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The Effect of Buying versus Leasing on Entry Deterrence

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1. Introduction

Pricing models of entry deterrence typically assume that incumbents can deter entry if they possess a cost advantage over potential entrants. The incumbent sacrifices some short term profit to be able to sustain their monopoly over the market. Neven (1989) provides a review of the literature. More recently, Gupta, Mallikkarjun, Cho, and Jaisingh (2003) show that in an information technology (IT) intensive industry where established incumbents incur higher costs than potential entrants would, the optimal strategy of the incumbent is to earn monopoly profits in the first period knowing that entry cannot be deterred and that post entry profits will be lower. The rationale is that new entrants can take advantage of lower costs that result from technological advance while incumbents are wedded to a high-cost old technology. This problem would seem to be greater in the IT sector where technological advance occurs at a faster pace than in other sectors.

There are, however, ways in which an incumbent can create an environment whereby lower-cost potential entrants are deterred. Erutku (2006), for example, argues that rebates can be used to create loyalty to incumbents and thereby deter entry of a more efficient rival. This paper adds to the discussion by proposing that the leasing of inputs is another strategy incumbents can employ to deter entry in an environment where input costs fall over time. This paper analyzes the conditions under which short-term leasing of an input which declines in cost over time enable a monopolist to deter entry. The model has specific applications to Information Technology (IT) intensive industries where technological advances have typically left incumbents at a cost disadvantage.

A recent example of IT for which cost could be declining over time would be radio-frequency identification (RFID). RFID involves placing a chip in every item to track inventory, but at this point in time due to cost considerations, the chip could be placed at the palette level only. As the price of the chip falls over time, it will become more cost effective to use RFID at the item level. In any event, infrastructure must be in place to scan the palette or item and track inventory. Firms that invest in today's technology may find themselves at a cost disadvantage over time as technology advances.

The example is not just an academic exercise. A few years back, WalMart announced that, by January 2005, its top one hundred suppliers must implement RFID technology and the rest by January 2006. Anderson (2007) estimates that $1.3 billion has been invested in RFID vendors, and he concludes that unfortunately, the "technology is young, and investments now could be obsolete or leap frogged." Soon and Gutierrez (2008) summarize the issues regarding RFID adoption and argue that late comers will adopt the technology only if it is cost effective. As a result, late entrants will have a cost advantage over incumbents who, voluntarily or involuntarily, invested early. Dutta, Lee and Whang (2007) argue that RFID must be adopted at all levels of the vertical chain to realize its full value. As a result of a free rider effect, some firms will play wait and see; these late entrants will most likely adopt the technology at a lower cost than the early entrants. This free rider effect could be mitigated by cost sharing between retailers and manufacturers as proposed by Gaukler and Seifert (2007). With cost sharing among early adopters, late entrants might not have a cost advantage.

Some modeling efforts have occurred already. Gupta, *et al* (2003) employ a Stackleberg model to show that incumbents have no advantage over potential entrants in an IT industry where costs are falling. Heese (2007) employs a Stackleberg model to analyze the behavior between retailer and manufacturer to analyze the cost-benefit of RFID to demonstrate that RFID adoption is more beneficial to a decentralized supply chain. While Hegji (2004) models the broader issue of vertical integration, his conclusion is relevant to our approach. Using the difference between book publishers and newspaper publishers as an example, Hegji shows that the decision to outsource is not only a function of current profits but also future costs. In his case, those costs are the future risks attached to the variance in profit. In our model, we argue that the decision to purchase technology is not just a function of profits but also the future costs of being at a cost disadvantage when technology improves.

This paper proceeds as follows. Section 2 develops a two-firm model of an incumbent and a potential entrant who compete along the same horizontal rung of the vertical supply chain and must utilize an input that is expected to fall in price over time due to technological advancements such as IT equipment. The incumbent has the choice of buying or leasing IT equipment in period 1. In period 2, the potential entrant can enter or not depending on whether entry is profitable. The model shows that entry can be deterred under certain conditions regarding the decline in marginal cost over time versus the additional transactions costs incurred by leasing (or outsourcing) the equipment. Section 3 concludes the paper.

