

# Technology transfer in a two dimensional model

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# Introduction

The new technology improves one quality of the product

Process innovation

the use of the new technology reduces the product unit cost

Product innovation

Technology transfer

Patent holding firm

Non innovative firm

Fixed fee

royalty

Auction

Licensing regimes

# Licensing regimes

- Fixed fee (not depending on the quantity produced by the use of the new technology)
  - A fixed fee must not be higher than the profit increase of the non innovative firm when using the new technology
$$F^{\max} = \pi^{\text{with licence}} - \pi^{NL}$$
- Royalty (depending on the quantity produced by the non innovative firm)
  - Patent holding firm will choose a royalty rate maximizing its total revenue
$$r^* = \arg \max_r (\pi^{\text{patent holding firm}} + r q^{\text{non innovative firm}})$$
  - Royalty must be lower than the size of the innovation
$$0 < r^* < \varepsilon$$
- Auction (some licenses are sold to firms paying more than the others)

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# Plan

## ■ Revue of literature

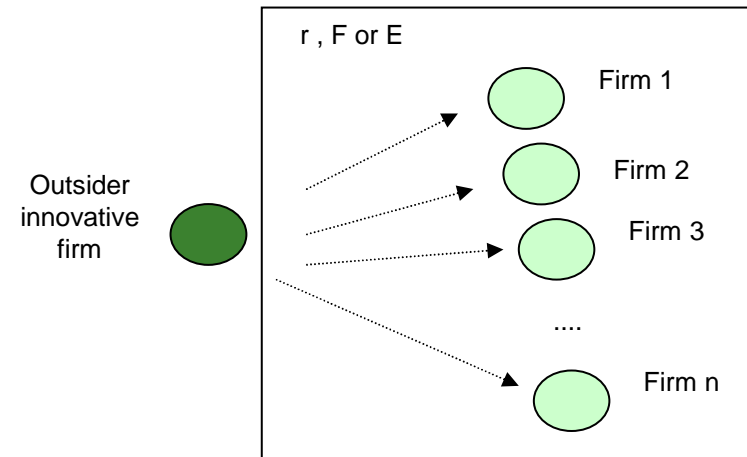
- ❑ Kamien, Oren and Tauman (1992)
- ❑ Muto (1993)
- ❑ Wang (1998 and 2002)
- ❑ Sen (2002)
- ❑ Caballero, Moner and Sempere (2002)
- ❑ Poddar and Sinha (2004)

## ■ Model

- ❑ Symmetric model
- ❑ Asymmetric model

# Kamien, Oren and Tauman (1992)

*Optimal licensing of cost-reducing innovation*



Fixed fee licensing or auction are better than royalty licensing for the patent holding firm and consumers

