Effect of Patent Pools on Innovation

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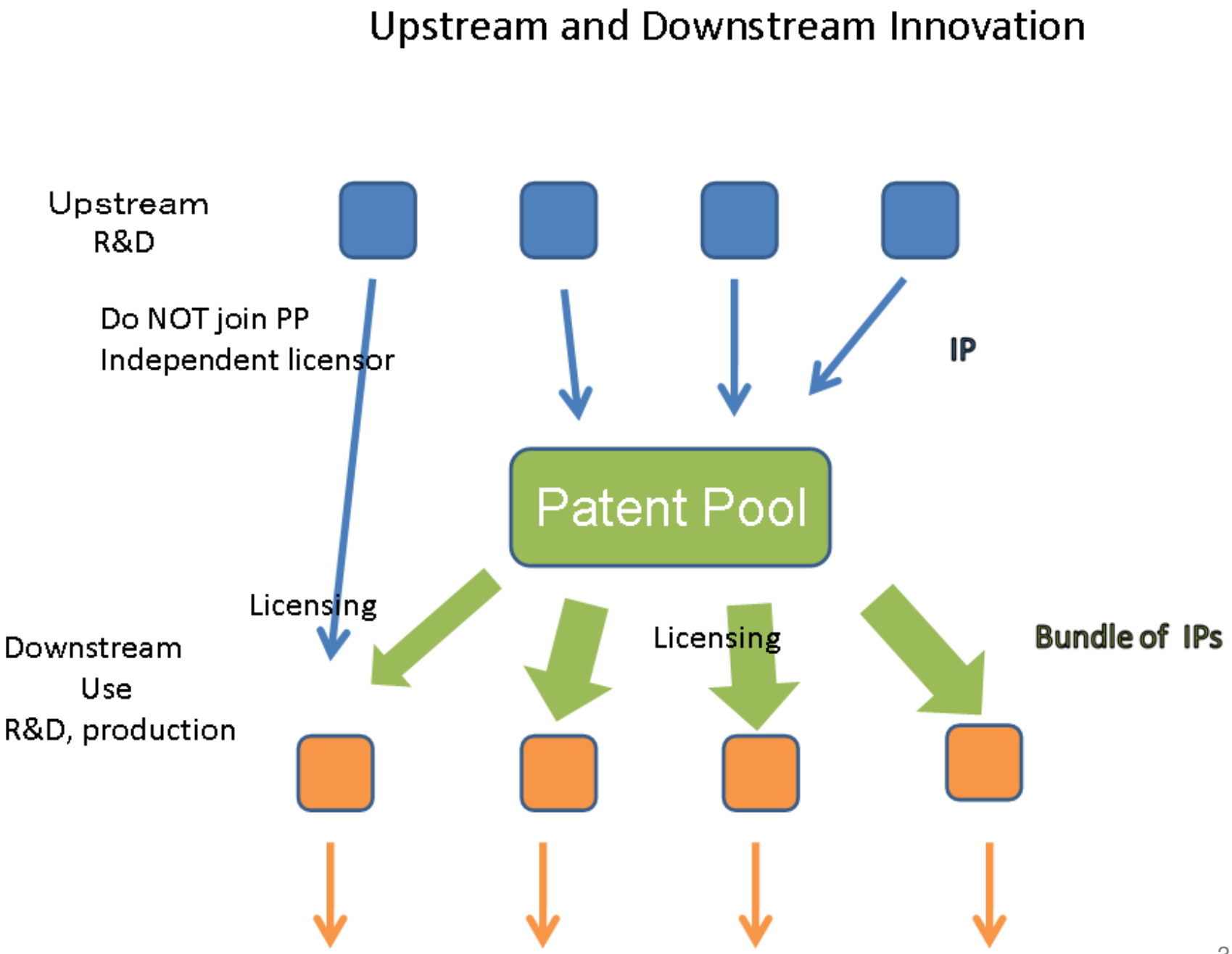
Function of Patent Pools

- Patent pools (collective rights organizations)
  - Standard implementing technologies - DVD, MPEG item DNA sequences for DNA microarrays (DNA-on-a-chip)
  - (ASCAP)
- Centralized licensing of multiple patents (IP rights)
  - Economies of scale in negotiations and royalty collection.
  - Overcome 'tragedy of anticommons' (complementary patents) problem by collective licensing.
- Promotes downstream use (production, cumulative innovation) of complementary IP
- Feeds back into upstream incentives to innovate.

