# Mergers, Spinoffs, and Employee Incentives

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This article studies mergers between competing firms and shows that while such mergers reduce the level of product market competition, they may have an adverse effect on employee incentives to innovate. In industries where value creation depends on innovation and development of new products, mergers are likely to be inefficient even though they increase the market power of the post-merger firm. In such industries, a stand-alone structure where independent firms compete both in the product market and in the market for employee human capital leads to a greater profitability. Furthermore, our analysis shows that multidivisional firms can improve employee incentives and increase firm value by reducing firm size through a spinoff transaction, although doing so eliminates the economies of scale advantage of being a larger firm and the benefits of operating an internal capital market within the firm. Finally, our article suggests that established firms can benefit from creating their own competition in the product and labor markets by accommodating new firm entry, and the desire to do so is greater at the intermediate stages of industry/product development. (*JEL* G34)

This article studies the effect of mergers on employee incentives and shows that in industries with high human capital intensity, mergers between competing firms can be inefficient, since they weaken employee incentives to innovate. Hence, our article provides an explanation for why many mergers fail to create value even though they reduce the level of competition in the product market. In addition, our analysis suggests that a multidivisional firm can improve employee incentives and create value by reducing firm size through a spinoff transaction.

We consider two firms operating in the same product market where firm value is created by developing innovations generated by employees. Innovation arises as an outcome of costly effort exerted by employees. The firms can choose between two types of organization structure. The first is a stand-alone structure where the two firms operate independently in the same product market. The second is a merger where the two firms merge into a single firm.

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The stand-alone structure and the merger are different in terms of their effect on product market competition and competition for employee human capital. In the stand-alone structure the two firms compete with each other in the final goods market. In addition, the presence of two separate firms in the same product market implies that employees can move from one firm to another, implying that the firms also compete for employee human capital. The merger combines the two firms into a single firm, and reduces competition in the product market. At the same time, the merger also reduces competition for employee human capital by decreasing the number of stand-alone firms in the industry.

In our model, firm expected profits critically depend on the choice of organization structure. In the stand-alone structure, greater competition in the product market is costly for firms, since it implies a lower ex post payoff from employee innovations. The stand-alone structure also leads to greater competition for employee human capital and higher employee rents. Although higher employee rents imply lower firm payoffs from employee innovations, they may result in greater ex ante expected firm profits by improving employee effort. This is because in the absence of complete contracts, employees face a hold-up problem where they may obtain too low rents from ex post bargaining with their firm, especially if their bargaining power is low. The stand-alone structure mitigates employees' concern about being held up by their firm because the presence of multiple firms in the same product market provides them with the ability to move from one firm to another. This, in turn, increases employee rents from obtaining an innovation, with a positive effect on their incentives to exert effort.

The merger, in contrast, reduces product market competition between the two firms, with a positive effect on firm ex post payoff from employee innovations. In addition, the merger provides a co-insurance benefit typically associated with internal capital markets (as in Stein 1997). This is because with two employees, the firm obtains an innovation as long as at least one of the employees is successful. However, the merger has two adverse effects on employee incentives: First, it decreases the number of firms in the same product market, and reduces the extent of competition for human capital. Second, the presence of two employees allows the post-merger firm to extract greater rents from the employees. Both effects lead to weaker employee incentives to exert innovation effort. From the firms' perspective, while the merger always leads to greater *ex post* payoff from employee innovations, it can still reduce *ex ante* firm expected profits if its negative effects on employee incentives are sufficiently large.[1]

We show that, under certain parameter values, the two firms do not find it desirable to merge even if doing so provides the post-merger firm with a monopoly position in both the product market and the labor market, and the

1 See Rotemberg and Saloner (1994) for a similar effect of having two employees on ex ante incentives.

co-insurance benefit. This happens precisely because the merger has a negative effect on employee incentives to innovate. Hence, our article offers an explanation for why many mergers fail to create value, and why mergers might be bad for innovation and development of new products. This result is particularly relevant given the findings by Hoberg and Phillips (2009) that mergers are motivated primarily by the desire to introduce and develop new products in order to enter new product markets.

A novel result from our analysis is that the positive effect of the stand-alone structure on employee incentives is most valuable when the hold-up problem faced by the employees is more severe and when the cost of exerting innovation effort is high. Under such conditions, improving employee effort by facilitating employee mobility across competing firms turns out to be very desirable, since, in the absence of employee mobility, employee incentives to exert innovation effort turn out to be too weak. Similarly, the firms are more likely to choose the stand-alone structure when employee ability to move to other firms is at a moderate level.

An important implication from our article is that an established firm may benefit from creating its own competition by accommodating new firm entry or by encouraging new firm spawning by its employees. Encouraging the creation of new firms increases employee mobility, with a positive effect on employee incentives to exert effort. When this incentive effect is sufficiently large, accommodating new firm entry increases firm profits, although it also leads to more intense competition in the product market and in the market for employee human capital. This result is consistent with empirical evidence showing that in many industries, the majority of new firms are created by employees of established firms, and such firms end up competing in similar industries as their parent firm.[2] As an example, some of the most prominent software companies of recent times were founded by former Oracle employees, including Siebel Technologies, Salesforce.com, and NetSuite. An important question still open is why established firms do not prevent the creation of such new firms that lead to greater competition both in the product market and in the market for human capital. Our article addresses this question by showing how established firms can benefit from creating their own competition, and provides an explanation for the emergence of new firms founded by existing employees of established firms.

We also study firm investment incentives for innovation, and show that a market structure where stand-alone firms compete can be more innovation-friendly than a monopoly structure where the post-merger firm does not face any competition. This is because employee incentives in the post-merger firm can be sufficiently weak that the firm does not find it worthwhile to invest toward innovation. This result arises in spite of the fact that the post-merger firm is larger, pays lower employee rents, faces no competition, and enjoys

2 For a review of this literature, see Franco (2005).

economies of scale, relative to each stand-alone firm. An interesting implication of this result is that a firm starting with a monopoly position may have greater incentives to invest in innovation by accommodating new firm entry. Another implication is that in smaller firms not only employee incentives but also firm incentives to innovate will be stronger.

Our article is related to the literature on internal capital markets, internal agency costs, and the theory of the firm.[3] The merger in our model exhibits features similar to the internal capital markets in that the post-merger firm has two employees, allowing the firm to create value as long as at least one of the employees is successful. This feature is similar to the winner picking advantage of internal capital markets identified in Stein (1997). In addition, in our model the firm gains a bargaining advantage when it has two "winners." Interestingly, this ex post bargaining advantage may not be always desirable for the firm, since it leads to an ex ante inefficiency by weakening employee incentives. In addition, the merger further increases the rent extraction ability of the firm by reducing the number of stand-alone firms to which employees can transfer their human capital. This second effect also has a negative effect on employee incentives to innovate.

Our article is also related to the literature examining the interaction between location choice of firms and incentives to undertake relation-specific investment. Rotemberg and Saloner (2000) show that the equilibrium locations of firms and their input suppliers are determined interdependently in a way to mitigate the hold-up problem between the suppliers of input and the buyers of input. Similarly, Matouschek and Robert-Nicoud (2005) and Almazan, de Motta, and Titman (2007) study the link between firm location and employee incentives to invest in human capital. Matouschek and Robert-Nicoud (2005) show that the location decision of a firm depends on whether the firm or the employee invests in human capital, and whether human capital investment is industry specific or firm specific. According to Almazan et al. (2010), geographical proximity promotes the development of a competitive labor market, and firms prefer to cluster when employees pay for their own training, while they locate apart from industry clusters when firms pay for employee human capital development. Almazan et al. (2010) show that firms located within industry clusters undertake more acquisitions than other firms in their industry located outside clusters.[4]

Although several papers study the existence and the benefits of industry clusters, an important and unexplored question examines the incentives of firms located within the same industry clusters to merge. Our article shows that the merger decision depends on the degree of the hold-up problem between the firms and the employees as well as the level of competition in the product

3 See, among others, Gertner, Scharfstein, and Stein (1994), Scharfstein and Stein (2000), and Fulghieri and Hodrick (2006). For a review of this literature, see Stein (2003).

4 See Duranton and Puga (2004) for a review of work on agglomeration economies.

market. We find that firms will be more willing to cluster, pay greater employee rents, and bear greater competition in the product market especially in industries characterized with a greater degree of the hold-up problem and a higher cost of exerting effort toward innovative products.

Our article is also related to the literature studying the relation between product market competition and innovation in the context of an agency problem between firms and managers.[5] In our model, competition plays a role in mitigating the extent of the hold-up problem between the firms and the employees. When the benefit of competition in improving employee incentives is sufficiently large, the firms choose to operate as stand-alone firms. Otherwise, they merge and reduce competition in the product market as well as competition for employee human capital.

Finally, our article suggests that firms in similar product markets may benefit from enhancing employee mobility by adopting compatible technologies or choosing similar industry standards. This is because the creation of homogeneous industry standards could lead to greater transferability of employee human capital from one firm to another. Such practices will be particularly desirable in human-capital-intensive industries with a high cost of exerting innovation effort, since improving employee incentives has the highest benefit in such industries. Similarly, our model shows why it may be detrimental for human-capital-intensive firms to restrict employee mobility by requiring employees to sign a "no-compete" agreement, which limits employee ability to work for other firms or start their own firms. Imposing a no-compete agreement reduces employee incentives to innovate by weakening the outside option of the employee, ultimately leading to lower innovation output and firm profitability.

The article is organized as follows. In Section 1, we present the basic model, and analyze the stand-alone structure and the merger. Section 2 analyzes firm incentives to accommodate new firm entry and discusses the implications of our model in the context of a spinoff transaction. Section 3 examines firm investment incentives for innovation as a function of firm organizational structure. Section 4 analyzes firm incentives to take ex ante actions to improve employee mobility. Section 5 presents the empirical predictions of our model, and Section 6 concludes. All proofs are in the Appendix.

## 1. The Model

We consider an economy where firms operate in imperfectly competitive markets, both in the final goods market and in the labor market. For analytical tractability, we restrict our attention to two firms and two employees. All agents are risk neutral, and there is no discounting. We assume that at the beginning of the game, each firm is already matched with one of the two employees. We also

5 See, among others, Hart (1983), Scharfstein (1988), and Schmidt (1997).

assume that the employees have limited wealth and rule out ex ante monetary transfers between the firms and the employees.

The two firms are human capital intensive in the sense that they create value by developing employee-generated innovations. An innovation involves two stages of a project. The first stage of the project is performed by the employee and, if successful, generates an innovation.[6] The second stage involves the development of the innovation and is performed by the firm with the collaboration of the employee. We assume that the active participation of the employee who initially generated the innovation is necessary in the second stage for its development into a final product.[7] Although our initial model assumes that the only necessary input for generating an innovation is employee effort, in Section 3 we relax this assumption and analyze our model in a more realistic setting where employees are able to innovate only if their firm makes a monetary investment before they exert effort.

The success probability in the first stage of the project depends on effort exerted by the employee, denoted by $e_i$, $i = 1, 2$. If an employee fails to obtain an innovation, the project is worthless and is discarded. Employee effort determines the success probability $p$ of the project such that $p_i(e_i) = e_i \in [0, 1]$. Exerting effort is costly: We assume that effort costs are convex and given by $\frac{k}{2}e_i^2$ with $k > 0$, where $k$ measures the unit cost of exerting such effort. We interpret employee effort broadly as representing the costly investment made by the employee to acquire the knowledge and human capital necessary for the success of the project.

In our model, employee incentives to exert effort depend on the organizational structure chosen by the firms. The firms choose either to operate as stand-alone or to merge into a single firm. If they choose the stand-alone structure, they operate in the same product market as separate firms, with each firm having one employee. In this case, it is possible for the employees to transfer (albeit imperfectly) their innovation and human capital from one firm to the other. This assumption captures the notion that the presence of other firms in the same product market enables employees to develop human capital that can be valued outside their current firm. Hence, the stand-alone structure not only leads to competition in the product market, but also creates competition for scarce employee human capital.