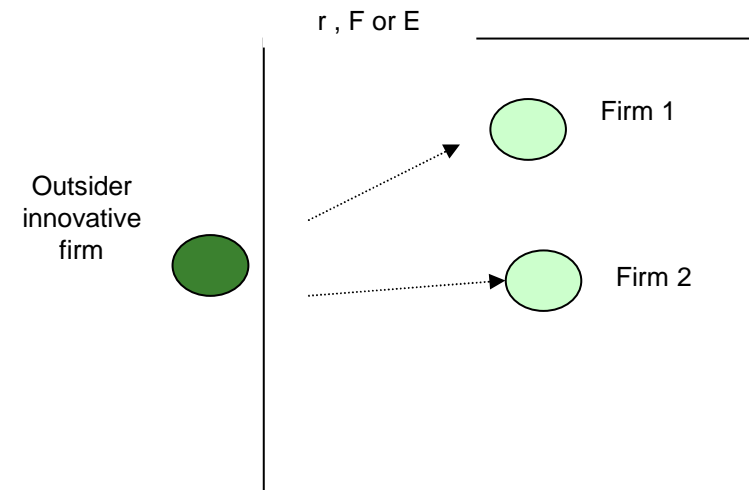
Innovation : process innovation

Competition: Cournot and Bertrand

Products : homogeneous

# Muto (1993)

*On licensing policies in Bertrand competition*



Royalty can be better than fixed fee  
or auction licensing

Innovation : process innovation

Competition: Bertrand

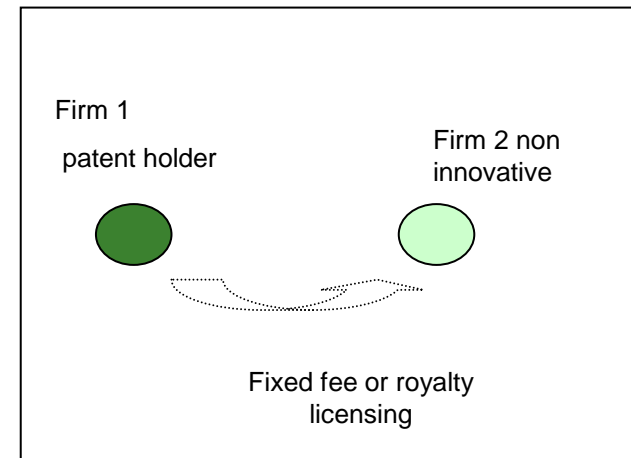
Products : differentiated

# Wang (1998 and 2002)

*Fee versus royalty licensing in a Cournot duopoly model*

*Fee versus royalty licensing in differentiated Cournot oligopoly*

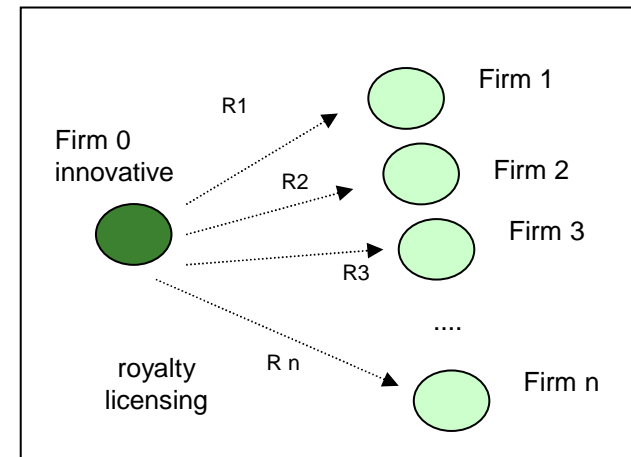
Royalty licensing is better or  
equivalent than fixed fee



Patent hlding firm is an insider

# Sen (2002)

*Monopoly profit in a Cournot oligopoly*



The patent holding firm can make its monopoly profit with a royalty licensing contract

Cournot oligopoly containing more than three firms

Innovation : process innovation

Competition: Cournot

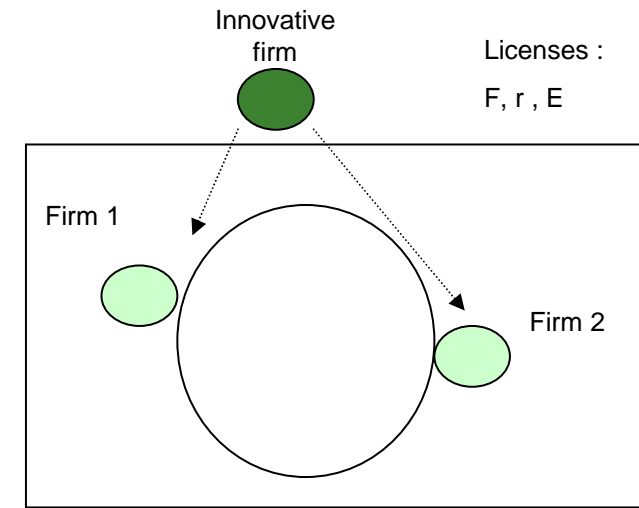
Products : homogeneous



# Caballero, Moner and Sempere (2002)

## *Optimal Licensing in a Spatial Model*

royalty are better for the patent holder  
than auction or fixed fee licensing  
regardless of the innovation size



The two non innovative firms are located  
on a circular model

Licensing regimes are : fixed fee, royalty  
and auction

Innovation : process innovation

Competition: Cournot

Products : homogeneous

# Poddar and Sinha (2004)

*On patent licensing in spatial competition*

Studied technology transfer in a linear model where firms are located at the end points of the city for an outsider and then an insider patentee