2. The Model

In the first period, the incumbent, I, is the monopoly firm of the market. The incumbent decides whether to buy or to lease the equipment as well as its quantity of production. In the second period, the entrant, E, decides whether or not to enter the market. If the potential entrant makes the decision to enter, the market becomes a duopoly; otherwise, the market stays a monopolistic one. In the case of duopoly, we assume that the incumbent chooses its production quantity first. The incumbent is the established firm. The potential entrant waits to see what level of output the incumbent chooses before deciding whether entry will be profitable, and if so, at what level.

The entrant, after observing the incumbent's decision, must decide on whether to buy or to lease the equipment as well as its quantity of production. In the case of monopoly, the incumbent is the only one who chooses its quantity of production. For simplicity, we only consider two periods.

The following are some assumptions regarding the costs and the market demand. In Period 1, if the incumbent buys its equipment, its total cost would be $cq_I + F_I$, where c is the marginal cost, q_I is the incumbent's quantity of production and F_I is the fixed cost of buying. If the incumbent leases, its total cost would be $(c+\delta)q_I + (F_I - \Delta)$, where δ are Δ are assumed to be positive. As a trade-off, leasing would result in a higher marginal cost but lower fixed cost in the current period. In Period 2, the incumbent's fixed cost is zero, hence its cost of buying is just cq_I and its total leasing cost in the second period is $(c+\delta-\varepsilon)q_I$, where ε is positive and reflects the cost reduction that results from technology advances. Here the assumption is that leasing offers more flexibility with the most up-to-date technology, hence lower marginal cost in the subsequent period, whereas buying forces the incumbent to be stuck with the old technology.

The incumbent's situation in the first period is as follows. Buying the equipment requires an upfront fixed payment to acquire the equipment. With leasing, the incumbent does not purchase the equipment upfront but still incurs some transaction costs. In terms of upfront fixed costs, there is an advantage to leasing. The leasing firm will, however, charge the incumbent a higher rental rate than would be the cost of operating its own equipment. In terms of marginal cost, there is a disadvantage to leasing. Thus, there is a tradeoff between leasing and buying. This tradeoff is further complicated when technological advances lower the cost of operation. If the incumbent had purchased the equipment, then they are stuck with old technology. If the incumbent had leased the equipment, they can return the old equipment at the end of the lease term and then lease the newer technology which operates at the lower cost.

The leasing cost for the entrant in the second period would be $(c+\delta-\varepsilon)q_E + F_E - \Delta$. And the buying cost for the entrant in this period would be $(c-\varepsilon)q_E + F_E$. Note the same assumption regarding the trade-off of buying versus leasing applies to the entrant as well. The following chart summarizes the cost structure for the incumbent and the entrant.

		Marginal Cost (MC)		Fixed Cost (FC)	
		Buy	Lease	Buy	Lease
Period 1 (Monopoly)	Incumbent	c	$c+\delta$	F_I	$F_I-\Delta$
Period 2 (Duopoly)	Incumbent	c	$c+\delta-\varepsilon$	0	0
	Entrant	$c-\varepsilon$	$c+\delta-\varepsilon$	F_E	$F_E-\Delta$

By comparing the marginal costs of buying for both the incumbent and the entrant in the second period, one can see that the entrant has the advantage due to the late entry into the industry. The justification is that the entrant can take advantage of the new technology available, whereas the incumbent is stuck with the old technology due to its purchasing decision made in the prior period. However, this advantage disappears if both firms decide to lease.

