Contracts in Offshore Software Development: An Empirical Analysis

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Abstract

In this paper we study the determinants of contract choice in offshore software projects and examine how the choice of contract and other factors in the software project affect project profits to the software vendor. Using data collected on 93 offshore projects from a leading Indian software vendor, we provide evidence that specific vendor, client and project related characteristics such as requirement uncertainty, project team size and resource shortage significantly explain contract choice in these projects. Our analysis of the project profit determinants suggests that contract choice significantly determines project profit. Additionally, some *ex-ante* vendor, client and project related characteristics known at the time of choosing the contract continue to significantly influence project profits after controlling for contract choice. We also provide evidence to show that project duration and team size affect project profits.

1. Introduction

Offshore software development has seen tremendous growth in the last few years. This particular kind of outsourcing occurs when the contracting parties are in different countries and the software is developed in the developer's country and then shipped to the buyer's organization. Spurred by the trend toward globalization in the business world, countries like India, Ireland and Israel have seen an impressive growth in their software industries. Offshore software development also poses significant challenges because lack of proximity hampers a client's ability to monitor its vendors and coordinate development activities closely. Therefore, viability and profitability of vendor-client relationships depend crucially on the efficacy of contractual arrangements both parties agree to at the outset [Lacity and Willcocks, 1998].

In this paper, we conduct an empirical investigation of the determinants of offshore contractual arrangements, and the manner in which contract choice affects project performance. Our research site is a leading Indian software developer with an extensive network of clients in Asia, Europe and North America. The size of the Indian software industry is $8.1 Billion in 2002 and was approximately $1.6 Billion in 1995-1996 when the data for this paper was collected. Most of the revenue comes from turnkey development and maintenance projects under different contractual arrangements, ranging from individual contracts for individual projects to long-term (10-year) contracts for dedicated offshore centers. The majority of the development projects in 1995-1996 were individual contracts negotiated between client and vendor teams. The size of the Indian industry, the offshore setting and the availability of relevant data provide a unique

opportunity to study contracts in this market. Although the context in this paper is offshore contracts, we believe that the basic framework and variables used can be extended to domestic outsourcing contracts as well.

Theoretically, in a world of complete information, it does not matter which type of contract is chosen; parameters of different types of contracts can always be chosen to make them ex ante welfare-equivalent. However, most real-world settings are characterized by incomplete information [Hart and Moore, 1988]; the software context is no exception. It seems unreasonable to assume that the contracting parties can foresee all future contingencies at the time of contracting. All else being the same, a risk-averse agent would prefer a contract that shields him from risk ex post to a contract that does not adequately compensate for risk ex ante because of incomplete information.

In the software context, analyzing how contracts are formed, and the extent to which contracts account for risks and uncertainties, is important in understanding the dynamics behind what drives project success. A recent survey of contract choices in franchise decisions by Lafontaine and Slade [2001] shows that the contract theory of risk and incentives is not supported by empirical studies of contracts in various industries, and stress the need for both theoretical models and empirical studies to better understand real-world contracts. Since offshore software development involves contracting between parties from different economies in differing political and cultural climates, it provides a unique opportunity in this regard.

Based on this motivation, we examine the adoption of the two prevalent forms of contracting in the software industry – fixed price contracts and time and materials contracts. Under a fixed price contract, the vendor bears all the major portion of the development risk. Under a time and materials contract, the client bears the major portion of the development risk. While a risk-neutral vendor would be indifferent between these contractual forms, a risk-averse vendor (client) would prefer a time and materials (fixed price) contract, all else equal. A testable implication of this premise is that with a risk-averse vendor, the preference for a time and materials contract is increasing in task uncertainty. In this paper, we test this implication using a dataset containing details of a single software vendor's contractual arrangements with 93

offshore clients.[1,2] We identify a set of vendor-, client-, and project-related characteristics that could potentially explain the choice of the contractual form.

Our contributions are threefold. First, our paper is one of the first attempts to empirically study the determinants of contract choice in the software industry. Although there is some discussion of the importance of outsourcing contracts in the trade press [King and Hoffman, 1998; Binstock, 1999], extant literature offers little by way of empirical research in this area. While there has been some research in describing outsourcing contracts [Lacity and Willcocks, 1998; Fitzgerald and Willcocks, 1996] and some theoretical contributions [Whang, 1992; Richmond et al, 1992], these papers do not provide insight into when a particular contractual form would prevail. Second, our paper builds on the growing body of research on the Indian offshore software industry [Arora et al, 1999; Banerjee and Duflo, 2000]. Although this literature focuses on industry-wide practices and business issues, little work has been conducted at the project or organization level. This paper fills this gap in the literature by analyzing contracts at the project level.

Finally, we address the linkage between contract choice and profits to the vendor in a project and identify other software engineering performance variables that determine project profits in offshore software projects. The sequential analysis of contract choice followed by project profit model also enables us to test the efficiency of contract choice with respect to the information available to both parties before contract is chosen. Although project performance has been measured in terms of costs, schedules and quality metrics in past research [Krishnan et al., 2001; Gopal et al, 2002], as per our knowledge, this is the first time absolute project profits has been used to characterize project performance.

Based on data collected from 93 offshore projects at a leading Indian software vendor, our results indicate that specific vendor-, client- and project-related characteristics significantly explain contract choice in these projects. We find that higher requirements uncertainty in the project, shortage in the skilled human resources for the specific platform and domain of the project and number of prior projects completed by the vendor increases the likelihood of a time and materials contract choice which guards the vendor from risk. We also find that after

[1] We thank an anonymous referee for suggesting a shift in emphasis from risk aversion to task uncertainty, especially given that our sample pertains to just one software vendor.

controlling for all other factors, a mature internal MIS department at the client site and size of the client increases the likelihood of fixed price contract. Our analysis of the project profit determinants provides evidence in support of the inefficiency of contract choice with respect to the given information. We find that contract choice significantly determines project profit and interestingly, some *ex-ante* vendor-, client- and project-related characteristics known at the time of choosing the contract continue to significantly influence project profits. In addition we find that increase in some software engineering performance variables such as project duration and people turnover during projects are associated with decrease in project profits.

