Creative Destruction and Productive Preemptive Acquisitions*

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Abstract

We develop a model of entrepreneurial innovation for entry and sale into oligopolies suitable for welfare analysis. We show that the expected consumer welfare can be higher under commercialization by sale than under commercialization by entry despite increased market power in the product market. The reason is that when the quality of the invention is sufficiently high, preemptive bidding competition among incumbents drives the acquisition price above the entry value. Entrepreneurs who sell their inventions will then have a stronger incentive to develop high-quality inventions than entrepreneurs who aims at entering the product market. Incumbents are hurt by this creative destruction process ignited by the entrepreneurs and thus have an incentive to undertake research to block entrepreneurs’ research activities. We show that incumbents’ own research effort can reduce, but not eliminate, the entrepreneurs’ incentives to innovate for entry or sale.

Keywords: Preemption, Acquisitions, Entry, Entrepreneurship, Innovation, Preemption, Ownership, Quality

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1. Introduction

Schumpeter (1942) argued that the ongoing process where new inventions create "monopoly rents" for entrepreneurs while reducing rents for incumbent firms is central for sustained growth in a market economy. This process of "creative destruction" and its welfare implications have been extensively studied in the case where an entrepreneur commercializes the invention by entering the product market.\(^1\) However, if the incumbents’ profits are diminished by entrepreneurial entry, incumbents have an incentive to acquire these entrepreneurial firms (or their inventions) to block entry (entry-deterring acquisitions) or preempt rivals from obtaining superior assets (preemptive acquisitions).\(^2\)

The purpose of this paper is to examine how the innovation process and its welfare effects are affected by the hitherto ignored fact that entrepreneurial entry might be blocked by incumbents – either by entry-deterring or preemptive acquisitions. To this end, we develop a theoretical model where, initially, an entrepreneur decides how much to invest in research to discover an invention. If successful, the entrepreneur can either enter the product market with the invention or sell it to one of many incumbent firms competing to acquire the invention in an auction framework. Finally, firms compete in oligopoly fashion, thereby generating profits.

We first examine what type of inventions – in terms of quality – that will be sold. At first sight, it seems reasonable that the level of quality should not matter in a context of perfect information, since the entrepreneur’s reservation price and the incumbents’ willingness to pay should be equally affected by a change in quality. However, we show that the incentive for commercialization by sale relative to commercialization by entry increases with a higher quality of the invention, when the invention is used in an oligopolistic market. The reason is that the incumbents’ willingness to pay for the invention increases more than the entrant’s profit due to the fact that the value for the incumbent of preempting others from using the invention increases in the quality of the invention.

Next, we examine how the acquisition price (the reward from selling) depends on the quality of the invention. We show that for medium quality, the entrepreneur is paid her reservation price which is simply the entrepreneur’s net profit from entry. Such entry-deterring acquisitions are then replaced by preemptive acquisitions at even higher quality. The reason is that since non-acquiring incumbents’ profits in the product market deteriorate when the quality of the invention becomes higher, a bidding war among incumbents’ over the invention will eventually occur.

We then direct our attention to welfare implications. Entrepreneurship has emerged as a key issue in the policy arena in Europe and the US, where policy makers believe small entre-


\(^2\) Bloningen and Taylor (2000), Granstrand and Sjölander (1990), and Lerner and Merges (1998) present evidence of firms acquiring innovative targets to gain access to their technologies. Grimpe and Hussinger (2008) empirically test how the acquisition price is related to key technologies in the acquired and acquiring firms. The authors find that firms with technologies that deter entry and preempt competition are of high value for acquiring firms.
preneurial firms to be the firms that are better at capturing opportunities and coping with challenges created by the ongoing globalization process. In the European Union, for instance, the Commission has taken action, launching the “Small Business Act for Europe” in June 2008, proposing that member states should create an environment that rewards entrepreneurship and small firm growth. According to a report by the OECD (OECD 2007), in the year 2007 several countries offered tax subsidies for R&D targeted specifically at SMEs. Examples are: the UK, Canada, Japan, the Netherlands, Norway and Poland. Moreover, many countries effectively tax-favor the market entry of entrepreneurs over the alternative of selling a business or patent. Government policy can also be geared towards supporting commercialization by young and small firms. Examples of this type of policy are financial support for incubators, and loans specifically designed to facilitate the commercialization process in new firms. Recently, there has been a substantial increase in spending on such policies. For example, in 2009, the US Small Business Administration had approved over $13 billion in loans and $2.7 billion in surety guarantees to small businesses in a year.

Thus, government policy tends to disfavor innovation for sale over innovation for entry. To capture this in a stylized way, we compare two policies: (i) one where there is no government intervention referred to as the non-discriminatory policy and (ii) one where innovation for sale is extremely disfavored by being forbidden. We refer to this policy as the discriminatory policy.

We show that the expected consumer welfare can be higher under commercialization by sale despite the risk of increased market power. The reason is that when the quality of the invention is sufficiently high, preemptive acquisitions emerge where the bidding competition drives the acquisition price above the entry value (the reservation price). Entrepreneurs who sell will then have a stronger incentive to develop high-quality inventions than entrepreneurs who enter. The welfare analysis thus suggests that incumbent acquisitions of entrepreneurial inventions are beneficial for society if they are preemptive in nature (i.e. not entry deterring). Despite the fact that innovations are associated with creative destruction, i.e. the value of the incumbents’ assets is diminished – even to zero for an incumbent that exits – the fact that the new innovations are so efficient compared to existing assets implies that total welfare may increase. Moreover, from a welfare perspective, innovation for sale implies that the invention reaches the market while entry costs are avoided.

We also establish that allowing incumbents to undertake research can reduce (but not eliminate) the entrepreneurs’ incentives to undertake research for new inventions. However, a shift from commercialization by entry to commercialization by sale will still increase the entrepreneur’s research effort, while the incumbent’s incentive to invent may even decrease.

This paper contributes to the literature on entrepreneurship, innovation and welfare (for overviews, see Acs and Audretsch (2005) and Bianchi and Henrekson (2005)). Previous litera-

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3 Baumol (2002) documents that small entrepreneurial firms create a large share of the breakthrough inventions in the United States. Scherer and Ross (1990) list a large number of breakthrough inventions made by independent innovators and state that “new entrants without a commitment to accepted technologies have been responsible for a substantial share of the really revolutionary new industrial products and processes”.

4 See, e.g., the chapter on small business taxation in Mirrlees et al. (2011).

ture has shown that entrepreneurs play an important role in challenging existing oligopolistic markets through de-novo entry into the product market. Yet, we identify another important role of the entrepreneur as a challenger of existing oligopolies through the aggressive development of inventions for sale. The role as an aggressive invention supplier may be even more important than the role as a de-novo entrant. Indeed, we show that the possibility of preemptive incumbent acquisition gives entrepreneurs an incentive to increase their efforts in high-quality research projects so that the expected welfare can increase despite the risk of increased market power.

This paper also contributes to the literature studying when assets will be sold on the market. To date, it has been found that commercialization by sale is more likely when entry costs are high, when the entrepreneurial firm lacks complementary assets, when brokers facilitating trade are available, when the expropriation problem associated with asset transfers is low, when the intensity of product market competition is high and when the network effects are strong (see, for instance, Anton and Yao (1994), Gans and Stern (2000), Gans, Hsu and Stern (2002), Norbäck and Persson (2012) and Norbäck, Persson and Tåg (2014)). We show theoretically that when inventions are sold into oligopolistic markets, the externalities imply that only high-quality assets will be sold on the market. In particular, what is novel here is that we derive welfare results comparing a Non-discriminatory (ND) policy (where incumbent acquisitions of entrepreneurial firms are allowed) to a Discriminatory (D) policy (which prohibits or discourages the acquisitions of small innovative firms). This enables us to show that acquisitions of potentially entering innovative firms can increase total welfare and consumer welfare despite the fact that the acquisition creates market power in the product market. The reason is that entrepreneurs will have a stronger incentive to invent when the possibility to sell inventions under bidding competition exists.

This paper can be seen as a contribution to the literature on endogenous ownership and efficiency dating back to Coase (1960). Coase argued that in a zero-transaction world, laissez-faire always leads to the optimal outcome irrespective of the initial assignment of property rights. Departing from the zero transaction cost assumption, authors such as Grossman and Hart (1986) and Hart and Moore (1990) have shown that the ownership structure has implications for efficiency when the contracts are incomplete. We follow the approach taken by Jehiel, Moldovanu and Stacchetti (1996, 1999) determining the ownership of assets in an auction with an externalities set-up. Jehiel and Moldovanu (1999) have shown that the equilibrium ownership allocation is not efficient when auctions have externalities and contracts are incomplete.