In this model, we assume a simple linear demand function: $p = a - b(q_I + q_E))$. Next we calculate the profits of the two firms. In Period 1, the Incumbent, I, is the monopoly. The profits are $\pi_I^1 = \frac{(a-c)^2}{4b} - F_I$ when it buys and $\pi_I^1 = \frac{(a-c-\delta)^2}{4b} - (F_I - \Delta)$ when it leases. The detailed calculation can be found in Appendix A. In Period 2, we calculate the Stackelberg equilibrium with incumbent as the leader and the entrant, E, as the follower. There are four cases. See Appendix B for the detailed calculation.

E \ I	Buy	Lease
Buy	$\pi_I^2 = \frac{(a-c-\varepsilon)^2}{8b}$ $\pi_E^2 = \frac{(a-c+3\varepsilon)^2}{16b} - F_E$	$\pi_I^2 = \frac{(a-c+\delta-\varepsilon)^2}{8b}$ $\pi_E^2 = \frac{(a-c-3\delta+3\varepsilon)^2}{16b} - (F_E - \Delta)$
Lease	$\pi_I^2 = \frac{(a-c+\varepsilon-2\delta)^2}{8b}$ $\pi_E^2 = \frac{(a-c+\varepsilon+2\delta)^2}{16b} - F_E$	$\pi_I^2 = \frac{(a-c-\delta+\varepsilon)^2}{8b}$ $\pi_E^2 = \frac{(a-c-\delta+\varepsilon)^2}{16b} - (F_E - \Delta)$

First of all, it is difficult to figure out each firm's decision on buying and leasing. For instance, consider the top two cases whereby the incumbent buys and the entrant may buy or lease. To determine whether or not it is in the best interest of the entrant to buy or to lease, we need to compare π_E^2 in both cases. The result however is ambiguous. It depends on the values of the parameters involved, specifically, the trade-ff between δ and Δ. By comparing the bottom two cases, one gets similar results.

Since the focus of the paper is entry deterrence, we will only consider the conditions under which entry is deterred. Of course, the conditions for absolute entry deterrence again depend on the parameters in each of the four cases. However, let's first compare the two cases on the left. Namely, assume, for the moment, that the entrant will buy. As we can see, if the incumbent buys, then the entrant's profit will be

$\pi_E^2 = \frac{(a-c+3\varepsilon)^2}{16b} - F_E$; and if the incumbent leases, then the entrant's profit will be

$\pi_E^2 = \frac{(a-c+\varepsilon+2\delta)^2}{16b} - F_E$. Hence $\frac{(a-c+3\varepsilon)^2}{16b} - F_E > \frac{(a-c+\varepsilon+2\delta)^2}{16b} - F_E$ iff $\varepsilon > \delta$.

Furthermore, by comparing the two cases on the right, one can obtain the same result, i.e., $\frac{(a-c-3\delta+3\varepsilon)^2}{16b} - (F_E - \Delta) > \frac{(a-c-\delta+\varepsilon)^2}{16b} - (F_E - \Delta)$ iff $\varepsilon > \delta$. Hence the above comparisons lead us to the following conclusion.

Conclusion: Leasing increases the incumbent's likelihood to deter entry as long as $\varepsilon > \delta$. And buying increases the incumbent's likelihood to deter entry as long as $\varepsilon < \delta$. Furthermore, this conclusion is independent of the entrant's buying/leasing decision in the following period.

In other words, if the future cost-savings from new technology exceed the marginal transaction costs of leasing the current equipment, then leasing increases the incumbent's ability to deter entry. For a given differential in transaction costs, δ, then in industries where the pace of technology is slow, and ε is therefore small, incumbents are better off buying their equipment. Where technology is expected to advance rapidly, such that ε is large, then leasing capital equipment puts the incumbent in a better position to deter entry.