If the two firms choose to merge, the post-merger firm operates as a monopolist in the product market. This implies that employee innovations can be developed only within the post-merger firm, since there is no rival firm in the product market to which employees can transfer their innovation. Thus, the

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6 Innovation can be broadly interpreted as any new idea or new product that improves firm profitability.

7 This assumption implies that if a successful employee with an innovation leaves his firm at the end of the first stage, the firm cannot implement the innovation without the original employee. Similarly, the successful employee cannot implement the innovation by himself, but he must join another firm with the resources and capabilities necessary to implement the innovation.

merger eliminates competition in the product market as well as competition for employee human capital.[8]

We assume that employee effort is not observable, exposing firms to moral hazard. Following Grossman and Hart (1986) and Hart and Moore (1990), we also assume that the firms and the employees cannot write binding contracts contingent on the development of successful innovations and that they can withdraw their participation from the project before the development phase. If an employee generates an innovation, the allocation of the surplus from the development of the innovation is determined at the interim date through bargaining between the firm and the employee, before the second stage of the project is performed.

The outcome of bargaining between the employee and the firm depends on their relative bargaining power and on each party's outside option. We assume that each firm's outside option while bargaining with its employee is limited, since the firm cannot replace its current employee with a new one from the general labor market population, but it can hire an employee from only a rival firm in the same product market. This assumption captures the notion that it is impossible (or infinitely costly) for the firm to continue production by replacing the original employee with a new one from the generic (unskilled) labor market pool. This assumption is easy to justify if employees need a training in the first period to develop the innovation in the second period.[9] The presence of an outside option for the employee depends on whether the employee can transfer his human capital from one firm to the other. This will be possible only if the employee can move from his original firm to a rival firm in the same product market; that is, if the firms choose the stand-alone structure.

Ex post payoffs from developing employee innovations depend on the organization structure chosen by the firms and whether the employees of one or both firms have been successful in the first stage of their project. In the stand-alone structure, if the employees in both firms obtain an innovation, the two firms compete in the development of the innovation. We assume that the two firms engage in Bertrand competition and obtain 0 payoff.[10] If, instead, only one of the employees succeeds in obtaining an innovation, then the firm with

8 More realistically, after a merger in an industry there will be other independent firms that will compete with the post-merger firm in the product market. In addition, employees of the post-merger firm will still have the ability to move to other existing firms in the industry. Hence, the merger will not completely eliminate competition but will reduce it. Our assumption that we have only two firms, and that their decision to merge eliminates competition, is only for analytical tractability. All we need for our results is that the merger reduces the level of product market competition as well as competition for employee human capital.

9 Relaxing this assumption and allowing the firm to hire a new employee from the labor market does not change our results as long as the value created by the firm and the new employee is lower than the value created with the original employee, due to the relationship-specific nature of the original employee's effort.

10 We make this assumption for analytical tractability. The main results of our article can be extended to include different forms of product market competition between the two firms.

the successful employee will be a monopolist in the product market and the project will generate payoff $M > 0$. If the two firms merge, and if at least one of the employees is successful in obtaining an innovation, then the project payoff will be $M$. Note that, different from the stand-alone structure, if both employees in the post-merger firm succeed, the project payoff will still be $M$**,** since the post-merger firm will not face any competition in the product market. In the remainder of the article, we assume $M < k$ to ensure that we have interior solutions.

The game unfolds as follows. At time $t = 0$, the two firms decide whether to merge or to be stand-alone in the same product market. If the firms decide to merge, we show that it is always optimal for the post-merger firm to retain both employees.[11] At $t = 1$, after observing the organizational choice decision of the firms, each employee exerts effort that determines the success probability of his project.

At $t = 2$, the outcome of the first stage of the project is known. If the first stage is successful, then each employee bargains with his firm over the division of the surplus from the development of the innovation. The share of the surplus obtained by the employee may be interpreted as the wage (or bonus) that the employee receives for his contribution necessary for the subsequent development and commercialization of the innovation. When bargaining with his firm, the employee captures fraction $\beta$ of the net joint surplus that depends on his bargaining power, with $\beta \in (0, 1)$. Thus, we will refer to parameter $\beta$ as employee "bargaining power."

The payoffs from bargaining depend on the employee outside option, which, in turn, depends on whether the two firms operate stand-alone or merge. If the firms operate stand-alone, employee human capital can be redeployed at the rival firm. This possibility generates an outside option for an employee when bargaining with his own firm. Specifically, we assume that the employee can transfer his innovation to the competing firm, where it can be developed with payoff $\delta M$ with $0 \leq \delta \leq 1$. We interpret parameter $\delta$ as measuring the degree of transferability of employee human capital across firms. We assume initially that $\delta$ is an exogenous parameter. In Section 4, we allow firms to choose the value of $\delta$ endogenously at the time of the organizational structure decision at $t = 0$. If the two firms merge into a single firm, the employees cannot transfer their innovation to any other firm, since after the merger, the post-merger firm is the only firm in the product market. Thus, both the employees and the post-merger firm have zero outside options while bargaining.

At $t = 3$, the payoff is realized and the cash flow is distributed.

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11 In Section 3, we introduce firm investment in innovation for each employee to be able to generate an innovative idea and show that it might be optimal for the post-merger firm to downsize and have only one employee. In the absence of such firm investment in innovation, it is always optimal for the post-merger firm to have two employees.

### 1.1 The stand-alone structure

The stand-alone structure has two important implications. The first is that it exposes the firms to competition in the product market, and the second is that it creates competition for employee human capital.

The outcome of bargaining between the firms and the employees, and thus the allocation of the surplus, depends on whether only one or both employees generate an innovation. If only one employee, say employee $i$, is successful in generating an innovation, he bargains with his firm over the division of the payoff $M$. Given that employee $j$ has failed, employee $i$ has the ability to transfer his innovation to firm $j$, where the innovation can be developed with payoff of $\delta M$.[12] Thus, the value $\delta M$ is the highest wage that firm $j$ can offer to employee $i$, and it represents employee $i$'s reservation wage (i.e., his outside option) while bargaining with firm $i$. This implies that when employee $i$ bargains with his current firm, he obtains $\delta M + \beta(M - \delta M) = (\delta + \beta(1-\delta))M$, which is equal to his outside option $\delta M$ plus $\beta$ proportion of the additional surplus $M - \delta M$ created from developing his innovation with his current firm. The firm obtains $(1-\beta)(1-\delta)M$.[13]

If both employees are successful in obtaining an innovation, the firms compete in the product market and both the firms and the employees obtain zero payoff.

In anticipation of his payoff from bargaining, employee $i$ chooses his effort level, denoted by $e_i^S$, given the effort level $e_j^S$ exerted by employee $j$, by maximizing his expected profits denoted by $\pi_{E_i}^S$:

$$\max_{e_i^S} \ \pi_{E_i}^S \equiv e_i^S e_j^S 0 + e_i^S(1-e_j^S)(\delta + \beta(1-\delta))M - \frac{k}{2}(e_i^S)^2;$$
$$i, j = 1, 2; \ i \neq j. \tag{1}$$

Correspondingly, firm $i$'s expected profits, denoted by $\pi_{F_i}^S$, are given by

$$\pi_{F_i}^S \equiv e_i^S e_j^S 0 + e_i^S(1-e_j^S)(1-\beta)(1-\delta)M; \ i, j = 1, 2; \ i \neq j. \tag{2}$$

The first-order condition of Equation (1) provides employee $i$'s optimal response, given employee $j$'s choice of effort, as follows:

$$e_i^S(e_j^S) = \frac{e_i^S e_j^S 0 + (1-e_j^S)(\delta + \beta(1-\delta))M}{k}; \ i, j = 1, 2; i \neq j. \tag{3}$$

[12] Note that in equilibrium the employees will not transfer their innovation to the rival firm, since $\delta \leq 1$. It is straightforward to extend our model such that with some exogenous probability the innovation generates a higher value at the rival firm.

[13] Note that this division of the surplus corresponds to the Nash-bargaining solution with outside options where the bargaining power of the employee and the firm are given by $\beta$ and $1-\beta$, and their outside options are given by $\delta M$ and 0, respectively. See Binmore, Rubinstein, and Wolinski (1986).

The stand-alone structure has two effects on employee incentives to exert effort. The first effect is negative and reflects the reduction in employee payoff due to competition in the product market. If employee $j$ at the rival firm obtains an innovation, which occurs with probability $e_j^S$, competition in the product market drives project payoff to 0, with a negative impact on employee $i$'s effort. The second effect is positive and originates from the fact that the two firms compete for employee human capital. When employee $j$ fails in generating an innovation, since employee $i$'s innovation is valuable at his current firm as well as at the rival firm, this creates an outside option for employee $i$, and enables him to extract greater rents from his firm, enhancing his incentives to exert effort.

The following lemma presents the Nash equilibrium of the effort subgame in the stand-alone structure, and the corresponding expected profits of the employees and the firms.

**Lemma 1.** The Nash equilibrium of the effort subgame under the stand-alone structure is

$$e_i^{S*} = e_j^{S*} = e^{S*} \equiv \frac{(\beta + (1-\beta)\delta)M}{k + (\beta + (1-\beta)\delta)M}. \tag{4}$$

The corresponding expected profits for the employees and the firms are:

$$\pi_{E_i}^{S*} = \frac{(\beta + (1-\beta)\delta)^2\, M^2 k}{2(k + (\beta + (1-\beta)\delta)M)^2};\ i = 1, 2, \tag{5}$$

$$\pi_{F_i}^{S*} = \frac{(1-\beta)(1-\delta)(\beta + (1-\beta)\delta)M^2 k}{(k + (\beta + (1-\beta)\delta)M)^2};\ i = 1, 2. \tag{6}$$

The following lemma presents some important properties of the equilibrium effort level in the stand-alone structure.

**Lemma 2.** The equilibrium effort level in the stand-alone structure, $e^{S*}$, is increasing in project payoff $M$, in employee bargaining power $\beta$, and in human capital mobility $\delta$:

$$\text{(i)}\ \frac{\partial e^{S*}}{\partial M} > 0; \quad \text{(ii)}\ \frac{\partial e^{S*}}{\partial \beta} > 0; \quad \text{(iii)}\ \frac{\partial e^{S*}}{\partial \delta} > 0.$$

Furthermore, (iv) $\frac{\partial^2 e^{S*}}{\partial\delta\partial\beta} < 0$.

The level of effort is increasing in both project payoff $M$ and employee bargaining power $\beta$, since both parameters increase employee expected profits from exerting effort to innovate, giving (i) and (ii). In addition, since the two firms compete for employee human capital, this creates an outside option for the employees, with a positive effect on incentives to exert effort, giving (iii). Interestingly, the positive effect of the employee outside option $\delta$ on employee effort is larger for lower values of employee bargaining power $\beta$, giving (iv). The intuition is that smaller $\beta$ implies lower employee effort, all else equal. Hence, the marginal benefit of the outside option in terms of improving employee effort is greater for lower values of $\beta$.

It is straightforward to show that the first-best level of effort in the stand-alone structure is $e_{FB}^{S*} = \frac{M}{M+k}$. Furthermore, by comparing $e^{S*}$ with $e_{FB}^{S*}$ it is easy to show that $e^{S*} < e_{FB}^{S*}$, which means that there is always underinvestment in employee effort due to incompleteness of contracts. Importantly, employee outside option, $\delta M$, reduces the extent of underinvestment by increasing the rent extraction ability of the employees, reflected by the property $\frac{\partial(e_{FB}^{S*} - e^{S*})}{\partial \delta} < 0$, which is straightforward to prove.

Having examined the effect of employee outside option on employee effort, we now turn our attention to its effect on firm expected profits. Firm expected profits depend on employee effort and on the firms' share of the surplus from developing the innovation. If only one employee is successful, the successful employee uses the option of moving to the competing firm to extract greater rents from his current firm, reducing his firm's ex post rents. Although employee outside option $\delta M$ has a negative effect on ex post firm payoffs, when employee bargaining power and employee outside option are sufficiently low, its overall effect on ex ante firm expected profits can be positive. The reason is that, in the absence of the outside option, a low employee bargaining power implies weak incentives to exert effort and, thus, a low probability of obtaining an innovation. Hence, in such a case, employee outside option increases firm expected profits through its positive effect on employee effort incentives, provided that it is not too large to lead to a disproportionate decrease in firm ex post payoffs, given by $(1-\beta)(1-\delta)M$. The following lemma presents the overall effect of the employee outside option on firm expected profits.