## For an outsider patentee

royalty licensing is optimal for both drastic and non drastic innovations

## For an insider patentee

Non licensing is optimal for a drastic innovation

royalty is optimal for a non drastic innovation



- Linear city
- Firms located at the end points
- unit transportation cost

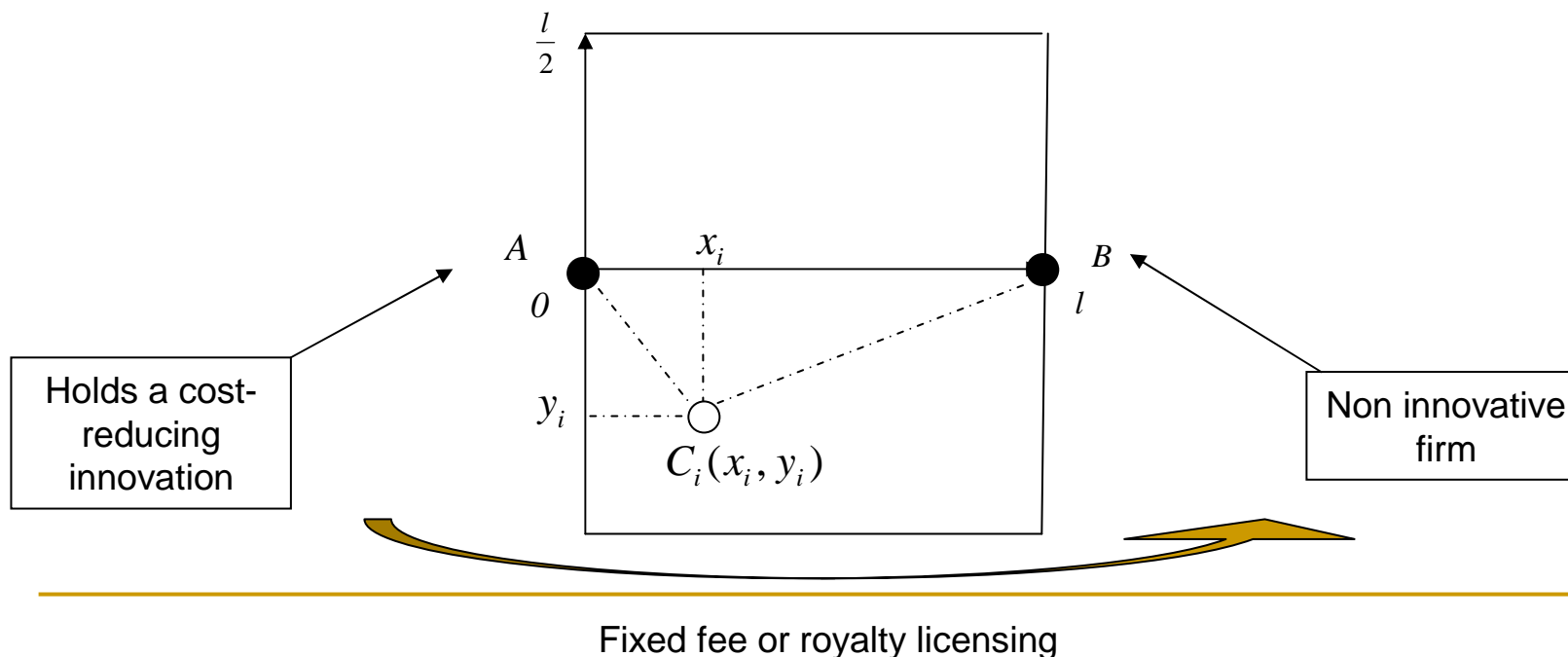


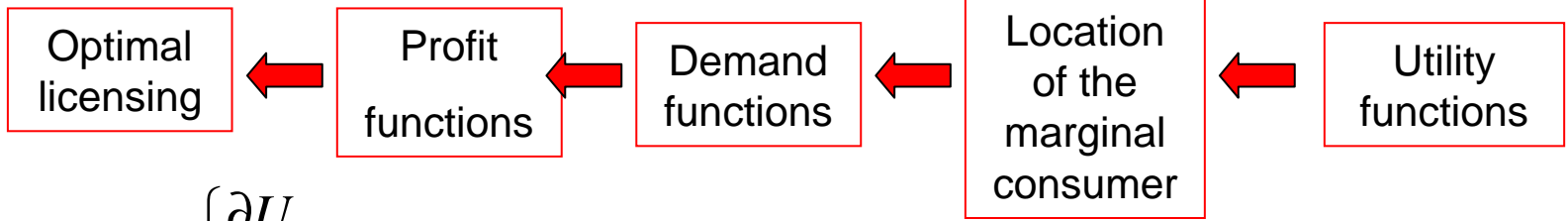
# Model

# Model (symmetric costs)

- A two dimensional city (square model)
- The patent holder and a non innovative firm
- Firms are located at the end points of the city
- Products are homogeneous
- Production unit costs are **symmetric**
- Consumers are uniformly distributed on the square city
- Each consumer pay a quadratic transportation cost equal to  $td^2$

