When Rivals Originate from Within

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ABSTRACT. This paper examines two questions that affect entrepreneurial activity. First, under what conditions are new opportunities exploited by managers rather than their employer firms and second, under what conditions do the employer firms have sufficient incentive to pay off managers to deter entrepreneurial activity? The paper develops and analyzes an economic model to examine the condition sets. Results are consistent with recent findings in the empirical literature on managerial salaries and on technology adoption in oligopolistic industries.

1. Introduction

When IBM rejected employee Gene Amdahl's idea to introduce new products that would cannibalise existing sales, he left IBM to start Amdahl Computers and compete successfully against his former employer in the mainframe market. Amdahl Computers, Rockwell Tools & Electric, Ferrari Cars, Beechcraft Aircraft, and Stiffel Lamps are all recent examples of successful, innovative new ventures built mainly on the industry experience of their founders (see Fucini and Fucini, 1985, for details). These founding entrepreneurs exploited opportunities that were available to their previous employers – IBM, Torbensen Axle Co., Alfa Romeo, Travel Air Mfg. Co., and Nelie Kaplan Co., respectively. The *phenomenon* of a manager-turned-entrepreneur competing against a former employer[1] is the subject of this paper. The examination of this phenomenon provides important benefits to a number of parties. Would-be entrepreneurs can better evaluate new venture opportunities by accounting for the reaction from incumbents including their employers. Current employers can better value a manager by additionally considering her worth in terms of the competitive threat the manager holds when operating a new rival firm. Policy-makers can better understand how to affect new venture creation with a model of this phenomenon. Entrepreneurial activity is an important factor in the revitalisation and growth of modern economies,[2] and entrepreneurs who have started their firms in the same market they had been working in constitute the vast majority of that activity (e.g., Cooper, 1985).

Regardless of such benefits from exploring this phenomenon, there has been little work in this area of entrepreneurial studies other than the description of specific cases and some relevant aggregate descriptive statistics regarding venture origin. Theoretical examination of the phenomenon is lacking. This paper addresses this gap in the literature in the following way. This paper develops and analyses an economic model to answer two questions relevant to the phenomenon. *Under what conditions are new opportunities exploited by managers rather than their employer firms and entrepreneurial activities result? When such conditions exist, under what circumstances do the employer firms then have sufficient incentive to pay off the managers to deter such entrepreneurial activity?* The main contribution of this paper is in the formal modelling of the relationship between the incumbent employer and the manager-as-potential-entrepreneur.

Although each question is interesting in its own right, taken together they provide a more complete valuation of the manager to the employer. This valuation is necessary for determining when the manager decides to become an entrepreneur. The first question explores a main source of potential

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entrepreneurial activity. It also addresses incentive differences among possible adopters of new knowledge including entrepreneurs. In addition, it examines the characteristics that the new knowledge must possess for adopters to be able to compete successfully against incumbents. The second question explores one main destroyer of potential new ventures. It inextricably links to the first question because answering the first question quantifies the pay-off required to successfully deter entrepreneurial activity. The two questions, together, address the manager's value to the firm when the manager is inside the firm as well as when the manager is outside the firm operating as a rival. When the values to the firm are relatively low and the manager has a higher expected private return outside the firm then entrepreneurial activity occurs.

Development and analysis of the model generates three main results. The first result is a theoretical range of variable values that satisfies the conditions implied by the two research questions. A model that captures dynamics (i.e., has multiple periods), competition among firms (i.e., includes incumbents and potential entrants), and an introduction of a new exploitable opportunity (i.e., here, the availability of a new process technology) is relatively complex. Additional conditions consistent with the literature in the entrepreneurship field are imposed to simplify the model. However, the model has enough degrees of freedom left (i.e., in terms of unconstrained variable values) to satisfy all of the conditions. This is because no one condition conflicts with the others to deny the possibility that some variable values exist that satisfy all of the conditions at once.

The second result is that it is easier to satisfy the conditions as industry concentration increases (where the count of firms in an industry is inversely proportional to industry concentration). This result has not only a basic economic explanation but also a consistency with recent relevant empirical findings. Industry concentration increases the potential rents available for each firm in any economic market structure where firms can realise rents (e.g., Cournot competition). Thus, when industry concentration increases, the incentive increases for a manager to become an entrepreneur in an attempt to appropriate those rents. This addresses the effect of industry concentration on the first research question. The side-payment to the manager to deter entrepreneurial activity is a private cost but the benefits are shared among all incumbents. Thus, when industry concentration increases, the benefit-to-cost ratio increases for paying off the manager. This addresses the effect of industry concentration on the second research question.

Recent empirical work has shown that the wages of salaried workers increases (e.g., Luski and Weinblatt, 1994) and that technology adoption and innovation decreases (e.g., Geroski and Pomroy, 1990) as industry concentration increases. The model result is consistent with the first empirical finding given that managers are more likely to receive side-payments as industry concentration increases. The model is also consistent with the second empirical result given that the deterred would-be-entrepreneur managers would have adopted a new technology to start their ventures.

The third result involves the patterns of new opportunity adoption by would-be-entrepreneur managers and by incumbent firms. The pattern of adoption is based on who adopts as the rewards from adoption increase. The rewards measure the differences in private economic gains from opportunity adoption gross of any competitive effects. When the reward is sufficiently low, no party is interested in adoption. As the reward increases, only the would-be-entrepreneur managers have an incentive to adopt because their opportunity costs are below those of the incumbent firms. Within this range of rewards lies a span where incumbents have the incentive to pay off the managers in order to deter entrepreneurial activity. Increasing the reward further, incumbents then adopt the new opportunity while would-be-entrepreneur managers do not. This reversal occurs in part because the net reward to the entrepreneur is significantly reduced when the incumbent firms in the industry also adopt the opportunity. Finally, when the reward has increased sufficiently, all parties have an incentive to adopt. In the early span of this reward range, incumbents again have the incentive to pay off the managers to deter entrepreneurial activity. This action strictly reduces the number of potential competitors in the industry.

This pattern of opportunity adoption shows

some similarities and some differences to the technology adoption literature. For example, the range of reward values where managers adopt but incumbents do not mirrors the result in the literature where incumbents fail to exploit some opportunity because of sunk costs and cannibalisation (e.g., Conrad and Duchatelet, 1987). An example of the unique contribution of the paper lies in a subset of this range of values where managers have the incentive to adopt but incumbents do not. It is the subset of values where incumbents pay off the managers and deter the adoption of the new opportunity. Such side payments have not been studied in the literature in this employer-employee context for technology adoption, although it is an important issue in entrepreneurship. It is also an important issue in social welfare because the side payments also deter the exploitation of new opportunities that benefit the economy.

The remainder of the paper explores the side payment effect on entrepreneurial activity. The next section describes the phenomenon in general terms, develops the theoretical model, and defines the conditions required to address the research questions. Discussion and extension of the results are followed by conclusions.

2. The model

2.1. *A general overview*

An incumbent firm deters independent entrepreneurial activity on the part of a manager for two reasons. The first reason is to prevent the loss of a valuable manager. The second reason is to prevent the loss of rents due to the increased competition created by a departing manager who subsequently spawns a venture in the same industry.

Consider the first reason for deterrence. When the employer-firm is an oligopolist and the supply of valuable managers is restricted in the short-run then a straightforward examination of the decision to retain a valuable manager is possible. The manager and employer are co-specialized when the manager has built enough experience and expertise to add more value to the firm than an outside manager could and the firm is unique enough so that the manager's experience and expertise is not as valuable to other incumbents. They can determine a fair managerial salary through bargaining. The Nash bargaining solution splits the added value created by the specific manager working at the specific firm equally between the two parties when each has similar bargaining power. However, bargaining power shifts to the manager when the manager finds an attractive new opportunity. The manager can appropriate more of the net value added by the manager-firm combination as long as the firm ends up with some share of it. Thus, the employer deters entrepreneurial activity on the part of a manager with an increase in salary that is ultimately restricted in size by the net value added by the unique manager-firm combination.

Consider the second reason for deterrence. There are at least three different bases for how a manager can compete against a former employer. There is competition based on pure substitution. There is competition based on the timing of adoption of new knowledge. There is competition based on cumulative technologies where the cost of using them decreases over time.

Competition based on pure substitution is straightforward. As a simple example, consider an industry characterised by Cournot equilibrium – where firms in the industry choose output considering both the demand function and the reactions of any competing firms, and where they know the market sets price. Initially, there is a monopoly. Now imagine that one manager employed by the monopolist has an opportunity to create a direct competitor. The manager has an incentive to do so when the manager's current compensation is less than the share of the potential duopoly profits. The employer-monopolist has an incentive to pay off the manager to deter the entrepreneurial activity by increasing the manager's compensation. This is because monopoly profits are greater than the sum of profits in a duopoly. Thus, the employer would still earn greater-than-duopoly profits even after paying off a manager who was capable of operating a competing firm. Similar reasoning can extend to larger incumbent oligopolies and their incentives to deter, collectively or individually, the entrepreneurial activity of their managers.