The rest of the paper is organized as follows. In the next section, we develop our research hypotheses pertaining to contract choice. In section 3, we describe the data collection methodology and the variables used to test our hypotheses pertaining to contract choice. In section 4 we describe our data analysis while we discuss the results from our contract choice model in section 5. In section 6, we present a model on project profits to test the validity of our operating assumptions and identify other drivers of project performance. In section 7 we present analysis of our model on project profits and discuss our findings from this analysis. The final section concludes the paper with directions for future research.

2. Research Hypotheses

Contracts found in the offshore software development area can be broadly classified into two categories - Fixed Price contracts and Time and Material contracts [Banerjee and Duflo, 2000; Gopalakrishnan et al, 1996].[3] Banerjee and Duflo [2000] show that in a market characterized by highly uncertain reputations of clients and vendors, these two contractual types strictly dominate other mixed or hybrid contractual types. Other arrangements that exist are variations of these two broad types. Fixed Price contracts include a fixed fee for the software that is negotiated before the start of the project. The vendor bears the major part of the risk in this case since the actual fee for the project is fixed. In a Time and Materials contract, the vendor contracts out his services at a certain rate. The vendor bills the client at the end of every billing cycle for the time and materials used in the project at the agreed upon rate. This contract type reduces the vendor's risk

[2] In testing this implication, we are implicitly assuming that the vendor is risk-averse. While lack of support to the hypothesized association between task uncertainty and the choice of the contract form is inconclusive, evidence supporting this association would validate this assumption.
[3] See Figure 1 for a timeline of events in a typical offshore development project.

since he is insured against most cost and schedule over-runs, which are billed to the vendor. The client is responsible for monitoring progress on the project and thus bears the cost of over-runs.

In developing testable implications regarding contract choice, we assume that the decision-makers for the client and the vendor are risk-averse. Most Indian vendors are much smaller financially than their European or North American clients and therefore, the financial burden of a terminated contract is considerable. In addition, the decision-makers for both the vendor and the client are aware of a loss of personal reputation in the case of terminated or unsuccessful projects. From the client side, non-delivery of the required software could result in loss of revenues and time. We categorize the factors of interest in the following manner to facilitate discussion and clarity.

Software development risks

Software development is an inherently uncertain process. Software development risks adversely affect the development and delivery of software systems and increase task uncertainty. Software risk assessment is an important part of software project management and some research has been done in suggesting analytical methods of risk assessment in software projects [Pressman, 1992]. In past work, Barki et al [1993] identify requirements uncertainty and project size as significant variables that characterize risk in a software project. Thus, projects that are large and projects with greater requirements uncertainty pose greater risks and task uncertainty. As a result, we would expect a risk-averse vendor to prefer time and material contracts in such cases. There is some evidence to this effect in the context of procurement contracts in the construction industry. Bajari and Tadelis [2001] show that simple projects with high levels of design completeness will be procured using fixed price contracts. Alternatively, more complex projects with low levels of design completeness will be procured using cost-plus (i.e. time and materials in our context) contracts [Bajari and Tadelis, 2001]. Following the same argument, we propose the following hypotheses.

Hypothesis 1: Increased perceived requirements uncertainty is associated with a higher probability of a Time and Materials contract.

Hypothesis 2: Larger projects are associated with a higher probability of a Time and Materials contract.

The importance of people in software development activities has also been stressed in past research [Krishnan et al., 2000; Barki et al., 1993, Gopal et al. 2002]. The lack of trained software engineers is a major problem in most software companies and this is particularly so in the Indian context [Nidomolu and Goodman, 1993]. Attrition in the software industry remains high as the market for software engineers continues to present attractive prospects for trained personnel. Projects requiring specific training impose even greater risk because training costs are often not recovered. The importance of trained personnel is stressed in most prior research that discusses the determinants of successful software outsourcing [McFarlan and Nolan, 1995; Lacity and Hirschheim, 1993]. The availability of trained personnel to work on a project is therefore a risk that adversely affects task uncertainty, leading us to the following hypothesis.

Hypothesis 3: Higher perceived risk of availability of trained personnel is associated with a higher probability of a Time and Materials contract.

Client knowledge set

In any outsourcing arrangement, the role of the client cannot be overlooked. Anecdotal evidence of the importance of client knowledge and competence in managing the software development activity has been discussed by McFarlan and Nolan [1995] and Lacity and Hirshheim [1993] in detail. We try to capture certain aspects of the client's knowledge set and evaluate their impact on the contract type chosen and subsequent project profitability.

In the transaction costs literature, it is well established that the ability to foresee future contingencies reduces transactions costs and improves contracting efficiencies [Williamson [1979]. Clients with greater experience in handling offshore outsourcing contracts can be expected to have greater ability to specify contractual terms more precisely, which mitigates task uncertainty from the vendor's point of view. Consequently, the vendor may be more inclined to accept a fixed price contract since the overall risk profile of the project is reduced. Additionally, more experienced clients are, all else being equal, potential repeat customers. Therefore, there are incentives for the vendor to accept a fixed price contract for the current project.

In a similar vein, agency theory suggests that effective monitoring reduces agency costs in contractual arrangements [Jensen and Meckling, 1976]. In professionally managed firms characterized by separation of ownership from control, agency theory posits that the management can reduce financing costs by submitting itself to monitoring. In our context, effective monitoring reduces task uncertainty. If the client's MIS department is experienced,

system specifications tend to be more precise and well defined, and monitoring the vendor would be more efficient and less expensive. This in turn reduces the level of uncertainty for the vendor in meeting the client's requirements. Lacity et al [1995] state that in order to ensure success in an outsourcing relationship, it is important that the client's team or MIS department be experienced and capable. Therefore, we propose the following hypotheses.