3. Conclusion

In a market where incumbents enjoy no advantage over potential entrants, it is typically argued that entry cannot be deterred. In cases where potential entrants are the ones with a cost advantage, entry deterrence seems impossible and incumbents need to either be creative or succumb to entry. This paper suggests a way in which incumbents can be creative. By leasing IT inputs, incumbent firms reduce the possibility that they will be stuck with outdated technology while potential entrants have lower cost technology. Specifically, if the gain on the new technology translates to a bigger "saving" on marginal costs than the added transaction cost of leasing as opposed to buying, then leasing will increase the likelihood to deter entry. On the other hand, if the reverse is true, then buying will help the cause for the incumbent. This paper adds an additional dimension for the consideration of entry deterrence when technological advances lower input costs over time.

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Appendix A

In the first period, the Incumbent is the monopolist facing the demand $p = a - bq_I$. Its total cost is $cq_I + F_I$ if it decides to buy; and the total cost is $(c+\delta)q_I + F_I - \Delta$ if it decides to lease instead.

In the case of buying,

$\pi_I^1 = (a - bq_I)q_I - (cq_I + F_I)$.

Thus $\frac{\partial \pi_I^1}{\partial q_I} = 0 \Rightarrow q_I = \frac{(a-c)}{2b}$. And the maximum monopoly profit is

$\pi_I^1 = \frac{(a-c)^2}{4b} - F_I$.

In the case of leasing,

$\pi_I^1 = (a - bq_I)q_I - ((c+\delta)q_I + F_I - \Delta)$.

Thus $\frac{\partial \pi_I^1}{\partial q_I} = 0 \Rightarrow q_I = \frac{(a-c-\delta)}{2b}$. And the maximum monopoly profit is

$\pi_I^1 = \frac{(a-c-\delta)^2}{4b} - F_I + \Delta$.

Appendix B

Next, we focus on the calculations of optimal quantities and profits for the Incumbent and Entrant in the second period, assuming that the Entrant will enter the market. All the calculations are based on the Stackelberg duopolistic competition, with the Incumbent, I, as the leader and the Entrant, E, as the follower in the quantity selections.

Case I. Incumbent buys and Entrant buys

The market price is $p = a - b(q_I + q_E)$.

We start with the follower E's profit maximization problem,

$$\pi_E = p \times q_E - ((c-\varepsilon)q_E + F_E)$$
$$= (a - b(q_I + q_E)) \times q_E - (c-\varepsilon)q_E - F_E$$
$$= (a - c + \varepsilon - bq_I) \times q_E - bq_E^2 - F_E$$

For optimal q_E, we set $\frac{\partial \pi_E}{\partial q_E} = 0 \Rightarrow q_E = \frac{a-c+\varepsilon}{2b} - \frac{1}{2} q_I$.

The leader I takes the follower's reaction into consideration:

$$\pi_I = (a - b(q_I + q_E))q_I - cq_I$$
$$= (a - b(q_I + \frac{a-c+\varepsilon}{2b} - \frac{1}{2} q_I))q_I - cq_I$$
$$= \frac{a-c-\varepsilon}{2} q_I - \frac{b}{2} q_I^2$$

To maximize π_I, we set $\frac{\partial \pi_I}{\partial q_I} = 0 \Rightarrow q_I = \frac{a-c-\varepsilon}{2b}$.

Hence the follower E's optimal quantity is

$$q_E = \frac{a-c+\varepsilon}{2b} - \frac{1}{2} q_I = \frac{a-c+\varepsilon}{2b} - \frac{1}{2}(\frac{a-c-\varepsilon}{2b})$$
$$= \frac{a-c+3\varepsilon}{4b}$$

Thus the maximum profits are

$$\pi_I = \frac{a-c-\varepsilon}{2} q_I - \frac{b}{2} q_I^2 = \frac{(a-c-\varepsilon)^2}{8b} \text{ and}$$

$$\pi_E = (a - c + \varepsilon - bq_I) \times q_E - bq_E^2 - F_E$$
$$= (a - c + \varepsilon - b\frac{a-c-\varepsilon}{2b}) \times \frac{a-c+3\varepsilon}{4b} - b(\frac{a-c+3\varepsilon}{4b})^2 - F_E = \frac{(a-c+3\varepsilon)^2}{16b} - F_E.$$

Case II. Incumbent leases and Entrant buys

Again the market price is $p = a - b(q_I + q_E)$.

