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Improving Work Performance of Services Delivered Off-Shore: Ex Post Inspection or Ex Ante Monitoring?

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Completed Research Paper

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Abstract

Advances in Information Technology have allowed companies to deliver varied services from off-shore locations with work performance being closely monitored and contracted on. While business reports have focused on the delivered quality of services moved offshore, statistical evidence is needed to study the effectiveness of different instruments on improving the work performance. Based on our primary data, we conduct empirical tests to investigate the effectiveness of different governance instruments, including monitoring and contracting instruments, for improving the work performance of services delivered off-shore. The findings indicate that while monitoring instruments are effective for improving work performance in general, currently used contracting instruments fail to align the incentive of the buyer with that of provider of services off-shored. Furthermore, a buyer company's real-time monitoring is far more effective than a provider company's monitoring for improving the work performance, and this comparative advantage increases as service process codifiability decreases.

Keywords: Service Off-shoring, Work Performance, Governance Instruments

Introduction

The practice of global sourcing of services has gone beyond call centers to expertise-intensive functions such as financial analysis, supply chain coordination, and even research and development (R&D). Service off-shoring, however, may fail to deliver the expected cost savings after adjusting for work performance (Deloitt 2005). While more and more US companies are off-shoring their services to low-labor-cost countries, finding effective ways to improve work performance of services delivered off-shore becomes an essential issue.

Having been farming out their manufacturing for several decades, US companies are not unfamiliar with the phrase of "quality control". Nonetheless, there are some major differences between the production of services and the production of physical goods. Traditional services literature suggests four differences in the nature of services versus products – intangibility, inseparability of production and consumption, heterogeneity of customer demand and perishability – that will raise problems in service marketing and service performance (Rathmell, 1966; Regan, 1963; Shostack, 1977; and Zeithaml *et al* 1985). Although the definition and the scope of services being delivered offshore are not the same as those in traditional service literature, the similar characteristics creates challenges in controlling the work performance when services are delivered offshore. While inseparability and perishability make the false delivery more harmful to the company, intangibility and heterogeneity make it extremely difficult to have good measurements of the performance. Principle-Agency (P-A) theory (Grossman and Hart 1983; Holmstrom 1979; Holmstrom1982; Holmstrom and Milgrom 1991) shows that the lack of measurements of the performance will likely lead to suboptimal results because of moral hazard problem and opportunistic behavior of the buyer and/or the provider. When services are delivered off-shore, this problem worsens due to language and other cross-cultural differences (BusinessWeek 2006).

The governance instruments for work performance improvement can be broadly categorized into two groups: contracting and monitoring. To be specific, companies can use incentive pay or penalties to motivate vendors through a contract; they can also increase monitoring levels to control work performance in real-time. Since both contracting and monitoring are expensive, it is important for companies to know how to allocate resources between these two different groups of instruments. Similar questions were first raised by researchers in legal studies on optimal law enforcement schemes (Shavell 1984; Wittman 1977) and later studied by economists under principal-agent and asymmetric information settings (Kolstad et al. 1990; Mookherjee and Png 1992). The contracting instruments are usually called *ex post inspection* and monitoring instruments are usually regarded as *ex ante regulation*. Extant research show that the balance between these two depends on factors such as information, insurance and transaction costs. The basic insights can be generalized to many applications, such as crime prevention (Benshahar 1995; Di and Schargrodsky 2003; Di and Schargrodsky 2004), insurance policy, tax enforcement (Chander and Wilde 1998), environmental regulations (Pfaff and Sanchirico 2000), economic analyses of corruption (Acemoglu 2000; Aidt 2003), information technology security (Cavusoglu et al. 2005), and contract design with the moral hazard problem (Dye and Sridhar 2005). Despite theoretical abundance, few studies quantitatively measure the effectiveness of these two groups of instruments.

Our purpose in this paper is to fill the gap between theory and practice in this question. While different governance instruments are being used to maintain or improve work performance, it is of central interest for the companies to know the cost-effectiveness of these instruments and their interactions with the characteristics of varied off-shored services. We conduct an empirical analysis based on the primary data we collected from several service off-shoring contracts. For monitoring instruments, we use real time monitoring made by project managers. For contracting instruments, we include incentive and penalty arrangements. We show that for services off-shored, most monitoring instruments are effective for improving the work performance while contracting instruments have an insignificant or weak relationship with work performance. This result demonstrates that while currently used work performance metrics do not have the power to align provider's incentive with buyer's, real time monitoring is a more effective way to improve the work performance of off-shored services.

Furthermore, advanced information and telecommunication technologies have greatly reduced the cost of long distance real-time monitoring. As a result, the managers from buyer companies have instant access to detailed process data, which enable them to monitor and control the work performance during the execution phase. Since managers from buyer companies have the same resource as the managers from provider companies, we designed the research to study the effectiveness of real-time monitoring from both the buyer company's managers and provider company's managers. We find that time spent by buyer companies in monitoring is much more effective than the same time spent by the provider companies and this managerial advantage is bigger for some services than others.

Although this paper has not studied the reason of different effectiveness, the findings could help both buyer and provider companies use monitoring instruments more effectively, which can reduce the total service off-shoring cost and improve the social welfare.

Research Model

Moral Hazard and Incentive Contracts

Off-shore service delivery involves a lot of outsourcing situations, or a relationship between a principal (User Company) and an agent (Provider Company) where the principal delegates tasks to the agent. The main problems arisen from this relationship are so-called moral hazard problems, that is, the agent deliberately under-performs which results in lower productivity or lower work performance. Principal-Agent (P-A) theory (Grossman and Hart 1983; Holmstrom 1979) has been studying this relationship and moral hazard problems. According to P-A theory, the existence of information asymmetry and conflict of interests between principal and agent are the primary reasons that lead to moral hazard problems. Incomplete contract theory (Fudenberg and Tirole 1990; Hart and Moore1988; Hart and Moore 1990) raises the opportunity renegotiation and the hold-up problem as other factors that affect an agent's incentive to deliver better performance. Based on both theories, an incentive contract is then designed to reduce such problems. According to a written contract, the provider company's payment will depend on the inspection results of some agreed measurements of work performance. In order to induce certain level of effort from an agent, the buyer company could promise a higher payment for a better work performance, which is called *incentive pay*. Another instrument that takes the opposite format but has the positive effect on agent’s effort and work performance is a *monetary penalty* for a sub-optimal work performance. Contracting instruments thus take effect through ex post inspection with contracted incentives or penalties.

