Value Co-Creation in IT Outsourcing and Software Development*

We study the relationship between a client and a vendor in IT outsourcing and software development where the client gets utility from the project throughout the development period, and the effort levels are not observable but might be monitored. The output is contingent on the effort levels of each party and we allow these effort levels to be dynamic. Hence, the client needs to optimally decide the terms of the contract so as to maximize the project output and minimize its cost. We analyze different contracts and find the best one for the client in diverse settings. We show that the remaining time of the project, and the client's valuation of the project regulate the behavior of the effort levels and some other characteristics in the collaboration. We derive the conditions under which the client chooses not to observe vendor's effort and operates in a double moral hazard environment. In addition, we find that the equilibrium effort levels or the benefits of the parties from the collaboration do not necessarily increase when the output becomes more sensitive to either party's effort. Based on the results of our model, we present several other interesting managerial insights.

Key words: Value co-creation, collaboration, differential game, Nash equilibrium.

1. Introduction

Management of IT outsourcing and software development has increasingly become more sophisticated and challenging. Attaining high productivity and efficiency levels has been argued to be difficult because of many factors such as higher customer expectations for better service with higher quality and lower prices, rapidly evolving information technologies, relationship-specific investments, tailoring of services or software to meet customer needs, and in particular, significant customer involvement throughout the process (Bettencourt et al. 2002, Gopal et al. 2003, Ramasubbu et al. 2008, Susarla et al. 2010, Susarla 2012). In this paper, we contribute to the literature by studying customer firm's involvement in generating a service in a dynamic environment where the effort levels are not observable but maybe monitored —if the client chooses to do so.

1.1. Dynamic Collaborative Environments

Our focus is on collaborative and dynamic IT settings in this paper. We consider that the relationship between the client and the vendor is collaborative, which means that these firms need

* The bulk of the work was done by a student.

to work together closely on the project in order to create a successful IT service or software. IT services are becoming more complex, unstructured, and tailored to fit unique needs of particular clients. Therefore, in order to attain successful outcomes, clients must participate in the creation of the services. In effect, clients get involved in the IT projects in (i) the problem definition stage, (ii) the selection of the solution, and (iii) the implementation of the solution. Many examples in information systems such as information technology outsourcing and software projects can be given as examples of value co-creation environments. However, in the information systems literature, the relationship between a client and a vendor has been studied generally with a focus where the vendor assumes the whole responsibility in the collaboration (DiRomualdo and Gurbaxani 1998, Gurbaxani 2007, Susarla et al. 2011, Whitaker et al. 2011, Mani et al. 2012). However, the specifics of the client-vendor relationship is changing towards creating value through value co-creation in service environments (Toppin and Czerniawska 2005) and we assume this collaborative view in this paper.

Moreover, the setting in our study is dynamic in several aspects. However, collaboration literature generally focuses on (i) the total effort required in the collaboration (not on its dynamics), and (ii) the final outcome of the project or collaboration. First, the parties do not need to adhere to the same level of work-hours throughout the collaboration. In reality, they can freely adjust their effort levels according to the needs of the project from the beginning to the end of the collaboration. Secondly, a system or application being developed in a collaborative project may become an essential part of the client's business even "during" its development —not after the project is due. Furthermore, in software development, the parties collaborate starting from the initial development of the software to its eventual release. They continue collaborating in the updated versions of the release version in order to fix bugs or to help improve the software. The beta version or other intermediate versions of the software is valuable to the client, and the parties collaborate until the end of the useful life of the software. Accordingly, until Section 6, we consider that the project's terminal value (i.e., value of the project when the collaboration ends) is less important compared to the on-going utility received from the collaboration, and can be ignored. However, in Section 6, we consider the scenario where the client receives value both during and at the end of the collaboration. Note that a special case of such setting includes environments where the value is received only at the end.

1.2. Contributions

Collaboration, with a focus on dynamic environments, has not received considerable attention in the literature. Karmarkar and Pitbladdo (1995) point out the importance of the involvement of customers in the service delivery process, and call for explicit modeling of service co-creation. We respond to this call by analyzing a dynamic setting that requires joint efforts from a client and a vendor for the generation of the output. We further consider that the effort levels are not observable or verifiable. However, they can be monitored (with some cost) if the client chooses to do so.

