Human Capital Integration in Mergers and Acquisitions

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Abstract

This paper presents a theory of post-merger human capital integration where successful integration depends on the willingness of employees of the merging firms to collaborate and share knowledge. In our model, employees in the post-merger firm choose between collaboration to create synergies, and competition to extract greater resources from the corporate headquarters. We show that incentives to collaborate are stronger in mergers between firms with greater human capital complementarity. In such mergers the post-merger firm has a greater reliance on employee human capital in internalizing the benefit of collaboration, increasing the likelihood that employees will be retained in the post-merger firm and receive higher wages. Anticipating the importance of their human capital, employees become more willing ex ante to choose collaboration over competition, resulting in a greater likelihood of successful human capital integration. Consistent with recent empirical evidence, our model suggests that mergers between firms with greater human capital complementary lead to better merger performance. In addition, our model generates novel predictions such as post-merger wages increasing, and layoffs decreasing in the level of human capital complementarity between merging firms.

1 Introduction

Mergers and acquisitions often disappoint, and human capital integration failure is consistently cited as one of the major reasons for disappointing merger outcomes. Supportive of this view, an emerging body of research provides evidence on the importance of human capital as a source of value creation in mergers. Tate and Yang (2016) show that diversifying mergers result in productivity gains through collaboration and communication between employees when they occur between firms in industries with greater skill and human capital transferability. Relatedly, Tate and Yang (2015) find that employees in diversified firms exhibit higher productivity and receive a wage premium, relative to employees in focused firms, and interpret this finding as consistent with the view that diversifying firms provide stronger human capital development incentives. Lee, Mauer and Xu (2017) examine empirically the importance of human capital complementarity as an important driver of mergers and merger performance, and find that mergers between firms with complementary human capital exhibit better stock price performance at merger announcement as well as better operating performance in the post-merger period. We provide a novel theoretical explanation for these results based on the notion that a merger represents an economic channel through which employees engage in knowledge sharing, learn from each other and increase their productivity. Importantly, the knowledge sharing and learning channel emerges only in mergers between firms with a high level of human capital and skill complementarity between them, such as in diversifying mergers. As the level of human capital complementarity becomes smaller, knowledge sharing mechanism becomes weaker and each firm becomes more interested in obtaining the assets of the other firm than collaborating with the other firm.

In our model, we have a two-divisional firm formed through a merger. Human capital integration between the two divisions depends on the willingness of employees of each division to blend their assets and resources, and collaborate towards creation of innovative ideas and products. Alternatively, employees choose to work with their existing assets, without collaborating with the other division. Collaboration results in additional value creation if both employees are successful in their collaboration effort. Otherwise, it has a downside, relative to each employee focusing on his existing divisional assets. We show that incentives to collaborate depend on the extent to which employees of each division will be needed and retained in the post-merger firm after the collaboration stage ends. When employees have greater skill and human capital complementarity between them, the firm has a lower ability to internalize the outcome of the collaboration effort if it chooses to generate savings by downsizing and reducing post-merger employment. Hence, as skill complementarity between employees increases, each employee becomes more indispensable in synergy creation. This, in turn, reduces the firm's willingness to downsize and reduce employment, and results in greater employee wages. Although ex post it is more expensive for the firm to retain employees with greater human capital complementarity, this ex post cost may turn into an ex ante benefit for the firm as it results in a higher probability of successful integration and greater employee productivity. For lower levels of human capital complementarity, employees choose to work with their existing divisional assets in an effort to obtain the other division's resources, without exerting costly collaboration effort. The desire to get control of the other division's assets is stronger when the two divisions have assets with a greater redeployment value across the two divisions. Hence, our paper predicts that collaboration incentives would be stronger in mergers between firms from seemingly different industries. Mergers between firms from similar industries, on the other hand, result in weaker incentives to share knowledge, resulting in a lower likelihood of successful integration, and greater reduction in post-merger employment. Interestingly, in our model economies of scale motives as a main driver of mergers between firms in similar industries may exacerbate collaboration incentives. In such mergers, employees in different divisions choose not to collaborate, but compete for the other division's resources as it becomes more attractive to get control of the other division's assets precisely because of their high redeployment value. Hence, our model predicts that integration and collaboration incentives would be weaker within-industry mergers. It is important to note that the lack of collaboration incentives is not due to post-merger reduction in employment. It is because employees in divisions with similar assets find it less desirable to exert costly synergy effort, compared to working with their existing assets with a desire to get a control of the resources of the other division. As a response to lack of employee collaboration, the firm finds it optimal to reduce employment and generate value through scale economies.

Our results are consistent with the importance of human capital as a source of value creation in diversifying mergers as identified in Tate and Yang (2015) and Tate and Yang (2016). In addition, our paper implies that post-merger wages would be higher and post-merger layoffs would be fewer in mergers between firms with higher human capital complementarity. These results are consistent with the evidence in Ouimet and Zarutskie (2012) that mergers motivated by the desire to acquire human capital of the target firm are associated with greater post-merger wage increases and lower post-merger employee turnover. Our results are also consistent with empirical evidence in Hoberg and Phillips (2011) that mergers of firms with complementary assets are more successful in value creation through the introduction of new products. Our analysis adds a nuance to this finding that greater human capital complementarity leads to stronger collaboration incentives, resulting in scope economies through innovative products.

In addition to generating results consistent with recent empirical evidence, our model also yields novel empirical predictions. The first prediction is that mergers between firms in industries with greater human capital complementarity leads to fewer post-merger layoffs. Although the firm's ability to generate savings through economies of scale decreases, the firm's greater reliance on employee human capital leads to creation of scope synergies. The second prediction is that post-merger wages increase in the degree of skill and human capital complementarity. The third prediction is that there is a positive association between post-merger wages and the profitability of the merger in terms of scope synergies such as the introduction of new products.

There are important studies on the importance of physical asset complementarity as an important driver of mergers (Hart and Moore 1990, and Rhodes-Kropf and Robinson 2008). Complementing these studies, our paper focuses on human capital complementarity as an important synergy source for mergers, and shows greater human capital complementarity between merging firms leads to greater merger gains by inducing greater collaboration effort, although it also results in greater wages and lower employment reduction in the post-merger firm. Hence, in our model, greater human capital complementarity benefits shareholders as well as employees as one of the important stakeholders of the firm.

