Learning Across Alternatives IV:

Market Competition

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Motivating Example

- **Entering a new market.**
- Imagine it is 2005 and a new entrant has decided to enter car manufacturing.

- All existing manufacturers (US, EU, Japanese/Korean) build ICE cars with a long-standing dominant design.

- The entrant have several options to enter. Should it enter with:
  - A tweak on existing cars?
  - A fully-electric sports car & luxury sedan?

- These choices differ significantly on:
  - The likelihood of successful manufacture and performance, AND
  - Consumer demand and degree of competition with incumbents.

- Tesla chose the latter.
  - Great cars + product differentiation from incumbents = success.
  - Is this disruption? (Smells like it but ... incumbents still in business.)

- What are the incentives to innovate boldly vs. incrementally?
  - What role does antitrust/competition policy play in this choice?

Innovation & Product Market Competition

- Develop a model of product market competition in which an entrant chooses the novelty of its technology.
  - Uncertainty about the outcome increases in novelty.
  - Competition with incumbent declines in novelty.

- Method: Overlay a Brownian motion onto an Hotelling model of competition.
  - Brownian motion = product quality.

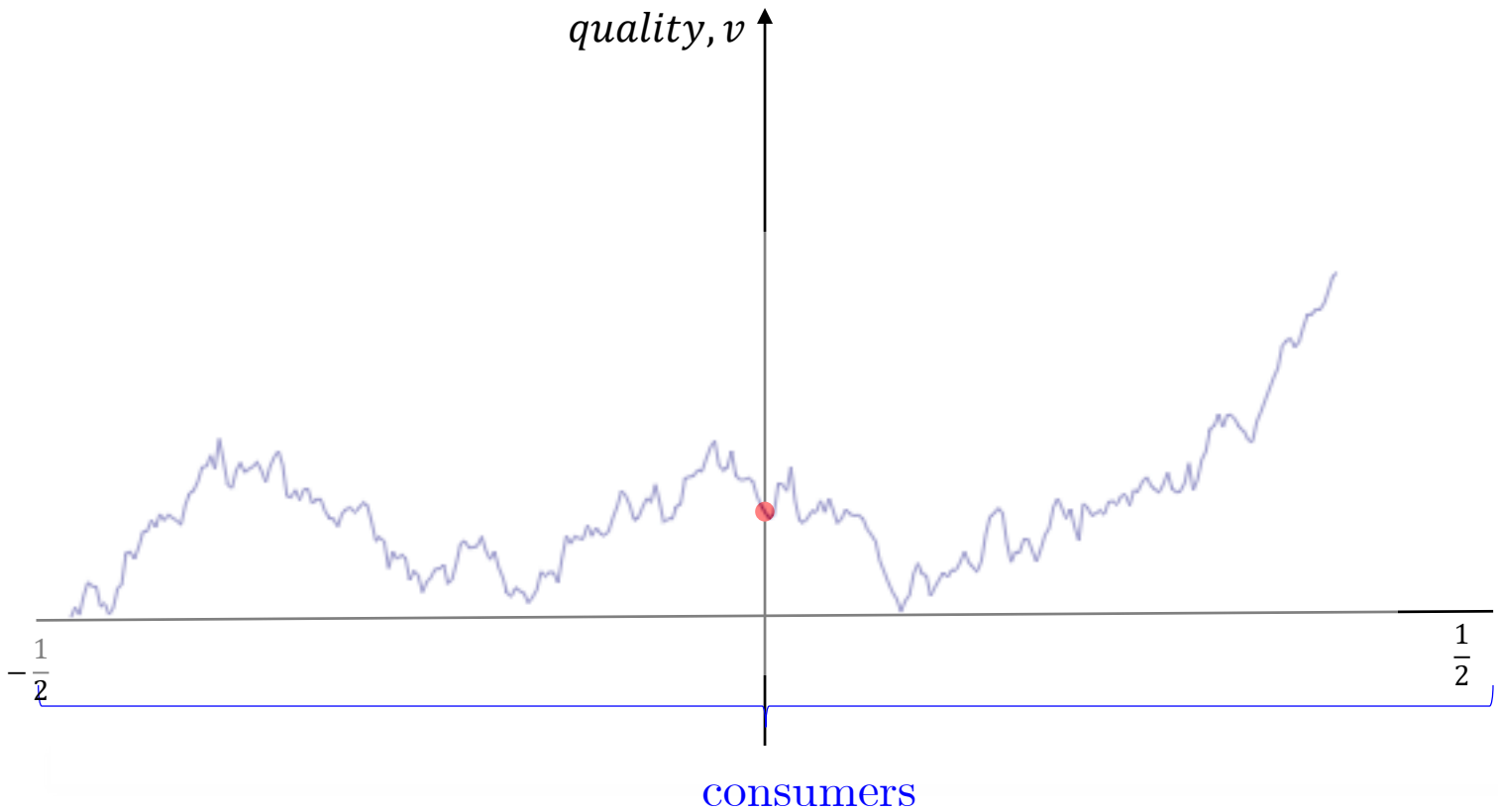
- Show a spatial variant of the "Arrow Replacement Effect" holds.
  - (Arrow effect: Monopolist's invest less intensely than competitive firms.)
  - Spatial Arrow: Independent entrant – an entrepreneur – innovates with more novelty than does an incumbent.
    - Logic is different to that of Arrow.

  - <u>But</u> this result is reversed if the incumbent can acquire the entrant.
  - Mergers incentivizes innovation but pushes entrepreneurs toward incremental innovations.

