Imitation versus Innovation Costs: Patent Policies under Common Patent Length

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Motivation

LCD panel market

- **In 1997, Japanese firms (e.g. SHARP) had 80% market share in production of LCD**
- **In 2006, Japanese share dropped to 13%.**

  Taiwanese firms 45% and Korean firms 38%
- **Patent length is 20 years**
- **Taiwan and Korea did not infringe on patents held by SHARP**
- **Now SHARP is on the verge of bankruptcy**

Motivation

- **Unintended technology outflow →**
- **non-infringing imitations (inventing around the original patent) are abound**
- **How various patent-related policies affect innovations when imitations are abound?**
- **Any role for supporting trade secrecy? Such as the Soleau Envelope system in France and Belgium?**

Motivation

- Basic 2 Roles of **Patent system**

1. To give **incentive** **to innovate** a new product (grant a **monopoly** for a certain period = duration of the patent protection ***T***)
2. To contribute to followers by making the **patented information available to the society** (the **disclosure** **requirement** for patentability); to accelerate aggregate innovation by **dissemination**

Motivation

- 2nd **disclosure** requirement can create a problem for the original innovator.
- **Imitation** or **inventing-around** is abound
- How **broad** the patent system should be?
- 2 definitions of **breadth** (patent system):

1. Product space … how substitutable these goods are
2. Technology space … how costly it is to find a noninfringing substitute

Breadth of Patent: Example

- (Too) Broad
  - Harvard Medical School **Oncomouse** used in cancer research (patent applied to all mammals)
- Narrow
  - **Insulating sleeves for paper cups** that protect users from burning their fingers (minor changes in the pattern of dimples stamped into the sleeves have received patent protection)
  - **Paper clips** (various shapes)

Breadth and Imitation

- If broad enough, then there should be **NO** imitation problem. (There will NOT be many competition because it is easy to infringe the original broadly-defined patent.)
- If narrow enough, then **imitation** prevails. (There will be many competing products which do not infringe the narrowly-defined patent.)

Two costs

- The model in this paper treats the following two costs important:

1. imitation cost ***k*** paid by rivals
2. innovation cost ***c*** paid by an innovator

Patent Breadth and Imitation Costs

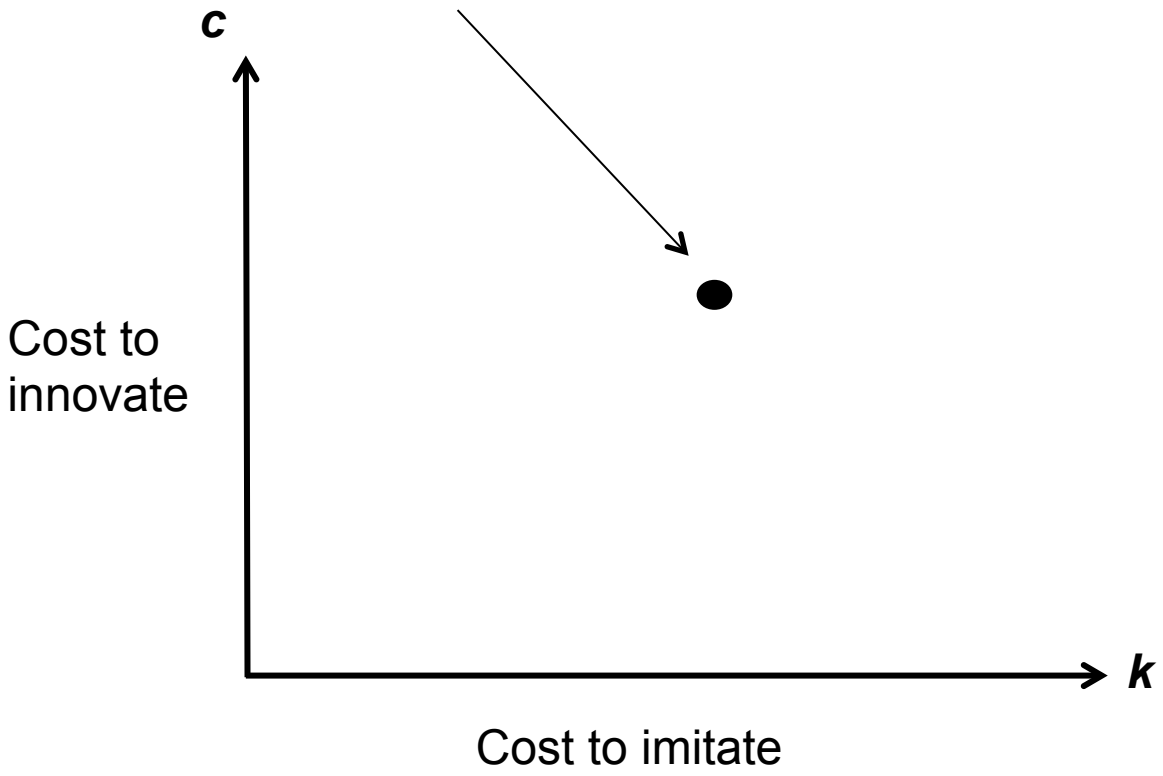
- Once the original idea is patented, the rivals (followers) can examine the patent claims and may be able to come up with a way to produce **similar products without infringing the original patent** by R&D.
- Suppose such research cost is $k > 0$.
- Imitation cost k is a measure of patent breadth.

Innovation Costs

- The process of **technological innovation** itself is **expensive**.
- New products do not spring full-grown from the creative mind of an innovator.
- It takes years of R&D to make a flash of idea into **commercially viable** and marketable one.
- Suppose such research cost is $\boldsymbol{c > 0}$.

Heterogeneity of Ideas

- An idea in this paper's model is characterized by a vector (***k***, ***c***)



Previous literature

- Optimal Patent Policy
  - What is optimal duration (length, ***T***) of patent?
  - What is the optimal breadth of patent?
- Gallini (1992) model of costly imitation
  - Think of one industry
  - Given ***k***, what is optimal ***T***?
  - Her answer was ***T*** must be short enough so that there is no imitation by rival firms
  - No discussion about ***c***.

This paper

- Extend Gallini (1992) by introducing heterogeneous imitation costs ***k*** varying industry by industry and by introducing (possibly heterogeneous) innovation cost ***c*** explicitly
- Consider various patent-related policies given a common patent length ***T***
- Effects of the Soleau Envelope system
- Other patent-related policies

Basic Model (modified Gallini 1992)

- An innovator comes up with an idea
  - Decides either to pay $c > 0$ to do research to make the idea marketable, or not to pay (This decision is **not** in Gallini 1992)
  - After R&D, decides either to patent the idea or to keep it secret
    - After patenting, the innovator may (or may not) face imitation from rivals (imitation cost is $k > 0$)
    - After keeping it secret, the innovator faces the risk of someone figuring out the invention independently with probability $p > 0$. (Zero profit in this case.)