Our paper is related to the property rights theory of the firm (Grossman and Hart (1986), Hart and Moore (1990) and (1994)). One of the important messages from this seminal theory is that when contracts are incomplete, complementary *physical* assets should be owned by the same firm to minimize the negative effect of the hold-up problem on incentives to undertake relation specific investment. In our paper, greater human capital complementary between merging firms may serve as a commitment mechanism for the post-merger firm not to hold-up its employees ex post. Although the reduction in the firm's hold-up ability is costly ex post, it may still turn into an advantage for the firm as it leads to greater collaboration effort, and greater employee productivity. Our work is also related to the theory of the firm and internal capital markets. Existing work in these areas considers the advantages and disadvantages of firms with a large number of divisions (see, among others, Gertner, Scharfstein and Stein, 1994). We present a new benefit of having divisions with complementary human capital in terms of improving divisional incentives to collaborate. Interestingly, our model implies that greater physical asset complementarity between divisions of a firm may be an impediment to collaboration and communication, as it induces employees of one division to compete for the other division's assets. This result is consistent with the findings in Seru (2014) that incentives to create innovation are weaker in firms with more active internal capital markets. Our model provides a novel explanation for this finding: a more active internal capital market weakens collaboration incentives by inducing employees to compete for other divisions' resources at the expense of foregoing collaboration. Finally, we study the effect of decentralization on collaboration incentives where the post merger firm can commit not to engage in resource reallocation across the two divisions. Interestingly, decentralization has a positive impact on collaboration incentives when asset redeployability across divisions is large while it has a negative impact when asset redeployability is low.

This paper is organized as follows. Section 2 describes the model. Section 3 analyzes the basic model, and Section 4 concludes.

2 The Model

There is a two-divisional firm formed through a merger. Each division employs a manager, and the two divisions are owned and controlled by corporate headquarters (CHQ). The CHQ and the managers are risk-neutral, and the managers are wealth-constrained. There is no discounting.

At $t = 0$,the two managers decide between *collaboration* to create synergies and *no collaboration*. Collaboration is possible only if both managers choose to collaborate with each other. If one manager chooses to collaborate and observes that the other manager is not willing to collaborate, it is optimal for him not to collaborate as well. Whether the two managers collaborate is observable but not contractible. Collaboration refers to integrating and blending the resources and the assets of the two divisions. It allows the managers to have access to each other's resources, skills and human capital, and exert individual effort to create synergies in the form of an innovation such as a new product. No collaboration refers to each manager working independently within his division using his existing assets, where he exerts effort to create value with no collaboration and communication with the other division.

If at least one of the managers decides not to collaborate, at $t = 1$, manager i exerts effort p_i for $i = 1, 2$ at a personal effort cost of $\frac{1}{2}{p_i}^2$. At $t = 2$, the outcome of each manager's effort is observed. There are three possible states of the world: 1) both managers are successful, 2) only one manager is successful, and 3) both managers are unsuccessful. If managerial effort is successful, value creation depends on whether the CHQ decides to keep the division active or not. If both managers are successful in their effort, the CHQ decides between keeping one division or both divisions active. Conditional on the CHQ keeping both divisions active, each division generates payoff y, with $y > 0$. If the CHQ closes one of the divisions and lays off its manager, it allocates the resources of the terminated division to the active division. The terminated division generates payoff 0 while the division which receives the resources of the terminated division generates payoff βy, with $0 \leq \beta$. For $\beta \leq 2$, downsizing the firm by redeploying all assets in one division lowers the payoff, compared to keeping both divisions active. For $\beta > 2$, downsizing generates additional surplus, compared to keeping both divisions active, and in this case, a higher value of β can be interpreted as the two divisions having greater physical asset complementarity, or as the existence of greater scale economies between the divisions.[1]

If only one of the managers succeeds in the first stage, the failed division is terminated with payoff 0, and the successful division generates payoff y. Finally, if both managers fail, both divisions are terminated with payoff 0.

If both managers unilaterally choose collaboration at $t = 0$, the two divisions are integrated in the sense that the two managers have access to all combined assets and resources, and to each other's human capital and skills. Using a broader base of integrated assets and resources, each manager exerts synergy effort to generate an innovation in the form of new knowledge or product. Specifically, we assume that manager i exerts effort p_i^S at a cost of $\frac{k}{2}(p_i^S)^2$ at $t = 1$, with $k > 1$. Note that, compared to the no collaboration case where each manager focuses exclusively on his own divisional assets, exerting collaboration effort to create synergies is more costly, because synergies involve new knowledge creation where the managers use a broader and possibly a new set of assets than using their existing assets within their division. There are three possible states of the world: 1) each manager succeeds in his collaboration effort, 2) only one manager is successful, and 3) both managers fail.

If each manager succeeds in his collaboration effort during the first stage, the CHQ makes a decision to keep one or both managers in the integrated firm. If the CHQ keeps both managers, the two managers generate a joint payoff sy where s measures the extent of synergy creation from the collaboration effort, with $s > 2$. This implies that the synergy effort has an upside, compared to the case where each manager uses his own assets, is successful in his effort and the total payoff of the two divisions is $2y$. If the CHQ decides to retain only one manager and lays off the other manager, the retained manager and the CHQ can generate payoff $(1 - \theta)sy$ with $0 < \theta \leq 1$. The value of θ depends on the importance of each divisional manager for the implementation of the synergies created in the first stage. For higher values of θ, the firm has a greater reliance on each

[1] Later in the analysis, we will impose an upper bound on β to make sure our model have interior solutions to managerial effort.

divisional manager in realizing the synergies created from the collaboration effort. Since the loss in the synergy gain is greater for higher values of θ, one natural interpretation of θ is the degree of human capital and skill complementarity between the managers.

There is a potential downside to the synergy effort under collaboration, compared to the no-collaboration case. We assume that synergy creation occurs only if both managers are successful in their collaboration effort. If one of the managers fails in his effort, the payoff generated with the successful manager is given by $(1-d)y$ where d measures the downside of the synergy effort, with $0 \leq d < 1$, compared to each manager choosing no collaboration and focusing exclusively on his own division. Hence, the collaboration effort has an upside, measured by s, as well as a downside measured by d, relative to the case with no collaboration. Finally, if both managers fail, the payoff generated is 0.

We assume that contracts are incomplete in the sense that it is not feasible to contract ex-ante on the participation of either the managers or the CHQ to the second stage of the value creation process.[2] The division of the total surplus between the CHQ and the managers is determined through bargaining at $t = 2$ after the realization of the managers' effort outcome.

We characterize the payoffs that result from bargaining between the CHQ and the managers by using the notion of Shapley value (see Myerson, 1991, and Winter, 2002). Based on this solution concept, each player obtains the expected value of his marginal contribution to all coalitions that can be formed with all other players engaged in bargaining.