Upstream vs Downstream



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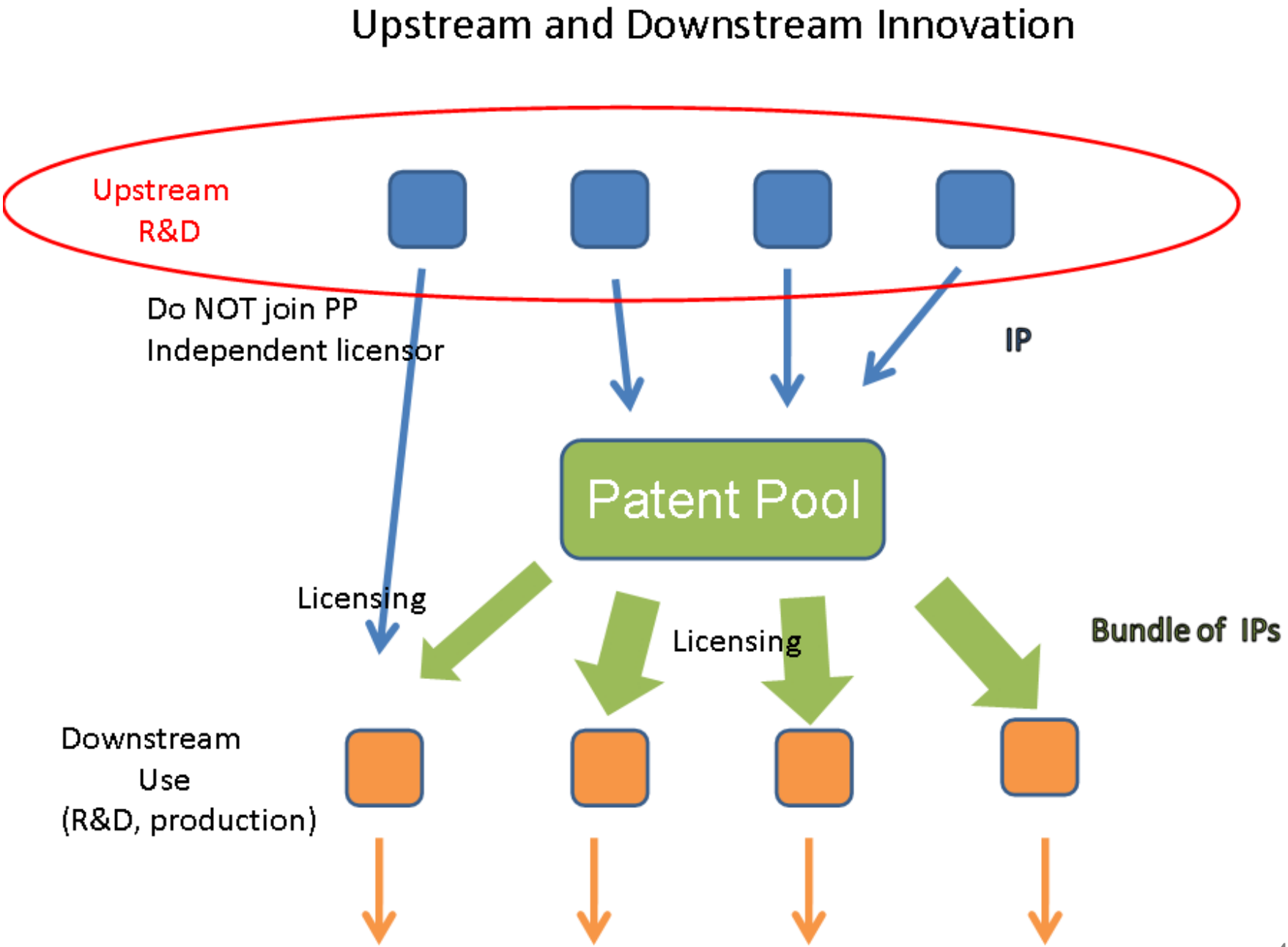

Focus of Our Work

- Examine effects of patent pools on upstream incentives to innovate
- Patent pools of complementary intellectual property
- Specifically, we examine how patent pools effect
  - Ex-post (after upstream innovation) licensing
  - Ex-ante incentives to invest in upstream research.
- Compare different patent licensing revenue (royalty) distribution rules.
- Incorporate the effect of simple antitrust rules.