6 Most papers in this literature treat the size of the asset for sale as exogenous. To our knowledge, the only exceptions are Katz and Shapiro (1986) who determine the optimal licensing fee of a research lab which can affect the size of the innovation and Norbäck and Persson (2009) who determine the optimal development investment for a venture-backed firm that will exit by a trade sale to an incumbent. Fabrizi, Lippert, Norbäck and Persson (2013) extend Norbäck and Persson (2009) to allow for patent-signaling by informed venture capitalists to incumbent acquirers of developed innovations. Friberg, Norbäck and Persson (2012) determine optimal pre-merger investments by sellers and buyers in an oligopolistic merger evaluation model.

Our study differs from these papers by determining the optimal research effort (not development levels) by both the entrepreneur and the incumbent in an oligopolistic research model.
Taking the starting point that competition laws forbid cooperation between incumbents and that inventions (entrepreneurial firms) are sold in a competitive environment, we use a first price auction to determine the ownership of the invention. This enables us to show that entrepreneurs who sell their inventions will have a greater incentive to invest in R&D effort as compared to the acquirer of the invention, as well as compared to entrepreneurs who enter the market. This result occurs due to the externalities of the acquisition auction and implies that not only the ownership allocation can be distorted from the point of view of firms participating in the market for control of the innovation, but also the R&D effort itself. However, in our setting where inventors overinvest in R&D effort under commercialization for sale, it is noteworthy that such overinvestment is likely to benefit consumers.

2. The model

Consider an oligopolistic industry which is initially entry stable, defined as: There are \( n \) symmetric firms that are able to cover the entry cost \( G \) and a fixed operating cost \( \tau \) at the existing technology. Outside this market, there is an entrepreneur, denoted \( e \), with a potentially superior technology. Figure 2.1 illustrates the interaction. In stage 1, the entrepreneur decides how much to invest in research, thereby affecting the probability of discovering an invention with a fixed quality \( k \). In stage 2, if successful, the entrepreneur commercializes the invention into an innovation. She either sells the invention at a first-price perfect information auction, where the \( n \) incumbent firms are the potential buyers, or she enters the product market. There may then be exits of incumbent firms. Finally, in stage 3, the active firms in the product market compete in oligopoly interaction, setting an action \( x_i \). We solve the game by backward induction.

In order to highlight how the entrepreneurs’ incentives for innovation for entry and innovation for sale differ and how the commercialization mode affects welfare, we start by abstracting from the incumbents’ innovation incentives. In section 4, we incorporate incumbent innovations into the analysis.

2.1. Stage 3: Product-market equilibrium

This stage determines firms’ equilibrium product market profits. Let the set of potential firms in the industry be the entrepreneur and the incumbents, \( J = e \cup I \), where \( e \) is the entrepreneur and \( I = \{i_1, i_2, \ldots, i_n\} \) is the set of incumbent firms. We denote the owner of the entrepreneur’s invention, \( k \), by \( l \in J \). In the product market interaction, firm \( j \) chooses an action \( x_j \in R^+ \) to maximize its direct product market profit, \( \pi_j(x_j, x_{-j}, l) - \tau \), which depends on its own and its rivals’ market actions, \( x_j \) and \( x_{-j} \), the identity of the owner of the invention, \( l \), and the fixed cost \( \tau \) to serve the market. We may consider the action \( x_j \) as setting a quantity or a price. We assume there to exist a unique Nash-equilibrium, \( x^*(l) = (x^*_j, x^*_{-j}) \), defined as \( \pi_j(x^*_j, x^*_{-j}, l, k) - \tau \geq \pi_j(x_j, x^*_{-j}, l, k) - \tau, \forall x_j \in R^+ \), where we assume the product market profits to be positive.

Conveniently, this allows us to define a reduced-form product market profit for a firm \( j \), taking as given ownership \( l \):

\[
\pi_j(l) \equiv \pi_j(x^*_j(l), x^*_{-j}(l), l).
\]
1. **Invention**: Entrepreneur $e$ chooses effort to invent, $\rho E$

(where $\rho E$ increases the probability of discovering an invention of quality $k$.)

2. **Commercialization**: Acquisition/entry and exit game

3. **Product market interaction**: Oligopoly

\[
\begin{align*}
    x_b(l) & \quad \{ \quad x_A(l) \quad \}
    \quad \{ \quad x_{E}(e) \quad \}
    \quad \{ \quad x_{NA}(e) \quad \}
    \\
    x_{NA}(l) & \quad \{ \quad x_{NA}(i) \quad \}
\end{align*}
\]

Ex-ante symmetry between incumbent firms

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Figure 2.1: The structure of the game.
This reduced-form profit function simply summarizes how the invention affects firms’ interactions in the product market and how this impacts firms’ profits. The assumption that incumbents $i_1, i_2, ..., i_n$ are symmetric before the acquisition takes place implies that we need only distinguish between two types of ownership; entrepreneurial ownership ($l = e$) and incumbent ownership ($l = i$). Note that there are then three types of firms of which to keep track, $h = \{E, A, NA\}$, i.e. the entrepreneurial firm ($E$), an acquiring incumbent ($A$) and the non-acquiring incumbents ($NA$). In addition, we have the trivial outcome where the entrepreneur fails and the initial symmetric equilibrium is preserved ($l = 0$).

Let us now define the quality of an invention. Our measure of quality will be in terms of its effect on firms’ reduced-form product market profits, $\pi_h(l)$:

**Definition 1.** (Creative Destruction) When the quality of the innovation $k$ increases, the profits of the firm in possession of the invention increase, while the profits of its rivals decline: (i) $\frac{d\pi_A(i)}{dk} > 0$, (ii) $\frac{d\pi_E(e)}{dk} > 0$, and (iii) $\frac{d\pi_{NA}(l)}{dk} < 0$, $l = \{e, i\}$.

Definition 1 is central: Parts (i) and (ii) thus state that the reduced-form product market profit for the possessor is strictly increasing in the quality of the invention, whereas Part (iii) states that increased quality strictly decreases the rivals’ profits. Definition 1 is consistent with a situation where the impact on profits of an invention could either be due to reduced variable costs or increased consumers’ product value. These types of effects are present in most standard innovation oligopoly models used in the literature (Gilbert 2006).7

Note how the creative destruction process is incorporated in Definition 1: At increasing innovation quality, the increase in the entry profit for the entrepreneur is directly mirrored by a decline in the profits of the incumbents, thereby reducing the value of the incumbents’ assets (possibly so much that exits of incumbents occur). The formulation in Definition 1 also incorporates how creative destruction occurs when the entrepreneur sells the invention to an incumbent. When the quality of the invention pushes up the profit of the possessing (acquiring) incumbent, the incumbent’s (non-acquiring) rivals face declining profits. The latter reduction in rivals’ profits stems from a deteriorating market position but may also stem from a reduction in profits due to the cost of replacing their assets which become obsolete after the introduction of the new invention $k$.

In the next section, we will show how the negative externality on incumbents which are left without the innovation can be exploited by the entrepreneur and how this induces her not only to sell high-quality inventions; at high invention quality she will also able to sell at a premium since incumbents compete in order to avoid a weak market position as the non-acquirer.

### 2.2. Stage 2: Commercialization

This stage determines the equilibrium ownership of the invention and the number of firms active in the product market. There is first an entry-acquisition game where the entrepreneur

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7 We should note that Definition 1 does not hold for fixed cost innovations: if $\frac{d\pi}{dk} < 0$, part (iii) would not be fulfilled. Definition 1 also requires that the number of firms in the market is given: if the quality $k$ is increased so much that incumbents are forced to exit, the concentration effect thereof may induce an increase in $\pi_{NA}(l)$, once more violating part (iii). Exit effects are discussed in Section 3.
can decide either to sell the invention to one of the incumbents or to enter the market at a fixed cost, $G$. Given the mode of commercialization, non-acquiring incumbents may then exit the market.

For the sake of exposition but without loss of generality, we will make several simplifying assumptions: First, we assume that entrepreneurial entry is always profitable, i.e. $k$ is above the level quality of the innovation $k_{E}^{min}$ that guarantees that entry is profitable, $\pi_{E}(e) - \tau \geq G$. Second, while Definition 1 captures how creative destruction leads to a decline in the profits of non-acquiring incumbents when the quality of the invention increases, we will assume that the quality is not so high that commercialization induces exits. That is, we will assume that the net profit of a non-acquiring incumbent is always positive, $\pi_{NA}(l) \geq \tau$. This requires that the invention quality is also below a threshold $\bar{k}$. These assumptions can succinctly be stated as:

**Assumption A1** $k \in (k_{E}^{min}, \bar{k})$.

For the details on initial entry stability and Assumption A1, see Appendix 6.1. Assumption A1 is relaxed in Section 3.

### 2.2.1. Why entrepreneurs sell their best inventions

The commercialization process in stage 2 is depicted as an auction where $n$ incumbents simultaneously post bids, and the entrepreneur then either accepts or rejects these bids. If the entrepreneur rejects these bids, she will enter the market. Each incumbent announces a bid, $b_i$, for the invention. $b = (b_1, \ldots, b_n) \in R^n$ is the vector of these bids. Following the announcement of $b$, the invention may be sold to one of the incumbents at the bid price, or remain in the ownership of entrepreneur $e$.