Hypothesis 4: Perceptions of higher client MIS experience are associated with higher probabilities of a Fixed Price contract.

Hypothesis 5: Perceptions of higher client experience with outsourcing are associated with higher probabilities of a Fixed Price contract.

Bargaining power

The contract choice depends on the relative bargaining power of the two parties. Given our earlier premise that both the client and the vendor are risk-averse on the margin, each party would prefer a contract form that would shield them from the risks inherent in the contractual arrangement, all else being equal. In our context, the client would prefer a fixed price contract that transfers the risk to the vendor, and the vendor would prefer a time and materials contract. Bargaining power weakens the association between task uncertainty and contract choice. A vendor with considerable bargaining power would be better able to negotiate a time and materials contract independent of the level of task uncertainty, while a vendor with less bargaining power may have to settle for a fixed price contract more often than not. Thus, in assessing the impact of task uncertainty on contract choice, we hypothesize and control for the role of bargaining power. Bargaining power has explicitly been studied in other settings such as crop-sharing contracts in agriculture [Bell and Zusman, 1976] and natural resource development contracts between governments and MNCs [Anandalingam, 1987]. Studying the role of some bargaining power variables in this setting will improve our understanding of how these factors affect contract choice.

Some common indicators of bargaining power in our context include the reputation of the parties, future business potential and the relative size of the parties [McFarlan and Nolan, 1995; Bannerjee and Duflo, 2000]. The reputation of the client increases the client's bargaining power and can be leveraged by the client during the contracting process. Similarly, the possibility of future business with the client can also increase the client's bargaining power. Size of the client relative to the vendor is an important variable that has been studied in other outsourcing contexts

and strongly increases client's bargaining power [Mjoen and Tallman, 1997; Yan and Gray, 1994].

A variable that can arguably reduce the client's bargaining power is the importance of the project to the client. The more important the project is to the client, the lesser the client will be using her bargaining power during negotiations. Clearly, vendor reputation and size are also important variables; however, we have data from only one vendor. Based on these arguments, we propose the following hypotheses.

Hypothesis 6: Perceptions of higher client reputation are associated with higher probabilities of a Fixed Price contract.

Hypothesis 7: Perceptions of higher future business potential are associated with higher probabilities of a Fixed Price contract.

Hypothesis 8: Larger clients are associated with higher probabilities of a Fixed Price contract.

Hypothesis 9: Perceptions of greater project importance to the client are associated with higher probabilities of a Time and Materials contract.

Market conditions

Competition in the offshore software industry provides the client with an alternative, thereby preventing the vendor from locking in the customer [Lacity and Hirschheim, 1993]. Williamson [1979] discusses the effects of having alternative suppliers on the contracts formed and the transaction costs. Thus, the presence of competition reduces the vendor's bargaining power. On the other hand, if the vendor has already completed several projects for the client and has an established relationship, then the transactions costs of switching to an alternative vendor can be an issue for the client. All the hypotheses are summarized in Table 1.

Hypothesis 10: Perceptions of greater competition will be associated with higher probabilities of a Fixed Price contract.

Hypothesis 11: A higher number of projects completed by the vendor for the client will be associated with higher probabilities of a Time and Materials contract.

3 Methodology and Data Collection

3.1 Research Site

The data for this paper was collected on 93 projects completed by a leading offshore software developer in India. The firm employs around 5000 people with its primary area of expertise being software development and maintenance of business systems. It has five primary development centers in India and offices in Europe, USA and Japan. The data for this paper was collected on individual projects completed between 1995 and 1997. The data collection instrument used was a questionnaire that was developed after discussions with the senior management at the research site and was pretested before administration to project personnel.

The questionnaires were not administered at the point of contracting. In some cases, the project was in development during questionnaire administration and in others, the project was close to completion. To minimize recall bias, data for different aspects of the project was sought from different persons and in certain cases, two or more people answered the same questionnaire items for the same project independently. In cases where there was a clear gap between the two responses to questionnaire items, the project was dropped from the analysis. The respective project managers provided the project-specific details and the marketing or business unit manager in charge of that client provided the client and contract-specific information. The perceptual information was gathered through the questionnaire and the project information was extracted from the company database. The sample consists of 55 Time and Materials and 38 Fixed Price contracts. The projects in the sample were completed for 32 clients, with the highest number of projects for a client being 4. 10 projects were maintenance, 34 were development and 49 were re-engineering projects.

3.2 Variable Descriptions

The data for this study were tested for reliability and principal component analysis was used to identify patterns within the individual questionnaire items based on prior theory. In order to ensure validity, wherever possible, we created several questionnaire items for each of the perceptual variables. Using multiple items for a variable increases the validity of the variable and it is also possible to assess the reliability of the measurement. To assess reliability of the multiple-item factors, we calculated Cronbach's alpha for each of these factors. In general, the items had good reliability scores between 0.70 and 0.90, as shown in Table 3.

Most of the variables using multiple questionnaire items were taken from previous work in software outsourcing and software development [Barki et al, 1993; Nidomolu, 1995]. Therefore, confirmatory factor analysis (principal components) was performed on these questionnaire items prior to subsequent use[4]. The principal components were calculated and used in subsequent analysis rather than the individual items to conserve the degrees of freedom. The principal components used were thus a smaller set of factors capturing the maximum possible variance in the original set of questionnaire items. We build on prior research that has used these techniques to build smaller sets of more coherent variables for subsequent analysis [Krishnan et al., 2001].