  - Positive role for strict anti-trust policy.

- Explore implications for disruption, competition, and "killer acquisitions."

Vertical & Horizontal Differentiation

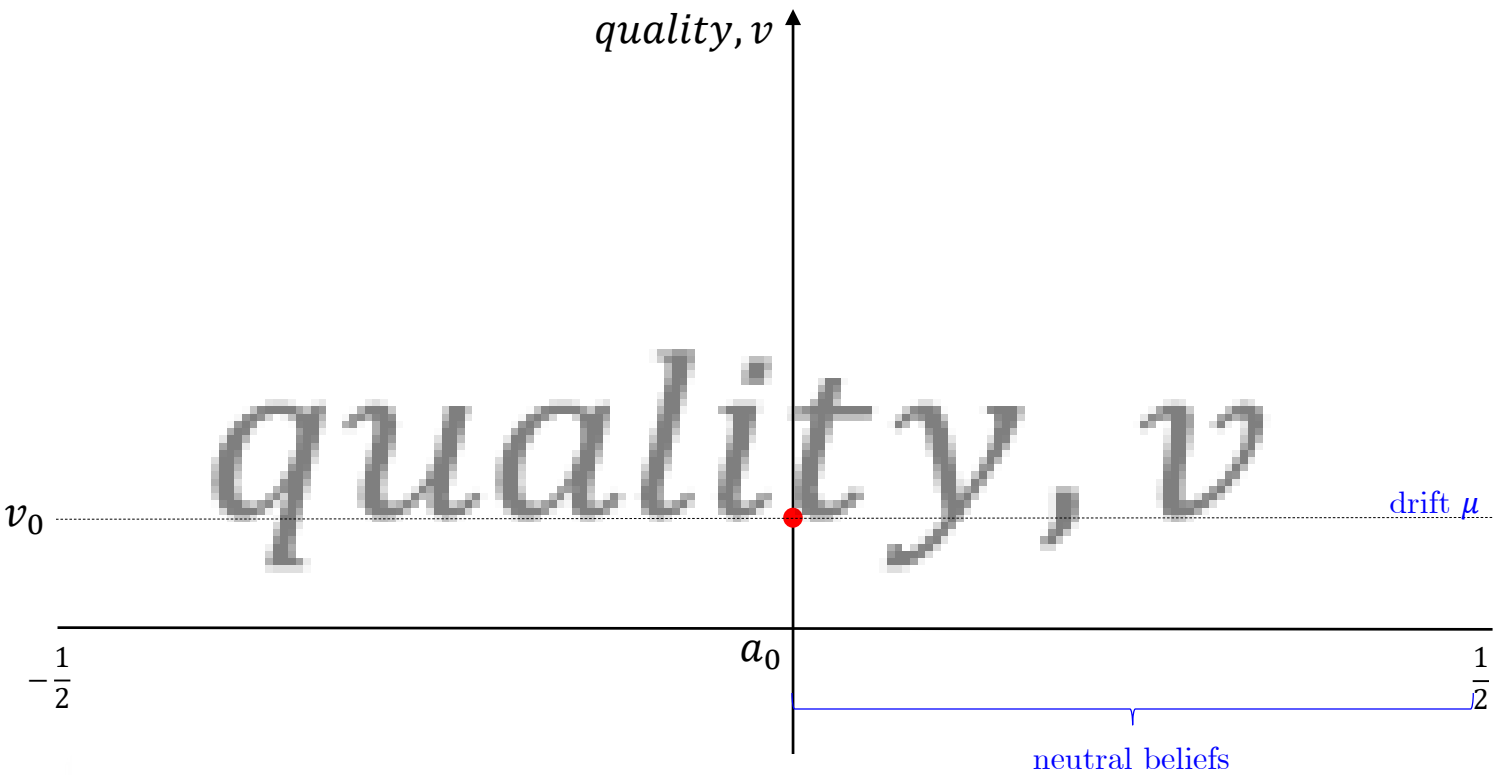


- Model of price competition with horizontal and vertical differentiation.
  - IO models get messy! We'll analyze one-shot, one entrant competition.
- Not enough models of Hotelling competition under uncertainty.
  - Demand uncertainty – Meagher and Zauner (2004).

The Model

- Preferences:
  - Consumer location $s \sim U\left[-\frac{1}{2}, \frac{1}{2}\right]$.
  - Consumer s's utility from consuming Product $j \in \{0,1\}$ is given by: $\underbrace{v_j}_{\text{quality}} - \underbrace{t(s - l_j)^2}_{\text{transportation cost}} - \underbrace{p_j}_{\text{price}}$.
- Production:
  - Product 0 is located at $l_0 = 0$ and Product 1 at $l_1 \in \left[0, \frac{1}{2}\right]$ wolog.
  - Product 0 is an existing product with given "quality" $v_0 \geq \frac{5}{4}t$.
  - Product 1 is a new product with quality v_1 drawn from $N(v_0 + \mu l_1, l_1 \sigma^2)$.
    - Underlying mapping of product quality is a Brownian motion; assume $\mu < t$.
  - Development costs of Product 1 are $c(a_1) > 0$, where $c(0) = 0$ and $c'(\cdot), c''(\cdot) > 0$.
    - Cost of development increasing in novelty.
    - Nb. Restraint exogenous, not driven by risk aversion (Garfagnini-Strul. & Leeat's paper).
  - Cost of production for both products are zero.