In practice, the transaction costs associated with an asset transfer can be substantial. These include direct administrative and legal transaction costs as well as costs associated with merging two organizations or two different organizational cultures. The transaction cost can also be viewed as a reduced-form cost of asymmetric information and include different costs associated with verifying the quality of the invention. To capture these aspects in a simple way, we assume that the buyer faces a fixed transaction cost $T$ when acquiring the invention.

There are then three different valuations of the invention:

- $v_{ie}$ in (2.2) is the "entry-deterring valuation". This is the value of obtaining the invention for an incumbent, when the entrepreneur would otherwise keep it. The first term shows the profit when possessing the invention, where $T$ is the transaction cost associated with acquiring it. The second term shows the profit when the entrepreneur keeps the invention and then commercializes by entry. Note that the fixed operation cost $\tau$ cancels in (2.2) since it is paid irrespective of whether an incumbent is the acquirer or a non-acquirer.

$$v_{ie} = \pi_{A}(i) - T - \pi_{NA}(e). \quad (2.2)$$

- $v_{ii}$ in (2.3) is the "preemptive valuation". This is the value of obtaining the invention for an incumbent, when a rival incumbent would otherwise obtain it. The first term once more
shows the profit when possessing the invention $k$. The second term is different and shows the profit if a rival incumbent obtains the invention. Note that the market power effect implies that the profit as a non-acquirer is lower under entry than under an acquisition, $\pi_{NA}(i) > \pi_{NA}(e)$; there are $n$ firms in the product market under an acquisition, while there are $n + 1$ firms under entry. Hence, it follows that the entry-deterring valuation exceeds the preemptive valuation, $v_{ie} > v_{ii}$.

$$v_{ii} = \pi_A(i) - T - \pi_{NA}(i).$$  \hspace{1cm} (2.3)

- $v_e$ in (2.4) is the "reservation price" for the entrepreneur, or her "entry value". More specifically, it is the value for the entrepreneur of keeping the invention and entering the market, paying the fixed operating cost $\tau$ and the entry cost $G$

$$v_e = \pi_E(e) - \tau - G. \hspace{1cm} (2.4)$$

Our main interest here is how the mode of commercialization – by entry or by sale – is related to the quality of the invention, $k$. To highlight how the entrepreneur’s choice of mode of commercialization is related to the quality of the invention, we shall also assume that the transaction costs are below a higher bound $T^H$ (so that acquisitions can take place in equilibrium), but above a lower bound $T^L$ (so that entry can take place in equilibrium).8 Furthermore, defining $k^{ED}$ as the invention quality where the entry-deterring motive for an incumbent acquisition just matches the entrepreneur's entry value ($v_{ie} = v_e$), and $k^{PE}$ as the invention quality where the preemptive motive for an incumbent acquisition is equal to the entrepreneur’s entry value ($v_{ii} = v_e$), we have the following Lemma.

**Lemma 1.** Suppose that Assumption A1 is fulfilled and that the transaction costs are of medium size, $T \in (T^L, T^H)$. Then, if the negative externality of creative destruction on non-acquiring incumbents is sufficiently strong, $\left(\frac{d\pi_A(i)}{dk} - \frac{d\pi_E(e)}{dk} - \frac{d\pi_{NA}(i)}{dk} > 0\right)$: (i) commercialization by entry ($l^* = e$) takes place if the quality of the invention is sufficiently low, $k \in (k^{min}_E, k^{ED})$, (ii) commercialization by sale ($l^* = i$) occurs at sales price $S^* = v_e$ if the quality of the invention is of intermediate size, $k \in [k^{ED}, k^{PE})$, and (iii) commercialization by sale ($l^* = i$) occurs at sales price $S^* = v_{ii} \geq v_e$ if the quality of the invention is sufficiently high, $k \in [k^{PE}, \bar{k})$.

Lemma 1 is central in our analysis: it shows that entrepreneurs will commercialize their best invention by selling it to incumbents, and that selling under bidding competition may lead to a significantly higher reward for the entrepreneur than if she had commercialized by entry. We will now prove Lemma 1. Readers may find the illustrations in Figure 2.2 helpful when following the proof.

**Entry at lower invention quality** We will first show that entry must take place at low levels of invention quality. From Definition 1, the reservation price $v_e$ must be increasing in quality

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8 The bounds, $T^H$ and $T^L$, are derived in the Appendix 6.2.
since the entry profit $\pi_E(e)$ is increasing in the quality of the invention (i.e. $v_{e,k}' = \frac{d\pi_E(e)}{dk} > 0$, where $v_{e,k}' = \frac{d\pi_N(i)}{dk}$). However, we also know that due to the fixed operating cost $\tau$ and the entry cost $G$, the entrepreneur can only commercialize inventions of at least minimum quality, $k_E^{\text{min}}$. This is shown in panel (i) in Figure 2.2 where the value of entry is zero at $k = k_E^{\text{min}}$ (i.e. $v_e = \pi_E(e) - \tau - G = 0$ at $k = k_E^{\text{min}}$). In order to have commercialization by entry in equilibrium at a low quality of the invention, the transaction cost must also be sufficiently high. Assuming that the transaction cost exceeds the lower threshold, $T > T^L$, the reservation price $v_e$ will exceed the incumbents’ valuations $v_{ie}$ and $v_{ii}$, at a low invention quality (i.e. $v_e > 0 > v_{ie} > v_{ii}$). Commercialization by entry is then chosen in the region $k \in (k_E^{\text{min}}, k_E^{ED})$, as depicted in panels (i) and (ii) in Figure 2.2, where it also assumed that the entry cost is sufficiently low to make entry worthwhile.

**Entry-deterring acquisitions at medium invention quality** What happens when there is a further increase in invention quality? The entry-deterring valuation of an incumbent $v_{ie}$ will increase more than the entrepreneur’s value of entry $v_e$ when the quality of the invention increases. To see why, note that the first term in $v_{ie} = \pi_A(i) - T - \pi_NA(e)$ increases by a similar amount as the first term in $v_e = \pi_E(e) - \tau - G$. This is the creative destruction process at work where the possessor’s market position is improved. But the creative destruction process also implies that the incumbent’s market position as a non-acquirer deteriorates with increasing invention quality. With the profit of a non-acquirer $\pi_NA(e)$ declining in invention quality $k$, there must then be an additional increase in the incumbent’s entry-deterring valuation, $v_{ie}$. When this negative externality of creative destruction is sufficiently strong, the entry deterring valuation will increase more strongly than the entrepreneurs’ reservation price (i.e. $v_{ie,k}' - v_{e,k}' = \left( \frac{d\pi_A(i)}{dk} - \frac{d\pi_E(e)}{dk} \right) - \frac{d\pi_NA(e)}{dk} > 0$). This will trigger an *entry deterring acquisition* at the acquisition price $S^* = v_e$ at $k = k^{ED}$, as shown in panel (ii) in Figure 2.2.

Note that other incumbents will not preempt a rival acquisition in this region $k \in [k^{ED}, k^{PE})$, since the preemptive value $v_{ii}$ is lower than the reservation price $v_e$. Intuitively, when the quality of the invention is not too high, the competition from the rival incumbent possessing the invention is modest, and non-acquiring incumbents predominantly benefit from the market power effect from the acquisition by the rival (giving weak incentives to challenge it). Thus, as shown in panel (ii) in Figure 2.2, the entrepreneur will commercialize by sale ($l^* = i$) at price $S^* = v_e$ in this region.

**Preemptive acquisitions at high invention quality** What if the quality of the invention increases even further? This will provoke a preemptive acquisition. A higher invention quality also decreases the profit of a non-acquiring incumbent $\pi_NA(i)$ when there is an incumbent acquisition. If this negative externality is sufficiently strong, an incumbent’s preemptive valuation $v_{ii}$ will also increase more in quality than the reservation price $v_e$ (i.e. $v_{ii,k}' - v_{e,k}' = \left( \frac{d\pi_A(i)}{dk} - \frac{d\pi_E(e)}{dk} \right) - \frac{d\pi_NA(i)}{dk} > 0$). As shown in panel (i) in Figure 2.2, when increasing the quality of the invention further than $k^{PE}$, the preemptive valuation $v_{ii}$ becomes strictly higher than the reservation price, $v_e$. The creative destruction process now induces a bidding war between incumbents, driving the equilibrium sales price above the entry value for
Figure 2.2: The Equilibrium Ownership Structure (EOS), the reward to the entrepreneur and invention quality, $k$. Panel (i) shows how the entrepreneur’s mode of commercialization is determined from the incumbent’s value of deterring entry by acquiring the entrepreneur’s invention ($v_{ie}$), the incumbents’ value of preempting rivals from acquiring the invention ($v_{ii}$), and the entrepreneur’s value of pursuing own entry ($v_{ei}$). Panel (ii) summarizes how the entrepreneur’s decision to enter ($l^*=e$) or to sell ($l^*=i$) depends on the quality of the invention, $k$. Panel (ii) also displays the acquisition price $S^*$. Panel (iii), finally, displays the reward for the entrepreneur when commercializing the invention. It also shows the premium – or the excess reward over the entry value – that the entrepreneur can attain from selling an invention of very high quality under bidding competition.
the entrepreneur, \( S^* = v_{ii} > v_e \). The entrepreneur will thus commercialize by sale \((l^* = i)\), receiving the sales price \( S^* = v_{ii} \) in the region \( k \in [k^{PE}, \tilde{k}) \). In sum, the negative externality associated with a rival acquiring the invention becomes very large when the invention is of high quality. This explains the strong bidding competition and the high sales price.