Amongst the variables studied, new measures were created for two variables (Client Experience and Client MIS Experience) based on descriptions of these factors in Lacity and Hirshheim [1993] and discussions with project managers at the research sites. These two multi-item variables however showed good validity and reliability measures. The Human Resources variables were adapted from previous research [Gopal et al., 2002]. No factor analysis was performed on single item variables or binary variables. Three of our measures (Future Business, Project Importance and Client Reputation) are single-item and are therefore potentially susceptible to measurement problems. The questionnaire items and their antecedents are discussed in Table 2.The factor loadings of the principal components analysis are shown in Table 3. The summary statistics for all variables are shown in Table 4.

3.3 Data Analysis

We hypothesized that the contract choice is a function of information that is available to the parties during the contracting stage. In order to test our hypotheses, we use regression analysis. Since the dependent variable Contract is binary, we cannot use ordinary least squares since OLS estimates are inefficient and cannot be restricted to the [0,1] interval. Therefore we use a Probit regression specification to test our hypotheses.

$$\text{Contract } C = \boldsymbol{f}(X'\beta) + u \qquad (1)$$

Where C = 0 if Time and Materials, 1 if Fixed Price

The information variables are used to estimate the probability of a Time and Materials or Fixed Price contract. The model being estimated is the following:

$$\textit{Contract} = \boldsymbol{f}(\textit{Effort, Req\_Un, HRR\_Tr, Cl\_Exp, Mis\_Exp, Reputation, Future,} \qquad (2)$$

[4] Some of the items are reverse-scored and were reversed before being used in analysis. Also, some of the variables used have single question items and therefore do not have factor loadings in Table 3.

Cl_Size, Proj_Imp, Compet_Off, Compet_Local, Prior, P_type)

The Contract variable is 1 when the contract is a Fixed Price contract and 0 when Time and Materials. Since effort and client size are interval variables and are very large compared to the other variables, we standardize these variables. The Probit specification was estimated using maximum likelihood and the results are shown in Table 5. The expected signs for the various coefficients are shown in Table 6. Note that since project type is used as a control variable, we do not specify any expectation for the sign of this coefficient.

4. Results and Discussion

Referring to the estimation results in Table 5, the over-all model fit is good with a statistically significant chi-square of 57.46 (p-value < 0.01). The correlation between the predicted contract type and the actual chosen contract type is around 0.90, again indicating a good model fit.

We receive support for our hypotheses of task uncertainty on contract choice. Our analysis indicates that projects with higher requirements uncertainty are associated with time and materials contracts since the vendor faces considerable risk from changing requirements. Similarly, larger projects in terms of effort are associated with time and materials contracts. As mentioned before, project size is an extremely strong variable in software engineering and therefore is an important part of the contracting parties' decision-making process. Moreover, cost and schedule models show that estimation error is higher in larger projects. This is because the complexity of size increases the degree of task uncertainty, thus making the outcomes of the project riskier [Jones, 1994]. Our results also indicate that projects involving considerable risk of getting and retaining trained personnel are associated with a time and materials contract.

The two hypotheses regarding the client knowledge set receive mixed support. Hypothesis 4 regarding the client MIS department experience receives strong support while Hypothesis 5 is not supported. The presence of a strong client MIS department reduces the risk for the vendor in the outsourcing relationship, as indicated by Lacity et al [1995]. Therefore, the vendor is more amenable to accepting a Fixed Price contract. An experienced client MIS department also increases the bargaining power of the client by providing her with an alternative - to keep the software development in-house. It may be argued that a strong MIS department would encourage the client to accept a Time and Materials contract since it can manage the outsourced project

efficiently. However, we believe this would not be true since the co-ordination and transaction costs of managing a project would outweigh the potential savings from outsourcing offshore. Our discussions with the project managers at the research site support this reasoning, indicating that a capable MIS department would rather keep the project in-house than outsource offshore and incur the costs of managing the project from remote.

Hypothesis 5 that relates client experience with outsourcing is not supported in our results. This variable exhibited low variance in our sample, indicating that there was little difference in the outsourcing experience levels amongst the clients. Managers at the research site confirmed that clients in our data did not have much prior experience in offshore outsourcing. The insignificance of the coefficient can be attributed to low variance in the independent variable.

Hypotheses 6 through 9 pertain to bargaining power and specify conditions under which the client would accept one contract type over another. Of these four hypotheses, 2 are supported in our analysis. Hypotheses 6 and 7 are not supported. Hypothesis 6 pertains to client reputation and Hypothesis 7 pertains to future business. Although discussions with project managers indicated that these variables were influential in their decision-making, we do not see a significant result. It is possible that since both variables were single item measures, there is significant measurement error in these constructs. In addition, these two questions may also be measuring the same underlying phenomenon.

Hypothesis 8 is supported and pertains to the client size variable. The results show that larger clients are associated with a higher probability of a Fixed Price contract. The size of the firm increases the client's bargaining power and also indicates to the vendor a strong possibility of future business. Therefore, the vendor can be induced into accept a Fixed Price contract. Hypothesis 9, which refers to the importance of the project to the client, is also supported and in the direction expected. We had hypothesized that the importance of the project to the client organization would reduce the client's bargaining power. Therefore, an increase in this variable would be associated with an increasing probability of a Time and Materials contract. The client might also prefer a Time and Materials contract since it can control the development process of important projects.

Hypothesis 10, pertaining to the presence of competition, receives mixed support in our analysis. The coefficients for both client-country competition and vendor-country competition are statistically significant although the coefficient for vendor-country competition is in the

opposite direction. The coefficient for client-country competition is in the expected direction. Thus, the presence of alternative developers in the client country, by reducing the bargaining power of the vendor, is associated with an increase the probability of a Fixed Price contract. The coefficient for vendor-country competition is opposite to our expectation and is significant. The presence of other vendors in India increases the probability of Times and Materials contracts.

