

Competition, Mergers and Innovation Incentives

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Abstract

This paper studies the effect of organization structure on competition for human capital and competition in the product market, and develops a theory of firm organization structure where firms either choose to operate stand-alone under product market competition, or merge and reduce competition in the product market. The stand-alone structure implies both competition in the product market and competition for employee human capital. While product market competition is always detrimental for employee incentives and firm profits, competition for human capital may prove beneficial for firms since it improves employee incentives to innovate. The merger reduces both product market competition, and competition for employee human capital. Although the post-merger firm always benefits from lower competition in the product market, a lower level of competition for employee human capital may hurt firm profits, by weakening employee incentives to innovate. We show that, under certain conditions, mergers may be detrimental to innovation incentives, and hence, firms may prefer to operate stand-alone under product market competition. The positive effect of the stand-alone structure is more valuable in riskier industries which are at an earlier stage of development while its negative effect is more pronounced in mature industries at a late stage of development. Finally, we investigate the role of *no-compete agreements* on employee incentives to innovate, and identify the conditions under which no-compete agreements emerge endogenously within the context of an industry equilibrium.

1 Introduction

This paper studies the effect of different organizational structures on the level of competition for employee human capital and the level of product market competition, and develops a theory of firm organization structure as a function of industry characteristics such as the size of the industry, and the risk associated with developing new products in the industry.

Firms can choose between two types of organization structure. The first one is a stand-alone structure where firms operate as independent firms in the same product market. The second one is a merger where firms operating in the same product market merge into a single firm. The stand-alone structure and the merger are different in terms of their effect on product market competition (competition in the final goods market), and competition for employee human capital. In the stand-alone structure, since two firms operate in the same product market, they compete with each other in the final goods market. In addition, the presence of two firms in the same product market implies that employees can move from one firm to another. Hence, firms not only compete in the product market, but also they compete for employee human capital. The merger, however, combines two competing firms into a single firm, and eliminates competition in the product market. Furthermore, the merger also eliminates competition for employee human capital by reducing the number of firms, and employee's ability to move from one firm to another. Thus, relative to the stand-alone structure, the merger reduces both product market competition and competition for human capital. Since both types of competition have an effect on *ex ante* employee incentives to generate an innovation, and *ex post* firm payoffs from employee innovations, firm expected profits critically depend on the organization structure chosen. We show that while the stand-alone structure leads to higher firm profits in smaller industries with greater risk, the merger becomes the optimal organization structure in late stage industries with greater market size and lower risk.

In our model, firm value is created by commercializing innovations generated by employees. Innovation arises as an outcome of costly investment in human capital by employees. We assume that there are two firms, and each firm has an employee. The two firms either can operate as stand-alone in the same product market, or merge into one single firm and operate as a monopolist in the product market.

In the stand-alone structure, greater competition in the product market is costly for the firms since it has a negative effect on *ex ante* employee incentives to exert innovation effort and implies a lower *ex post* payoff from employee innovations. However, the stand-alone structure also leads to greater competition for employee human capital, and increases the price of human capital. Although the higher price of

employee human capital lowers firms' *ex post* payoff from employee innovations, it may have a positive effect on *ex ante* firm profits by improving employee effort. The intuition for this result is that in the absence of complete contracts, employees face a hold-up problem where they may obtain low rents from *ex post* bargaining with their firm, especially if their bargaining power is low. In such a case, the stand-alone structure mitigates the employees' concern about being held-up by their firm, with a positive effect on their *ex ante* incentives to innovate. This is because under the stand-alone structure, the presence of multiple firms in the same product creates an ability for the employees to move from one firm to another, and increases their rents from obtaining an innovation, with a positive effect on the probability of innovation.

The merger, on the other hand, eliminates product market competition between the two firms, with a positive effect on employee incentives to innovate. However, the merger also has two negative effects on employee incentives: first, it decreases the number of firms in the same product market, and hence reduces the extent of competition for human capital and second, it creates internal competition between the employees by allowing the post-merger firm to extract greater rents from the employees. Both effects lead to weaker employee incentives to exert innovation effort. The overall effect of the merger on employee incentives, relative to the stand-alone structure, is positive if the reduction in product market competition dominates the reduction in competition for employee human capital. Otherwise, if the benefit of reducing competition in the product market is limited, then the merger leads to weaker incentives, relative to the stand-alone structure, by reducing the extent of competition for employee human capital. From the firm's perspective, even though the merger always leads to greater *ex post* payoff from employee innovations, it can still reduce *ex ante* firm expected profits if its overall effect on employee incentives is negative.

Evaluating the costs and the benefits of each structure, our paper shows that, under certain condition, the two firms competing in the same product market do not find it desirable to merge even if doing so strictly increases the market power of the post-merger firm, relative to the market power of each firm operating stand-alone. This is precisely because the merger can have a negative effect on employee incentives to innovate and introduce new products. Hence, our paper offers an explanation for why many mergers fail to create value, and why mergers might be bad for innovation and discovery of new products. This result is particularly important given the evidence in a recent paper by Hoberg and Phillips (2009) that one of the most important drivers of mergers is to improve the ability to introduce new products and to create competitive advantage with respect to rival firms in the product market.

A novel result from our analysis is that the positive effect of the stand-alone structure on employee incentives is most valuable especially in early stage industries with smaller size and high risk potential.

Supplementing employee incentives by providing the employees with the ability to move across competing firms turns out to be very desirable in such industries since, in the absence of employee mobility, a small market size and high risk inherent in such industries fail to provide strong incentives to innovate. Hence, an interesting implication from our model is that the stand-alone structure plays a positive role on innovation output in early stage industries with new emerging technologies whereas in more mature industries with greater market size and lower risk, mergers have a more positive effect on innovation.

Our paper is 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 input suppliers and buyers of inputs. Input suppliers have incentives to choose locations where they are closer to firms demanding inputs. This is because the resulting competition among firms reduces the suppliers' concerns about being held-up by firms, and enhances their incentives to invest ex ante in the technology to deliver the inputs efficiently. 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 firms depends on whether the firm or the employee invests in human capital, and whether human capital investment is industry-specific or firm-specific. In Almazan et al. (2007), 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 their employees' human capital development.

Although several papers study the existence and the benefits of industry clusters, an interesting and unexplored question related to firm behavior within industry clusters is whether firms located within the same industry clusters find it optimal to merge. Put differently, it is not clear what prevents firms within an industry clusters from merging and what makes industry clusters sustainable. The main idea in our paper is to investigate the incentives of firms located within an industry cluster to merge. Our paper suggests that the merger decision depends on its effect on the extent of the hold-up problem between the post-merger firm and the employees as well as its effect on the level of competition in the product market. Similar to the literature on the location choice of firms, we also show that one of the benefits of locating within an industry cluster is that it mitigates the hold-up problem between firms and employees, with a positive effect on employee incentives. Importantly, different from this literature, our paper identifies the conditions under which firms within an industry cluster will find it optimal to merge, and the industry

cluster will not be sustainable. More specifically, we find that firms will be more willing to cluster, pay greater wages and bear greater competition in the product market especially in early stage industries with smaller market size and greater risk. As the industry matures, becomes larger, and less risky, firms within the cluster will find it more desirable to merge to reduce product market competition. In addition, the desire to merge will be smaller in human capital intensive industries whereas in more physical capital intensive industries, the desire to reduce competition in the product market through horizontal mergers will be more pressing.

Our paper also generates insights on the choice of industry standards and compatible technologies. Since employee mobility among firms can be promoted by the adoption of compatible technologies or choosing similar industry standards, firms may benefit from the creation of homogeneous industry standards that facilitate the transferability of employee human capital from one firm to another. We show that firms competing in the same product market will benefit from setting similar industry standards or choosing compatible technologies. Although doing so increases the price of human capital, it also improves employee incentives, and increases the innovation output of the firm. Notably, choosing compatible technologies and homogeneous standards is particularly desirable in emerging industries with new and risky technologies since improving employee incentives through such practices has the highest benefit in such industries.

Our paper also helps explain how firms benefit from employee mobility, and why it may be detrimental for human capital intensive firms to restrict their employees' mobility by, for example, requiring employees to sign "no-compete" agreements that would limit employees' ability to work for other firms. Imposing a no-compete agreement affects employee incentives to innovate by affecting the outside option of the employee in the wage negotiations. In addition, it creates an externality for the competing firms in the same industry due to the strategic interactions between the firms competing in the same product market. We show that this externality leads to either an equilibrium where all firms in the industry limit employee mobility by imposing no-compete agreements, or to an alternative equilibrium where no firm imposes such agreements. In the equilibrium where no firm imposes no-compete agreements, employees obtain higher rents, exert greater innovation effort and generate greater innovation output, relative to the equilibrium where all firms restrict employee mobility. These results are consistent with the view in Gilson (2004) suggesting that an important element accounting for the better relative performance of Silicon Valley with respect to Boston's Route 128 can be traced to the differences in their legal environments (since California does not enforce *no-compete* clauses, while Massachusetts does). They are also consistent with the evidence

in Samila and Sorenson (2009) that the use of no-compete agreements significantly hinders the innovation activity and growth.