To obtain the Shapley value, we first need to define the set of players engaged in the bargaining process denoted by N. The Shapley value is then obtained as follows. Let C be a possible (sub)coalition of players from the set of all players engaged in bargaining N, that is, $C \subseteq N$. Let $\Pi_T(C)$ be the total payoff that can be obtained by the players in C if they cooperate, that is, by the (sub)coalition $C \subseteq N$, with $\Pi_T(\varnothing) = 0$. The Shapley value for player $i \in N$, denoted by v_i, is then given by

$$v_i = \sum_{C \subseteq N-i} \frac{|C|!(|N|-|C|-1)!}{|N|!} \left(\Pi_T(C \cup i) - \Pi_T(C)\right). \tag{1}$$

[2] Thus, contracts are incomplete in the sense of Grossman and Hart (1986) and Hart and Moore (1990, 1994).

Intuitively, the Shapley value reflects the notion that each player's payoff from bargaining depends on the player's marginal contribution to the total payoff, given what the other players can obtain by themselves or by forming subcoalitions.

At $t = 3$, the payoff is realized and distributed between the CHQ and the manager(s).

3 Model Analysis

3.1 No collaboration

If the managers choose not to collaborate, each manager focuses exclusively on his divisional resources, with no possibility of successful integration, collaboration and communication between the two divisions. Hence, there is neither the collaboration benefit sy nor the collaboration cost $(1 - d)y$, relative to the payoff y that each manager generates conditional on his own effort succeeding.

Given that the two managers are symmetric in our model, for ease of notation, we describe manager 1's choices in analyzing the model. Recall from the previous section that, under no collaboration, manager 1 exerts effort p_1, which determines the success probability of his division, and at the end of the first stage, there are three different states of the world: (i) both managers are successful in the first period, that is, state SS, (ii) manager 1 is successful, and manager 2 fails, state SF, (note that we have state SF when manager 1 fails, and manager 2 succeeds as well)[3], (iii) both managers fail, state FF.

In the simplest case where both managers fail, that is, in state FF, both divisions are terminated and all agents obtain zero payoffs.

We define the Shapley value in state SS and SF for the CHQ as $\{v_{CHQ}(SS),\ v_{CHQ}(SF)\}$ and for manager 1 as $\{v_{M_1}(SS), v_{M_1}(SF)\}$. The CHQ's expected profit, denoted by π_{CHQ}, is

[3]Note that, given that the two managers are identical, it is irrelevant which one is successful. Thus, we will treat these two separate but symmetric cases effectively as a single case, and refer to the state where one manager succeeds and one fails as state SF.

then given by

$$\pi_{CHQ} \equiv p_1 p_2 v_{CHQ}(SS) + p_1(1-p_2)v_{CHQ}(SF) + p_2(1-p_1)v_{CHQ}(SF). \tag{2}$$

Manager 1's expected profit, denoted by π_{M_1}, is given by

$$\pi_{M_1} \equiv p_1 p_2 v_{M_1}(SS) + p_1(1-p_2)v_{M_1}(SF) - \frac{1}{2}(p_1)^2. \tag{3}$$

We now describe the surplus allocation between the CHQ and the managers, based on whether the state is SF or SS. First, suppose that only manager 1 is successful, that is, we are in state SF. The set of bargaining players is then given by the CHQ and manager 1, yielding $N = \{CHQ, M_1\}$. The total payoff of the coalition formed by the CHQ and manager 1 is $\Pi_T^{SF}(CHQ, M_1) = y$. If manager 1's division is closed, the CHQ and manager 1 obtain zero payoff alone, yielding $\Pi_T^{SF}(CHQ) = \Pi_T^{SF}(M_1) = 0$. This implies that the Shapley values for the CHQ and manager 1, denoted by $v_{CHQ}(SF)$ and $v_{M_1}(SF)$ are given respectively by

$$v_{CHQ}(SF) = \frac{\Pi_T^{SF}(CHQ, M_1) - \Pi_T^{SF}(M_1)}{2} = \frac{y}{2}, \tag{4}$$

$$v_{M_1}(SF) = \frac{\Pi_T^{SF}(CHQ, M_1) - \Pi_T^{SF}(CHQ)}{2} = \frac{y}{2}. \tag{5}$$

If both managers are successful at the end of the first stage, that is, if the state is SS, the CHQ decides between keeping both divisions active, and keeping only one division active and reallocating the assets of the terminated division to the active division. We assume that if the CHQ decides to close one of the divisions, each division is chosen with probability $\frac{1}{2}$ to be terminated. Suppose that the CHQ keeps division 1, and closes division 2 and reallocates its resources to division 1. The payoff the CHQ and manager 1 can generate together is given by $\Pi_T^{SS,1}(CHQ, M_1) = \beta y$, resulting in the following payoffs for the CHQ and manager 1, based on the fact that both the CHQ and manager 1 would obtain zero payoffs if manager 1's division is closed, that is, $\Pi_T^{SS}(CHQ) = \Pi_T^{SS}(M_1) = 0$:

$$v_{CHQ}^1(SS) = \frac{\beta y}{2} \tag{6}$$

$$v_{M_1}^1(SS) = \frac{\beta y}{2}. \tag{7}$$

If the CHQ decides to keep both divisions active, the set of bargaining players is given by $N = \{CHQ, M_1, M_2\}$, and the payoff the CHQ and the two managers can generate is given by $\Pi_T^{SS,2}(CHQ, M_1, M_2) = 2y$. The total payoff of the coalition formed by the CHQ and manager 2 is given by $\Pi_T^{SS,2}(CHQ, M_2) = \beta y$. This implies that the Shapley values for the CHQ and manager 1, denoted by $v_{CHQ}^2(SS)$ and $v_{M_1}^2(SS)$ respectively are given by

$$\begin{aligned} v_{CHQ}^2(SS) &= \frac{2\Pi_T(CHQ, M_1, M_2) + 2\Pi_T(CHQ, M_2)}{6} && (8) \\ &= \frac{(2+\beta)y}{3}, && (9) \\ v_{M_1}^2(SS) &= \frac{2\left(\Pi_T^{S,SS}(CHQ, M_1, M_2) - \Pi_T^{S,SS}(CHQ, M_2)\right) + \Pi_T^{S,SS}(CHQ, M_1)}{6} && (10) \\ &= \frac{(4-\beta)y}{6}. && (11) \end{aligned}$$

Comparing $v_{CHQ}^1(SS) = \frac{\beta y}{2}$ with $v_{CHQ}^2(SS) = \frac{(2+\beta)y}{3}$, we obtain that the CHQ keeps both divisions active for $\beta \leq 4$, and only one division active for $\beta > 4$. Hence, we have

$$v_{CHQ}(SS) = \begin{cases} \frac{(2+\beta)y}{3} & for\ \beta \leq 4 \\ \frac{\beta y}{2} & for\ \beta > 4 \end{cases}, \tag{12}$$

and

$$v_{M_1}(SS) = \begin{cases} \frac{(4-\beta)y}{6} & for\ \beta \leq 4 \\ \frac{\beta y}{2} & for\ \beta > 4 \end{cases}. \tag{13}$$