It is obvious that a higher-power incentive contract - a higher amount or percentage of incentive pay and penalty - can induce more effort from an agent and therefore should have a positive relationship with work performance. The framing of the contract does have impacts on agent’s preference and effort level too. Management literature has documented that employees generally prefer bonus contract to penalty contract because they think bonus contracts are fairer (Luft 1994). However, the actual work performance also depends on other risk factors which are not controlled by employees. For risk aversion employees, they will make more effort under penalty contract even when they think it is not fair enough (Hannan et al. 2005). Furthermore, many factors could affect the effectiveness of these instruments. Kerr describes in his famous article (Kerr 1975) the difficulties of setting the right reward system to achieve the desired results from agents because you may be rewarding the wrong achievements. More importantly, if the measurement of work performance that the contract is based on is too noisy, which means that some unmeasured factors other than an agent’s effort bring a lot of uncertainty to work performance, a high-power incentive contract will reduce the agent’s incentive to participate in such kind of contract. Or, if the measurement of work performance that the contract is based on does not align with the agent's incentive, this positive relationship may be very weak, does not exist, or even be negative. Therefore in order to alleviate the Moral-Hazard and the Hold-Up problems, the evaluation of the work performance and the alignment of performance measurement and agent’s incentive are extremely important in driving the work performance (Anderson and Schmittlein 1984; Holmstrom and Milgrom 1991). Since the purpose of contractual performance measurement is to align buyer’s interests with provider’s interest, we expect agent’s incentive will be positively correlated with principal’s inspection cost, the more the buyer company invest in inspection, the better the performance measurement. Therefore, we have the following hypotheses:

H1: A higher-power incentive contract will increase work performance of service

H1a: A higher incentive pay will increase work performance

H1b: A higher monetary penalty will increase work performance

H1c: A higher contracting cost will increase work performance

Close Monitoring of Buyer Company

The advent of the Internet and the relatively cheap availability of bandwidth have enabled companies in the United States and Europe to link themselves reliably to companies in China, India, and other off-shore countries, which made it possible for buyer companies to monitor projects, people, and the execution of processes across the globe in real time and in great detail (Kaiser and Hawk 2004). An example of deep links between companies can be found in the case of Allsec Tech, a Chennai-based company that has placed its process execution specialists on its buyer's premises across the city, inside the Ford Motor Company's "trusted zone". Allsec Tech's agents resolve supply chain coordination problems by tracking invoice clearance, payment, and accounts receivables and payables (by querying data repositories that are located in Detroit and Chennai), and provide expert intervention when it is called for. The agents of the provider work under the direct supervision of the provider's managers and the virtual supervision of the buyer's (buyer's) managers. Other companies such as I-OneSource, Progeon and Wipro also have developed information systems to offer their buyers real-time information on the progress of their projects, productivity of teams and work performance of process execution.

The effectiveness of real time monitoring is affected by many factors such as the length of the time spent on monitoring, the resources for monitoring, the metrics monitored, and the style of communication, etc. While managers from both sides spend time monitoring the buyer companies' agent, they have their own advantage and disadvantage in terms of service process expertise, language, corporate ethic and culture, as well as managerial authority (Oshri et al. 2007). Therefore the relative effectiveness of their real-time monitoring and management is also unknown to practitioners, which is worth further studying. In our model, we test the monitoring time of managers from buyer and provider's company separately. Therefore, we have the following hypotheses:

H2: More monitoring efforts will increase work performance of service

H2a: More monitoring efforts from provider's managers will increase work performance

H2b: More monitoring efforts from buyer's managers will increase work performance

In addition, we also test on the process-specificity of two important managerial resources, the information system and the manager who use information systems to monitor. If these two resources are process-specific, it may increase the efficiency and effectiveness of monitoring. Therefore, we have the following hypotheses:

H3: A process-specific monitoring resource will increase work performance of service

H3a: A process-specific information system may increase work performance

H3b: A process-specific process manager may increase work performance

Knowledge Transfer and Process Codifiability

Today's service off-shoring are enabled by Information and Communication Technologies (ICT), therefore it mostly involves the sharing and transferring of digitalized knowledge. Knowledge transfer theories have identified five central dimensions of knowledge: *Codifiability, Procedural Complexity, Teachability, System Dependence and Observability* (Roger 1980; Winter 1987; Zander and Kogut 1995). Among these five constructs, codifiability has been found as one of the main influential elements in both inter-organizational (Zander and Kogut 1995) and inter-personal (Brown et al. 2006) knowledge transfer. Codifiability captures the degree to which knowledge can be encoded. Higher codifiability improves knowledge transfer in terms of speed and work performance. As a result of better knowledge transfer, work performance is higher since the provider is likely to make fewer errors. Codifiability has also been identified as the driver of the other dimensions of knowledge, therefore affecting the work performance in an indirect way through its impact on the "teachability"' and "systems dependence".

Process codifiability not only is a primary determinant of work performance of services off-shored, it may also affect the effectiveness of governance instruments in improving the work performance. First, codifiability may have a positive impact on the effectiveness of contracting instruments. For less codifiable processes, there are many intangible factors that affect work performance. Therefore, an objective performance measurement might have less power to provide the proper incentive to the agent. Second, codifiability may have a negative impact on buyer company's managerial advantage for the following reason: if the process is less codifiable, it is more difficult for the the buyer company to transfer managerial knowledge to the provider company. Therefore, the buyer company's expertise in managing less codifiable process has more value than for a more codifiable process.

While controlling for this important factor, we also control for other factors which affect the work performance, such as the number of agents working on a single task because more agents involved in executing a process increase the complexity of the coordination and therefore the likelihood of operational errors.

Theoretical Model

Based on above extant theories, we form the following theoretical model to address the effectiveness of different governance instruments on improving work performance of services delivered off-shore, shown in figure 1.