Related to our paper's focus on the development of human capital, Morrison and Wilhelm (2004) explores the role of partnerships in the formation of human capital. Morrison and Wilhelm (2007) develops a theory of partnership in the investment banking industry and suggest that the interaction of the partnership structure and technological advances explain the IPO decision of investment banks. In our paper, the organization structure decision has implications for product market competition. In a related setting, Mathews and Robinson (2006) examine how a firm chooses its optimal organizational design as an interaction between product markets and capital markets. They compare a stand-alone firm and an integrated firm in terms of their effect on entry deterrence and on predatory capital raising, and show that the integrated firm's greater flexibility in resource allocation can deter entry from stand-alone firms when product markets are uncertain. However, an integrated firm also faces a capital commitment problem, which can encourage predatory capital raising from a stand-alone firm when uncertainty in the product markets is lower.

Our results suggest that especially in human capital intensive industries, mergers may affect employee incentives so adversely that firms may prefer to stay stand-alone although the merger reduces competition in the product market. These results are interesting in the context of the findings in Hochberg, Ljungqvist and Lu (2009) who find that VC firms form networks in order to prevent the entry of new VC firms and to limit the extent of competition for entrepreneurs. It is possible that VC firms do not find it optimal to merge to reduce competition in the product market since doing so, as our paper suggests, will have a negative effect on employee incentives. Although our paper is silent about the comparison of mergers and formation of networks in terms of their effect on product market competition and employee incentives, the results in Hochberg et al. (2009) suggest that forming a network of independent VC firms appears to be a more efficient mechanism than a merger between VC firms in limiting competition in the product market.

The paper is organized as follows. In section 2, we present the basic model, and analyze the stand-alone structure and the merger. Section 3 examines two extensions of our model: first, firms' incentives to take ex ante actions to improve employee mobility, and second, firms' incentives to use no-compete agreements to limit employee mobility within the context of an industry equilibrium. Section 4 concludes. All proofs are in the Appendix.

2 The Model

We consider an economy endowed with 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 assume also that employees have limited wealth and we rule out ex ante monetary transfers between firms and employees. The two firms are human capital intensive in the sense that they create value only by implementing their employees' 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.¹ The second stage involves the development and commercialization 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.²

The success probability in the first stage of the project depends on an unobservable effort exerted by the employee, which is 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 of the project: $p_i(e_i) = e_i \in [0, 1]$. Exerting effort is costly: we assume that effort costs are convex and given by $\frac{k}{2}e_i^2$ with $k \geq 1$ 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.

Human capital acquired by an employee in the first stage of the project is essential for both the generation of an innovation and the subsequent development of the innovation into a final product. The key feature of our model is that employee incentives to acquire human capital depend on the organizational structure that their firms choose. The firms either choose to operate as stand-alone firms, or choose to merge into one 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 employees to transfer (albeit imperfectly) their innovation and human capital from one firm to the other. This implies

¹Innovation can be broadly interpreted as any new idea, process or product which improves firm profitability.

²This assumption implies that if an employee with a successful innovation leaves his firm at the end of the first stage, the firm cannot implement the innovation without the original employee. Similarly, we assume that if the employee leaves the firm, he cannot implement the innovation by himself but he must join another firm with the resources and capabilities necessary to implement the innovation. We assume also that the employee needs the firm's resources during both stages of the production process, which implies that he can generate an innovation only if he has joined a firm at the beginning of the game.

that the presence of other firms in the same product market enables employees to develop human capital that can be valued outside the original firm, allowing employees to move from one firm to another. In this way, the presence of multiple firms in the same product market creates competition for employee human capital. Hence, the stand-alone structure not only leads to competition in the product market, but also to 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, and both employees are employed in the post-merger firm. This implies that employee innovations can only be developed and commercialized within the post-merger firm, since there is no rival firm in the product market to which employees can transfer their innovation. Thus, the merger eliminates competition in the product market as well as competition for employee human capital.

We assume that employee effort is not observable, exposing firms to moral hazard. Following Stole and Zwiebel (1996a and 1996b), and in the spirit of Grossman and Hart (1986) and Hart and Moore (1990), we also assume that firms and 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 (as in Stole and Zwiebel, 1996a and 1996b) at the interim date by intra-firm bargaining between the firm and the employee, before the second stage of the project is performed.³

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 by the fact that the firm cannot replace its current employee with a new one from the general labor market population, but it can only hire an employee from 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 produce in the second period.⁴ The presence of an outside option for the employee depends on the employee's ability to 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

³For a further discussion on the role of employment *at will* and renegotiation on surplus allocation, see Stole and Zwiebel (1996a) and (1996b).

⁴Relaxing this assumption and allowing the firm to hire a new employee from the labor market does not change our results in any significant way, as long as the value created by the firm and the new employee is lower than the value created by the original employee, due to relationship specific nature of original employee's investment.

firms choose the stand-alone structure.

Ex post payoffs from employee innovations depend on the organization structure choice of the firms. If the firms operate stand-alone, then the payoff from the project depends on whether the employees of one or both firms have been successful in the first stage of their project. If both firms have been successful (that is, if employees at both firms obtain an innovation) the two firms compete in the commercialization of the innovation. We assume that the two firms engage in Bertrand competition, which drives project payoff at each firm down to 0.⁵ If, instead, only one of the employees succeeds in obtaining an innovation, then the firm with the successful employee will be a monopolist in the market and the payoff from the project will be M . 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 at the post-merger firm succeeds, the post-merger firm will not face any competition in the product market, and project payoff will still be M .

The game unfolds as follows. At time $t = 0$, the two firms decide whether to merge or to be stand-alone firms in the same product market. If the two firms merge, the post-merger firm retains both employees. At $t = 1$, after observing the organizational choice decision of the firms, each employee exerts effort which determines the success probability of his project. Effort choices are made simultaneously by the two employees.

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 commercialization of the innovation. The share of the surplus earned 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 a share $\beta \in [0, 1]$ of the net joint surplus that depends on his bargaining power. Thus, we will refer to the parameter β as measuring the 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, provided that he has succeeded in generating an innovation. We assume that the employee can transfer his innovation to the competing firm and commercialize it with a potential

⁵We make this assumption for analytical tractability. The main results of our paper can be extended to include different forms of product market competition between the two firms.

payoff $\delta \leq M$. We interpret the parameter δ as measuring the degree of transferability of employee human capital across firms. We assume initially that δ is an exogenous parameter; in Section 3.1, we allow firms to choose the value of δ 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 market. Thus, both employees and firms have zero outside options while bargaining.

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

2.1 The stand-alone structure

This section examines the stand-alone structure where the two firms choose to operate as two separate firms in the same product market. The firms' choice to operate as stand-alone entities has two implications. The first one is that it exposes the firms to competition in the product market. This is costly because, when the employees in both firms are successful, competition in the product market drives payoffs for each firm down to 0. The second one is that the stand-alone structure creates competition for employee human capital. This is because the presence of two firms in the same product market implies that the employees can move from one firm to another, which gives them an outside option while bargaining with their firm.

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 . Employee i has the ability to transfer his innovation and human capital to the competing firm j with payoff of δ .⁶ We model the bargaining game between employee i and firm i as one in which the two parties make alternating offers under the threat that the bargaining process breaks down with a certain exogenous probability. If bargaining with firm i breaks down, employee i has the option to start a new round of bargaining with firm j . Thus, the payoff from bargaining with firm j represents employee i 's outside option when bargaining with firm i . One can show that, as the probability that the bargaining process breaks down tends to zero, the outcome of the subgame perfect equilibrium of the bargaining game between firm i and employee i is such that the employee and the firm receive the value of their outside

⁶Note that in equilibrium the employees will never transfer their human capital and innovation to the rival firm since $\delta \leq M$. It is straightforward to extend our model to the case where (with some exogenous probability) the employees may generate a higher value when they redeploy their human capital at the rival firm, outside their original firm. This occurs, for example, when $\delta > M$, and therefore employees move from one firm to another in equilibrium.

options (the value that they can obtain in the case of a breakdown in bargaining), plus the fractions β and $1 - \beta$, respectively, of the surplus that they jointly generate net of the sum of their outside options.⁷

We can determine the payoffs from bargaining between firm i and employee i by proceeding backwards. If bargaining between employee i and firm i breaks down, employee i has the opportunity to bargain with firm j . In this second bargaining game, both employee i and firm j have zero outside options. The employee and the firm will therefore divide the joint surplus, δ , and the employee obtains payoff $\beta\delta$, which represents the value of employee i 's outside option while bargaining with firm i . Since employee j has failed to obtain an innovation, firm i has an outside option with value zero. This implies that employee i 's payoff from bargaining with firm i is equal to $\beta\delta + \beta(M - \beta\delta) = \beta M + \beta(1 - \beta)\delta$. Note that this payoff corresponds to the employee's outside option (given by $\beta\delta$) plus the proportion β of the total surplus created by employee i and firm i net of the sum of each party's outside option, given by $\beta(M - \beta\delta)$. Correspondingly, firm i 's payoff is given by $(1 - \beta)(M - \beta\delta)$.

