Start-up Acquisitions, Strategic R&D, and the Entrant's and Incumbent's Direction of Innovation

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Section 1

Introduction

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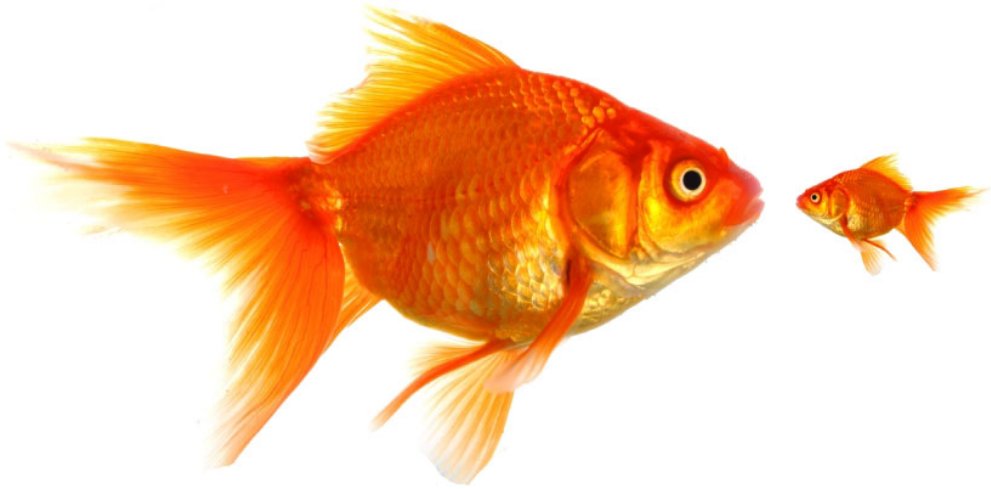


- "*I remember your internal post about how Instagram was our threat and not Google+. You were basically right. One thing about startups though is that you can often acquire them.*" – Mr. Zuckerberg on April 9, 2012, the day Facebook announced it was acquiring Instagram, cited in FTC vs. Facebook, Case No.: 1:20-cv-03590.
- "*Examples of things we could scale back or cancel: . . . Mobile photos app (since we are acquiring Instagram).*" – Mr. Zuckerberg on April 22, 2012, cited in FTC vs. Facebook, Case No.: 1:20-cv-03590.

Some famous start-up acquisitions

- *Instagram* was launched on Oct 6, 2010. Its founders also worked on *Burbn*, a check-in app for sharing locations with friends. A couple of years later, in 2011-2012, *Facebook* attempted to develop a competing app for images transmission. In 2012 *Facebook* acquired *Instagram* for $1 bn.

- In 2008 *Google* bought *DoubleClick* for $ 3.1 bn. Before, *DoubleClick* had been active in the markets for search marketing services (*Performics*) and consumer-purchasing data (*Abacus Direct*). Likewise, *Google* started developing its own online ad technology *AdWords* in 2000 and added new functionalities year after year.

- *Microsoft* developed *Messenger* in 1999, which allowed for voice calls and instant messaging. The once most- famous voice-over-IP service *Skype* entered the market later, in August 2003. Its founders also invested in a streaming video service known as *Joost*, which later turned unsuccessful. In 2011 *Microsoft* bought *Skype* for $8.5 bn and *Microsoft* discontinued *Messenger*.

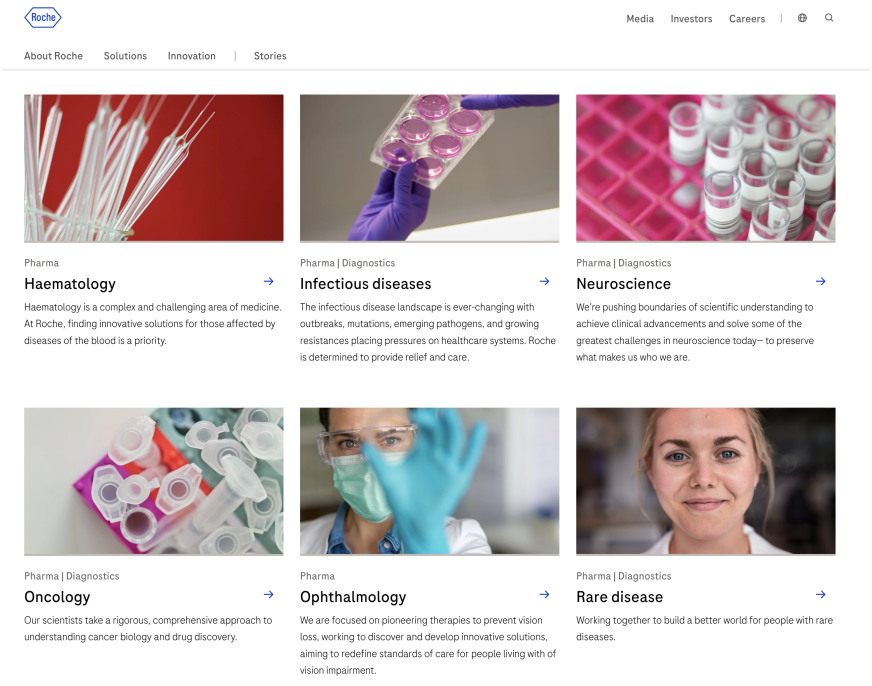
These famous start-up acquisitions have two important features in common.

- First, before the acquisition, both the target and the acquirer were actively investing in various technological developments and hence held a portfolio of investment projects.
- Second, some (but not all!) of the target's projects overlapped with the acquirer's projects, which created "local" rivalry between the firms.

In such a setting, this paper develops a theory to assess the impact of start-up acquisitions on the innovation portfolios of both the target and the acquirer, as well as on prices and overall consumer surplus.

By relating the portfolio of projects of a firm with its positioning in the technological space, the paper's focus is on the impact of start-up acquisitions on a new margin, namely, the innovation direction (Malek et al. (2022); Arts et al. (2023)).