Competition based on the timing of adoption of new knowledge is more complicated. Consider an incumbent that has invented a technology that

either is valued initially only by an emerging market or is a next-generation technology with broad market appeal. While the incumbent firm may not have an incentive to develop and exploit the opportunity, a manager who has overseen the project may. The manager may wish to leave the firm and start a new venture based on the new technology.

It is important to explain why the incumbent firm would not want to introduce the new technology, and there are a number of possible reasons. The technology may yield a next-generation type product that would not only cannibalise sales of products based on existing technologies but also introduce many associated problems.[3] The technology may be initially only of value to a small emerging market (i.e., very early adopters who need the highest performance). Profits from such a market may not be large enough for the incumbent firm, although they might be for the smaller entrepreneur. As well, an incumbent may face costs arising from negative externalities when pursuing the new technology that an entrepreneur would not face.[4]

The history of the disk-drive industry (e.g., Christensen and Bower, 1996) provides a rough example for the competition based on the timing of adoption of new knowledge. Incumbent firms invented the next generation of many technologies but saw most of the potentially advanced products resulting from the technology as attractive to only emerging and small market-niches. These incumbents allowed other firms to develop the *niche-targeted* technologies while they focused on principal-market technologies. The firms targeting niches included new ventures founded by the managers who oversaw the creation of the new technologies while employed by the incumbent firms. The niche-targeted technologies subsequently turned out to better suit the main markets in the longer term. This allowed entrepreneurs to effectively displace incumbents with technologies developed, to some extent, by the incumbents themselves.

A model of competition based on cumulative technologies follows.

2.2. *Model development*

Five assumptions of convenience contribute to the model's development. First, utility is measured in monetary terms in order to make comparison of alternatives easier.[5] Second, an incumbent has no other method of deterring the entrepreneurial inclinations of their managers than paying them off. This makes the assessment of the alternatives considered by both employers and employees easier because it is expressed in the same monetary terms. Third, new, commonly available technologies originate from exogenous rather than endogenous sources. This simplifies the model, as it does not need to include the complex process of technological innovation. Fourth, little informational uncertainty exists among the parties regarding the utility functions, the demand function, the technologies, and the probabilities of successful technology adoption. This simplifies the model because accounting of learning costs and risk-reducing activities is not required. Fifth, financial markets are efficient in that any manager who wants to launch a viable industry-related venture can find the financing to do so. This simplifies the model because the entrepreneur-investor relationship is made peripheral. The latter part of the discussion section (Section 2.4) reviews the implications of these simplifying assumptions on the results.

Five generalisation-type assumptions also contribute to the model's development. These five generalization-type assumptions frame the model in the existing literature. First, managers with industry experience are superior potential entrepreneurs.[6] This stylized fact is supported in the literature (e.g., Chandler, 1996). Industry experience is the source of the majority of entrepreneurial ideas, (e.g., see Case's 1989 survey of ideas) and it is a source of valuable resources for new ventures like supplier contacts and production expertise. It is necessary for the entrepreneur to have industry experience to qualify for investment from most capital markets (e.g., Riquelme and Rickards, 1992). Second, it is possible for entrepreneurs to enter an industry and compete successfully against incumbents when underlying technologies are changing. The memory-less patent race literature (e.g., Reinganum, 1983, 1982, 1979) shows the entrant winning the race

when subsequent monopoly profits are the prize. Experience-based patent races (e.g., Harris and Vickers, 1987, 1985) reveal that when leapfrogging is possible entrants compete successfully with incumbents. This can occur when there are discontinuities in the accumulation of experience, as with multi-stage patent races. Third, production technologies show improvements with cumulative experience. Experience effects, learning curves, Bayesian updating and numerous other theories and constructs use the idea that task efficiency improves at a decreasing rate over time.[7] Fourth, entrepreneurial activity is a function of the opportunity costs of the would-be-entrepreneur. The literature (e.g., Campbell, 1992) supports the presumption that the choice to be an entrepreneur is made on economic grounds among other considerations. Fifth, the phenomenon of a manager-turned-entrepreneur competing with a former employer is not uncommon. The literature cites the influence of previous employers as incubators of entrepreneurs in general (e.g., Westhead, 1990) and of competitive entrepreneurs specifically (e.g., Birley, 1987).

The following model development is set in the context of a generic manufacturing industry and assumes that the exploitable opportunity is a process improvement.[8] The improvement is based on a new technology. The new technology is so different that any adopting incumbent firm faces a new experience curve and starts at a point worse than its current position on the existing experience curve of the old technology.

The theoretical model requires a number of important specifications to operationalise the preceding assumptions and context. At least two separate entities exist at an incumbent firm of interest – an *owner* entity and a *manager* entity.[9] The manager receives compensation for work in the form of a wage and a share of profits. The owner is the residual claimant of the remaining firm profits. While the owner's responsibilities may involve more strategic and financial decisions, the manager's are typically focused on the production level. As such, the manager is in a good position to run a competing firm should the opportunity arise.

Two further specifications involve the technology. First, the efficiency of a production technology increases, at a decreasing rate, as a firm uses that technology over time. The production technology is a major factor in the firm's cost function and, thus, in its profits as well. Second, at time T a new production technology is available that also becomes more efficient over time. This new technology allows a firm to produce the same output at less cost for every given experience level. However, the technology is not so much better that it is cheaper to use in a firm's first time-period of experience than the current technology at a firm's Tth time-period of experience. However, in the long run, because of decreasing efficiency gains, there is a time T_s when the new technology at the $T_s - T$ experience level is cheaper to use than the old technology at the T_s experience level.

The gross profit function of each firm i in the industry made up of n firms at each period in time t is:

$$\prod_{i,t} = (P_t - c_{i,t})\, q_{i,t} \tag{1}$$

where P denotes price, c denotes variable costs, and q denotes output sold (assumed for simplicity to be equal to output produced). Firm output in the industry is assumed homogeneous. Thus, the price in the industry is not firm-specific, but it is industry-specific and time-specific. The inverse demand function at each time-period is:

$$P_t = \phi_P \left[\sum_{i=1}^{n} q_{i,t} \right], \quad \phi'_P < 0 \tag{2}$$

The variable cost to a firm is given by:

$$c_{i,t} = \phi_c[\text{time using its current technology, type of technology in use at firm}] \tag{3}$$

where the function is decreasing in the first argument.

The output of a firm is:

$$q_{i,t} = \phi_{q_i} \left[c_{i,t}, \sum_{j=1}^{n, j \neq i} q_{j,t} \right] \tag{4}$$

where the function is non-increasing in each argument.

Three entry barriers exist to support the oligopoly. First, the probability of successful entry, denoted p ($0 \leq p \leq 1$), differs for owners, managers and others (i.e., outsiders) and is an increasing function of industry experience. The probability

of success for adopter i at time t is denoted by $p_{i,t}$. Outsiders face a larger failure probability at any period in time than owners or managers. They are less exposed to the required knowledge spilled over from the firms, and they are less capable of absorbing the spillovers.[10] Second, start-up costs of a new venture are material, and these are paid in the period of attempted entry whether the venture is ultimately successful or not. Third, there is a material penalty for failure exclusive of the opportunity costs.

Given these entry barriers, an oligopoly exists at time t if the following holds true:

$$p_{e,t}\sum_{\tau=t}^{\infty}[\Pi_{e,t}\delta^{\tau-t}] - C_{\text{start-up}} - (1-p_{e,t})C_{\text{failure}} - (1-p_{e,t})\sum_{\tau=t+}^{\infty}[\text{Opportunity Costs}_e\delta^{\tau-t}] < \sum_{\tau=t}^{\infty}[\text{Opportunity Costs}_e\delta^{\tau-t}]\ \forall\ e \qquad (5)$$

where δ is (1 – discount rate), e is any potential adopter of technology, and $t+$ denotes the time when the failed adopter returns to its previous role.

The new technology is available at time-period T. In order for managers to be the only would-be entrepreneurs with an incentive to exploit the new technology at this time then Equation (5) must hold for owners and outsiders but not for managers. This must hold although the equation is adjusted for the profits available from the new technology. The condition with respect to outsiders holds true when the probability of failure for an outsider differs sufficiently from that for a manager to overcome any difference in opportunity costs.[11] This condition is reasonable because the failure probability is assumed to decrease with industry experience. The condition with respect to owners holds true when the difference in opportunity costs between an owner and a manager is greater than any difference in failure rates. This differential in opportunity costs is expected to arise because owners receive the residual oligopoly profits which are assumed greater than the manager's compensation.