**Lemma 3.** Firm expected profits are increasing in $\delta$ if employee bargaining power and employee outside option are sufficiently low; that is, $\frac{\partial \pi_{F_i}^{S*}}{\partial \delta} \geq 0, i = 1, 2,$ if and only if $\beta \leq \beta^S$ and $\delta \leq \delta^S$ where $\beta^S$ and $\delta^S$ are defined in the Appendix.

This result suggests that for sufficiently low values of employee bargaining power and employee outside option, the firms benefit from an increase in $\delta$ even though an increase in $\delta$ reduces their ex post payoff from employee innovations. One interesting implication of this result is that the firms may benefit from taking actions to increase the outside option of their employees. We examine this possibility in detail in Section 4.

### 1.2 The merger

If the two firms decide to merge, the post-merger firm has two options: to downsize by firing one employee or to operate at a larger scale by retaining both employees. In the Appendix (see Lemma A1), we show that the advantage of having two employees dominates its cost, and the post-merger firm always finds it optimal to keep two employees.[14] With two employees, as before, after the firms make the organization structure choice, each employee exerts effort $e_i^M$ $i = 1, 2$, which determines the probability of generating an innovation. We assume that the innovations generated by the two employees are perfect substitutes, and that the post-merger firm implements only one of the employee innovations if both employees generate an innovation.[15]

The merger has implications both for the level of product market competition and for the level of competition for employee human capital. Recall that under the stand-alone structure, when the employees of both firms are successful in generating an innovation, competition in the product market results in 0 payoffs. After the merger, in contrast, the post-merger firm obtains a positive payoff from employee innovations even when both employees are successful, since the merger combines two previously competing firms into a single firm with a monopoly position. The merger also affects competition for employee human capital. This is because after the merger there is no rival firm to which the employees can transfer their innovation. This implies that the employees lose their outside option when they bargain with the post-merger firm.[16]

Notably, the merger not only eliminates the outside option of the employees, but it also creates a bargaining advantage for the post-merger firm. This is because when both employees are successful, the firm has two employee innovations to choose from, and can extract more surplus from its employees. In addition, the merger provides a co-insurance benefit from having two employees, since the post-merger firm is able to develop an innovation as long as at least one of the employees is successful.[17]

We now proceed with the derivation of firm and employee payoffs under the merger. First, consider the case where only one employee generates an

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[14] The intuition is as follows. Keeping both employees generates an advantage to the firm because, as long as at least one employee is successful in the first stage, the firm has an innovation to develop. This advantage is similar to the coinsurance benefit of having an internal capital market. In addition, with two employees the firm gains a bargaining advantage in the state where both employees innovate. However, this bargaining advantage comes at the cost of affecting employee incentives negatively by lowering their rents. Overall, the positive effect of having two employees dominates its negative effect. Importantly, in Section 3, where we introduce costly firm investment for financing the projects, there are parameter values for which the firm finds it optimal to downsize.

[15] See Rotemberg and Saloner (1994) for a similar assumption.

[16] Recall that our assumption that the merger *eliminates* competition in the product market and employee outside option is for analytical tractability. All we need for our results is that the merger *reduces* competition in the final good market and in the market for employee human capital.

[17] Note that if the success probability $e$ of obtaining an innovation is the same under both organization structures, the overall probability of an innovation is always greater in the merger scenario than in the stand-alone scenario. However, given that the merger has adverse effects on endogenous success probability of obtaining an innovation, the post-merger firm can experience a lower innovation probability than the stand-alone firms.

innovation. Since the post-merger firm is a monopolist, and only one employee has an innovation, both the firm and the employee have zero outside options when they bargain. Thus, the employee obtains $\beta M$, and the firm retains the remainder payoff, $(1-\beta)M$. Notice that, with respect to the stand-alone structure, the employee loses his outside option $\delta M$.

If both employees generate an innovation, we assume that the two employees engage with each other in Bertrand-style competition for having their innovation chosen and implemented by the firm. Since in the post-merger firm both employees have zero reservation wages, this implies that each employee captures 0 rents from the project, while the firm captures the entire surplus $M$. Thus, firm payoffs when both employees are successful in the merger scenario are different from those in the stand-alone structure for two reasons: First, the monopoly position of the firm implies that the total payoff from employee innovations is always $M$ as long as at least one employee succeeds in generating an innovation. Second, in the merger scenario, having two successful employees creates a bargaining advantage for the post-merger firm and allows the firm to extract the entire rents from employee innovations.

In anticipation of his payoff from bargaining with the firm, given the effort level $e_j^M$ chosen by employee $j$, employee $i$ chooses his effort level, $e_i^M$, by maximizing his expected profits, denoted by $\pi_{E_i}^M$:

$$\max_{e_i^M} \ \pi_{E_i}^M \equiv e_i^M e_j^M 0 + e_i^M (1-e_j^M)\beta M - \frac{k}{2}(e_i^M)^2; \ i, j = 1, 2; \ i \neq j. \quad (7)$$

The expected profits of the post-merger firm denoted by $\pi_F^M$ are given by

$$\pi_F^M \equiv e_i^M e_j^M M + e_i^M (1-e_j^M)(1-\beta)M + e_j^M (1-e_i^M)(1-\beta)M; \\ i, j = 1, 2; \ i \neq j. \quad (8)$$

The first-order condition of Equation (7) provides employee $i$'s optimal response, given employee $j$'s effort choice, as follows:

$$e_i^M(e_j^M) = \frac{e_i^M e_j^M 0 + (1-e_j^M)\beta M}{k}; \ i, j = 1, 2; \ i \neq j. \quad (9)$$

From Equation (9), it can be immediately seen that employee $i$'s effort is a decreasing function of employee $j$'s effort, due to the firm's ability to extract the entire surplus from each employee in the state where both employees are successful.

The following lemma presents the equilibrium level of employee effort in the merger scenario, and the expected profits of the employees and the post-merger firm.

**Lemma 4.** The Nash equilibrium of the effort subgame under the merger is

$$e_i^{M*} = e_j^{M*} = e^{M*} \equiv \frac{\beta M}{k+\beta M}. \quad (10)$$

The corresponding expected profits of the employees and the firm are

$$\pi_{E_i}^{M*} = \frac{k\beta^2 M^2}{2\,(k+\beta M)^2},\ i = 1, 2; \tag{11}$$

$$\pi_F^{M*} = \frac{\beta\,(2k(1-\beta)+\beta M)\,M^2}{(k+\beta M)^2}. \tag{12}$$

As a result of the merger's negative effects on employee rents, employee effort in the post-merger firm is always lower than that in the stand-alone structure, as presented in the following proposition.

**Proposition 1.** The level of employee effort under the merger is always smaller than that under the stand-alone structure: $e^{M*} < e^{S*}$. Furthermore, the difference in effort levels between the stand-alone structure and the merger is decreasing in $\beta$; that is, $\frac{\partial(e^{S*}-e^{M*})}{\partial\beta} < 0$.

The property $\frac{\partial(e^{S*}-e^{M*})}{\partial\beta} < 0$ suggests that the positive effect of the stand-alone structure on employee effort is greater for lower values of $\beta$, since in the absence of the employee outside option, low $\beta$ leads to low employee effort, and the role of the employee outside option in increasing employee effort becomes more pronounced.

Having analyzed the effect of the merger on employee incentives to exert effort, we now turn to its effect on firm expected profits and thus on the decision to merge. The merger affects firm expected profits in two ways: through its impact on employee incentives and its impact on the post-merger firm's ex post payoff from employee innovations. The *ex post* effect is always positive for the firm, since the merger eliminates both competition in the product market and competition for employee human capital, leading to an increase in its ex post payoffs. The *ex ante* effect is ambiguous because the merger reduces employee effort, and therefore reduces the probability of obtaining an innovation. The following proposition characterizes the firms' choice of organization structure.

**Proposition 2.** (i) If $\beta > \beta_c$, the two firms obtain greater expected profits with the merger. (ii) If $\beta \le \beta_c$, there are unique values $\delta_1$ and $\delta_2$ such that the two firms choose the stand-alone structure if and only if $\delta_1 \le \delta \le \delta_2$, where $\beta_c$, $\delta_1$, and $\delta_2$ are defined in the Appendix. Furthermore, $\frac{\partial\beta_c}{\partial M} < 0$ and $\frac{\partial\beta_c}{\partial k} > 0$.

When employee bargaining power is sufficiently large, that is, when $\beta > \beta_c$, employee incentives to exert effort are already strong even with no employee outside option. Hence, the two firms find it desirable to merge to enjoy the monopoly position in the product market, the co-insurance benefit of having two employees, and the ability to extract greater rents from employee innovations. In contrast, when employee bargaining power is low, that is, when

$\beta \leq \beta_c$, providing the employees with stronger incentives becomes particularly important for the firms, since, absent the outside option, low employee bargaining power leads to low effort. Hence, the firms prefer the stand-alone structure, provided that the benefit of the stand-alone structure in terms of its impact on employee incentive is sufficiently strong, that is, $\delta \geq \delta_1$, while its cost in terms of lower rents for the firms is not too large, that is, $\delta \leq \delta_2$. Put differently, at moderate levels of $\delta$, not only the incentive benefit of the stand-alone structure is sufficiently large, but also its cost is limited. Hence, it is optimal for the firms to choose the stand-alone structure over the merger.

The threshold level $\beta_c$ is decreasing in $M$ and increasing in $k$. The first property implies that as $M$ increases, the parameter space over which the firms find it optimal to merge expands. The intuition for this result is that for higher values of $M$, the desire to eliminate product market competition and to obtain the monopoly payoff from employee innovations becomes stronger. If we interpret $k$ as a measure of the human capital intensity of the innovative project, the second property implies that the firms are more likely to choose the stand-alone structure in industries characterized by a greater level of human capital intensity. In such industries, all else equal, motivating employee effort is more difficult given the high cost of exerting innovation effort. Hence, the stand-alone structure becomes more desirable due to its positive effect on employee rent extraction ability.

## 2. New Firm Entry

In the previous section, we compared the combined profits of the two stand-alone firms in a duopoly with the profits of the single post-merger firm, and show that the stand-alone structure may lead to greater overall firm profits than the merger. In this section, we study a related question regarding the incentives of a firm starting with a monopoly position in the labor and product markets to accommodate new firm entry in both markets. We do this by comparing the initial profits of the monopoly firm with two employees to the profits of an individual firm with one employee in the resulting duopoly structure. Our motivation for this comparison is to understand whether a monopoly firm can benefit from creating its own competition by accommodating new firm entry into the industry by allowing one of its existing employees to start a new firm operating in the same product market through a spinoff transaction.[18]

Consider a monopolistic firm with two employees. The following proposition establishes that for sufficiently low values of employee bargaining power and intermediate values of employee outside option, the monopoly firm finds it optimal to downsize by allowing one of its employees to leave and start

[18] There is ample evidence showing that a vast majority of new firms in the economy are started by the employees of established firms and such employee-founded new firms typically compete in similar product markets as their parent firm. New firms started by employees of established firms are also referred to as spinouts. See Franco (2005) for a review of work on employee-founded new firms.

a new firm in the same product market. It is worth stressing that this result obtains because the value of the monopoly firm is below the value of an *individual* stand-alone firm in the duopoly structure. This implies that, perhaps surprisingly, accommodating new firm entry can be optimal even though the firm loses its monopoly position both in the product market and in the market for human capital, loses the co-insurance benefit of having two employees, and operates at a smaller scale with only one employee/division. What makes such a transaction desirable for the monopoly firm is its positive impact on the incentives of the remaining employee to exert effort toward innovation.

**Proposition 3.** If $\beta \leq \tilde{\beta}_c$, the monopoly firm accommodates entry if and only if $\tilde{\delta}_1 \leq \delta \leq \tilde{\delta}_2$, where $\tilde{\beta}_c$, $\tilde{\delta}_1$, and $\tilde{\delta}_2$ are defined in the Appendix. Furthermore, $\frac{\partial \tilde{\beta}_c}{\partial M} < 0$ and $\frac{\partial \tilde{\beta}_c}{\partial k} > 0$.