Basic Model (Gallini 1992)

- Discount time factor
  - Let us define $\beta(T)$ as follows
    - Given the common discount rate per period r

$$\beta(T) = \int_0^T e^{-rt} dt = \frac{1 - e^{-rT}}{r}$$

$$\beta(\infty) = \lim_{T \to \infty} \int_0^T e^{-rt} dt = \frac{1}{r}$$

Basic Model (Gallini 1992)

- Rivals
  - After the innovator patented the product,
    - Rival firms decides to pay the cost of imitation ***k > 0*** and enter (or not) into the imitation market.
  - If imitation is successful,
    - Both the original innovator and rival firms (number is ***m***) will compete in product market in an oligopolistic manner and earn ***π(m)***
    - They enter until profits are dissipated (Zero Profit Condition): $\pi(m)\beta(T) = k$

Profit for the innovator

1. non-imitated patent (monopoly for ***T***)

$$E\Pi^{P} = \pi(0)\beta(T)$$

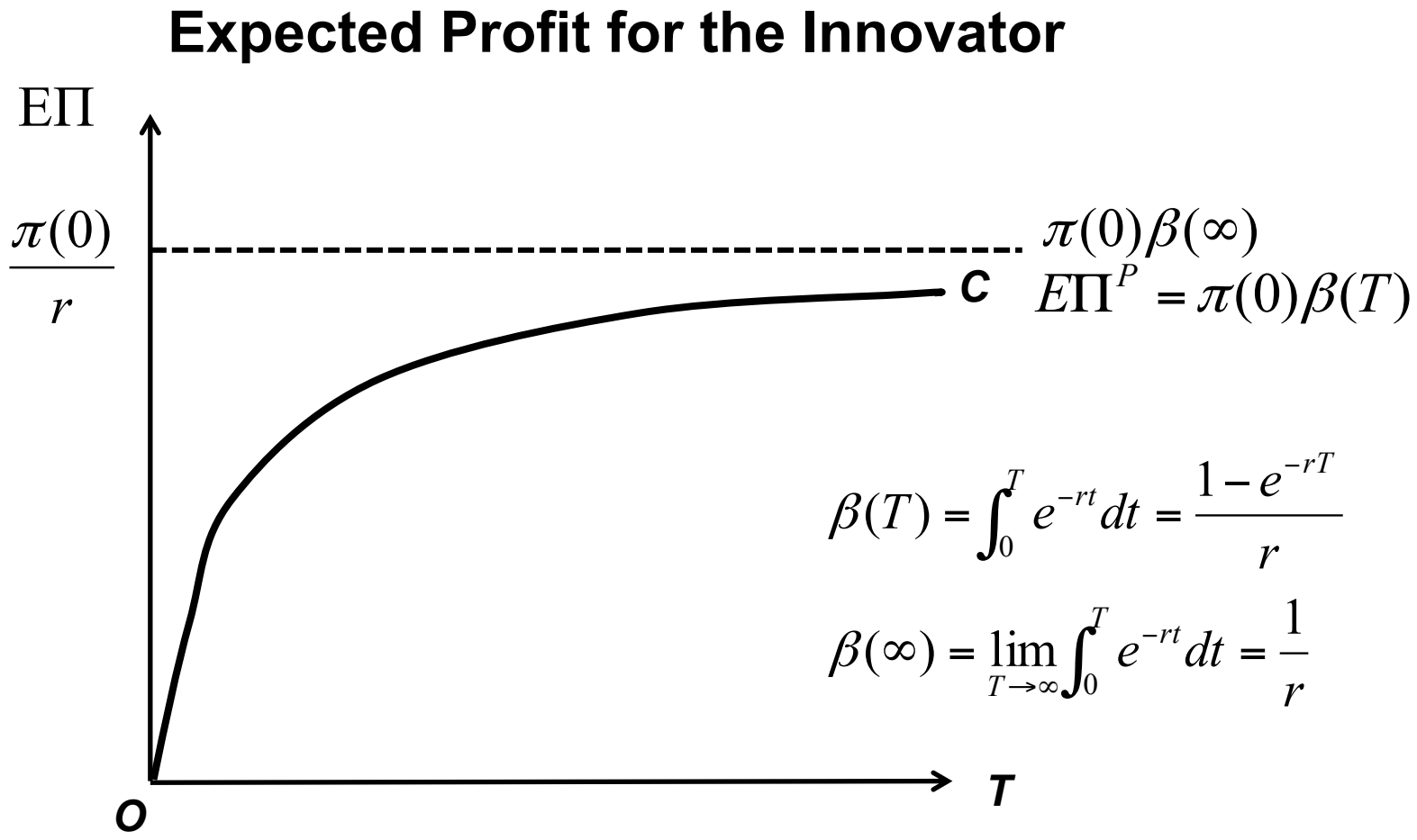
2. patent & imitation (oligopoly for ***T***)

$$E\Pi^{M} = \pi(m)\beta(T) = k$$

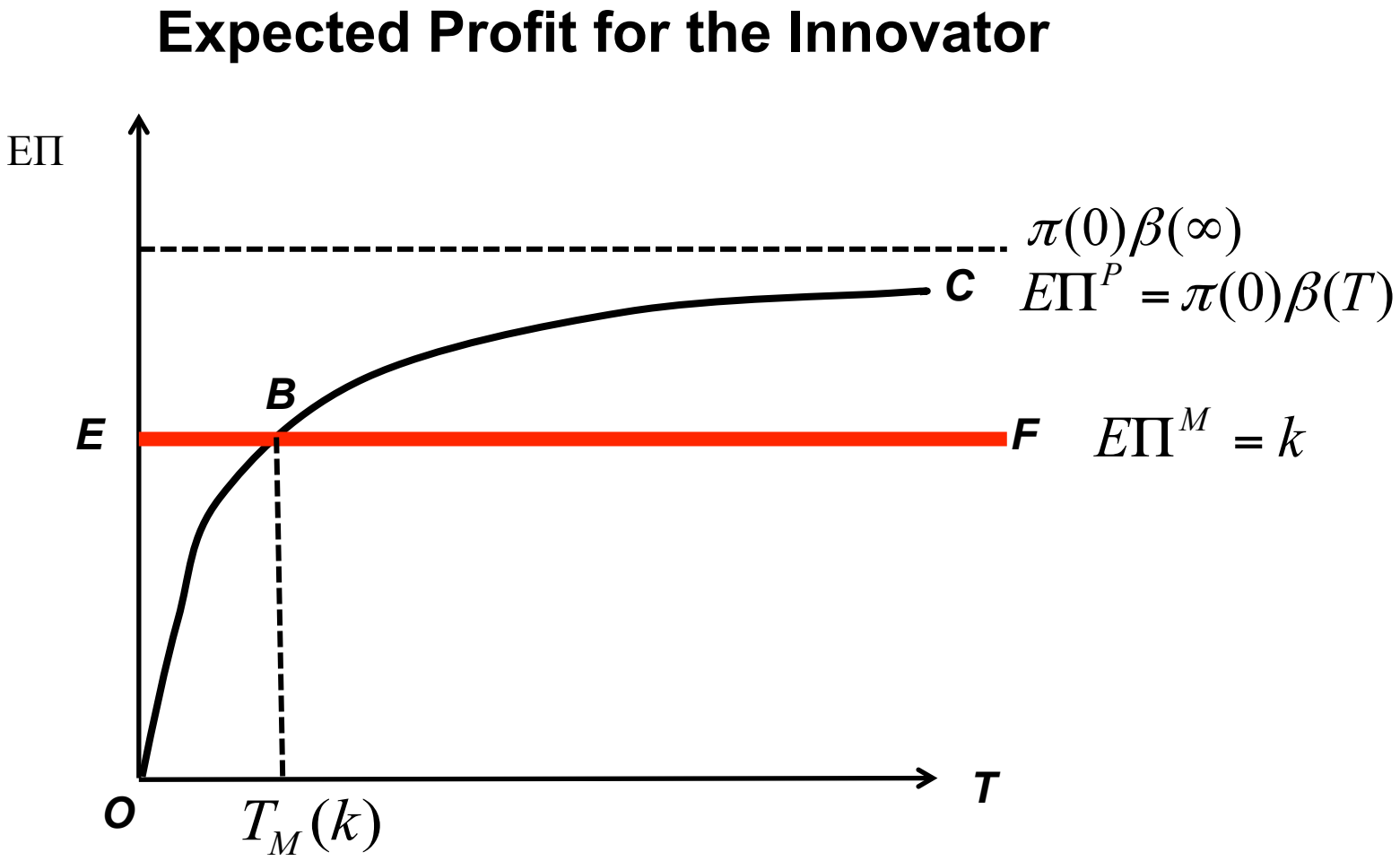
3. trade secret (with probability ***1-p***, monopoly forever)