$$c_1 = c_2$$



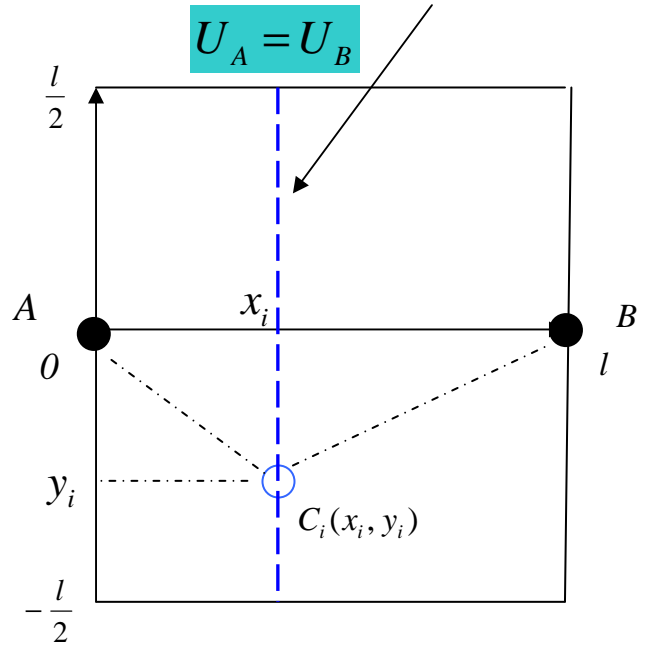


$$\begin{cases} \frac{\partial U_i}{\partial p_i} < 0 \\ \frac{\partial U_i}{\partial d_i} < 0 \end{cases}$$