Product Quality Mapping



The Model

- Three variants on ownership of entrant (Product 0 is produced by the incumbent firm)
  i. Product 1 is produced by an independent entrant – an entrepreneur.
  ii. Product 1 is produced by the incumbent firm itself.
  iii. (Product 1 is produced by an entrepreneur & then entrepreneur can be acquired by the incumbent.)

- Timing:
  1. Location of the new product l_1 is chosen.
  2. Quality of the new product v_1 is realized and becomes publicly known.
  3. Prices p_0 and p_1 are chosen simultaneously.
  4. Consumption decisions are made and profits are realized.

- Notation: denote the quality difference by $\Delta \equiv v_1 - v_0$.
- Solve by backward induction ...

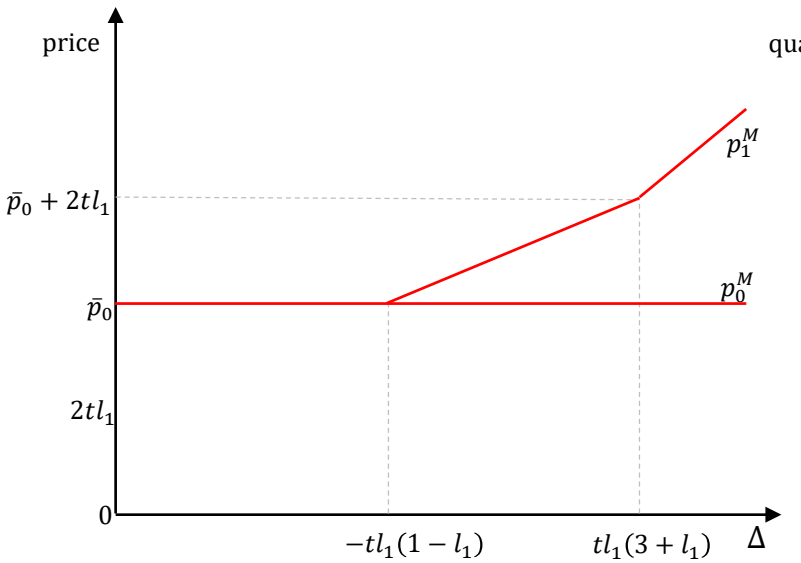
Single Product Benchmark

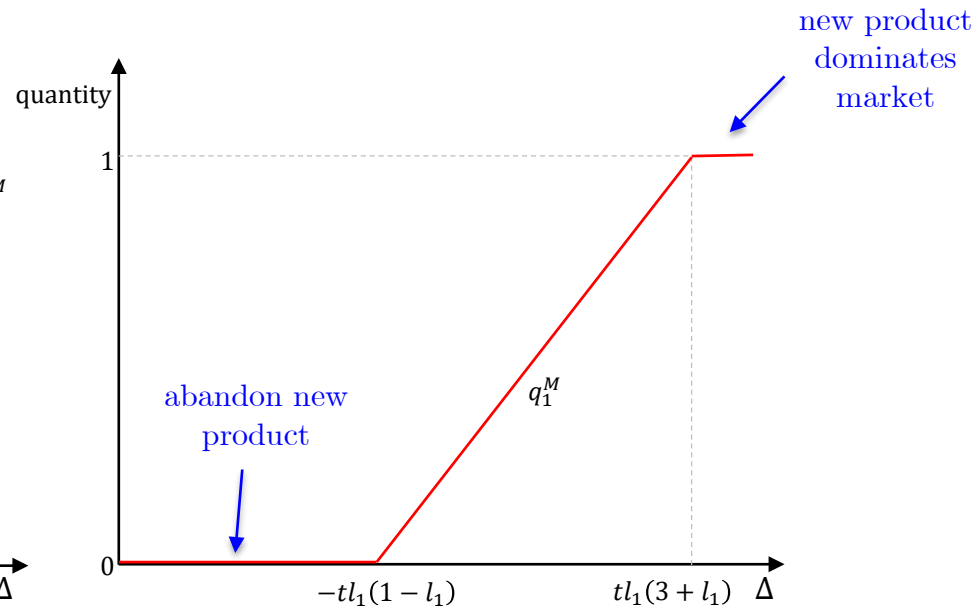
- Suppose there is no new product.
- Then the incumbent sells the existing product at $\bar{p}_0 = v_0 - \frac{1}{4}t$.
- The highest price such that every consumer buys it.
- And the incumbent realizes profits $\bar{\pi}_0 = \bar{p}_0$.
- We refer to these as the status quo price and profit.

Incumbent Owned Entrant – Fix $l_1 \in \left[0, \frac{1}{2}\right]$

Proposition 1 *If the incumbent owns the entrant, its profits are*

$$\pi_0^M + \pi_1^M = \begin{cases} \overline{\pi}_0 + \Delta - tl_1(1+l_1) & \text{if } \Delta \geq tl_1(3+l_1) \\ \overline{\pi}_0 + \frac{1}{8tl_1}(\Delta + tl_1(1-l_1))^2 & \text{if } -tl_1(1-l_1) \leq \Delta \leq tl_1(3+l_1) \\ \overline{\pi}_0 & \text{if } \Delta \leq -tl_1(1-l_1). \end{cases}$$





- Price for Product 0 constant (extract maximum surplus from left-side consumers).
- Price and market share for entrant both increasing in quality differential.
- For low quality, $\Delta \leq -tl_1(1-l_1) < 0$, incumbent abandons the new product.