$$E\Pi^{S} = (1-p)\pi(0)\beta(\infty)$$

1. non-imitated patent



2. imitation: red



3. secrecy: blue

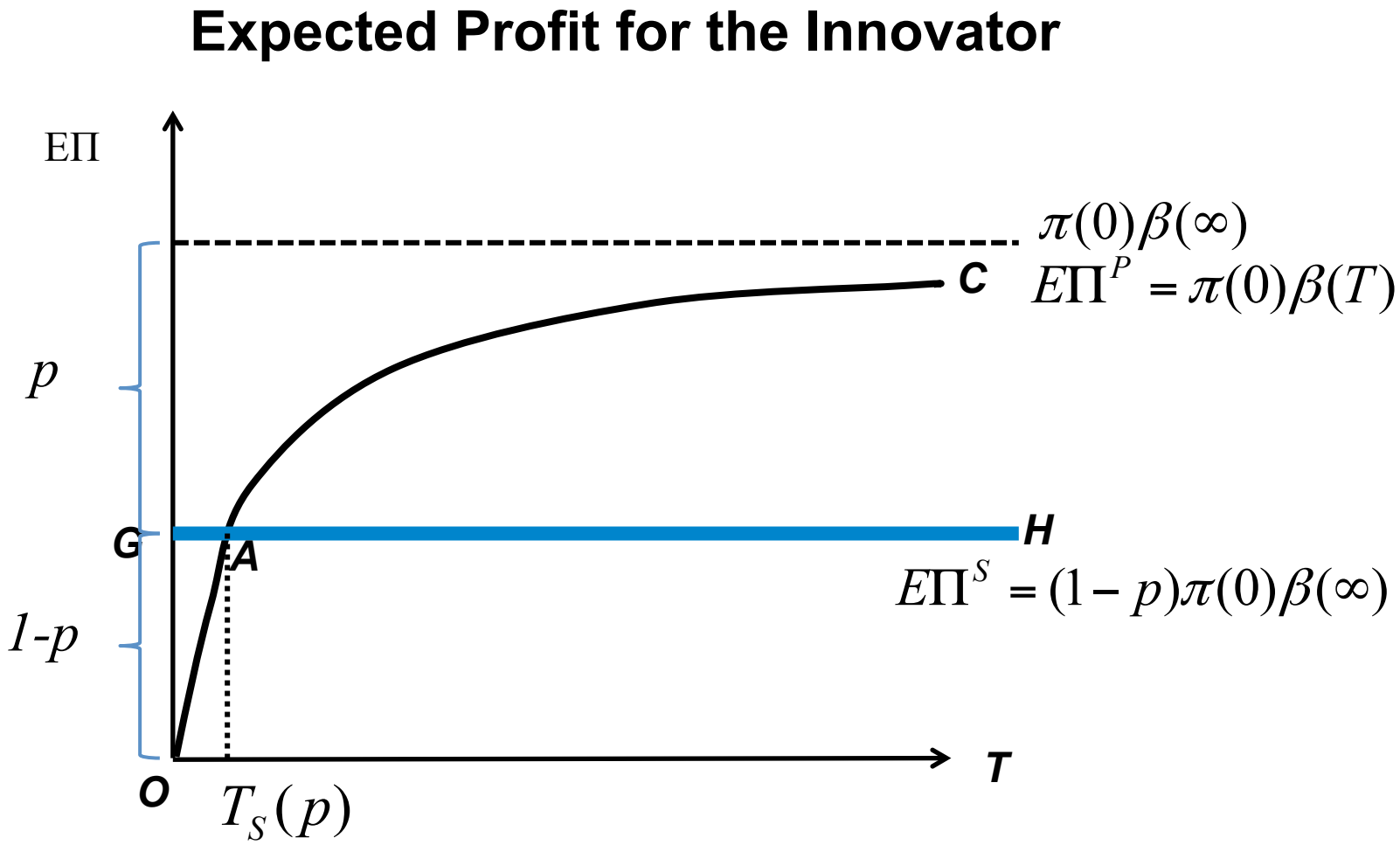
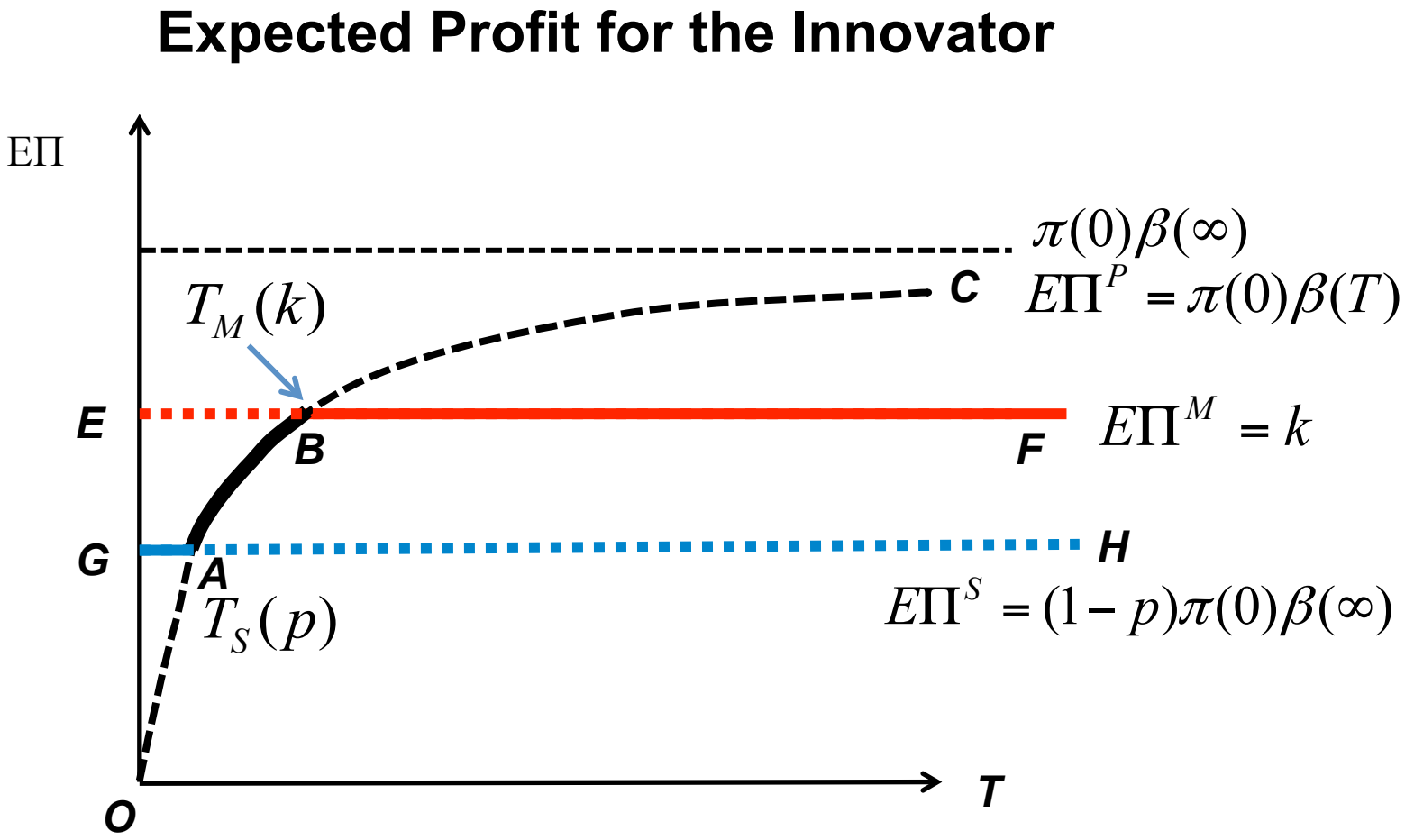