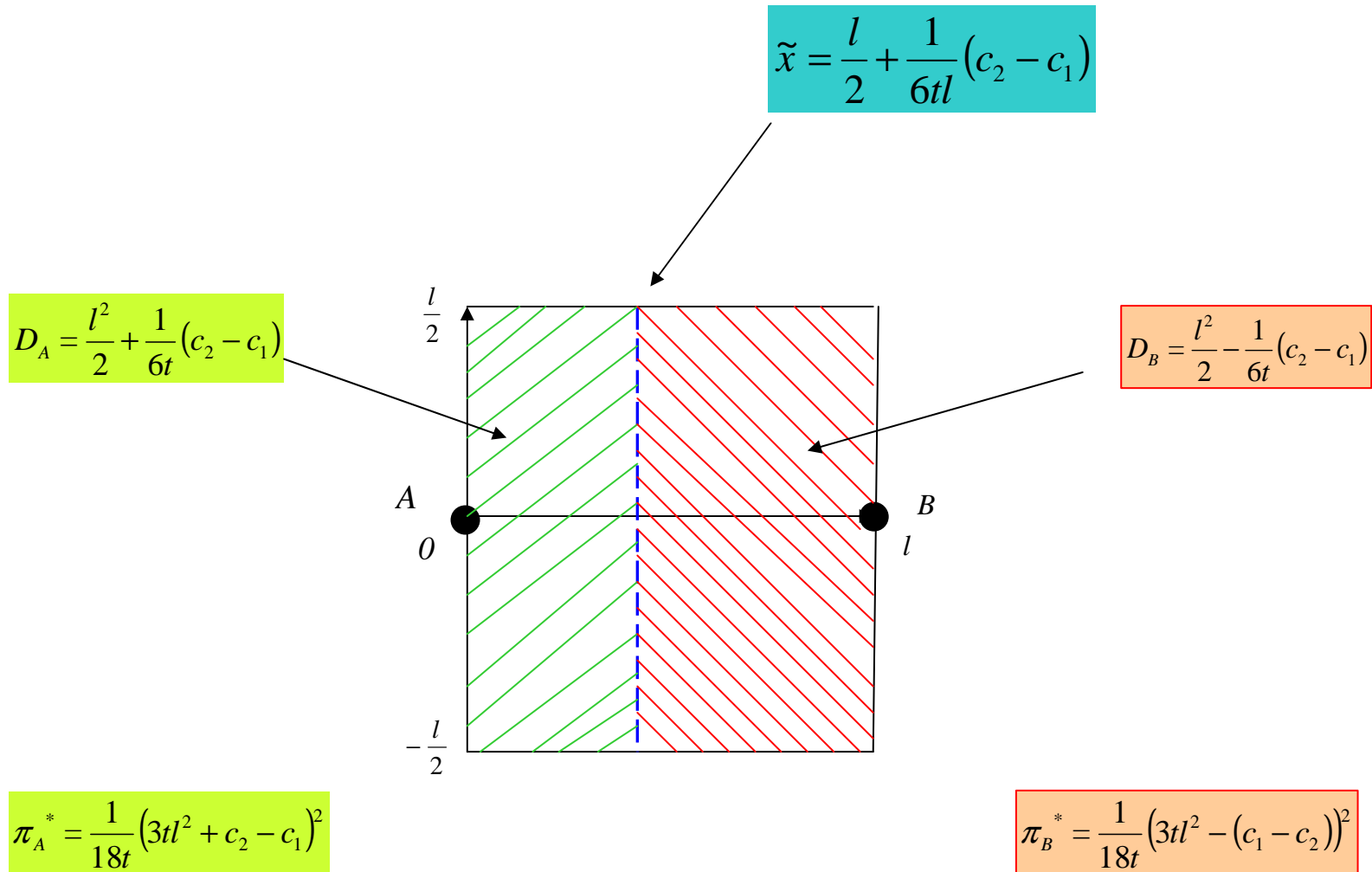
$$U_i = -p_i - td_i^2$$

Location of the marginal consumer

$$U_A = -p_1 - t(x^2 + y^2)$$



$$U_B = -p_2 - t((l-x)^2 + y^2)$$



# No licensing (symmetric costs)

Innovative firm profits alone from its innovation while non innovative firm uses the old technology



	Non Drastic innovation	Drastic innovation
$\pi_A^{NL}$	$\frac{1}{18t}(3tl^2 + \varepsilon)^2$	$(\varepsilon - tl^2)l^2$
$\pi_B^{NL}$	$\frac{1}{18}(3tl^2 - \varepsilon)^2$	0

# Fixed fee licensing (symmetric costs)

Non innovative firm can use the new technology in exchange of the payment of a fixed fee to the patent holding firm

Firms profits are  $\pi_A^F = \frac{1}{2}tl^4$   $\pi_B^F = \frac{1}{2}tl^4$

	Non Drastic innovation	Drastic innovation
$F = \pi_B^F - \pi_B^{NL}$	$\frac{\varepsilon}{18t} (6tl^2 - \varepsilon)$	$\frac{1}{2}tl^4$
$\Pi_A^F = \pi_A^F + F$	$\frac{1}{18} (9t^2l^4 + \varepsilon(6tl^2 - \varepsilon))$	$tl^4$

**Lemma 1** : No licensing is better for the patent holding firm than fixed fee licensing independently of the innovation size.



# Royalty licensing (symmetric costs)

In the royalty regime, the patented cost-reducing innovation is licensed to the non innovative firm in exchange of a royalty depending on the production made with the use of the new technology

Firms profits are  $\pi_A^r = \frac{1}{18t}(3tl^2 + r)^2$   $\pi_B^r = \frac{1}{18t}(3tl^2 - r)^2$

Total revenue of innovative firm is  $\Pi_A^r = \pi_A^r + rD_B = \frac{1}{18t}(3tl^2 + r)^2 + r\left(\frac{l^2}{2} - \frac{r}{6t}\right)$

Maximizing firm A total revenue with respect to r :  $r^* = \frac{15}{4}tl^2$

Since royalty rate r is such that  $0 < r < \varepsilon$   
then we distinguish between two  
optimal values:

$$\begin{cases} r^* = \varepsilon & \text{if } \varepsilon < \frac{15}{4}tl^2 \\ r^* = \frac{15}{4}tl^2 & \text{if } \varepsilon > \frac{15}{4}tl^2 \end{cases}$$