If both employees have been successful, the firms compete in the product market and both firms and 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 $\pi_{E_i}^S$:

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

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

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

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

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

Examination of the first-order condition (3) reveals that the stand-alone structure has two effects on employee incentives to exert effort. The first effect, captured by the term $-e_j^S \beta M$, 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 between the two firms drives

⁷Note that this division of the surplus corresponds to the Nash-bargaining solution with outside options, in which the employee's and the firm's bargaining powers are, respectively, β and $1 - \beta$. See again Binmore, Rubinstein, and Wolinski (1986).

project payoff to zero, with a negative impact on employee effort. The second effect, captured by the term $(1 - e_j^S)\beta(1 - \beta)\delta$, is positive and originates from the property that the two firms compete for employee human capital: in the state where only one employee is successful in generating an innovation, that is, the two firms compete for the successful employee. Since employee i 's innovation is valuable at his current firm as well as at the rival firm, this creates an outside option for the employee, and enables him to extract greater rents from his firm, enhancing his incentives to exert effort. It is worth mentioning that this effect arises only when the employee at the rival firm fails, which happens with probability $1 - e_j^S$.

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 unique (symmetric) Nash-equilibrium of the effort subgame under the stand-alone structure is given by:*

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

The corresponding expected profits for the employees and the firms are

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

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

The following lemma presents some interesting 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 the level of project payoff M , in the employee bargaining power β , and in the degree of transferability of human capital δ :*

$$\frac{\partial e^{S*}}{\partial M} > 0, \quad \frac{\partial e^{S*}}{\partial \beta} > 0, \quad \frac{\partial e^{S*}}{\partial \delta} > 0.$$

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

The level of effort is increasing in both project payoff M and employee bargaining power β since both parameters increase employee expected profits from exerting effort to innovate. Next, 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, yielding $\frac{\partial e^{S*}}{\partial \delta} > 0$. Interestingly, the positive effect of the employee outside option δ on incentives becomes stronger when innovation payoff M is smaller, that is, $\frac{\partial^2 e^{S*}}{\partial \delta \partial M} < 0$. The intuition for this result is that when M is smaller, employee's incentives are weaker since a smaller payoff

from the innovation reduces their motivation to exert effort. This implies that the effect of the outside option in terms of improving employee incentives is relatively more important when M is smaller. If we interpret M as measuring the expected payoff from commercializing and developing employee innovations, the value of M will be lower when the size of the market for such innovations is smaller, and/or when the idiosyncratic risk associated with successful development of employee innovations will be higher. This means that when the employees expect a larger market with lower risk for their future innovations, their incentives to exert effort are already strong and the marginal benefit of the outside option in improving employee incentives is smaller.

The positive effect of δ on employee incentives is also stronger for lower values of β , implied by $\frac{\partial^2 e^{S*}}{\partial \delta \partial \beta} < 0$. The intuition for this result is that when employee bargaining power is lower, the employees obtain lower ex post rents from bargaining with their firm, and have weaker incentives to exert effort ex ante. Thus, supplementing employee incentives through the outside option becomes more important when β is smaller. If we interpret β as a measure of the extent of the hold-up problem, that is, a measure of the firms' ability to expropriate their employees ex-post, this result suggests that the stand-alone structure affects incentives more positively by increasing the price of human capital when the severity of the hold-up problem faced by the employees is greater.

Having examined the effects of the stand-alone structure on ex ante employee incentives to exert effort, we now turn our attention to its effects on firm expected profits, determined as a function of employee effort and firms' ex-post payoffs from developing employee innovations. As we discussed above, the stand-alone structure has both positive and negative effects on ex ante employee incentives. However, it always has a negative effect on firms' ex post payoffs from developing an employee innovation for two reasons. First, if both employees are successful in generating an innovation, competition in the product market drives innovation payoff to zero for both firms. Second, if only one employee is successful, the successful employee uses his outside option of moving to the competing firm to extract greater rents from his current firm, reducing firms' rents.

The overall effect of the stand-alone structure on firm expected profits can be positive in the sense that firm expected profits can be a positive function of employee outside option δ if the employee bargaining power is sufficiently low. The intuition for this result is that, in the absence of the outside option, a low employee bargaining power implies weak incentives and, thus, a low probability of obtaining an innovation. Hence, in such case, it is most desirable to improve employee incentives through competition for human capital. In addition, when β is low, the additional rent extraction ability of the employee is not too costly

for the firm. This can be seen by noting that the cost of δ in terms of reducing ex post firm payoff $(1 - \beta)(M - \beta\delta)$ from employee innovations is smaller for smaller β . The following lemma presents the effect of the outside option on firm profits formally.

Lemma 3 *Firm expected profits are increasing in δ if employee bargaining power is sufficiently low, that is, $\frac{\partial \pi_{F_i}^{S^*}}{\partial \delta} \geq 0, i = 1, 2$ for $\beta \leq \bar{\beta}_F$ (where $\bar{\beta}_F$ is defined in the Appendix).*

2.2 The merger

If the two firms decide to merge, the post-merger firm retains both employees. As before, after the firms make the organization structure choice, each employee exerts effort e_i^M , 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 in case if both employees generate an innovation.⁸

As in the case of stand-alone structure, the merger has implications both for the level of competition in the product market and the level of competition for employee human capital. Recall that under stand-alone structure, when the employees of both firms are successful in generating an innovation, competition in the product market drives payoffs to zero. After the merger, in contrast, the post-merger firm obtains a positive payoff, M , from employee innovations even when both employees are successful, since the merger eliminates competition in the product market. The merger affects also competition for employee human capital by eliminating for each employee the rival firm to which he can transfer his innovation. This implies that the employees lose their outside option when they bargain with the post-merger firm.

Notably, the merger not only eliminates the outside option of the employees, but it also creates an outside option for the post-merger firm. This is because when both employees are successful, the firm has the ability to bargain with two employees rather than only one. If bargaining with one employee fails, the firm can bargain with the second employee. Hence, the presence of the second employee allows the firm to extract greater rents from the first employee, compared to the stand-alone structure where the firm has no outside option.⁹

⁸An example of such an innovation would be a “process innovation,” that is, the discovery of a new technology that is necessary to produce a product. See Rotemberg and Saloner (1994) for a similar assumption.

⁹Note that the fact that the post-merger firm extracts greater rents when it employs more than one employee is similar to the result in Stole and Zwiebel (1996a and 1996b), who show that firms may overemploy in order to gain a bargaining advantage in the wage negotiations with their employees.

We now proceed with the derivation of firm and employee payoffs under the merger. First, consider the simpler case where only one employee generates an innovation. In this case, the employee will bargain with the firm for his share of the payoff from the development of the 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 will obtain payoff βM , and the firm will retain the remainder payoff, $(1 - \beta)M$. Note that these payoffs are different from the payoffs the successful employee and his firm obtains under the stand-alone structure. Since after the merger there is no rival firm that the successful employee can transfer his innovation, he loses his outside option δ .

If both employees generate an innovation, we assume that the firm selects randomly and with equal probability one of the two employee innovations to commercialize. The selected employee, say employee i , will then bargain with the firm for his share of the surplus. This case differs from the stand-alone structure in that, now, while bargaining with employee i , the firm has the option of developing the innovation generated by employee j , if bargaining between the firm and employee i breaks down. Hence, the merger creates an outside option for the post-merger firm.

To obtain the payoffs in the state where both employees are successful, we model the bargaining game between employee i and the firm as before, and assume that the two parties make alternating offers under the threat that the bargaining process breaks down with a certain exogenous probability. If bargaining with employee i breaks down, the firm has the option to start a new round of bargaining with employee j . Thus, the payoff from bargaining with employee j represents the firm's outside option when bargaining with employee i . As before, the payoff of the subgame perfect equilibrium of the bargaining game is such that the employee and the firm receive the value of their outside options (the value that they can obtain in case of a breakdown in the bargaining game) plus, respectively, the fractions β and $1 - \beta$ of the surplus they jointly generate, net of the sum of their outside options.