Figure 1


Expected Profit for the Innovator
EΠ
$\pi(0)\beta(\infty)$
C
$E\Pi^P = \pi(0)\beta(T)$
$T_M(k)$
E
B
F
$E\Pi^M = k$
G
H
A
$T_S(p)$
$E\Pi^S = (1-p)\pi(0)\beta(\infty)$
O
T

For small ***k*** or small ***p***,

Blue line can be above red line
(up to the dotted line) or
Red line can be below Blue line

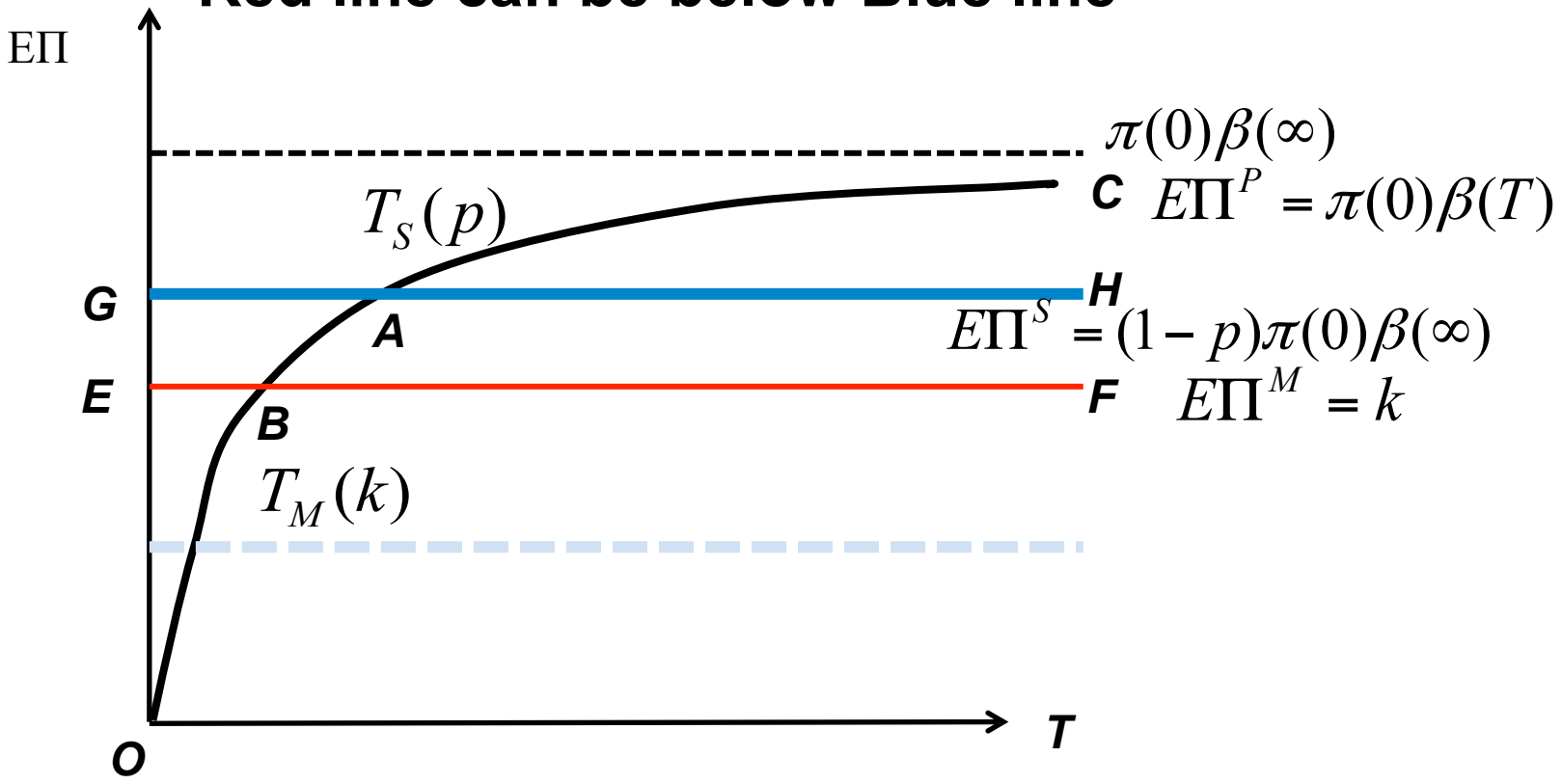
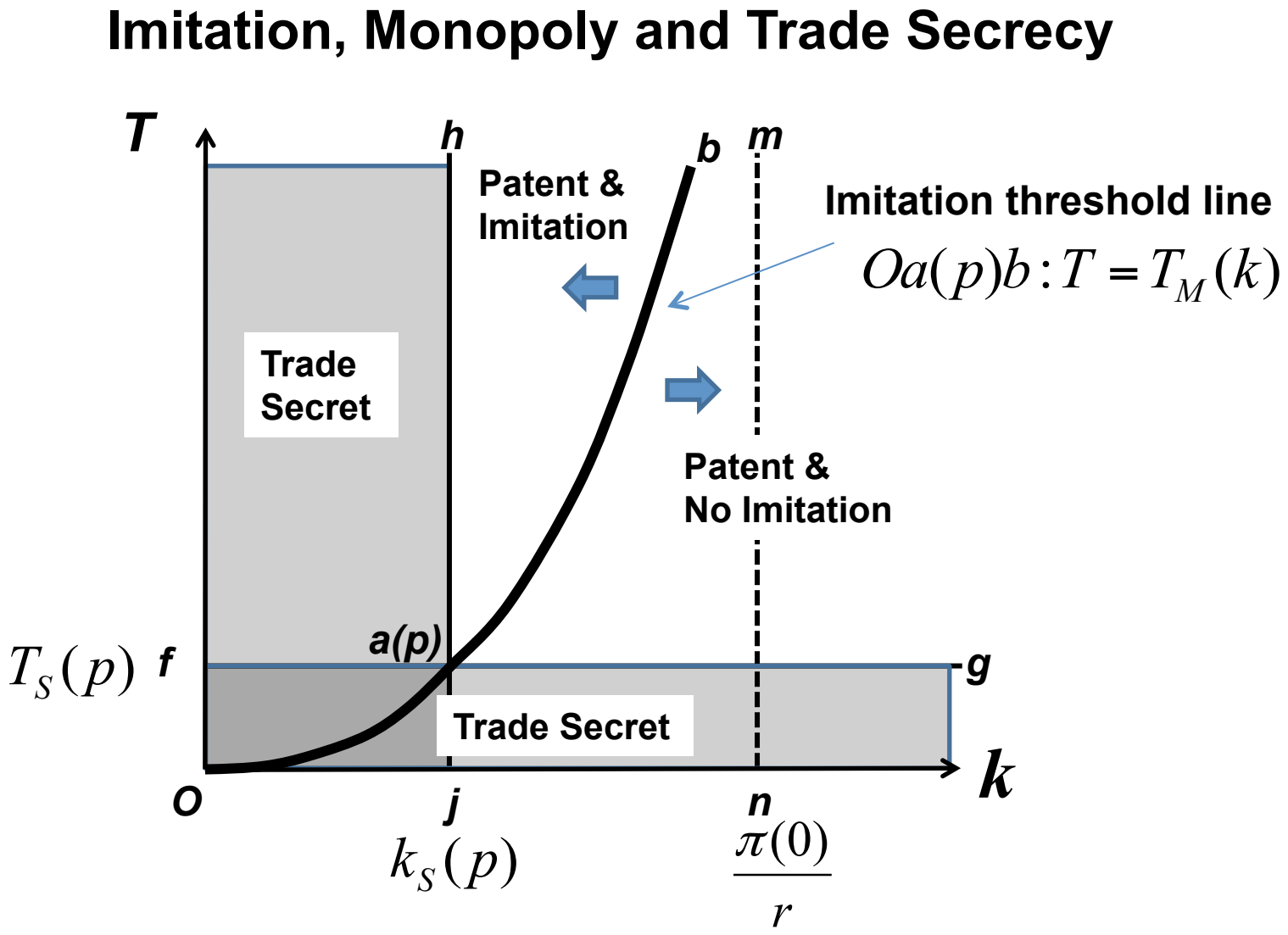


Figure 2


Imitation, Monopoly and Trade Secrecy
T
h
b
m
Patent &
Imitation
Imitation threshold line
$Oa(p)b : T = T_M(k)$
Trade
Secret
Patent &
No Imitation
$T_S(p)$
f
a(p)
g
Trade Secret
k
O
j
n
$k_S(p)$
$\frac{\pi(0)}{r}$

Basic Model (Gallini 1992)

- Gallini 1992 problem
  - Given ***k > 0*** ,
    - What is optimal ***T***?
  - The answer is $T_M(k)$,
    - above which no increase in incentives to R&D
    - above which, unnecessary imitation
    - below which, the expected profit for innovator can increase with larger ***T***

What's new? (This paper)

- Introduce innovation cost: ***c > 0*** compare this cost to expected profit from secrecy, patent, patent with imitation
- Imitation cost ***k > 0*** can vary