We propose the following reason for this finding. All software vendors in India operate at approximately the same margins and costs. This reduces the influence of costs alone as the deciding factor between different Indian firms. Therefore, the choice between different vendors falls on past performance or reputation. The firm with the highest reputation and quality is able to leverage this factor and in effect, increase its bargaining power. Banerjee and Duflo [2000] confirm the influence of reputation in the Indian software industry. Thus, an increase in vendor-country competition indirectly increases the bargaining power of the vendor. This could be particularly true in our sample since our research site is a market leader in the Indian industry. Additionally, the fact that two single-item measures were used to characterize competition in this setting could lead to the ambiguous results. More research is required in creating valid measures for competition in the offshore market.

The final hypothesis pertains to the number of prior projects completed by the vendor for the same client and receives strong support. An increase in the number of prior projects tends to increase the bargaining power of the vendor since this leads to a lock-in effect. The client would prefer to contract again with the same vendor rather than incur the transaction costs of finding another vendor. It may be argued that the vendor too is locked into the relationship with the client and there should be a reduction in his bargaining power too. However, it may be argued that the domain and firm specific business knowledge gained by the vendor may increase the likelihood of time and materials contract. In addition, in the Indian software context in 1995, trust was an important factor in the client's decision-making since the offshore market was perceived as being risky. Therefore, the client would be more amenable to a Time and Materials contract in repeat projects since the trust factor is higher.

5. Tests of Contract Efficiency - Framework

The results of the previous section established that a set of vendor-specific task uncertainty factors and client-specific characteristics help explain contract choice. These results underscore

the incompleteness in the contracting environment. Our sample also presents us with a unique opportunity to test the efficiency of offshore contracts, which we present in this section.

It is important to recognize that an incomplete contract need not be inefficient with respect to available information at the time of contracting. While incompleteness may result in one contractual form being preferred over another in particular settings, the chosen arrangement should fully and efficiently incorporate all information available to the two negotiating parties at the time of contracting. Efficiency requires that the client fully understand the vendor's skill set, competition in the vendor's market, the vendor's technological risks and so forth, and be able to negotiate appropriately. Efficiency also requires that the vendor fully understand the client's negotiating power, monitoring ability in negotiating the contract as well.

If the parameters of the contract are chosen efficiently, any deviation of the actual performance under the contract from expected performance should only be a function of contingencies that were unanticipated; there should be no systematic and predictable association between realized performance under the contract and information upon which the contract is based. Any such association is indicative of (i) the inability of the contracting parties to fully comprehend the relevance of available information for contracting, and (ii) possible information asymmetries between the contracting parties, which could be potentially exploited by one of the contracting parties.

To formalize these arguments, let C be the type of contract chosen. Let

$EP = f(C, I_c)$,

where EP = expected profit, C = contract type and I_c = information available during the contracting period.

Contract efficiency implies that the contract choice incorporates all available information known at the time of contracting. If the contracts were chosen efficiently with respect to the information variables I_c, then any deviation of the realized profit from the expected profit should be random, and should not be systematically related to these variables over a cross-section of projects. Let

$$RP = EP + e \quad (3)$$

Where RP = Realized Profit and e = random error term. Substituting for EP, we get

$$RP = f(C, I_c) + e \quad (4)$$

Expanding this equation and assuming a linear specification, we get the following.

$$RP = \alpha_0 + \alpha_1 C + \alpha_2 I_c + e \quad (5)$$

Given the results of the previous section, we would expect α_1 to be non-zero. In particular, if the Vendor's profits were to be higher under the preferred Time and Material contracts, we expect $\alpha_1 < 0$. Note that failure to reject the null in this case does not necessarily imply that the vendor is indifferent between the contract types. Such a conclusion would conflict with the evidence we see in the first part of this paper, i.e. where the contract choice was modeled. Therefore, failure to reject the null in this case may indicate that further research is required in clarifying the vendor's preferences either through further modeling or from additional data.

Additionally, we can form tests for the vector of coefficients α_2. In order to do this, we adopt the reasoning used in rational expectations whereby players form rational expectations based on all available information [Keane and Runkle, 1990]. Efficiency requires that all the information known to the player at the time of the forecast be used in forming the expectation. Therefore, the information available to the player must be uncorrelated with any errors in the forecast.

We can apply a similar reasoning here. Since the contract is formed using the information variables known then, the effects of these variables should be limited to the contracting stage and should have no effect on realized profits once the contract type is controlled for. In other words, once the contract type is controlled for, the information variables should be uncorrelated with the deviation of the realized profit from expected profit. Therefore, in equation 5, the coefficient vector α_2 should be zero. Even if one of the coefficients in α_2 is not zero, then that variable influences the realized profits after controlling for the contract type, indicating that the contract was inefficient with respect to that variable.[5]

Finally, to add power to these tests, we include some ex post "performance" variables in equation 4 that would explain some of the deviation of the realized profit from expected profit (i.e. variables correlated with the error term e). A typical example of a development factor is the actual duration of the project (cycle time). Although the contracting parties may have expectations of the schedule of the project, the actual duration is susceptible to other unforeseen circumstances such as rework that may have arisen during the development of the software. Therefore, this variable should be able to explain some of the variance in the profits that is part

[5] Note that we could have devised more direct, and perhaps stronger, tests if we had access to price and expected profit information on the projects in our sample. This information is sensitive and therefore was not provided to us due to strict confidentiality requirements. This is a data limitation and our results should be interpreted keeping this limitation in mind.

of the error term e. Thus, we can augment equation 5 with these variables called D in the following manner.

$$RP = \alpha_0 + \alpha_1 C + \alpha_2 I_c + \alpha_3 D + e, \quad (6)$$

where D = Development factors (known ex post). We include three development factors - duration, core team size and the level of employee turnover during the project.

