

Quality, Incentives and Inspection Regimes in Offshore Service Production: Theory & Evidence

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The term “offshore outsourcing” (or “offshoring” for short) is widely used these days, particularly in the context of a debate on the trade-off between efficiency gains leading to producer and consumer surplus versus labor losses. The term refers to the phenomenon of firms outsourcing their entire back-office operations to off-shore third party service providers who execute these processes for them. Expert estimates suggest that the off-shore BPO industry will grow from \$123.6 billion in 2001 to over \$230 billion in 2015 [Forrester (2003), Gartner (2004)]. The growth of off-shore outsourcing in recent times has been extraordinary not just in scale (as evidenced by the dollar volume of business) but also in scope: Currently, offshoring includes diverse services requiring a wide range of expertise such as equity research, financial analysis, transaction processing, insurance claims management and underwriting, supply chain coordination and tax accounting.

While there is some research on the trade-offs between *cost* and *quality* in the outsourcing of information systems development, there is little if any, research that investigates the emergent phenomenon of outsourcing of business processes to offshore labor regimes and the attendant trade-offs that buyers and suppliers face between monitoring of work, inspection of output, wage arbitrage gains and the extent of control that managers can exert across the boundaries of the firm.

Two issues are critical in determining the quality of service of offshore providers: *Monitoring* (supervision to measure adherence to prescribed quality standards and performance metrics, and enforce these standards) and *Incentives* (to ensure that service providers make the right investments and trade-offs in meeting customer requirements). In a service supply chain, unlike in the production of physical goods, the production and distribution of purely information goods involves just the flow of digitized information.

Our study of offshoring of services was two-pronged: First, we studied the process production of four firms (recognized as leading offshore service providers) in three countries, and gathered data through both survey instruments and by capturing the parameters of the contract (discussed in greater detail in the empirical section). One of the unusual features of the offshoring environment in services is the wide variance in the way incentives and penalties are structured into the contract. Unlike in the case of most physical products where the cost of inspecting the buyer’s quality is a fraction of the cost of production of goods, in the case of services, the cost of inspecting a unit volume of output could be

as high as the cost of producing¹ that output. As a result buyers reserved the right to inspect the finished output or not. While the quantum of incentives and penalties were pre-specified in the contract the extent of inspection by the buyer of the supplier's output was not. This resulted in a form of contract where buyer would announce the fraction of output to be inspected *ex-ante* production (at the start of each period) or *ex-post* production (at the end of the period²).

Our objectives in this research are two-fold. Firstly, based on a wide-ranging study of around 72 processes across four offshore supplier firms, we develop a theoretical model of the contractual structures observed in practice between a buyer/customer and an offshore supplier. We observe three key control variables used in practice (and implemented as part of the terms of contract) by firms offshoring processes, to monitor quality and implement performance controls. These are: (i) *Inspection of output at the transaction (process) level*, to measure quality; (ii) *Performance-based incentives* for meeting quality targets; and (iii) *Penalties* for losses due to suppliers' errors. Associated with the inspection is a *Inspection Proportion*, which measures the fraction of transactions scrutinized by the buyer. The advantages of preemptive commitment to an inspection proportion are obvious. In the context of a 'game' between supplier and buyer, such a commitment makes the threat of inspection credible, and further, gives the buyer an 'early-mover' advantage *à la* Stackelberg. Thus, the buyer can influence the quality levels (and measures) put in place by the supplier for his processes. On the other hand, when inspection is costly, the buyer may be able to shave inspection costs by not pre-committing to an inspection proportion; also, he retains a further element of surprise by varying the actual inspection proportion. Our game-theoretic model captures the roles of incentives, penalties and inspection proportions in a contract between a buyer and a supplier. Further, we develop two models that differ only in respect to their *compliance regimes*, reflecting the two popular implementations of inspection discussed above. In the *preemptive compliance regime*, the inspection proportion is specified *ex-ante* by the buyer, in the terms of the contract. In the *reactive compliance regime*, the buyer sets an inspection proportion *ex-post* (after the supplier delivers output). We derive the values of the incentives, inspection proportions and supplier quality levels in closed form, in the equilibria arising in each compliance regime. We compare their values, and study the drivers of these parameters. We also derive and compare the supplier's and buyer's expected profits under each regime. Since the model reflects the state of praxis, we are in a position to compare the predictions of the model against data gathered from field research and test the extent to which there is empirical support for the predictions of the model.