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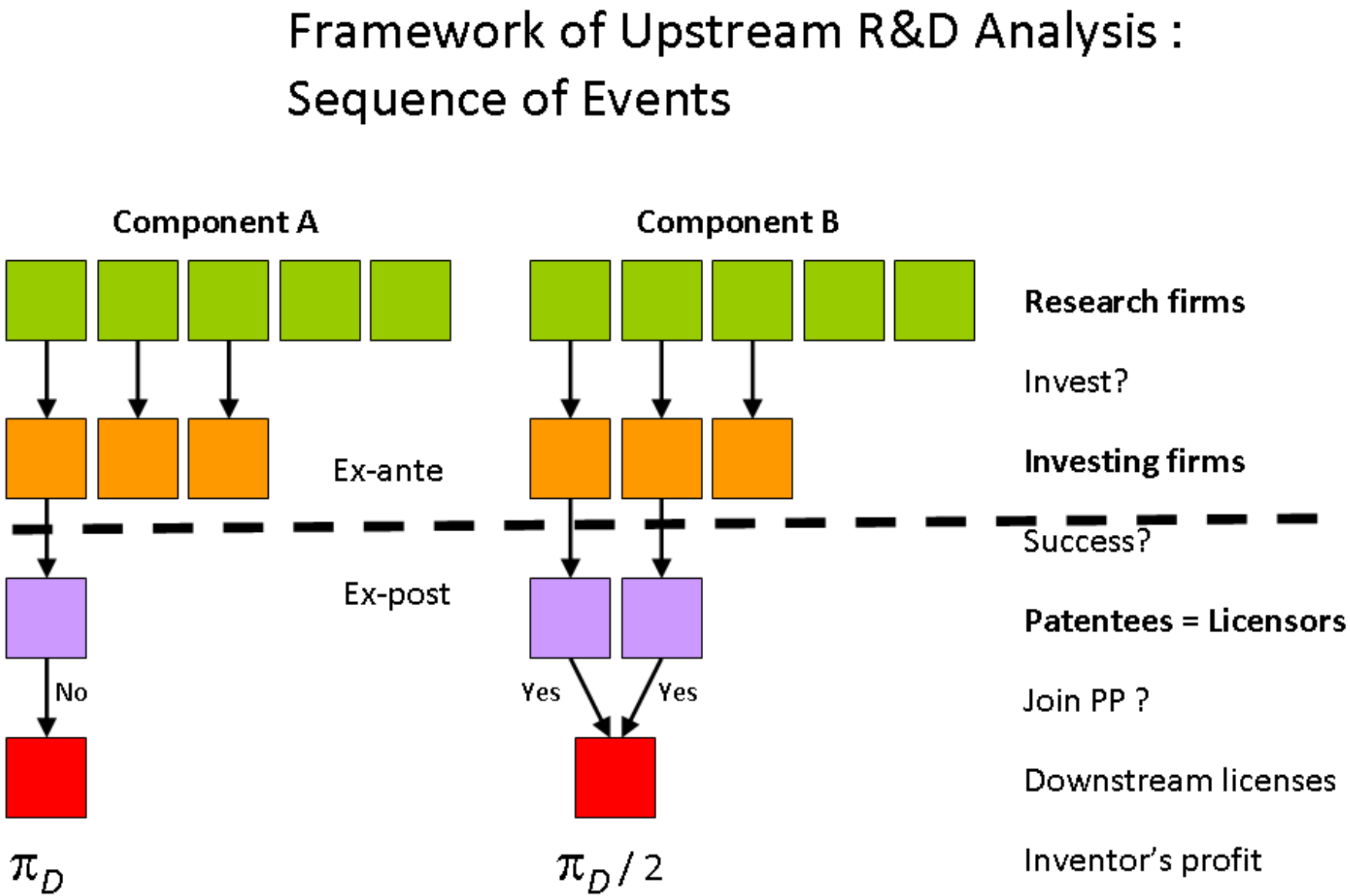