When Equation (5) holds for owners and outsiders but not for managers and the assumptions of the general model hold then the conditions required to answer the first research question are met. Theoretically, there exists a range of functional forms and parameter values that satisfy the conditions because they do not constitute an inconsistent set. Imposing any number of the conditions does not violate the remaining conditions for every possible relevant functional form and parameter value at this general level of model description.

When the conditions required to meet the premise of the first research question are satisfied, owners may have an incentive to deter the managers from becoming entrepreneurs. The owners simply pay the managers more to compensate them for the foregone expected rewards from entrepreneurial activity. This pay off is rational only when it is less than the amount that firm profits are decreased by such activity. The amount that the owners must pay the managers at each time-period t after T is the right-hand-side (RHS) of the adjusted Equation (5) subtracted from its left-hand-side (LHS). The total pay-off is the discounted integral of that compensation at time t as t goes from T to the time when the RHS less the LHS of the adjusted Equation (5) equals zero. This net present value of the pay-off is then compared to the difference in net present value of an owner's earnings with and without entrepreneurial activity starting at time T. If the pay-off is less than the difference in expected earnings then an owner increases the management compensation to deter entrepreneurial activity.

The second research question is answered by comparing an owner's net present value returns from paying off the manager to those returns from alternative strategies including allowing competitive entrepreneurial activity on the part of the manager. As before, there exists a range of functional forms and parameter values that theoretically satisfies not only the conditions required in the first research question but also the condition that the paying off the manager is the best strategy for the owner. The existence of all these conditions is implied again because at this general level of description the conditions do not constitute an inconsistent set. The next sub-section provides a proof of the existence of each set of conditions for a more specific model.

2.3. *Existence of a consistent set of conditions for the Model*

A specific consistent set of conditions implied by the two research questions is formulated using a more specific model of the phenomenon. The model is further specified so as to be mathematically tractable. The simplest set of common economic modelling assumptions that can characterise the phenomenon completely, including the time dimension for the cumulative technologies, defines this specific model. There is linear inverse demand, Cournot competition in supply, and the minimal set of technology factors and time periods.

Formally, assume a linear inverse demand that is constant across time:

$$P_t = A - \sum_{i=1}^{n_t} q_{i,t} \tag{6}$$

where A holds constant across time periods, P denotes price, q denotes quantity, n denotes the number of firms in the industry, t denotes the time period, and i denotes the firm. Assume each firm has a cost function that is denoted by the variable cost alone. The variable cost, $c_{i,t}$, is calculated using one basis production cost C_0 and one of two learning curve factors, α and β ($0 < \beta < \alpha < 1$), depending on whether the old or the new technology is used. Assume that the manager's compensation is made up of two factors – a wage w and a share s of firm profits. Assume Cournot competition as before. This set of assumptions leads to the following profit equation for firm i at time t:

$$\prod_{i,t} = (1 - s)\frac{\left(A + \sum_{j=1}^{n_t, j \neq i} c_{j,t} - n_t c_{i,t}\right)^2}{(n_t + 1)^2} - w \tag{7}$$

Now consider four time-periods – T0, T1, T2, T3. At T0, an oligopoly exists, the old technology is used, and the firms and managers gain experience. There is no allowance for entry. At T1, the old technology is still the only choice, but now entry is possible but not attractive to the managers using the old technology. At T2, the new technology is introduced, and entry using it is possible and attractive to the managers. At T3, the new technology is more efficient than the old technology. A firm that adopted the new technology at T2 has lower production costs than a firm that retained the old technology through to T3, even accounting for the difference in experience using the technologies.

Even in this simple example there are many variables to consider: A, δ, α, β, p, C_0, C_{startup}, C_{failure}, w, s, and n. The symbol δ denotes the rate at which a future period is valued one period earlier, p denotes the probability of success for a manager-turned-entrepreneur, and C_{startup} and C_{failure} denote the start-up and failure costs to new ventures respectively.

The conditions implied by the two research questions set the restrictions on this set of variables. These restrictions are then analyzed for their sensitivity to industry concentration.

Seven conditions need to be fulfilled to satisfy the two research questions – one regarding premature entry, two regarding manager incentives, and four regarding owner incentives. The formal mathematical equations of the seven conditions and their derivatives with respect to increasing industry concentration, n, can be found in the Appendix (where conditions are identified as equations C1 through C7). These equations and derivatives are based on the Equations (1) through (7).

The first condition is that no manager has an incentive to enter at T1 using the old technology. The condition is easier to meet as industry concentration increases when, among other things, p is smaller.

The second condition is that the manager has an expectation of positive compensation, net of the opportunity costs, when starting up the new venture using the new technology at T2. The condition is easier to meet as industry concentration increases when, among other things, p is larger.

The third condition is that the manager will adopt the new technology and start a new venture even when the first owner does. This condition eliminates any incentive of an incumbent to block entry, or threaten to, using this strategy. The condition is easier to meet as industry concentration increases when, among other things, p is larger.

The fourth condition is that none of the owners adopts the new technology when the manager does

at T2. This condition takes a different form than the others. It must be proven that no number of owner firms, x ($1 \leq x \leq n$) chooses to adopt the new technology. Thus, a function f must be created to measure the collective profits generated by the owners when x of them adopts the new technology. If f has no local minimum between $x = 0$ and $x = n$ then it is sufficient that the initial slope of f with respect to x is negative in order to fulfill the condition.[12] The condition is easier to meet as industry concentration increases.

The fifth condition is that the owner's returns from paying off the manager exceed the returns from allowing the manager to become an entrepreneur. The condition is easier to meet as industry concentration increases when, among other things, s is relatively larger than p.

The sixth condition is that the owner's return from paying off the manager is greater than the owner's return from buying out a successful manager-turned-entrepreneur at T3. Although the condition does not need to hold to obtain the required results in the short-term, it must hold in order that the new ventures remain in the economy in the longer-term. The condition is easier to meet as industry concentration increases when, among other things, s is relatively larger than p.

The seventh condition is that the owner's return from paying off the manager is greater than the manager-turned-entrepreneur's compensation. The condition is easier to meet as industry concentration increases when, among other things, p is smaller.

The preceding analysis of the specific functional model form provides one example of the restrictions that can be imposed on important variables to fulfill the conditions implied by the research questions. There are seven restrictions on the eleven variables. There are also non-negativity constraints on all variables, range constraints on δ, α, β, p, and s, as well as ordering constraints on A versus C_0, and on α versus β. Although it may appear that this system of equations is underspecified in terms of restrictions on variables; unfortunately it is not. A formal proof of the existence of a range of variable values that satisfies the restrictions is not trivial. A formal mathematical proof of the existence of this set is algebraically intractable because the roots of the restriction equations cannot be expressed with common mathematical operators because some are higher than quadratic in nature. However, the existence of the set can be proven through a numerical example.[13] A similar form of proof can be applied to the restrictions on derivatives with respect to n to show that the conditions implied by the research questions are more easily satisfied when industry concentration increases.

In this specific model, the benefit to the adopter of the new opportunity is in the form of lower marginal costs of production. The incidental costs of adoption range from minimal for the incumbent to a start-up cost plus a possible failure cost for the entrepreneur. The most important cost to consider is the opportunity cost of the adopter – the manager's foregone compensation or the incumbent's foregone profits using the old technology. By definition, the former is less than the latter, or the owner would instead opt to be a manager. Another asymmetry also affects the difference in each party's decision to adopt. While the manager can create a new venture to reap an owner's level of reward if successful, the incumbent can only reap the rewards of reduced marginal costs. Beyond these gross benefits and costs of adoption are the benefits and costs that competition creates. These competitive benefits and costs are dependent on the number and type of adopters.

Consider what occurs when the benefit-to-cost ratio from adoption increases over a full continuum of values from lowest to highest. For simplicity, consider specifically the incumbent's benefit-to-cost ratio. Gauge it in terms of the discounted difference between using the new technology and using the old technology in the industry, gross of competitive effects (Figure 1).