Proposition 3 mirrors Proposition 2. As before, employee effort is lower, all else equal, for lower values of employee bargaining power. Hence, for sufficiently low values of $\beta$, that is, for $\beta \leq \tilde{\beta}_c$, a spinoff transaction leads to greater firm expected profits provided that employee outside option is at a moderate range; that is, $\tilde{\delta}_1 \leq \delta \leq \tilde{\delta}_2$. The condition $\delta \geq \tilde{\delta}_1$ makes sure that the incentive benefit of the spinoff due to the creation of the outside option for the employee is sufficiently high, while the condition $\delta \leq \tilde{\delta}_2$ makes sure that the cost of the spinoff transaction in terms of the reduction in ex post firm rents is not too high.

In addition, the monopoly firm is more likely to undertake a spinoff transaction for lower values of $M$ and higher values of $k$, implied by $\frac{\partial \tilde{\beta}_c}{\partial M} < 0$ and $\frac{\partial \tilde{\beta}_c}{\partial k} > 0$. The intuition behind the first property is that the cost of bearing competition in the product market is lower for lower values of $M$, given that the loss in payoff from employee innovations is $M$ when both firms are successful in bringing an innovation to the market. The intuition for the second property is that a higher cost of exerting effort $k$ implies lower employee effort, all else equal, which makes improving employee incentives through the spinoff more desirable. In summary, the cost of the spinoff transaction decreases in $M$ while its benefit increases in $k$.[19]

Proposition 3 establishes that the monopoly firm decides to undertake a spinoff transaction only if doing so increases its own profits, without taking into account its effect on employee expected profits. Importantly, a spinoff transaction can also improve overall welfare, where overall welfare is defined as the total firm and employee profits, as presented in the following proposition.

[19] Note that in our model, a spinoff transaction results in two identical firms competing in the same product market. New firms spunoff from established firms or new firms founded by the existing employees of established firms are rarely as large as their parent firms are. However, this is not a limitation for our model since it will be straightforward to modify our analysis such that the new firm spunoff from the monopoly firm is smaller in size and represents a less aggressive competitor for the parent firm in the product market.

**Proposition 4.** If $\beta \leq \hat{\beta}_c$, a spinoff transaction where the monopoly firm separates one of its divisions increases welfare for $\hat{\delta}_1 \leq \delta \leq \hat{\delta}_2$, where $\hat{\beta}_c$, $\hat{\delta}_1$, and $\hat{\delta}_2$ are defined in the Appendix. Furthermore, $\frac{\partial \hat{\beta}_c}{\partial M} < 0$, $\frac{\partial \hat{\beta}_c}{\partial k} > 0$, and $\hat{\beta}_c > \tilde{\beta}_c$.

An important implication from this result is that in human-capital-intensive industries where employee bargaining power is low and the cost of exerting innovation effort is high, encouraging new firm entry will be welfare improving for moderate values of $\delta$, even if it implies greater competition in the product market and lower firm rents from employee innovations. Furthermore, $\hat{\beta}_c > \tilde{\beta}_c$ implies that when the decision to accommodate new firm entry is based on maximization of firm profits rather than the total firm and employee profits, the firms accommodate new firm entry at a suboptimal level, since they consider its effect on their own profits only, and ignore its positive effect on employee rents.

## 3. Organization Structure and Firm Investment in Innovation

Our analysis so far has assumed that innovation generation requires only employee effort, and hence focused on the effect of the organizational structure on employee incentives to exert innovation effort. In this section, we extend our analysis such that we model firm incentives to finance innovative projects, and show that firm organization structure has an important effect also on the firms' incentives to invest in innovation.

We modify our basic model such that a necessary condition for the employees to generate an innovation is that their firms make an initial investment before the employees exert effort. This investment can be viewed as the firms investing in physical assets that are necessary for the employees to be able to generate new innovative ideas. Alternatively, it can be seen as the firms making an investment in employee human capital such as innovation-specific training that the employees need before working toward innovative projects.

We analyze firm incentives in two different organization structures. In the first one, the two firms operate as stand-alone and, as before, face competition both in the product market and in the market for employee human capital. In the second structure, we consider the post-merger firm with a larger scale with two employees/divisions and a monopoly position in the product market. In addition, we assume that the post-merger firm has a synergy advantage due to economies of scale in financing the initial investment required to operate two divisions. We then compare firm incentives to undertake the initial investment under the two organization structures, and show that when employee bargaining power $\beta$ is sufficiently low and employee outside option is at a moderate level, the stand-alone firms have the incentives to invest in innovation, while the post-merger firm does not have sufficient incentives to invest in innovation. The intuition for this result is that the productivity of the firms' investment in innovation depends on employee effort. Since the stand-alone structure leads to greater employee effort than the merger for lower levels of employee bargaining power and moderate levels of employee outside option, firm investment in innovation has greater productivity and results in greater firm expected profits, increasing firms' willingness to invest in innovation in the first place.

We modify our model as follows. At $t = 0$, if the two firms choose to operate stand-alone, each firm must incur an initial investment $I > 0$ so that its employee has access to the resources necessary to work toward an innovative idea. In contrast, for the post-merger firm with two employees/divisions, the necessary initial investment is $KI$ with $K \leq 2$, implying that it enjoys economies of scale. Different from the earlier section where the post-merger firm always prefers to have two employees, introducing firm investment into the model creates the possibility that the monopoly firm may prefer to downsize by firing one of the employees (or closing down one of the divisions) to reduce the initial investment cost from $KI$ to $I$. The following proposition characterizes the firm's optimal downsizing decision.

**Proposition 5.** If $K \leq K^C$, where $K^C$ is defined in the Appendix, it is optimal for the monopoly firm to have two employees/divisions; if $K > K^C$, it is optimal for the monopoly firm to scale down and retain only one employee/division.

The intuition is as follows. From the discussion in Section 1.2 (and Lemma A1), we know that when there is no firm investment for financing the projects, that is, when $I = 0$, the post-merger firm always finds it optimal to retain two employees. When $I > 0$, the amount of monetary investment required increases in the number of employees retained by the firm. When $K$ is sufficiently small, that is, when $K \leq K^C$, the scale advantage of operating two divisions is sufficiently large to justify the incremental investment. In other words, the marginal expected profit generated by the additional employee is in excess of the incremental investment, and the post-merger firm finds it optimal to have two employees. In contrast, when the scale advantage of being a two-divisional firm is not large enough, that is, when $K > K^C$, the marginal profit from the additional employee does not justify the incremental investment, and the post-merger firm prefers to downsize to reduce the investment cost from $KI$ to $I$.

It is interesting to examine the welfare effects of the post-merger's firm downsizing decision. One conjecture is that the post-merger firm may find it optimal not to downsize by retaining both employees in the firm even when doing so is socially suboptimal. This is because retaining both employees provides the firm with greater bargaining power with respect to its employees, although it has a negative effect on employee incentives to innovate. The following proposition presents the conditions under which the post-merger firm chooses to retain both employees in the firm when downsizing is socially optimal.

**Proposition 6.** If $K^S \leq K \leq K^C$, where $K^S$ is defined in the Appendix, the monopoly firm finds it optimal to have two employees/divisions when downsizing, and retaining only one employee/division is socially optimal.

When $K$ is sufficiently large, that is, when $K^S \leq K$, the scale advantage of having a two-divisional firm is not too valuable, and it is socially optimal to downsize. However, if the additional cost of having a second employee/division is not too large, that is, if $K \leq K^C$, the post-merger firm finds it optimal to retain both employees, and extract greater rents from employee innovations, although this bargaining advantage comes at the expense of weaker employee incentives to exert effort and paying the additional investment costs of retaining two employees.

The post-merger firm's inefficient downsizing decision is interesting since, contrary to widely held belief that mergers usually lead to downsizing and elimination of jobs, this result suggests that in industries where workers have firm-specific human capital, sometimes mergers fail to produce efficient downsizing. The intuition for this result is that by keeping both employees/divisions, the post-merger firm gains a bargaining advantage in its negotations with the employees. Although this bargaining advantage weakens employee incentives to exert innovation effort, and leads to lower employee surplus, since the post-merger firm's decision is based on maximization of its own expected profits, the firm inefficiently chooses to retain both employees.

We can now turn to the organization structure choice. The following proposition shows that there is an equilibrium in which the stand-alone structure, where each firm incurs $I$ to finance the investment in innovation, leads to positive firm profits net of investment costs, while the monopoly structure where the post-merger firm operates either as a one- or two-divisional firm results in negative firm expected profits, and thus does not prove to be viable.

**Proposition 7.** (i) Let $K \leq K^C$ so that it is optimal for the merged firm to have two employees/divisions. If $\beta \leq \tilde{\beta}_c$ and $\tilde{\delta}_1 \leq \delta \leq \tilde{\delta}_2$, there exists an equilibrium in which only the stand-alone firms invest in innovation, while the post-merger firm with two divisions does not. (ii) Let $K > K^C$ so that it is optimal for the monopoly firm to have only one employee/division. If $\beta \leq \breve{\beta}_c$, and $\breve{\delta}_1 \leq \delta \leq \breve{\delta}_2$, where $\breve{\beta}_c$, $\breve{\delta}_1$, and $\breve{\delta}_2$ are defined in the Appendix, there exists an equilibrium in which only the stand-alone firms invest in innovation, while the post-merger firm with one division does not.

When $K$ is sufficiently small, that is, when $K \leq K^C$, the post-merger firm finds it optimal to have two divisions, since the scale advantage of operating two divisions is sufficiently large. When we compare the profits of the two-divisional monopoly firm with those of each stand-alone firm with only one division, we find that for sufficiently low values of $\beta$ and moderate values of $\delta$, it is possible that each stand-alone firm's expected profits exceed the initial investment cost of $I$, whereas the post-merger firm's expected profits fall below $KI$. This implies that the stand-alone firms operating under duopoly find it optimal to invest $I$, while the monopoly firm does not find it desirable to incur $KI$. Hence, only the duopoly structure with smaller firms competing in the same product market and for employee human capital turns out to be profitable and viable.

When the scale advantage of being a two-divisional firm is not large enough, that is, when $K > K^C$, the post-merger firm prefers to downsize to reduce the investment cost from $KI$ to $I$. However, for sufficiently low values of $\beta$ and moderate values of $\delta$, it is still more desirable to be a stand-alone firm in a duopoly structure in order to improve employee incentives to exert innovation effort. Greater employee effort, in turn, leads to greater firm profits and makes the duopoly structure more profitable and viable than the monopoly structure.

These results suggest that in industries characterized by a greater degree of the holdup problem, small and stand-alone firms competing in similar product markets have greater incentives to invest in innovation.

Proposition 7 has also implications for spinoff transactions. A two-divisional firm will have greater incentives to invest in innovation after reducing its size in a spinoff transaction that creates a competing firm in the same product market. Accommodating new firm entry and creating competition for human capital can improve employee incentives sufficiently that firm expected profits can go up after a spinoff transaction.

In the equilibrium identified in Proposition 7, only the stand-alone firms have incentives to undertake the investment in innovation financing, while the post-merger firm does not find it profitable to invest in innovation. Since firm investment is necessary for the employees to exert innovation effort, the employees in the post-merger firm do not exert effort, and the firm and the employees obtain zero profits. In contrast, in the stand-alone firms, the employees exert innovation effort, and both the firms and employees obtain positive profits. This implies that the spinoff transaction leads to greater welfare, where welfare is defined as the sum of firm and employee profits.

## 4. Human-capital Mobility

In the previous sections, we showed that the stand-alone structure can be more desirable than the merger since it provides the employees with a greater rent extraction ability due to the possibility of moving to a rival firm. Since their greater rent extraction ability results in a higher innovation probability, firm expected profits in the stand-alone structure are an increasing function of employee outside option $\delta$ for sufficiently low values of employee bargaining power $\beta$. This result suggests that the firms in the stand-alone structure may find it desirable to take ex ante actions that increase the ex post level of human-capital mobility measured by parameter $\delta$.

