Monopoly and the Incentive to Innovation When Adoption Involves Switchover Disruptions

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The Impact of Competition on Adoption of Cost Reducing Innovation

Evidence: monopolists aren't as inclined to adopt new cost reducing technologies

The fat happy monopolist

- Don't see waves of innovation after trade protection (Smoot-Hawley)
- Do see waves of innovation after trade liberalization
- AT&T

Well documented cases

- Midwest iron ore
- Chilean copper industry
- Cement manufacturing

Existing Theories of Innovation and Market Power

Arrow: competition leads to more innovation

Competitors produce more, so more units to spread the fixed cost over

- Are fixed costs that relevant to adoption of new innovations?
- Each individual competitor may produce less than a single monopolist
- Depends critically on demand elasticity

Gilbert and Newberry: competition leads to less innovation

Monopolist has incentive to adopt to preempt rivals

- But you don't need to adopt it to preempt – just patent it
- G&N argue that even invention without adoption is socially desirable
- Unfortunately their argument is wrong

Switchover Disruption

- Usual assumption: new techology unambiguously good or you wouldn’t consider using it
- But new technologies never work properly – they eventually work better with some probability
- One cost of adopting are lost or delayed sales
- The more profitable each sale the greater the opportunity cost of adoption

Examples of Switchover Disruption

- Boeing Dreamliner – switch to offsite assembly
- GM – robotic assembly line
- United Airlines – Denver automated baggage handling
- Japan steel switch from open hearth to basic oxygen, initial 14% drop in TFP, three years to reach old level of productivity (Nakamura and Ohashi)
- Supply chain management – see Hendricks and Singhal [2003]
- Work rule changes
- Organizational structure
- CEO change (big literature on this)
- IT infrastructure
- And on and on

The Existing Market

Industry demand $D(p)$

Inelastic case $D(p) = 1, p \leq \theta$

Incumbent produces at MC c^0

Rivals produce at $c^0 + \tau$

$p_0^M > c^0 + \tau$ pure monopoly price

The New Technology

production takes place over time $0 \leq t \leq 1$,interest rate ρ

$c_t = f(t)$ marginal cost with new technology

$f(t)$ strictly decreasing

$\overline{c} = f(0), \underline{c} = f(1) < c^0$

change of variable for integrating

$G(c)$ time remaining when marginal cost is c

$g(c) = -G'(c)$ density

$h(c) = e^{-\rho(1-G(c))} g(c)$

fixed cost of adoption F drawn from a continuous distribution

Who Has the Opportunity to Innovate?

- Arrow: only incumbent can adopt
- Gilbert and Newbery: technology belongs to an outsider, incumbent chooses to adopt or allow rival adopt

The Arrow Case

not a drastic cost reduction: monopoly price at $\underline{c}$ assumed still to be above $c^0 + \tau$

No switchover disruption $c^0 \geq \overline{c}$

Net gain from adopting:

$$w^{No\_SD} = D(c^0 + \tau) \int_{\underline{c}}^{\overline{c}} h(c)[c^0 - c]dc$$

adoption if $w^{No\_SD} \geq F$

with downward sloping demand, less market power meaning smaller τ means more D hence more adoption

from this point we assume that D is inelastic, eliminating the arrow effect

Switchover Disruption

$c^0 < \overline{c}$

big relative to market power $c^0 + \tau \leq \overline{c}$

so you won't sell until $c_t \leq c^0 + \tau$

$$w_{arrow}^{SD} = \int_{\underline{c}}^{c^0+\tau} h(c)[c^0 + \tau - c]dc - \int_{\underline{c}}^{\overline{c}} h(c)\tau dc$$

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$$\frac{dw_{arrow}^{SD}}{d\tau} = -\int_{c^0+\tau}^{\overline{c}} h(c)dc$$

negative: more market power, less innovation

Gilbert and Newbery

v value to incumbent of adopting

u value to incumbent if rival adopts

r value to rival from adopting

No Switchover Disruption

$$v^{No\_SD} = D(c^0 + \tau)\int_{\underline{c}}^{\overline{c}} h(c)[c^0 + \tau - c]dc$$

$$u^{No\_SD} = \int_{\max\{c^0-\tau,\underline{c}\}}^{\max\{\overline{c},c^0-\tau\}} h(c)[c + \tau - c^0]dc$$

$$r^{No\_SD} = \int_{\min\{c^0-\tau,\underline{c}\}}^{\min\{\overline{c},c^0-\tau\}} h(c)[c^0 - \tau - c]dc$$

then

$$\frac{d(v^{No\_SD} - u^{No\_SD})}{d\tau} = \int_{\underline{c}}^{\overline{c}} h(c)dc - \int_{\max\{c^0-\tau,\underline{c}\}}^{\max\{\overline{c},c^{0-\tau}\}} h(c)dc$$

so non-negative and if the max operators bind, strictly positive

Gilbert Newbery Conclusions

- more monopoly power, more innovation
- incumbent always get the new technology, never the rival
- incumbent never suppresses innovation always adopts

Switchover Disruption

$$H^{disrupt} = \int_{c^0}^{\overline{c}} h(c)dc$$

$$H^{beyond} = \int_{\underline{c}}^{c^0} h(c)dc$$

$H^{disrupt}$ measures the duration of the switchover

Monopoly Power is Small

Proposition 3: Suppose that $\overline{c} > c^0$ and that τ is small. Consider three different durations of disruption

(i) (short disruption) $H^{disrupt} < H^{beyond}$ incumbent innovates and innovation increases in market power τ

(ii) (intermediate disruption) $H^{beyond} \leq H^{disrupt} \leq 2H^{beyond}$ incumbent innovates and innovation decreases in market power τ

(iii) (long disruption) $H^{disrupt} \geq H^{beyond}$ rival innovates

Large Monopoly Power

Supression can occur if τ exceeds a threshold $\hat{\tau}$

$f'(t)e^{-\rho t}$ increasing in t

the discounted version of f convex

initial advances faster than subsequent advances

implies $h(c)$ decreases in c

4: Proposition 3 (ii) and (iii) continue to hold for $\tau \leq \min\{c^0 - \underline{c}, \hat{\tau}\}$

Comparative Statics

What does price cost margin measure? Monopoly power?

Take the Arrow setting

Suppose the monopolist will not innovate at the current value of τ

Suppose his monopoly power is reduced a little bit, so τ goes down, and this leads him to introduce an innovation that reduces cost

Then his price-cost margin goes UP not down

Reinterpretation of the Model

$h(c)$ is a density function from which marginal cost is drawn

the new technology has time constant MC, but the new technology is irreversible