- Most firms (including start-ups!) are multi-product



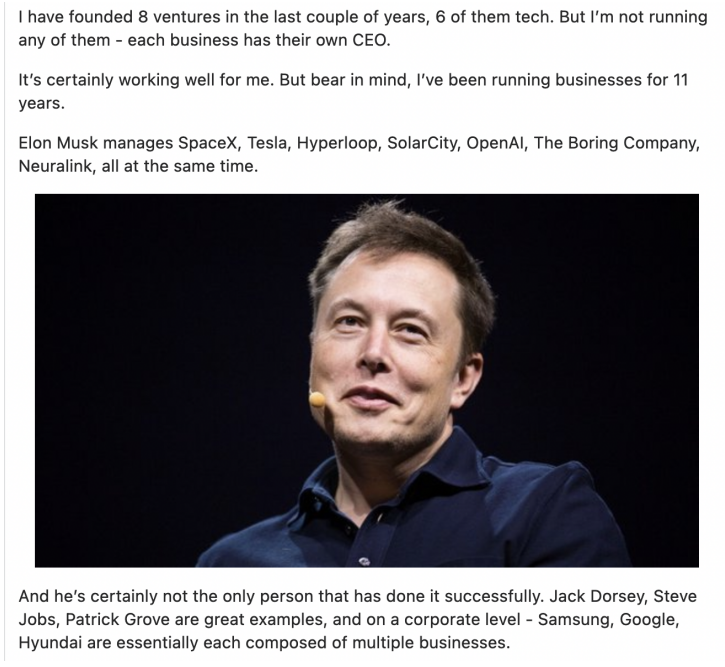


Figure: Roche's innovative medicines and Musk's start-ups

- They choose not just whether to enter "the" market, or how much to invest in "the" product, but which products to develop.

Main policy implications

- Anticipation of an acquisition alters the relative returns from the investment portfolios the agents hold, who correspondingly move their investment funds across projects to maximize profits.
  - Because the project fundings of both the target and the acquirer are altered, even if a merger causes something wrong on one player, it could cause something right on another player. Tradeoff!
  - Moreover, because the funding of all projects change, evaluating start-up acquisitions employing the traditional *market-definition-approach* based only on overlapping projects is really too narrow!
  - Variables that play an important role in start-up acquisitions assesment:
    - size of the Arrow replacement effect,
    - bargaining power of the players,
    - the consumer surplus appropriability of each market.

Section 2

Related literature

Literature

- **Innovation direction:** Acemoglu (2023), Rappuoli et al. (2002), Acemoglu and Johnson (2023), Hopenhayn and Squintani (2021), Letina (2016), Bryan and Lemus (2017), Bryan and Hovenkamp (2020), Bryan Lemus and Marshall (2022), Chen, Pan, and Zhang (2018).
- **Innovation Portfolios:** Dasgupta and Maskin (1987), Cabral (1994), Letina (2016), Moraga, Motchenkova and Nevrekar (2022), .
- **Start-up acquisitions:** Cunningham et al. (2019), Motta and Peitz (2021), Cabral (2018, 2021), Hollenbeck (2020), Katz (2020), Letina, Schmutzler and Seibel (2020), Gilbert and Katz (2022), Teh, Banerjee and Wang (2022), Motta and Shelegia (2023), Dijk, Moraga and Motchenkova (2023), Manenti and Sandrini (2023); and the empirical work of Gautier and Lamesch (2021) and Eisfeld (2023).
- **Out of market (in-)efficiencies:** Crane (2015), Areeda and Hovenkamp (2023)