Analysis - Factors to Consider

- Licensing by the patent pool must be optimal ex-post (after upstream innovation) given the ex-post outcome of innovation (market structure)
  - Maximize joint profit
  - Induce patent owners to rationally join
- R&D incentive determined by ex-ante expected profit
- Ex-ante expected profit depends on ex-post profit and R&D technology (probability distribution over outcomes)
  - Ex-post optimal royalty distribution rule may not provide right incentives ex-ante
  - Expected profit depends on number of firms investing (ex-ante market structure)
  - Firms differ: Some firms are competitors (substitute technologies) and some are partners (complementary technologies)

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Main Conclusions

- In general, patent pools stimulate upstream R&D investment
  - But patent pools may hurt the incentive of an inventor with unique ability (ex-ante monopoly, firms ex-ante asymmetric)
    - patent pool dilutes rent
  - And incentives to invest may be socially excessive
- Patent pools that distributes licensing revenue unequally among its members is less likely to lead to welfare loss
  - Unequal distribution helps form patent pool
  - Even if inventors are symmetric ex-ante, ex-post asymmetries may emerge
- Firm's profit ranking over different patent pool rules differs ex-ante or ex-post and by firm (monopolist or not) $\Rightarrow$ likely to lead to disagreement over patent pool rules and formation
- Implication: Determination of patent pool rules (revenue distribution, antitrust) should take into account R&D technology

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Related Literature (1)

- Collective licensing
  - Shapiro (2001) discusses various types of patent pools to mitigate anticommons problems
  - van Zimmeren et al 2006, Aoki & Schiff 2008 , Heller, & Eisenberg 1998 (anticommons) , Merges 1996 (PP)
- Patent pools
  - Lerner & Tirole (2004) examine ex post efficiency
  - Lerner et al (2007) empirical examination of licensing rules
  - Layne-Farrar & Lerner (2008) and Aoki & Nagaoka (2005) examine royalty distribution rules and incentives of patent owners to join pools (SSOs)
- Hoppe and Ozdenoren (2005) examine patent pools as intermediaries to reduce informational problems in licensing markets
- These papers take technologies (IP) in PPs as given

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Related Literature (2)

- We focus on innovation of technologies in the patent pool
- Related to work on innovation of complementary technologies
- Gilbert & Katz (2007) examine division of profits among innovators racing to develop complementary components
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Work in Progress

- In the current paper, there is no patent pool when innovation takes place - only prospect of patent pool
- What is the incentive of patent pool members and outsiders when a patent pool already exists ?
  - How did DVD patent pool influence speed of development of Blu-ray ?
- Competition within pool (inside) and outside
- Replacement effect for pool members
- Empirical evidence
  - Lampe and Moser (2008): US sewing machine PP
    - Innovation increased before PP formation and after PP resolved
    - Innovation by members and outsiders slowed while PP existed
  - Nicol et al.: Australian bio=technology (to come !)