We start with the follower E's profit maximization problem,

$$\begin{aligned}
\pi_E &= p \times q_E - ((c-\varepsilon)q_E + F_E) \\
&= (a - b(q_I + q_E)) \times q_E - (c-\varepsilon)q_E - F_E \\
&= (a - c + \varepsilon - bq_I) \times q_E - bq_E^2 - F_E
\end{aligned}$$

For optimal q_E, we set $\dfrac{\partial \pi_E}{\partial q_E} = 0 \Rightarrow q_E = \dfrac{a-c+\varepsilon}{2b} - \dfrac{1}{2}q_I$.

The leader I takes the follower's reaction into consideration:

$$\begin{aligned}
\pi_I &= (a - b(q_I + q_E))q_I - (c+\delta-\varepsilon)q_I \\
&= (a - b(q_I + \frac{a-c+\varepsilon}{2b} - \frac{1}{2}q_I))q_I - (c+\delta-\varepsilon)q_I \\
&= \frac{a-c+\varepsilon-2\delta}{2}q_I - \frac{b}{2}q_I^2
\end{aligned}$$

To maximize π_I, we set $\dfrac{\partial \pi_I}{\partial q_I} = 0 \Rightarrow q_I = \dfrac{a-c+\varepsilon-2\delta}{2b}$.

Hence the follower E's optimal quantity is

$$\begin{aligned}
q_E &= \frac{a-c+\varepsilon}{2b} - \frac{1}{2}q_I = \frac{a-c+\varepsilon}{2b} - \frac{1}{2}(\frac{a-c+\varepsilon-2\delta}{2b}) \\
&= \frac{a-c+\varepsilon+2\delta}{4b}
\end{aligned}$$

Thus the maximum profits are

$$\pi_I = \frac{a-c+\varepsilon-2\delta}{2}q_I - \frac{b}{2}q_I^2 = \frac{(a-c+\varepsilon-2\delta)^2}{8b} \text{ and}$$

$$\begin{aligned}
\pi_E &= (a-c+\varepsilon-bq_I) \times q_E - bq_E^2 - F_E \\
&= (a-c+\varepsilon-b\frac{a-c+\varepsilon-2\delta}{2b}) \times \frac{a-c+\varepsilon-2\delta}{4b} - b(\frac{a-c+\varepsilon-2\delta}{4b})^2 - F_E. \\
&= \frac{(a-c+\varepsilon+2\delta)^2}{16b} - F_E
\end{aligned}$$

Case III. Incumbent buys and Entrant leases

The market price is $p = a - b(q_I + q_E)$.

We start with the follower E's profit maximization problem,

$$\pi_E = p \times q_E - ((c + \delta - \varepsilon) q_E + F_E - \Delta)$$
$$= (a - b(q_I + q_E)) \times q_E - (c + \delta - \varepsilon) q_E - F_E + \Delta$$
$$= (a - c - \delta + \varepsilon - bq_I) \times q_E - bq_E^2 - F_E + \Delta$$

For optimal q_E , we set $\frac{\partial \pi_E}{\partial q_E} = 0 \Rightarrow q_E = \frac{a - c - \delta + \varepsilon}{2b} - \frac{1}{2} q_I$.

The leader I takes the follower's reaction into consideration:

$$\pi_I = (a - b(q_I + q_E)) q_I - cq_I$$
$$= (a - b(q_I + \frac{a - c - \delta + \varepsilon}{2b} - \frac{1}{2} q_I)) q_I - cq_I$$
$$= \frac{a - c + \delta - \varepsilon}{2} q_I - \frac{b}{2} q_I^2$$

To maximize π_I , we set $\frac{\partial \pi_I}{\partial q_I} = 0 \Rightarrow q_I = \frac{a - c + \delta - \varepsilon}{2b}$.