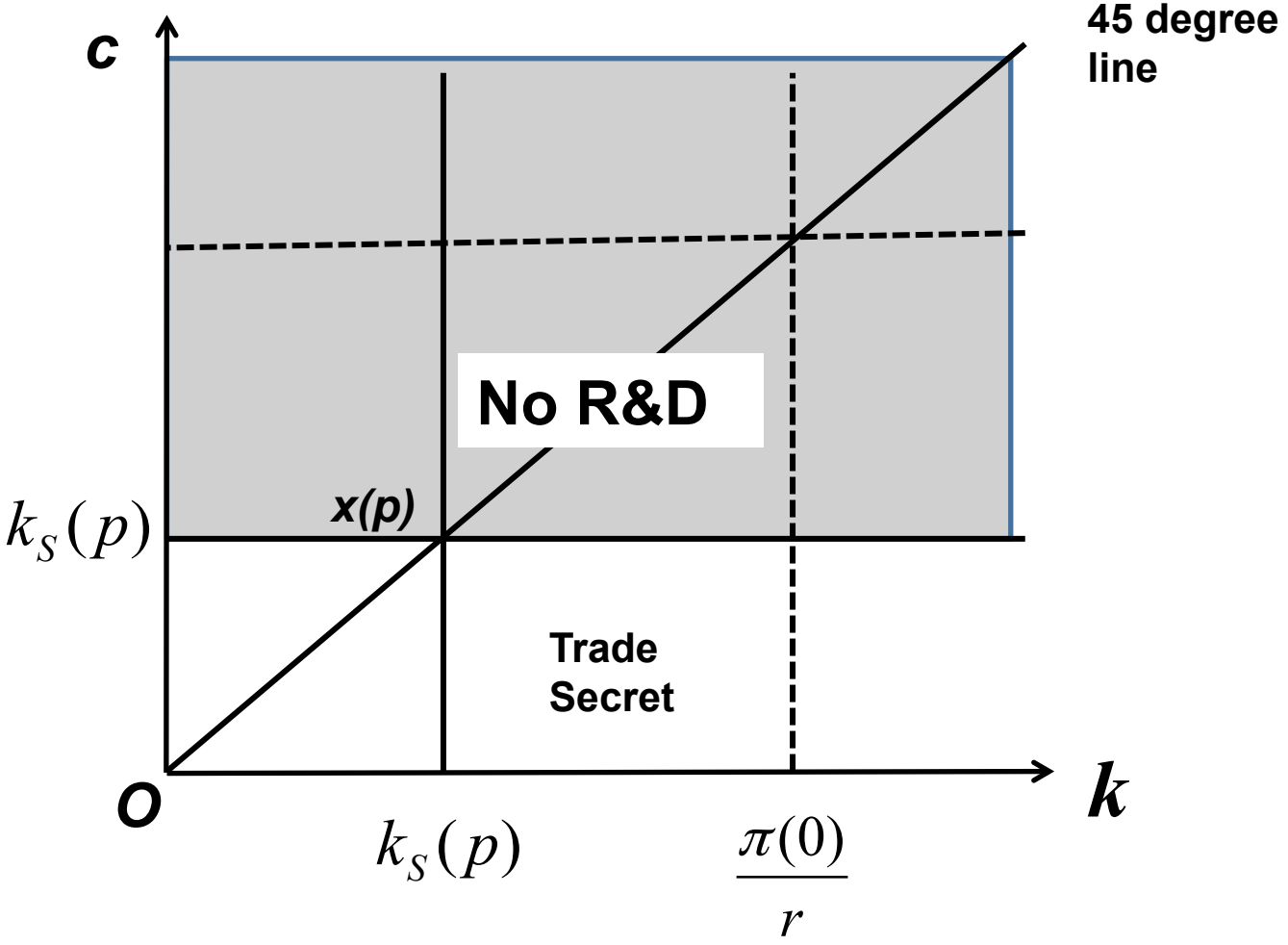
- Therefore, we have to take ***T*** to be given for now (in a small open economy setting with TRIPS, this is a reasonable assumption, too.)

What's new? (This paper)

- Take ***T*** to be given, what are the optimal strategy for an idea inventor with the cost combination **(*k* , *c*)** ?
- Given optimal decisions by heterogeneous inventor firms, what are the effects of different patent-related policies?

Figure 3

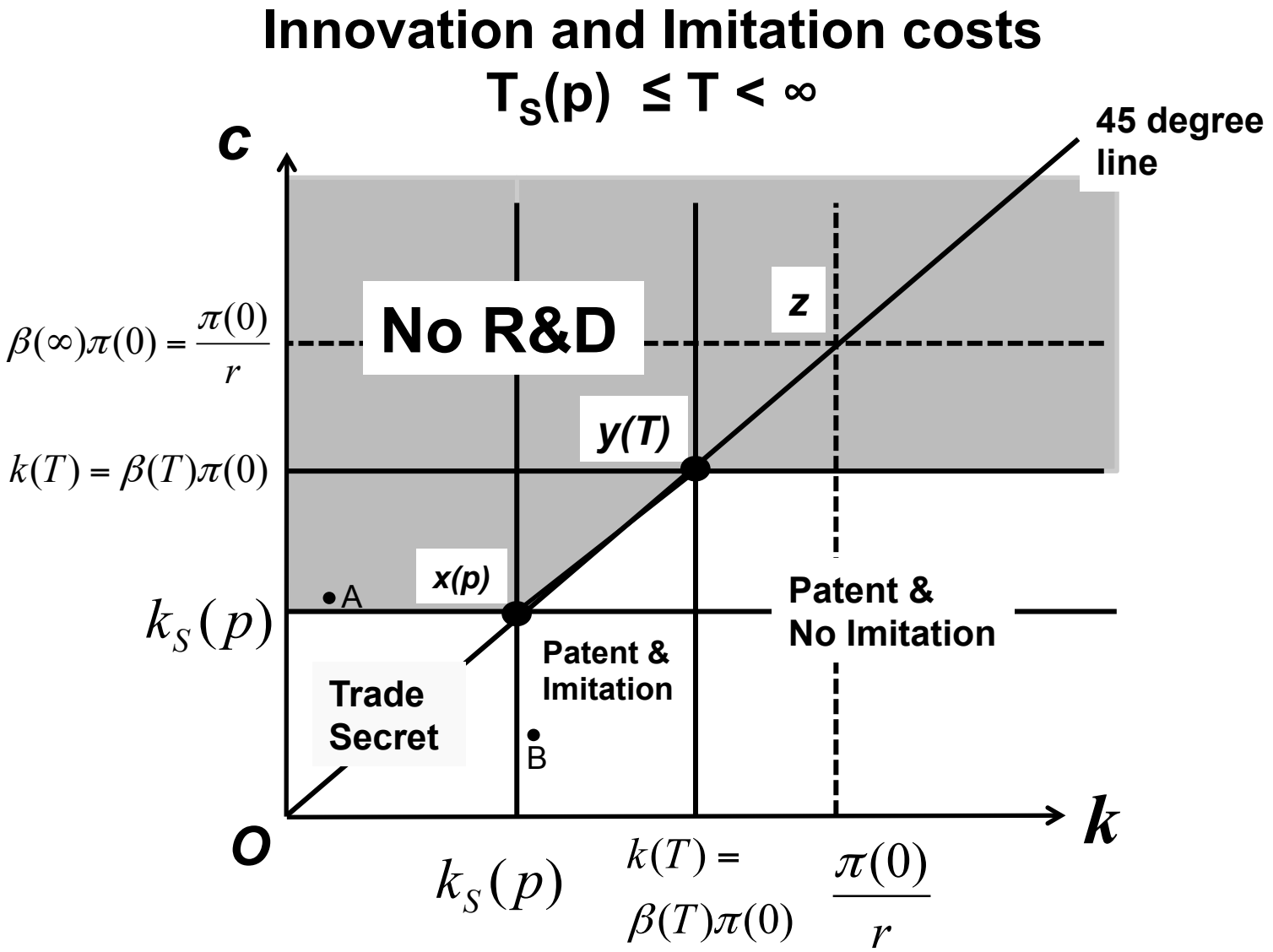
Innovation and Imitation costs
When T is small, i.e., $0 \leq T < T_S(p)$



when T is too small

- When $0 \leq T < T_S(p)$ holds,
- no patenting exists in the equilibrium
- it is better to increase T above the level of threshold $T_S(p)$
- but this $0 \leq T < T_S(p)$ case is probably not likely the case in the real world (it is likely that $20 > T_S(p)$ holds.)