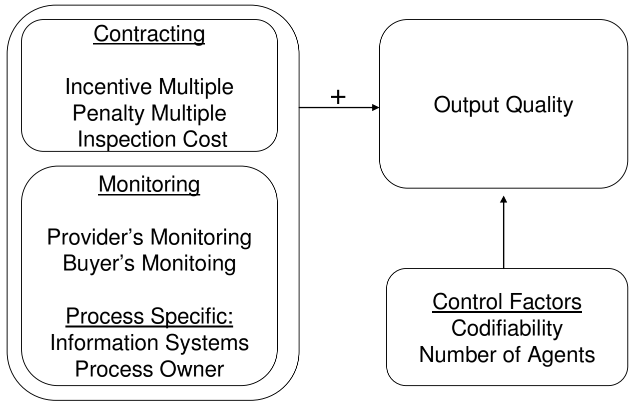

Figure 1: Theoretical Model

Empirical Design

In order to test the above model, we conducted a field research to collect detailed information from outsourcing contracts as well as work performance and monitoring work log over time. Given the difficulties in getting companies to disclose contract details and allow outsiders to take a deep look into their work log, we were fortunate being able to get access to 80 service outsourcing contracts and its execution details. The field research was conducted from 2002 to 2003. Four providers were drawn from countries including Singapore, India, Mauritius, Thailand and the buyers were drawn from US and the UK. All of 80 contracts are Business Process Outsourcing contracts (BPO).

Defining Work Performance

We define work performance (*performance*) as the probability that service execution is error-free. Work performance is not a well-defined concept because it is a construct that has both tangible and intangible factors and also depends on a consumer's subjective expectations and perceptions. Compared to the quality of physical goods, the work performance of services is even more difficult to measure because it is driven by more intangible factors and fewer tangible factors (Zeithaml 1981). In this paper, we borrow the concept of defect rate in manufacturing to define the work performance as the extent to which the output of a process is error-free. Service off-shoring involves the delivery of information-rich processes. The errors in the execution of off-shoring may be in the form of inaccurate (mistake-ridden) process delivery, delays in completing work, incomplete or inaccurate audit trails, among others. In general, a deviation from a predetermined form of output is an operational error. The error rate is recorded in the monthly "Payments and Completion Schedule", which is the basis on which the provider is paid by the buyer. It is a fraction between zero and one. The work performance is calculated by subtracting the error rate from one. There are two advantages to proceed with this definition: (1) the company that buys the services specifies what an error is in the service level agreement (SLA), thereby restricting the ambit of analysis to what really matters; and (2) parsimony: this model of work performance is a parsimonious construction that can include different kinds of work performance factors - errors of execution, delay in delivery, and customer satisfaction.

Constructing Contracting Instruments

Incentive multiple (*incentive*) is a ratio of the commission rate paid for exceeding targeted work performance specified in the Service Level Agreements (SLAs) over the total payment. This commission is supposed to give an agent incentive to make more effort to increase the work performance.

Penalty multiple (*penalty)*, similarly, is a ratio of the penalty for delivery of sub-optimal work performance over the total payment. Sometimes the avoidance of a penalty can be the incentive, but these two different forms will have a different impact on an agent's incentive (Luft, 1994). Since companies explicitly put both in their contract, we use two separate variables to test its individual effectiveness on work performance.

Insp_cost is an estimate of the cost of inspecting the process output incurred by the buyer company as a fraction of total cost of production, which is a proxy of buyer company's contracting-related effort. We assume that the more effort the buyer put in inspecting, the better the incentive alignment contract will be created between buyer and provider.

The first two variables are obtained or calculated through the data in the contracts. The third variable is an estimate scaled by the process volume and multiplied by the wage rate of the buyer.

Constructing Monitoring Instruments

The manager's time spent on monitoring is the primary monitoring instrument we are interested in. For this purpose, we mainly use two variables: *provider_mon* and *buyer_mon*. These represent the fraction of time spent by the manager (from provider company or buyer company) on monitoring and controlling the agents who execute the process. Following is a detailed description of how these two variables are calculated.

- **Provider's Monitoring Effort** (*provider_mon*): This variable is a temporal variable. It is a weighted-average measure: Each process has a manager or a set of managers that head the operations at the process level and are responsible for the agents that execute that process and process outcomes. Tasks that have to do with monitoring Work-In-Process (WIP) of agents executing the process, inspecting their work procedures, compliance with procedures, documentation, QA, direct communication etc. all fall under the rubric of Provider's Monitoring/Control Effort. We estimate this as the fraction of the total time spent by each manager and weigh it by the number of agents that report to the manager. For the i^{th} manager if the number of agents that report to this manager is n_i and the fraction of their time that they spend monitoring WIP agents is given by w_i, then:

$$PM_j = \frac{\sum_{i=1}^{N} w_i n_i}{\sum_{i=1}^{N} n_i}$$

  For each time period:

$$PM_{jt} = \frac{\sum_{i=1}^{N} w_{it} n_{it}}{\sum_{i=1}^{N} n_{it}}$$

  Where PM_{jt} is the Provider Monitoring effort of the j^{th} process with N operational managers. Usually, $n_{it} \leq 8$.

- **Buyer's Monitoring Effort** (*buyer_mon*): Similar to the calculation of the above measure, this variable is estimated by the provider's account manager. We created a charter of engagement which details the buyer managers' level of engagement during process production. As before, we estimate this as the fraction of total time spent by each of the buyer managers and averaged across the buyer. For the i^{th} manager (of the buyer) if number of agent report to this manager is m_i and the fraction of time spent (during service execution) is given by c_i, then

$$BM_j = \frac{\sum_{i=1}^{M} c_i m_i}{\sum_{i=1}^{M} m_i}$$

  For each time period

$$BM_{jt} = \frac{\sum_{i=1}^{M} c_{it} m_{it}}{\sum_{i=1}^{M} m_{it}}$$

Where BM_j is the Buyer's Monitoring effort of the j^{th} process with *M* operational managers. Usually, $m_{jt} = 1 \; or \; 2$.

It is important to note that we cannot really measure the cost as opposed to effort because the wage structures vary in different countries.

- **Process Specific Resources:**

  Additionally, we ask two questions in our survey that generate two variables. The first question is about Process Specific Systems (proc_spec_sys). The question is "Does the provider/buyer use Information Systems dedicated solely to measure a particular process? (0 / 1 Measure) Yes = 1, No = 0." The second question is about the Process Owner (proc_owner): "Is there a single person within the buyer company responsible for work performance outcomes across a process? (0 / 1 Measure) Yes = 1, No = 0". Therefore these two variables are both dummy variables with the value of 0 or 1. These two variables are both process specific resources.

