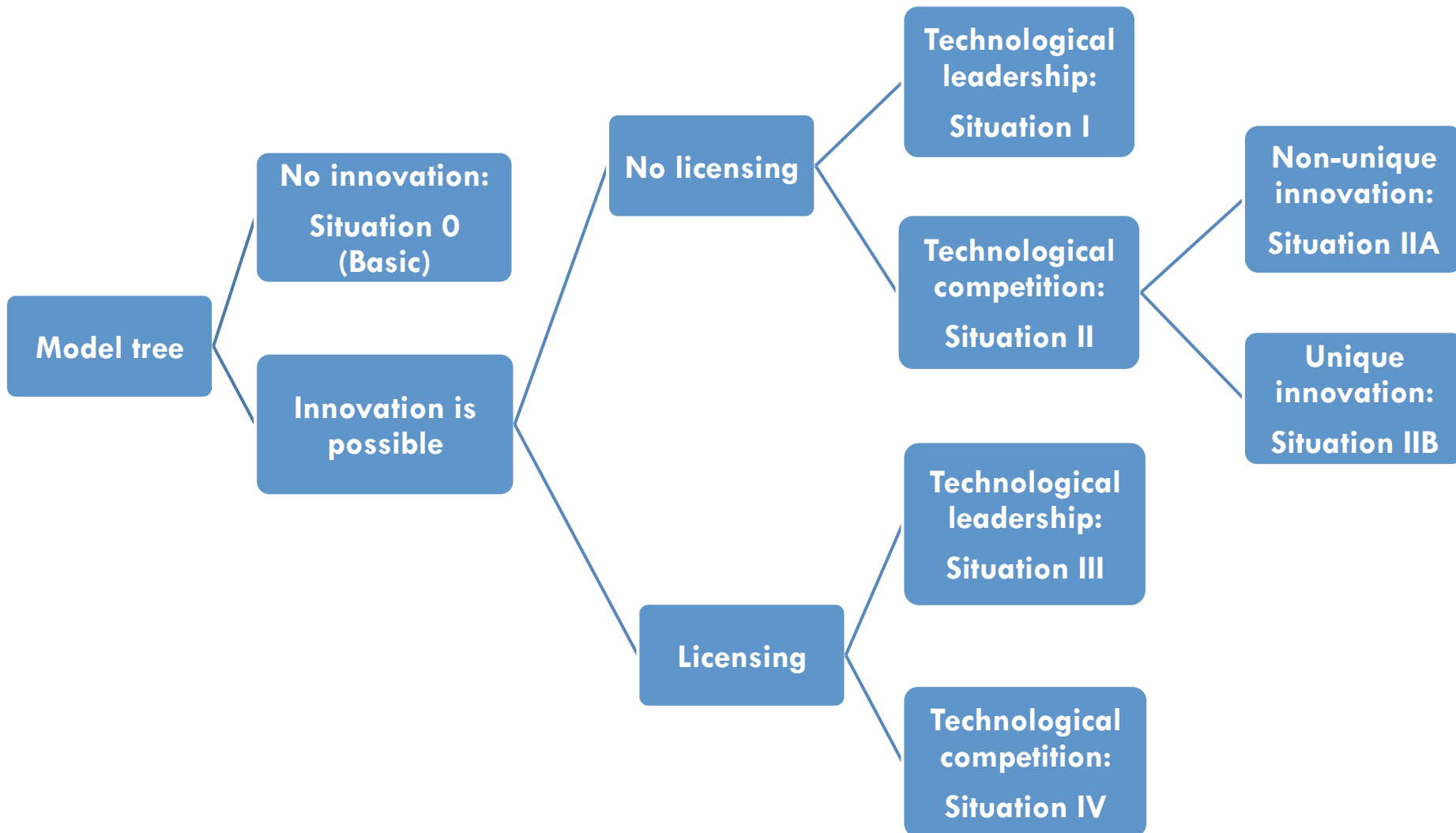
# Timeline of the model

9



# The model tree

10



# Situation 0 (basic): No innovation

11

## □ Equilibrium *a la Cournot*

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

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

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

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

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,  $\pi_1$  and  $\pi_2$  – profits obtained by each of two firms,  $\Pi$  – total profit of both firms concerned,  $CS$  – consumer surplus,  $TS$  – total surplus.

# Situation I: technological leadership without licensing

12

- The position of the leader improves (at least in terms of market share), 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  $M$

# Estimating the readiness to innovate

13

- $M$  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:

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

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

14

- Investment ceiling depends directly on (1) intensity of process innovation, (2) resulting correlation between reserve demand price and marginal cost, (3) reverse demand quantity sensitivity on price (not elasticity)
- There are some substitution ties for particular level of investment ceiling (the higher the  $a$  the lower the  $c$  and vice versa with constraints mentioned above: ( $a > c, c > c', a > 0, c > 0, c' > 0$ ))
- The higher demand sensitivity the higher c.p. elasticity of demand. And the higher elasticity of demand the higher investment ceiling

# Situation II: technological competition without licensing

15

Let's assume that the innovation is **non-unique**, 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

16

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

17

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

18

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

19

Let's assume that the innovation is **unique**, 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

20

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

21

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

22

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	$\frac{5(c - c')^2 + 2(a - c)(a - c')}{18b} - M;$	$\frac{(a + c - 2c')^2}{9b} - M;$
	To invest	$\frac{5(c - c')^2 + 2(a - c)(a - c')}{18b} - M$	$\frac{(a - 2c + c')^2}{9b}$
	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.