Figure 4a


Innovation and Imitation costs
$T_S(p) \leq T < \infty$
c
45 degree line
No R&D
z
y(T)
$\beta(\infty)\pi(0) = \frac{\pi(0)}{r}$
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$\frac{\pi(0)}{r}$

When T is larger than $T_S(p)$

- threshold value $k(T)$ exists from $T_M(k) = T$
- Given T, patented idea earns $k(T) = \beta(T)\pi(0)$
- if k is below that, then imitations occur.
- area below x and $y(T)$: patent and imitation
- area below horizontal line $y(T)$ and right of vertical line $y(T)k(T)$: no-imitation patent
- area $k \leq k_S(p)$ and $c \leq k_S(p)$: trade secret

Prop: imitation exists

When there are positive density in ideas within the region:

$$\{(1-p)\pi(0)/r \leq k < \beta(T)\pi(0)\} \cap \{c \leq k\}$$

there exist equilibrium with imitation.

- The result here contrasts sharply with the one in Gallini (1992) where there is no imitation in the optimal patent length equilibrium.

Policy affecting ***p***

- Government cannot change the location of ***p*** directly, but can affect a small change in ***p***
- similar to foreign exchange intervention with floating system
- Reduction of ***p*** is like Soleau Envelope policy because by helping registering trade secret, the policy reduces the risk of others find out trade secret independently.

The Soleau Envelope system

- The Soleau Envelope system (within a first-to-file patent system) is a way for innovators to keep its "trade secret" as secret and yet to be protected its legal right to use the technology as a first inventor by creating a way to register the trade secret in an official manner.

- When an innovator create some idea and he wants to keep it secret for some reason (maybe he thought the idea can be easily invented around if the crucial process is revealed in its patent publication, or maybe there are still rooms for some improvement before applying to the patent system, etc.), he put all the necessary information (description, blueprints, explanation of the processes, etc.) into an sealed envelope (the Soleau Envelope) and register at the Patent office (not as a patent but as a trade secret).

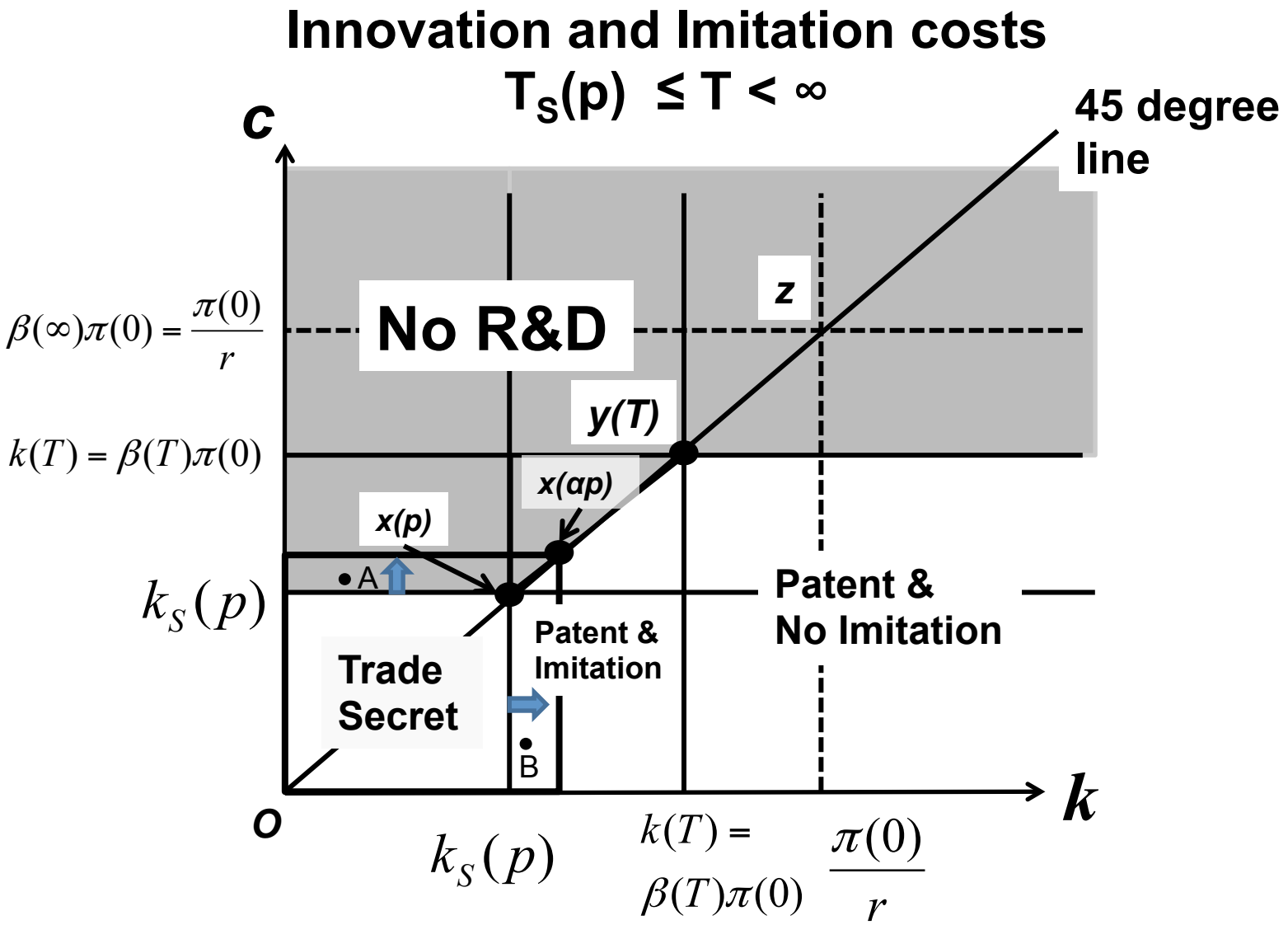
- The Soleau Envelope system allows the original innovator to use this dated and sealed envelope (the Soleau Envelope) as an evidence to prove that he is the first inventor on this innovation and ask for the prior-use exclusion from patent-infringement when someone else later sued him for an infringement of the relevant patent.

- Usually most society with first-to-file patent system protects trade secret in the prior-use exclusion clause when the trade secret is proven to be invented earlier than the patent holder, but the prior-use is, in reality, hardly used because the burden of proof is too severe without a system like the Soleau Envelope.
- This paper is the first paper to analyze the Soleau Envelope system using formal economic modeling.

Define: Soleau Envelope Policy

- A policy like Soleau envelope can be expressed as $\alpha = 1 - \varepsilon$ where $\varepsilon > 0$ is a very small number.
- A policy can affect p such that $p \rightarrow \alpha p < p$
- Given $\varepsilon > 0$ being a very small number, a Soleau envelope policy is defined as $\alpha = 1 - \varepsilon$ where the probability p becomes αp.
- the Soleau envelope policy changes the location of $x(p)$ to $x(\alpha p)$.