**The reward for the entrepreneur** What is then the gain for the entrepreneur? Let \( R_E(l) \) be the net revenue or reward that the entrepreneur gets from commercializing the invention. It follows that the reward is simply the entry value, or the reservation price, \( R_E(e) = v_e \), when the entrepreneur chooses to enter the market for a low invention quality, \( k \in [\tilde{k}, k^{ED}) \). Note, however, that when preemptive acquisitions occur in the region \( k \in (k^{PE}, \tilde{k}(e)) \), the entrepreneur will earn a premium since the reward from selling under bidding competition is strictly higher than what she would earn from entry, \( R_E(i) = S^* = v_{ii} > v_e \). However, when selling without bidding competition in the region \( k \in (k^{ED}, k^{PE}) \), the reward from commercialization will be the same as under entry, \( R_E(i) = S^* = v_e \). These results shown in panel (iii) in Figure 2.2 will be useful when we turn to the welfare analysis.

**Comparative statics** Let us end this section by presenting some comparative statics results proved in Appendix 6.2. First, since both the entry costs \( G \) and the operating fixed costs \( \tau \) reduced the entry profits, a sale becomes more likely when there is an increase in these costs. Second, the opposite holds true when the transaction costs associated with a sale \( T \) increase. We can summarize:

**Proposition 1.** Suppose that Lemma 1 holds. In the choice between commercializing by sale to incumbents or entering the market, an entrepreneur will then prefer sale when (i) the quality of the invention \( k \) is high, (ii) the entry costs \( G \) are high, (iii) the operating fixed costs \( \tau \) are high, and (iv) the transaction costs associated with a sale \( T \) are low.

**2.3. Why preemptive acquisitions promote the process of creative destruction**

In this section, we will show that preemptive acquisitions will accelerate the process of creative destruction by increasing the entrepreneur’s incentive to undertake research when she can sell the invention. In particular, when the entrepreneur sells a high-quality invention, the bidding competition will be very stiff among incumbents as they try to preempt rivals from obtaining the invention. As the sales price of such inventions is pushed up to a level substantially higher than the reservation price of the entrepreneur, the entrepreneur has a substantially stronger incentive to succeed with her research. This is the mechanism through which preemptive acquisitions promote the process of creative destruction. We will now show this in more detail.

**2.3.1. Stage 1: Effort by the entrepreneur**

In stage 1, entrepreneur \( e \) invests in research \( \rho_E \) to succeed with invention \( k \). For simplicity, assume that the probability of succeeding with an invention is simply the research effort, i.e. \( \rho_E \in [0, 1] \), and that effort is associated with an increasing and convex cost \( y(\rho) \), i.e. \( y'(\rho) > 0 \), and \( y''(\rho) > 0 \). Recall that \( R_E(l) \) is the reward for the entrepreneur from the commercialization
of a successful invention. $\Pi_E = \rho_E R_E(l) - y(\rho_E)$ is then the expected net profit for the entrepreneur of undertaking a research effort. The optimal effort $\rho_E^*$ is given from the first-order condition:

$$\frac{d\Pi_E}{d\rho_E} = R_E(l) - y'(\rho_E^*(l)) = 0,$$

(2.5)

with the associated second-order condition being guaranteed from the assumptions about the effort cost.

Applying the implicit function theorem in (2.5), we can state the following Lemma:

**Lemma 2.** The equilibrium effort by the entrepreneur in stage 1, $\rho_E^*(l)$, and hence, the probability of a successful invention, increase with the reward for an invention, $R_E(l)$, i.e. $\frac{d\rho_E^*(l)}{dR_E} > 0$.

In section 2.4, we will evaluate the welfare effects of innovation for entry and innovation for sale. To this end, we can state the following proposition:

**Proposition 2.** Assume that Lemma 1 holds and compare a situation where only innovation for entry or innovation for sale can take place. Then, entrepreneurs with high-quality projects will be substantially more likely to succeed with an invention under commercialization by sale as compared to commercialization by entry, $\rho_E^*(i) > \rho_E^*(e)$ if $k \in (k^{PE}, \bar{k}(e))$.

The proposition is illustrated in Figure 2.2(ii), which depicts the reward of the entrepreneur $R_E(l)$ as a function of the quality of the invention $k$. When quality is low $k \in (\bar{k}(e), k^{ED})$, commercialization by entry occurs and the reward is entry value $R_E(e) = v_e$ for the entrepreneur. This is also the case when an entry deterring acquisition occurs in region $k \in [k^{ED}, k^{PE})$, since the acquiring incumbent pays the reservation price of the entrepreneur, $R_E(i) = S^* = v_e$.

However, at very high quality, $k \geq k^{PE}$, preemptive acquisitions occur and the bidding competition among incumbents for the benefits as an acquirer – as well as in order to avoid a weak position as a non-acquirer – drives the reward for commercialization by sale to be strictly higher than the reward for commercialization by entry, $R_E(i) = v_{ii} > v_e = R_E(e)$. Since the research effort, and hence the likelihood of a successful innovation $\rho^*(l)$, are increasing in the reward $R_E(l)$, it follows that there will be a higher probability of a successful invention under commercialization by sale (Lemma 2). This is illustrated in Figure 2.2(iii) which shows that preemptive incumbent acquisitions of entrepreneurial inventions can be productive by substantially increasing the research incentives for entrepreneurs.

Thus, we have shown that entrepreneurs with high-quality projects will be substantially more likely to succeed with an invention under commercialization by sale as compared to commercialization by entry. The reason is that the entrepreneur realizes that bidding competition will occur when a successful invention of high quality is sold to an incumbent, which will induce the entrepreneur to provide more effort to succeed with the invention.

**2.4. Why preemptive acquisitions may increase welfare**

In this section, we will examine the welfare effects of preemptive acquisitions. We will show that preemptive incumbent acquisitions can be beneficial for consumers by increasing the entrepreneurs’ incentives to invest in research. In particular, we show that despite the fact that
preemptive acquisitions increase the concentration in the product market (since fewer firms will be active in the product market), consumer welfare can increase when taking the effect on innovation incentives into account. We will then refer to such acquisitions as productive preemptive acquisitions.

As described in the introduction, recent government policy tends to favor innovation for entry over innovation for sale. To capture this trend, we compare a Non-discriminatory (ND) policy (where incumbent acquisitions of entrepreneurial firms are allowed) to a Discriminatory (D) policy (which prohibits the acquisitions of small innovative firms). Then, we add a stage 0 where a government chooses between the D-policy with such high transaction costs that no sale could occur and an ND policy where the transaction costs are reduced so that commercialization by sale is also a viable option (for at least some parameter values in the model). Naturally, this is a highly stylized policy comparison but, in its simplicity, it can be seen as a valuable way of capturing the effects of substantial changes in transaction costs for acquisitions due to changes in policies that might block or increase the cost of acquiring small innovative firms.

Let us now compare the two policies in more detail. Let $CS(l)$ be the consumer surplus, and $\Pi_I(l)$ be the aggregate profit for the incumbents, when a successful invention is commercialized by entry or sale, $l = \{e, i\}$. $\Pi_I(e) = n [\pi_N(e) - \tau]$ is then the aggregate profit for the $n$ incumbents when the entrepreneur commercializes by entry, and $\Pi_I(i) = \pi_A(i) - \tau - T - S^*$ + $(n - 1) [\pi_N(i) - \tau]$ is the aggregate profit for the incumbents (the acquiring incumbent and the $n - 1$ non-acquiring incumbents) when the entrepreneur sells the invention at the sales price $S^*$. Let $CS(0)$ denote the consumer surplus, and $\Pi_I(0) = n [\pi(0) - \tau]$ the aggregate profit of the incumbents, when the entrepreneur fails with her research.

The expected total surplus is then simply

$$\mathbb{TS}(l) = \Pi_E(l) + \mathbb{CS}(l) + \Pi_I(l), \quad (2.6)$$

where $\Pi_E(l) = \rho_E^*(l)R_E(l) - y(\rho_E^*(l))$ is the reduced-form net profit for the entrepreneur, where the research effort, and hence the probability of succeeding, $\rho_E^*(l)$, is given from (2.5). $\Pi_E(l)$ is thus the expected net profit for the entrepreneur anticipating that successful research will lead to commercialization by sale ($l = i$) or by entry ($l = e$).