Firms can affect the mobility of employee human capital in a number of ways. For example, stringency of *no-compete* agreements imposed on employees at the time they join a firm influences employee ability to move to competing firms. Alternatively, location choice of firms may have an effect on employee mobility in that employees of firms located within regional industry clusters will find it easier to move from one firm to another. In addition, firms can cooperate and jointly agree to select common industry standards, such as compatible technologies and protocols so that employee skills and human capital can be valuable outside their current firm.[20]

In this section, we examine firms' ex ante incentives to increase employee mobility, characterized in our model by a high level of $\delta$, or impede employee mobility by choosing a low level of $\delta$. We modify the basic model as follows. At $t = 0$, the two firms individually and simultaneously choose the degree of mobility of their employees, with firm $i$ setting $\delta_i$ with $0 \le \delta_i \le 1$ in order to maximize its own expected profits. For simplicity, we assume that the firms do not incur any cost in choosing $\delta_i > 0$.[21] The rest of the game remains as in Section 1.

Proceeding backward, employee $i$ exerts effort $e_i^S(\delta_i, \delta_j)$ in order to maximize his expected profits, given by $\pi_{E_i}^S(\delta_i, \delta_j)$:

$$\max_{e_i^S(\delta_i,\delta_j)} \ \pi_{E_i}^S(\delta_i, \delta_j) \equiv e_i^S(1-e_j^S)(\delta_i+\beta(1-\delta_i))M - \frac{k}{2}(e_i^S)^2;\ i, j = 1, 2;\ i \neq j. \tag{13}$$

The first-order condition of Equation (13) provides employee $i$'s optimal response, given employee $j$'s choice of effort, as follows:

$$e_i^S(e_j^S) = \frac{(1 - e_j^S)(\delta_i + \beta(1 - \delta_i))M}{k}; i, j = 1, 2; i \neq j. \tag{14}$$

Setting $e_j^S = e_i^S$, and solving Equation (14) for $e_i^S$ yields the Nash-equilibrium level of effort chosen by the two employees, denoted by $e_i^{S*}(\delta_i, \delta_j)$:

$$e_i^{S*}(\delta_i, \delta_j) = \frac{(\beta + (1 - \beta)\delta_i)\left(k - (\beta + (1 - \beta)\delta_j)M\right) M}{k^2 - (\beta + (1 - \beta)\delta_i)\left(\beta + (1 - \beta)\delta_j\right) M^2}. \tag{15}$$

By direct differentiation, it is easy to verify that equilibrium effort level for employee $i$, $e_i^{S*}(\delta_i, \delta_j)$, is increasing in his own human-capital mobility, $\delta_i$, and decreasing in human-capital mobility of the employee at the rival firm, $\delta_j$. This observation implies that by increasing the mobility of its own employee, each firm can not only improve the effort level of its own employee, but also

[20] In related work, Morrison and Wilhelm (2004) suggest that technological shocks, such as advances in information technology, may increase employee mobility by reducing the costs of moving to a firm with an unfamiliar culture, and reduce firm investment in employee human capital.

[21] It is possible to extend the analysis such that it is costly for the firms to choose a positive level of $\delta$.

lower the effort level at the rival firm. Hence, an increase in $\delta_i$ provides firm $i$ with a strategic advantage by decreasing innovation effort at firm $j$.

Given the level of employee effort, $e_i^{S*}(\delta_i, \delta_j)$, firm $i$ chooses $\delta_i$ to maximize its expected profits, denoted by $\pi_{F_i}^S(\delta_i, \delta_j)$:

$$\pi_{F_i}^S(\delta_i, \delta_j) \equiv e_i^S(1-e_j^S)(1-\beta)(1-\delta_i)M;\ i, j = 1, 2;\ i \neq j; \quad (16)$$
$$\delta_i$$
$$s.t. \quad 0 \leq \delta_i \leq 1. \quad (17)$$

There are three factors affecting firm $i$'s choice of $\delta_i$. The first is the direct effect of an increase in $\delta_i$ on employee $i$'s incentives to exert effort: An increase in $\delta_i$ increases the probability that firm $i$ obtains an innovation. The second factor is strategic, and derives from the fact that an increase in $\delta_i$ leads, all else equal, to a lower level of employee effort at the rival firm, creating a strategic advantage for firm $i$. Since firm $i$ obtains greater payoff when it is the sole innovator, which happens with probability $e_i^S(1-e_j^S)$, these two factors always lead firm $i$ to prefer a greater value of $\delta_i$. In addition, because the benefit of an increase in $\delta$ in improving the innovation probability is greater for lower values of employee bargaining power, the two firms will find it most desirable to enhance employee mobility for lower values of $\beta$. The third factor is negative and is due to the impact of an increase in $\delta_i$ on firm ex post payoffs from employee innovations. A greater value of $\delta_i$ increases the rent extraction ability of employee $i$ and, therefore, lowers firm $i$'s ex-post payoff, as reflected by the term $(1-\beta)(1-\delta_i)M$ in Equation (16). All else equal, the cost of increasing $\delta_i$ for firm $i$, in terms of the loss of rents to the employee, is smaller for lower values of employee bargaining power $\beta$. Hence, for lower levels of $\beta$, not only the benefit of an increase in $\delta$ is larger, but also its cost is smaller. The following proposition characterizes the Nash-equilibrium level of $\delta_i$.

**Proposition 8.** The unique Nash-equilibrium level of $\delta_i$, denoted by $\bar{\delta}^*$, is given by

$$\bar{\delta}_i^* = \bar{\delta}_j^* = \bar{\delta}^* \equiv \begin{cases} \bar{\delta} \equiv \frac{k^2-\beta M^2-k\sqrt{k^2-M^2}}{(1-\beta)M^2} & \text{if } \beta \leq \bar{\beta}; \\ 0 & \text{if } \beta > \bar{\beta}, \end{cases}$$

with $\partial\bar{\delta}/\partial\beta < 0$ and $\partial\bar{\delta}/\partial M > 0$, where $\bar{\beta}$ is defined in the Appendix. Furthermore, $\partial\bar{\beta}/\partial M > 0$.

The Nash-equilibrium level of $\delta$ is decreasing in employee bargaining power $\beta$. This is because the importance of improving employee incentives through a greater outside option is greater for lower levels of employee bargaining power. In addition, as noted above, the cost to the firms of increasing $\delta$ is smaller for lower levels of employee bargaining power.

The property that the Nash-equilibrium level of $\delta$ is increasing in project payoff $M$ arises from the direct effect of employee mobility on employee incentives to innovate, and its strategic effect discussed above. The intuition is that, under product market competition, the firms obtain the monopoly payoff $M$ only in the state where their employee is successful while the employee at the rival firm fails. This means that each firm has the desire to increase the probability of this state by promoting the effort of its own employee and reducing the effort of the employee at the competing firm. Furthermore, the benefit of increasing the probability of this outcome is greater when payoff $M$ from the innovation is larger, leading to a positive relation between employee mobility $\delta$ and project payoff $M$. Finally, consistent with this argument, we obtain $\partial\bar{\beta}/\partial M \geq 0$, implying that the parameter space over which the firms choose a positive level of $\delta$ expands as $M$ becomes larger.

Our analysis in this section suggests that firms can benefit from locating closer to similar firms to improve employee incentives, and their desire to do so is greater when employees are more vulnerable to opportunistic behavior by their firms; that is, when they have lower bargaining power. In addition, firms are less likely to adopt clauses restricting employee mobility especially when there is more to gain from being ahead of the competing firms; that is, when payoff $M$ is greater. Finally, our analysis has the implication that firms individually may find it desirable to establish common industry standards and protocols to facilitate employee mobility within an industry.

## 5. Empirical Implications

In this section, we derive the empirical predictions of our model considering the role of critical parameters in driving the main results. The first key parameter is the degree of employee bargaining power $\beta$, which determines the amount of rents that the employees can obtain from the firms for the development of new products. One potential interpretation of this parameter is that it characterizes the severity of the holdup problem that employees are subject to in ex post negotiations with their firm. Specifically, a lower $\beta$ implies a greater degree of the holdup problem and, thus, smaller employee rents.

The second key parameter is $\delta$. This parameter characterizes the degree of firm-specificity of employee human capital and, thus, provides a measure of employee ability to leave their current firm to join a rival firm.

The third critical parameter is the ex post payoff from employee innovations, $M$. This parameter can be interpreted as characterizing the expected value of the innovation, which in turn depends on factors such as the potential size of the market for the innovation and the risk of failure in developing a new product. To see this, suppose that, conditional on an employee generating an innovation, the success of the development phase of the innovation is given by an exogenous parameter $q$, and conditional on successful development, the payoff from the innovation is given by $m$. In such a setting, the expected payoff at the development phase of an innovation is given by $M = qm$. Hence, ex ante, project payoff $M$ will be lower when the failure probability of developing new products, $1 - q$, is higher, and it will be higher for projects with greater potential value $m$.

The last key parameter is $k$, the unit cost of exerting innovation effort. This parameter can be interpreted as characterizing the degree of human capital intensity of the project. In addition, a higher value of $k$ implies, all else equal, lower employee effort and lower probability of generating an innovation, leading to riskier projects with larger failure rates.

From Lemma 2, the positive effect of $\delta$ on employee effort, and hence on the success probability of the project, is greater for lower values of $\beta$. Similarly from Proposition 2, the difference in effort levels between the stand-alone structure and the merger is greater for lower values of $\beta$, leading to the following prediction.

*(i) Innovation rates will be greater in stand-alone firms than in multidivisional firms. Furthermore, the difference in innovation rates will be greater when employees are exposed to a greater degree of the holdup problem.* This prediction is consistent with the finding by Seru (2007) that single-divisional firms are more innovative than multidivisional firms. Our model generates the additional prediction that the difference in innovation output between single- and multidivisional firms will be greater when employees are subject to a greater degree of the holdup problem.

Proposition 2 shows that the total firm profits in the stand-alone structure (duopoly profits) are greater than the profits of the post-merger firm for sufficiently lower values of $\beta$, provided that employee outside option is at a moderate level. This result implies that in industries with a greater degree of the holdup problem, smaller stand-alone firms prefer to compete in the same product market and in the market for human capital rather than to merge and become a larger monopoly firm in both markets, leading to the following prediction.

*(ii) Market structures where smaller firms compete in similar product and labor markets are more likely to emerge in industries where the extent of the holdup problem faced by the employees is greater.* Note that this prediction is consistent with the emergence of industry clusters where firms operating in similar product markets and using similar types of human capital locate in closer geographical regions. Operating within a cluster of similar firms in the same geographical area promotes the accumulation of employee human capital by creating a local labor market that facilitates employee mobility. This result provides an explanation for why industry clusters are sustainable, even if firms in the cluster have the opportunity to merge. Our analysis also suggests that such clusters will be more viable in industries with a greater degree of the holdup problem faced by the employees.

Proposition 2 also establishes that the parameter space over which the stand-alone firms prefer to operate under competition rather than to merge becomes larger for lower values of $M$ and higher values of $k$, leading to the following prediction.

*(iii) Stand-alone structures where firms compete in similar product and labor markets are more likely to be viable in industries with a higher risk of developing new products and a greater human-capital intensity.* An additional implication from Proposition 2 is that firms will be less likely to merge in industries with higher human-capital intensity (higher $k$), such as industries with "new economy" firms where innovation generation requires more costly effort from employees. In contrast, mergers will be more desirable in industries with "old economy" firms where innovation generation requires a lower amount of costly effort from employees (lower $k$), yielding the following prediction.

*(iv) Stand-alone structures will be more likely in human-capital-intensive industries, while mergers will be more likely in physical-capital-intensive industries.* Consistent with this implication, anecdotal evidence shows that mergers are largely uncommon in the private equity, venture capital, and investment banking industry, where costly human-capital acquisition by employees is particularly important for value creation. Although two investment banks can merge and increase their pricing power in the product market for their underwriting business, our model suggests that keeping competition alive in the product market and creating competition for their own employees may lead to greater profitability.