Independent Entrant – Fix $l_1 \in \left[0, \frac{1}{2}\right]$

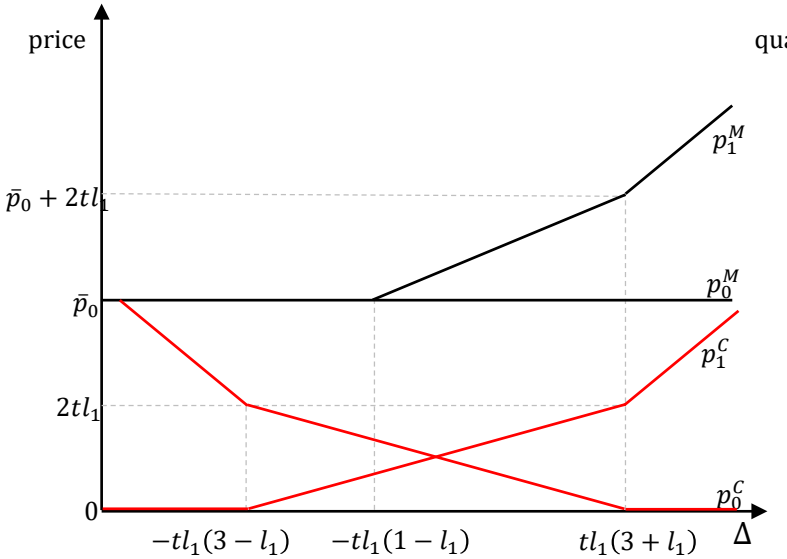
Proposition 2 *If the entrant is independent, the incumbent's profits are*

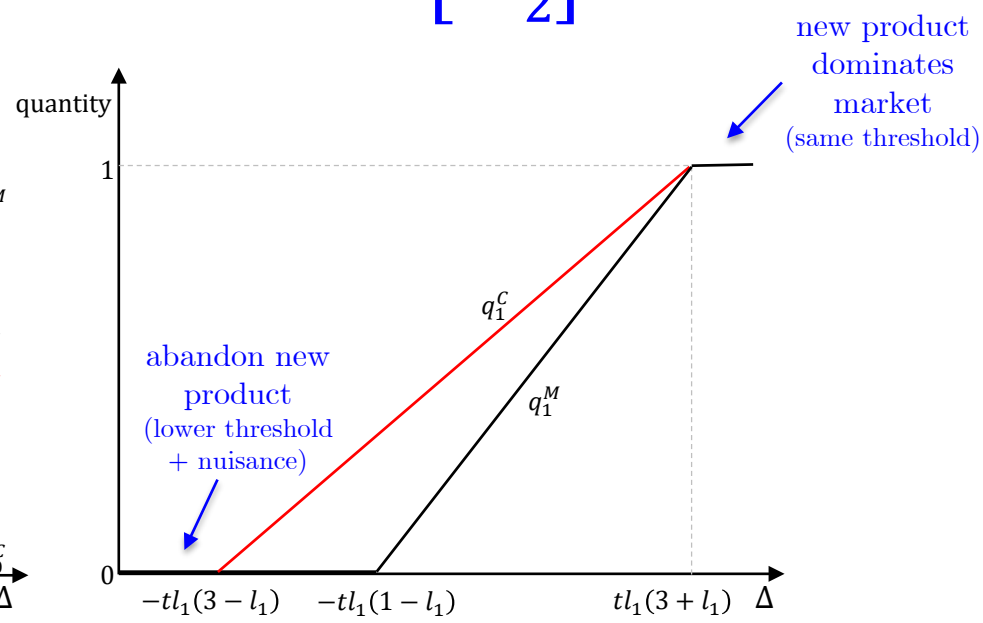
$$\pi_0^C = \begin{cases} 0 & \text{if } \Delta \geq tl_1(3+l_1) \\ \frac{1}{18tl_1}(\Delta - tl_1(3+l_1))^2 & \text{if } -tl_1(3-l_1) \leq \Delta \leq tl_1(3+l_1) \\ -\Delta - tl_1(1-l_1) & \text{if } \frac{1}{4}t - tl_1(1-l_1) - v_0 \leq \Delta \leq -tl_1(3-l_1) \\ \overline{\pi}_0 & \text{if } \Delta \leq -tl_1(1-l_1) - \left(v_0 - \frac{1}{4}t\right) \end{cases}$$

and the entrant's profits are

$$\pi_1^C = \begin{cases} \Delta - tl_1(1+l_1) & \text{if } \Delta \geq tl_1(3+l_1) \\ \frac{1}{18tl_1}(\Delta + tl_1(3-l_1))^2 & \text{if } -tl_1(3-l_1) \leq \Delta \leq tl_1(3+l_1) \\ 0 & \text{if } \Delta \leq -tl_1(3-l_1). \end{cases}$$

Independent Entrant – Fix $l_1 \in \left[0, \frac{1}{2}\right]$





- Prices for both products are cheaper – price competition!
- Entrant's price increasing and incumbent's is decreasing in Δ .
- Entrant's market share is higher when independent.
- Entrant more likely to stay in market. Abandon market only if $\Delta \leq -tl_1(3 - l_1)$.
  - For lower range, entrant is "nuisance product"—no market share but constrains incumbent.
- Profit in both Propositions is quadratic in Δ. Firms risk-taking even with linear utility

Choosing Innovation $l_1 \in \left[0, \frac{1}{2}\right]$

- Proposition 3: The new product is more differentiated from the existing one if the entrant is independent than if it is owned by the incumbent, that is,

$$\boxed{l_1^C > l_1^M.}$$

- The spatial Arrow effect: Independent entrepreneur is more innovative in product development than is an incumbent.
  - (Arrow replacement effect: Monopolist has less incentive to invest in cost-reduction technology.)