Operationalizing Codifiability

Codifiability (*codifiability*) captures the degree to which knowledge can be encoded. It is a weighted combination of four factors, each of which is measured via a seven-point Likert Scale.[1]

1. Information Specification. Two measures:
   - What fraction of the agent's Response tasks involves extraction of information? t_1: $t_1 \in [0,1], t_1 + t_2 + t_3 \le 1$
   - To what extent does such information extraction depend on communication with humans based in non-structured domains (non-technical communication, non-domain restricted communication)? X_1: X_1 = (1,2,3,4,5,6,7)
2. Rule-Based Recognition. Two measures:
   - What fraction of the agent's response tasks involves rule-based recognition of patterns? t_2: $t_2 \in [0,1], t_1 + t_2 + t_3 \le 1$
   - To what extent can rules specify the domain of patterns that the agent should recognize? X_2: X_2 = (1,2,3,4,5,6,7)
3. Communication. Two measures:
   - What fraction of the agent's response tasks involves persuasion (often refer as "view adoption")? t_3: $t_3 \in [0,1], t_1 + t_2 + t_3 \le 1$
   - To what extent can agents refer to rules and unambiguously structured information in persuading other humans? X_3: X_3 = (1,2,3,4,5,6,7)
4. Residual Tasks. Single measure:
   - To what extent can agents refer to rules and objective means of disambiguation in all other tasks that they encounter? X_4:X_4 = (1,2,3,4,5,6,7)

The codification index of the process is a composite of four factor-weighted measures given by:

$$Codifiability = t_1 * X_1 + t_2 * X_2 + t_3 * X_3 + [1 - (t_1 + t_2 + t_3)] * X_4$$

By construction , service with a largerer codifiability means the service process is more codifiable. The descriptive statistics are summarized in Table 2.

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[1] Often five ordered response levels are used, although many psychometricians advocate using seven or nine levels; a recent empirical study (Dawes, 2008) found that data from 5-level, 7-level and 10-level items showed very similar characteristics in terms of mean, variance, skewness and kurtosis after a simple transformation was applied.

Table 2: Summary Statistics and Correlations

		Mean	Std. Dev.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)	performance	0.90	0.07	1.000	0.904	-0.416	-0.287	0.081	0.342	0.087	0.007	0.119	-0.073
(2)	codifiability	4.76	1.61		1.000	-0.484	-0.383	0.037	0.218	-0.075	0.040	0.050	-0.116
(3)	insp_cost	0.42	0.43			1.000	0.361	-0.095	-0.064	0.176	0.074	-0.059	0.109
(4)	penalty	1.14	0.54				1.000	-0.058	-0.159	0.035	0.043	-0.106	0.115
(5)	incentive	0.05	0.05					1.000	-0.029	-0.023	-0.073	0.162	-0.123
(6)	prov_mon	0.11	0.06						1.000	0.078	-0.125	-0.061	0.095
(7)	buyer_mon	0.03	0.02							1.000	-0.029	-0.269	0.029
(8)	proc_spec_sys	0.34	0.48								1.000	0.079	0.099
(9)	proc_owner	0.54	0.50									1.000	-0.032
(10)	num_agent	6.39	3.65										1.000

Econometric Model

We adopt the following empirical model. It is noticed that causality problem may exist between work performance and some of independent variables such as monitoring instruments. In order to reduce the effect of endogenous problem, our work performance data has one or two periods lag behind the monitoring instruments.

$$\begin{aligned} performance = {} & \beta_0 + \beta_1 \times codifiability + \beta_2 \times insp\_cost + \beta_3 \times penalty + \beta_4 \times incentive \\ & + \beta_5 \times provider\_mon + \beta_6 \times buyer\_mon + \beta_7 \times proc\_spec\_sys \\ & + \beta_8 \times proc\_owner + \beta_9 \times num\_agent + \varepsilon \end{aligned}$$

Contracting versus monitoring: which instruments are more effective?

Analysis of effectiveness of contracting instruments

Test results are reported in Table 3. The table shows that only hypothesis H1b was weakly supported (significance level is larger than 0.01 but less than 0.05). This means contracting instruments overall do not significantly affect the work performance. Inspection costs and the incentive arrangement in contract do not have a significant relationship with work performance. Although the penalty arrangement could affect the work performance in a significant way, the degree of the effectiveness is not that big. According to our variable construction, work performance and penalty are both fractions. Therefore we can say a 1% increase in penalty instrument is associated with only a 0.013 decrease in the error rate, i.e., a reduction from 0.10 to 0.087. The significance of penalty contracting is consistent with management literature that loss aversion caused employees to expend more effort under the penalty contract than under the monetarily equivalent bonus contract (Luft, 1994).

However, this does not necessarily imply that the contracting instruments in general are not effective in improving the work performance. The reasons for insignificance may come from many sources. Look at the summary statistics of our data, average incentive multiple is only 0.05 which means only 5% of total payment will be rewarded if the agent has done a great job. The insignificance of incentive multiple may be because this incentive multiple is not high enough to induce a higher effort. Another possible explanation is that the measurements of work performance are too noisy. If we look at incentive instruments more carefully, there are two important assumptions behind the effectiveness of this group of instruments: 1) The measurements in the incentive pay contract have a strong relationship with the agent's effort; 2) The same measurements have a strong positive relationship with work performance. The failure of either of these two assumptions could result in the insignificant result in our test. We know that the second assumption holds based on our survey design. If there are too many other factors that affect the work performance other than the agent's effort, a significant relationship is hard to establish between the power of the incentive contract and work performance.