Patent holding firm total revenue

$$\Pi_A^r = \begin{cases} -\frac{1}{9t}\varepsilon^2 + \frac{5}{6}l^2\varepsilon + \frac{1}{2}tl^4 & \text{if } \varepsilon < \frac{15}{4}tl^2 \\ \frac{33}{16}tl^4 & \text{if } \varepsilon > \frac{15}{4}tl^2 \end{cases}$$

Lemma 2 : Royalty licensing is better than no licensing when innovation is non drastic while no licensing is better for a drastic innovation

# Optimal regime (symmetric costs)

	Non drastic innovation $\varepsilon < 3tl^2$	Drastic innovation $3tl^2 < \varepsilon < \frac{15}{4}tl^2$	Drastic innovation $\varepsilon > \frac{15}{4}tl^2$
$\Pi_A^r - \Pi_A^F$	$\frac{\varepsilon}{18t}(9tl^2 - \varepsilon) > 0$	$-\frac{1}{9t}\varepsilon^2 + \frac{5}{6}l^2\varepsilon + \frac{1}{2}t^2l^4 > 0$	$\frac{17}{16}tl^4 > 0$

***Lemma 3** royalty licensing is always better than fixed fee licensing independently of the innovation size (drastic or non drastic).*

## **Proposition 1**

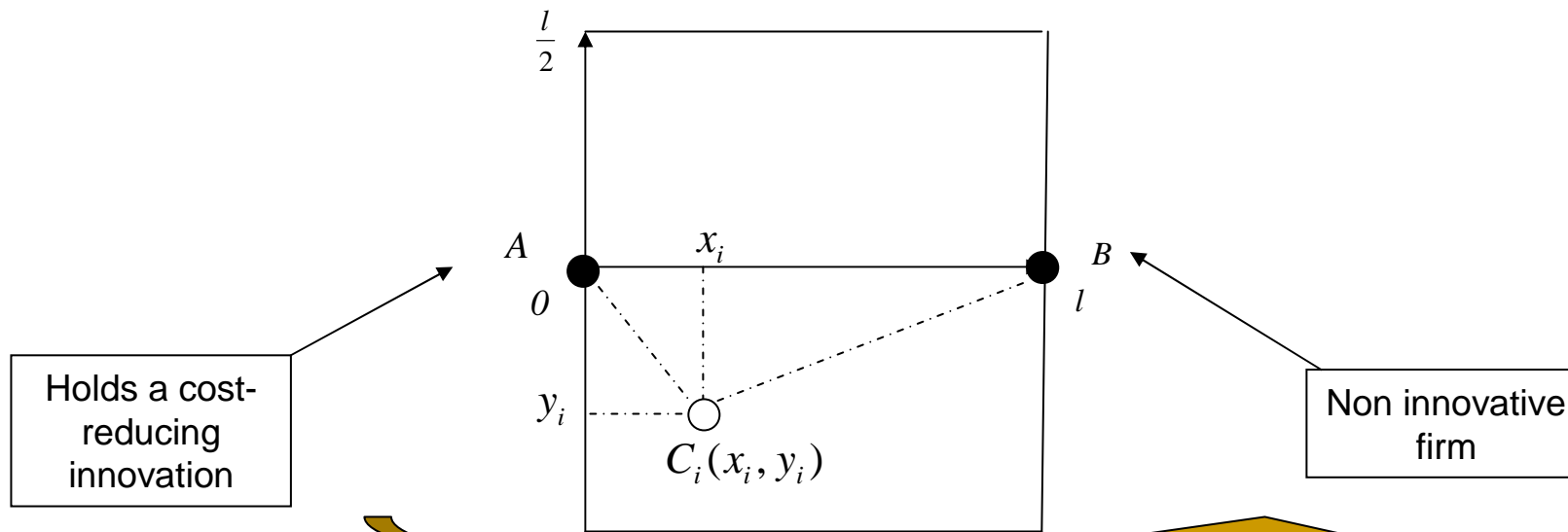
In a two dimensional model where costs are symmetric, the optimal licensing regimes are the same as in the two one dimensional models à la Hotelling and à la Salop and where a royalty licensing is optimal for a non drastic innovation while non licensing is optimal when the innovation is drastic.