In (2.6), $\mathbb{CS}(l)$ is the expected consumer surplus and $\Pi_I(l)$ is the expected aggregate profit for the incumbents, given as

$$\begin{align*}
\mathbb{CS}(l) &= CS(0) + \rho_E^*(l)[CS(l) - CS(0)] \quad \text{At outset Expected change in consumer surplus} \\
\Pi_I(l) &= \Pi_I(0) + \rho_E^*(l)[\Pi_I(l) - \Pi_I(0)] \quad \text{At outset Expected change in incumbent profits} \\
\end{align*} \quad (2.7)$$

The expected consumer surplus $\mathbb{CS}(l)$ is simply the sum of the consumer surplus when the entrepreneur fails, $CS(0)$, and the expected change in the consumer surplus from entrepreneurial research, $\rho_E^*(l)[CS(l) - CS(0)]$. In the same way, the expected aggregate profit for the incumbents is the aggregate profit for the incumbents when the entrepreneur fails, $\Pi_I(0)$, plus the expected change in aggregate profit for the incumbents from entrepreneurial research,
\[ \rho^*_E(l)[\Pi_I(l) - \Pi_I(0)]. \]

Since the D-policy does not allow for commercialization by sale, the expected total surplus under the discrimination is simply the expected surplus under commercialization by entry, \( TS^D = TS(e) \). Intuitively, since the ND-policy allows the entrepreneur to choose commercialization mode, the expected total surplus under the ND-policy is the expected total surplus when the entrepreneur freely chooses commercialization mode, \( TS^{ND} = TS(l) \). Let us now compare the two policies for different types of inventions.

### 2.4.1. Inventions of lower quality

When the entrepreneur’s research project involves an invention of lower quality, \( k \in (k_{E}^\text{min}, k^{ED}) \), we know that the entrepreneur will choose commercialization by entry if she succeeds (Lemma 1). Since the commercialization mode is the same under two policies, the expected total surplus does not vary with the policy.

### 2.4.2. Medium-quality inventions

What if the research idea of the entrepreneur concerns an invention of medium quality, \( k \in (k_{E}^{min}, k^{PE}) \)? If the ND-policy is applied, we know that the entrepreneur will sell the invention at the reservation price \( S^* = v_e \), given that she succeeds (Lemma 1). Since the reward for the entrepreneur is then identical under the two policies, her research effort is unaffected by the policy choice, i.e. \( \rho^*_E(e) = \rho^*_E(i) \). The entrepreneur must therefore be indifferent between the two policies. Assume that consumers benefit from the higher quality of an innovation and from more firms being present in the market. The consumer surplus for a commercialized invention is then highest under entry, followed by commercialization by a sale and with the lowest consumer surplus arising when the invention is not present, \( CS(e) > CS(i) > CS(0) \). Hence, for medium innovation quality, \( k \in [k^{ED}, k^{PE}) \), consumers will be better off under the D-policy due to the market power effect associated with an acquisition, \( CS(e) - CS(i) = \rho^*_E(e)[CS(e) - CS(i)] > 0 \). In contrast, the market power effect of an acquisition benefits the incumbents, \( \Pi_I(i) - \Pi_I(e) = \rho^*_E(e)[\Pi_I(i) - \Pi_I(e)] > 0 \). Since consumers and incumbents have opposing interests, we cannot a priori tell which policy gives the highest expected total surplus without making more specific assumptions. In many countries, however, policy makers (such as competition authorities) predominantly prioritize consumer interests. Thus, when consumer interests are important and inventions are medium quality, choosing the D-policy and restricting incumbent acquisitions of entrepreneurial firms seems more attractive.

### 2.4.3. Inventions of high quality

What if the entrepreneur then creates an invention of high quality, \( k \in (k^{PE}, k(e)) \)? If the ND-policy is applied, we know that the entrepreneur will sell a successful invention to an incumbent exploiting preemptive bidding competition between incumbents, driving the sales price above the entry profit obtained under the D-policy, \( S^* = v_{ii} > v_e \) (Lemma 1). Not only does the

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9 It can be shown that \( \Pi_I(i) - \Pi_I(e) = (n - 1)|v_{ie} - v_{ii}| + v_{ie} - v_e > 0 \), where \( v_{ia} > v_e > v_{ii} \) holds when \( k \in (k_{E}^\text{min}, k^{ED}) \), as shown in Figure 2.2(i).
ND policy then increase the entrepreneur’s reward from succeeding, the entrepreneur will also significantly increase her research effort and hence, her probability of succeeding, $\rho^E_E(i) > \rho^E_E(e)$ (Lemma 2). This implies that the invention is more likely to reach the product market under the ND-policy.

**The entrepreneur** It directly follows that the entrepreneur must be better off when allowed to take advantage of selling under bidding competition to increase and increase her reward from succeeding with the invention under the ND policy.10

**Consumers** At first sight, we would expect consumers to benefit if the entrepreneur were forced to commercialize by entry, since the market power effect associated with an acquisition makes consumer worse off, $CS(i) < CS(e)$. However, this argument neglects to take into account how the policy affects the research incentives of the entrepreneur. The creative destruction process induces preemptive bidding competition between incumbents under the ND policy. Since preemptive acquisitions increase the reward from succeeding, inventions will be more likely to be available for consumers, $\rho^E_E(i) > \rho^E_E(e)$. Due to these stronger research incentives, consumers may still be better off under the ND policy despite the market power effect.

This mechanism is shown in Figure 2.3(ii), which depicts the locus of the expected consumer surplus under entry $CS^D(\rho_E) = CS(0) + \rho_E[CS(e) - CS(0)]$, as well as the locus of the expected consumer surplus under sale, $CS^{ND}(\rho_E) = CS(0) + \rho_E[CS(i) - CS(0)]$. Both loci slope upwards, thereby reflecting the gain for consumers, $CS(l) > CS(0)$, as a higher research effort increases the probability that the new invention becomes available for consumers. While lower market power makes the D-policy better for consumers for a given research effort, $CS^D(\rho_E) > CS^{ND}(\rho_E)$, we note that the higher research effort under the ND policy, $\rho^E_E(i) > \rho^E_E(e)$, can make the ND-policy preferable for consumers. Figure 2.3(iii) depicts a case where the innovation effort effect dominates and thus, $CS^{ND}(\rho^E_E(i)) > CS^{ND}(\rho^E_E(e))$.

We can now summarize the above analysis and state when preemptive acquisitions will be productive from consumers’ point of view:

**Proposition 3.** Consumers will prefer the ND-policy over the D-policy when the innovation effect from preemptive acquisitions is sufficiently strong relative to the market power effect.

**Incumbents** Proceeding as with consumers, Figure 2.3(iii) depicts the expected aggregate profit for incumbents under entry and incumbent acquisition, $\Pi^D_I(\rho_E) = \Pi_I(0) + \rho_E[\Pi_I(e) - \Pi_I(0)]$ and $\Pi^{ND}_I(\rho_E) = \Pi_I(0) + \rho_E[\Pi_I(i) - \Pi_I(0)]$, respectively. These loci slope downwards, thereby reflecting the loss for incumbents if the invention reaches the market: $\Pi_I(i) - \Pi_I(0) = -n[\pi(0) - \pi_{NA}(i)] < 0$ reflects the aggregate loss for incumbents when an incumbent buys the invention under preemptive bidding competition leaving all incumbents – including the buyer – at the profit level of a non-acquirer, $\pi_{NA}(i)$. Likewise, $\Pi_I(e) - \Pi_I(0) = -n[\pi(0) - \pi_{NA}(e)] < 0$, reflects the aggregate decline in profits for the incumbents from entry by the entrepreneur. For a given research effort by the entrepreneur, the market power effect implies that the loss for

10 From the higher reward, $\nu_{ii} > \nu_i$, and the stronger incentive to conduct research, $\rho^E_E(i) > \rho^E_E(e)$, there is an increase in the expected net profit for the entrepreneur, $\bar{\Pi}_E(i) - \bar{\Pi}_E(e) > 0$. 16
Figure 2.3: Illustrating productive preemptive acquisitions. Panel (i) shows the expected consumer surplus and the probability of a successful invention ($\rho_E$), when a successful high-quality invention ($k \in (k^{PE}, \bar{k})$) will be sold under bidding competition $CS^{ND}(\rho_E)$ and when entry is the only route to commercialization, $CS^D(\rho_E)$. Panel (ii) displays the corresponding expected aggregate profits for incumbents when sale is allowed, $\Pi_f(i)$, and when only entry is allowed, $\Pi_f(e)$. 