At the lowest end when the net rewards are insufficient, there are no adopters. Label this the *unattractive* range. As the ratio increases, adoption is more attractive to a manager than to an incumbent as long as the manager's lower opportunity costs are not outweighed by the manager's higher incidental adoption costs. This is the range addressed in the first research question. Label this the *pre-incremental* range. In this range, there is a differential in benefits between manager and incumbent as well as a competitive effect that is detrimental to the incumbent. The benefit differential is indeterminate without specifying variable

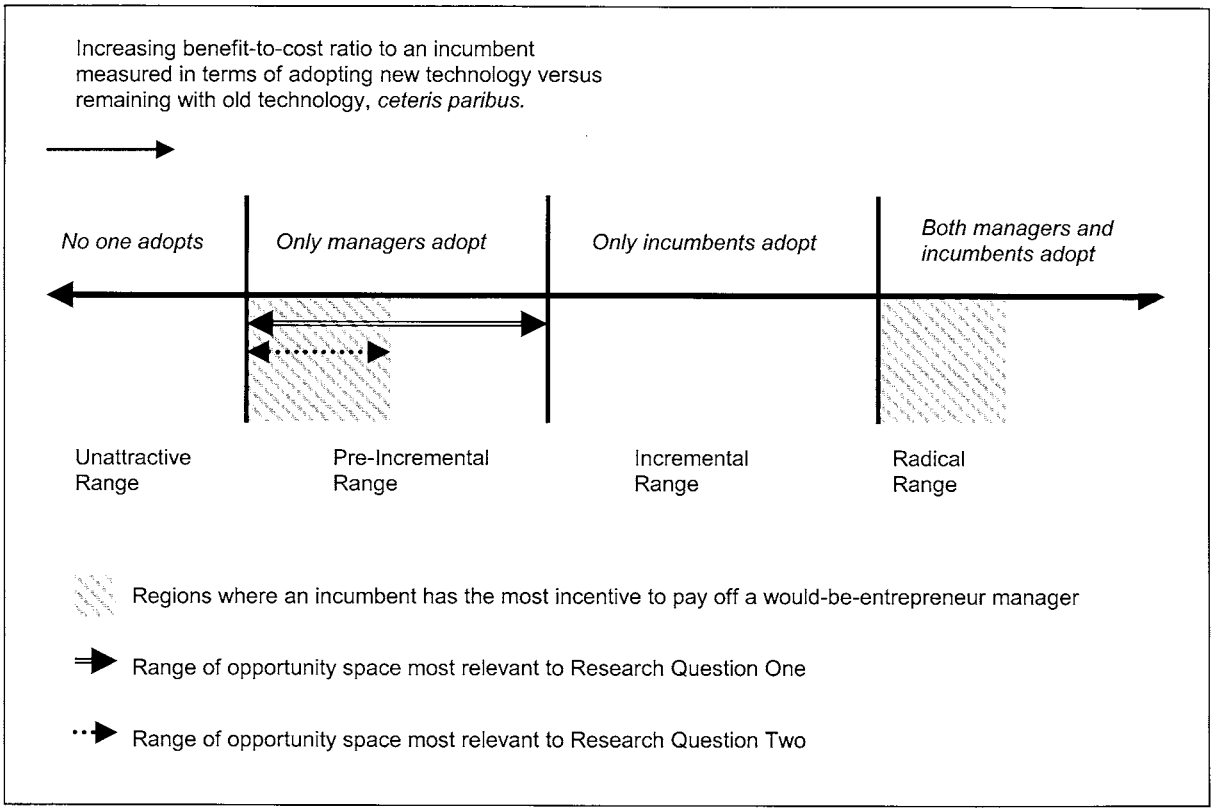

Figure 1. A redefinition of the opportunity space.

values. The competitive effect increases with the benefit-to-cost ratio as long as the incumbent does not adopt because the adopting entrepreneur is increasing its cost advantage over the incumbent. Within the pre-incremental range is a span where the incumbent has the incentive to pay off the manager to deter the manager's adoption of the technology and the subsequent founding of a competitive venture. At the lower end of the pre-incremental range, it is both cheaper to pay off the manager and less costly to allow the manager to found the new venture. In the specific model, the pay-off increases faster than the cost of business stolen by the new venture as the benefit-to-cost ratio of adoption increases. Thus, the conditions that satisfy both of the research questions simultaneously are found in the left-most span of the pre-incremental range.

Farther along the benefit-to-cost ratio of technology adoption, there is a discontinuity in adoption. Here, the incumbents adopt but the managers do not. This change is due solely to a competitive effect that is detrimental to a potential entrepreneur influencing the manager's decision to adopt. When the incumbents adopt then the manager loses any relative cost advantage, and the incumbents experience an increased reward from adoption. They not only deter entrepreneurial activity but do so without any making a pay-off. Label this range where only incumbents adopt the *incremental* range.

Still father along the benefit-to-cost ratio of technology adoption lies a final range. In this range, the net benefits to all parties are sufficiently high that all parties adopt the technology. Benefits have been so radically increased that entrepreneurial entry is attractive, even when accounting for both the opportunity costs and the competitive effects of other adopters. Label this the *radical* range. Interestingly, at the beginning of

this final range, there is also a theoretical span where an incumbent may have the incentive to pay off a manager to deter added competition.

Thus, opportunities that are worth exploiting fall into only three interesting ranges. Opportunities with the conditions that satisfy both of the research questions fall in the start of the first range. Here, welfare is reduced as both competition and efficient adoptions are deterred while rewards to incumbent-firm managers are increased.

2.4. *Discussion*

The analysis of the model generates the following results. First, it has been proven that the conditions implied by the two research questions can be fulfilled. A manager may have an incentive to exploit a new opportunity when an incumbent employer does not, but then that employer may have an incentive to pay off the manager not to pursue it. Second, these conditions have been proven more easily satisfied when industry concentration increases with certain restrictions. Third, the range of attractive opportunities, understood in terms of a continuum ranging from poor to excellent, theoretically has the following pattern – only managers, then only incumbents, then finally both exploit the new opportunity.

Consider separately what each of these results implies. The first result implies that management compensation is based not only on a manager's foregone opportunities with existing firms but also is based on foregone entrepreneurial opportunities. New information technologies, like the Internet, should continue to reduce the search costs for opportunities as well as some of the new venture start-up costs. Consequently, management compensation may be based increasingly on foregone new venture opportunities. The second result implies support for, as well as an explanation of, recent findings regarding the managerial salaries and technology adoption rates in more concentrated industries. The explanation stresses a negative effect of industry concentration. Concentration can increase the alignment of any private costs that provide shared benefits among incumbents, while at the same time it can increase the absolute rents available to each incumbent. This increases incentives for any privately-funded entry-deterring investments, regardless of the effects on social welfare. The third result implies a redefinition of opportunity types, at least in the present context. Concepts of incremental and radical technological progress should be considered from an entrant's perspective as well as from an incumbent's. This produces a pre-incremental range of technological progress where a specific type of entrant adopts while incumbents do not, chiefly due to differences in opportunity costs.

These results are neither intuitive conclusions given the assumptions, nor are they totally dependent on many of the assumptions. The main results hold even when many of the assumptions are relaxed. Consider five examples of what occurs when convenience-type assumptions are relaxed.

First, relax the assumption that owners have no alternatives to deterring entrepreneurial activity than paying off their managers. One obvious alternative to paying off managers ex-post is to insist that managers sign a non-competition agreement ex-ante. However, the courts, which already find it difficult to enforce such contracts.[14] They may find it even more difficult when the entrepreneur is using a different technology, is implementing only non-private industry-level skills, and may not be competing with an exact substitute product or to exactly the same market. Another reason why non-competition agreements may not be a significant factor in deterring managerial entrepreneurial activity is that many potential entrepreneurs would not be approached to sign such an agreement. For example, many entrepreneurs who ended up competing with former employers were co-owners, presidents, franchisees, distributors, sales agents, retailers, or technicians of the employer firms, or operated in a different national market altogether. As such, they were not, or legally could not be, asked to sign such an agreement. Furthermore, examples continue of entrepreneurs starting businesses that compete with former employers (for example, see Bahrami and Evans, 1995, for many examples in Silicon Valley alone). The main model results hold when these entry-deterring alternatives are either ineffective or more costly than the ex-post payoffs.

Second, relax the restriction that the opportunity arises from exogenous sources. If technological progress is made with certainty, and it is

completely endogenous to incumbents, and the incumbents could not appropriate its value but entrepreneurs could, then it would not ever occur. When entrepreneurs can innovate or when uncertainty over technological progress exists then the model results remain.

Third, relax the certainty assumptions in the model. There is little uncertainty in the model other than addressed in the failure rate. Entrepreneurial activity is fraught with uncertainty (e.g., Bouchikhi, 1993; Silverberg et al., 1988), only part of which may be picked up by the failure rate variable. For example, there could be a stochastic return from the new technology. In general, increased uncertainty allows the model results to remain when the uncertainty produces greater room for error or bad luck for the incumbents. This kind of uncertainty increases the possibility of not adopting good opportunities. It also increases the possibility of paying-off managers as insurance against such misfortune.