- Why? Different logic to Arrow. Two forces:
  1. Arrow effect says incumbent doesn't want to cannibalize existing product, whereas independent entrant can steal market share.
     - → pushes incumbent-owned entrant further to right.
  2. Price competition: Incumbent can coordinate on pricing, entrepreneur cannot.
     - → pushes independent entrant further to right to soften competition.
- Proposition 3 says that the price competition effect dominates.

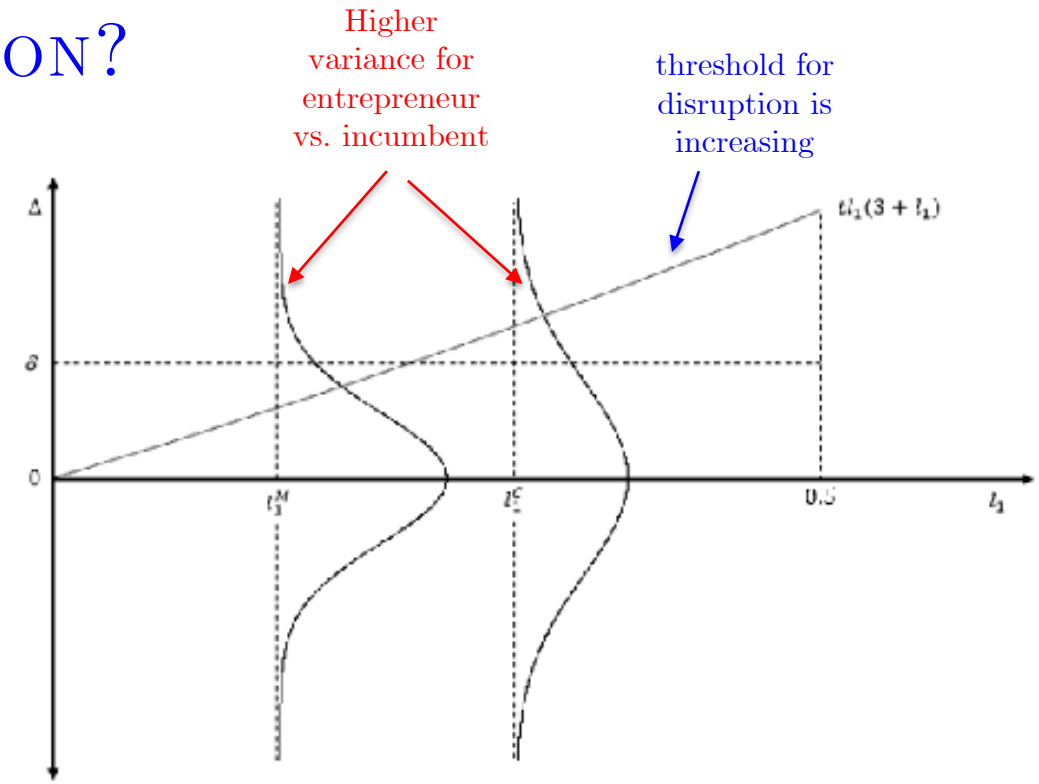
Disruption?

- "Disruption" is a very famous and familiar concept but it is poorly defined.
- Christensen (1997) argues for two types of innovation, 'disruptive' and 'sustaining.'
  - → Disruption can only come from disruptive innovations!
- But several of Christensen's best-known examples of disruption ... didn't disrupt.
  - The disrupted incumbents remain in business years later.
- Let's define disruption as driving the existing product from the market.

Corollary 1: The incumbent product's market share is zero with higher probability when the entrant is incumbent-owned than when it is independent.

- Recall: The quality differential required is the same across entrant types.
- The entrepreneur has higher variance and more chance of a breakthrough.
- But with softer price competition, the entrepreneur has a higher standard to disrupt.

Disruption?



- The Corollary proves the threshold increases faster than the variance.
- What Christensen missed:
  - Innovation is a matter of degree not type.
  - Disruption depends on quality of innovation AND product differentiation.
- Converse: Incumbent product more likely to fail (higher threshold + price comp).
  - Is this why incumbent firms are thought to be bad at innovation?

Acquisitions (Takeovers, Mergers)

- Suppose the Incumbent firm can acquire the entrepreneur.
  - Timing: After quality of innovation (new product) has been realized.
  - Acquisition price: Nash bargaining. Entrepreneur bargaining power is $\alpha \in [0,1]$.

- Two questions:
  1. When do acquisitions occur and what is the nature of the merger?
  2. What effect does potential acquisition have on the incentive to innovate?

- Start with Question 1. Acquisitions always occur!
  - Acquisitions are competition decreasing – always profitable for firms.