$CS(0)$

$CS(e)$

$CS(i)$

$\rho_E^*(e)$

$\rho_E^*(i)$

$\Pi_f(0)$

$\Pi_f(e)$

$\Pi_f(i)$

$\Pi_f^{NE}(\rho_E)$

$\Pi_f^D(\rho_E)$

$\Pi_f^{ND}(\rho_E)$

Expected consumer surplus

Expected incumbent profits

Entry

Sale

(Probability to succeed)

(Probability to succeed)
the incumbents is smaller when an incumbents acquires the invention, \( \Pi^N_D(\rho_E) - \Pi^P_D(\rho_E) = \rho_E[\pi_{NA}(i) - \pi_{NA}(e)] > 0 \). However, since the entrepreneur exerts a stronger research effort when anticipating a preemptive sale, we cannot a priory tell if incumbents will prefer the D-policy or the ND policy. Figure 2.3(iii) depicts a case where the market power effect dominates and the aggregate profits of the incumbents under a preemptive sale are higher than under entry by the entrepreneur, \( \Pi^N_D(\rho^*_E(i)) > \Pi^N_D(\rho^*_E(e)) \).

Summing up, consumers gain from stronger research incentives in a sale but are worse off from the market power effect. The opposite holds for incumbents. The entrepreneur cannot be worse off from being allowed to sell. These results indicate that if the consumer effects are sufficiently strong (or if the consumer effects are of greater importance for the policy maker), the policy maker may choose the ND policy when incumbent acquisitions occur under bidding competition.

3. Exits and Synergies

Exits by incumbents constitute an inherent feature of the creative destruction process. As described above, the creative destruction process is incorporated in Definition 1: At increasing innovation quality, the increase in the entry profit for the entrepreneur is directly mirrored by a decline in the profits of the incumbents, thereby reducing the value of the incumbents’ assets. In the same way, if an acquisition occurs, rival incumbents see their profits decline. Eventually, when the quality of the invention is sufficiently high, one or more of the incumbents will be forced to exit.

How will such exits affect the Equilibrium Ownership Structure? When there is an exit of an incumbent, the pattern where rising invention quality gives rise to entry, entry-deterring acquisitions and preemptive acquisitions is simply repeated in the market with \( n - 1 \) incumbents. At an ever increasing quality, this pattern is repeated in cycles, where entry is first replaced by entry-deterring acquisitions and then by preemptive acquisitions, until a monopoly is reached. The details of this process are described in the working paper version (Norbäck, Persson and Svensson, 2009). Thus, allowing for exits will not qualitatively affect our main results that: (i) entrepreneurs sell their best inventions under bidding competition (preemptive acquisitions) and that (ii) preemptive acquisitions can improve consumer welfare (despite their market concentration effect) by increasing entrepreneurs’ incentives to undertake research.

How would the result then change if we allowed for synergies between the invention and the incumbent’s assets? An incumbent could, for instance, use its existing distribution network to reach potential consumers for the products associated with the invention in a more efficient way. Synergies would then simply make a sale more attractive for the entrepreneur since the bidding competition for a high-quality invention with strong synergies would be more intense. As shown in Norbäck, Persson and Svensson (2009), synergies will make the profits in Definition 1 more sensitive to changes in quality under incumbent ownership: synergies will lead to a stronger increase in the profits of the acquirer, but also to a stronger decline in the profits of a non-acquirer (when a rival incumbent is the acquirer). The profit of a non-acquirer under a rival acquisition can then be lower than under entry, despite the fact that the number of firms is higher under entry, \( \pi_{NA}(i) < \pi_{NA}(e) \). Hence, under synergies, the preemptive valuation can
now be higher than the entry deterring valuation, $v_{ii} > v_{ie}$. While this leads to more outcomes, it is straightforward to solve the commercialization auction.

How would the welfare evaluation of the Non-discriminatory (ND) policy and the Discriminatory (D) policy then change when allowing for exits and synergies? In Norbäck, Persson and Svensson (2009), we show that the same main effects are present: consumers gain from stronger research incentives in a sale but are worse off from the market power effect. The opposite holds for incumbents. The entrepreneur cannot be worse off from being allowed to sell. In particular, consumers now tend to benefit more from a non-discriminatory policy since the incentive for innovation for sale increases when synergies imply that the bidding competition over high quality inventions becomes even stronger.

4. Research by incumbents

So far, we have ignored incumbents undertaking own research. Ignoring the incumbent research effort may be a reasonable assumption when there are many entrepreneurs contemplating entering the market with novel innovations. Incumbents might not be able to foresee all potential entrepreneurial ideas in the innovation process. Indeed, as documented by, for instance, Baumol (2004), in many industries, entrepreneurs provide research and incumbents focus on development. Our set-up is clearly valid in such situations.

In other situations, entrepreneurs and incumbents may race for inventions. From Figure 2.3(iii), it is also clear that incumbents are made worse off when the entrepreneur succeeds with a high-quality invention. Would then the incentive for incumbents to “invent for preemption” imply that our main results do not hold?

In this section, we will show that allowing for incumbents to undertake research will reduce the entrepreneur’s incentive to undertake research. However, we also show that the entrepreneur’s incentive to undertake research will still be higher under commercialization by sale than under commercialization by entry. The reason is once more that the tough bidding competition over the high-quality invention for sale spurs the research effort incentives. The next section illustrates this result in more detail.

4.1. Competition in research

Consider a simple setting where only one of the incumbents invests in the research stage (we discuss a generalization to any number of incumbents below). To focus on the incentive for preemptive research by incumbents, we assume that if both the entrepreneur and the incumbent succeed in the project delivering the invention $k$, the entrepreneur refrains from commercialization. A reason for this is that the incumbent may have more financial resources, contacts or other patents, giving the incumbent the upper hand in a law suit.

Suppose that the quality is sufficiently high to generate commercialization by sale under bidding competition if a sale is allowed, i.e. $k \in (k^{PE}, \tilde{k}(e))$. The expected profits for the

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11 There is a relatively large literature on innovation races (see Gilbert 2006 for an overview). However, this literature typically does not study how the incentives for entrepreneurs and incumbents depend on the quality of the innovation and if incumbent and entrepreneurial innovations are substitutes or complements in such situations.
entrepreneur and the incumbent can then be written:

\[
\Pi_E = (1 - \rho_i)\rho_E R_E(l) - y(\rho_E)
\]

\[
\Pi_i = \rho_i (\pi_A(i) - \tau) + (1 - \rho_i) \{\rho_E [\pi_{N A}(l) - \tau] + (1 - \rho_E) [\pi(0) - \tau]\} - y(\rho_i)
\]

where \(\rho_i \in [0, 1]\) is the research effort undertaken by the incumbent. We once more make the simplification that an agent’s research effort is equal to her probability of succeeding.

As shown in (4.1), the entrepreneur can only commercialize when she succeeds and the incumbent fails. This occurs with probability \((1 - \rho_i)\rho_E\) in which case she receives the reward \(R_E(l)\), which depends on her choice of mode of commercialization in stage 2. As shown in (4.2), the incumbent obtains the same product market profit as the acquiring incumbent in the main section, \(\pi_A(i) - \tau\) if she succeeds, which occurs with probability \(\rho_i\). If she fails, which occurs with probability \(1 - \rho_i\), the incumbent obtains an expected profit as the non acquirer, \(\rho_E [\pi_{N A}(l) - \tau] + (1 - \rho_E) [\pi(0) - \tau]\), where \(\rho_E [\pi_{N A}(l) - \tau]\) is her expected profit if the entrepreneur succeeds, and \((1 - \rho_E) [\pi(0) - \tau]\) is her expected profit if the entrepreneur fails, in which case the initial entry stable profit is obtained. If a preemptive sale occurs in stage 2, all incumbents obtain the profit \(\pi_{N A}(i)\) since \(\pi_A(i) - T - v_{ii} = \pi_{N A}(i)\).

Each agent chooses effort (i.e. success probability) to maximize her expected net profit, taking as given the effort of her rival. The first-order conditions are

\[
(1 - \rho^*_E(l)) R_E(l) = \frac{y'(\rho^*_E(l))}{MC_E(l)}
\]

\[
\pi_A(i) - \tau - \left\{ (1 - \rho^*_E(l)) [\pi(0) - \tau] + \rho^*_E(l) [\pi_{N A}(l) - \tau] \right\} = \frac{y'(\rho^*_l(l))}{MC_i(l)}
\]

where it is assumed that the effort cost \(y(\cdot)\) is sufficiently convex so that the second-order conditions are fulfilled. The left-hand side (LHS) in each equation is the marginal (expected) benefit associated with choosing a marginally higher probability of success \((MB)\), while the right-hand side (RHS) is the marginal cost \((MC)\). Since the quality is sufficiently high to generate commercialization by sale under bidding competition if a sale is allowed, the reward under a sale is \(R_E(i) = v_{ii}\). If a sale is not allowed, the reward in (4.3) is the entry value \(R_E(e) = v_e\).