Note that the CHQ's decision to downsize differs from the efficient outcome. Keeping both divisions active is the efficient outcome for $\beta \leq 2$ although the CHQ keeps both managers' division active for $\beta \leq 4$. This is because the CHQ obtains an additional benefit from keeping both divisions active as it allows her to pay lower wages and extract greater rents due to her ability to transfer the resources of one division to the other division. When the CHQ decides to keep one division active, she closes one of the divisions, and in her bargaining with the manager of the active division, she no longer has the outside option of transferring the resources to the terminated division. The additional bargaining advantage with two divisions induces the CHQ to retain both managers even when it is more efficient to combine the divisions, and generate payoff βy as opposed to $2y$. It is important to emphasize that the main results from the paper hold when we assume that the CHQ can commit ex ante to the efficient downsizing decision, and choose to downsize only for $\beta > 2$.

First, suppose $\beta > 4$, and hence, the CHQ keeps only manager 1's division active in the SS state. Anticipating his bargaining payoffs in different states of the world, manager 1 determines his effort level denoted by p_1^1 by maximizing his expected profit $\pi_{M_1}^1$. By substituting the Shapley values (5) and (7) into the manager's expected profit given by (3), we obtain that the effort level p_1^1 is determined by

$$\max_{p_1^1} p_1^1 p_2^1 (\frac{1}{2} \times \frac{\beta y}{2}) + p_1^1 (1 - p_2^1) \frac{y}{2} - \frac{1}{2}(p_1^1)^2. \tag{14}$$

Note that in state SS, manager 1's division is continued with probability $\frac{1}{2}$, yielding expected payoff $\frac{1}{2} \times \frac{\beta y}{2}$.

By substituting (4) and (6) into the CHQ's expected profit (2), we obtain

$$\pi_{CHQ}^1 = p_1^1 p_2^1 \frac{\beta y}{2} + p_1^1 (1 - p_2^1) \frac{y}{2} + (1 - p_1^1) p_2^1 \frac{y}{2}. \tag{15}$$

The first-order condition of (14) with respect to p_1^1 is given by

$$p_1^1(p_2^1) = \frac{(2 + (\beta - 2) p_1^1) y}{4}. \tag{16}$$

Setting $p_2^1 = p_1^1$,and solving the first order condition for p_1^1 yields equilibrium level of effort under no collaboration denoted by p^{1*}[4]:

$$p^{1*} = \frac{2y}{4 - (\beta - 2) y}. \tag{17}$$

Substituting $p_2^1 = p_1^1 = p^{1*}$ into (14) and (15) yields the expected profits of the CHQ, the managers and the total expected profits of the CHQ and the managers as follows:

$$\begin{aligned}
\pi_{CHQ}^{1*} &= \frac{8y^2}{(4 - (\beta - 2) y)^2}, && (18)\\
\pi_{M1}^{1*} &= \pi_{M2}^{1*} = \pi_M^{1*} = \frac{2y^2}{(4 - (\beta - 2) y)^2}, && (19)\\
\pi_T^{1*} &= \frac{12y^2}{(4 - (\beta - 2) y)^2}. && (20)
\end{aligned}$$

[4]We assume $\beta y < 4$ to make sure that $0 < p^{1*} < 1$.

Note that both managerial effort, and the expected profits of the managers and the CHQ are higher for higher values of β, reflecting the CHQ's ability to create value by reallocating resources across the two divisions. In other words, a high value of β allows the CHQ to create scale economies. However, as we will elaborate later in the paper, presence of such strong scale motives may be an impediment to induce collaboration between the divisions, and create synergies through scope economies.

Now, suppose we have $\beta \leq 4$, and hence, the CHQ keeps both divisions active in the SS state. Anticipating his bargaining payoffs in different states of the world, manager 1 determines his effort level denoted by p_1^2 by maximizing his expected profit denoted by π_{M1}^2. By substituting the Shapley values (5) and (11) into the manager's expected profit given by (3), we obtain that the effort level p_1^2 is determined by

$$\max_{p_1^2} p_1^2 p_2^2 \frac{(4-\beta)y}{6} + p_1^2(1-p_2^2)\frac{y}{2} - \frac{1}{2}(p_1^2)^2. \tag{21}$$

Similarly, by substituting the Shapley values 4) and (9) into the CHQ's expected profit (2), we obtain the expected profits of the CHQ as

$$\pi_{CHQ}^2 = p_1^2 p_2^2 \frac{(2+\beta)y}{3} + p_1^2(1-p_2^2)\frac{y}{2} + (1-p_1^2)p_2^2\frac{y}{2}. \tag{22}$$

The first-order condition of (14) with respect to p_1^2 is

$$p_1^2(p_2^2) = \frac{(3+(1-\beta)p_2^2)y}{6}. \tag{23}$$

Setting $p_2^2 = p_1^2$,and solving the first order condition for p_1^2 yields equilibrium level of effort under no collaboration denoted by p^{2*}[5]:

$$p^{2*} = \frac{3y}{6+(\beta-1)y}. \tag{24}$$

Substituting $p_2^2 = p_1^2 = p^{2*}$ into (14) and (15) yields the expected profits of the CHQ, the managers and the total expected profits of the CHQ and the managers as follows:

[5] We assume $y < \frac{3}{2}$ to make sure that $0 < p^{2*} < 1$.

$$\pi_{CHQ}^{2*} = \frac{6(3+(\beta-1)y)y^2}{(6+(\beta-1)y)^2}, \tag{25}$$

$$\pi_{M1}^{2*} = \pi_{M2}^{2*} = \pi_{M}^{2*} = \frac{9y^2}{2(6+(\beta-1)y)^2}, \tag{26}$$

$$\pi_{T}^{2*} = \frac{3(9+2(\beta-1)y)y^2}{(6+(\beta-1)y)^2}. \tag{27}$$

Note that for $\beta > 1$, the CHQ's reallocation ability weakens managerial effort, as the CHQ is able to pay lower wages for higher values of β. Although the reduction in managerial effort is clearly undesirable, the CHQ's rent extraction ability would play a positive role in inducing the managers to collaborate, as we will show later.