Framework

- New downstream product needs two complementary upstream innovations: A and B.
- Large number of competitive upstream research firms:
  - Each has capacity for one research 'project' at cost c
  - Specialized in development of A or B
  - Revenues only from licensing
- Each firm either independently succeeds or fails (probabilistic) .
- All successful projects (= patent) of a single component result in perfect substitutes.
- patent pool
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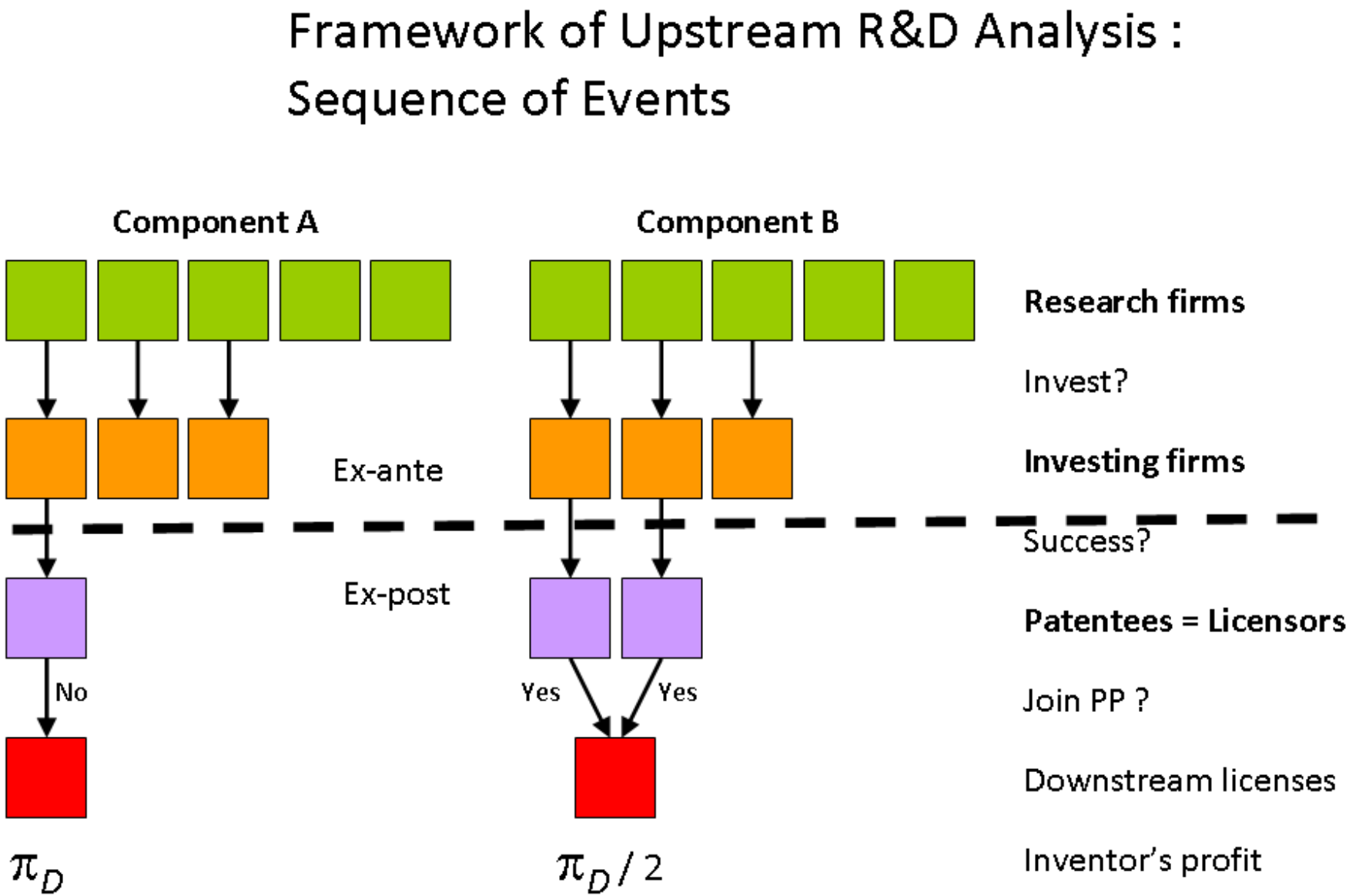

Assumptions

- Tragedy of Anticommons:

$$\pi_M \geq 2\pi_D \text{ and } W_0 \geq W_M \geq W_D.$$

  - π_M and W_M: Monopoly licensing profit and welfare.
  - π_D and W_D: Duopoly licensing profit and welfare.
  - W_0: Welfare when both components are licensed at zero price

- $P(k, N)$: Probability that k substitute versions of a component are invented when N projects are undertaken for that component (probability of k success from N trials):

$$\sum_{k=0}^{N} P(k, N) = 1 \text{ and } lim_{N\to\infty} P(k, N) = 0.$$

  Probability that k firms succeed when N firms invest

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Licensing Revenue and Antitrust Rules