Acquisitions

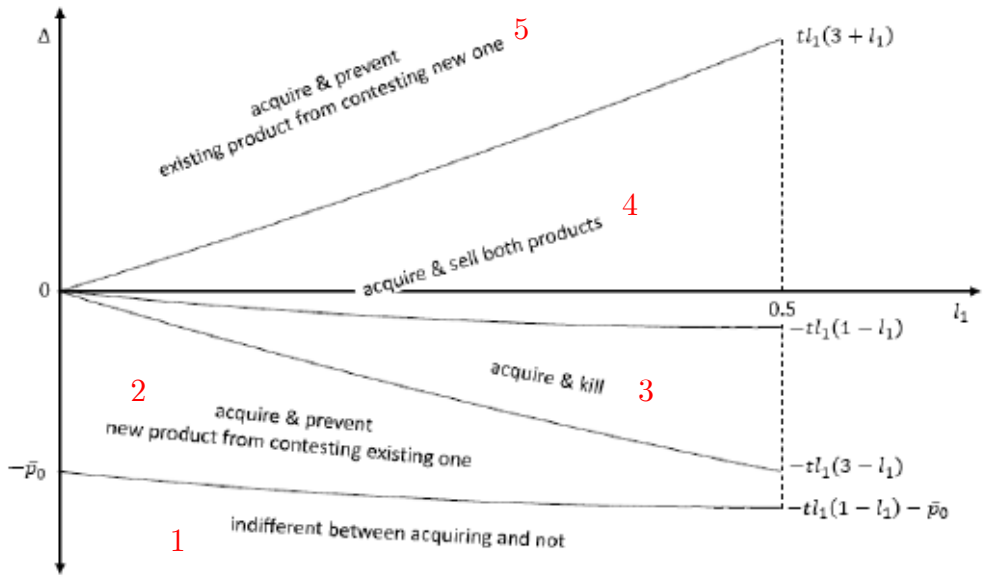


Figure 3: Acquisition Strategy of the Incumbent Firm

1. (Bottom). Entrant such low quality, merger has no effect. Zero price.
2. Entrant's market share would be zero, but price positive. "Nuisance" that "contests" the market.
3. "Killer acquisitions". Broader range the more distant is new technology.
4. Products coexist. Market spanning coverage + price coordination.
5. Existing product has zero market share and would "contest" new product. "Seppuku acquisition."

Acquisitions (Takeovers, Mergers)

- Question 2. What effect does the prospect of takeover have on the incentive to innovate?

Proposition 4: An independent entrant that is later acquired has an optimal location $l_1^A(\alpha)$ that is decreasing in its bargaining power and satisfies

$$\boxed{l_1^A(0) = l_1^C \text{ and } l_1^A(1) = (0, l_1^M).}$$

location unchanged if zero bargaining power

entrepreneur innovates less than incumbent would

- The spatial Arrow effect is reversed if the entrant's bargaining power is not too small.
  - nb. zero bargaining weight for the entrant → same payoff as if no acquisition (so no change in location).

- Why does the entrant innovate with less novelty?
  - Post-merger incumbent will coordinate prices. Producer surplus maximized at l_1^M.
  - Covering more of the market is valuable.

- The entrepreneur innovates with less novelty as it is rent seeking.
  - $l_1^A < l_1^M$ decreases post-merger profits but also decreases profit if not merge.
  - Lower outside option effect dominates → Higher acquisition price.

Antitrust/Competition Policy

- The entrepreneur innovates with less novelty than does an incumbent.
- The lure of future acquisition incentivizes innovation (get bought out!) but does so in a way that suppresses the novelty of innovation.
- Consumer surplus is the loser (as is the incumbent).

- What can antitrust policy do to remedy this distortion?
- Answer: Stricter enforcement to block acquisitions.

- Most arguments for antitrust are forward-looking on innovation: What effect will an acquisition have on future innovation.
- We show that it needs to be backward looking as well. A lax antitrust policy will distort the innovations of would-be entrepreneurs.

Competition in a Complicated World

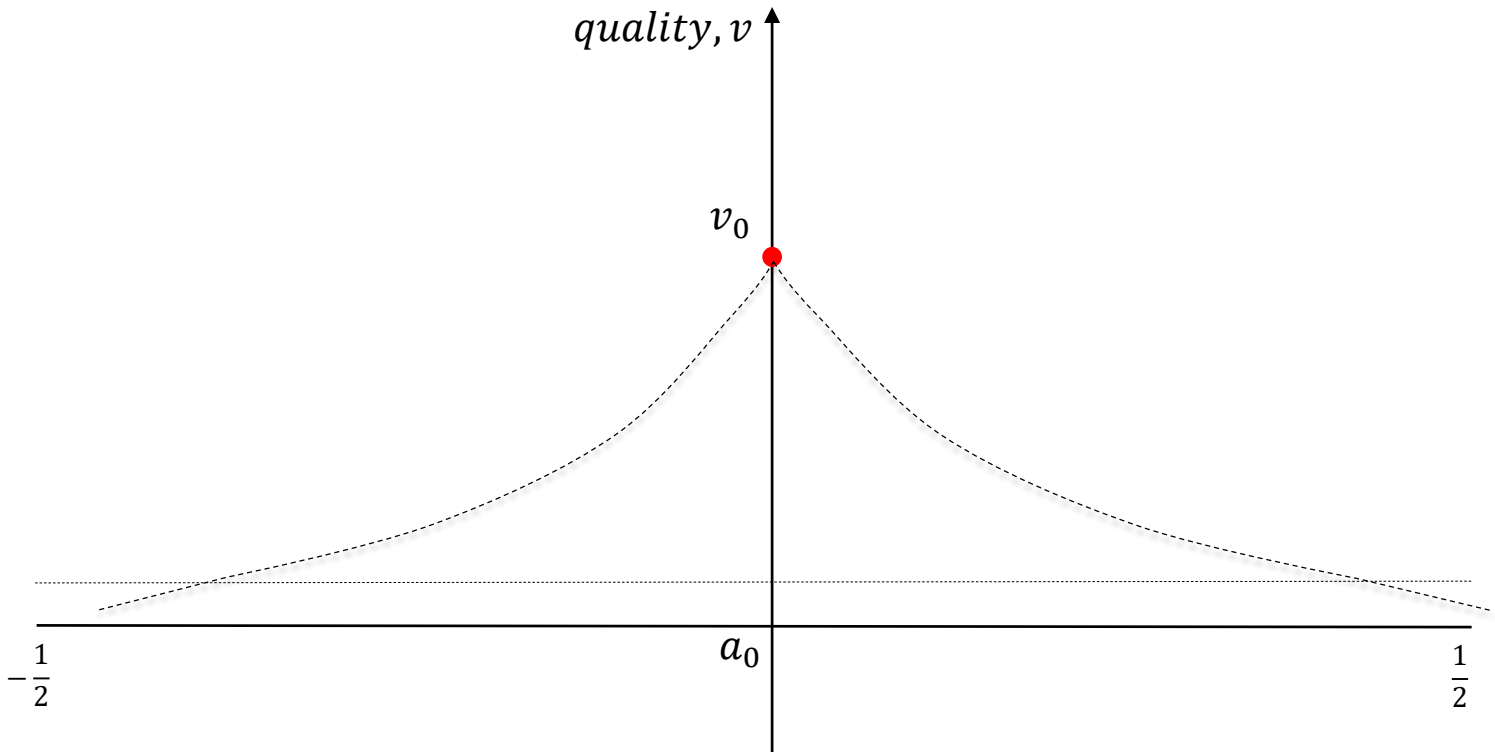
- This paper – Callander and Matouschek (2020, wp).