Fourth, relax the assumption that spillovers occur only at the firm level (i.e., rewards from experience at a technology are available only to those in the firm). Brezis et al. (1993) model them at the national level, and there are arguments for modelling them at a local level, for example, to help explain rents from agglomeration.[15] When spillovers leak outside the firm then incentives for initiating any new activity may be decreased. This results in decreased entrepreneurial activity of managers and lowers the probability of maintaining the model results.

Fifth, relax the assumption that entrepreneurs have access to capital at the same cost as incumbents in the same industry. Capital markets are not so efficient. When capital costs are higher to entrepreneurs than incumbents then the relative net return to an entrepreneur is decreased. Thus, the observed entrepreneurial activity of managers is decreased, as is the probability of maintaining the model results.

3. Extending the model to product differentiation and growing-market type opportunities

Many new ventures are not based on new technological processes but rather on new product designs and on new growth markets. The model outlined in this paper is meant not only to detail how new ventures arise out of process improvement opportunities but also is meant to provide some intuition behind how new ventures arise out of these other types of opportunities.

It is important to explain why there are only three basic types of opportunities before exploring the parallels between them. Consider the standard profit equation; there are only three different elements to manipulate. The cost element, made up of fixed and variable components, leads to process-improvement type opportunities. Therefore, there are opportunities to lower costs in order to increase profits. The price element leads to product-differentiation type opportunities. Thus, there are opportunities for changing the product offering to lower direct competition to increase margins. The quantity element leads to growing-market type opportunities. Thus, there are opportunities for directing efforts at capturing share in expanding niche and substitute markets to increase profitable volume. The strategies associated with these opportunity types are easily recognisable – low-cost, differentiation, and focus. The interrelationships among the elements, however, are complicated and not as easily defined. Entrepreneurs have used numerous variations of strategies based on the three elements to enter markets successfully.[16] Only the two other basic opportunity types, product-differentiation opportunities and growing-market opportunities, are explored in this section.

There exist parallels between the process-improvement opportunities and the product-differentiation opportunities. Cournot competition based on the manufacturing cost differences of homogeneous products has similar features to Bertrand competition based on product attribute differences (for example, product quality or physical product location). The similarities arise when the degree of vertical or horizontal product differentiation is related in specific ways to the distribution of demand for the products along the differentiated attribute (see Tirole, 1989, for examples of this similarity). Also, consider the parallel in how product-differentiation improves over time, for example in the quality dimension. Imagine a product attribute improvement curve as a counterpart to the manufacturing process improvement curve. Past the initial stages of the

product definition, further product improvements arise with experience and effort at a decreasing rate. This is similar to the diminishing returns from experience under manufacturing process improvements. So there is a parallel in travelling down an improvement curve.

To jump to a new product improvement curve requires further explanation. When a new architecture or design arises that constitutes a close substitute to an existing product then a new product-differentiation opportunity exists. Think of the new product as based on a different chassis performing many of the same functions as an existing chassis. Incremental product improvements are simply the components bolted on to the chassis. However, at some future time a better chassis may come along that is superior to the old one even accounting for differences in the availability of compatible components. For example, consider an operating system (O/S) as the chassis and compatible software as components. A newer O/S may initially be a worse value because there are fewer components available. However, time may bring enough appropriate applications so that its long-term value is greater than the old O/S. This is regardless of whether the older product has more applications because, for example, the new O/S is faster or more reliable.

Consider the two parallels combined – incremental product differentiation improvement as travelling down manufacturing process type learning curves, and radical product-differentiation improvements as jumping to totally new manufacturing process type learning curves. They can be combined so that product-differentiation type opportunities completely parallel the manufacturing process opportunities modelled in this paper. As such, the model's results apply to this second opportunity type. Simply use Bertrand competition with quality-differentiated products instead of Cournot competition with homogeneous goods and differing process costs in the model. The same general results arise.

Consider the parallels between the process-improvement opportunities and the growth-market opportunities. Instead of manufacturing processes or product attributes changing, market segments are changing, specifically in their growth rates. The way the changes occur is similar to the competition based on the timing of new knowledge adoption described earlier in the paper (Section 2.1). The parallel of the exploitation of opportunities in growing market niches to the exploitation of opportunities in manufacturing process improvements is based on two assumptions. The first is that markets can be grown incrementally just as processes can be improved incrementally and where the growth improvements are diminishing in returns. The second is that new substitute niche markets often arise that later expand to absorb older markets just like newer manufacturing processes are often improved to the point where they make older ones obsolete. Japanese entry into the North American auto market through the small car niche may be one example of this type of entrepreneurial opportunism where niche markets are grown to absorb established segments of the mass market. Body Shop's entry into the cosmetic market through the environmentally friendly niche may be another example.

The necessary parallels exist under these assumptions. Incremental improvements in manufacturing processes parallel incremental growth of market niches. Jumps to new manufacturing process improvement curves parallel jumps to new growth niches from established segments that such niches expand into in the long-run. When the parallels exist, then the model represents what occurs with the exploitation of the growing-market type opportunities as well. So, the results also hold for this third basic opportunity type.

Continuing along an older manufacturing process or product-quality or growth-market curve may be more attractive to incumbents than jumping to a new curve at an initially worse position (i.e., a higher cost or lower product quality or lower demand) even though that new curve provides a better market position in the long-term. However, the new curve may be attractive to entrepreneurs, especially working managers, due to differences in opportunity costs between the incumbents and entrepreneurs. When this occurs, then the incumbents may have an incentive to deter any entrepreneurial activity that would be detrimental to their long-term competitive position.

4. Conclusions

Relevant industry experience is not only a major source of the ideas and resources that are required to start a successful business, but it also substantially reduces the uncertainties involved in initiating such entrepreneurial activity. The value of such experience rises with its rarity and breadth.[17] In general, this means that managers who are closer to the top of the hierarchy have the more valuable experience. As such, they constitute an important breeding ground of potential entrepreneurial activity.

This paper has explored the conditions under which any such would-be-entrepreneur manager has the incentive to start a new venture. The event that creates the incentive is the availability of a new technology that does not offer enough of an immediate improvement for incumbent firms to adopt it. However, the managers have an incentive to adopt it and start their own businesses because the managers have a lower opportunity cost than their employer firms do.

Moreover, conditions can exist where the owners have an incentive to pay off their managers in order to deter such activity. These side-payments by the owners are legal but potentially detrimental to social welfare because competition and technological adoption are both suppressed. The paper shows that this is more likely to occur when there are fewer incumbents – when industry concentration is high.

These results are consistent with recent empirical work. Specifically, studies have shown that managerial salary levels increase and technology adoptions decrease as industry concentration grows. The first result is consistent with increasing side-payments being offered as the number of incumbents decreases, and the second is consistent with the higher likelihood of technology adoption being deterred as the number of incumbents decreases.

These results have implications for firm strategy. The first implication is in the area of spin-off entrepreneurial activity that occurs when sophisticated international firms locate business activities in less developed countries. The costs and benefits of the decision calculus in Equation (5) are altered significantly in favour of entrepreneurial activity for a local manager when the rest of the local competition is weak and the manager's personal expertise is locally scarce. The implication for the firm is to keep recent technological improvements away from that country in order to deter entrepreneurial activity on the part of its managers in that country. Such a strategy has additional benefits, for example, it allows the firm to sell last-generation-technology inventories in that country. But the strategy but also entails costs; in this case it is the lack of local customisation based on local innovations that would make products in that country more profitable. Governments may want to consider such costs carefully in setting policies on foreign investments when entrepreneurial activity is an issue.

The second implication involves the use of options and the use of internal venture capital by incumbent firms. Financial options theory is increasingly applied to firm strategy. Consequently, firms are making decisions that more accurately value the worth of strategies that delay commitments. They are keeping more options open. This approach should reduce the cannibalization effect in the model. The incumbent firms should have less attachment to any current technology and be more open to adopting a new one when each is considered as an option. This would reduce the opportunity for the *compete-preneurs*; the entrepreneurs that start up new ventures to compete against their employers. Alternatively, the incumbents may want to use the would-be-entrepreneurs as a hedge. Incumbents would do so by investing in an entrepreneurial manager's spin-off venture. This scheme would not only make it easier for the incumbent to buy out the spin-off should it be successful but it also makes it easier to retain the valued manager.