We can determine the payoffs of the bargaining game between the firm and employee i by proceeding backwards. If bargaining with employee i breaks down, the firm bargains with employee j . In this second bargaining game, both employee j and the firm will have zero outside options. The employee and the firm will therefore divide the joint surplus according to their bargaining power, obtaining βM and $(1 - \beta)M$, respectively. Since there are no other firms to which employee i can go, he has no outside option when bargaining with the firm. This implies that employee i 's payoff from bargaining with the firm is now equal to $\beta(M - (1 - \beta)M) = \beta^2 M$. Furthermore, since employee i 's innovation is chosen with probability $\frac{1}{2}$, his expected payoff is $\frac{\beta^2 M}{2}$. Correspondingly, the firm's payoff is given by $(1 - \beta)M$

$$+(1 - \beta)(M - (1 - \beta)M) = (1 - \beta^2)M.$$

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

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

The expected profits of the post-merger firm denoted by π_F^M are

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

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

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

From the first order condition (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 greater surplus from each employee in the state where both employees are successful. The following lemma presents the equilibrium level of employee effort, 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 given as follows:*

$$e_i^{M*} = e_j^{M*} = e^{M*} \equiv \frac{2\beta M}{2k + \beta(2 - \beta)M}. \quad (10)$$

The corresponding expected profits of the employees and the firm are

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

$$\pi_F^{M*} = \frac{4\beta(1 - \beta)(2k + \beta M)M^2}{(2k + \beta M(2 - \beta))^2}. \quad (12)$$

Relative to the stand-alone structure, the merger has three effects on employee incentives to exert effort. The first is effect is positive, and due to the merger's role in eliminating competition in the product market. In the state where both employees are successful, each employee obtains a positive payoff (as opposed to obtaining zero payoff in the stand-alone structure), and exerts higher effort, all else constant. The second effect is negative, and stems from the fact that the merger also eliminates competition for employee human capital. Since the employees at the post-merger firm have no rival firms to which they can transfer their innovation, they lose their outside option when they bargain with the firm, obtain lower rents, and have lower incentives to exert effort. The third effect is again negative, and arises from the

post-merger firm's ability to have a bargaining advantage in the state where both employees are successful. Having two employees to bargain with creates an outside option for the post-merger firm, and reduces employee rents in the bargaining, with a negative effect on employee incentives to exert effort.

The following lemma compares employee effort in the merger scenario to that under the stand-alone structure.

Lemma 5 *If $\frac{\beta^2(2-\beta)}{1-\beta} \leq \frac{2k}{\delta}$, the level of effort under the stand-alone structure is greater than that under the merger if and only if $M \leq \frac{-\delta\beta(1-\beta) + \sqrt{\delta(1-\beta)(8k + \delta\beta^2(1-\beta))}}{2\beta}$. If $\frac{\beta^2(2-\beta)}{1-\beta} > \frac{2k}{\delta}$, the level of effort under the merger is always greater.*

Lemma 5 shows that the overall effect of the merger on employee effort level, relative to the effort level in the stand-alone structure, can be both negative and positive. When employee bargaining power and payoff from employee innovations are low, that is, when $\frac{\beta^2(2-\beta)}{1-\beta} \leq \frac{2k}{\delta}$ and $M \leq \frac{2k(1-2\beta)}{\beta(2+\beta)}$, the negative effects of the merger dominate the positive one, and the merger always leads to a reduction in employee effort. Note that $\frac{\beta^2(2-\beta)}{1-\beta}$ is an increasing function of β , which implies that the condition $\frac{\beta^2(2-\beta)}{1-\beta} \leq \frac{2k}{\delta}$ is more likely to hold for lower values of β . The intuition for this result is that the merger leads to weaker incentives when β is lower because it eliminates the outside option for the employees, which is most valuable when employee bargaining power is low. In addition, when the payoff M from employee innovations is low, employee incentives to exert effort, all else constant, are weak, and the marginal benefit of the employee outside option in improving employee incentives is high. Hence, the elimination of the employee outside option through the merger hurts employee incentives to a greater extent when M is lower. In addition, when M is lower, the benefit of the merger in terms of reducing product market competition is more limited as well, reducing the desirability of the merger. When the employee bargaining power is higher, the positive effect of the merger on incentives dominates the two negative effects, and employee effort turns out to be higher in the post-merger firm than in the stand-alone firm. This is because while the merger reduces incentives by eliminating competition for human capital, it also eliminates product market competition and allows the post-merger firm and the employees to obtain a positive payoff even if both employees are successful in generating an innovation. Since high employee bargaining power already implies strong incentives, the negative effects of the merger on incentives, in terms of loss of competition for human capital, are weaker in magnitude and become second order for the employee with respect to the increased expected payoff from the innovation.

The merger affects firm expected profits through its impact on ex ante employee incentives and the

post-merger firm's ex post payoff from employee innovations. As we discussed above, while the merger's overall effect on employee incentives depends on the level of employee bargaining power β and project payoff M , its effect on the firm's ex-post payoff from employee innovations is always positive. This is because the merger eliminates both competition in the product market and competition for employee human capital, leading to an increase in ex post payoffs for the firm, provided that at least one employee is successful in generating an innovation. Moreover, the merger creates an outside option for the firm in case both employees are successful, allowing the firm to extract more surplus from the employees.

By evaluating the combined effect of the merger on employee incentives and the firm's ex post payoff, the next proposition provides a set of conditions under which the two firms choose the stand-alone structure.

Proposition 1 *Let $\frac{M\beta(2-\beta)}{(2\beta^2-4\beta+1)} \leq k$ and $\delta = M$. The two firms obtain greater expected profits under the stand-alone structure than the merger, and hence, choose the stand-alone structure.*

When employee bargaining power and the payoff from the project are lower, we know from Lemma 5 that employee incentives are stronger in the stand-alone structure than in the merger scenario. In addition, the benefit of the merger in terms of reducing the project market competition is limited for lower values of M . Note that the condition $\frac{M\beta(2-\beta)}{(2\beta^2-4\beta+1)} \leq k$ is more likely to hold at lower values of β since $\frac{\beta(2-\beta)}{(2\beta^2-4\beta+1)}$ is an increasing function of β . In addition, the condition $\delta = M$ implies that the firms need the the incentive benefit of the stand-alone structure to be at its highest possible level in order to give up the merging option. Note that while having $\delta = M$ yields strong employee incentives, its cost for the firms in terms of lower rents from employee innovations is not too high given that employee bargaining power β is low.

The negative effect of the merger on incentives suggests that, all else equal, the merger is more likely to be profitable in industries with a lower human capital intensity and greater physical capital intensity, that is, in sectors where motivating employee incentives is less critical. To see this, suppose that the probability of innovations is given exogenously, and does not depend on employee effort. This implies that the merger only has a positive effect on firm profits by increasing the post-merger's firm ex post payoffs. Hence, in such industries, the incentives to merge will be greater and, the likelihood of observing industry clusters where firms operate stand-alone in similar product markets will be lower. When providing employee incentives is of first order importance, the merger may lead to weaker incentives, and may prove undesirable, in spite of increasing the market power of the post-merger firm. This result is consistent with the observation that mergers between human capital intensive firms, such as venture capital and private equity firms, are relatively uncommon despite both venture capital and private equity industry face intense levels of

competition in the product market as well as in the market for skilled human capital. Our model suggests that in such industries, by keeping firm size and the number of employees small, the stand-alone structure leads to stronger incentives to exert effort and to acquire human capital, although it may imply greater competition among venture capital and private equity firms in the product market.

Finally, if we interpret the parameter M as the size of the potential market for employee innovations, an additional interesting implication from our model is that mergers will hurt innovation incentives especially in industries at an earlier development stage with high risk associated with the development of employee innovations. In such industries, the stand-alone structure, which gives rise to both competition in the product market and competition for human capital will have a positive effect on innovation probability. In more mature industries with greater size and lower risk, mergers will become more desirable since eliminating product market competition in such industries will be more important in terms of improving employee incentives and firms' ex post payoff from employee innovations. Hence, our model implies that as an industry matures and its size increases, the likelihood of mergers between firms competing in the product market will increase. Note that this result is not only due to the merger's effect in terms of eliminating product market competition. The merger has an important effect on the probability of innovations. Our analysis suggests that there are conditions under which even if the merger reduces competition in the product market, the firms will choose not to merge to maintain stronger employee incentives. Hence, keeping competition alive in the product market will lead to competition for human capital, and will ultimately benefit the firms through the higher likelihood of innovations.

3 Extensions

In this section we extend our basic model in two dimensions. First, we study the possibility that the firms can choose the degree of transferability of employee human capital measured by δ . Second, we investigate firms' incentives to limit employee mobility by imposing ex ante *no-compete* agreements on their employees.