Collaborative business environments have been studied from many angles. However, most of the literature has focused on static settings, but not on the dynamics of collaboration. Based on whether the effort levels are observed or not, we study two contracts in this paper. In the first case, effort levels are not monitored. Hence, a double moral hazard problem arises and an output dependent contract is utilized. In the second scenario, the effort level of the vendor is monitored,and an effort dependent contract is utilized. In this paper, because of the complementary effort levels, the nature of the collaboration is different from most of the past studies. We capture all the dynamism discussed so far by utilizing a differential game approach.

Based on the results of our model, we derive several useful managerial insights pertaining to many aspects of the collaborative environments. Most importantly, we answer the questions regarding how the client should manage the collaborative relationship. Specifically, we identify which type of contract is better for the client under various scenarios and when the vendor's effort should be monitored. We also derive the optimal payment terms for these contracts and the evolution of the equilibrium effort levels. We further our analysis by answering several other managerially important questions. Finally, we explore some interesting extensions of the model: pure revenue-sharing settings, and the effects of the salvage value of the project on the dynamics of the collaboration.

2. Problem Definition and the First Best Scenario

The client's (referred to as *she*) objective is to find the contract that will maximize her value, i.e., the difference between the value of the output and all costs related to the collaboration. On the

other hand, the vendor (referred to as *he*) maximizes his value in any setting, which is the difference between the payment he receives and the costs related to participating in the collaboration. As discussed earlier, we consider problem settings that differ based on whether the effort levels are monitored or not. Next, we introduce our model starting with the input parameters of the parties.

2.1. Input Parameters

We denote the effort levels of the client and the vendor at time t by $u(t)$ and $v(t)$, respectively. These levels represent the resources exerted by each party. The total time horizon of the collaboration is denoted by T. We model the cost of client's effort with a general power term structure as $c_c u(t)^\gamma$. Here, c_c is the cost multiplier for client's effort. The parameter γ is considered to be more than 1 to reflect the fact that the marginal cost of effort increases with the level of effort. Similarly, the cost for the vendor is $c_v v(t)^\delta$. We also refer to γ and δ as costliness of client and vendor, respectively.

In general, the effort levels are not observable or verifiable. The client might not have direct authority to prescribe vendor behavior. Furthermore, if the vendor is remotely located, it is more difficult to monitor the vendor because of the dispersion of people, coordination issues, and loss of communication richness (Carmel 1999). However, in some environments, the effort levels can be monitored, which in turn, relieves the double moral hazard problem. In the problem settings we analyze, we show that monitoring both parties' effort levels is not optimal. Hence, in this paper, only vendor's effort is monitored if the client chooses to do so. Clearly, the costs related to monitoring need to be taken into account if the effort levels are monitored. Monitoring cost comprises of fixed and variable costs that are F_m and $c_m v(t)^\delta$ respectively. Here, c_m is the cost multiplier for monitoring vendor's effort. Next, we discuss the output parameters.

2.2. Output Parameters

As mentioned earlier, in many business settings, the client gets utility from the output as the collaboration is in progress.[1] Therefore, we model the output, which we denote by $q(t)$, as continuous,

[1] As discussed in Section 1.1, we do not rule out the possibility that the parties receive value also at the end of the collaboration. We study such a setting in Section 6.

doubly differentiable, strictly concave for positive effort levels, and nondecreasing in effort levels. Furthermore, the instantaneous increase in output is due to the collaborative work between the client and the vendor. Therefore, both parties need to exert effort in order to generate output. Similar to the other studies, the output is considered to be a Cobb-Douglas function (Cohen et al. 1996, Kim and Nettessine 2012). This implies that if one party exerts higher levels of effort, then the other party will have incentive to do so as well. More specifically, we model the instantaneous increase in the output as $\dot{q}(t) = u(t)^{\alpha} v(t)^{\beta}$ with $\alpha, \beta \geq 0$, and $\alpha + \beta < 1$. The Cobb-Douglas functional form is flexible in the sense that it can represent a traditional setting where the vendor assumes the whole responsibility in the generation of the output. This is possible by setting α to 0. Here, the parameters α and β represent the output elasticity (or sensitivity) to client's and vendor's efforts, respectively.