Continuing the research on the sources, endurance, and deterrence of entrepreneurial activity may help to satisfy the current interest in new venture effects on the economy held by many academics, businesspeople, and policy-makers. This interest is piqued further by recent technological and organisational changes. The phenomenal rise of Internet-related ventures (e.g., Amazon.com, eToys.com) successfully competing against established firms that use more traditional marketing and distribution methods is one example of the impact of a recent technological change. The emergence of lean and virtual new

ventures (e.g., Dell) that compete against more established diversified firm through efficient outsourcing and networking is an example of the impact of a recent organizational change. In the short-term, such changes make the research questions posed in this paper of greater concern because these changes allow would-be-entrepreneurs more opportunities to exploit with lower costs of entry.

Recent developments in technology, organization, expansion, and firm decision-making prompt the need for continued research into the factors that influence entrepreneurs, entrepreneurship, the actions of existing competitors, and the impact of entrepreneurship on incumbents. This paper is one such piece of research focusing on factors that influence new venture creation and its private deterrence by incumbents.

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Appendix

$$C_{\text{startup}} + C_{\text{failure}}(1-p) + w(1+\delta+\delta^2) + \frac{s}{(n+1)^2}\left[(A-\alpha C_0)^2 + \delta(A-\alpha^2 C_0)^2 + \delta^2(A-\alpha^3 C_0)^2\right]$$
$$> \frac{p(1-s)}{(n+2)^2}\left[(A - C_0(1+n(1-\alpha)))^2 + \delta(A-\alpha C_0(1+n(1-\alpha)))^2 + \delta^2(A-\alpha^2 C_0(1+n(1-\alpha)))^2\right] \quad \textbf{(C1)}$$

$$-C_{\text{startup}} - C_{\text{failure}}(1-p) - w(1+\delta) - \frac{s}{(n+1)^2}\left[(A-\alpha^2 C_0)^2 + \delta(A-\alpha^3 C_0)^2\right]$$
$$+ \frac{p(1-s)}{(n+2)^2}\left[(A + n\alpha^2 C_0 - (n+1)C_0)^2 + \delta(A + n\alpha^3 C_0 - (n+1)\beta C_0)^2\right] > 0 \quad \textbf{(C2)}$$

$$-C_{\text{startup}} - C_{\text{failure}}(1-p) - w(1+\delta) - \frac{s}{(n+1)^2}\left[(A + (n-1)\alpha^2 C_0 - nC_0)^2 + \delta(A + (n-1)\alpha^3 C_0 - n\beta C_0)^2\right]$$
$$+ \frac{p(1-s)}{(n+2)^2}\left[(A + (n-1)\alpha^2 C_0 - nC_0)^2 + \delta(A + (n-1)\alpha^3 C_0 - (n-1)\beta C_0)^2\right] > 0 \quad \textbf{(C3)}$$

$$\left.\frac{\partial f}{\partial x}\right|_{x=0} < 0 \Rightarrow C_0\{n(n+4)[(1-\alpha^2)^2 + \delta(\alpha^3-\beta)^2] + 4\alpha^2[1-\alpha^2-\alpha\delta(\alpha^3-\beta)]\} < 4A[1-\alpha^2-\delta(\alpha^3-\beta)]$$
$$\Rightarrow \frac{\partial}{\partial n}\left[\left.\frac{\partial f}{\partial x}\right|_{x=0}\right] < 0 \quad \textbf{(C4)}$$

$$C_{\text{startup}} + C_{\text{failure}}(1-p) + w(1+\delta) + \frac{1-(1-p)(1-s)}{(n+1)^2}\left[(A-\alpha^2 C_0)^2 + \delta(A-\alpha^3 C_0)^2\right]$$
$$- \frac{p(1-s)}{(n+2)^2}\left[(A + n\alpha^2 C_0 - (n+1)C_0)^2 + \delta(A + n\alpha^3 C_0 - (n+1)\beta C_0)^2\right]$$
$$> \frac{p(1-s)}{(n+2)^2}\left[(A + C_0 - 2\alpha^2 C_0)^2 + \delta(A + \beta C_0 - 2\alpha^3 C_0)^2\right] \quad \textbf{(C5)}$$

$$C_{\text{startup}} + C_{\text{failure}}(1-p) + w(1+\delta) + \frac{1-(1-p)(1-s)}{(n+1)^2}[(A-\alpha^2C_0)^2 + \delta(A-\alpha^3C_0)^2]$$
$$- \frac{p(1-s)}{(n+2)^2}(A + n\alpha^2C_0 - (n+1)C_0)^2$$
$$> p\left[\frac{(1-s)}{(n+2)^2}(A + C_0 - 2\alpha^2C_0)^2 + \frac{(1-s)}{(n+1)^2}\delta(A-\alpha^3C_0)^2\right] \quad \textbf{(C6)}$$

$$C_{\text{startup}} + C_{\text{failure}}(1-p) - w(1+\delta) + \frac{(1-s)}{(n+1)^2}[(A-\alpha^2C_0)^2 + \delta(A-\alpha^3C_0)^2]$$
$$> \frac{p(1-s)}{(n+2)^2}[(A + n\alpha^2C_0 - (n+1)C_0)^2 + \delta(A + n\alpha^3C_0 - (n+1)\beta C_0)^2] \quad \textbf{(C7)}$$

The first derivatives with respect to n for equations (2) to (4) and (6) to (8) are provided below:

$$\frac{\partial(\textbf{C1})}{\partial n} < 0 \Rightarrow (n+2)^3 s[(A-\alpha C_0)^2 + \delta(A-\alpha^2C_0)^2 + \delta^2(A-\alpha^3C_0)^2]$$
$$> (n+1)^3 p(1-s)\left[\begin{array}{l}(A - C_0(1+n(1-\alpha)))^2 + \delta(A-\alpha C_0(1+n(1-\alpha)))^2 + \\ \delta^2(A-\alpha^2C_0(1+n(1-\alpha)))^2 + \\ C_0(n+2)(1-\alpha)\left[\begin{array}{l}(A - C_0(1+n(1-\alpha))) + \alpha\delta(A-\alpha C_0(1+n(1-\alpha))) + \\ \alpha^2\delta^2(A-\alpha^2C_0(1+n(1-\alpha)))\end{array}\right]\end{array}\right]$$

$$\frac{\partial(\textbf{C2})}{\partial n} < 0 \Rightarrow (n+2)^3 s[(A-\alpha^2C_0)^2 + \delta(A-\alpha^3C_0)^2]$$
$$< (n+1)^3 p(1-s)\left[\begin{array}{l}(A + n\alpha^2C_0 - (n+1)C_0)^2 + \delta(A + n\alpha^3C_0 - (n+1)\beta C_0)^2 + \\ C_0(n+2)\left[\begin{array}{l}(1-\alpha^2)(A + n\alpha^2C_0 - (n+1)C_0) - \\ \delta(\alpha^3-\beta)(A + n\alpha^3C_0 - (n+1)\beta C_0)\end{array}\right]\end{array}\right]$$

$$\frac{\partial(\textbf{C3})}{\partial n} < 0 \Rightarrow (n+2)^3 s[(A + (n-1)\alpha^2C_0 - nC_0)^2 + \delta(A + (n-1)\alpha^3C_0 - n\beta C_0)^2]$$
$$< (n+1)^3 p(1-s)\left[\begin{array}{l}(A + (n-1)\alpha^2C_0 - nC_0)^2 + \delta(A + (n-1)\alpha^3C_0 - n\beta C_0)^2 + \\ C_0(n+2)\left[\begin{array}{l}(1-\alpha^2)(A + (n-1)\alpha^2C_0 - nC_0) - \\ \delta(\alpha^3-\beta)(A + (n-1)\alpha^3C_0 - n\beta C_0)\end{array}\right]\end{array}\right]$$

$$\frac{\partial(\textbf{C5})}{\partial n} < 0 \Rightarrow (s+p-sp)(n+2)^3[(A-\alpha^2C_0)^2 + \delta(A-\alpha^3C_0)^2]$$
$$> (n+1)^3 p(1-s)\left[\begin{array}{l}(A + n\alpha^2C_0 - (n+1)C_0)^2 + \delta(A + n\alpha^3C_0 - (n+1)\beta C_0)^2 + \\ C_0(n+2)\left[\begin{array}{l}(1-\alpha^2)(A + n\alpha^2C_0 - (n+1)C_0) - \\ \delta(\alpha^3-\beta)(A + n\alpha^3C_0 - (n+1)\beta C_0)\end{array}\right] \\ (A + C_0 - 2\alpha^2C_0)^2 + \delta(A + \beta C_0 - 2\alpha^3C_0)^2\end{array}\right]$$

$$\frac{\partial(\textbf{C6})}{\partial n} < 0 \Rightarrow (s+p-sp)(n+2)^3[(A-\alpha^2C_0)^2 + \delta(A-\alpha^3C_0)^2]$$
$$> p(1-s)\left[\begin{array}{l}(n+1)^3\left[\begin{array}{l}(A + n\alpha^2C_0 - (n+1)C_0)^2 + (A + C_0 - 2\alpha^2C_0)^2 + \\ (n+2)(1-\alpha^2)C_0(A + n\alpha^2C_0 - (n+1)C_0)\end{array}\right] \\ (n+2)^3\delta(A-\alpha^3C_0)^2\end{array}\right]$$

$$\frac{\partial(\mathbf{C7})}{\partial n} < 0 \Rightarrow (n+2)^3[(A-\alpha^2C_0)^2 + \delta(A-\alpha^3C_0)^2]$$
$$> (n+1)^3 p \left[\begin{array}{l} (A + n\alpha^2C_0 - (n+1)C_0)^2 + \delta(A + n\alpha^3C_0 - (n+1)\beta C_0)^2 + \\ C_0(n+2)\left[\begin{array}{l} (1-\alpha^2)(A + n\alpha^2C_0 - (n+1)C_0) - \\ \delta(\alpha^3 - \beta)(A + n\alpha^3C_0 - (n+1)\beta C_0) \end{array} \right] \end{array} \right]$$