Section 3

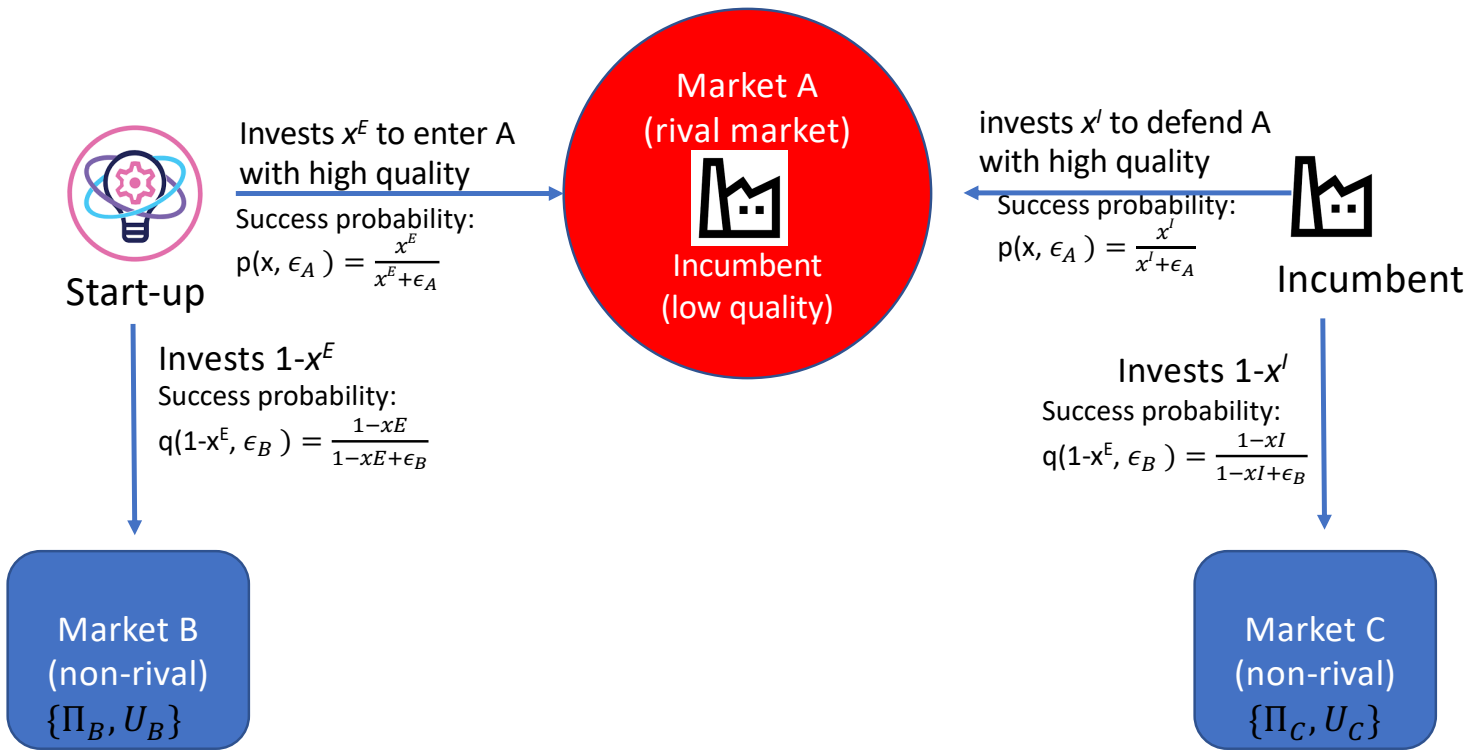
Model

Model

I is initially present in markets A and C selling goods of "basic" quality.

Both I and E have a research budget of 1 and has to be spent in research (interpret as scientist-hours).

E invests x^E to enter A ("rival" market) and $1 - x^E$ to enter B (non-rival); then I invests x^I to "defend" A and $1 - x^I$ to improve in C.



Stochastic R&D; one-person contest competing against *Nature*.

Games:

NO-ACQUISITION GAME

Start-up invests x^{E} in `rival' project A & 1- x^{E} in independent B.

Projects' outcomes realize

$p(x^{E}, \epsilon_A) = \frac{x^{E}}{x^{E}+\epsilon_A}$

$q(1-x^{E}, \epsilon_B) = \frac{1-x^{E}}{1-x^{E}+\epsilon_B}$

Incumbent invests x^{I} in 'rival' project A & 1- x^{I} in independent C.

Projects' outcomes realize

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Start-up and Inc. compete in A.

Start-up serves B and Incumbent serves C.

$\{\pi_h^m, \pi_l^m, \pi_{hh}, \pi_{hl}, \pi_{lh}\}$

$\{\Pi_B, U_B\}, \{\Pi_C, U_C\}$

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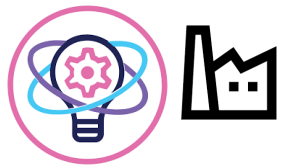

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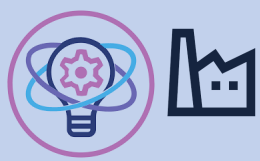

Start-up and Incumbent bargain over the acquisition rents

Incumbent serves market A, B and C.

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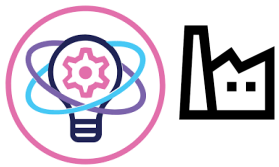

Start-up and Inc. compete in A. Start-up serves B and Incumbent serves C.

$\{\pi_h^m, \pi_l^m, \pi_{hh}, \pi_{hl}, \pi_{lh}\}$

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Start-up invests x^{E} in `rival' project A & 1- x^{E} in independent B.

Projects' outcomes realize

Incumbent invests x^{I} in 'rival' project A & 1- x^{I} in independent project C.

Projects' outcomes realize

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Nash bargaining. Let $\delta \in (0,1)$ be the bargaining power of I and $1-\delta$ that of E.

We have 5 extensions where:

1. The order of moves in the investment market is reversed.
2. Acquisitions occur before investment is decided.
3. I does not observe the outcome of Es investment projects but just its investment portfolio
4. E is financialluy constrained
5. E success causes positive spillovers on I

The results stay qualitatively the same.

Section 4

A preliminary result

The investment portfolio problem

- Regardless of the decision-maker and acquisition regime, the objective function always has the following form:

$$\boxed{\mathbb{E}R(x) = \frac{x}{x+\epsilon_A} R_A^s + \frac{\epsilon_A}{x+\epsilon_A} R_A^f + \frac{1-x}{1-x+\epsilon_z} R_z^s.} \tag{1}$$

where the R's could be profits, CS or welfare.

- The investment x (1-x) in the "rival" project A (non-rival project B) that maximizes the objective is given by the expression:

$$\boxed{x\left(R_A/R_z;\epsilon_A,\epsilon_z\right) = \max\left\{0, \min\left\{\frac{1+\epsilon_z-\epsilon_A\sqrt{\frac{\epsilon_z}{\epsilon_A}}\sqrt{\frac{R_z}{R_A}}}{1+\sqrt{\frac{\epsilon_z}{\epsilon_A}}\sqrt{\frac{R_z}{R_A}}}, 1\right\}\right\}.} \tag{2}$$

- $R_A \equiv R_A^s - R_A^f$ are the "incremental gains" from project A and raises x.
- $R_z \equiv R_z^s - R_z^f$ are the "incremental gains"' from the alternative project z (B for entrant and C for the incumbent) and lowers x.
- These gains relate to the "*Arrow replacement effect*": projects with a disproportionately large *ARE* will receive less funding.

Section 5

The solution of the games

Incumbent's conditional investments:

1. **Entrant's project fails:** E doesn't enter and I investment decision is the same as in the no-acquisition and acquisition games:

$$x_f^I = x\left(\frac{\pi_h^m - \pi_\ell^m}{\pi_C}\right)$$

in project A and the rest of the budget in project C.

2. **Entrant's project succeeds:** E enters and I invests

$$x_s^{I,a} = x\left(\frac{\pi_{hh} + \delta(\pi_h^m - 2\pi_{hh}) - (\pi_{\ell h} + \delta(\pi_h^m - \pi_{\ell h} - \pi_{h\ell}))}{\pi_C}\right).$$

in project A and the rest of the budget in project B, where
$\pi_h^m - 2\pi_{hh}$: acquisition rents if I's project A succeeds
$\pi_h^m - \pi_{h\ell} - \pi_{\ell h}$: acquisition rents if I's project A fails.
Hence, *an acquisition changes the size of the I's ARE!*

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   Hence, *an acquisition changes the size of the I's ARE!*

Entrant's investments: Anticipating I investment strategy:

$$x^{E,a} = x\left(\frac{\frac{x_s^{I,a}[\pi_{hh}+(1-\delta)(\pi_h^m-2\pi_{hh})]+\epsilon_A[\pi_{h\ell}+(1-\delta)(\pi_h^m-\pi_{h\ell}-\pi_{\ell h})]}{x_s^{I,a}+\epsilon_A}}{\pi_B}\right)$$

This function increases in the (anticipated) rents from the acquisition (innovation for buyout), but fall in I's investment.