Since the client gets value from the project during its development, we can define it as

$$\int_0^T kq(t)dt. \tag{1}$$

In the above equation, k is used to convert the output to a utility measure. One possible interpretation of k is dollar value per unit output. Hence, we also refer to k as the valuation of the project. From the discussion above, we can write $q(t)$ as

$$q(t) = \int_0^t u(s)^{\alpha} v(s)^{\beta} ds;\ q(0) = 0. \tag{2}$$

2.3. Model Preliminaries

In the settings we analyze, the client is the principal and the vendor is the agent. Building the discussion in the reverse setting is also possible without any further complication. The client offers a contract to the vendor and the vendor accepts it if the gain is more than his reservation utility. These reservation utilities are denoted by R_c and R_v for client and vendor, respectively. If the offer is accepted by the vendor, both parties start working together and select and adjust their effort levels dynamically. We begin with analyzing the first best (FB) contract.

2.4. First Best

The first best setting represents the ideal case. Here, the client and the vendor behave as if they are a single firm and the effort levels are observable and verifiable. As a result, total value that could be generated in the collaboration is maximized. Therefore, we compare the first best solution with the solutions of the output dependent and effort dependent contracts in Section 5 in order to study their relative performances. The single objective in the first best case is to maximize profits that is the difference between the total value of the output and the participation costs of the parties. We skip discussing the details of this model, as well as its solution due to space limitation.

3. Unobservable Effort Levels

First best approach assumes that (i) effort levels are observable or verifiable, and (ii) the objective of both parties is to maximize the total value in the collaboration. However, in many real business settings, effort levels of parties are not observable and parties have rather different and often conflicting objectives. Therefore, a double moral hazard problem arises in many business settings. Accordingly, in this section, we assume that effort levels of both parties are not observable. Therefore, the client cannot transfer payments based on vendor's effort level. Therefore, the client offers the vendor a portion of the output and a fixed fee, i.e., $\int_0^T lq(t)dt + F_d$. Here, l denotes the transfer payment per unit output, and F_d is the fixed fee. Hence, the model can be written as:

$$\begin{aligned}
\max_{u(t),l,F_d} \quad & \left\{ \int_0^T kq(t)dt - \int_0^T c_c u(t)^\gamma dt - \int_0^T lq(t)dt - F_d \right\}, \\
\max_{v(t)} \quad & \left\{ \int_0^T lq(t)dt + F_d - \int_0^T c_v v(t)^\delta dt \right\},
\end{aligned}$$

subject to

$$\begin{aligned}
& \dot{q}(t) = u(t)^\alpha v(t)^\beta;\ u(t) \geq 0;\ v(t) \geq 0 \\
& \int_0^T kq(t)dt - \int_0^T c_c u(t)^\gamma dt - \int_0^T lq(t)dt - F_d \geq R_c; \\
& \int_0^T lq(t)dt + F_d - \int_0^T c_v v(t)^\delta dt \geq R_v.
\end{aligned}$$

The solution of this differential game (skipped for brevity) for a given l reveals the equilibrium effort levels that is presented in the lemma below assuming that the participation constraints hold.

LEMMA 1. *When the effort levels are not monitored, the equilibrium effort levels are:*

$$u(t)=\left((T-t)^{\delta}\left(\frac{l\beta}{\delta c_v}\right)^{\beta}\left(\frac{(k-l)\alpha}{\gamma c_c}\right)^{\delta-\beta}\right)^{\frac{1}{(\gamma-\alpha)\delta-\beta\gamma}}, v(t)=\left((T-t)^{\gamma}\left(\frac{l\beta}{\delta c_v}\right)^{\gamma-\alpha}\left(\frac{(k-l)\alpha}{\gamma c_c}\right)^{\alpha}\right)^{\frac{1}{(\gamma-\alpha)\delta-\beta\gamma}}.$$

In the next subsection, we derive the optimal payment terms based on Lemma 1.

3.1. Optimal Payment Terms

The client has no incentive to leave any value more than what is needed in order to make the vendor participate in the collaboration. Hence, in this contract, the client makes the vendor's participation constraint binding. Therefore, $F_d=-\int_0^T lq(t)dt+\int_0^T c_v v(t)^{\delta}dt+R_v$. After substituting F_d and the equilibrium effort levels provided in Lemma 1 into the objective function of the client, it is easy to observe that the client's value is concave in l. Therefore, the first and second order conditions with respect to l reveal the optimal payment parameters that we present in Lemma 2.