All the three development variables are important variables from a software engineering perspective. The duration of a software project is an important aspect of a software project and has been used in the literature as a performance metric for a software project [Gopal et al, 2002; Harter et al, 2000]. Pressman [1997] analyzes the importance of the project duration and states that schedule slips can often lead to much heavier costs further along the project. Although the drivers of project duration have been studied, we try to assess the impact of project duration on project profits for the first time.

Core team size refers to the core number of programmers that were assigned to the development team during the development of the project. Note that the actual number of people working on a project changes over time but the core team personnel remain on the project. The quality of programmers or project personnel also has been shown to have a positive effect on project performance. Krishnan et al [2000] and Guinan et al [1998] study the effects of programmer experience and quality on the performance in software projects. In our context, rather than use people skills, we use the core team size since our dependent variable is project profit rather than effort or quality.

The third variable we introduce is the effect of employee turnover in the project team during the project lifecycle. Although the trade press has addressed this phenomenon in some detail [Mandell, 1998; McGee, 1998], there has been little empirical work in analyzing the effects of employee attrition in development projects. High attrition rates in software development firms are common in the Indian software industry as well [Nidomolu and Goodman, 1993; Miller and Kaye, 1999]. Thus, the effects of employee attrition will significantly impact the profits of the vendor. Given the nature of attrition, it is difficult to capture an exact figure since people occupy different levels of importance in a project team. The loss of a project manager will be more keenly felt that the loss of a programmer. Therefore, rather than use the number of employees quitting the company during the project site, we use two questionnaire items that were filled out by the project manager.

6. Analysis and Results of Profit Model

In order to estimate equation 6, the independent variables we use are the I_c variables, which we described in the previous sections of this paper, the development factors and the contract type (Fixed Price or Time and Materials). The dependent variable is project profit measured in Indian rupees. Project profits are the net profits attributed to each project and is calculated by subtracting all travel and project related costs from the total revenues attributable to the project. The profit was not converted into dollars to avoid confounding the analysis with currency exchange risks and other currency fluctuations that occurred in the market during the project.

The model of interest to be estimated is equation 5. However, the estimation of equation 6 depends upon the model for contract choice equation 2. We can specify the two equations as follows

$$\text{Contract } C = \boldsymbol{f}(X'\beta) + u \qquad (1)$$

$$RP = \alpha_0 + \alpha_1 C + \alpha_2 I_c + \alpha_3 D + e, \qquad (6)$$

It is important to keep in mind that the vendor has an expectation of profits from a given contract type, which drives his preference for a certain contract type. This creates an endogeneity problem in the estimation of equation (6). It is well known that in the presence of endogeneity problem, OLS estimates are biased and inconsistent [Maddala, 1983]. We use the Heckman two-stage model to control for this endogeneity problem (Heckman [1976]).[6] In particular, we use the treatments effect model described in Barnow, Cain and Goldberger [1981] to estimate equation 6. In stage 1 of this method, a probit regression is estimated of the reduced form contract choice equation. From this estimation, inverse Mills ratios, referred to as λ_i, are calculated for each of the data points as follows

$$\lambda i = -\left[\phi(X'\hat{\beta}) / \Phi(X'\hat{\beta})\right] \quad \text{when C= 1, } \hat{\beta} = \text{estimates of coefficients from probit} \qquad (7)$$

$$\lambda i = \left[\phi(X'\hat{\beta}) / 1 - \Phi(X'\hat{\beta})\right] \text{ when C=0, } \hat{\beta} = \text{estimates of coefficients from probit} \qquad (8)$$

where $\phi(.)$ is the standard normal density and $\Phi(.)$ is the normal distribution function, both evaluated at $X'\hat{\beta}$.

[6] We thank an anonymous reviewer for pointing out the problem of endogeneity to us.

Stage two of the procedure entails introducing the λi as an additional explanatory variable in equation 6. This two-step procedure produces consistent and unbiased estimates of the profit equation 6 [Shehata, 1991]. Therefore, the estimated equation is the following:

$$RP = \alpha_0 + \alpha_1 C + \alpha_2 I_c + \alpha_3 D + \alpha_3\lambda + e_H, \quad (9)$$

where e_H is the Heckman-corrected error term.

Equation 9 can now be estimated using OLS and the resulting coefficients are consistent and unbiased. Least square estimates of the standard errors are, however, biased and corrected errors are calculated using the estimator proposed in Heckman [1976]. The coefficient α_3 of the λs are used to control for endogeneity and are indicative of the presence or absence of the effects of endogeneity or sample selection in the specification. Before estimating equation 9 using OLS, we tested for the presence of multicollinearity [Belsley et al, 1980], outliers and normality of errors [Shapiro and Wilks, 1965] and no assumptions of the OLS model were rejected. The estimates from Heckman's two-stage model are heteroskedastic in nature and our analysis automatically corrects the errors [Maddala, 1983]. The results of the estimation of equation 9 are shown in Table 7. Note that the earlier probit results remain the same since the first stage of the Heckman procedure involves estimating a probit contract choice model.

Recall that one of the maintained hypotheses specified that the vendor prefers a Time and Materials contract. We see support for that hypothesis in this analysis. Our analysis indicates that after controlling for all other factors, Time and Materials projects are associated with higher profits. The coefficient α_3 is significant in our model, indicating the presence of endogeneity. The contract variable is significant even after controlling for endogeneity and the presence of the lambdas. The contract variable indicates that vendor profits are Rs 748,000 (roughly $20,000) less in a Fixed Price contract, all else being equal. Thus, the null hypothesis of contract equivalence can be dismissed. This finding is significant because it indicates that even in the presence of a risk premium that might have been charged for Fixed Price projects, the vendor might still incur some losses due to unforeseen circumstances in Fixed Price contracts.