3.2 Collaboration

If the two managers choose to collaborate, the assets and the resources of the two divisions are blended and integrated, and the two managers use the blended asset base to generate an innovation or a novel product. Manager 1 exerts synergy effort p_1^S at a cost of $\frac{k}{2}(p_1^S)^2$ with $k > 1$. As mentioned before, different from the case with no collaboration, exerting effort is more costly, that is, $k > 1$, as innovation involves new knowledge creation by working with a larger asset base, as opposed to the managers working with their existing assets. After the realization of the effort outcomes, if both managers are successful in their synergy effort, the CHQ chooses between keeping only one manager, and keeping both managers in the firm. If the CHQ keeps both managers, the total payoff due to the synergy is given by sy. We assume that $s > 2$ and $s > \beta$, implying that conditional on collaboration effort succeeding, there is synergy creation relative to the case with no collaboration, and the extent of synergy creation measured by s is greater than combining the assets within one division and creating value from scale economies, measured by β. If the CHQ lays off one of the managers, and retains only one manager, the synergy payoff is $(1-\theta)sy$ with $0 \leq 1 \leq \theta$, where θ measures the loss in value due to separating one of the managers from the firm, and implementing synergies with the remaining manager. If only one of the managers succeeds in his synergy effort, and the other one fails, the payoff the CHQ can create with the successful manager is given by $(1-d)y$, with $0 \leq d \leq 1$ where d measures the downside of the synergy effort. This implies that although there is an upside to collaboration effort, the upside is conditional on both managers succeeding in their synergy effort. If one of them fails, the successful manager's effort generates a lower payoff than if he were to focus exclusively on his division, implied by $(1-d)y \leq y$. If both managers fail, all agents obtain zero payoff.

Based on the outcome of the synergy effort of both managers, there are three different possible states of the world: (i) both managers are successful in their first-stage synergy effort, state ss, (ii) one manager is successful while the other one fails, state sf,(iii) both managers fail, state ff.

In the simplest case where both managers fail, that is, in state ff, all agents obtain zero payoffs.

To determine the surplus allocation between the CHQ and the divisional managers in states ss and sf, define the Shapley value in state ss and sf for the CHQ as $\{v^S_{CHQ}(ss), v^S_{CHQ}(sf)\}$ and for manager 1 as $\{v^S_{M_1}(ss), v^S_{M_1}(sf)\}$ respectively. The CHQ's expected profit under collaboration, denoted by π^S_{CHQ}, is then given by

$$\pi^S_{CHQ} \equiv p^S_1 p^S_2 v^S_{CHQ}(ss) + p^S_1(1-p^S_2)v^S_{CHQ}(sf) + (1-p^S_1)p^S_2 v^S_{CHQ}(sf); \tag{28}$$

and manager 1's expected profit, $\pi^S_{M_1}$, is given by

$$\pi^S_{M_1} \equiv p^S_1 p^S_2 v^S_{M_1}(ss) + p^S_1(1-p^S_2)v^S_{M_i}(sf) - \frac{k}{2}(p^S_1)^2. \tag{29}$$

In state sf where only one of the managers is successful, say manager 1, the set of bargaining players is given by the CHQ and the successful manager, yielding $N = \{CHQ, M_1\}$. Thus, the total payoff of the coalition formed by the CHQ and manager 1 is $\Pi^{S,sf}_T(CHQ, M_1) = (1-d)y$. If manager 1's division is closed, the CHQ and manager 1 obtain zero payoff, yielding $\Pi^{S,sf}_T(CHQ) = \Pi^{S,sf}_T(M_1) = 0$. This implies that the Shapley values for the CHQ and manager 1, $v^S_{CHQ}(sf)$ and $v^S_{M_1}(sf)$, are

$$v^S_{CHQ}(sf) = \frac{\Pi^{S,sf}_T(CHQ, M_1) - \Pi^{S,sf}_T(M_1)}{2} = \frac{(1-d)y}{2}, \tag{30}$$

$$v^S_{M_i}(sf) = \frac{\Pi^{S,sf}_T(CHQ, M_1) - \Pi^{S,sf}_T(CHQ)}{2} = \frac{(1-d)y}{2}. \tag{31}$$

In state ss, both managers are successful in their collaboration effort. Suppose that the CHQ lays off manager 2. The payoff that the CHQ and manager 1 can generate is given by $\Pi_T^{S,ss,1}(CHQ, M_1) = (1-\theta)sy$ resulting in the following payoffs for the CHQ and manager 1, given that both the CHQ and manager 1 can generate 0 payoff alone:

$$v_{CHQ}^{S,1}(ss) = \frac{(1-\theta)sy}{2}, \tag{32}$$

$$v_{M_1}^{S,1}(ss) = \frac{(1-\theta)sy}{2}. \tag{33}$$

If the CHQ decides to retain both managers, the set of bargaining players is given by $N = \{CHQ, M_1, M_2\}$, and the payoff that the CHQ and the two managers generate is given by $\Pi_T^{S,ss,2}(CHQ, M_1, M_2) = sy$. The total payoff of the coalition formed by the CHQ and manager 1 is given by $\Pi_T^{S,ss}(CHQ, M_1) = (1-\theta)sy$. This implies that the Shapley values for the CHQ and manager 1, given by $v_{CHQ}(ss)$ and $v_{M_1}(ss)$ respectively, are

$$v_{CHQ}^{S,2}(ss) = \frac{2\Pi_T^{S,ss,2}(CHQ, M_1, M_2) + 2\Pi_T^{S,ss}(CHQ, M_2)}{6} \tag{34}$$

$$= \frac{(2-\theta)sy}{3}, \tag{35}$$

$$v_{M_1}^{S,2}(ss) = \frac{2\left(\Pi_T^{S,ss,2}(CHQ, M_1, M_2) - \Pi_T^{S,ss,1}(CHQ, M_2)\right) + \Pi_T^{S,ss}(CHQ, M_1)}{6} \tag{36}$$

$$= \frac{(1+\theta)sy}{6}. \tag{37}$$

Given that $v_{CHQ}^{S,1}(ss) = \frac{(1-\theta)sy}{2} < v_{CHQ}^{S,2}(ss) = \frac{(2-\theta)sy}{3}$ for all θ, the CHQ always finds it optimal to keep both managers in the ss state where collaboration effort of both managers succeeds. Hence, we have

$$v_{CHQ}^{S}(ss) = \frac{(2-\theta)sy}{3}, \tag{38}$$

$$v_{M_1}^{S}(ss) = \frac{(1+\theta)sy}{6}. \tag{39}$$

Compared to the case with no collaboration, choosing to collaborate has a positive impact on the likelihood of each manager being retained in the firm. With no collaboration, the CHQ finds it optimal to lay off one of the managers when the magnitude of scale economies is sufficiently large, that is, when β is sufficiently large. Even if the CHQ does not lay off one of the managers, that is, for $\beta \leq 4$, her ability to reallocate and utilize the assets of one manager with the other manager allows her to pay lower wages. With collaboration, not only each manager with a successful outcome is always retained in the firm, but also, he extracts greater wages as the human capital complementarity between the two managers increases, that is, as θ increases. Although ex post these two forces alone always induce the managers to choose collaboration over no collaboration, ex ante managerial decision to collaborate depends on other factors, such as the relative cost k of exerting synergy effort, potential downside of the synergy effort given by d, as well as the attractiveness of competition for the other managers' resources under no collaboration, measured by β.

