Direction of Innovation

Diomides Mavroyiannis

PSL/Paris Dauphine

July 10, 2019

Motivation

Definition: A buyout will be used to refer to the purchase of technological assets

Buyouts are prevalent, the basic effect of buyouts is that they decrease the price elasticity of the market.

From an economic theory point of view, buyouts are a double edged sword.

Positive: Increase potential payoff for entrepreneurs, more projects undertaken, more innovation

Negative: Increases monopoly power

Sometimes buyouts can occur without these side effects, value buyers.

Literature review

Empirically firms which are less innovative are more likely to engage in buyouts. Higgins and Rodriguez (2006) and Zhao (2009)

Coase theorem works here because substitutability can be framed in terms of externalities.See Kuechle & Rios (2012)

Large firms avoid engaging in competition effects, Aghion (2005)

Cabal (2003) has an R&D race where two firms choose R&D technologies.

Firms and cost structure

There are two firms, an entrant(c_e) and incumbent(c_i) competition

Two potential future costs: intermediate c_1 and advanced c_2

Firms only use the best technology available to them. Incumbent technology is only inferior to the advanced tech. $\pi_i(c_i, c_{e2}) > \pi_i(c_{i1}, c_{e2})$

The entrant technology is inferior to both other technologies. $\pi_e(c_i, c_{e1}) > \pi_i(c_i, c_e)$

Timing:
Negotiation $\rightarrow$ Incumbent chooses $\rightarrow$ competition(a priori) Entrant chooses $\rightarrow$ negotiation $\rightarrow$ competition(a posteriori)

Sub-additive competitive profits

Monopoly assumption

Pesky Entrant

$$\pi_i(c_{i2}, c_e) \geq \pi_i(c_i, c_{e2}) + \pi_e(c_i, c_{e2})$$

$$\pi_i(c_i, c_e) \geq \pi_i(c_i, c_{e1}) + \pi_e(c_i, c_{e1})$$

Sequential

Entrant payoff:

$$\pi_e(c_i, c_{i1})(t_2 - t_1) + \pi_e(c_i, c_{e2})(T + 1 - t_2)$$

Incumbent payoff:

$$\pi_i(c_i, c_e)t_1 + \pi_i(c_i, c_{i1})(t_2 - t_1) + \pi_i(c_i, c_{e2})(T + 1 - t_2)$$

Monopoly payoff:

$$\pi_i(c_i, c_e)t_2 + \pi_i(c_{i2}, c_e)(T + 1 - t_2)$$

Sequential

$$WTP = \Pi_s^m - \Pi_{is} = (\pi_i(c_i, c_e) - \pi_i(c_i, c_{i1}))(t_2 - t_1) + (\pi_i(c_{i2}, c_e)$$

$$S_s = (\pi_i(c_i, c_e) - \pi_i(c_i, c_{i1}) - \pi_e(c_i, c_{i1}))(t_2 - t_1) + (\pi_i(c_{i2}, c_e) - \pi_i(c_i, c_{e2})$$

Model:Technology

The sequential technology takes two periods to innovate. In the first period the entrants cost is c_1 and in the second it is c_2

In the radical technology, with probability q, the cost will be c_2 in the first period.

If the technology fails then with probability q it will succeed in the second period.

A priori

A priori cutoff

If the buyouts are priori, the decision criteria for the radical innovation to be chosen by the incumbent is:

$$\frac{3-\sqrt{5}}{2} < q^p$$

Proof.

We need only set:

$$\Pi_{IR}^m > \Pi_{IS}^m$$

$$\pi_i^m(1-q)(2-q) + \pi_{i2}^m q(3-q) > \pi_i^m + \pi_{i2}^m$$

□

Bertrand: Sequential

The market profits of the incumbent in the sequential technology case is:

$$\overline{\Pi}_{IS} = \pi_{i1} = (1 - c_{i1})(c_{i1} - c_i)$$

The market payoffs of the entrant

$$\overline{\Pi}_{ES} = \pi_{e2} = (1 - c_i)(c_i - c_{e2})$$

The monopoly profit of the incumbent with a buyout is

$$\Pi_{IS} = \pi_i + \pi_{i2}$$

Therefore the bargaining payoff if there is a buyout of the entrant is:

$$B_{ES}(\omega) = \pi_{e2}(1 - \omega) + \omega(\pi_i + \pi_{i2} - \pi_{i1})$$

Model: Sequential 2

We can also compute the difference between the entrant buyout profits to the non-buyout profits as

$$B_{ES}(\omega) - \overline{\Pi}_{ES} = \omega(\pi_i + \pi_{i2} - \pi_{i1} - \pi_{e2})$$

This is the incentive effect of buyouts

Note the effect of barganing power.