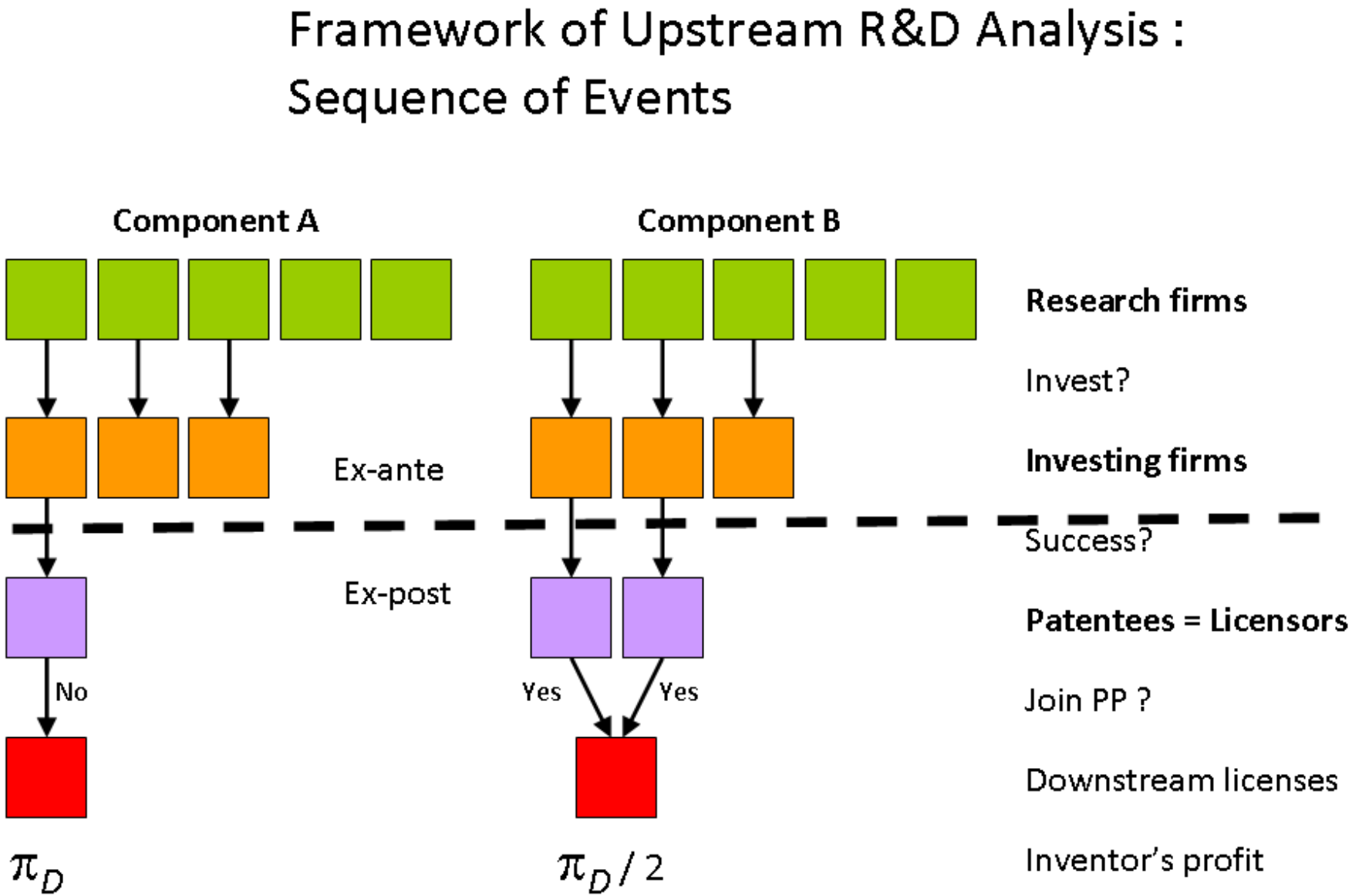
(1) (π = total PP licensing revenues)

(2) Joint licensing of substitutes is not allowed:
   - Strict Antitrust Rule: PP randomly chooses at most one member of each component to license; royalties are shared equally between the chosen.

(3) Joint licensing of substitutes by the PP is allowed:
   - Equal: With n members, each receives π/n.
   - Unequal: If one component has a single inventor and the other component has $n \geq 2$ substitute inventors, the single inventor receives $z\pi$ and the others receive $(1-z)\pi/n$ with $z \in [0,1]$. Otherwise, equal shares.