Start with the case when commercialization by entry is the only option for the entrepreneur (i.e. the D-policy from Section 2.4 applies). The Nash-equilibrium in research efforts \((\rho^*_{E,Entry}, \rho^*_{i,Entry})\) is then shown at the point labeled \(Entry^*\) in panel (ii) of Figure 4.1 at the intersection of the agents’ reaction functions. Note that the reaction function of the entrepreneur, labeled \(R^*_{E,Entry}\) (representing the entrepreneur’s optimal research effort for a given choice of incumbent), is downward-sloping in the \(\rho_E - \rho_i\) space in panel (ii), so that the entrepreneur will respond with a lower effort when the incumbent chooses a higher effort. This follows since a higher effort by the incumbent \(\rho_i\) reduces the entrepreneur’s marginal expected benefit from succeeding \((1 - \rho_i)v_e\) in (4.3). The entrepreneur chooses her highest effort when \(\rho_i = 0\), labeled.
\( R_i^{Entry} \). This is the research level chosen under entry discussed in Proposition 2, and it is derived in panel (i) of Figure 4.1.

In contrast, the incumbent’s reaction function labeled \( R_i^{Entry} \) is upward-sloping in the \( \rho_E - \rho_i \) space, as shown in panel (ii) of Figure 4.1. Thus, the incumbent’s response to a higher innovation effort by the entrepreneur is to also choose a higher research effort. To see why, note that the marginal benefit of succeeding in (4.4) first consists of her profit from the innovation, \( \pi_A(i) - \tau \). However, the marginal benefit from succeeding is reduced by the second term which mirrors a "replacement": when the incumbent succeeds she replaces the profits she would obtain absent invention.\(^\text{12}\) Since an increased research effort by the entrepreneur \( \rho_E \) reduces the expected loss from replaced profits, the incumbent will choose a higher probability of success, \( \rho_i \).

Panel (ii) of Figure 4.1 reveals that by reducing the incentive for the entrepreneur to innovate and by responding to an increased research effort by the entrepreneur with increased research effort, the presence of the incumbent will reduce the equilibrium research by the entrepreneur under entry, i.e. \( \rho_E^{Entry} < \rho_E^{Entry^*} \).

Let us now examine how the equilibrium research efforts by the agents are then affected if commercialization by sale is allowed (i.e. the ND policy is allowed). The Nash-equilibrium given future commercialization by sale, labeled \( Sale^* \) in panel (ii) of Figure 4.1, is obtained by first substituting \( R_E = v_{ii} \) into the first-order condition (4.3). From Lemma 1, we know that a sale under preemptive bidding competition gives a higher reward, \( R_E(i) = v_{ii} > v_e = R_E(e) \). For a given effort by the incumbent, it follows that the entrepreneur will always choose a higher research effort under commercialization by sale than under commercialization by entry. Hence, the entrepreneur’s reaction function will shift out from \( R_i^{Entry^*} \) to \( R_i^{Sale} \) in Figure 4.1(ii).

Turning to the incumbent, we note that commercialization under preemptive bidding competition leaves all incumbents with the same net profit \( \pi_A(i) - v_{ii} = \pi_{NA}(i) \). Hence, we must replace \( \pi_{NA}(e) \) in (4.4) with the profit \( \pi_{NA}(i) \). How does this affect the incumbent’s incentive? First, note that the market power effect makes a non-acquirer better off under commercialization by sale than under commercialization by entry, \( \pi_{NA}(i) > \pi_{NA}(e) \). This implies that the replacement effect in (4.4) must be larger under commercialization by sale. With a larger expected profit being replaced by successful innovation under commercialization by sale than under commercialization by entry, the incumbent will thus choose a lower research effort when she knows that the entrepreneur would choose commercialization by sale instead of commercialization by entry in stage 2. Thus, the reaction function for the incumbent will shift down from \( R_i^{Entry^*} \) to \( R_i^{Sale} \) in panel (ii) in Figure 4.1(ii).

Comparing the Nash-equilibria under entry and sale, \( Entry^* \) and \( Sale^* \) in panel (ii), it is then clear that allowing for commercialization by sale in stage 2 will increase the equilibrium research effort by the entrepreneur, while the research effort by the incumbent may not change or even decrease. Summing the above analysis, we can state the following result:

\(^{12}\) More specifically, this replacement effect, \((1 - \rho_E) [\pi(0) - \tau] + \rho_E [\pi_{NA}(e) - \tau] \), is the incumbent’s expected profit as a non-acquirer, where the first term is the expected profit when the entrepreneur fails and the second is the expected profit when the entrepreneur succeeds and enters the market in stage 2. It is instructive to rewrite the replacement effect as \( \pi(0) - \tau - \rho_E [\pi(0) - \pi_{NA}(e)] \). Note that if the entrepreneur chooses a higher research effort, \( \rho_E \), the expected loss from entry, \( \rho_E [\pi(0) - \pi_{NA}(e)] \), will increase which, in turn, reduces the replacement effect, \( \pi(0) - \rho_E [\pi(0) - \pi_{NA}(e)] \).
Figure 4.1: Panel (i) shows the innovation choice in stage 1 by the entrepreneur without incumbent innovation. Panel (ii) shows the strategic interaction in stage 1 between the entrepreneur and one incumbent and how this depends on the anticipated commercialization in stage 2. The potential invention is of high quality, i.e. $k \in (k^{PE}, k(e))$. 
Proposition 4. Suppose that Proposition 2 holds. Then; (i) Allowing for incumbent research in stage 1 will decrease the entrepreneur’s research effort; (ii) Allowing for commercialization by sale in stage 2 will increase the equilibrium research effort by the entrepreneur also in the presence of incumbent research.

Welfare Let us now turn to a discussion of the welfare evaluation of the Non-discriminatory (ND) policy and the Discriminatory (D) policy when allowing for incumbent research. The analysis becomes much more involved as not only the entrepreneur’s research effort will be affected by the policy, but so will also the incumbent’s research effort. It is instructive to first consider a benchmark where only the incumbent conducts research and then bring in the entrepreneur to the analysis.

We know that the entrepreneur always must gain from the opportunity to do research. Thus, we can focus on the effects on expected consumer surplus and expected aggregate profits for incumbents. Let us start with consumer surplus. The incumbent will always raise her research effort when the entrepreneur undertakes research, since succeeding then becomes less costly from a smaller replacement effect. This is true irrespectively of the commercialization mode of the entrepreneur, $\rho_i^*(I) > \rho_i^*$, as shown in panel (ii) of Figure 4.1. This will benefit consumers: even if the entrepreneur fails, the innovation is more likely to be present due to the higher research effort by the incumbent. Moreover, consumers are also better off since the entrepreneur can succeed when the incumbent fails.¹³

What about the welfare evaluation of the Non-discriminatory (ND) policy and the Discriminatory (D) policy in this more complicated setting? Under reasonably general circumstances, it also turns out that Proposition 3 still applies. To see this, note again that even if the incumbent realizes that the entrepreneur is more aggressive in research under a sale, and hence should respond with more aggressive research, the larger replacement effect under a sale dampens the incumbent’s research effort. As shown in panel (ii) of Figure 4.1, the incumbent may not react significantly to the entrepreneur’s choice of commercialization. Therefore, the same main effects apply as in Section 2.4: consumers gain from stronger research incentives in a sale but are worse off from the market power effect. If the former effect dominates the latter, consumers are better off from the ND policy. Again, it can be shown that the opposite holds for incumbents.

5. Concluding remarks

Previous literature has shown that entrepreneurs play an important role in challenging existing oligopolistic markets through de-novo entry into the product market. Yet, we identify another important role of the entrepreneur as a challenger of existing oligopolies through the aggressive development of inventions for sale. This development incentive is particularly strong when

¹³ It can be shown that the expected consumer surplus when both the entrepreneur and the incumbent undertake research is given by

$$
CS(l) = CS(0) + \rho_i^*(I)[CS(i) - CS(0)] + [1 - \rho_i^*(I)]\rho_e^*(I)[CS(i) - CS(0)]
$$

Outset Incumbent succeeds Incumbent fails and entrepreneur succeeds
the invention has such a high quality that incumbent buyers try to preempt each other from acquiring the invention (preemptive acquisitions). The role of an aggressive invention supplier may be even more important than the role of a de-novo entrant: preemptive acquisitions give entrepreneurs the incentive to increase their efforts in high-quality research projects so that the expected welfare can increase despite the risk of increased market power.

The welfare benefits of "creative destruction and productive preemption" then crucially depend on whether there is bidding competition over entrepreneurial firms, i.e. whether acquisitions are preemptive (where incumbents bid their full valuation) rather than entry deterring (where incumbents only pay the entrepreneur her entry value).