LEMMA 2. *When effort levels of both parties are not observable, the optimal payment per unit output, and the fixed payment terms are given by:*

$$l^*=k\frac{\beta(\gamma-\alpha)-\sqrt{\alpha\beta(\gamma-\alpha)(\delta-\beta)}}{\beta\gamma-\alpha\delta},\ F_d^*=T^{\frac{(2\gamma-\alpha)\delta-\beta\gamma}{(\gamma-\alpha)\delta-\beta\gamma}}\frac{(\gamma-\alpha)\delta-\beta\gamma}{(2\gamma-\alpha)\delta-\beta\gamma}\ l^*\left(\left(\frac{(k-l^*)\alpha}{\gamma c_c}\right)^{\alpha\delta}\left(\frac{l^*\beta}{\delta c_v}\right)^{\beta\gamma}\right)^{\frac{1}{(\gamma-\alpha)\delta-\beta\gamma}}\left(\frac{\beta-\delta}{\delta}\right).$$

By setting the payment parameters l and F_d to the levels presented in Lemma 2, the client maximizes the total value in the system and her utility. This is because the vendor receives only his reservation utility irrespective of the other parameter values. It is an interesting finding that the optimal payment term l^* does not depend on the cost per unit effort terms for both parties, i.e., c_c and c_v —hence, is not much variable. This fact is actually evidenced in Bhattacharyya and Lafontaine (1995), and we complement their finding in the case of continuous value co-creation settings. On the other hand, F_d^* has more variability. This finding is also observed in real business settings (Bhattacharyya and Lafontaine 1995). In the next proposition, we summarize the behavior of l^* with respect to output and cost elasticity terms α, β, γ, and δ.

PROPOSITION 1. *The optimal payment parameter l^* strictly decreases with α and δ, and strictly increases with β and γ.*

Proof: Proposition 1 follows from the derivative of l^* with respect to corresponding parameters. ■

Proposition 1 implies that if the output becomes more sensitive to client's effort (i.e., if α increases) or if vendor's marginal cost parameter increases (i.e., if δ increases), then the optimal payment term decreases. Here, as α increases, the ratio of output sensitivity to cost sensitivity with respect to client's effort (i.e., α/γ) increases. This ratio represents client's productivity in a sense. Similarly, β/δ represents vendor's productivity. Therefore, as either α or δ increases, the relative productivity of the client (i.e., $\frac{\alpha/\gamma}{\beta/\delta}$) increases. Hence, the client tends to assume more responsibility in the collaboration. In other words, the client attempts to reduce the effort level of the vendor that is achieved by reducing the payment term. Using the similar argument, if the output becomes more sensitive to vendor's effort (i.e., if β increases) or if client's marginal cost parameter increases (i.e., if γ increases), the relative productivity of the vendor increases. Hence, in this case, it is beneficial for the client to increase the optimal payment term in order to entice vendor to work more.

3.2. Behavior of Effort Levels

Using the results in Lemmas 1 and 2, we can easily characterize the effort levels of both parties in the double moral hazard case. In the next proposition, we present the impacts of output sensitivity parameters and marginal cost terms on the effort levels of the parties.

PROPOSITION 2. *In the output dependent structure:*

(a) With an increase in output elasticity to client's effort (i.e., α), client's effort increases iff $k > O_{\alpha c}$ and vendor's effort increases iff $k > O_{\alpha v}$.

(b) With an increase in output elasticity to vendor's effort (i.e., β), client's effort increases iff $k > O_{\beta c}$ and vendor's effort increases iff $k > O_{\beta v}$.

(c) With an increase in cost elasticity to client's effort (i.e., γ), client's effort decreases iff $k > O_{\gamma c}$, and vendor's effort decreases iff $k > O_{\gamma v}$.

(d) With an increase in cost elasticity to vendor's effort (i.e., δ), client's effort decreases iff $k > O_{\delta c}$ and vendor's effort decreases iff $k > O_{\delta v}$.