- Other stochastic processes.
  - We explore non-linear drift.
  - Mean-reversion: Ornstein-Uhlenbeck process.

- Dynamics & multiple firms.
  - In this paper we only use one normally distributed draw.
  - What would a second entrant do?
  - Would incumbent firm respond by searching for better product/location?
    - Connection: this is what organizational sociologists debate about.
  - (warning: IO models get messy!)

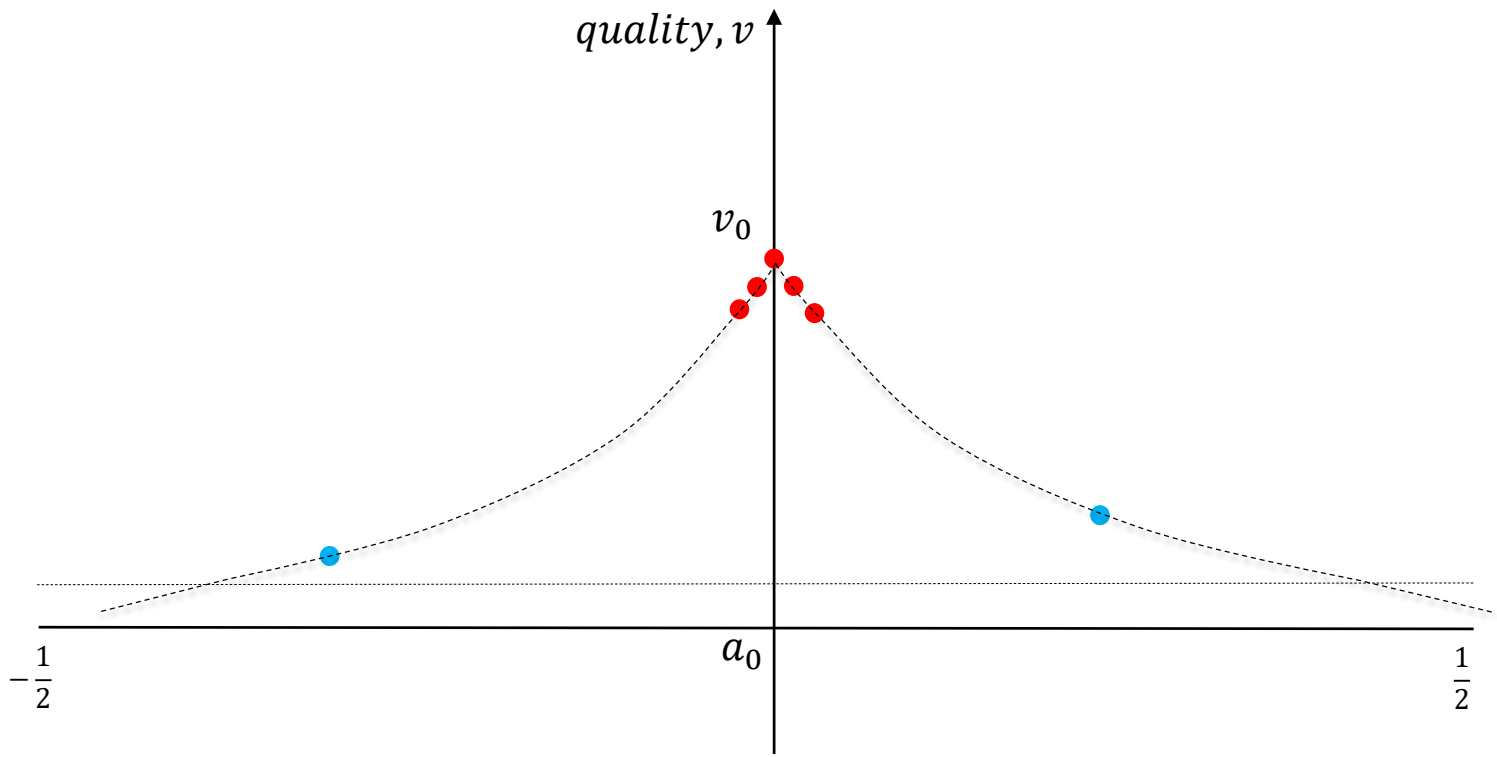
- Many more open questions & ideas ...