Notes

[1] For example, Cooper et al. (1986) study the manager-turned-entrepreneur, Gene Amdahl. Examples of the deterrence of the phenomenon, where managers are paid off not to compete through new ventures, are expectedly lacking.

[2] Entrepreneurial activity accounts for a significant and growing proportion of employment and innovative activity in many advanced nations. While the claim of superiority of new and small business to generate both innovation and net job growth is in question, the significance of the contribution of these businesses in modern economies is not. Both the literature that supports the claims of superiority (e.g., Acs and Audretsch, 1988, 1987) and that refutes such claims (e.g., Tether, 1998) find that the contributions of small and new business to job creation and to technological progress are important. Currently, examples from well-publicized venture areas as Silicon Valley and from internet-related industries increase at least the public's perception that such contributions continue to have an impact on modern economies.

[3] For example, the new technology may create a costly standards war over the exact form of the next generation of technology. It may also create a costly delay in sales as the majority of the market waits for the next and future generations of the technology before they purchase. It may even create dissatisfaction among existing customers as their network externalities and current product values diminish with the introduction of new technology. It may also possibly eliminate existing second sources of a product that are valuable to both the firm and consumers.

[4] Consider, for example, an incumbent drawing further funds from imperfect capital markets. The incumbent needs the additional funds both to invest in capacity expansion in its current market and to invest in a riskier new technology. If investors cannot monitor the firm's capital expenditures effectively (i.e., they cannot determine whether funds are being invested in the current or the new technology) then they may demand a premium on the loan reflecting the information hazard. The premium would be in excess of what the efficient risk premium would be if monitoring were costless. If the excess premium is greater than the expected value-added that the new technology alone could bring to the firm then the incumbent has no incentive to adopt the new technology. When the entrepreneur takes on the project, however, the financial markets would not have to consider alternative uses of funds and, thus, would not impose any added costs (i.e., the excess premium). This difference in financing costs may leave the project attractive only to the entrepreneur. Further, failure in the project would have repercussions on existing incumbent business. For example, the reputation of the incumbent may be tarnished resulting in a loss of goodwill and credit. The entrepreneur, however, need not worry about these repercussions on existing business (as there it has no other businesses). Again, the asymmetry in negative externalities may lead to a higher valuation of the project by the entrepreneur.

Although the negative externality is imposed only on the incumbent firm, the entrepreneur will generally encounter higher financing costs for any given project or technology adoption. Nevertheless, the excess premium charged to the incumbent constitutes another cost that enters into the decision whether to adopt the new technology, making the adoption less likely.

[5] Any pay-off, compensation, or opportunity cost referred to in this paper is assumed purely monetary for simplicity of exposition and modeling. Non-monetary compensation and costs can be accommodated (e.g., consider perks provided by firms to managers, or the satisfaction an entrepreneur gets from being successful) in a more complex model, however, without significant changes in the results. A related literature addresses the motivations of entrepreneurship. Entrepreneurs do not generally *claim* that economic profit is the primary motive (e.g., Stewart et al., 1999). Regardless of what the true motivations are, however, the economic reward remains an important factor. It is an explanatory variable in most studies that survey the claims of entrepreneurs (Campbell, 1992).

[6] The assumption that an entrepreneur's experience correlates well with new venture success is not without controversy. There are logical arguments in support (see arguments following in the paper). There is empirical evidence that venture capitalists believe it (see cites following in the paper). There is empirical support that management experience is an important factor in venture success (e.g., Hustedde and Pulver, 1992). There is empirical support that technology-based ventures are more successful when a greater technology transfer occurs as a result of experience at the source organization (e.g., Roberts, 1992, 1991). However, reviews of the relevant literature (e.g., Reuber and Fischer, 1994) fail to find a consistent, positive correlation between an entrepreneur's experience and venture success.

[7] Cumulative technology is also associated with experience based on task volume rather than simply time spent performing a task. Efficiency improvements based on production volume complicate the dynamic optimizations in this paper, but do not alter the results. A cursory check reveals that Cournot oligopoly incumbents may actually produce less output per period under volume-based, rather than time-based, cumulative production. This would increase the rents available to both incumbents and potential entrepreneurs.

[8] The context appears more restrictive than it actually is. The manufacturing firm representation and the functional representation of a process improvement technology are both simple to model, and algebraically tractable. However, the general model has a larger range of applicability than this context implies. The *Extensions* section (Section 3) of the paper does

discuss the application to changes in products and in markets versus changes in processes. Explicitly, the model does apply to firms in the service sectors as well. Many of them use technologically dependent processes to generate their services. For example, consider how the Internet has changed book retailing and travel agency. The extensions to products and markets naturally also apply to services and to their markets.

[9] Either entity can be, at the most general, composed of multiple individual agents. The owner can be widely dispersed shareholders who act as a single decision-making entity. The manager can be a number of managers who collectively constitute an entrepreneurial threat. The model and specific functional example assume that each entity is a single agent for simplicity. Thus, the focal firm may be publicly-traded and of any size, and the threat posed by the manager can be quite significant (e.g., a number of partners leave a firm with their client lists to start a rival).

[10] The role of spillovers is important to consider when studying the entry of firms in technology-related industries, especially when the basis technology is changing. For the general model, it is not necessary that outsider entrepreneurs (e.g., new firms founded by managers from elsewhere) garner no or even fewer spillovers from the target industry than manager-turned-entrepreneurs. It is only necessary that there is an incentive for a target-industry manager to become an entrepreneur in the target industry regardless of whatever other entry occurs. This latter condition is more likely to occur with less entry and fewer extra-firm spillovers. The literature review contains references to work in the area of new venture success, formation, and access to capital as a function of the venture managers' related experience. This is an indirect way of supporting the assumption that the target-industry managers should capture more of the spillovers. The literature on the role of spillovers answers the question of which firms are best able to capture the spillovers; the specific literature concerning absorptive capacity is most direct in the answer. The defining article by Cohen and Levinthal (1990) constructs the firm-level capacity from an individual-level analysis. The ideas concerned thus apply well to the entrepreneur-level capacity to absorb and apply spillovers from target-industry firms. Individuals have to be intensely exposed to related knowledge in order to learn new knowledge better. This hypothesis is embodied in a focal assumption of the present paper. Target-industry managers must have greater absorptive capacity than managers-from-elsewhere. This assumption is also consistent with the hypothesis that proximity to the spillover source will enhance absorption (e.g., by removing any noise and delay in accessing the knowledge).

[11] In reality, outsiders (e.g., serial entrepreneurs, students, immigrants, academics, etc.) do regularly start-up new ventures. This is because industry experience is only one important factor in the choice to start up a new firm and in its subsequent performance. In the model it is assumed that industry experience is the most important factor, all else being equal except opportunity costs. In the specific functional example, the outsiders are completely assumed away for algebraic simplicity. These assumptions are made because the existence of outsiders does not affect the main results of the paper. It may make it more difficult for manager-turned-entrepreneurs to succeed given the increased competition from outsiders, but it does not change the general result that the managers still pose a threat that their employers must deal with.

[12] When f does have a local minimum, then another condition is required – that the value of f at $x = n$ be less than or equal to that at $x = 0$. This condition is met through the functional form (i.e., $A >> C_0$). Since the second derivative of f with respect to x is not a function of x, no other cases of local extrema need be considered (i.e., the condition will hold).