We hypothesized that if the contract were efficient with respect to the I_c variables, there should be no significant effect of these variables on Realized Profits once the contract type was controlled for. The hypothesis of efficiency is rejected in our sample since several of the I_c variables are significant at the p=0.05 level. Therefore, our analysis indicates that the contract is inefficient with respect to I_c variables. This result is also consistent with earlier empirical work in

rational expectations in which finds limited support for the rational expectations hypothesis [Lovell, 1986]. In our context, since we do not have expected profit information, we cannot conclusively reject the contract efficiency hypothesis. Although our results provide evidence in support of contract inefficiency, this result should be interpreted with a caveat. Note that in our sample, contracts are of only two types. The significance of I_c variables in the profit model may also be due to this restriction of contract types.

Project effort is significant and is associated with increases the project profits. This result is not surprising since effort is an integral part of the software engineering process and is a strong driver of most performance measures in software development. Requirements uncertainty also affects project profits and this result is intuitive. Shaky requirements are the bane of most software development projects. A more surprising result from our analysis is the association between number of prior projects executed for the same client and project profits. Past research on software contracting in custom software development has shown vendors adopting a "low-balling" strategy, i.e. bid low at first and then hike rates once the client is locked in [Whang, 1995]. Hence it is argued that profits to the vendor will increase over time with more projects executed with the same client. The underlying reasoning behind this argument is the vendor's learning about the client's business domain, thereby leading to more efficient execution of later projects and consequently, greater profits. However, in the present setting, we find the opposite effect, i.e. profits reduce in subsequent projects for the same client.

We discussed the above results with senior managers at our research site and identified several possible reasons for this finding. First, it was established that the vendor had signed long term contracts on fixed billing rates with nominal adjustments for annual increments with large clients. The projects in our sample spanned from 1994 to 1998 - a period of high growth in both global software and the Indian offshore market. Due to the strong demand for software services, the market rate for software services had increased much faster than the annual increments worked into long-term contracts with clients. This situation could have driven a decrease in profits in repeat projects for the vendor. In addition, we learned that in these long-term multi-project contractual arrangements, the vendor typically retained the same experienced staff in repeat projects with clients. This was in order to leverage the learning that had already taken place. The vendor was, however, forced to pay his experienced staff market-level compensation, thereby squeezing the vendor's margins further. Thus, the vendor finds itself locked into a long-

term contractual agreement with the client on one hand and an increasing cost of development on the other, leading to lower margins on such profits.

The decrease in profits with repeat projects may also be explained due to the intense competition among software vendors in the Indian software industry. It is possible that large clients may be benefiting from this competition and hence gaining more of the surplus in projects over time. The association of offshore competition variable with lower profits in our analysis further supports this argument.

The two competition variables are significant but with opposite signs. Offshore competition is associated with lower profits for the vendor. This result is intuitive since the presence of competition in the offshore market limits the price that the vendor can charge to a client and therefore, would have a negative effect on the vendor profit. The presence of onshore competition tends to increase the profit from a project. Project importance to the client reduces the profits from a project for the vendor and this result is explained by the high level of interaction required in such projects between the client and vendor teams. Managers at the research site indicated that critical projects had a higher level of travel requirements, larger onsite teams for requirements and testing stages and increased costs of monitoring and progress reporting on the project. Since these activities are usually not specified in the contract but emerge during the development phase of the projects, their costs tend to drive down vendor profits on average. The intangible benefits gained from successful implementation of a critical project are, however, immense and accrue over a longer time period.

The other variable that is significant is the client MIS experience variable that tends to increase the profit of the vendor. As discussed in Lacity and Willcocks [1998], the presence of an experienced MIS department at the client side makes the outsourcing arrangement more efficient. Requirement ambiguity is reduced and open issues arising during the development phase are sorted out faster. This is true for both contract types since the experienced MIS department provides quicker feedback and useful information that is uniformly beneficial for both parties. Discussions with project managers at the research site indicated that this is particularly true in the offshore context where the cultural and linguistic differences add to the technical complexity already present in the outsourcing process.

We had hypothesized that the three development factors would be significant. Team size and duration of the project are significant but employee turnover is insignificant in our analysis. It is

possible that the subjective nature of the turnover measure did not capture the whole impact of attrition on the project team. The core team size variable is significant and indicates that the vendor's profit increases from an additional team member. Larger core teams tend to be more self-contained units with lesser interactions with non-core team members on average. Therefore, co-ordination time and effort with non-core team members is reduced. Additionally, larger core teams are generally able to manage attrition from the team better since there are other members within the team who might be able to pick up the slack.

Our result with respect to the last development factor, project duration, is ambiguous because of the sign of the coefficient. The variable is statistically significant and positive, indicating that longer projects are associated with greater vendor profits. This is usually true for Time and Materials projects since longer projects involve larger billings, which translate to larger profit. However, in Fixed Price contracts, this result is contrary to what is expected. In a Fixed Price project, the vendor has an incentive to shorten the duration of a project since the price is fixed. This result could again be driven by our sample where Time and Materials projects are larger than Fixed Price projects. In addition a t-test on effort between the two contract types indicates that Time and Materials projects are statistically larger than Fixed Price projects ($t = 2.861$, 96 df, $p < 0.005$).

7. Conclusions and Future Research

In this paper, we have empirically studied how contracts are chosen in offshore software development projects. We use prior theory in task uncertainty, incomplete contracts and bargaining power to determine the influence of information known to the contracting parties during contracting on the chosen contract type. The results support both our underlying assumptions regarding the different contract preferences the two contracting parties have and the hypotheses made on the actual contract chosen.

In subsequent analysis, we study the efficiency of the contract by examining the effect of the information known during contracting on project profits. We also introduce three development factors in order to improve the fit of the regression analysis. We also interpret these results in the context of prior contributions in the software engineering literature. Although we are hampered by the lack of some data, our results indicate that the vendor does make higher profits from Time and Materials contracts, controlling for project specific variables such as project type and effort.