Interestingly, in our model, as shown in Proposition 3, not only total firm profits in the duopoly structure can be greater than the value of the monopoly firm, but also the value of an individual duopoly firm can be greater than the value of the monopoly firm for sufficiently low values of $\beta$ and intermediate values of $\delta$. Under these conditions, a monopoly firm benefits from creating its own competition, either by accommodating new firm entry or by encouraging new firm spawning from its own employees. The incentives to accommodate entry can, however, change with the development stage of an industry/product. When a firm introduces a new product or technology, human capital is likely to be specific to the firm where the innovation is generated, leading to low employee mobility and low value of $\delta$. As the product develops and matures, one can expect that human capital becomes more easily transferable across firms, due to the entry of new firms to the industry, and information and technology spillovers across firms. This, in turn, will result in greater employee mobility and higher values of $\delta$. Hence, incentives to accommodate new firm entry will be lowest at the earliest and the latest stages of industry/product life cycle (low or high $\delta$), while they will be greater at intermediate stages (moderate $\delta$). These observations lead to the following prediction.

*(v) Blocking new firm entry will be more likely at very early stages of the industry/product life cycle. New firm entry will take place at intermediate stages. At later stages of the industry/product life cycle, firms will find it more desirable*

*to merge as well as to block new firm entry. Similarly, the number of firms will be U-shaped as a function of industry/product life cycle.*

This prediction may be helpful in explaining the current evolution of the smart-phone industry. Early on, Apple had the monopoly position in this industry with its I-Phone. More recently, there has been an increase in the number of firms developing products competing with Apple's I-Phone. To the extent that Apple has the ability to acquire (some of) these companies, and it has not chosen to do so, suggests that there may be benefits for encouraging (or at least not preventing) competition, especially on Apple's ability to continue to add new innovative features to its product as well as to develop new innovative products. The interesting implication from our article is that firms' incentives to accommodate entry and encourage competition will decrease at later stages of industry/product development, during which the desire to reduce competition will become a greater concern, leading to an increase in merger activity. This implies that new industries and product markets will experience an increase in the number of firms during early stages of development, followed by a decrease in the number of firms through mergers at later stages of development.

Proposition 7 shows that when employee bargaining power is sufficiently low, firm incentives to finance innovative projects are greater in the competitive market structure than in the monopoly structure. Greater innovation incentives for firms, in turn, translate into a greater innovation output, and greater profitability of the competitive structure, relative to the merger, resulting in the following prediction.

*(vi) Firm investment in innovation will be greater under competition than under monopoly when the severity of the holdup problem faced by employees is greater.* Related to this result, our model also implies that multidivisional firms can improve employee incentives and innovation output by undertaking a spinoff transaction even though doing so creates competition in the product market and competition for employee human capital, and eliminates the scale advantage of being a larger firm. This implication is consistent with the finding by Dittmar and Shivdasani (2003), who show that parent firms tend to increase their rate of investment after they divest businesses. Our article provides a potential explanation for the finding that reducing firm size improves employee incentives and employee productivity (effort), which, in turn, increases firm investment incentives. This result is also consistent with empirical evidence showing that the stock market reaction to spinoff announcements is positive, as shown by Hite and Owers (1983) and Miles and Rosenfeld (1983).

In Section 4, where we endogenize employee mobility $\delta$, Proposition 8 shows that the firms in the stand-alone structure will be more willing to choose a higher level of $\delta$ for lower levels of $\beta$ and higher values of $M$, leading to the following prediction.

*(vii) Firms will have greater incentives to choose similar and compatible technology standards, and not to impose no-compete agreements when employees are subject to greater degrees of the holdup problem and when the*

*importance of being ahead of the competing firm is greater.* This result is consistent with the view by Gilson (1999) that one explanation for superior performance of Silicon Valley relative to Boston's Route 128 could be that California does not enforce *no-compete* clauses, while Massachusetts does. It is also consistent with the evidence by Samila and Sorenson (2009) that the use of no-compete agreements significantly hinders innovation activity and growth.

The prediction of our model on the importance of enhancing employee mobility is interesting in the context of recent research summarized in MIT Sloan Management Review/WSJ, October 26, 2009. This study argues that the best way to retain valuable employee human capital is to make it easier for employees to leave. Providing employees with the skill and experience set that make them more attractive in the job market not only helps firms retain valuable employees, but also makes employees more valuable within the firm. The study finds that executives plan to stay longer at firms that provide greater opportunities to enhance their employability. This finding is consistent with our analysis that although enhancing employability of employees makes it more costly to retain employees, it can still increase firm profitability by making employees more innovative and valuable within their current firm.

## 6. Conclusions

Many mergers are driven by the desire to reduce competition in the product market and to develop new products to enter into new markets. This article argues that these two motives may be in conflict with each other in that mergers reducing product market competition have a negative effect on employee incentives to innovate and develop new products. On one hand, mergers reduce the product market competition and increase expected payoffs from employee innovations. On the other hand, by reducing the number of firms in the product market, mergers limit employee ability to go from one firm to another with a negative effect on incentives. Moreover, mergers create internal competition between the employees of the post-merger firm, with an additional negative effect on incentives to innovate. When the negative effects of the merger on incentives are sufficiently large, firms are better off competing in the product market and competing for employee human capital rather than merging and eliminating competition. In other words, firms prefer not to merge and bear competition in the product market to maintain stronger employee incentives.

Our results on the negative effect of mergers on employee incentives have interesting implications for spinoff transactions. Our article suggests that a multidivisional firm can create value by undertaking a spinoff transaction since reducing firm size can have a positive effect on employee incentives. This incentive benefit can be sufficiently strong that the spinoff leads to greater firm profits even at the loss of the co-insurance benefit of an internal capital market within the multidivisional firm, and economies of scale from having multiple divisions. Similarly, our article suggests that a monopoly firm may benefit from creating its own competition in the product market and in the market for human capital when employee bargaining power is low, and when the industry is at an intermediate stage of its life cycle.

We also study how firms can improve employee mobility through their location choices and use of *no-compete* agreements. Our analysis shows that firms will choose to locate closer to similar firms in order to enhance employee incentives, although doing so exposes them to greater competition in the product market and in the market for employee human capital. Similarly, we show that firms will improve employee mobility by adopting less restrictive *no-compete* agreements, or by locating in regions where such agreements are not enforced. The desire to do so is greater when there is more to gain from being ahead of the competing firms.

Our article focuses mainly on horizontal mergers between firms operating in similar product markets and is silent about mergers across unrelated industries. Similarly, firms in our model are homogenous in the sense that when merged into a single firm, there can be synergies through only economies of scale rather than economies of scope. It would be interesting in future research to study the effect of mergers on employee incentives if mergers combine two firms where employee innovations complement each other and developing them together creates synergies from economies of scope.

## Appendix

**Proof of Lemma 1.** From the reaction function (3), the Nash-equilibrium effort level $e^{S*}$ is obtained by setting $e^S = \frac{(1-e^S)(\delta+\beta(1-\delta))M}{k}$ and solving for $e^S$. Substituting (4) into (1) and (2) gives (5) and (6).

**Proof of Lemma 2.** Differentiating the equilibrium level of employee effort (4) with respect to $M$ yields $\frac{\partial e^{S*}}{\partial M} = \frac{(\beta+(1-\beta)\delta)k}{(k+(\beta+\delta(1-\beta))M)^2} > 0$, giving (i). Similarly, differentiating (4) with respect to $\beta$ and using $0 < \beta < 1$ and $\delta \le M$ yields $\frac{\partial e^{S*}}{\partial \beta} = \frac{(1-\delta)Mk}{(k+(\beta+\delta(1-\beta))M)^2} > 0$, giving (ii). Differentiating (4) with respect to $\delta$, and using $0 < \beta < 1$, we obtain $\frac{\partial e^{S*}}{\partial \delta} = \frac{(1-\beta)Mk}{(k+M(\beta+\delta(1-\beta)))^2} > 0$, giving (iii). Finally, differentiating $\frac{\partial e^{S*}}{\partial \delta}$ with respect to $\beta$, and noting that $2M - (\delta + \beta(1-\delta))M > 0$ yields $\frac{\partial^2 e^{S*}}{\partial \delta \partial \beta} = \frac{-(k+2M-(\delta+\beta(1-\delta))M)Mk}{(k+M(\beta+\delta(1-\beta)))^3} < 0$, giving (iv).

**Proof of Lemma 3.** Differentiating the equilibrium level of firm profits (6) with respect to $\delta$, we obtain

$$\frac{\partial \pi_{F_i}^{S*}}{\partial \delta} = \frac{(1-\beta)\,(k-(\delta+\beta(1-\delta))\,(M+2k))M^2k}{(k+M\,(\beta+\delta\,(1-\beta)))^3}.$$

Since the denominator of $\frac{\partial \pi_{F_i}^{S*}}{\partial \delta}$ is always positive, it follows that $\frac{\partial \pi_{F_i}^{S*}}{\partial \delta} \ge 0$ if and only if $\delta \le \frac{(1-2\beta)k-\beta M}{(1-\beta)(M+2k)}$. Since we have $0 \le \delta \le 1$, and $\frac{(1-2\beta)k-\beta M}{(1-\beta)(M+2k)} \ge 0$ for $\beta \le \frac{k}{M+2k}$, it follows that $\frac{\partial \pi_{F_i}^{S*}}{\partial \delta} \ge 0$ if and only if $\beta \le \beta^S$ and $\delta \le \delta^S$, where $\beta^S \equiv \frac{k}{M+2k}$ and $\delta^S \equiv \frac{(1-2\beta)k-\beta M}{(1-\beta)(M+2k)}$.

**Proof of Lemma 4.** From the reaction function equation (9), the equilibrium value of $e^{M*}$ is obtained by setting $e^M = \frac{(1-e^M)\beta M}{k}$ and solving for $e^M$. Substituting (10) into (7) and (8) gives (11) and (12).

**Proof of Proposition 1.** From comparing (4) and (10), it is immediate to see that $e^{S*} > e^{M*}$. Using (4) and (10), we obtain $e^{S*} - e^{M*} = (\frac{(\beta+(1-\beta)\delta)}{k+(\beta+(1-\beta)\delta)M} - \frac{\beta}{k+\beta M})M$. Taking the derivative of $e^{S*} - e^{M*}$ with respect to $\beta$ yields $\frac{\partial(e^{S*}-e^{M*})}{\partial\beta} = \frac{-\left(k(k+2M)+(\delta+\beta(2-\beta)(1-\delta))M^2\right)k\delta M}{(k+(\beta+(1-\beta)\delta)M)^2(k+\beta M)^2} < 0$. Since the denominator of $\frac{\partial(e^{S*}-e^{M*})}{\partial\beta}$ is always positive, and it is straightforward to see $k(k+2M)+(\delta+\beta(2-\beta)(1-\delta))M^2 > 0$, we obtain $\frac{\partial(e^{S*}-e^{M*})}{\partial\beta} < 0$.

**Lemma A1.** It is optimal for the post-merger firm to have two employees.

**Proof of Lemma A1.** It is straightforward to obtain the expected profits of the post-merger firm with only one employee, as given by $\pi_F^{M1*} \equiv \frac{\beta(1-\beta)M^2}{k}$. From (12), we have the expected profits of the post-merger firm with two employees, as given by $\pi_F^{M*} = \frac{\beta M^2(2k(1-\beta)+\beta M)}{(k+\beta M)^2}$. Comparing $\pi_F^{M1*}$ with $\pi_F^{M*}$ gives that $\pi_F^{M*} \geq \pi_F^{M1*}$ if and only if $P \equiv (1-\beta)k^2 + \beta(2\beta-1)Mk - \beta^2(1-\beta)M^2 \geq 0$. $P$ is a convex parabola in $k$, with two roots $k_1$ and $k_2$ given by

$$k_1 \equiv M\frac{-\beta(2\beta-1) - \beta\sqrt{(8\beta^2-12\beta+5)}}{2(1-\beta)},$$

$$k_2 \equiv M\frac{-\beta(2\beta-1) + \beta\sqrt{(8\beta^2-12\beta+5)}}{2(1-\beta)}.$$

This implies that $\pi_F^{M*} \geq \pi_F^{M1*}$ for $k \leq k_1$ or $k \geq k_2$. It is straightforward to show that $k_1 < 0$ and $k_2 < M$ for all $0 < \beta < 1$. Given that we have $k > M$, we obtain $P \geq 0$, and hence $\pi_F^{M*} \geq \pi_F^{M1*}$ for all $k > M > k_2$.