Figure 4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$\frac{\pi(0)}{r}$

Soleau Envelope Policy

- The policy change broadens the region of trade secret.
- The point **A** was previously in the No R&D region, but it is now in the Trade Secret region. So the points like **A** are the innovations that are previously not realized but now invested (in R&D) and kept as secret. Therefore, the Soleau envelope policy can be said to increase the stock of new innovation.

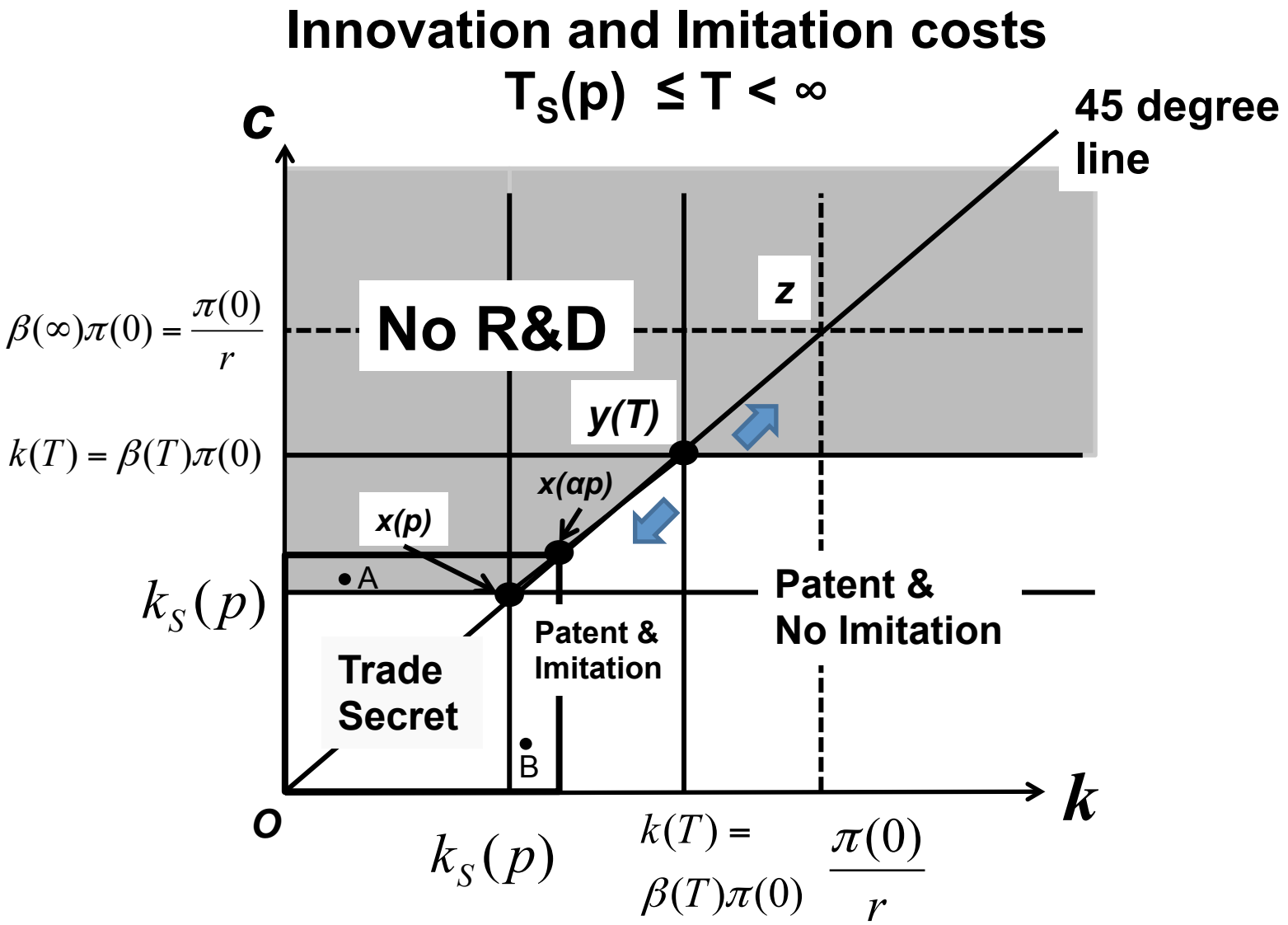
Soleau Envelope Policy

- The point **B** was previously in the Patent & Imitation region, but it is now in the Trade Secret region. So the points like **B** are the innovations that are previously patented (and imitated) but now kept as secret. Therefore, the Soleau envelope policy decreased the stock of patented knowledge and reduced the imitation. Within the framework of this model, patenting itself will not create a new innovation, but it does in the real world.

Soleau Envelope Policy

- In an economy with many innovations with cost structure (***k,c***) which is close to point **A**, then the Soleau envelope policy will improve the social welfare.
- In an economy with many innovations with cost structure (***k,c***) which is close to point **B**, then the Soleau envelope policy will not change the stock of innovation as a whole, but will reduce the stock of patented knowledge available to the society.
- If the stock of patented knowledge has the dynamic effect (which is outside of this model), then it might be the case that the Soleau envelope policy may have some negative impacts for innovations relating to the points near point **B**.

Figure 4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Policy affecting *T*

- If ***T*** is changed, then what happens?
- The point ***y(T)*** will move along 45 degree line up (increase in ***T***) or down (decrease in ***T***)
- Raising ***T*** involves some trade-offs. It will increase the number of new innovation, but imitation also increases and socially imitation cost ***k*** is considered wasteful.

Policy affecting (*k,c*)

- Joint distribution of (***k***, ***c***) can be affected by many policy changes:

1. Long-run … education, basic R&D
2. Short-run … applied R&D, patent filing, court decisions
3. Overall … education, R&D, patent filing
4. Locally … court decisions

Summary

- Extend Gallini (1992) to include ***c*** and heterogeneous ***k***.
- When we map the relationship between ***k*** and ***T***, we can conclude the following results:
- (1) for shorter ***T*** and smaller ***k***, innovators will choose not to patent and keep the innovation secret. (2) for longer ***T*** and larger ***k***, innovators will choose to patent the idea. (3) Among the ideas which are patented, whether the rivals imitate or not depends on the relative relationship between ***T*** and ***k***.

Summary

- Interesting interaction between ***c*** and ***k***.
- Figure 4 summarizes the optimal strategies for each idea innovator.
- Both small ***c*** and ***k***, trade secret is chosen.
- Intermediate ***k***, we see patenting and imitation below 45 degree line.
- Large ***k***, we see patent monopoly but ***c*** must be below ***k(T)***.

Summary

- The effects of various policies are analyzed.
- The Soleau envelope policy will expand the region of trade secrecy. This will increase total innovations researched, but some previously patented ideas may become trade secrecy in response to the policy change.
- Joint distribution of **(*k*, *c*)** can be affected by policy changes.

Limitations

- This paper does not seek optimal length of patent.
- This paper also ruled out the possibility of licensing the ideas to third parties.
- One other possible extension of the current paper's model is to introduce foreign imitators.