Table 3: Regression Results

Variable	OLS	Log (Y)	Interaction1	Interaction2	Final Model
Codifiability	0.040*** (0.000)	0.046*** (0.000)	0.047*** (0.000)	0.051*** (0.000)	0.051*** (0.000)
Insp_cost	-0.004 (0.667)	-0.007 (0.430)	-0.010 (0.213)	-0.008 (0.3421)	
Penalty	0.013* (0.029)	0.015* (0.038)	0.018** (0.003)	0.017** (0.005)	0.015** (0.002)
Incentive	0.052 (0.364)	0.061 (0.354)	0.053 (0.327)	0.040 (0.460)	
Prov_mon	0.186*** (0.001)	0.206*** (0.001)	0.649*** (0.000)	0.643*** (0.000)	0.632*** (0.000)
Buyer_mon	0.570*** (0.000)	0.640*** (0.000)	0.002 (0.995)	0.575*** (0.000)	0.558*** (0.000)
Pro_spec_sys	-0.003 (0.682)	-0.004 (0.620)	-0.001 (0.814)	-0.002 (0.799)	
Proc_owner	0.020** (0.002)	0.022** (0.003)	0.021*** (0.000)	0.021*** (0.000)	0.022*** (0.000)
Num_agent	0.0003 (0.738)	0.0003 (0.785)	0.0005 (0.510)	0.0004 (0.625)	
Cod_pmon			-0.091** (0.003)	-0.090** (0.003)	-0.088** (0.001)
Cod_bmon			0.119 (0.122)		
N	80	80	80	80	80
F (Prob>F)	60.068 p<0.0001	60.068 p<0.0001	57.320 p<0.0001	61.513 p<0.0001	132.01 p<0.0001
R^2	87%	86.6%	88.7%	88.4%	89.6%

Note: 1) p-value in parentheses, *** p-value ≤0.001, ** p-value ≤ 0.01, * p-value ≤ 0.05.
2) Final model uses robust standard error.

Analysis of the effectiveness of monitoring instruments

We find that hypotheses H2 is significantly supported by our data. Higher monitoring levels from the provider as well as the buyer company's managers are significantly and strongly associated with higher work performance. According to our design, provider or buyer company's monitoring effort is the weighted fraction of manager's time spent on monitoring Work-In-Process (WIP) of workers. Since it is a fraction, a unit increase in monitoring level can only be a fraction too. Therefore, if managers spend one more hour per day of their working time (assuming eight working hours per day) monitoring process execution, work performance will increase by 0.023 which equals to 0.186 multiplied by 0.125. For example, if the error rate is 0.10, i.e., 90% of work will be error free, it will become 92.3% after provider's managers spend one more working hour per day monitoring process. This is a large increase since most processes have error rates of 0.1 or less. Therefore a 12.5% increase in a manager's time spent on monitoring might result in a nearly 3% increase in the work performance.

The buyer company's monitoring is even more effective than the provider company's. In this case, one more hour increased in monitoring by the buyer company's manager may result in an increase of 8% in work performance (from 90% to 97.1%), three times higher than the provider company. The reason for this managerial advantage is itself an interesting topic. In this paper, this result provides strong support for the idea that IT-enabled real time monitoring from the buyer's side may have a very significant impact on work performance of off-shored services.

Regarding hypothesis H3, results from Table 3 indicate that a sole process owner can increase the work performance by 0.020 (reduce the error rate from 10% to 8%) which is a large improvement. Surprisingly, the process-specific information system doesn't improve the work performance in a significant way. We know that a customized information system is more expensive than a non-customized one. Therefore this result is important to the buyer company that wishes to further reduce the transaction costs of off-shoring.

Model Robustness Tests

We also test the robustness of our OLS model by log transforming our dependent variable. The result is shown in the second column of Table 3. It is almost the same as the OLS model in terms of the significance of the variables. It does not change the result quantitatively. The log transformation will change the interpretation from unit change to percentage change. For example, column 2 shows that process owner will increase work performance by 2.2%. The average work performance is 0.9, therefore a 2.2% increase roughly equals to 0.0198, almost close to coefficient in the OLS model (0.020). This test applies to all coefficients in the OLS model. We have also used other power transformations including Zero-skewness Box-Cox transformation to retest the model and found similar results and therefore conclude the robustness of our OLS model.

How codifiability affects the effectiveness of governance instruments

Regression results also confirm our hypothesis on process codifiability. Codifiability in general has a positive relationship with work performance. That means, given the same level of monitoring and contracting, a less codifiable process will result in a lower work performance (4% more error rate), which makes a big difference. In additions, we are also interested in how codifiability interacts with monitoring instruments. We expect that when the process is less codifiable, the buyer company's monitoring will be more effective but provider company's monitoring will be less effective because the buyer company has more experience with the services and therefore has greater managerial advantage. We add the interaction terms between codifiability and monitoring (cod_pmon, cod_bmon) into the regression model. Column 3 and 4 in Table 3 shows the results of model with both interaction term (interaction 1) and only interaction term between codifiability and provider's monitoring (interaction 2). The sign of the coefficients has confirmed our hypotheses but unfortunately interaction between codifiability and buyer's monitoring is not statistically significant (with a p-value of 0.122). We keep the interaction term between codifiability and provider's monitoring in the final model which only includes variables which are statistically significant.[2] It shows that the effect of codifiability on the disadvantage of provider's monitoring effort. [3]

The Effectiveness of Close Monitoring

The results in initial test motivated us to do more tests on the managerial advantage of buyer company in improving service performance using real-time monitoring and how the process codifiability will affect its advantage. For this purpose, we were able to find a complete panel data set of 21 processes over 36 time periods (two data points every month)[4]. When we apply panel data regression techniques, we control for omitted variables that differ between processes but are constant over time. We control for *proc_vol* which is the ratio of the volume of process executed during a particular period to the volume of process specified in the SLA. This is another time-variant variable which also has an impact on the work performance. Following is how we constructed this variable.

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[2] For the insignificance of contract instruments, we have also tested the interaction term between codifiability and three contracting instruments. Only inspection cost shows weak significance (with p-value 0.06 and 0.105 on interaction term).

[3] The interpretation of coefficients is more complicated when involving in interaction term. In table 3, the coefficient of provider company's monitoring level looks higher than buyer company's. However, provider company's monitoring also has effect on performance through the interaction term. Since the lowest codifiability in our data is 1, the highest effect of provider company's monitoring is 0.632 – 0.088 = 0.544, which is lower than coefficient of buyer company's monitoring 0.558.

[4] Other processes do not have enough time series data point, so we delete them from the test thereafter.