**Proof of Proposition 2.** The firms will choose the stand-alone structure if and only if $2\pi_{F_i}^{S*} \geq \pi_F^{M*}$. Comparing $2\pi_{F_i}^{S*}$ with $\pi_F^{M*}$, it follows that $2\pi_{F_i}^{S*} \geq \pi_F^{M*}$ if and only if $G \equiv a\delta^2 + b\delta + c \leq 0$, where

$$a \equiv (1-\beta)^2\left(\beta M^2(2k+\beta M) + 2k^2(k+2\beta M)\right),$$

$$b \equiv 2(1-\beta)(k+\beta M)\left(\beta M(k+\beta M) + k^2(2\beta-1)\right),$$

$$c \equiv \beta^2 M(k+\beta M)^2.$$

Since $a > 0$, $G$ is convex in $\delta$ with two roots given by

$$\delta_1 = \frac{-b-\sqrt{b^2-4ac}}{2a}, \quad \delta_2 = \frac{-b+\sqrt{b^2-4ac}}{2a}.$$

Since $b^2 - 4ac \geq 0$ if and only if $\beta \leq \beta_1$ and $\beta \geq \beta_2$, $\delta_1$ and $\delta_2$ are real for $\beta \leq \beta_1$ and $\beta \geq \beta_2$, where

$$\beta_1 \equiv k\frac{M+2k-\sqrt{2}\sqrt{M(k+M)}}{4k^2+M(2k-M)}, \quad \beta_2 \equiv k\frac{M+2k+\sqrt{2}\sqrt{M(k+M)}}{4k^2+M(2k-M)}.$$

Hence, it follows that for $\beta \leq \beta_1$ and $\beta \geq \beta_2$ there exist $\delta_1$ and $\delta_2$ such that $G \leq 0$ and $2\pi_{F_i}^{S*} \geq \pi_F^{M*}$ for $\delta_1 \leq \delta \leq \delta_2$. Note that we have $0 \leq \delta \leq M$. Since $\delta_1 \leq \delta_2 \leq 0$ when $\beta \geq \beta_2$, and $0 < \delta_1 \leq \delta_2 \leq M$ when $\beta \leq \beta_1$, it follows that $2\pi_{F_i}^{S*} \geq \pi_F^{M*}$ if $\beta \leq \beta_1$ and $\delta_1 \leq \delta \leq \delta_2$. Defining $\beta_c \equiv \beta_1$ gives part (ii) of the proof. Since $2\pi_{F_i}^{S*} < \pi_F^{M*}$ when $G > 0$, and $G > 0$ for $\beta > \beta_c$, we obtain $2\pi_{F_i}^{S*} < \pi_F^{M*}$ for $\beta > \beta^C$, yielding part (i) of the proof. Taking the partial derivative of $\beta_c$ with respect to $M$, we obtain

$$\frac{\partial \beta_c}{\partial M} = \frac{(M\,(M+4k)\,\sqrt{M(k+M)} - \sqrt{2}(M^2(M+\frac{3}{2}k) + k^2\,(3M+2k)))k}{\sqrt{M(k+M)}\left(M(2k-M)+4k^2\right)^2}.$$

It is easy to see that the denominator of $\frac{\partial \beta_c}{\partial M}$ is always positive. By straightforward algebra, it is also straightforward to show that $M\,(M+4k)\,\sqrt{M(k+M)} < \sqrt{2}(M^2(M+\frac{3}{2}k) + k^2\,(3M+2k))$, implying that the numerator is always negative. Hence, $\frac{\partial \beta_c}{\partial M} < 0$. Taking the partial derivative of $\beta_c$ with respect to $k$,we obtain

$$\frac{\partial \beta_c}{\partial k} = \frac{(-M\,(M+4k)\,\sqrt{M(k+M)} + \sqrt{2}(M^2(M+\frac{3}{2}k) + k^2\,(3M+2k)))M}{\sqrt{M(k+M)}\left(M(2k-M)+4k^2\right)^2}.$$

Since the denominator is always positive and $M\,(M+4k)\,\sqrt{M(k+M)} < \sqrt{2}(M^2(M+\frac{3}{2}k) + k^2\,(3M+2k))$, we obtain $\frac{\partial \beta_c}{\partial k} > 0$.

**Proof of Proposition 3.** The monopoly firm will accommodate new firm entry through separating one of its employees/divisions if and only if $\pi_F^{M*} \leq \pi_{F_i}^{S*}$. Following the same steps as in the proof of Proposition 2, and defining

$$\tilde{a} \equiv (1-\beta)^2 \left(\beta M^2\,(k(2-\beta)+\beta M) + k^2\,(k+2M\beta)\right),$$
$$\tilde{b} \equiv (1-\beta)\,(k+M\beta)\left(k^2\,(2\beta-1) + \beta\,(3-2\beta)\,kM + 2\beta^2 M^2\right),$$
$$\tilde{c} \equiv \beta\,((1-\beta)k+\beta M)\,(k+M\beta)^2.$$

one can show that if $\beta \leq \tilde{\beta}_c \equiv \frac{k(3M+4k)-2k\sqrt{(M+k)(3M+2k)}}{8k^2+M(4k-3M)}$, we have $\pi_F^{M*} \leq \pi_{F_i}^{S*}$ for $\tilde{\delta}_1 \leq \delta \leq \tilde{\delta}_2$, where

$$\tilde{\delta}_1 \equiv \frac{-\tilde{b} - \sqrt{\tilde{b}^2 - 4\tilde{a}\tilde{c}}}{2\tilde{a}}, \quad \tilde{\delta}_2 \equiv \frac{-\tilde{b} + \sqrt{\tilde{b}^2 - 4\tilde{a}\tilde{c}}}{2\tilde{a}}.$$

Taking the partial derivative of $\tilde{\beta}_c$ with respect to $M$ gives

$$\frac{\partial \tilde{\beta}_c}{\partial M} = -\frac{(9M^2\,(2M+5k) + 4k^2\,(13M+6k) - \sqrt{2k^2+M\,(5k+3M)}\,(8k^2+3M\,(3M+8k)))k}{\left(8k^2+M\,(4k-3M)\right)^2\sqrt{2k^2+M\,(5k+3M)}}.$$

Since the denominator of $\frac{\partial \tilde{\beta}_c}{\partial M}$ is always positive, and it is possible to show by straightforward algebra that $9M^2\,(2M+5k) + 4k^2\,(13M+6k) - \sqrt{2k^2+M\,(5k+3M)} > 0$, we have $\frac{\partial \tilde{\beta}_c}{\partial M} < 0$. Taking the partial derivative of $\tilde{\beta}_c$ with respect to $k$ gives

$$\frac{\partial \tilde{\beta}_c}{\partial k} = \frac{(9M^2\,(2M+5k) + 4k^2\,(13M+6k) - \sqrt{2k^2+M\,(5k+3M)}\,(8k^2+3M\,(3M+8k)))M}{\left(8k^2+M\,(4k-3M)\right)^2\sqrt{2k^2+M\,(5k+3M)}}.$$

Since we have $9M^2\,(2M+5k) + 4k^2\,(13M+6k) - \sqrt{2k^2+M\,(5k+3M)} > 0$, both the numerator and the denominator of $\frac{\partial \tilde{\beta}_c}{\partial k}$ are positive, and hence, $\frac{\partial \tilde{\beta}_c}{\partial k} > 0$.

**Proof of Proposition 4.** The total firm and employee profits in the monopoly structure are given by $\pi_T^{M*} \equiv \pi_F^{M*} + 2\pi_{E_i}^{M*} = \frac{(k(2-\beta)+\beta M)\beta M^2}{(k+\beta M)^2}$. Similarly, the total firm and employee profits in the stand-alone structure are given by $\pi_T^{S*} \equiv 2\pi_{F_i}^{S*} + 2\pi_{E_i}^{S*} = \frac{(2-\delta-\beta(1-\delta))(\delta+\beta(1-\delta))kM^2}{(k+(\beta+(1-\beta)\delta)M)^2}$. Comparing $\pi_T^{M*}$ with $\pi_T^{S*}$, and using the same steps as in the proof of Proposition 2, and defining

$$\hat{a} \equiv (1-\beta)^2 \left(k^2\,(k+2\beta M) + \beta M^2\,(2k+\beta M)\right),$$

$$\hat{b} \equiv 2\,(1-\beta)\,(k+\beta M)\left(\beta M\,(k+\beta M) - (1-\beta)k^2\right),$$

$$\hat{c} \equiv \beta^2 M\,(k+\beta M)^2\,.$$

one can show that if $\beta \le \hat{\beta}_c \equiv \frac{k(k+M)-k\sqrt{M(k+2M)}}{k^2+M(k-M)}$, we have $\pi_T^{M*} \le \pi_T^{S*}$ for $\hat{\delta}_1 \le \delta \le \hat{\delta}_2$, where

$$\hat{\delta}_1 \equiv \frac{-\hat{b} - \sqrt{\hat{b}^2 - 4\hat{a}\hat{c}}}{2\hat{a}}, \quad \hat{\delta}_2 \equiv \frac{-\hat{b} + \sqrt{\hat{b}^2 - 4\hat{a}\hat{c}}}{2\hat{a}}.$$

Taking the partial derivative of $\hat{\beta}_c$ with respect to $M$ gives

$$\frac{\partial\hat{\beta}_c}{\partial M} = \frac{(2M(2k+M)\sqrt{M(k+2M)} - \left(M\left(4M^2+3k^2\right) + k\left(3M^2+k^2\right)\right))k}{2\left(M(k-M)+k^2\right)^2\left(\sqrt{M(k+2M)}\right)}.$$

Since the denominator of $\frac{\partial\hat{\beta}_c}{\partial M}$ is always positive, and it is possible to show by straightforward algebra that $2M(2k+M)\sqrt{M(k+2M)} - \left(M\left(4M^2+3k^2\right) + k\left(3M^2+k^2\right)\right) < 0$, we have $\frac{\partial\hat{\beta}_c}{\partial M} < 0$. Taking the partial derivative of $\hat{\beta}_c$ with respect to $k$ gives

$$\frac{\partial\hat{\beta}_c}{\partial k} = \frac{(-2M(2k+M)\sqrt{M(k+2M)} + M\left(4M^2+3k^2\right) + k\left(3M^2+k^2\right))M}{2\left(M(k-M)+k^2\right)^2\left(\sqrt{Mk+2M^2}\right)}.$$

Since we have $-2M(2k+M)\sqrt{M(k+2M)} + \left(M\left(4M^2+3k^2\right) + k\left(3M^2+k^2\right)\right) > 0$, both the numerator and the denominator of $\frac{\partial\hat{\beta}_c}{\partial k}$ are positive, and hence $\frac{\partial\hat{\beta}_c}{\partial k} > 0$.

Comparing $\hat{\beta}_c$ to $\tilde{\beta}_c$ yields that $\hat{\beta}_c > \tilde{\beta}_c$ if and only if $(8k^2+M(4k-3M))\sqrt{M\,(k+2M)} - 2(k^2+M(k-M))\sqrt{(M+k)\,(3M+2k)} < k\left(5Mk+2M^2+4k^2\right)$. Squaring both sides, we obtain $\hat{\beta}_c > \tilde{\beta}_c$ if and only if $(10M-k)\,(M+k)\left(Mk-M^2+k^2\right)\left(4Mk-3M^2+8k^2\right) < 4(k^2+M(k-M))(8k^2+M(4k-3M))\sqrt{M\,(k+2M)}\sqrt{(M+k)\,(3M+2k)}$. Taking the square of each side of the inequality and rearranging yields $\hat{\beta}_c > \tilde{\beta}_c$ if and only if $-4M^2\,(8k-M) + k^2\,(k-51M) < 0$. Noting that $M < k$, for $k < 51M$, it always holds that $-4M^2\,(8k-M) + k^2\,(k-51M) < 0$. For $k \ge 51M$, we have $-4M^2\,(8k-M) + k^2\,(k-51M) < -4M^2\,(8k-M) + M^2\,(k-51M) = -M^2\,(47M+31k) < 0$, and hence $\hat{\beta}_c > \tilde{\beta}_c$.