Section 6

The impact of acquisitions on innovation

Proposition 1:

(a) Suppose that acquisitions are allowed and

$$\pi_h^m - 2\pi_{hh} < \pi_h^m - \pi_{h\ell} - \pi_{\ell h}.$$

Then, anticipation of the acquisition of the entrant enhances I's *ARE* and hence I will invest less in the rival project A (and thus more in the alternative project C). Meanwhile, anticipating its acquisition E will invest more in the rival project A (and thus less in B).

(b) Suppose that acquisitions are allowed and, alternatively,

$$\pi_h^m - 2\pi_{hh} > \pi_h^m - \pi_{h\ell} - \pi_{\ell h}.$$

Then, anticipation of the acquisition weakens I's *ARE* and so I will invest more in the rival project A (and hence less in C) and:

(i) If I's bargaining power

$$\delta > \bar{\delta}(\epsilon_A, \epsilon_C, \pi_C, \pi_h^m, \pi_{hh}, \pi_{h\ell}, \pi_{\ell h}), \tag{3}$$

E will invest less in the rival project A (and thus more in B).

(ii) Otherwise, E will also invest more in the rival project A (and so less in the alternative project B).

Intuition:

- I's incentives driven by how monopolization rents change ARE: "incumbency for buyout".
- E's incentives also driven by monopolization rents, or "innovation for buyout", but, in addition, there is a "strategic effect" due to strategic substitutability of investments.

- Part (a): $ARE\uparrow$: $\underbrace{\pi_h^m - 2\pi_{hh}}_{\text{acquisitions rents if } A \text{ succeeds}} < \underbrace{\pi_h^m - \pi_{h\ell} - \pi_{\ell h}}_{\text{acquisitions rents if } A \text{ fails}}$.
  - I decreases investment in A
  - innovation for buyout: E increases investment in A
  - strategic effect: E increases investment in A
- Part (b): $ARE\downarrow$ $\underbrace{\pi_h^m - 2\pi_{hh}}_{\text{bargaining surplus if } A \text{ succeeds}} > \underbrace{\pi_h^m - \pi_{h\ell} - \pi_{\ell h}}_{\text{bargaining surplus if } A \text{ fails}}$
  - I increases investment in A
  - innovation for buyout: E increases investment in A
  - strategic effect: E decreases investment in A
    - when δ is large the strategic effect dominates the innovation for buyout

Example:

Illustration of Proposition 1 using Sutton's (2001) demand system:

$$U_A = \sum_{i=1}^{2} \left[\alpha q_i - \left(\frac{\beta q_i}{s_i} \right)^2 \right] - \sigma \sum_{i=1}^{2} \sum_{j<i} \frac{\beta q_i}{s_i} \frac{\beta q_j}{s_j} - \sum_{i=1}^{2} p_i q_i.$$

$$p(q_i, q_j; s_i, s_j) = \alpha - \frac{2\beta^2 q_i}{s_i^2} - \frac{2\beta^2}{s_i} \frac{q_j}{s_j}, \quad i, j = h, \ell.$$

- I's basic product has quality $s_\ell > 0$.
- Upon success, E enters with quality s_h, with $s_\ell < s_h < 2s_\ell$.
- For tractability, assume away horizontal product differentiation by setting $\sigma = 2$.
- Quantity competition with marginal costs equal to zero.
- Solve for all relevant quantities:
  - π_h^m, π_ℓ^m, π_{hh}, $\pi_{h\ell}$ and $\pi_{\ell h}$.
  - U_h^m, U_ℓ^m, U_{hh}, $U_{h\ell}$ and $U_{\ell h}$

Region I: s_h/s_ℓ small $\rightarrow \pi_{h\ell} + \pi_{\ell h} < 2\pi_{hh} \rightarrow ARE\uparrow$ after merger $\rightarrow x^I \downarrow \rightarrow$ innovation for buyout and strategic effect aligned so $x^E \uparrow$

Regions II and III: s_h/s_ℓ large $\rightarrow ARE\downarrow$ after merger $\rightarrow x^I \uparrow$.

- Region II: δ high $\rightarrow$ strategic effect dominates and $x^E \downarrow$.
- Region III: δ low, strategic effect bounded, innovation for buyout dominates and $x^E \uparrow$.