We now proceed to determine managerial effort under collaboration. Manager 1 determines his effort level p_1^S by maximizing his expected profit $\pi_{M_1}^S$. By substituting the Shapley values (31) and (39) into the manager's expected profit given by (29), we obtain that the effort level p_1^S is determined by

$$\max_{p_1^S} p_1^S p_2^S \frac{(1+\theta)sy}{6} + p_1^S(1-p_2^S)\frac{(1-d)y}{2} - \frac{k}{2}(p_1^S)^2. \tag{40}$$

Similarly, by substituting the Shapley values (30) and 38) into the CHQ's expected profit (28), we obtain

$$\pi_{CHQ}^S = p_1^S p_2^S \frac{(2-\theta)sy}{3} + p_1^S(1-p_2^S)\frac{(1-d)y}{2} + (1-p_1^S)p_2^S\frac{(1-d)y}{2}. \tag{41}$$

The first-order condition of (40) with respect to p_1^S is given by

$$p_1^S(p_2^S) = \frac{3(1-d)y + ((1+\theta)sy - 3(1-d)y)p_2^S}{6k}. \tag{42}$$

Setting $p_2^S = p_1^S = p^{S*}$, and solving the first order condition for p^{S*} yields the equilibrium level of effort under collaboration[6]:

$$p^{S*} = \frac{3(1-d)y}{6k - (1+\theta)sy + 3(1-d)y}. \tag{43}$$

[6]To make sure we have interior solutions, we assume $k > \frac{(1+\theta)sy}{6}$.

It is straightforward to see that the synergy effort of each manager under collaboration is increasing in θ, or equivalently, is increasing in the degree of human capital complementarity between the managers. Conditional on both managers collaboration effort succeeding, a higher level of θ gives the CHQ a more limited ability to realize synergies by retaining only one of the managers, and hence, leads to greater managerial wages. This, in turn, leads to stronger managerial incentives to collaborate in order to create synergies. Substituting $p_2^S = p_1^S = p^{S*}$ into (40) and (41) yields the expected profits of the CHQ, and the managers, and the total expected profits of the CHQ and the managers as follows:

$$\pi_{CHQ}^{S*} = \frac{3(1-d)^2(6k+sy(1-2\theta))y^2}{(6k-sy(1+\theta)+3y(1-d))^2}, \tag{44}$$

$$\pi_{M1}^{S*} = \pi_{M2}^{S*} = \pi_M^{S*} = \frac{9k(1-d)^2y^2}{2(6k-sy(1+\theta)+3y(1-d))^2}, \tag{45}$$

$$\pi_T^{S*} = \frac{3(1-d)^2(9k+sy(1-2\theta))y^2}{(6k-sy(1+\theta)+3y(1-d))^2}. \tag{46}$$

Although the CHQ pays greater wages as the human capital complementarity between the managers increases, its ex ante expected profits increase in the level of human capital intensity for sufficiently low values of θ. This is because for lower values of human capital complementarity, the ex ante benefit of an increase in θ in incuding greater collaboration effort outweighs its ex post cost in terms of higher managerial wages. The following proposition presents this result formally.

Proposition 1 $\frac{\partial \pi_{CHQ}^{S*}}{\partial \theta} > 0$ *for* $\theta < \frac{2s-3(1-d)}{s}$.

Having derived the expected profits of the managers under collaboration and no collaboration, we now characterize the conditions under which the managers are willing to choose collaboration at $t = 0$. Since the collaboration behavior of each manager is observable, if a given manager chooses not to collaborate, the other manager chooses not to collaborate as well, yielding each manager the expected profits from the no collaboration case. Hence, the managers decide between collaboration and no collaboration by comparing their expected profits under each strategy. The following proposition shows that managers have incentives to collaborate only if the degree of human capital complementarity between them measured by θ is sufficiently high.

Proposition 2 *The managers choose to collaborate if the human capital complementarity between them is sufficiently high, that is, if* $\theta \geq \theta_M$ *where*

$$\theta_M \equiv \begin{cases} \theta_M^1 \equiv \frac{6k+3(1-d)y-\sqrt{k}(1-d)(6-y(1-\beta))}{sy} - 1 & for\ \beta \leq 4 \\ \theta_M^2 \equiv \frac{2(6k+3(1-d)y)-3\sqrt{k}(1-d)(4-(\beta-2)y)}{2sy} - 1 & for\ \beta > 4 \end{cases}.$$

An interesting implication from Proposition 2 is that managerial incentives to collaborate are stronger for $\beta \leq 4$ than for $\beta > 4$. The intuition for this result is that when the CHQ's asset reallocation ability from one division to another is high, the managers prefer to focus exclusively on their own division since doing so increases their chances of obtaining the other division's resources. Instead of choosing collaboration, exerting effort for a new idea or a product at a larger effort cost, and being exposed to the down side of the synergy effort, they are better off not collaborating but competing for the other division's assets which have a large redeployment value measured by β. For lower values of β, collaboration incentives are stronger for two different reasons. The first reason is that for lower values of β, conditional on the managers choosing no collaboration, the CHQ prefers to keep both divisions active since she can extract greater rents from each manager through her ability to take away the resources of the division and allocating them to the other division. This leads to lower managerial wages. Second, for lower values of β, in equilibrium, asset reallocation does not happen as combining the assets within one division and generating scale economies is not very profitable. Hence, the managers do not obtain greater resources. Put differently, for lower values of β, not only there is a chance for obtaining the other division's resources, but also there is a cost of no collaboration in terms of lower wages. As a result of these two factors, collaboration becomes more attractive for lower values of β. This result implies that the likelihood of collaboration and synergy creation would be greater when the two divisions have distinct assets with a low reallocation value across the two divisions. This result has important implications on the effects of mergers on innovation and new product introductions. For example, horizontal mergers between two firms with a similar asset base and strong scale economies motive are less likely to lead to collaboration, and introduction of new products. Although these mergers may create value from combining similar assets within one division, and generating savings through the elimination of overlap and redundancies, they would have a negative impact on incentives to share information and create synergies by integrating the assets and capabilities of each merging firm. The following proposition presents this result formally.