# Model (asymmetric costs)

- A two dimensional city (square model)
- The patent holder and a non innovative firm
- Firms are located at the end points of the city
- Products are homogeneous
- Production unit costs are **asymmetric** (inefficient patent holder)
- Consumers are uniformly distributed on the square city
- Each consumer pay a quadratic transportation cost equal to  $td^2$

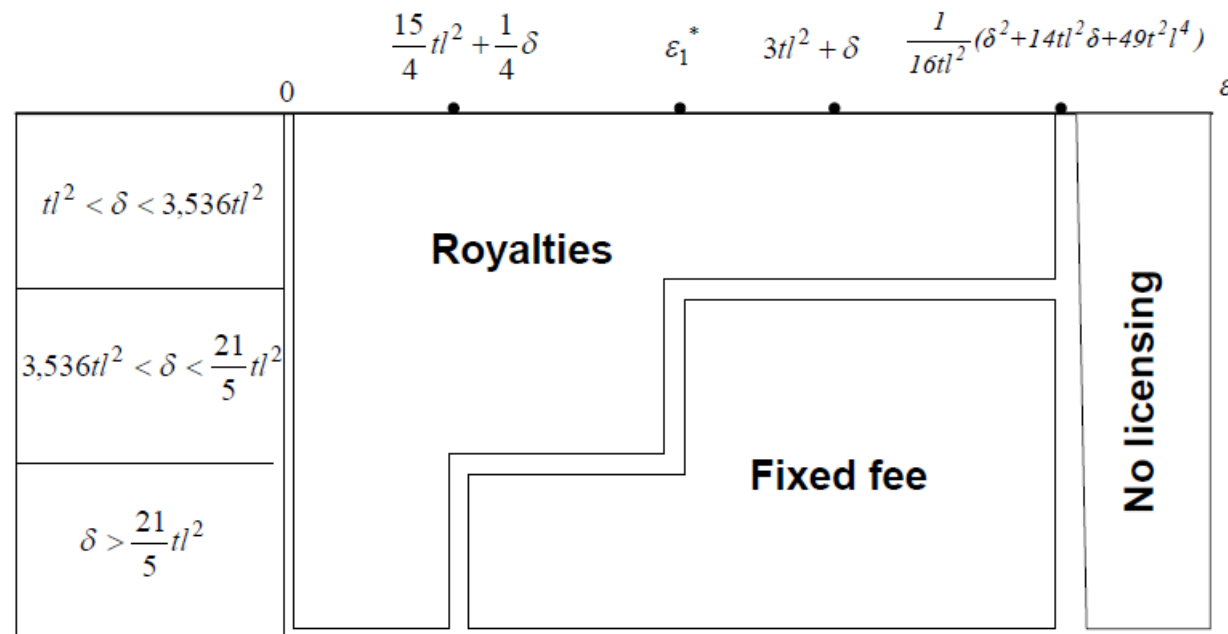
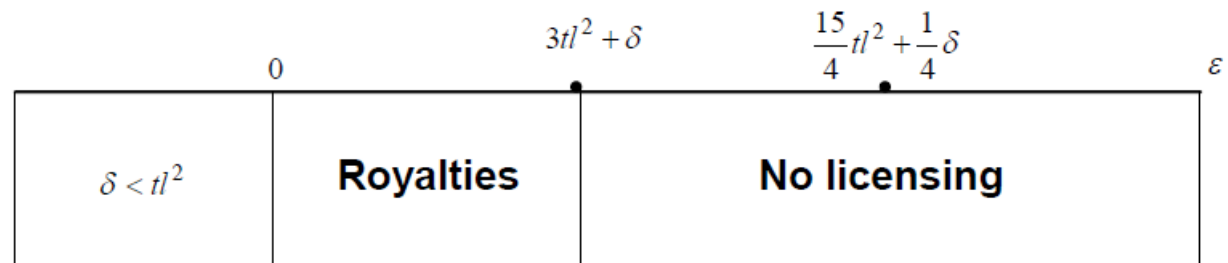
Inefficient patent holder

$$\delta = c_1 - c_2 > 0$$



Fixed fee or royalty licensing

# Inefficient Patent Holder





Thank you