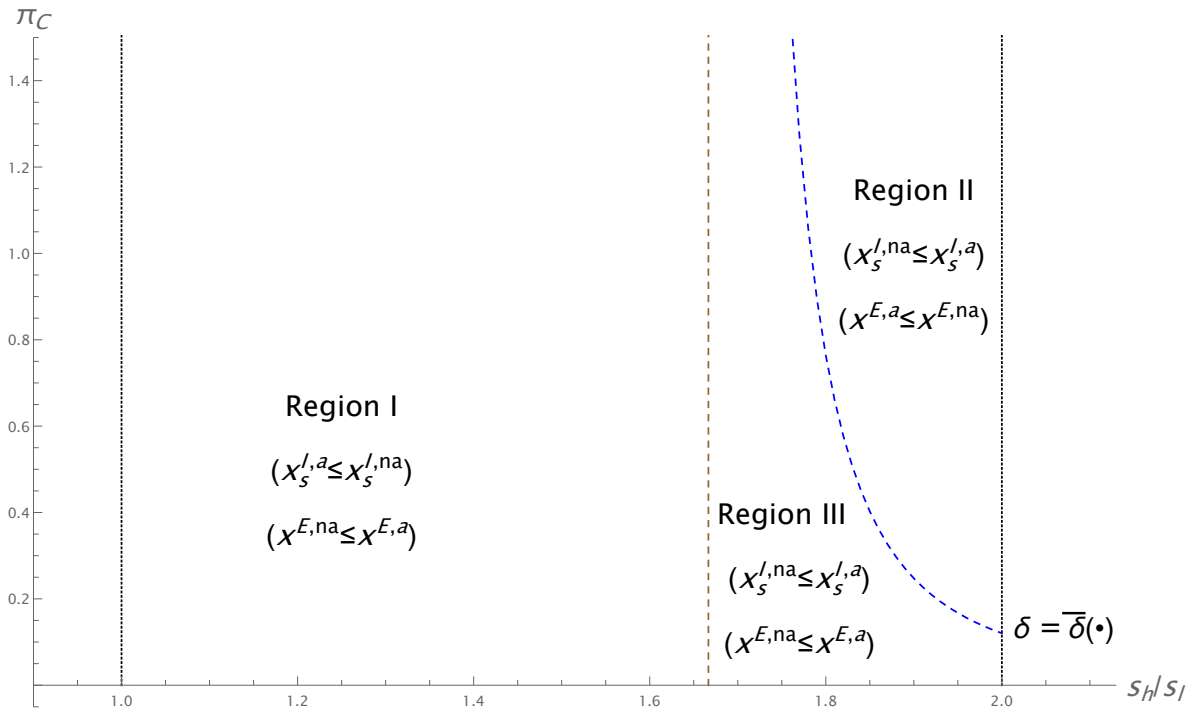


Figure: I's and E's adjustment in investment portfolios

- RI (Facebook/Instagram): F scales back, Insta up, "reverse killer".
- RII (Microsoft/Skype): M scales up, Skype down, "killer"
- RIII (Google/Double Click): G and DC scale up.

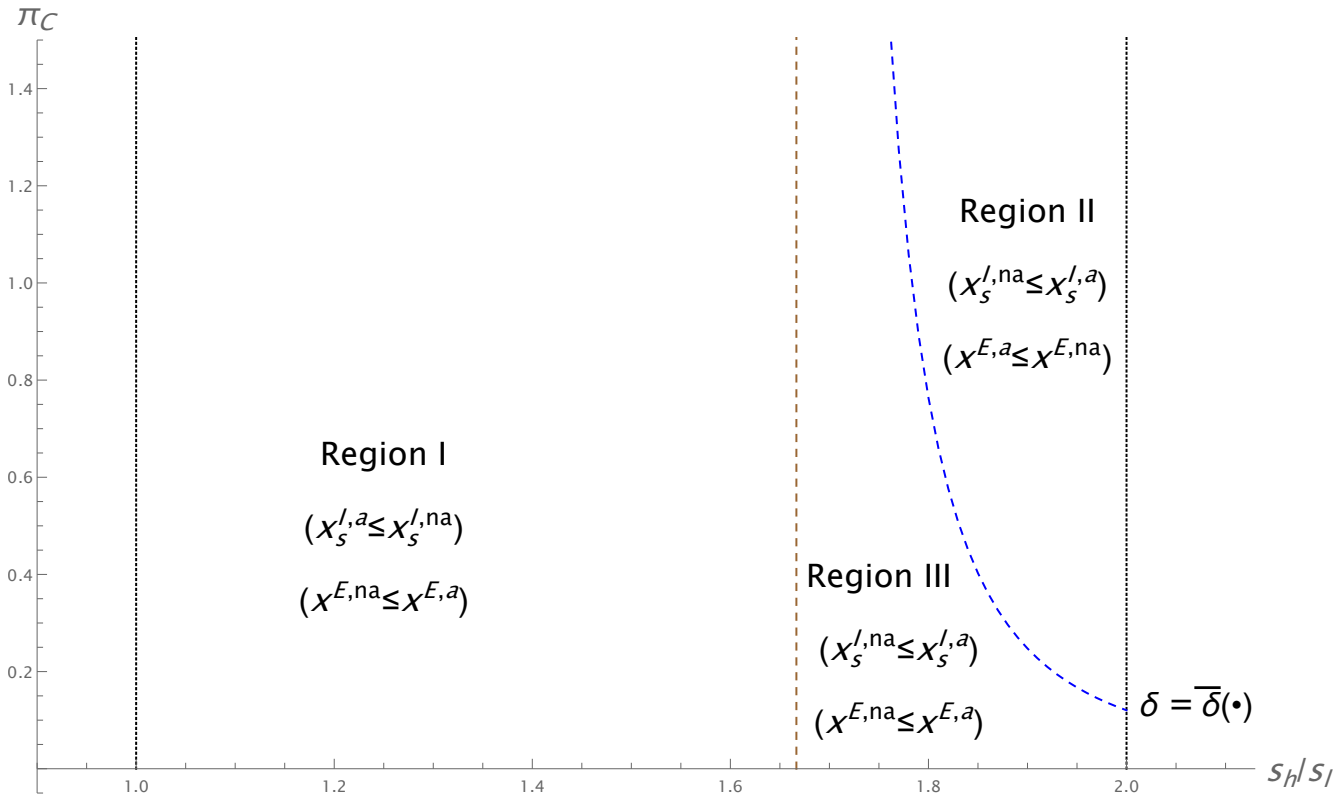


Figure: I's and E's adjustment in investment portfolios

Section 7

Welfare

The social planner

Assumptions:

- We use consumer surplus as the standard for social welfare maximization.
- We assume that the planner can control investment portfolios but cannot control the firms' production levels (second best).
- Finally, we take the case in which acquisitions are not allowed as a welfare benchmark.

Acquisitions have three implications:

- By changing I's ARE, they bear on the direction of innovation of the incumbent. (☺ or ☹?)
- By the accrual of monopolization rents, and the strategic anticipation of the I's portfolio change, they also affect the E's direction of innovation. (☺ or ☹?)
- They increase market prices. ☹!