3.1 Endogenous human capital transferability

In the previous section we showed that, under certain conditions, the firms can benefit from their employees having a greater ability to move from one firm to another, even though this implies paying employees greater rents and operating under competition in the product market. This result suggests that firms may

ex ante take certain actions to determine the value of the parameter δ in a way to maximize firm expected profits.

Firms can affect the degree of transferability employee human capital in a number of different ways. For example, they can choose compatible technologies and similar industry standards so that human capital accumulated by an employee in one firm can be more easily transferred to a competing firm. Alternatively, firms' choice of their geographical location could influence the magnitude of δ given that employees have a greater ability to transfer their skills to firms located at closer geographical distances to their current firm. Finally, the level of enforcement of *no-compete* agreements within an industry (or industry cluster) may have an effect on employees' ability to move from one firm to another. For example, by choosing to locate in regions where non-compete clauses are not enforced, firms can provide their employees with a greater ability to move from one firm to another, and greater rent extraction ability.¹⁰

In this section, we examine the possibility that firms in the stand-alone structure choose the level of employee outside option δ endogenously in order to maximize their expected profits. We modify the basic model as follows. Suppose that at the beginning of the game, $t = 0$, if the firms choose the stand-alone structure, they can also set the value of δ cooperatively, with $0 \leq \delta \leq M$, in order to maximize their ex ante expected profits. For simplicity, we assume that the firms do not incur any cost in choosing $\delta > 0$.¹¹

The following proposition establishes the level of δ chosen cooperatively by the two firms in a way to maximize their expected profits.

Proposition 2 *The firms set δ such that if $\beta \leq \frac{1}{2}$,*

$$\delta^* = \begin{cases} M & \text{if } M \leq \frac{k(2\beta^2 - 4\beta + 1)}{\beta(2 - \beta)}; \\ \frac{kM(1 - 2\beta) - \beta M^2}{\beta(1 - \beta)(M + 2k)} & \text{if } \frac{k(2\beta^2 - 4\beta + 1)}{\beta(2 - \beta)} < M \leq \frac{k(1 - 2\beta)}{\beta}; \\ 0 & \text{if } M > \frac{k(1 - 2\beta)}{\beta}. \end{cases}$$

Furthermore, $\partial\delta^*/\partial\beta \leq 0$ and $\partial\delta^*/\partial M \leq 0$. If $\beta \geq \frac{1}{2}$, $\delta^* = 0$.

Two important insights emerge from Proposition 2. First, for low values of employee bargaining power, that is, for $\beta \leq \frac{1}{2}$, the two firms are more likely to benefit from a higher level of δ , since a low β implies weak employee incentives, all else constant. Hence, the firms have the incentive to choose a high value of δ to increase the rent extraction ability of their employees and thus, employee effort. Note that the optimal

¹⁰Section xxx investigates the firms' incentives to impose non-compete agreements on their employees within the context of an industry equilibrium.

¹¹It is possible to extend the analysis in a way that it is costly for the firms to choose a positive level of δ .

level δ^* is weakly decreasing in β ; this is because when employee bargaining power increases, employees incentives to exert effort become stronger, which reduces the need for the firm to increase employee rents by improving the transferability of employee human capital. When employee bargaining power is sufficiently high, that is, when $\beta \geq \frac{1}{2}$, employee incentives are already sufficiently strong, and the firms are better off by choosing $\delta^* = 0$. This is because the benefit of setting $\delta > 0$ is limited at high values of β , whereas its cost in terms of leading to lower ex post rents for the firms is high. Recall that the reduction in firms' rents from employee innovations at a given level of δ is greater as β goes up, which can be seen from firms' rents given by $(1 - \beta)(M - \delta)$.

The second insight from the Proposition 2 is that the firms' desire to choose a high δ is stronger for lower values of M . This property is due to the fact that improving employee incentives through the outside option is most valuable when the potential payoff from employee innovations is not large enough. Conversely, when the payoff from employee innovations is sufficiently high, that is, when $M > \frac{k(1-2\beta)}{\beta}$, employee incentives are already strong, and hence, the firms set $\delta^* = 0$. Finally, the optimal level of δ decreases in M given that the importance of enhancing employee incentives by increasing their rent extraction ability is most desirable at lower levels of M .

3.2 No-compete clauses and employee incentives

Firms may restrict the mobility of their employees by requiring them to sign ex-ante agreements that prevent them from joining rival firms. The choice of imposing such an agreement can be interpreted in our model as setting $\delta = 0$. In this section, we examine the incentives of the firms in the stand-alone structure to impose a no-compete clause on their employees. This endogenous choice of δ is different from the earlier analysis in that rather than allowing the firms cooperatively choosing the level of δ , for example by adopting compatible technologies and industry standards, this section focuses on each firm's individual incentives whether to impose a no-compete clause on its own employee. As expected, since the two firms compete in the same product market, each firm's decision creates an externality on the other firm, and each firm takes into account the rival firm's decision about the no-compete clause in deciding whether to impose such a clause on its own employee.

To keep the analytical tractability of the model, we assume $M = k = 1$. We modify the basic model as follows. We assume that the two firms operate as stand-alone firms and each firm can require its employee to sign ex-ante a *no-compete* agreement that prevents the employee from joining the rival firm at a later date. If firm i decides to impose a no-compete clause on its employee, this choice is modeled as setting

$\delta_i = 0$. If, on the other hand, it does not impose a no-compete clause on its employee, this is modeled as $\delta_i = \delta$, with $0 < \delta_i < 1$, which implies that the employee has the ability to join the rival firm, where his innovation will have a value of δ . Note that for analytical tractability, we assume δ is an exogenous parameter measuring the extent of employee mobility.

The modified game is as follows. At time 0, the firms simultaneously choose whether or not to require their employees to sign a *no-compete* agreement, that is, whether to set $\delta_i = 0$, or $\delta_i = \delta$. We will refer to this game as the *agreement-choice* game. After that, the game unfolds as before. The only difference with the basic model is that now an employee, while bargaining with his firm at the interim date, will have an outside option only if he has not entered into a *no-compete* agreement with his firm at time 0.

The following proposition characterizes the equilibrium behavior of the two firms in terms of imposing a no-compete clause on their employees.

Proposition 3 *There is a $\delta^{NC} \in (0, 1)$ (defined in the appendix) such that*

i) if $0 \leq \delta < \delta^{NC}$ neither firm requires its employee to sign a no-compete agreement. Furthermore, there is a $\delta_F^P \in [0, \delta^{NC})$ (defined in the appendix) such that, if $\delta_F^P \leq \delta < \delta^{NC}$, the equilibrium profits for both firms are (Pareto) dominated by the profits obtained when both firms can commit to impose a no-compete agreement on their employees.

ii) If $\delta^{NC} \leq \delta \leq 1$, the agreement-choice game has two (Nash) equilibria. In the first equilibrium, neither firm requires its employee to sign a no-compete agreement. In the second equilibrium, both firms require their employee to sign a no-compete agreement. Furthermore, firm profits in the equilibrium where firms do not impose the no-compete agreement are (Pareto) dominated by the equilibrium profits when both firms impose a no-compete agreement.

$$iii) \frac{\partial \delta^{NC}}{\partial \beta} < 0.$$

When firm i imposes a *no-compete* agreement on its employee, this has three separate effects on its expected profits. First, imposing the agreement eliminates employee i 's ability to join the rival firm and reduces the surplus extracted by the employee, with a positive effect on firm i 's ex post payoff from employee innovations. Second, the reduction in employee surplus has a negative effect on his ex ante incentives and leads to lower effort, with a negative impact on ex ante expected profits of firm i . Third, the reduction in employee effort at firm i generates a strategic response from the employee at the rival firm. This is because employee j the rival firm rationally anticipates the reduction in the effort of employee at firm i , and increases his own effort level. The intuition for this strategic effect is that when e_i goes

down, the probability of the employee at firm j being the only successful employee, that is, the probability $(1 - e_i)e_j$ increases, and leads to a greater effort from employee at firm j . This effect, in turn, puts firm i at a strategic disadvantage (by reducing the probability $e_i(1 - e_j)$ of obtaining a positive payoff) by promoting employee effort at the rival firm.

Evaluating the three effects (one positive and two negative effects) of the no-compete agreement on overall firm expected profits, it turns out that the firms' incentives to impose such agreements depend critically on the level of δ , that is, the extent of the ability of the employees to join rival firms given that their firm does not impose a no-compete agreement.