Process Volume *(proc_vol)*: This variable is a temporal variable. It is the ratio of the volume process executed during a particular period to the volume of process specified in the SLA (usually, this is the volume of work done at the commencement of the contract). For the process, if the volume specified - at the commencement of the contract - in the SLA is given by q_{i0} and the volume of work being performed in the current time period - i^{th} period - is q_{it}, then the process volume V_{it} is given by $V_{it} = \frac{q_{it}}{q_{i0}}$. The empirical model we use for this purpose is:

$$performance = \beta_0 + \beta_1 \times codifiability + \beta_2 \times provider\_mon + \beta_3 \times buyer\_mon + \beta_4 \times proc\_vol + \varepsilon$$

Buyer companies' managerial advantage

From results in Table 4, we confirm that the buyer company has a managerial advantage in monitoring and therefore the effectiveness of the close monitoring.

We ran both fixed-effects and random-effects GLS regression on the panel data, but the results show little difference from the pooled regression. We also ran the GLS regression for each company. All models show a similar result: for the same amount of monitoring, the buyer company's monitoring has a positive effect as high as three times more than the provider company's monitoring.

Table 4: Buyer Company's Managerial Advantage - Panel Data

Variable	Pooled	FE	RE-GLS	Firm1	Frim2	Firm3	Frim4
codifiability	0.004*** (0.001)	-	0.004*** (0.001)	0.003*** (0.005)	0.009*** (0.001)	0.006*** (0.002)	0.003*** (0.001)
prov_mon	0.250*** (0.015)	0.261*** (0.015)	0.258*** (0.015)	0.289*** (0.036)	0.183*** (0.019)	0.294*** (0.024)	0.264*** (0.030)
buyer_mon	0.704*** (0.057)	0.835*** (0.048)	0.804*** (0.047)	1.070*** (0.109)	0.529*** (0.073)	0.657*** (0.101)	0.642*** (0.066)
proc_vol	0.012*** (0.002)	0.014*** (0.002)	0.014*** (0.002)	0.036*** (0.005)	0.021*** (0.004)	0.027*** (0.004)	0.009*** (0.003)
Intercept	0.850*** (0.005)	0.859*** (0.004)	0.844*** (0.006)	0.801*** (0.014)	0.841*** (0.007)	0.817*** (0.012)	0.858*** (0.008)
N	756	756	756	252	180	108	216
F (Prob>F)	136.86 p<0.0001	217.34 p<0.0001					
Wald (Prob>Chi2)			669.55 (<0.0001)	669.55 (<0.0001)	332.72 (<0.0001)	263.47 (<0.0001)	248.16 (<0.0001)
R^2	47.81%	41.66%	47.66%	43.70%	65.53%	71.89%	54.05%

Standard error in parenthesis; *** -p<.001, ** - p<.01, * - p<.05

How does codification affect the effectiveness of close monitoring

It is clear from our analysis that one of the principal drivers of work performance is the extent to which a process and the work that goes into executing the process can be codified and explained analytically to the agents of the provider. The value of codification becomes even greater when the employees of the provider and the buyer are located in different countries. The employees offshore may be unfamiliar with the context of the work, although they may have a high degree of domain skill (such as in financial analysis, molecular biology, or accounting and actuarial services). Therefore, the investments made in transferring process knowledge pay considerable dividends in the form of lower operational risk (and therefore higher process work performance). Indeed, our survey found that companies (both buyers and providers) that invested the most in process specification and knowledge transfer were the ones that reaped the benefits of consistently high work performance of process productions. Companies such as Wipro and HCL in India and Beredium International in Mauritius are examples of companies that invest in detailed process specification (codification).

The fixed-effects model fails to support the effect of codifiability on the effectiveness of monitoring. Lastly, we ran GLS regression on each process and report the results in Table 5.

Table 5: Buyer Company's Managerial Advantage: Process Level

Variable	Proc 1	Proc 2	Proc 3	Proc 4	Proc 5	Proc 6	Proc 7	Proc 8	Proc 9	Proc 10
Codifiability (value)	6	4	3	2	2	7	5	4	3	4
provider_mon	0.365*** (0.039)	0.248*** (0.029)	0.335*** (0.052)	0.425*** (0.101)	0.109*** (0.017)	0.142*** (0.020)	0.318*** (0.039)	0.205*** (0.023)	0.225*** (0.030)	0.258*** (0.047)
buyer_mon	0.684*** (0.140)	0.748*** (0.109)	1.245*** (0.156)	2.09*** (0.316)	0.625*** (0.077)	0.334*** (0.079)	0.647*** (0.170)	0.617*** (0.083)	0.809*** (0.096)	0.694*** (0.204)
proc_vol	0.068*** (0.009)	0.024*** (0.005)	0.046*** (0.006)	0.083*** (0.024)	0.031*** (0.006)	0.019* (0.007)	0.013* (0.006)	0.023** (0.008)	0.037*** (0.008)	0.022*** (0.008)
Intercept	0.787*** (0.016)	0.845*** (0.009)	0.767*** (0.016)	0.710*** (0.035)	0.868*** (0.009)	0.927*** (0.009)	0.865*** (0.011)	0.861*** (0.010)	0.823*** (0.011)	0.854*** (0.012)
T	36	36	36	36	36	36	36	36	36	36
Wald Chi2 (Prob>Chi2)	165.89 (<0.0001)	151.12 (<0.0001)	148.13 (<0.0001)	74 (<0.0001)	137.16 (<0.0001)	79.02 (<0.0001)	92.51 (<0.0001)	155.50 (<0.0001)	162.99 (<0.0001)	59.55 (<0.0001)
Variable	**Proc 11**	**Proc 12**	**Proc 13**	**Proc 14**	**Proc 15**	**Proc 16**	**Proc 17**	**Proc 18**	**Proc 19**	**Proc 20**
Codifiability (value)	6	1	1	5	6	2	1	7	5	3
provider_mon	0.327*** (0.042)	0.223*** (0.059)	0.255*** (0.059)	0.331*** (0.035)	0.458*** (0.067)	0.262*** (0.067)	0.297*** (0.091)	0.109*** (0.026)	0.280*** (0.034)	0.245*** (0.057)
buyer_mon	0.738*** (0.190)	1.242*** (0.171	1.892*** (0.116)	0.907*** (0.183)	1.066*** (0.249)	1.378*** (0.240)	1.551*** (0.199)	0.162*** (0.034)	0.571*** (0.124)	0.997*** (0.166)
proc_vol	0.034*** (0.007)	-0.006 (0.004)	-0.013** (0.006)	0.009** (0.004)	0.011** (0.006)	0.005*** (0.006)	0.033 (0.032)	0.015* (0.003)	0.025** (0.007)	0.033*** (0.005)
Intercept	0.840*** (0.012)	0.872*** (0.014)	0.836*** (0.014)	0.852*** (0.011)	0.851*** (0.015)	0.853*** (0.017)	0.790*** (0.039)	0.927*** (0.007)	0.855*** (0.013)	0.816*** (0.015)
T	36	36	36	36	36	36	36	36	36	36
Wald Chi2 (Prob>Chi2)	116.08 (<0.0001)	65.28 (<0.0001)	286.6 (<0.0001)	114.92 (<0.0001)	68.64 (<0.0001)	48.59 (<0.0001)	71.29 (<0.0001)	66.42 (<0.0001)	100.69 (<0.0001)	89.61 (<0.0001)