Model: Radical

The market profits of the incumbent in the radical technology case is:

$$\overline{\Pi}_{IR} = (1-q)(2-q)\pi_i$$

The market payoffs of the entrant

$$\overline{\Pi}_{ER} = q2\pi_{e2} + (1-q)q\pi_{e2} = q\pi_{e2}(3-q)$$

The market profits of the incumbent with a buyout is

$$\Pi_{IR} = \pi_i(1-q)(2-q) + \pi_{i2}q(3-q)$$

Therefore the bargaining payoff if there is a buyout of the entrant is:

$$B_{ER}(\omega) = (3-q)q(\pi_{e2} + \omega(\pi_{i2} - \pi_{e2}))$$

Model: Radical 2

Incentive effect of the buyout is therefore:

$$B_{ER} - \overline{\Pi}_{ER} = \omega(3-q)q\left(\pi_{i2} - \pi_{e2}\right)$$

Notice that once again this heavily depends on bargaining power*

Model: Results

Proposition 1

The entrant will choose the radical innovation over the incremental innovation if there are no buyout iff:

$$\pi_{e2}(q(3-q)-1)+k_S-k_R>0$$

This is found simply by setting:

$$\overline{\Pi}_{ER}-k_R>\overline{\Pi}_{ES}-k_S$$

Corollary 1

Cutoff probability

If costs are identical then the required q for the radical innovation to prefered is given by:

$$q > \frac{3-\sqrt{5}}{2} = q^b$$

Results 2

Proposition 2

If costs are identical then a buyout will neccesarily require a higher q^{b*} than q^b to incite the entrant to pursue the radical innovation.

This follows by setting

$$B_{ER}(\omega) - k_R > B_{ES}(\omega) - k_S$$
$$\rightarrow (1-\omega)\pi_{e2}(q(3-q)-1) + \omega\pi_{i2}(q(3-q)-1)$$
$$-\omega(\pi_i - \pi_{i1}) > 0$$

Note that the third term is negative, $-\omega(\pi_i - \pi_{i1})$, which implies higher q

Example

Let $\pi_{e2} = 40$, $\pi_{i2} = 100$, $\pi_{e1} = 20$ $\pi_i = 80$.
$\omega = .5, q = 0.5$

No buyouts Sequential: Entrant earns 40. **Radical** entrant earns $.5(40 + 40) + (.5)^2(40) = 50$.
Radical>Sequential

Buyouts, Sequential bargaining surplus:
$NS_S = 100 + 80 - 20 - 40 = 120$. Therefore the payoff of the entrant is $40 + \frac{1}{2}(120) = 100$.
Radical innovation surplus:
$.5(200) + (.5)^2 180 + (.5)^2 160 - (.5)^2 80 - (.5)^2 - 50 = 75$.
Therefore the payoff after bargaining is
$50 + \frac{1}{2}(75) = 87.5$
Sequential $>$ Radical

Cournot: Sequential

The market profits of the incumbent in the sequential technology case is:

$$\overline{\Pi}_{ES} = \left(\frac{1 - 2c_{i1} + c_i}{3}\right)^2 + \left(\frac{1 - 2c_{i2} + c_i}{3}\right)^2$$

The market payoffs of the entrant

$$\overline{\Pi}_{IS} = \left(\frac{1 + c_{i1} - 2c_i}{3}\right)^2 + \left(\frac{1 + c_{i2} - 2c_i}{3}\right)^2$$

The monopoly profit is unchanged relative to Bertrand

Cournot: Sequential 2

The Nash surplus is given by:

$$NS_S^c = \pi^m + \pi_2^m - \pi_{i1}^c - \pi_{i2}^c - \pi_{e1}^c - \pi_{e2}^c$$

The Bargaining payoff of the entrant is:

$$B_{ES}^c = \Pi_{ES}^c + \omega NS_S^c$$

The barganing payoff of the incumbent is:

$$B_{IS}^c = \Pi_{IS}^c + (1-\omega) NS_S^c$$

Model: Radical

The market profits of the incumbent in the radical technology case is:

$$\overline{\Pi}_{IR} = (1-q)(2-q)\pi^m + q\pi^c_{i1}(3-q)$$

The market payoffs of the entrant

$$\overline{\Pi}_{ER} = q\pi^c_{e2}(3-q)$$

The monopoly profits are given by:

$$\Pi^m_R = \pi^m(1-q)(2-q) + \pi^m_2 q(3-q)$$

Cournot: Radical 2

The Nash surplus is given by:

$$NS_R^c = \pi^m(1-q)(2-q) + \pi_2^m q(3-q) - \Pi_{IR}^c - \Pi_{ER}^c$$
$$= q(3-q)(\pi_2^m - \pi_{e2}^c - \pi_{i1}^c)$$