When the value of δ is not too large, that is, when $\delta < \delta^{NC}$, the cost of imposing the agreement in terms of weaker employee incentives and the strategic disadvantage with respect to the rival firm dominates the benefit of the agreement in terms of higher firm rents ex post, and hence, neither firm finds it optimal to impose a *no-compete* agreement on its employee. By preserving its employee's outside option, each firm can strategically provide its employee with stronger incentives.

Interestingly, there are conditions under which not-imposing a no-compete agreement would hurt the firms. In other words, there are conditions under which if the two firms cooperate ex ante and prevent their employees from joining each other, they would benefit from doing so. This is because, in the absence of the no-compete clauses, if δ is too large, employee incentives may be too strong in the sense that the two firms end up competing very aggressively in the product market. Remember that if employees at both firms are successful, then competition in the product market drives payoffs from employee innovations to 0. Importantly, the probability of this outcome, given by $e_i e_j$, is greater when employee effort is too high. Similarly, say for firm i , the probability of being the only firm with an innovation and obtaining a positive payoff, given by $e_i(1 - e_j)$, is smaller when effort from each employee is too high. Hence, in such case, not imposing no-compete agreements will lead to an aggressive competition in the product market, and hurt each firm. However, due to the interaction in the product market and each firm's desire to be ahead of the rival firm in terms of being the only firm with an innovation, each firm unilaterally finds it desirable not to impose the agreement on its employee. As a result, when $\delta_F^P \leq \delta < \delta^{NC}$ the firms reach an inefficient outcome in the sense that the equilibrium profits are lower than those that would be obtained if both firms could coordinate ex-ante and commit to impose a *no-compete* agreement on their employees. Each firm's individual incentive to deviate and not to impose the agreement generates a classic Prisoner's Dilemma situation where the firms end up in an inefficient equilibrium.

When the value of the employee outside option is sufficiently large, that is, when $\delta \geq \delta^{NC}$, two

(symmetric) equilibria exist: in the first equilibrium, neither firm imposes a no-compete agreement, while in the second one they both impose an agreement. Furthermore, the equilibrium where the firms impose a no-compete agreement Pareto-dominates the one in which they do not do so. The intuition for these results can be seen as follows. At high values of δ , as we discussed before, improving effort incentives is not desirable for the firms, since too much effort leads to a more aggressive competition in the product market. In addition, higher values of δ imply lower levels of firm rents. Hence, in the absence of strategic interactions between the two firms, the optimal course of action for each firm is to impose a no-compete agreement on its employee. However, precisely because of the strategic interaction between the two firms, if one of the firms chooses not to impose the agreement, this puts the rival firm at a strategic disadvantage and the rival firm finds it optimal not to impose an agreement as well, leading to the first equilibrium which is inefficient relative to the second equilibrium.

Proposition 3 establishes the equilibrium decision of whether or not to impose a *no-compete* agreement when the firms maximize their own profits. It is interesting to contrast this case to the one in which the firms and the employees act as a coalition, and take the decision of whether or not to impose an agreement to maximize their joint profits.

Proposition 4 *If the firms maximize the total profits, the unique Nash-equilibrium of the agreement-choice game is such that neither firm requires its employee to sign a no-compete agreement. Furthermore, there is a $\delta_T^P \in [0, 1]$ such that, if $\delta_T^P \leq \delta \leq 1$, the equilibrium profits for both firms are (Pareto) dominated by the profits obtained when both firms can commit to impose a no-compete agreement.*

Comparing Proposition 3 and Proposition 4 reveals that, when the choice of whether or not to impose a no-compete agreement is made to maximize total profits, such agreements are never imposed in equilibrium. When the total profits are maximized, the reallocation of rents between a firm and its employee represents an internal transfer of surplus between the two parties. Thus, the rent extraction effect of imposing a no-compete agreement disappears, leaving only the strategic and the incentive effect in play. Hence, the two firms always benefit from not imposing a no-compete agreement. However, as before, when δ is too large, that is, when $\delta \geq \delta_T^P$, the equilibrium outcome is not Pareto-optimal. The firms are once again in a Prisoner's Dilemma outcome. As before, this result is due to property that a large value of the outside option δ results in a too-high equilibrium level of employee effort, and induces more aggressive competition between the two firms (by maximizing the likelihood of the state where both employees are successful). In this case, the two firms would be better off if they could coordinate ex-ante and commit not to hire

each-other's employee.¹²

In our model, lack of no-compete agreements allows employees to extract greater rents from their firm, lowering firms' ex post payoff from employee innovations. Since we abstract from costly firm investment or training in employee human capital, our paper is silent about the potential effect of greater employee mobility on firm incentives to invest in employee human capital or in employee training. In related work, Morrison and Wilhelm (2004) suggest that technological shocks, such as advances in information technology, will increase employee mobility by reducing the costs of moving to a firm with an unfamiliar culture, and reduce firm investment in employee human capital.

Our results regarding the use of no-compete clauses offer interesting insights. First, our paper suggests that firms' choice regarding the use of no-compete clauses has a strategic value. This means that firms do not choose whether or not to impose *no-compete* clauses in isolation, but rather in the context of an industry equilibrium. Thus, each firm makes its own decision by taking into account whether rival firms in the same product market impose a no-compete agreement or not and, leading to an equilibrium where either all firms in the industry impose a *no-compete* agreement, or no firm in the industry does so. This is consistent with anecdotal evidence that no-compete agreements are more common in certain industries than others. For example, investment banking and consulting industries (two human capital intensive industries) are characterized by an absence of *no-compete* agreements and thus, a high degree of employee mobility.

Our results also suggest that the use of no-compete agreements may lead to more aggressive competition in the product market and lower welfare, where welfare is defined as the total expected profits of employees and firms. This result implies that, in certain industries, actions aimed at limiting employee mobility could be welfare enhancing.

4 Conclusions

Many mergers are driven by the desire to introduce new products and to gain competitive advantage relative to rival firms in the product market. However, especially in human capital intensive industries, mergers might have a negative effect on employee incentives to innovate. On one hand, mergers reduce the external product market competition and increase expected payoffs from employee innovations, with

¹²This commitment may be obtained, for example, by creating an industry standard which requires that employees of all firms sign such agreements.

a positive effect on incentives to innovate. On the other hand, by reducing the number of firms in the product market, mergers limit employees' ability to go from one firm to another with a negative effect on incentive. Moreover, mergers create internal competition between the employees of the post-merger firm, with a second negative effect on incentives to innovate. When the negative effects dominate the positive effect, firms are better off competing in the product market 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.

We also study the role of *no-compete* agreements on innovation incentives. We identify the conditions under which imposing a *no-compete* agreement on employees, which restricts employee mobility and eliminates their ability to join rival firms, will be detrimental for a firm. Our analysis shows that, under certain conditions, imposing such agreements on employees affects innovation incentives adversely and reduces firm profits. Moreover, a firm can gain a strategic advantage over its rival firm by not imposing such agreements, since this enhances its own employee's innovation effort and depresses innovation incentives at the rival firm. Hence, our analysis highlights a strategic motive for the use of no-compete agreements in competitive industries.

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Appendix

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

Proof of Lemma 2 Differentiating the equilibrium level of employee effort (4) with respect to M yields $\frac{\partial e^{S*}}{\partial M} = \frac{\beta k}{(k + M\beta + \beta\delta(1-\beta))^2} > 0$. Similarly, taking the partial derivative of (4) with respect to β and noting $\delta \leq M$ yield $\frac{\partial e^{S*}}{\partial \beta} = \frac{(M + \delta - 2\beta\delta)k}{(k + M\beta + \beta\delta(1-\beta))^2} > 0$. Differentiating the equilibrium level of employee effort

(4) with respect to δ , and using $k \geq 1$, and $\beta > 1$, we obtain $\frac{\partial e^{S^*}}{\partial \delta} = \frac{\beta(1-\beta)k}{\beta^2(M+\delta(k-\beta))^2} > 0$. Similarly, taking the derivative of $\frac{\partial e^{S^*}}{\partial \delta}$ with respect to M yields $\frac{\partial^2 e^{S^*}}{\partial \delta \partial M} = \frac{-2k(1-\beta)}{\beta(M+\delta(k-\beta))^3} < 0$. Finally, taking the derivative of $\frac{\partial e^{S^*}}{\partial \delta}$ with respect to β yields $\frac{\partial^2 e^{S^*}}{\partial \delta \partial \beta} = -\frac{(M+\delta(k-3\beta+2\beta^2))k}{\beta^2(M+\delta(k-\beta))^3}$. It follows that $\frac{\partial^2 e^{S^*}}{\partial \delta \partial \beta} < 0$ if and only if $M + \delta(k - 3\beta + 2\beta^2) > 0$. The condition $0 < \beta < 1$ we have implies that $-3\beta + 2\beta^2 \geq -\frac{9}{8}$. Combining this condition with $k \geq 1$, we obtain $k - 3\beta + 2\beta^2 > -\frac{1}{8}$, which in turn, implies that $M + \delta(k - 3\beta + 2\beta^2) > M - \frac{\delta}{8}$. Since we have $0 \leq \delta \leq M$, $M - \frac{\delta}{8} > 0$, and hence, $\frac{\partial^2 e^{S^*}}{\partial \delta \partial \beta} < 0$.