For each of the parameter constellations delineated by Proposition 1, we examine the impact on welfare on two accounts:

- the direction of innovation account
- the overall CS account.

Subsubsection 1

The incumbent "gives up" the rival market ...

$\rightarrow$ does this improves innovation direction?

Suppose I's ARE becomes bigger after merger ($\pi_h^m - 2\pi_{hh} < \pi_h^m - \pi_{h\ell} - \pi_{\ell h}$):

- I gives up the contestable market and moves resources towards C,
- while E moves investment towards A and away from B.

These changes improve the direction of innovation of both players when planner cares about C and doesn't care about B.

Proposition 2: Let $\pi_h^m - 2\pi_{hh} < \pi_h^m - \pi_{h\ell} - \pi_{\ell h}$ so that by Prop. 1(a), anticipating an acquisition, I reduces investment in the rival market and E increases it. Assume further that:

$$\frac{\pi_C}{U_C} < \frac{\pi_{hh} + \delta(\pi_h^m - 2\pi_{hh}) - \pi_{\ell h} - \delta(\pi_h^m - \pi_{\ell h} - \pi_{h\ell})}{U_{hh} - U_{\ell h}} \text{ and}$$

$$\frac{\pi_B}{U_B} > \frac{\frac{x_s^{I,a}[\pi_{hh}+(1-\delta)(\pi_h^m-2\pi_{hh})]+\epsilon_A[\pi_{h\ell}+(1-\delta)(\pi_h^m-\pi_{h\ell}-\pi_{\ell h})]}{x_s^{I,a}+\epsilon_A}}{\frac{x_s^{I,o}U_{hh}+\epsilon_A U_{h\ell}}{x_s^{I,o}+\epsilon_A} + \frac{1-x_s^{I,o}}{1-x_s^{I,o}+\epsilon_C}U_C - \left(\frac{x_f^{I,o}U_h^m+\epsilon_A U_\ell^m}{x_f^{I,o}+\epsilon_A} + \frac{1-x_f^{I,o}}{1-x_f^{I,o}+\epsilon_C}U_C\right)}.$$

Then, if acquisitions are allowed, both I and E improve the direction of their innovation portfolios.

Proposition 2 focuses on circumstances under which the direction of innovation of both players improves

- demand in I's alternative market very convex
- demand in E's alternative market very concave

but there is a richer set of outcomes.

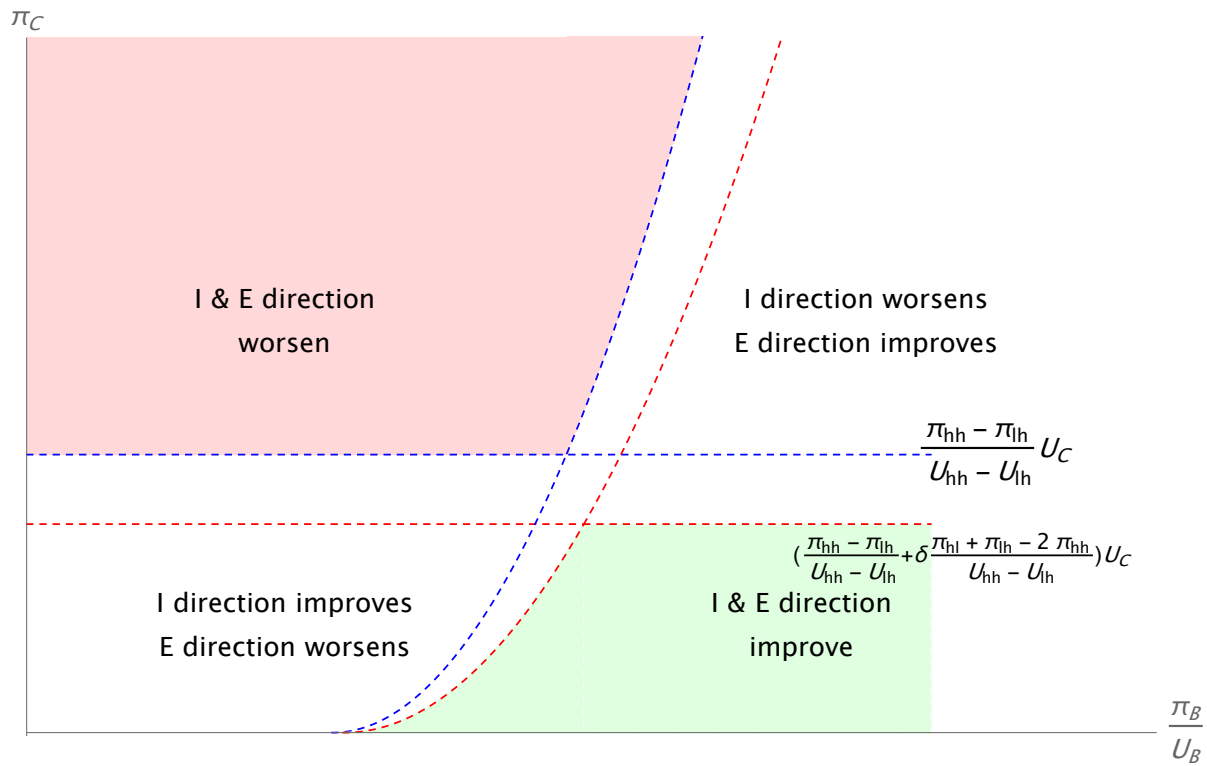


Figure: Parameter areas where acquisitions improve (green) or worsen (red) both target's and acquirer's innovation direction ($\pi_h^m - 2\pi_{hh} < \pi_h^m - \pi_{h\ell} - \pi_{\ell h}$)

Subsubsection 2

The incumbent "defends" the rival market ...

$\rightarrow$ we can do similar (Proposition 3)

Proposition 3: Assume now that $\pi_h^m - 2\pi_{hh} > \pi_h^m - \pi_{h\ell} - \pi_{\ell h}$.