We would like to note that, the threshold values in this proposition and hereafter are omitted due to space limitation. When the output elasticity to client's effort (i.e., α) increases, the output

improves at a faster rate with an increase in client's effort (see Equation (2)). As a result, the client has an incentive to increase her effort level when α increases. Moreover, because of the complimentary effort levels, the vendor has an incentive to increase his effort level as well. However, increasing their effort levels are costly for both parties. Hence, they need to consider the trade-off between the benefit and the cost of increased efforts. Since the benefit of increased output is higher for high valuation projects (see Equation (1)), both the client and the vendor increase their effort levels when α increases in such projects —hence, part (a) of the proposition. Other parts of the proposition can be explained similarly.

Furthermore, as the time passes in the collaboration, the benefit of increased effort reduces. Hence, in part (a), towards the end of the project, it is less beneficial for the parties to increase their efforts even for the high valuation projects. As a result, we find that the threshold levels in the proposition increase with the time elapsed in the collaboration and approach infinity at the end of the project. This implies that, at the later stages of collaboration, both parties decrease their effort levels as α increases, irrespective of the valuation of the output. All of the thresholds in Proposition 2 have similar properties with respect to time but we omit the details due to brevity.

3.3. Client's Net Value

Given the optimal payment terms in Lemma 2, we calculate and present client's value below.

LEMMA 3. *When effort levels of both parties are not observable, client's net value is* $T^{\frac{(2\gamma-\alpha)\delta-\beta\gamma}{(\gamma-\alpha)\delta-\beta\gamma}} \frac{(\gamma-\alpha)\delta-\beta\gamma}{(2\gamma-\alpha)\delta-\beta\gamma} \left(\left(\frac{(k-l^*)\alpha}{\gamma c_c} \right)^{\alpha\delta} \left(\frac{l^*\beta}{\delta c_v} \right)^{\beta\gamma} \right)^{\frac{1}{(\gamma-\alpha)\delta-\beta\gamma}} \left(k - \frac{(k-l^*)\alpha}{\gamma} - \frac{l^*\beta}{\delta} \right) - R_v,$
where $l^* = k\frac{\beta(\gamma-\alpha)-\sqrt{\alpha\beta(\gamma-\alpha)(\delta-\beta)}}{\beta\gamma-\alpha\delta}$.

Proof: Client's value is derived by substituting the equilibrium effort levels and the optimal payment terms (Lemmas 1 and 2, respectively) into the objective function of the client. ■

In Section 5, we analyze the behavior of the client's net value in the output dependent contract, and compare it with that in the first best solution and in the contract discussed in the next section.

4. Monitoring Vendor's Effort

If the effort levels of both parties are not observable, the client has a double moral hazard problem as we analyze in the previous section. However, as discussed in Section 2.1, in some settings, the vendor's effort can be made observable or verifiable through IT systems, regular meetings, site visits, submitting progress reports, etc. Because the vendor's effort is observable and the client's effort can be inferred from the output, the double moral hazard problem turns into a standard principal agent model with perfect information. A contract based on output coordinates this setting. We omit the details of this contract, the equilibrium effort levels, and the client's net value, and several insights due to space limitation. However, we analyze the behavior of client's value and several other results in the following section.

5. Discussion and Managerial Insights

In this section, we discuss our findings and outline managerial insights regarding how the value generated in the collaboration is affected by different characteristics of the parties and which contract is better under different circumstances. Because of the space limitation, we provide only some of the findings and insights.

5.1. Client's Net Value

In both contracts, with the help of the fixed fee, the client extracts all value from the collaboration leaving the vendor only his reservation utility. Hence, we use client's value and total value interchangeably in this section. Below, we discuss in Proposition 3 how the client's value is affected by the output sensitivity to effort levels.

PROPOSITION 3. *In both output dependent and effort dependent contracts, when the output sensitivity to client's or vendor's effort (i.e., α or β) is low, an increase in the same output sensitivity decreases the net value of the client.*

$$\frac{d(\textit{Client's Value})}{d\alpha} < 0 \textit{ when } \alpha \textit{ is low, and } \frac{d(\textit{Client's Value})}{d\beta} < 0 \textit{ when } \beta \textit{ is low.}$$

Proof: The conditions follow from the limiting behavior of the derivative of client's value with respect to α and β. ■

Intuitively, if the output becomes more sensitive to the effort level of either party, client's net value should increase. However, as shown in Proposition 3, when the relative responsibility in the generation of the output is low for either the client (i.e., α is low) or the vendor (i.e., β is low), then increasing the responsibility of the same party does not necessarily increase client's value (or total value). However, after the sensitivity increases substantially, the value starts to increase.