Proof of Lemma 3 Differentiating the equilibrium level of firm profits, (6), with respect to δ we obtain

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

$\frac{\partial \pi_{F_i}^{S^*}}{\partial \delta}$ is positive if and only if $G \equiv \delta(M+2k)\beta^2 - (M+2k)(M+\delta)\beta + Mk > 0$. Since G is a convex parabola in β , it has two roots given by

$$\begin{aligned} \beta_1 &\equiv \frac{(M+2k)(M+\delta)}{2\delta(M+2k)} - \frac{\sqrt{(M+2k)((M^2+\delta^2)(M+2k)+2\delta M^2)}}{2\delta(M+2k)}, \\ \beta_2 &\equiv \frac{(M+2k)(M+\delta)}{2\delta(M+2k)} + \frac{\sqrt{(M+2k)((M^2+\delta^2)(M+2k)+2\delta M^2)}}{2\delta(M+2k)}. \end{aligned}$$

It is straightforward to show that $\beta_2 > 1 > \beta_1 > 0$. Since $P > 0$ for $\beta \leq \beta_1$ or $\beta \geq \beta_2$, and we have that $0 < \beta < 1$, it follows that $P > 0$ for $\beta \leq \beta_1$. Defining $\beta_F \equiv \beta_1$ completes the proof.

Proof of Lemma 4 From the reaction function equation (9), the equilibrium value of e^{M^*} is obtained by setting $e^M = \frac{\beta(2-e^{HM}(2-\beta))}{2k}$, and solving for e^M . Substituting (10) into (7) and (8) gives (11) and (12).

Proof of Lemma 5 Comparing (4) and (10) reveals that $e^{S^*} \geq e^{M^*}$

if and only if

$$M \geq \frac{-\delta\beta(1-\beta) - \sqrt{\delta(1-\beta)(8k + \delta\beta^2(1-\beta))}}{2\beta},$$

or

$$M \leq \frac{-\delta\beta(1-\beta) + \sqrt{\delta(1-\beta)(8k + \delta\beta^2(1-\beta))}}{2\beta}.$$

Since $\frac{-\delta\beta(1-\beta) - \sqrt{\delta(1-\beta)(8k + \delta\beta^2(1-\beta))}}{2\beta} \leq 0$ and $M > 0$, it follows that $e^{S^*} \geq e^{M^*}$ if and only if $M \leq \frac{-\delta\beta(1-\beta) + \sqrt{\delta(1-\beta)(8k + \delta\beta^2(1-\beta))}}{2\beta}$. Since we have $M \geq \delta$, it turns out that $\frac{-\delta\beta(1-\beta) + \sqrt{\delta(1-\beta)(8k + \delta\beta^2(1-\beta))}}{2\beta} > \delta$ only if $\frac{\beta^2(2-\beta)}{1-\beta} \leq \frac{2k}{\delta}$. Hence, if $\frac{\beta^2(2-\beta)}{1-\beta} \leq \frac{2k}{\delta}$, $e^{S^*} \geq e^{M^*}$ if and only if $M \leq \frac{-\delta\beta(1-\beta) + \sqrt{\delta(1-\beta)(8k + \delta\beta^2(1-\beta))}}{2\beta}$. Otherwise, if $\frac{\beta^2(2-\beta)}{1-\beta} > \frac{2k}{\delta}$, we have $\frac{-\delta\beta(1-\beta) + \sqrt{\delta(1-\beta)(8k + \delta\beta^2(1-\beta))}}{2\beta} \leq \delta$, implying that we can not have $M \leq \frac{-\delta\beta(1-\beta) + \sqrt{\delta(1-\beta)(8k + \delta\beta^2(1-\beta))}}{2\beta}$, and hence, $e^{S^*} < e^{M^*}$.

Proof of Proposition 1 Using $\frac{\partial \pi_{F_i}^{S^*}}{\partial \delta} = \frac{\beta(1-\beta)k(\delta(M+2k)\beta^2 - (M+2k)(M+\delta)\beta + Mk)}{(k+\beta(M+(1-\beta)\delta))^3}$ from the proof of Lemma 3, and setting $\frac{\beta(1-\beta)k(Mk - M\beta(M+2k) - \delta\beta(M+2k)(1-\beta))}{(k+\beta(M+(1-\beta)\delta))^3} = 0$, we obtain $\frac{\partial \pi_{F_i}^{S^*}}{\partial \delta} = 0$ for at $\delta = \frac{kM(1-2\beta) - \beta M^2}{\beta(1-\beta)(M+2k)}$. It is straightforward to show that $\frac{kM(1-2\beta) - \beta M^2}{\beta(1-\beta)(M+2k)} \geq M$ if $M \leq \frac{k(2\beta^2 - 4\beta + 1)}{\beta(2-\beta)}$, implying that firm profits are maximized at $\delta^* = M$. Plugging $\delta^* = M$ into $\pi_{F_i}^{S^*}$ yields

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

Comparing $\pi_{F_i}^{S^*}(\delta^* = M)$ with the half of the profits of the post-merger firm yields that $\pi_{F_i}^{S^*}(\delta^* = M) \geq \frac{1}{2}\pi_F^{M^*}$ if and only if

$$2(2k + \beta M)(k + \beta M(2 - \beta))^2 \leq k(2 - \beta)(1 - \beta)(2k + \beta M(2 - \beta))^2.$$

The condition $M \leq \frac{k(2\beta^2 - 4\beta + 1)}{\beta(2-\beta)}$ implies $\beta M \leq \frac{k(2\beta^2 - 4\beta + 1)}{(2-\beta)}$ and $\beta(2 - \beta)M \leq k(2\beta^2 - 4\beta + 1)$. Using these two inequalities, we obtain $2(2k + \beta M)(k + \beta M(2 - \beta))^2 \leq \frac{(2\beta^2 - 6\beta + 5)(1-\beta)^4 k^3}{8(2-\beta)}$. Since we have $\frac{(2\beta^2 - 6\beta + 5)(1-\beta)^4}{8(2-\beta)} < (2 - \beta)(1 - \beta)$ and $k^3 < k(2k + \beta M(2 - \beta))^2$, it follows that $\frac{(2\beta^2 - 6\beta + 5)(1-\beta)^4 k^3}{8(2-\beta)} \leq k(2 - \beta)(1 - \beta)(2k + \beta M(2 - \beta))^2$.

Proof of Proposition 2 Using

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

from the proof of Lemma 3, and setting

$$\frac{\beta(1-\beta)k(Mk - M\beta(M+2k) - \delta\beta(M+2k)(1-\beta))}{(k+\beta(M+(1-\beta)\delta))^3} = 0,$$

we obtain $\frac{\partial \pi_{F_i}^{S^*}}{\partial \delta} = 0$ for at $\delta = \frac{kM(1-2\beta) - \beta M^2}{\beta(1-\beta)(M+2k)}$. First, consider the case where $\beta \geq \frac{1}{2}$. It follows that $\frac{kM(1-2\beta) - \beta M^2}{\beta(1-\beta)(M+2k)} < 0$, implying that firm profits are maximized at $\delta^* = 0$. Second, consider the case where $\beta < \frac{1}{2}$. It follows that $\frac{kM(1-2\beta) - \beta M^2}{\beta(1-\beta)(M+2k)} > M$ if $M \leq \frac{k(2\beta^2 - 4\beta + 1)}{\beta(2-\beta)}$ and $\beta \leq \frac{2-\sqrt{2}}{2}$. Hence, since we have that $\delta^* \leq M$, the firms set $\delta^* = M$. For $M > \frac{k(2\beta^2 - 4\beta + 1)}{\beta(2-\beta)}$ and $\beta \leq \frac{2-\sqrt{2}}{2}$, it follows that $0 < \frac{kM(1-2\beta) - \beta M^2}{\beta(1-\beta)(M+2k)} < M$, and the firms set $\delta^* = \frac{kM(1-2\beta) - \beta M^2}{\beta(1-\beta)(M+2k)}$. If $\beta > \frac{2-\sqrt{2}}{2}$, $\frac{kM(1-2\beta) - \beta M^2}{\beta(1-\beta)(M+2k)} \geq 0$ if and only if $M \leq \frac{k(1-2\beta)}{\beta}$. Hence, the firms set $\delta^* = \frac{kM(1-2\beta) - \beta M^2}{\beta(1-\beta)(M+2k)}$ for $M \leq \frac{k(1-2\beta)}{\beta}$, and $\delta^* = 0$ for $M > \frac{k(1-2\beta)}{\beta}$.