(4) Compare to No PP

Ex-ante and Ex-post



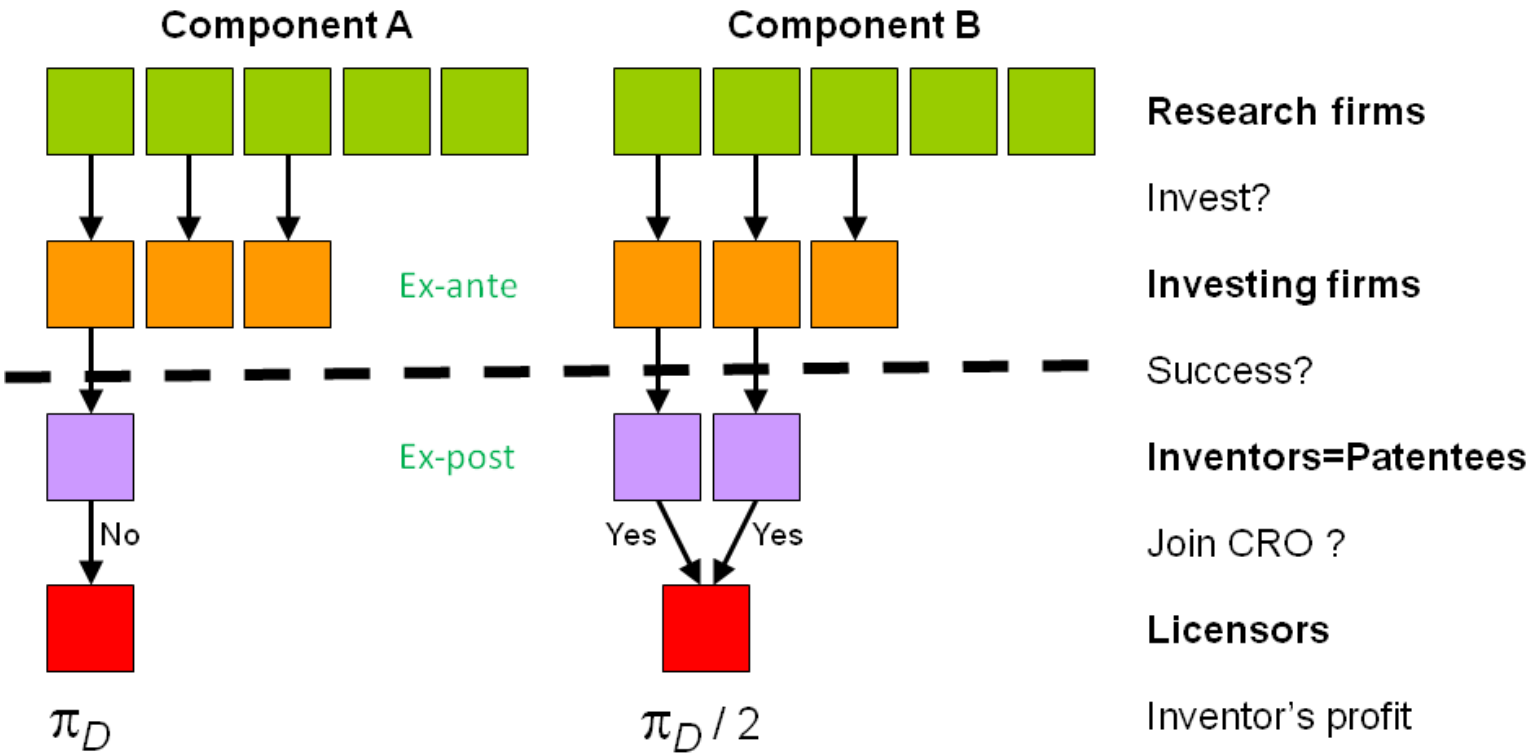
Ex-post Profits

- Ex-post equilibrium payoffs of successful inventors (Gains, Losses relative to no PP):

PP Type\ Profit	π_{MM}	π^{M}_{MC}	$\pi^{C}_{MC}(n)$	$\pi_{CC}(n_A, n_B)$
None	π_D	π_M	0	0
Equal	$\pi_M/2$	π_D	π_D/n	$\pi_M/(n_A+n_B)$
Unequal	$\pi_M/2$	$z\pi_M$	$(1-z)\pi_M/n$	$\pi_M/(n_A+n_B)$
Strict	$\pi_M/2$	$\pi_M/2$	$\frac{1}{n}\pi_M/2$	$\frac{1}{n_i}\pi_M/2$; $i=A,B$