5.2. Comparison of the Contracts

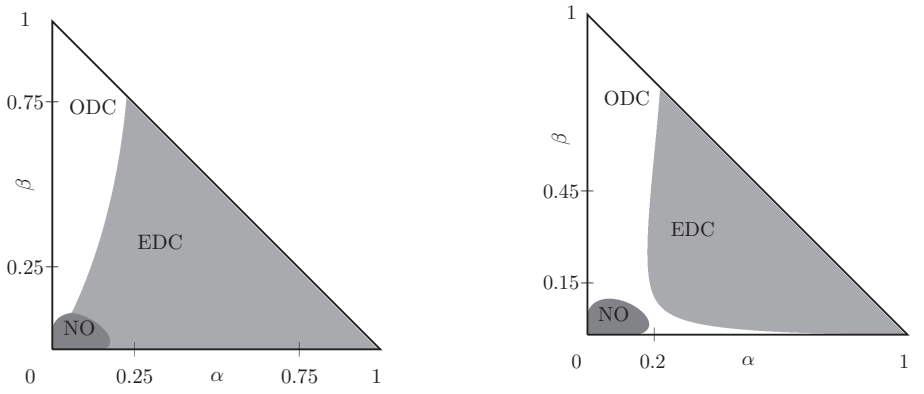
In this section, we compare the output dependent contract and the effort dependent contract with respect to different characteristics of the parties. This analysis would assist managers of the client firm in selecting the most beneficial contract while establishing a value co-creation environment. Compared to the first best case, the output dependent contract has inefficiency due to unobservable effort levels. On the other hand, the effort dependent contract has inefficiency due to costs pertaining to the monitoring of vendor's efforts. In the next proposition that is derived from comparing the values generated in the two contracts, we begin with studying how vendor's cost multiplier term c_v affects which contract is better.

PROPOSITION 4. *When the fixed cost for monitoring vendor's effort (i.e., F_m) is negligible, output dependent contract dominates the effort dependent contract iff the vendor's cost multiplier term (i.e., c_v) is sufficiently low. More specifically, the output dependent contract dominates iff*

$$c_v < \left(\left(\frac{(\gamma-\alpha)\delta-\beta\gamma}{(\gamma-\alpha)(\delta-\beta)+\sqrt{\alpha\beta(\gamma-\alpha)(\delta-\beta)}} \right)^{\frac{(\gamma-\alpha)\delta-\beta\gamma}{\beta\gamma}} \left(\frac{\beta\gamma-\alpha\delta}{\alpha(\beta-\delta)+\sqrt{\alpha\beta(\gamma-\alpha)(\delta-\beta)}} \right)^{\frac{\alpha\delta}{\beta\gamma}} \frac{\beta\gamma-\alpha\delta}{c_m\left(\beta(\gamma-\alpha)-\sqrt{\alpha\beta(\gamma-\alpha)(\delta-\beta)}\right)} - \frac{1}{c_m} \right)^{-1}.$$

When the cost multiplier term c_v is low, the vendor's equilibrium effort is relatively high, and hence, the total monitoring cost is high. Thus, in such a case, the severity of the double moral hazard problem is less than the costs related to monitoring vendor's effort. Therefore, as shown in Proposition 4, when it is less costly for the vendor to exert effort, the client should choose not to monitor vendor's effort and utilize the output dependent contract. If the fixed cost for monitoring vendor's effort (i.e., F_m) is not negligible, the threshold value for c_v is higher than the value in Proposition 4. We do not present the expression due to brevity, but the key insight are the same.

Let us now analyze how output sensitivity parameters α and β affect which contract is better. We conducted an extensive number of numerical studies and present two representative examples in Figure 1. In these graphs, "EDC" and "ODC" represent the regions where the effort dependent contract and the output dependent contract, respectively, are preferred. The phrase "NO" denotes the region where no contract is feasible, and therefore there is no collaboration.