# Comments on Situation II (technological competition without licensing) - 1

23

- 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**

# Comments on Situation II (technological competition without licensing) - 2

24

- If participants have some instruments of coordination (**commitments credibility creation**), 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 (unique /non-unique), benefits from innovation and parameters of demand
- Unique /non-unique innovation: positioning of lower bound of ceiling (there is threshold)



# Situation III: technological leadership with licensing

25

- Here we consider only **unique** 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

26

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

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

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

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

- 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:  $2a + 3c' - 5c > 0$ ) than the initial profits under technological leadership without licensing

# Situation III: technological leadership with licensing

27

- 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:

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

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

# Situation III: compulsory licensing and opportunistic behaviour

28

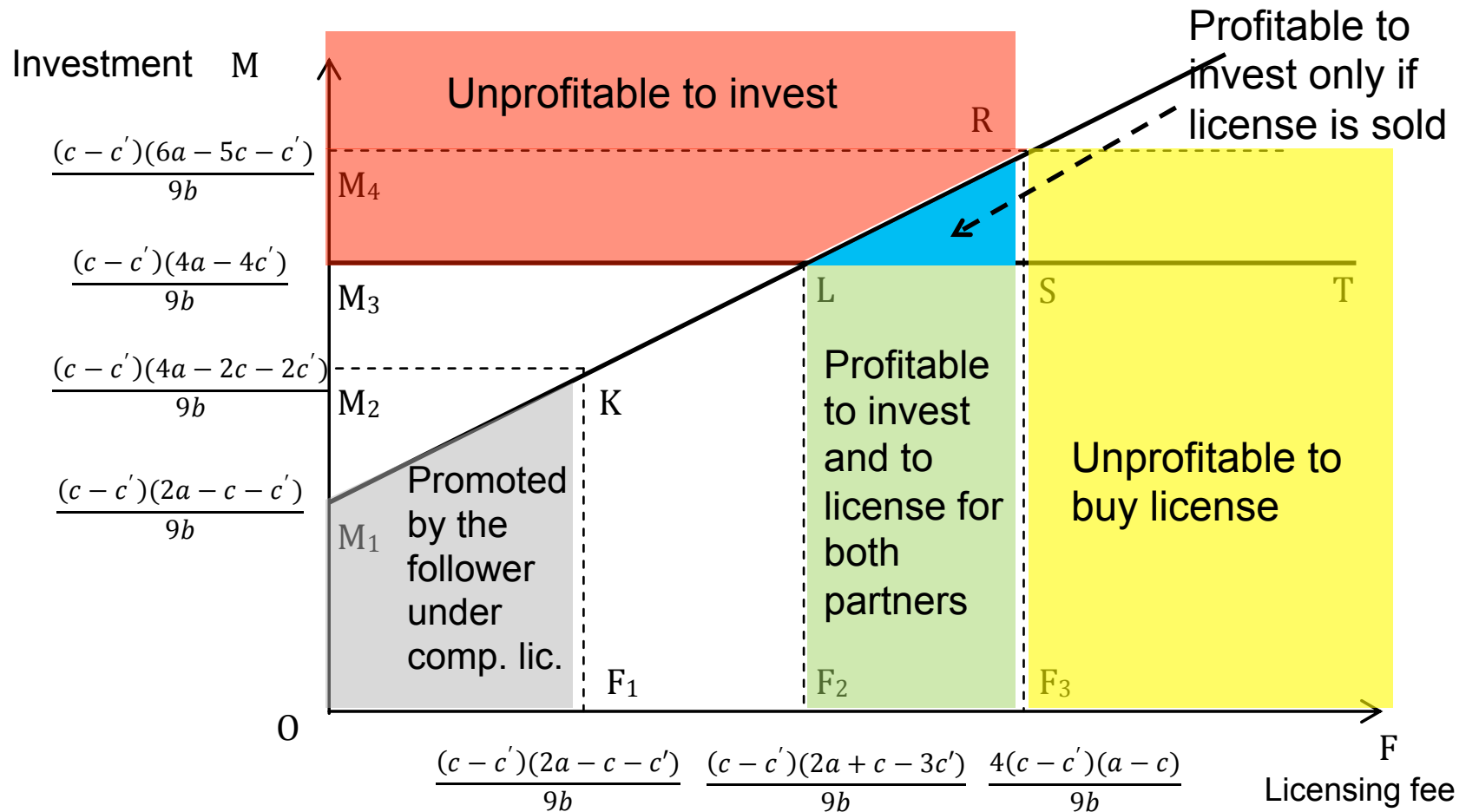
- Licensing seemingly provides increase in social welfare and innovative activity (if certain market conditions are satisfied)
- However, if the follower can block the innovation under the regime of compulsory licensing by rejecting licensing offer, she will do it until the fee will be considerably lower:

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

- 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

29



# Remedies against the follower's opportunism

30

- 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 (**credible commitment**) that the innovation with licensing is the only feasible alternative

# Main findings and conclusions

31

- 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

32

Thank you!