Standard error in parenthesis: *** -p<.001, ** - p<.01, * - p<.05

We still find the support for the buyer company's managerial advantage across the process. To make it easier to interpret and compare, we use the concept of Marginal Rate of Substitution (MRS) to represent the buyer company's managerial advantage. We define the MRS as the ratio of the marginal impact on work performance of the buyer's monitoring effort to that of the provider's monitoring effort. For example, if the work performance function is given by: $Q = Q(BM, PM, etc.)$, then

$$MRS = \frac{\frac{\partial Q}{\partial BM}}{\frac{\partial Q}{\partial PM}}$$

In our case,

$$MRS = \beta_3 / \beta_2$$

Table 6 shows the codifiability and the MRS for each process.

Table 6: Codifiability and MRS

Codifiability	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7
MRS	5.57	7.42	5.22	4.92	5.73	5.26	3.72	3.60	4.07	3.02	3.01	2.69	2.03	2.74	2.04	1.87	2.26	2.33	2.35	1.49

We can see this advantage across different processes. The average buyer managerial advantage is 3.56. Furthermore, we can also see the degree of the advantage is different across different processes. By plotting a simple effectiveness frontier (Figure 7) of MRS vs. codifiability, we find that the buyer company's managerial advantage is indeed related to process codifiability. As codifiability decreases, this advantage increases.

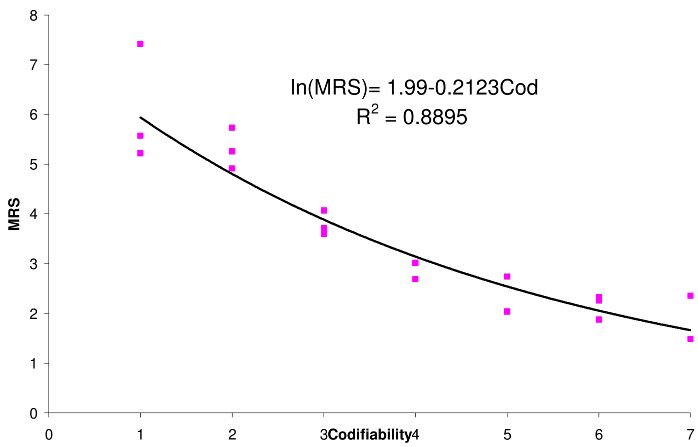

Figure 7: Codifiability and MRS

For a more formal study, we fit the plot using different regressions and find the best fit model is given by:

$$Ln(MRS) = 1.99 - 0.2123Cod$$

The regression results are shown in Table 8.

Table 8: Regression of MRS on Codifiability

Variable	MRS	Ln(MRS)
codifiability	-0.7497^{***} (0.07736)	-0.2123^{***} (0.0176)
Intercept	6.4529^{***} (0.3330)	1.9941^{***} (0.0759)
N	20	20
F (Prob>F)	94.02 p<0.0001	144.91 p<0.0001
Adj R^2	83.04%	88.34%

Standard error in parenthesis; *** -p<.001, ** - p<.01, * - p<.05

The research finding that codifiability affects the buyer company's managerial advantage negatively and in an exponential way could help the buyer company to allocate its resources to real-time monitoring and process specification more efficiently. Monitoring and process specification are substitutes in this sense.

Conclusions and Limitations

A number of interesting managerial implications can be drawn from this paper to help buyers and providers in service off-shoring use different governance instruments more strategically. First, we find that contracting instruments are not as effective as monitoring instruments. A buyer company could have two strategies for this problem. One is to spend even *more* money on *ex post inspection*, to improve measurement and to increase the effectiveness of contracting instruments. Another is to spend *less* on *ex post inspection* and move the investment to more effective instruments such as monitoring. Which one the buyer company should use depends on further study of costs and benefits. Secondly, we find that the buyer company's monitoring is far more effective than the provider company's monitoring. Given this result, the buyer company will favor the close monitoring because it will lead to a higher performance. Interestingly, the provider company will prefer the close monitoring too for the same reason since the buyer company's real-time monitoring actually helps the provider to improve the work performance and therefore the payment from the contract. The key contribution of close monitoring enabled by advanced information and telecommunication technologies is that they reduce the efficiency loss due to the asymmetric information thus improving the total social welfare. Finally, we find that this managerial advantage increases as the codifiability of processes decreases. Therefore, codification and monitoring are substitutes in this sense. As a result, the buyer company could have a balanced monitoring level given different levels of process codification.

It is important to note that this paper only compares the effectiveness of currently used contracting instruments vs. monitoring instruments in the service off-shoring. It is not necessarily valid to say that the contracting instruments are generally not as effective as monitoring instruments. The ineffectiveness of a contracting instrument might result from the noisy measurement of work performance. In addition, the effectiveness in this paper does not equal cost-effectiveness because we only use the quantity or percentage units, not real capital in our model. The reason we use quantity or percentage units is that wage rates and the contract transfer payment are quite different across companies and countries. A quantity or percentage unit will be more generalizable in this sense when applying our results to different companies in different countries.

References

Acemoglu, D. and Verdier, T. 2000. “The choice between market failures and corruption,” *American Economic Review* (90:1), pp.194-211.