Mean Reverting Process



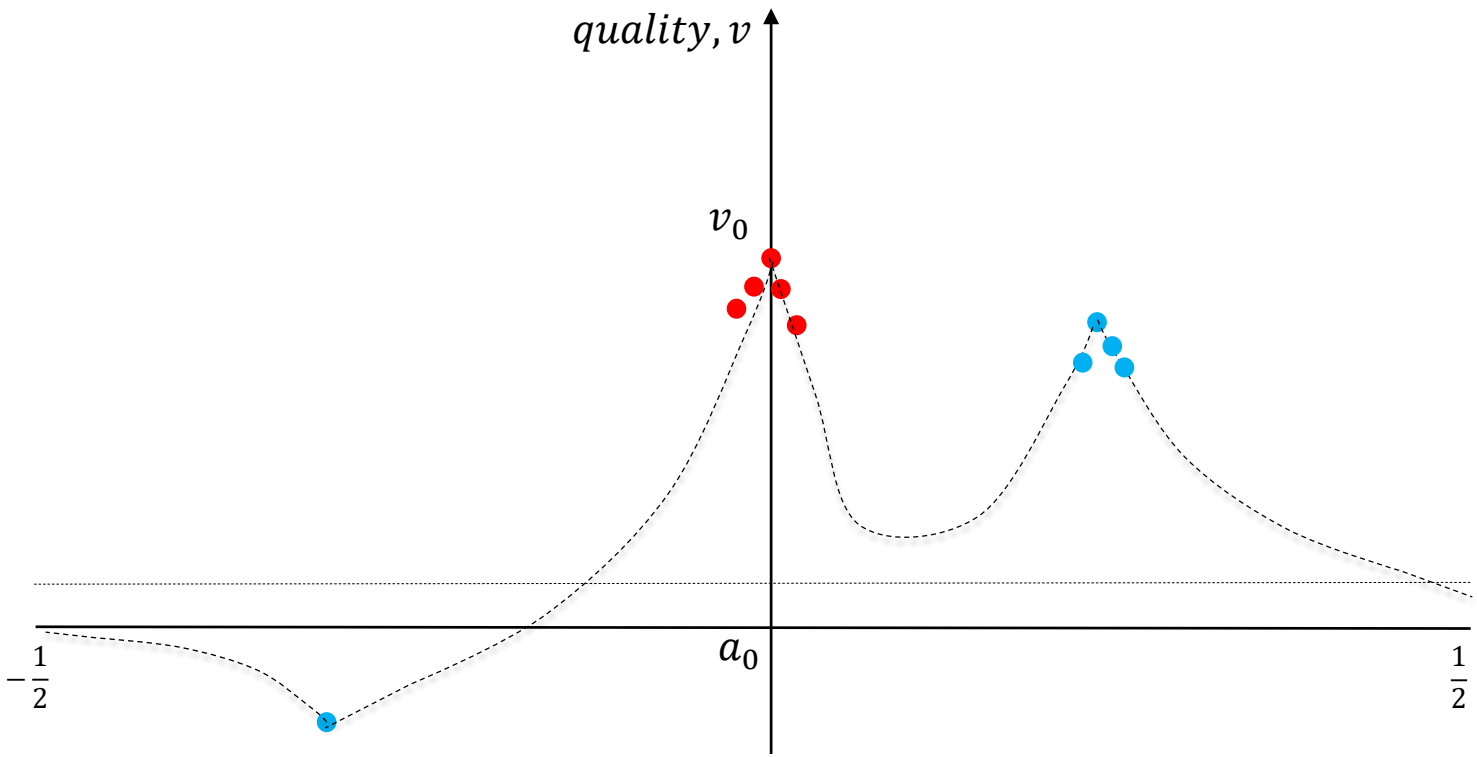
- Imagine the quality mapping is mean reverting – Ornstein-Uhlenbeck process.
  - (Arjada Bardi – next! – will show us a way to use this process... time permitting)
- Restraint on experimentation is firm expects lower quality as it moves away.

Mean Reverting Process & Firm Clustering



- Entry is around successful incumbent – clustering.
- Competition ↑ and profits ↓. Eventually next entrant makes a jump.
- What can happen next?

Mean Reverting Process & Firm Clustering



- Entry to the right is a success! New location cluster as expectations change.
- Entry to the left a failure. Close off market exploration in that direction.

Living in a Complicated World

- This completes the tour of four decision making environments & many applications.
- Learning across alternatives is important in many settings.
- The Brownian motion (and other stochastic processes) provides a realistic, tractable, an rich way to model this type of uncertainty.
- Lots more work to be done!

- I am working on several projects at the moment & have others planned.
- I would love to hear from you if you have questions about the papers I presented, ideas I suggested, or ideas of your own.
- Email me at: sjc@stanford.edu
- Find everything from these lectures at my webpage.