¹It is worth noting that inspecting the finished output of a service such as equity research, cash flow forecasts or tax accounting requires that the agent that inspects it re-do most of the original tasks that went into creating the output.

²A period usually constituted a quarter and in some cases six months (biannual production periods).

1 Models Of Compliance Regimes

An offshore supplier (provider) and a buyer (client) enter into a contract for the execution of business processes offshore. The value received by the buyer from his end customers by delivering a unit of service of adequate quality is V . He pays the supplier a transfer given by P ($< V$) for each unit of service delivered. The supplier can set his quality/effort level $\theta \in [0, 1]$, which is observable by both parties but not contractible, for reasons that will be discussed in the main paper. The service provided meets the quality threshold with probability θ , and fails to do so with probability $(1 - \theta)$. Thus, the buyer will obtain an expected revenue of $V \cdot \theta$, by sourcing a unit of service of quality θ from the supplier. The supplier's cost of producing a unit of the product is convex in the quality parameter θ .

The buyer has a choice of inspecting the output to determine the exact quality, at a unit cost $I \approx c$ and where f is the inspection proportion ($0 \leq f \leq 1$), set by the buyer. If a unit of service is inspected and found to be error-free, an incentive payment of λ is made by the buyer to the supplier. However, if the service or process is found to be defective, the supplier compensates the buyer to the tune of his lost gross margins, viz., $(V - P)$. *A key difference between conventional principal agent contracting models and our model is that when the buyer chooses not to inspect processes, there are neither incentives nor penalties levied.* Thus there is a *neutral inspection state* where no assumptions about quality is made by either party to the contract.

1.1 Preemptive Compliance Regime: Equilibrium Characteristics

The preemptive commitment regime has the following timeline. First, the buyer specifies λ and f contractually, the supplier responds by setting his quality/effort level θ ($\in [0, 1]$). Finally, the buyer can choose to inspect each unit of the output at the unit inspection cost I . If the output is defective, the buyer is compensated by the supplier for lost revenues (given by $(V - P)$) and if it is found to be error-free, the supplier is paid the additional bonus λ , in addition to P .

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Theorem 1 *Consider the following game, wherein the buyer first picks λ (≥ 0) and $f \in [0, 1]$, and the supplier then sets his process quality θ , also $\in [0, 1]$.*

1. *The unique subgame-perfect equilibrium for the entire game is given by:*

$$\begin{cases} f^* = \frac{2c}{V}, \lambda^* = 0 \text{ and } \theta^* = 1, & \text{when } \frac{V}{2c} > 1 + \frac{I}{V}; \\ f^* = \frac{1}{2} + \frac{c}{V} - \frac{cI}{V^2}, \lambda^* = 0 \text{ and } \theta^* = \frac{1}{2} + \frac{V}{4c} - \frac{I}{2V}, & \text{otherwise.} \end{cases}$$

2. The buyer's profits in equilibrium are:

$$\pi_B = \begin{cases} V - \frac{2cI}{V} - P, & \text{when } \frac{V}{2c} > 1 + \frac{I}{V}; \\ \frac{V^2}{8c} + \frac{V-I}{2} + \frac{c}{2} \cdot \left(1 - \frac{I}{V}\right)^2 - P, & \text{otherwise.} \end{cases}$$

The supplier's profits in equilibrium are:

$$\pi_S = \begin{cases} P - c, & \text{when } \frac{V}{2c} > 1 + \frac{I}{V}; \\ P - c \cdot \left(\frac{1}{2} + \frac{V}{4c} - \frac{I}{2V}\right) \cdot \left(\frac{3}{2} - \frac{V}{4c} + \frac{I}{2V}\right), & \text{otherwise.} \end{cases}$$

1.2 Reactive Compliance Regime: Equilibrium Characteristics

The problem structure is identical to the Preemptive Compliance regime, but the timeline differs in one crucial aspect. The buyer specifies λ early, as before, but not f , the proportion of inspection. The supplier sets his quality/effort level θ in response to λ , *anticipating* f . Then the buyer, having observed θ , tailors his choice of inspection level f to maximize his own profits. The solution to this game is by backward induction.