Proposition 3 *Let* $\beta > 4$. $\theta_M^1 < \theta_M^2$

Our model suggests that the importance of human capital complementarity between the managers in inducing managerial collaboration is greater when the cost k of exerting synergy effort is higher, and when the downside d of the synergy effort is greater, as implied by $\frac{\partial \theta_M}{\partial k} > 0$, and $\frac{\partial \theta_M}{\partial d} > 0$. This result implies that even if synergy effort has a significant upside, that is, even if s is significantly large, it may still not be possible to induce the managers to collaborate, especially when synergy creation involves exerting effort towards an unknown idea or when it involves a significant downside. This line of reasoning suggests that assessments of mergers based only on the upside potential of the merger could lead to misleading conclusions in terms of the desirability of the merger. Evaluating the desirability of a merger depends not only on its upside synergy potential but also its downside if the managers' collaboration effort fails, and anticipating potential downside of the synergy effort, whether the managers have the incentives to collaborate or not. The following proposition presents this result formally.

Proposition 4 $\frac{\partial \theta_M}{\partial k} > 0$*, and* $\frac{\partial \theta_M}{\partial d} > 0$.

Another interesting observation from our model is that managerial incentives to collaborate would be more sensitive to the downside of the collaboration effort than the upside of the collaboration effort when the cost of exerting collaboration effort is sufficiently large. Hence, ex ante desirability of the merger would depend more heavily on the downside of the merger than the upside of the merger for sufficiently high values of k, as presented in the following proposition.

Proposition 5 $\mid \frac{\partial \pi_M^{S*}}{\partial d} \mid > \frac{\partial \pi_M^{S*}}{\partial s}$ *for* $k > \frac{(1+\theta)(1-d+s)y}{6}$.

Our model implies that although collaboration to create synergies can be the efficient strategy in terms of leading to greater total profits for the CHQ and the managers, compared to no collaboration, the managers may still find it more desirable not to collaborate, when the degree of human capital complementarity between them is low. The following proposition presents this result formally.

Proposition 6 *Let $\theta < \frac{1}{2}$. There exist values of d such that for $d_M < d < d_T$ (where d_M and d_T are defined in the appendix) the managers choose not to collaborate although collaboration would result in greater total expected profits for the CHQ and the two managers. Hence, for $\theta < \frac{1}{2}$ and $d_M < d < d_T$, there is underinvestment in collaboration.*

In the next section, we study whether the CHQ can improve collaboration incentives if she can commit not to engage in resource reallocation across the divisions.

3.3 Decentralization

Our analysis so far assumes that when the managers choose no collaboration, the CHQ has the ability to reallocate resources from one division to another. When the CHQ's reallocation ability, proxied by β, is small, the CHQ uses its reallocation ability to pay lower wages. When it is high, the CHQ combines the two divisions, fires one of the managers and generates scale economies.

In this section, we explore a possibility where the CHQ can commit to a decentralized structure where each divisional manager obtains resources at $t = 0$, and the CHQ does not have the ability to engage in resource reallocation after the outcome of managerial effort is observed. Hence, each division receives its own resources, and if the managers choose not to collaborate, each manager engages in bilateral bargaining with the CHQ at the end of the first stage over the decision on whether his division will be continued or not. Interestingly, the effect of committing to a decentralized structure on collaboration incentives depends on the value of β. For lower values of β, decentralization would have a negative effect on collaboration incentives while for higher values of β it would have a positive impact on collaboration incentives. The intuition for this result is that for lower values of β, that is, for $\beta < 4$, the CHQ's ability to reallocate resources from one division to another is always costly for the managers, as they receive lower wages and never get a chance to obtain the resources of the other division. Hence, as explained before, for lower values of β collaboration becomes more attractive for the managers. This implies that when the CHQ commits not to engage in resource reallocation by choosing a decentralized structure, managerial incentives to collaborate weaken as under the decentralization structure they would have now greater wages even with no collaboration. For higher values of β, on the other hand, committing to a decentralized structure improves collaboration incentives. The reason is that under decentralization, the major benefit of not collaborating and getting control of the other division's resources disappears, increasing the managers' willingness to collaborate. These observations suggest that in multidivisional firms, it will be easier to induce collaboration with strong CHQs and weak divisional managers (i.e., under a centralized structure) when the CHQ's ability to reallocate resources from one division to another is low. When the CHQ's reallocation ability is higher, collaboration incentives will be greater with weak CHQs and strong divisional managers (i.e., under a decentralized structure). The following proposition presents this result.

Proposition 7 *Decentralization expands the parameter space over which the managers choose to collaborate for $\beta > 4$, while it shrinks it for $\beta \leq 4$.*

Note that these results are consistent with Seru (2014) that conglomerates operating more active internal capital markets exhibit lower innovation output, and they can benefit from decentralized R&D budgets in terms of generating more novel innovation.

4 Conclusions

In this paper, we examine managerial incentives in a post-merger firm to collaborate for a successful integration of the two firms. Creation of synergies is possible only if the managers of merging firms choose to integrate their resources and capabilities and have access to each other's human capital. Conditional on collaboration, a greater need for each divisional manager in achieving merger synergies yields greater wages for each manager, and hence increases incentives to collaborate. If the managers possess similar capabilities and resources to each other, incentives to collaborate and the likelihood of a successful post-merger integration will be weaker, since each manager will be more tempted to obtain the resources of the other manager.

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Appendix

Proof of Proposition 1: Taking the derivative of π^{S*}_{CHQ} in (44) with respect to θ yields $\frac{\partial \pi^{S*}_{CHQ}}{\partial \theta} = \frac{6sy^4(1-d)^2(s(2-\theta)-3(1-d))}{(6k-sy(1+\theta)+3y(1-d))^3}$. $\frac{\partial \pi^{S*}_{CHQ}}{\partial \theta} > 0$ for $\theta < \frac{2s-3(1-d)}{s}$.

Proof of Proposition 2: The managers choose to collaborate if the expected profits from collaboration given by (45) is greater than expected profits given by (26) for $\beta \leq 4$, and (19) for $\beta > 4$. First, take $\beta > 4$. Comparing $\pi^{1*}_M = \frac{2y^2}{(4-(\beta-2)y)^2}$ with $\pi^{S*}_M = \frac{9k(1-d)^2y^2}{2(6k-sy(1+\theta)+3y(1-d))^2}$ yields that $\pi^{S*}_M \geq \pi^{1*}_M$ for $\theta \geq \frac{2(6k+3(1-d)y)-3\sqrt{k}(1-d)(4-(\beta-2)y)}{2sy} - 1$. Similarly, for $\beta \leq 4$, comparing $\pi^{2*}_M = \frac{9y^2}{2(6+(\beta-1)y)^2}$ with $\pi^{S*}_M = \frac{9k(1-d)^2y^2}{2(6k-sy(1+\theta)+3y(1-d))^2}$ yields that $\pi^{S*}_M \geq \pi^{2*}_M$ for $\theta \geq \frac{6k+3(1-d)y-\sqrt{k}(1-d)(6-y(1-\beta))}{sy} - 1$. Defining θ_M such that

$$\theta_M \equiv \begin{cases} \theta^1_M \equiv \frac{6k+3(1-d)y-\sqrt{k}(1-d)(6-y(1-\beta))}{sy} - 1 & for\ \beta \leq 4 \\ \theta^2_M \equiv \frac{2(6k+3(1-d)y)-3\sqrt{k}(1-d)(4-(\beta-2)y)}{2sy} - 1 & for\ \beta > 4 \end{cases}$$

completes the proof.

