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 technology 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
production takes place over time \(0 \leq t \leq 1\), interest rate \(\rho\)

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

\(f(t)\) strictly decreasing

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

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 $c$ assumed still to be above $c^0 + \tau$

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

Net gain from adopting:

$$w_{No-SD}^N = D(c^0 + \tau) \int_{c}^{\bar{c}} h(c)[c^0 - c]dc$$

adoption if $w_{No-SD}^N \geq F$

with downward sloping demand, less market power meaning smaller $\tau$ means more $D$ hence more adoption

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

c^0 < \bar{c}

big relative to market power \( c^0 + \tau \leq \bar{c} \)

so you won’t sell until \( c_t \leq c^0 + \tau \)

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

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

\[
\frac{d w_{arrow}^{SD}}{d\tau} = -\int_{c^0+\tau}^{\bar{c}} h(c)dc
\]

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**

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

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

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

then

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

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

\[ H^{\text{disrupt}} = \int_{c^0}^{\bar{c}} h(c) dc \]

\[ H^{\text{beyond}} = \int_{\bar{c}}^{c^0} h(c) dc \]

\( H^{\text{disrupt}} \) measures the duration of the switchover
Monopoly Power is Small

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

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

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

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

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

$\frac{f'(t)e^{-\rho t}}{G9}$ 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 $\tau \leq \min\{c^0 - c, \hat{\tau}\}$
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 $\tau$
Suppose his monopoly power is reduced a little bit, so $\tau$ 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