Theorem 2 Consider the following game, wherein the buyer first picks λ (≥ 0), the supplier then sets his process quality $\theta \in [0,1]$, and finally, the buyer sets his inspection proportion f , also $\in [0,1]$.

1. The unique subgame-perfect equilibrium for the entire game is: $\lambda^* = f^* = 0$, and $\theta^* = 1 - \frac{I}{V}$.
2. Correspondingly, the buyer's profits are $\pi_B = V - P - I$ and the supplier's profits are $\pi_S = P - c \cdot \left(1 - \frac{I}{V}\right)^2$.

1.3 Comparisons of Compliance Regimes: Theoretical

In this Section, we compare (theoretically) the equilibria and profits under the two compliance regimes. Subsequently, we will compare these results to the results that obtain from field research.

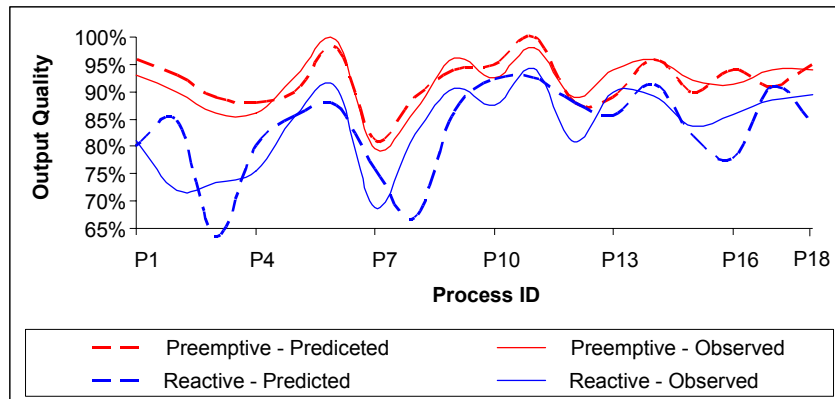
Proposition 3 The Preemptive compliance regime always leads to strictly superior output quality than the Reactive compliance regime.

Proposition 4 In both the Preemptive and the Reactive compliance regimes, the optimal quality-inducing incentives are always zero.

We tested the findings of the model against empirical evidence gathered from field research and highlight some of our findings below.

1.4 Comparisons of Compliance Regimes: Empirical Analysis

We studied 72 processes produced by four firms in three countries over a period of 15 months. We collected both longitudinal data from the *Production Logs* of the firms and cross sectional data - the parameters of *Contract Structures*. We inspected the production log to capture aspects of output quality such as error rates, proportion of output inspected and the volume and costs of production. We studied the contract structures for each process to capture the *incentives* for quality, *penalties* associated with sub-standard quality and the *price* (transfer) paid by the buyer. We grouped the processes into three regimes - Preemptive Compliance Regime, Reactive Compliance Regime and processes that changed from one compliance regime to another. Figure 1 below compares the quality of 36 processes (18 x 2) that differ only in the compliance regime. The dotted lines provide a trendline of theoretical values predicted by the model while the solid lines are of actual observed values. It can be seen that the model's predictions are borne out in practice in that the Preemptive Regime produces consistently higher quality than the Reactive Regime. Secondly, it can be also seen that actual predicted quality values in both regimes are reasonably close approximations of the observed quality values.



We will regress the quality of output against contract parameters as well as the variable parameters (inspection proportion) and construct an econometric model that explains the quality variance. We will investigate the extent to which incentives and penalties actually impact on output quality. Finally, we will investigate if there are interactive effects between the extent of inspection and the quantum of penalties. We will contrast the theoretical findings with the empirical model and explain the divergence if any, between the two.