Hence the follower E's optimal quantity is

$$q_E = \frac{a - c - \delta + \varepsilon}{2b} - \frac{1}{2} q_I = \frac{a - c - \delta + \varepsilon}{2b} - \frac{1}{2} (\frac{a - c + \delta - \varepsilon}{2b})$$
$$= \frac{a - c - 3\delta + 3\varepsilon}{4b}$$

Thus the maximum profits are

$$\pi_I = \frac{a - c + \delta - \varepsilon}{2} q_I - \frac{b}{2} q_I^2 = \frac{(a - c + \delta - \varepsilon)^2}{8b} \text{ and}$$

$$\pi_E = (a - c - \delta + \varepsilon - bq_I) \times q_E - bq_E^2 - (F_E - \Delta)$$
$$= (a - c - \delta + \varepsilon - b \frac{a - c + \delta - \varepsilon}{2b}) \times \frac{a - c - 3\delta + 3\varepsilon}{4b} - b (\frac{a - c - 3\delta + 3\varepsilon}{4b})^2 - F_E + \Delta .$$
$$= \frac{(a - c - 3\delta + 3\varepsilon)^2}{16b} - F_E + \Delta$$

Case IV. Incumbent leases and Entrant leases

The market price is $p = a - b(q_I + q_E)$.

We start with the follower E's profit maximization problem,

$$\pi_E = p \times q_E - ((c + \delta - \varepsilon)q_E + F_E - \Delta)$$
$$= (a - b(q_I + q_E)) \times q_E - (c + \delta - \varepsilon)q_E - F_E + \Delta$$
$$= (a - c - \delta + \varepsilon - bq_I) \times q_E - bq_E^2 - F_E + \Delta$$

For optimal q_E, we set $\frac{\partial \pi_E}{\partial q_E} = 0 \Rightarrow q_E = \frac{a - c - \delta + \varepsilon}{2b} - \frac{1}{2} q_I$.

The leader I takes the follower's reaction into consideration:

$$\pi_I = (a - b(q_I + q_E))q_I - (c + \delta - \varepsilon)q_I$$
$$= (a - b(q_I + \frac{a - c - \delta + \varepsilon}{2b} - \frac{1}{2} q_I))q_I - (c + \delta - \varepsilon)q_I$$
$$= \frac{a - c - \delta + \varepsilon}{2} q_I - \frac{b}{2} q_I^2$$

To maximize π_I, we set $\frac{\partial \pi_I}{\partial q_I} = 0 \Rightarrow q_I = \frac{a - c - \delta + \varepsilon}{2b}$.

Hence the follower E's optimal quantity is

$$q_E = \frac{a - c - \delta + \varepsilon}{2b} - \frac{1}{2} q_I = \frac{a - c + \varepsilon}{2b} - \frac{1}{2}\left(\frac{a - c - \delta + \varepsilon}{2b}\right)$$
$$= \frac{a - c - \delta + \varepsilon}{4b}$$

Thus the maximum profits are

$$\pi_I = \frac{a - c - \delta + \varepsilon}{2} q_I - \frac{b}{2} q_I^2 = \frac{(a - c - \delta + \varepsilon)^2}{8b}$$ and

$$
\begin{aligned}
\pi_E &= (a-c-\delta+\varepsilon-bq_I)\times q_E - bq_E^2 - F_E + \Delta \\
&= (a-c-\delta+\varepsilon-b\frac{a-c-\delta+\varepsilon}{2b})\times\frac{a-c-\delta+\varepsilon}{4b} - b(\frac{a-c-\delta+\varepsilon}{4b})^2 - F_E + \Delta\,. \\
&= \frac{(a-c-\delta+\varepsilon)^2}{16b} - F_E + \Delta
\end{aligned}
$$