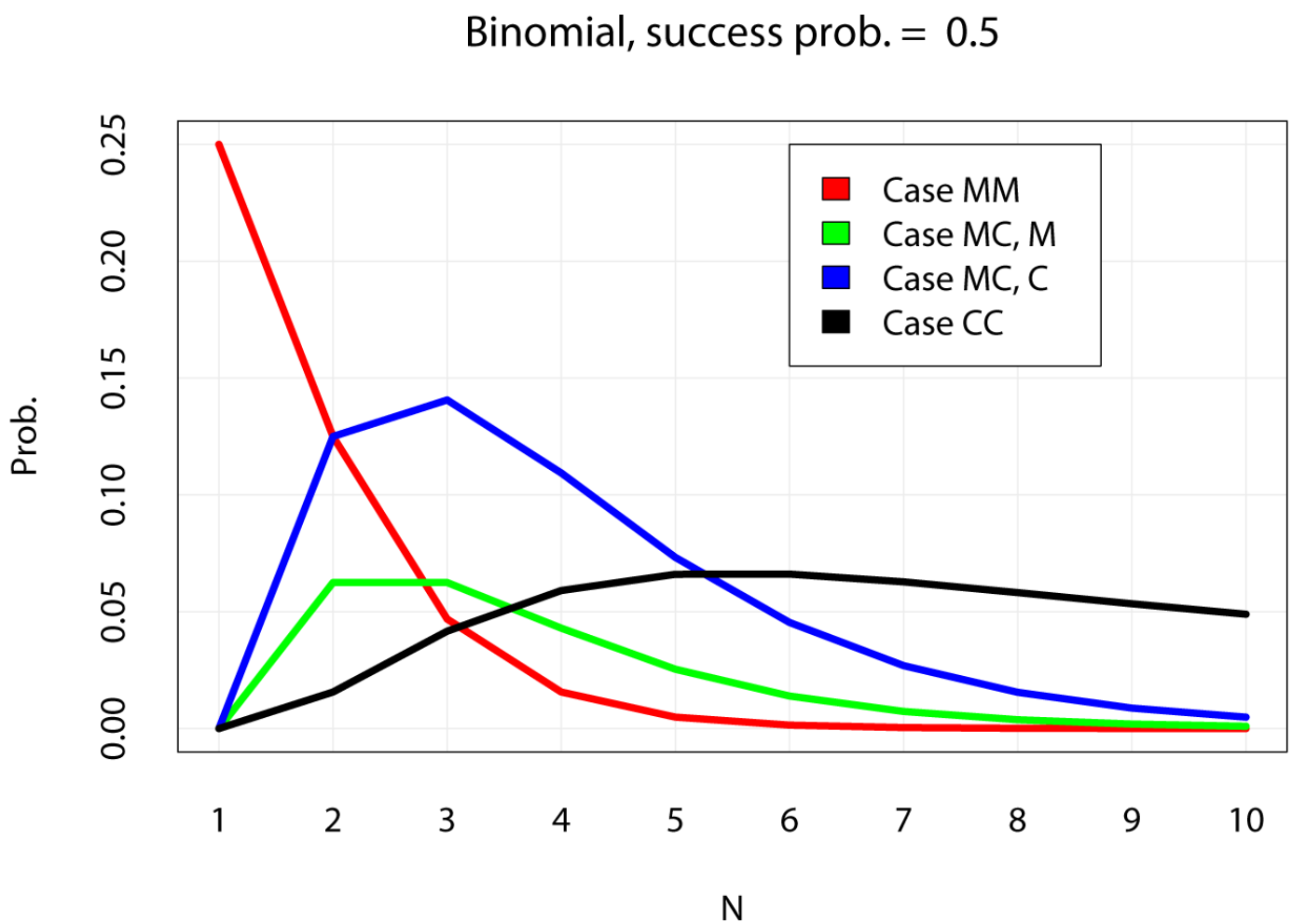
Ex-ante, firms don't know which outcome (which role in MC)

From Ex-post to Ex-ante



R&D Technology

- Probability that a given research firm becomes a successful inventor depends on the number of firms that invest.
- There are *N* firms engaged in R&D for each component



Firm A only firm that can invest in component A

- Firm A's share of patent pool revenue is z
- Firm A better off with smaller z to give component B innovators incentive
- Firm A needs component B