**Proof of Proposition 5.** From Lemma A1, we have the expected profits of the post-merger firm with only one employee, before investment cost $I$, as given by $\pi_F^{M1*} = \frac{\beta(1-\beta)M^2}{k}$, and its profits net of investment cost $I$ are given by $\pi_F^{M1*}(I) \equiv \frac{\beta(1-\beta)M^2}{k} - I$. With two employees, from (12), its expected profits net of investment cost $KI$, denoted by $\pi_F^{M*}(I)$, are given by

$$\pi_F^{M*}(I) \equiv \frac{\beta M^2\,(2k(1-\beta)+\beta M)}{(k+\beta M)^2} - KI.$$

Comparing $\pi_F^{M*}$ with $\pi_F^{M1*}(I)$ yields $\pi_F^{M*} \geq \pi_F^{M1*}(I)$ if and only if $K \leq \frac{\frac{\beta M^2(2k(1-\beta)+\beta M)}{(k+\beta M)^2} - \frac{\beta(1-\beta)M^2}{k} + I}{I}$. Given that we have $K \leq 2$, defining $K^C \equiv \min\left\{2, \frac{\frac{\beta M^2(2k(1-\beta)+\beta M)}{(k+\beta M)^2} - \frac{\beta(1-\beta)M^2}{k} + I}{I}\right\}$, it follows that if $K \leq K^C$, the post-merger firm chooses to have two employees/divisions. If $K > K^C$, it finds it optimal to scale down and retain only one employee/division.

**Proof of Proposition 6.** It is straightforward to obtain the expected profits of the employee in the post-merger firm with only one employee as $\pi_E^{M1*} \equiv \frac{\beta^2 M^2}{2k}$. Using the expected profits of the post-merger firm with only one employee $\pi_F^{M1*}(I) \equiv \frac{\beta(1-\beta)M^2}{k} - I$, given in the proof of Proposition 5, it follows that the total employee and firm expected profits in the post-merger firm with only one employee are given by $\pi_T^{M1*}(I) \equiv \frac{\beta^2 M^2}{2k} + \frac{\beta(1-\beta)M^2}{k} - I = \frac{\beta(2-\beta)M^2}{2k} - I$. Similarly, using the employee profits given in Equation (11) and firm profits $\pi_F^{M*}(I)$ given in the proof of Proposition 5, we have the total employee and firm expected profits in the post-merger firm with two employees as given by $\pi_T^{M2*}(I) \equiv 2\frac{k\beta^2 M^2}{2(k+\beta M)^2} + \frac{\beta M^2(2k(1-\beta)+\beta M)}{(k+\beta M)^2} - KI = \frac{(2k+M\beta-k\beta)M^2\beta}{(k+M\beta)^2} - KI$. Downsizing is socially optimal if $\pi_T^{M1*}(I) \geq \pi_T^{M2*}(I)$. Comparing $\pi_T^{M1*}(I)$ with $\pi_T^{M2*}(I)$ yields that $\pi_T^{M1*}(I) \geq \pi_T^{M2*}(I)$ for $K \geq K^S \equiv \frac{\frac{(2k+M\beta-k\beta)M^2\beta}{(k+M\beta)^2} - \frac{\beta(2-\beta)M^2}{2k} + I}{I}$. From the proof of Proposition 5, we have that the post-merger firm finds it optimal to keep both employees for $K \leq K^C$. Hence, it follows that for $K^S \leq K \leq K^C$, the post-merger firm does not downsize when downsizing is socially optimal. Note that for $\beta M > (\sqrt{2}-1)k$, it always holds that $\frac{(2k+M\beta-k\beta)M^2\beta}{(k+M\beta)^2} - \frac{\beta(2-\beta)M^2}{2k} < \frac{\beta M^2(2k(1-\beta)+\beta M)}{(k+\beta M)^2} - \frac{\beta(1-\beta)M^2}{k}$, implying that $K^S < K^C$.

**Proof of Proposition 7.** Let $K \leq K^C$ so that the firm chooses to have two employees. Let $\pi_{F_i}^{S*}(I) \equiv \pi_{F_i}^{S*} - I$ denote stand-alone firm profits net of investment cost $I$.

From the proof of Proposition 3, we have that if $\beta \leq \beta_c$, we have $\pi_{F_i}^{S*} \geq \pi_F^{M*}$ for $\delta_1 \leq \delta \leq \delta_2$. This implies that if $\beta \leq \beta_c$ and $\delta_1 \leq \delta \leq \delta_2$, $\pi_{F_i}^{S*}(I) = \pi_{F_i}^{S*} - I > \pi_F^{M*} - I > \pi_F^{M*}(I) = \pi_F^{M*} - KI$, given that $K > 1$. If we set $I_1 \equiv \pi_F^{M*}$ and $I_2 \equiv \pi_{F_i}^{S*}$, for all $I$ such that $I_1 < I < I_2$, we have $\pi_F^{M*} - KI < \pi_F^{M*} - I < 0$, and $\pi_{F_i}^{S*} - I > 0$, implying that the stand-alone firms obtain positive expected profits from investing in innovation while the monopoly firm with two divisions obtains negative profits, and hence it does not invest in innovation.

Now let $K > K^C$, implying that the post-merger firm finds it optimal to downsize and operate as a single-division firm. Following the steps in the proof of Proposition 2 and defining

$$\breve{a} \equiv (1-\beta)\,(k^2 + \beta(1-\beta)M^2),$$

$$\breve{b} \equiv k^2(2\beta - 1) + 2\beta\,(1-\beta)\,(k+\beta M)\,M,$$

$$\breve{c} \equiv \beta((k+\beta M)^2 - k^2),$$

one can show that if $\beta \leq \breve{\beta}_c \equiv \frac{((M+k)-\sqrt{M(k+M)})}{2(M+k)}$, we have $\pi_{F_i}^{S*} \geq \pi_F^{M1*}$ for $\breve{\delta}_1 \leq \delta \leq \breve{\delta}_2$, where

$$\breve{\delta}_1 \equiv \frac{-\breve{b}-\sqrt{\breve{b}^2-4\breve{a}\breve{c}}}{2\breve{a}}, \quad \breve{\delta}_2 \equiv \frac{-\breve{b}+\sqrt{\breve{b}^2-4\breve{a}\breve{c}}}{2\breve{a}}.$$

This implies that if $\beta \le \breve{\beta}_c$ and $\breve{\delta}_1 \le \delta \le \breve{\delta}_2$, we have $\pi_{F_i}^{S*}(I) \ge \pi_F^{M1*}(I)$. If we set $I_3 \equiv \pi_F^{M1*}$, for all $I$ such that $I_3 < I < I_2$, we have $\pi_F^{M1*}(I) < 0$, and $\pi_{F_i}^{S*}(I) > 0$, implying that the stand-alone firms obtain positive expected profits from investing in innovation, while the monopoly firm with one division obtains negative expected profits and hence does not invest in innovation.

**Proof of Proposition 8.** Using the reaction function equation in (14), we can obtain the Nash-equilibrium level of effort $e_1^S(\delta_1,\delta_2)$ and $e_2^S(\delta_1,\delta_2)$ as

$$e_1^S(\delta_1,\delta_2) = \frac{(\beta M + x_1)(k-\beta M - x_2)}{k^2-(\beta M + x_1)(\beta M + x_2)},$$

$$e_2^S(\delta_1,\delta_2) = \frac{(\beta M + x_2)(k-\beta M - x_1)}{k^2-(\beta M + x_1)(\beta M + x_2),}$$

where $x_1 \equiv (1-\beta)\delta_1 M$ and $x_2 \equiv (1-\beta)\delta_2 M$. Since we have $M < k$, and $x_i \le (1-\beta)M$, $\beta M + x_i \le k$ for all $0 < \beta < 1$, implying that $0 < e_i^S(\delta_1,\delta_2) < 1$, for $i = 1, 2$, holds for all parameter values. Plugging $e_1^S(\delta_1,\delta_2)$ and $e_2^S(\delta_1,\delta_2)$ into firm expected profits given in Equation (16), we obtain

$$\pi_{F_i}^S = \frac{k\left((1-\beta)M - x_i\right)(\beta M + x_i)\left(k-\beta M - x_j\right)^2}{\left(k^2-(\beta M + x_i)\left(\beta M + x_j\right)\right)^2}.$$

Taking the partial derivative of $\pi_{F_i}^S$ with respect to $x_i$, equating it to 0, and solving it for $x_i$, we obtain

$$x_i = \frac{(1-2\beta)Mk^2 + \beta((\beta M + x_j)M^2}{2k^2-(\beta M + x_j)M}.$$

Substituting $x_i = (1-\beta)\delta_i M$, setting $\delta_i = \delta_j = \delta$, and solving the equation for $\delta$, we obtain

$$\delta^{1*} = \frac{k^2-\beta M^2 - k\sqrt{k^2-M^2}}{(1-\beta)M^2}, \quad \delta^{2*} = \frac{k^2-\beta M^2 + k\sqrt{k^2-M^2}}{(1-\beta)M^2}.$$

Since $\delta_i$ must satisfy $0 \le \delta_i \le 1$, and $\delta^{2*} > 1$, it follows that $\delta^{2*}$ cannot be the equilibrium choice. It is straightforward to show that $\delta^{1*} < 1$. Since $\delta^{1*} < 0$ when $\beta > \bar{\beta} \equiv \frac{k(k-\sqrt{k^2-M^2})}{M^2}$, and given that $\delta_i$ must satisfy $\delta_i > 0$, in equilibrium the firms set $\delta_i^* = 0$ for $\beta > \bar{\beta}$. Similarly, given that $0 \le \delta^{1*} \le 1$ for $\beta \le \bar{\beta}$, the firms set $\delta_i^* = \delta^{1*}$ for $\beta \le \bar{\beta}$ . It is straightforward to verify that $\frac{\partial \pi_{F_i}^S}{\partial \delta_i} \le 0$ for $\beta \le \bar{\beta}$; hence, firm $i$'s profits are maximized at $\delta_i = 0$ and $\frac{\partial^2 \pi_{F_i}^S}{\partial \delta_i^2} < 0$ at $\delta_i = \delta^{1*}$, implying that $\delta^{1*}$ maximizes $\pi_{F_i}^S$. Defining $\bar{\delta}^* \equiv \delta_i^*$, $i = 1, 2$, and $\bar{\delta} \equiv \delta^1$ proves the main part of the proposition. Differentiating $\bar{\delta}$ with respect to $\beta$ yields $\frac{\partial \bar{\delta}}{\partial \beta} = \frac{k^2-M^2-k\sqrt{k^2-M^2}}{(1-\beta)^2 M^2}$. Given $M < k$, it is immediate to see that $\frac{\partial \bar{\delta}}{\partial \beta} < 0$. Differentiating $\bar{\delta}$ with respect to $M$ yields $\frac{\partial \bar{\delta}}{\partial M} = k\frac{2k^2-M^2-2k\sqrt{k^2-M^2}}{(1-\beta)\left(\sqrt{k^2-M^2}\right)M^3}$. The denominator of $\frac{\partial \bar{\delta}}{\partial M}$ is always positive. It is straightforward to show that $2k^2 - M^2 - 2k\sqrt{k^2-M^2} > 0$ for all $M < k$. Hence, we obtain $\frac{\partial \bar{\delta}}{\partial M} > 0$. Finally, differentiating $\bar{\beta}$ with respect to $M$ yields $\frac{\partial \bar{\beta}}{\partial M} = k\frac{2k^2-M^2-2k\sqrt{k^2-M^2}}{\sqrt{k^2-M^2}M^3}$. Since the denominator of $\frac{\partial \bar{\beta}}{\partial M}$ is always positive, and $2k^2 - M^2 - 2k\sqrt{k^2-M^2} > 0$ for $M < k$, we obtain $\frac{\partial \bar{\beta}}{\partial M} > 0$.

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