Aidt, T. S. 2003. “Economic analysis of corruption: A survey,” *Economic Journal* (113: 491), pp.632-652.

Anderson, E. and Schmittlein, D. 1984. “Integration of the Sales Force: A Empirical Examination,” *RAND Journal of Economics* (15:3), pp. 385-395.

Benshahar, O. 1995. “A Blaming the Victim - Optimal Incentives for Private Precautions against Crime,” *Jounal of Law Economics & Organization* (11:2), pp. 434-455.

Bloch, M., Jans, Ch. 2005. “Reducing Risk in Off-shoring Projects,” McKinsey Quarterly (3), pp.10-11.

Brown, S.A., Dennis, A.R., and Gant, D.B. 2006. "Understanding the Factors Influencing the Value of Person-to-Person Knowledge Sharing", in *Proceedings of 39th Annual Hawaii International Conference on System Sciences,* Track 7, Kauai, Hawaii, January 2006, pp.146b.

Calling a Change in the Outsourcing Market, Deloitte, April 2005.

Cavusoglu, H., Mishra, B., and Raghunathan, S. 2005. “The value of intrusion detection systems in information technology security architecture,” *Information Systems Research* (16:1), pp. 28-46.

Chander, P. and Wilde, L. L. 1998. “A general characterization of optimal income tax enforcement,” *Review of Economic Studies* (65:1), pp.165-183.

Culture Clashes Harm Off-shoring, in *BusinessWeek* Online:*http://www.businessweek.com*, July 17, 2006

Dawes, J. 2008. “Do Data Characteristics Change According to the number of scale points used? An experiment using 5-point, 7-point and 10-point scales,” *International Journal of Market Research* (50:1), pp. 61-77.

Di, T. R. and Schargrodsky, E. 2003. “The role of wages and auditing during a crackdown on corruption in the city of Buenos Aires,” *Journal of Law & Economics* (46:1), pp. 269-292.

Di, T. R. and Schargrodsky, E. 2004. "Do police reduce crime? Estimates using the allocation of police forces after a terrorist attack," *American Economic Review* (94:1), pp. 115-133.

Dye, R.A. and Sridhar, S.S. 2005. "Moral Hazard Severity and Contract Design," *RAND Journal of Economics* (36:1), pp. 78-92.

Fudenberg, D. and Tirole, J. 1990. "Moral Hazard and Renegotiation in Agency contracts," *Econometrica* (58:6), pp.1279-1319.

Grossman, S. and Hart, O. 1983. "An Analysis of the Principal-Agent Problem," *Econometrica* (1:1), pp. 7-46.

Hannan, R. L., Hoffman, V. and Moser, V. D. 2005. "Bonus versus Penalty: Does Contract Frame Affect Employee Effort?" in *Experimental Business Research,* Zwick, R. and Rapoport, A. (Eds.), Springer-Verlag, New York, pp.151-169.

Hart, O. and Moore, J. 1988. "Incomplete Contracts and Renegotiation," *Econometrica* (56:4), pp.755-785.

Hart, O. and Moore, J. 1990. "Property Rights and the Nature of the Company," *The Journal of Political Economy* (98:6), pp.1119-1158.

Holmstrom, B. 1979. "Moral Hazard and Observability," *Bell Journal of Economics* (10:1), pp. 74-91.

Holmstrom, B. 1982. "Moral Hazard in Teams," *Bell Journal of Economics* (13:2), pp. 324-340.

Holmstrom, B. and Milgrom, P. 1991. "Multitask Principal-Agent Analyses: Incentive Contracts, Asst Ownership, and Job Design," *Journal of Law, Economics and Organization* (7:Sp. Iss.), pp.24-52.

Joskow, P. 1988. "Asset Specificity and the Structure of Vertical relationships: Empirical Evidence," *Journal of Law, Economics, and Organization* (4:1), pp. 95-117.

Kaiser, K.M. and Hawk, S. 2004. "Evolution of Off-shore Software Development: From Outsourcing to Cosourcing," *MIS Quarterly Executive* (3:2), pp. 69-81.

Kerr, S. 1975. "On the Folly of Rewarding A, While Hoping for B," *Academy of Management Journal* (18:4), pp.769-783.

Kolstad, C.D., Ulen, T.S., and Johnson, G.V. 1990. "Ex Post Liability for Harm vs. Ex Ante Safety Regulation: Substitutes or Complements?" *American Economic Review* (80:4), September 1990, pp. 888-901.

Luft, J. 1994. "Bonus and penalty incentives: Contract choice by employees." *Journal of Accounting and Economics* (18:2), pp. 181-206.

Mookherjee, D. and Png, I.P.L. 1992. "Monitoring vis-a-vis Investigation in Enforcement of Law," *American Economic Review* (82:3), pp. 556-565.

Oshri, I., Kotlarsky, J., and Willcocks, L. 2007. "Managing Dispersed Expertise in IT Off-shore Outsourcing: Lessons from Tata Consultancy Services," *MIS Quarterly Executive* (6:2), pp. 53-65.

Pfaff, A.S.P. and Sanchirico, C.W. 2000. "Environmental self-auditing: Setting the proper incentives for discovery and correction of environmental harm," *Journal of Law economics & Organization* (16:1), pp. 189-208.

Rogers, E. 1980. *Diffusion of Innovations*, Free Press, New York.

Shavell, S. 1984. "Liability for Harm versus Regulation of Safety," *Journal of Legal Studies* (13:2), pp.357-374.

Winter, S. 1987. "Knowledge and Competence as Strategic Assets," in *The Competitive Challenge – Strategies for Industrial Innovation and Renewal*, Teece, D.J. (Ed.), Ballinger Publishing Company, Cambridge, Massachusetts, pp. 159-184.

Wittman, D. 1977. "Prior Regulation versus Post Liability: The Choice Between Input and Output Monitoring," *Journal of Legal Studies* (6:1), pp. 193-211.

Zander, U. and Kogut, B. 1995. "Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test," *Organization Science* (6:1), pp. 76-92.

Zeithaml, V.A. 1981. "How Consumer Evaluation Processes Differ between Goods and Services", in *Marketing of Services,* Donnelly, J.H, and George, W.R.(Eds), American Marketing Association, Chicago, Illinois, pp. 186-190.