(a) If $\delta > \overline{\delta}$, and by Proposition 1(b)(i), anticipating an acquisition, I raises investment in the rival market and E cuts it, then, if

$$\frac{\pi_C}{U_C} > \frac{\pi_{hh} + \delta(\pi_h^m - 2\pi_{hh}) - \pi_{\ell h} - \delta(\pi_h^m - \pi_{\ell h} - \pi_{h\ell})}{U_{hh} - U_{\ell h}} \text{ and} \tag{4}$$

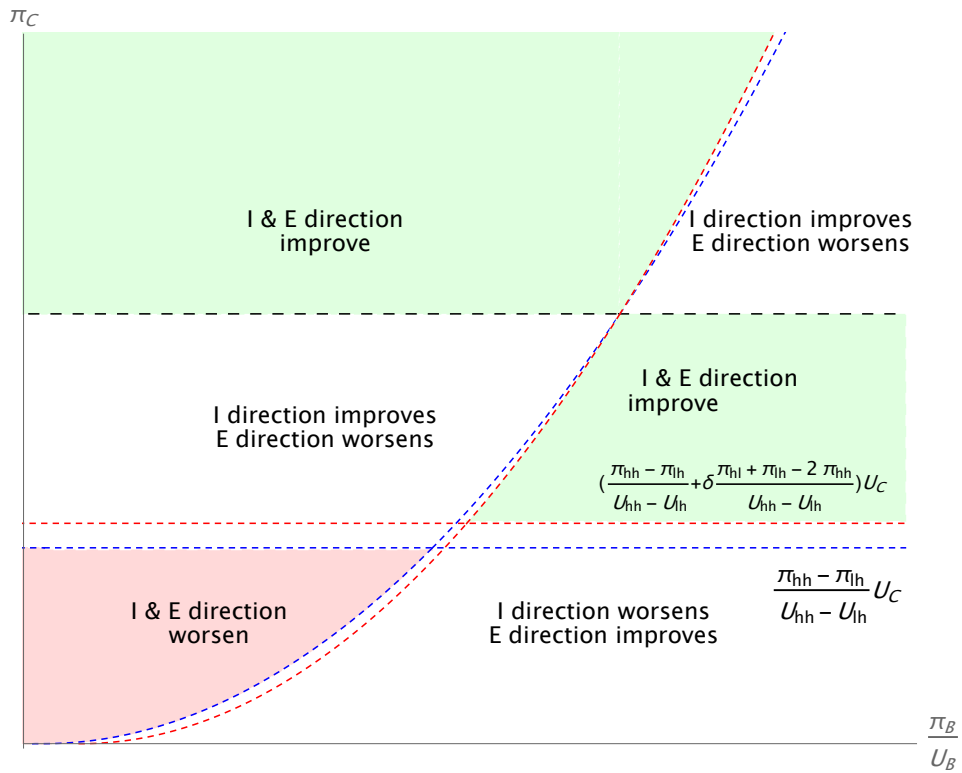
$$\frac{\pi_B}{U_B} < \frac{\frac{x_s^{I,a}[\pi_{hh}+(1-\delta)(\pi_h^m-2\pi_{hh})]+\epsilon_A[\pi_{h\ell}+(1-\delta)(\pi_h^m-\pi_{h\ell}-\pi_{\ell h})]}{x_s^{I,a}+\epsilon_A}}{\frac{x_s^{I,o}U_{hh}+\epsilon_A U_{h\ell}}{x_s^{I,o}+\epsilon_A} + \frac{1-x_s^{I,o}}{1-x_s^{I,o}+\epsilon_C}U_C - \left(\frac{x_f^{I,o}U_h^m+\epsilon_A U_\ell^m}{x_f^{I,o}+\epsilon_A} + \frac{1-x_f^{I,o}}{1-x_f^{I,o}+\epsilon_C}U_C\right)}. \tag{5}$$

allowing acquisitions improves I's and E's direction of innovation.

(b) Otherwise, if $\delta < \overline{\delta}$, and by Proposition 1(b)(i) both I and E raise investment in the rival market, then if (4) holds while (5) holds with the opposite sign allowing acquisitions improves I's and E's direction of innovation.

Suppose now I's ARE becomes smaller after merger:

- I moves resources towards A and away from C,
  - If δ is low, E too.
  - If δ is high, E's moves away from A and towards B.



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Subsection 2

The total (welfare) account

The total (welfare) account

Consumer Surplus: acquisitions impact consumers on two accounts, distortions in the direction of innovation and price distortions.

Consumer surplus in the no-acquisition game is given by:

$$\begin{aligned}\mathbb{E}U^{na}(x_s^{I,na}, x_f^I, x^{E,na}) = &\frac{x^{E,na}}{x^{E,na}+\epsilon_A}\left[\frac{x_s^{I,na}}{x_s^{I,na}+\epsilon_A}U_{hh} + \frac{\epsilon_A}{x_s^{I,na}+\epsilon_A}U_{hl} + \frac{1-x_s^{I,na}}{1-x_s^{I,na}+\epsilon_C}U_C\right] \\ &+ \frac{\epsilon_A}{x^{E,na}+\epsilon_A}\left[\frac{x_f^I}{x_f^I+\epsilon_A}U_h^m + \frac{\epsilon_A}{x_f^I+\epsilon_A}U_l^m + \frac{1-x_f^I}{1-x_f^I+\epsilon_C}U_C\right] \\ &+ \frac{1-x^{E,na}}{1-x^{E,na}+\epsilon_B}U_B, \end{aligned} \tag{6}$$

Consumer surplus in the acquisition game is given by:

$$\begin{aligned}\mathbb{E}U^{a}(x_s^{I,a}, x_f^I, x^{E,a}) = &\frac{x^{E,a}}{x^{E,a}+\epsilon_A}\left[U_h^m + \frac{1-x_s^{I,a}}{1-x_s^{I,a}+\epsilon_C}U_C\right] \\ &+ \frac{\epsilon_A}{x^{E,a}+\epsilon_A}\left[\frac{x_f^I}{x_f^I+\epsilon_A}U_h^m + \frac{\epsilon_A}{x_f^I+\epsilon_A}U_l^m + \frac{1-x_f^I}{1-x_f^I+\epsilon_C}U_C\right] \\ &+ \frac{1-x^{E,a}}{1-x^{E,a}+\epsilon_B}U_B. \end{aligned} \tag{7}$$

Proposition 4:

(a) Assume that $\pi_h^m - 2\pi_{hh} < \pi_h^m - \pi_{h\ell} - \pi_{\ell h}$ so that, by Prop. 1(a), $x_s^{I,a} < x_s^{I,na}$ and $x^{E,a} > x^{E,na}$. Then, $\exists\ \widetilde{U}_C > 0$ such that $\forall\ U_C > \widetilde{U}_C$, a prohibition of acquisitions results in a decrease in CS. Otherwise, a prohibition of acquisitions increases CS.