**Policy implications.** The results derived in the paper suggest that industry policies that disfavor innovation for sale over innovation for entry may be suboptimal. The reason is that reducing the cost of selling inventions may not only have a direct positive effect on the reward for entrepreneurship, it may also create bidding competition over high-quality inventions, which may further increase the incentives for entrepreneurial research. Policies that improve the M&A market could then be preferred. Such policies may involve making the tax system neutral between keeping and selling a firm, or improving the legal system to reduce the transaction costs associated with acquisitions in order to ensure a bidding competition over target firms. In contrast, the existing EU-policies do, to a large extent, exclusively focus on stimulating the growth of small firms, but lack policies that stimulate ownership transfers to large established firms.

**Limitations.** The model has several limitations. The theoretical result that high-quality inventions are conducive to sale does not hold if the oligopolistic effects are small. Our results will then vanish, since the externalities on non-acquirers are small. However, in practice, many markets where patented innovations are used are oligopolistic. For instance, in Sweden, most of the markets in the engineering industry have concentration ratios that are consistent with oligopolistic competition (see Heyman et al. 2013).

A second situation is when inventions cannot be transferred between the inventor and the incumbents without great efficiency losses. When such transfer costs are increasing in quality (because of higher quality products or better technologies being more complex), a higher invention quality is instead conducive to commercialization by entry. A special case would be if a potential acquisition by the incumbent only serves the purpose of closing down the invention. While being relevant in some cases, we believe that most sold patents are used efficiently. Indeed, there is ample evidence that many (leading) firms such as Microsoft, Google and Ericsson acquire inventions and patents, incorporating them highly efficiently into their businesses.

**Future Research.** We have treated the human capital of the entrepreneur as a constant in our analysis. However, the quality of human capital will likely affect the entry and sales pattern, since it will affect the value of the entrepreneurial venture. Indeed, Lofstrom, Bates and Parker (2014) find that advanced educational credentials of potential entrants predict entry into high-barrier fields and that college graduates positively select into industries where the expected earnings are high. On the other hand, the quality of the human capital will also be affected.
by the entry-sale pattern. Parker (2013) finds that the performance of serial entrepreneurs in one venture enhances their performance in subsequent ventures in which they engage. However, these positive effects tend to decline with the length of time between ventures. Consequently, sales of ventures might enable serial entrepreneurs to better exploit learning opportunities. Thus, endogenizing the human capital level in the analysis seems to be a fruitful avenue for future research.

References


6. Appendix

6.1. Initial entry stable equilibrium

We here show how the *initial* entry stability will constrain the invention-space, i.e. the size of $k$ in Assumption 1. Normalize the existing pre-innovation technology used by the incumbents to $k = 0$. Let $\pi(0)|_n$ be the symmetric profit with the pre-innovation technology ($k = 0$) when there are $n$ firms in the market, and let $\pi(0)|_{n+1}$ be the corresponding profit when there are $n + 1$ firms in the market. The *initial entry condition* then states that

$$\pi(0)|_{n+1} < G + \tau < \pi(0)|_n.$$  \hspace{1cm} (6.1)

The initial entry condition (6.1) is shown in panel (i) of Figure 6.1 at $k = 0$. Initial entry stability implies that the entrepreneur cannot commercialize by entry unless her invention has a sufficiently high quality, $k$. If the entrepreneur were to enter with the existing technology,
she would obtain the same product market profit as the incumbents and lose money, since $\pi_E(e) = \pi(0)|_{\mu+1} < G + \tau$. From Definition 1 the product market profit of the entrepreneur $\pi_E(e)$ is increasing in quality. Hence, there must exist a threshold invention quality $k_{E}^{\text{min}}$ at which variable profits exhaust fixed costs, $\pi_E(e)|_{k=k_{E}^{\text{min}}} = G + \tau$. Entry is thus profitable for any quality $k$ above $k_{E}^{\text{min}}$, as shown in panel (ii) in Figure 6.1.

Since non-acquiring incumbents have sunk the fixed entry cost $G$, while an acquiring incumbent has additionally sunk the acquisition price, $S$, incumbents’ continuing presence in the market is only contingent on the fixed operational cost, $\tau$. An acquiring incumbent will never exit the market. Note that from (6.1), the acquiring incumbent will be able to pay the operating fixed cost $\tau$ at a low – or even zero – quality of the invention, and her product market profit is increasing in quality by Deﬁnition 1. In contrast, non-aquirers’ proﬁts fall when the invention quality increases. As shown in panel (i) in Figure 6.1, there must also exist a threshold quality $\bar{k}(e)$ where non-acquiring incumbents’ proﬁts equal the operational ﬁxed cost, $\pi_{NA}(l) = \tau$. A further increase in quality will require exit by one of the non-acquiring incumbents.

We made the following assumptions in the main analysis: First, entry is always proﬁtable, i.e. $k$ is above $k_{E}^{\text{min}}$. Second, the quality of the invention is not so high that commercialization of the invention induces exits. As shown in panel (i) in Figure 6.1, this implies that the quality will be restricted to be below the threshold $k(e)$, which is smaller than the threshold $\bar{k}(i)$ due to the market power effect of a rival acquisition, $\pi_{NA}(i) > \pi_{NA}(e)$. These assumptions can thus be stated as, $k \in (k_{E}^{\text{min}}, \bar{k}(e)))$, where, for simplicity, we used the notation $\bar{k}(e) = \bar{k}$ in Assumption 1.

### 6.2. Threshold transaction costs and comparative statics results in Proposition 1

Panel (iii) in Figure 6.2 shows how the Equilibrium Ownership Structure (EOS) is jointly determined by the quality of the invention $k$ and the transaction cost $T$. Let $T^{ED}(k_{ED})$ be the entry-deterrence condition (ED-condition) defined from $v_{i}(k_{ED}, T) = v_{e}(k_{ED}, T)$, and let $T^{PE}(k_{PE})$ be the preemption condition (PE-condition) defined from $v_{i}(k_{PE}, T) = v_{e}(k_{PE}, T)$. Solving for $T$ in each equation, we have:

\begin{align}
T^{ED}(k) &= \pi_{A}(i) - \pi_{NA}(e) - [\pi_{E}(e) - \tau - G], \\
T^{PE}(k) &= \pi_{A}(i) - \pi_{NA}(i) - [\pi_{E}(e) - \tau - G].
\end{align}

(6.2)

(6.3)

The loci associated with the entry-deterrence condition $T^{ED}(k)$ and the preemption condition $T^{PE}(k)$ are upward-sloping in the $k - T$ space, reflecting the negative externality on non-aquirers from higher quality, $v'_{i,l,k} > v'_{e,k}$, under Lemma 1. Since the market power effect implies that non-aquirers are better off from a rival acquisition than entry, $\pi_{NA}(e) < \pi_{NA}(i)$, the critical transaction cost associated with takeover acquisitions is higher than the critical transaction cost associated with preemptive acquisitions, $T^{ED}(k) > T^{PE}(k)$. Panel (iii) in Figure 6.2 depicts the lowest cost needed to have entry in equilibrium as the starting point on the entry-deterrence condition, $T^{L} = T^{ED}(k_{E}^{\text{min}})$. This figure also shows the upper threshold at which preemptive acquisition occurs, $T^{H} = T^{PE}(\bar{k}(e))$. Then, note that $T^{H}$ is the transaction
(i) Profits and initial entry stability

Market is initially entry stable

Profits

\( \pi_A(i) = \pi_A(e) \)

\( \pi_N(i) = \pi_N(e) \)

\( \pi_N'(i) = \pi_N'(e) \)

(ii) The number of firms in the market

Assumption A1

Number of firms

\( n+1 \)

\( n \)

\( n-1 \)

Quality of the entrepreneur’s invention, \( k \)

Quality of the entrepreneur’s invention, \( k \)

Entry = Sale

Entry

Sale

Figure 6.1: Initial entry stability, product market profits and the number of firms.
cost that equalizes \( v_{ii} \) and \( v_e \) at \( \bar{k}(e) = \bar{k} \), and that \( T^L \) and \( T^H \) are the transaction costs used in Lemma 1.

Using Figure 6.2(iii), we can now infer the equilibrium ownership structure as we vary the transaction costs. We obtain commercialization by entry above the entry deterrence locus \( T^{ED}(k) \), indicated as \( l^* = e \). Entry deterring acquisitions occur for combinations of \( k \) and \( T \) between the takeover locus \( T^{ED}(k) \) and the preemption locus \( T^{PE}(k) \), indicated as \( l^* = i \) and \( S^* = v_e \). Preemptive acquisitions occur below the preemption locus \( T^{PE}(k) \), as indicated by \( l^* = i \) and \( S^* = v_{ii} \).

From (6.2) and (6.3), we note that increasing the entry cost \( \gamma \) shifts both the entry deterrence locus \( T^{ED}(k) \) and the preemption locus \( T^{PE}(k) \) upwards in Figure 6.2(iii), thereby increasing the region where commercialization by sale occurs. Increasing the fixed operating cost \( \tau \) has the same effect.
Figure 6.2: The Equilibrium Ownership Structure and transaction costs.