The Bargaining payoff of the entrant is:

$$B_{ER}^c = \Pi_{ER}^c + \omega NS_R^c$$

The barganing payoff of the incumbent is:

$$B_{IR}^c = \Pi_{IR}^c + (1-\omega)NS_R^c$$

Cournot no buyout cutoff

Cournot Cutoff preferences

The cutoff point for the entrant to prefer th radical innovation without buyouts is given by:

$$\frac{3}{2} - \frac{\sqrt{5\pi_{e2}^c - 4\pi_{e1}^c}}{2\sqrt{\pi_{e2}^c}} = q^c$$

Proof:

$$\Pi_{ER}^c > \Pi_{ES}^c$$

$$q\pi_{e2}^c(3-q) > \pi_{e1}^c + \pi_{e2}^c$$

$$q > \frac{3\pi_{e2}^c - \sqrt{\pi_{e2}^c}\sqrt{5\pi_{e2}^c - 4\pi_{e1}^c}}{2\pi_{e2}^c}$$

With buyout cutoff point

Cutoff with buyouts

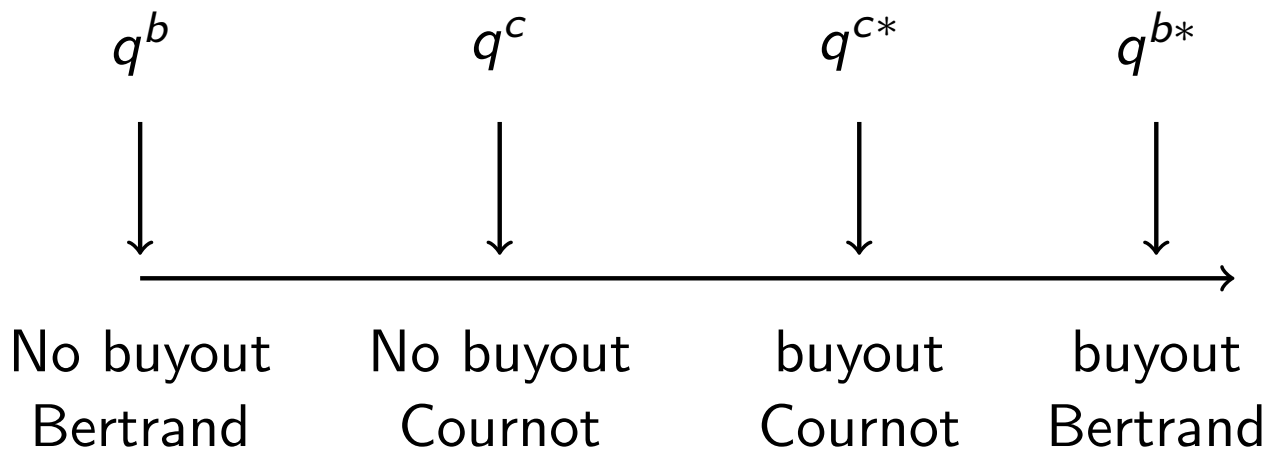
With buyouts, the cutoff efficiency of the radical innovation for it to be pursued is lower in Cournot competition than in Bertrand

Bertrand vs Cournot

Cournot radical preferences entail Bertrand

Without buyouts, if the radical innovation is preferred in Cournot competition, it is also preferred in Bertrand.

We note that q^c cutoff is strictly increasing in π_{e1}^c and that if $\pi_{e1}^c = 0$ we have the Bertrand payoff.



Main welfare result

Welfare proposition

The cutoff point for welfare to be maximized by radical innovation with buyouts, q^{w*} is the same as the a priori cutoff point,q^* and the posterior no buyout cutoff point, q^b

This follows by setting:

$$W_R > W_S \rightarrow w_{m2}(3q - q^2 - 1) - w_{mI}(3q - q^2 - 1) > 0$$

Conclusive comments

Allowing buyouts has distortion effects on the market if the entrant has bargaining power

Therefore any cost benefit analysis that evaluates the effects of buyouts should include the costs and benefits of industry diversification

Intellectual property may cause industry convergence

Convergence effect vs a divergence effect