Proof of Proposition 3 To prove this proposition, we need to characterize the Nash-equilibrium effort levels as a function of firms' choice on whether or not to impose a *no-compete* agreement. Let firm i choose $\delta_i \in \{0, \delta\}$, $i = 1, 2$, where $\delta_i = 0$ if firm i imposes a *no-compete* agreement on its employee, and $\delta_i = \delta$ if it chooses not to impose one. Employee i then solves the following problem

$$\max_{e_i} \pi_{E_i}(\delta_1, \delta_2) \equiv e_i(1 - e_j)(\beta + (1 - \beta)\beta\delta_i) - \frac{1}{2}e_i^2; \quad i = 1, 2; \quad i \neq j. \quad (\text{A1})$$

Firm i 's expected profits are given by

$$\pi_{F_i}(\delta_1, \delta_2) \equiv e_i(1 - e_j)(1 - \beta - (1 - \beta)\beta\delta_i); \quad i = 1, 2; \quad i \neq j. \quad (\text{A2})$$

Taking the first order condition of (A1) with respect to e_i and solving for e_i , after setting $e_j = e_i$, gives the Nash-equilibrium level of effort $e_i^*(\delta_i, \delta_j)$

$$e_i^*(\delta_i, \delta_j) = \frac{(\beta + (1 - \beta)\beta\delta_i)(1 - \beta\delta_i)}{1 + \beta(1 - \beta\delta_i - \beta\delta_j) - (1 - \beta)\beta\delta_i\beta\delta_j}; \quad i = 1, 2; \quad i \neq j. \quad (\text{A3})$$

Plugging (A3) into (A1) and (A2) and setting $\delta_1 \in \{0, \delta\}$ and $\delta_2 \in \{0, \delta\}$ gives the equilibrium value of expected profits for both firms and employees, as follows. First, when both firms set $\delta_i = 0$, $i = 1, 2$, we have

$$\pi_{E_i}^*(0, 0) = \frac{\beta^2}{2(\beta + 1)^2}; \quad \pi_{F_i}^*(0, 0) = \frac{\beta(1 - \beta)}{(\beta + 1)^2}; \quad \pi_{T_i}^*(0, 0) = \frac{\beta(2 - \beta)}{2(\beta + 1)^2}, \quad i = 1, 2.$$

When Firm 1 sets $\delta_1 = \delta$ and Firm 2 sets $\delta_2 = 0$ we have

$$\begin{aligned} \pi_{E_1}^*(\delta, 0) &= \frac{(\beta\delta + \beta(1 - \beta\delta))^2}{2(1 + \beta(1 - \beta\delta))^2}, & \pi_{F_1}^*(\delta, 0) &= \frac{(\beta\delta + \beta(1 - \beta\delta))(1 - \beta\delta)(1 - \beta)}{(1 + \beta(1 - \beta\delta))^2}; \\ \pi_{T_1}^*(\delta, 0) &= \frac{(\beta\delta + \beta(1 - \beta\delta))(2 - \beta\delta - \beta(1 - \beta\delta))}{2(1 + \beta(1 - \beta\delta))^2}; \\ \pi_{E_2}^*(\delta, 0) &= \frac{\beta^2(1 - \beta\delta)^2}{2(1 + \beta(1 - \beta\delta))^2}; & \pi_{F_2}^*(\delta, 0) &= \frac{\beta(1 - \beta)(1 - \beta\delta)^2}{(1 + \beta(1 - \beta\delta))^2}; \\ \pi_{T_2}^*(\delta, 0) &= \frac{\beta(2 - \beta)(1 - \beta\delta)^2}{2(1 + \beta(1 - \beta\delta))^2}. \end{aligned}$$

Finally, when both firms sets $\delta_i = \delta$, we have that:

$$\begin{aligned} \pi_{E_i}^*(\delta, \delta) &= \frac{(\beta\delta + \beta(1 - \beta\delta))^2}{2(1 + \beta\delta + \beta(1 - \beta\delta))^2}; & \pi_{F_i}^*(\delta, \delta) &= \frac{\beta(1 + \delta(1 - \beta))(1 - \beta\delta - \beta(1 - \beta\delta))}{(1 + \beta\delta + \beta(1 - \beta\delta))^2}, \\ \pi_{T_i}^*(\delta, \delta) &= \frac{\beta(1 + \delta(1 - \beta))(2 - \beta\delta - \beta(1 - \beta\delta))}{2(1 + \beta\delta + \beta(1 - \beta\delta))^2}, & i &= 1, 2. \end{aligned}$$

Consider first a candidate equilibrium in which both firms impose in equilibrium a *no-compete* agreement on their employees. $(\delta_1 = 0, \delta_2 = 0)$ is an equilibrium if and only if $\pi_{F_i}^*(\delta, 0) \leq \pi_{F_i}^*(0, 0)$ for $i = 1, 2$. By direct comparison, we have that $\pi_{F_i}^*(\delta, 0) < \pi_{F_i}^*(0, 0)$ if and only if $\delta \geq \delta^{NC} \equiv \frac{1 - \beta^2}{\beta(1 + \beta(1 - \beta))}$. Taking the derivative of δ^{NC} with respect to β yields $\frac{\partial \delta^{NC}}{\partial \beta} = -\frac{\beta(\beta^3 - 2\beta + 2) + 1}{(1 + \beta(1 - \beta))^2 \beta^2} < 0$.

Consider now a candidate equilibrium in which neither firm imposes a *no-compete* agreement on its employee. $(\delta_1 = \delta, \delta_2 = \delta)$ is an equilibrium if and only if $\pi_{F_i}^*(\delta, \delta) \geq \pi_{F_i}^*(0, \delta)$, for $i = 1, 2$. By direct comparison, it can immediately be seen that $\pi_{F_i}^*(\delta, \delta) \geq \pi_{F_i}^*(0, \delta)$ for all values of $0 \leq \delta \leq 1$ and $0 \leq \beta \leq 1$. Hence, $(\delta_1 = \delta, \delta_2 = \delta)$ is always an equilibrium.

Finally, comparing the equilibrium profits of both firms in the equilibrium without *no-compete* agreements, that is, with $(\delta_1 = \delta, \delta_2 = \delta)$, and those with *no-compete* agreements, that is, with $(\delta_1 = 0, \delta_2 = 0)$, reveals that $\pi_{F_i}^*(\delta, \delta) \geq \pi_{F_i}^*(0, 0)$ if and only if $\delta \leq \delta_F^P \equiv \frac{3\beta^2 + 2\beta - 1}{(3\beta^2 - 2\beta - 1)\beta}$. It is straightforward to show that $\delta_F^P < \delta^{NC}$ for all $0 \leq \delta \leq 1$ and $0 \leq \beta \leq 1$.

Proof of Proposition 4 Using the equilibrium total profits obtained in the proof Proposition 8, we have that $(\delta_1 = 0, \delta_2 = 0)$ is an equilibrium if and only if $\pi_{T_i}^*(\delta, 0) \leq \pi_{T_i}^*(\delta_1 = 0, \delta_2 = 0)$, for $i = 1, 2$. By direct comparison, we have that $\pi_{T_i}^*(\delta, 0) > \pi_{T_i}^*(0, 0)$ for all $0 \leq \delta \leq 1$ and $0 \leq \beta \leq 1$. Hence, when the equilibrium decision is made on the basis of maximizing the total profits, $(\delta_1 = 0, \delta_2 = 0)$ is never an equilibrium.

Consider now an equilibrium where neither firm imposes a no-compete agreement on its employee. $(\delta_1 = \delta, \delta_2 = \delta)$ is an equilibrium if and only if $\pi_{T_i}^*(\delta, \delta) \geq \pi_{T_i}^*(\delta, 0)$, for $i = 1, 2$. By direct comparison, we have that $\pi_{T_i}^*(\delta, \delta) \geq \pi_{T_i}^*(\delta, 0)$ for all $0 \leq \delta \leq 1$ and $0 \leq \beta \leq 1$. Hence, $(\delta_1 = \delta, \delta_2 = \delta)$ is always an equilibrium.

Comparing total profits in the equilibrium with $(\delta_1 = \delta, \delta_2 = \delta)$ with those in the equilibrium with $(\delta_1 = 0, \delta_2 = 0)$ reveals that $\pi_{T_i}^*(\delta, \delta) \geq \pi_{T_i}^*(0, 0)$ if and only if $\delta \leq \delta_T^P \equiv \frac{2(2\beta^2 + \beta - 1)}{\beta(4\beta^2 - 3\beta - 1)}$.