(a) Without Fixed Cost of Monitoring (b) With Fixed Cost of Monitoring

Figure 1 Client's Contract Choice

Figure 1(a) reveals that the output dependent contract dominates the effort dependent contract only when the output sensitivity to vendor's effort (i.e., β) is considerably higher than the output sensitivity to client's effort (i.e., α). Otherwise, the effort dependent contract yields more value to the client. In addition, we observe from both figures that when the output sensitivity to the effort levels of both parties are very low, they do not collaborate (see the left-bottom area labeled with "NO"). In such a case, neither contract can generate more value than the total reservation utilities of the parties. In Figure 1(b), the set of parameter values where the output dependent contract dominates the effort dependent contract is not convex. This can be explained as follows. For example, in Figure 1(b), when $\alpha = 0.20$ and β is lower than 0.15, the output dependent contract dominates. In such a case, the output does not depend highly on neither of the parties's effort levels, and the net value of the client is low. Hence, the client avoids paying for the fixed payment term of monitoring and chooses to use the output dependent contract. On the other hand, when $\alpha = 0.20$

and β is between 0.15 and 0.45, the effort dependent contract dominates. This is because when the output depends on the effort levels of both parties, the severity of the double moral hazard problem increases. However, when $\alpha = 0.20$ and β is more than 0.45, again the output dependent contract is preferred. In this case, the vendor exerts relatively more effort, hence the total cost of monitoring is increased. This is the reason why the output dependent contract performs better. As discussed before, we verified that these results hold for other problem instances as well. Now, in the next section, we present some extensions of the models discussed so far.

6. Extensions

In this section, we study two additional settings. Because of the space limitation, we do not report all of the findings but a summary of the important ones. First, we study pure revenue-sharing settings where the parties share the output without the transfer of a fixed fee (Gil and Lafontaine 2012). In this case, we find that the client cannot extract all the value from the vendor. In addition, the total value generated in the collaboration is reduced. Secondly, we allow the client or the vendor to get utility from the output even after the project is finished. We find in this case that most results are similar to the contracts studied in the earlier sections. However, the relationship between value and output sensitivity terms discussed in Proposition 3 changes its behavior when the project has a salvage value. Specifically, when the ratio of the salvage value to the ongoing value during the collaboration is high, an increase in the output sensitivity to either party's effort (i.e., α or β) always increases client's net value. In the next section, we conclude our paper.

7. Conclusions

In IT outsourcing and software development, the traditional view of analyzing supplier-client or consultant-client relationship needs to be re-visited in light of the fact that the output of these relationships may depend on the effort levels of both parties, not just the vendor's effort. Therefore, we analyze a value co-creation environment where the output necessitates the efforts of both parties. We would like to note that, because of the space limitation, we could not present many of our findings. Nonetheless, we go over all of our findings in this section.

In this paper, we consider the fact that the effort levels of the parties may not be monitored. This leads to a double moral hazard problem, however, the client may choose to observe the effort level of the vendor with a cost. In this environment, we derive the equilibrium effort levels of the client and the vendor as well as the optimal payment parameters and contracts. Next, we present and explain several results based on the sensitivity analyses of the equilibrium effort levels with respect to the parameters representing different characteristics of the parties. The client's valuation of the project and the progress in the collaboration play an important role in the behavior of the effort levels. Depending on these factors, the equilibrium effort levels might increase or decrease with the changes in the output sensitivities to effort levels and the cost elasticities of efforts.

We also compare the performances of different contracts in order to find the best one for the client under different circumstances. This analysis also reveals whether the vendor's effort should be monitored or not. We find that, as long as the participation cost of the vendor is not very low, his effort should be monitored and the client should use an effort dependent contract. Otherwise, the client should not monitor vendor's effort, and should operate under double moral hazard with an output dependent contract. Another interesting finding is that, if the sensitivity of output to vendor's effort is relatively higher than the sensitivity to client's effort, the client should use the output dependent contract and should not monitor vendor's effort.

We also find that, under certain circumstances, an increase in the sensitivity of the output to either parties' effort level does not necessarily increase the net values of the parties. However, if the relative value received at the end of the collaboration is high (compared to the on-going utility received), any increase in the output sensitivity to either party's effort level always increases the net value. Finally, we consider the pure revenue-sharing contracts and find that the total value generated in such an environment is lower than that in the output dependent contract.

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