Proof of Proposition 3: It follows directly from the comparison of θ^1_M to θ^2_M.

Proof of Proposition 4: Taking the partial derivative of θ^1_M with respect to k yields

$$\frac{\partial \theta^1_M}{\partial k} = \frac{6-(1-d)\frac{(6+(\beta-1)y)}{2\sqrt{k}}}{sy}.$$

Given that θ_M^1 is defined for $\beta \leq 4$, and we have $y < \frac{3}{2}$, and $k > 1$, it is straightforward to show that $\frac{\partial \theta_M^1}{\partial k} > 0$.Taking the partial derivative of θ_M^2 with respect to k yields

$$\frac{\partial \theta_M^2}{\partial k} = \frac{12 + (1-d)\frac{3}{2\sqrt{k}}\left(\left(\beta - 2\right)y - 4\right)}{2sy}.$$

Noting that θ_M^2 is defined for $\beta > 4$, $k > 1, d \leq 1$,it is straightforward to see that $\frac{\partial \theta_M^2}{\partial k} > 0$. Taking the partial derivative of θ_M^1 with respect to d yields

$$\frac{\partial \theta_M^1}{\partial d} = \frac{\sqrt{k}\left(\left(6 + \beta - 1\right)y\right) - 3y}{sy}.$$

Given that θ_M^1 is defined for $\beta \leq 4$, and we have $y < \frac{3}{2}$, and $k > 1$, it is straightforward to show that $\frac{\partial \theta_M^1}{\partial d} > 0$. Finally, taking the partial derivative of θ_M^2 with respect to d yields

$$\frac{\partial \theta_M^2}{\partial d} = \frac{3\sqrt{k}(4 - \left(\beta - 2\right)y) - 6y}{2sy}.$$

Noting that θ_M^2 is defined for $\beta > 4$, $k > 1, d \leq 1$,it is straightforward to see that $\frac{\partial \theta_M^2}{\partial d} > 0$.

Proof of Proposition 5: Taking the derivative of $\pi_M^{S*} = \frac{9k(1-d)^2y^2}{2(6k-sy(1+\theta)+3y(1-d))^2}$ with respect to d yields $\mid \frac{\partial \pi_M^{S*}}{\partial d} \mid = \frac{9k(1-d)(6k-(1+\theta)sy)y^2}{(6k-sy(1+\theta)+3y(1-d))^3}$. Similarly, taking the derivative of π_M^{S*} with respect to s yields $\frac{\partial \pi_M^{S*}}{\partial s} = \frac{9k(1-d)^2(1+\theta)y^3}{(6k-sy(1+\theta)+3y(1-d))^3}$. $\mid \frac{\partial \pi_M^{S*}}{\partial d} \mid > \frac{\partial \pi_M^{S*}}{\partial s}$ for $k > \frac{(1+\theta)(1-d+s)y}{6}$.

Proof of Proposition 6: Let $\beta < 4$. The managers choose not to collaborate if

$$\frac{9k(1-d)^2y^2}{2(6k - sy(1+\theta) + 3y(1-d))^2} < \frac{2y^2}{\left(4 - (\beta - 2)y\right)^2} \tag{47}$$

although collaboration results in greater total expected profits for the CHQ and the managers if

$$\frac{3(1-d)^2(9k + sy(1-2\theta))y^2}{(6k - sy(1+\theta) + 3y(1-d))^2} > \frac{12y^2}{\left(4 - (\beta - 2)y\right)^2}. \tag{48}$$

Let $x \equiv \frac{2}{(4-(\beta-2)y)}$. It is straightforward to show that for $(1-2\theta)sy > 0$, that is, for $\theta < \frac{1}{2}$, we have values of d such that for $d_M < d < d_T$, where

$$\begin{aligned} d_M &\equiv 1 + \frac{sxy(1+\theta) - 6kx}{3(\sqrt{k} - xy)}, \\ d_T &\equiv 1 + \frac{sxy(1+\theta) - 6kx}{\sqrt{9k + sy(1-2\theta)} - 3xy}. \end{aligned}$$

(47) and (48) hold together, implying that the managers choose not to collaborate although collaboration leads to greater total profits.

Proof of Proposition 7: Under decentralization, each division obtains resources at $t = 0$ where the CHQ has the ability to commit not to reallocate resources from one division to another. In addition, if the managers choose no collaboration, once the outcome of managerial effort is observed, each manager bilaterally bargains with the CHQ over the decision on whether his division will be continued or not. So, under no collaboration, manager 1 exerts effort p_1 to maximize his expected surplus given by $p_1 \frac{y}{2} - \frac{1}{2}p_1^2$. Note that at the interim bargaining, the Shapley value for manager 1 and the CHQ is given by $\frac{y}{2}$ given that the CHQ has no ability to engage in resource reallocation to the other division. The optimal effort level exerted by manager 1 is then given by $p_1^* = \frac{y}{2}$, leading to the following expected profits for the managers and the CHQ:

$$\pi^*_{CHQ} = \frac{y^2}{2}, \tag{49}$$

$$\pi^*_{M1} = \pi^*_{M2} = \pi^*_M = \frac{y^2}{8}, \tag{50}$$

$$\pi^{S*}_T = \frac{3y^2}{4}. \tag{51}$$

If the managers choose collaboration, the expected profits remain the same as in (44), (45) and (46). Comparing $\pi^*_M = \frac{y^2}{8}$ with $\pi^{S*}_M = \frac{9k(1-d)^2y^2}{2(6k-sy(1+\theta)+3y(1-d))^2}$ reveals that the managers choose collaboration for $\theta \geq \theta^D_M \equiv \frac{6k+3y(1-d)-6\sqrt{k}(1-d)}{sy} - 1$. It is straightforward to show that $\theta^D_M > \theta^1_M$ for $\beta \leq 4$, and $\theta^D_M < \theta^2_M$ for $\beta > 4$.