[13] One example set of values is: $A = 10$, $C_{\text{startup}} = 0.35$, $C_{\text{failure}} = 0.35$, $C_0 = 1$, $n = 5$, $p = 0.9$, $\delta = 0.95$, $\alpha = 0.9$, $\beta = 0.6$, $w = 0.5$, $s = 0.2$. This set of variable values meets the conditions implied by the two research questions. A percent decrease in marginal production costs results in a proportional percent change in potential overall welfare (i.e., consumer surplus plus compensation to owners and managers). For every 1% decrease in costs, there is a 0.4% increase in the welfare that could be realized in the industry if the first manager was not paid off by the employer.

[14] Courts find it difficult to enforce many non-competition contracts because they effectively take away an employee's best source of income, and can be used as a threat by employers to reduce an employee's earnings once the contract is signed. It is not necessarily in the employer's best interest to enforce the contract either. Enforcement would mean that there would be a lot less cross-mixing of the labor force among competitors, which is not necessarily optimal when diversification is valued. For example, absorptive capacity may increase with a broader knowledge base resulting from employees being trained at many different companies, including competitors.

[15] Consider a general model similar to the one presented here, but with technological efficiencies that spill over locally instead. As each firm in a geographic area gains experience at a given technology, every other firm using that technology learns the efficiency lessons as well. Thus, each firm using a technology is as efficient as the most experienced firm is. If technological efficiency improves with the sum of local experience, then spillovers are even of greater importance to firms. The main effect of such a local spillover assumption on the general model is that entrepreneurs who decide to exploit a new technology would have the incentive to locate geographically distant from incumbents. This way they can better appropriate benefits from experience at the new technology. Again, incumbents may not have the incentive to adopt the new technology or move to the entrepreneurs' new location if the costs of switching away from the old technology are large enough. The result of this story would be separate geographic locations for successive major generations of technology in an industry. Perhaps the east coast mainframe software versus the west coast PC-software industry is one example of such a phenomenon.

[16] The literature that documents many of the entry wedges used by entrepreneurs includes McDougall et al. (1992), McDougall and Robinson (1990), and Vesper (1990). All new venture strategies include at least one of the process, product, and market dimensions. Other dimensions include target growth rates, promotion intensity, and level of vertical integration.

[17] Consider managerial experience to be a form of *strategic*

asset (Amit and Schoemaker, 1993) to the manager. Its value grows with appropriability, demand, and scarcity. Scarcity increases with movement up the organizational pyramid – where fewer positions are available. Demand increases with breadth because more customers vie to purchase that experience. Appropriability increases as the manager gains the experience that creates the opportunity to be an entrepreneur. Entrepreneurial experience may also be considered a strategic asset, and this may explain why venture capitalists prefer to fund serial entrepreneurs as well as entrepreneurs with relevant industry and management experience.

References

Acs, Z. J. and D. B. Audretsch, 1987, 'Innovation, Market Structure, and Firm Size', *The Review of Economics and Statistics* **69**(4), 567–574.

Acs, Z. J. and D. B. Audretsch, 1988, 'Innovation in Large and Small Firms: An Empirical Analysis', *The American Economic Review* **78**(4), 678–690.

Amit, R. and P. J. H. Schoemaker, 1993. 'Strategic Assets and Organizational Rent', *Strategic Management Journal* **1**(4). 33–46.

Bahrami, H. and S. Evans, 1995, 'Flexible Re-cycling and High-technology Entrepreneurship', *California Management Review* **37**(3), 62–89.

Birley, S., 1987, 'New Ventures and Employment Growth', *Journal of Business Venturing* **2**(2), 155–165.

Bouchikhi, H., 1993, 'A Constructionist Framework for Understanding Entrepreneurship Performance', *Organization Studies* **14**(4), 549–570.

Brezis, E. S., P. R. Krugman, and D. Tsiddon, 1993, 'Leapfrogging in International Competition: A Theory of Cycles in National Technological Leadership', *American Economic Review* **83**(5), 1211–1219.

Campbell, C. A., 1992, 'A Decision Theory Model for Entrepreneurial Acts', *Entrepreneurship: Theory & Practice* **17**(1), 21–27.

Case, J., 1989, 'The Origins of Entrepreneurship', *Inc.* (June), 54.

Chandler, G. N., 1996, 'Business Similarity as a Moderator of the Relationship Between Pre-ownership Experience and Venture Performance', *Entrepreneurship: Theory and Practice* **20**(3), 51–65.

Christensen, C. M. and J. L. Bower, 1996, 'Customer Power, Strategic Investment, and the Failure of Leading Firms', *Strategic Management Journal* **17**(3), 197–218.

Cohen, W. M. and D. A. Levinthal, 1990, 'Absorptive Capacity: A New Perspective on Learning and Innovation', *Administrative Science Quarterly* **35**, 128–152.

Conrad, C. and M. Duchatelet, 1987, 'New Technology Adoption: Incumbent versus Entrant', *International Journal of Industrial Organization* **5**, 315–321.

Cooper, A. C., 1985, 'The Role of Incubator Organizations in the Founding of Growth-Oriented Firms', *Journal of Business Venturing* **1**, 75–86.

Cooper, A. C., G. E. Willard and C. Y. Woo, 1986, 'Strategies of High-Performing New and Small Firms: A Reexamination of the Niche Concept', *Journal of Business Venturing* **1**, 247–260.

Fucini, J. J. and S. Fucini, 1985, *Entrepreneurs, the Men and Women Behind Famous Brand Names and How They Made It*, Boston: G.K. Hall & Co.

Geroski, P. A. and R. Pomroy, 1990, 'Innovation and the Evolution of Market Structure', *The Journal of Industrial Economics* **38**(3), 299–315.

Harris, C. and J. Vickers, 1985, 'Perfect Equilibrium in a Model of a Race', *Review of Economic Studies* **52**, 193–209.

Harris, C. and J. Vickers, 1987, 'Racing with Uncertainty', *Review of Economic Studies* **54**, 1–21.

Hustedde, R. J. and G. C. Pulver, 1992, 'Factors Affecting Equity Capital Acquisition: The Demand Side', *Journal of Business Venturing* **7**(5), 363–374.

Luski, I. and J. Weinblatt, 1994, 'Concentration and the Inter-industry Wage Structure: The Israeli Manufacturing Sector', *Applied Economics* **26**(2), 121–127.

McDougall, P. P. and R. B. Robinson, 1990, 'New Venture Strategies: An Empirical Identification of Eight 'Architypes' of Competitive Strategies for Entry', *Strategic Management Journal* **11**, 447–467.

McDougall, P. P., R. B. Robinson and A. S. DeNisi, 1992, 'Modelling New Venture Performance: An Analysis of New Venture Strategy, Industry Structure, and Venture Origin', *Journal of Business Venturing* **7**, 267–289.

Reinganum, J. F., 1979, 'Dynamic Games with R&D Rivalry', Ph.D. Dissertation, Northwestern University.

Reinganum, J. F., 1982, 'A Dynamic Game of R&D: Patent Protection and Competitive Behavior', *Econometrica* **50**, 671–688.

Reinganum, J. F., 1983, 'Uncertain Innovation and the Persistence of Monopoly', *The American Economic Review* **73**(4), 741–748.

Riquelme, H. and T. Rickards, 1992, 'Hybrid Conjoint Analysis: An Estimation Probe in New Venture Directions', *Journal of Business Venturing* **7**(6), 505–518.

Roberts, E. B., 1991, 'The Technological Base of the New Enterprise', *Research Policy* **20**(4), 283–298.

Roberts, E. B., 1992, 'The Success of High-Technology Firms: Early Technological and Marketing Influences', *Interfaces* **22**(4), 3–12.

Silverberg, G., G. Dosi, and L. Orsenigo, 1988, 'Innovation, Diversity and Diffusion: A Self-Organisation Model', *Economic Journal* **98**(393), 1032–1054.

Stewart, W. H., W. E. Watson, J. C. Carland, and J. W. Carland, 1999, 'A Proclivity for Entrepreneurship: A Comparison of eEntrepreneurs, Small Business Owners, and Corporate Managers', *Journal of Business Venturing* **14**(2), 189–214.

Tether, B. S., 1998, 'Small and Large Firms: Sources of Unequal Innovations?', *Research Policy* **27**(7), 725–745.

Tirole, J., 1989, *The Theory of Industrial Organization*, The MIT Press, Cambridge, MA.

Vesper, K. H., 1990, *New Venture Strategies* (rev. ed.), New Jersey: Prentice Hall.

Westhead, P., 1990, 'A Typology of New Manufacturing Firm Founders in Wales: Performance Measures and Public Policy Implications', *Journal of Business Venturing* **5**(2), 103–122.