(b) Suppose that, alternatively, $\pi_h^m - 2\pi_{hh} > \pi_h^m - \pi_{h\ell} - \pi_{\ell h}$ so that, by Prop. 1(b), $x_s^{I,a} > x_s^{I,na}$. Then:

(i) If $\delta > \overline{\delta}(\cdot)$ so that $x^{E,a} < x^{E,na}$, $\exists\ \widehat{U}_B > 0$ such that $\forall\ U_B > \widehat{U}_B$, a prohibition of acquisitions results in a decrease in CS. Otherwise, a prohibition of acquisitions increases CS.

(ii) If $\delta < \overline{\delta}(\cdot)$ so that $x^{E,a} > x^{E,na}$, and if

$$\lim_{\delta \to 0} \frac{\left(x^{E,a} - x^{E,na}\right)\epsilon_A}{x^{E,na}\left(x^{E,a} + \epsilon_A\right)} > \frac{\frac{x_s^{I,na}}{x_s^{I,na}+\epsilon_A}\left(U_{hh} - U_h^m\right) + \frac{\epsilon_A}{x_s^{I,na}+\epsilon_A}\left(U_{\ell h} - U_h^m\right)}{\frac{\epsilon_A}{x_f^I+\epsilon_A}\left(U_h^m - U_\ell^m\right) + \left(\frac{1-x_s^{I,a}}{1-x_s^{I,a}+\epsilon_C} - \frac{1-x_f^I}{1-x_f^I+\epsilon_C}\right)U_C}, \tag{8}$$

$\exists\ \widetilde{U}_B > 0$ and $\widetilde{\delta} \in (0, \overline{\delta})$ such that $\forall\ U_B < \widetilde{U}_B$ and $\forall\ \delta < \widetilde{\delta}$, a prohibition of acquisitions results in a decrease in CS. Otherwise, if (8) does not hold, a prohibition of acquisitions increases CS.

Proposition 4 illustrated using the micro-founded model.

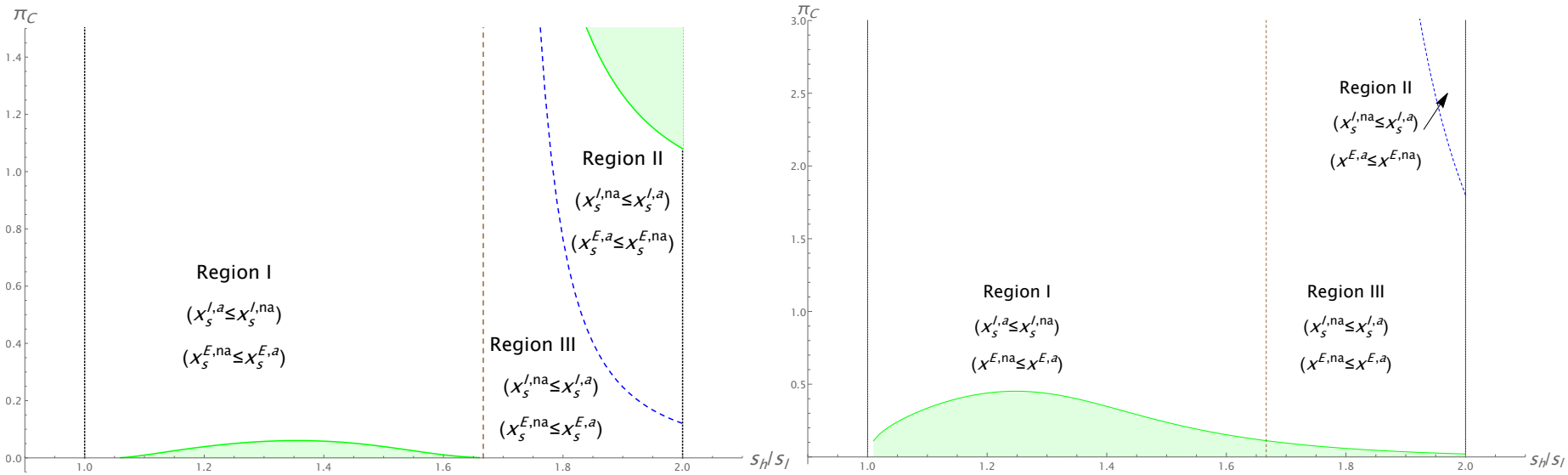

Figure: Parameters areas (green) for which permitting acquisitions raises consumer surplus

Section 8

Conclusion

Conclusion

- Paper focuses on the effects of start-up acquisitions on a new margin: *the direction of innovation of target and acquirer*.
- Model features an E that engages in an investment portfolio problem to possibly challenge one of the markets of an I; upon entry, I may "defend" its market or "give it up" and focus on other markets.

Insights for antitrust.

- The traditional *definition-of-the-market* approach overlooks the crucial fact that it is precisely the shift of resources towards and away from non-rival projects what may cause the bulk of the welfare gains and losses.
  - Implication for interpretation "out-of-market" (in)efficiencies.
- We suggest a case-by-case assessment to determine the potential benefits and drawbacks.
  - Useful variables to pay attention to: "size" of the innovation (ARE), and bargaining power, size and concavity/convexity of demand in non-overlapping markets.

THANK YOU!

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