Moreover, we see evidence suggesting that the contract is not efficient with respect to the information variables known during contracting. These information variables have a residual impact on project profit and we interpret these results accordingly.

Our analysis is subject to a few limitations and caveats. First, we do not have first-hand data from the individual clients and data on contract prices due to confidentiality reasons. We were not allowed to directly contact clients and elicit responses to our questionnaires. Second, some of the data is susceptible to recall bias and results must be interpreted accordingly. Third, as noted earlier, our research is limited to two contract choices. However these two contracts may not be always optimal. Further research is required to understand other incentive-based contracts such as agreements with a fixed price and a reward or penalty for the vendor based on the project outcome in terms of project schedule and product quality.

Although the context here is offshore software outsourcing, some broad results can be applied to domestic outsourcing as well. Many of the task uncertainty and risk factors studied apply to domestic outsourcing as well and the efficiency of contracts needs to be analyzed in this context as well. Additionally, it is possible that reputations of vendors and clients are more easily verifiable and disputes more easily resolved in domestic outsourcing, therefore leading to the occurrence of more hybrid contractual types. At present, there is a lack of empirical analysis of contracts in domestic outsourcing. This is an area for future research and it would also be beneficial to conduct a comparison of contract types between these types of outsourcing and their effects on project performance. Cost is often the primary reason to move offshore but it would be useful to analyze the determinants of this cost advantage and how they accrue over different contract types at the end of a project.

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Figure 1

Project Timeline

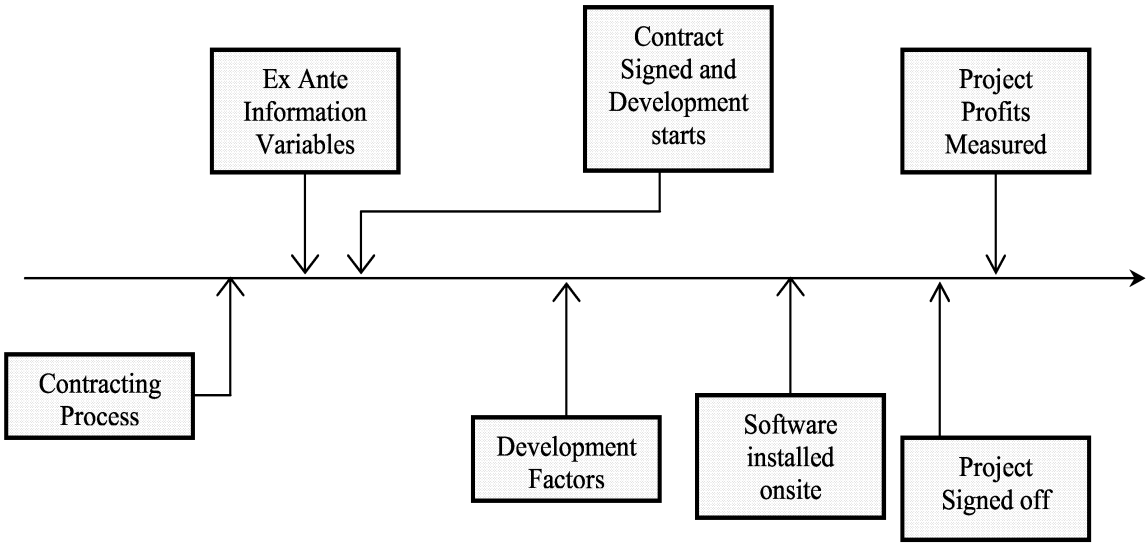

Table 1
Summary of Hypotheses

Hypothesis	Variable	Expected Contract Type
Hyp. 1	Requirements Uncertainty	Time and Materials
Hyp. 2	Effort	Time and Materials
Hyp. 3	HRR Training Risk	Time and Materials
Hyp. 4	MIS Experience	Fixed Price
Hyp. 5	Client Experience	Fixed Price
Hyp. 6	Client Reputation	Fixed Price
Hyp. 7	Future Business	Fixed Price
Hyp. 8	Client Size	Fixed Price
Hyp. 9	Project Importance	Time and Materials
Hyp. 10	Competition-Client Country	Fixed Price
Hyp. 10	Competition-Vendor Country	Fixed Price
Hyp. 11	Prior Projects For Client	Time and Materials

Table 2
Variable Descriptions

	Variable	Description and Measurement
1	**Size** (*Effort*)	Measured using the effort of the project (man-hours). The correlation between effort and size has been shown to be very high in the literature [Boehm, 1983] and therefore the use of effort as a proxy for size is reasonable
2	**Requirements Uncertainty** (*Req_Un)*	Measured using 4 questionnaire items adapted from Barki et al [1993]. These items have been tested before for psychometric properties in Barki et al [1003]
3	**Project Type** (*Ptype*)	This variable is categorical and captures the type of the proposed project: development, re-engineering and maintenance. We use it as a control variable. Development projects are projects where the functionality of the software is new and analysis and design needs to be carried out (Ptype = 0). Re-engineering involves either conversion of existing software from one platform to another or making significant changes in existent software to suit new business requirements (Ptype = 1), for example Year 2000 projects. Maintenance projects are contracts where the legacy systems or existent systems have to be maintained over a certain period of time (Ptype = 2)
4	**Human resources – Training** (*HRR_Tr*)	Measures the availability of trained personnel for the project using three questionnaire items. Measured on a 5-point Likert scale and adapted from Barki et al [1993]
5	**Client MIS Experience** (*Mis_Exp*)	Measured using four questionnaire items and was provided by the business unit manager. The questions pertain to the level of expertise and experience the client MIS department possessed. The items are created based on factors discussed in Lacity and Hirscheim [1993]
6	**Client Experience with Outsourcing** (*Cl_Exp)*	Measured the past experience that the client had with outsourcing in general using two questionnaire items on a 5-point scale. Items created based on factors discussed in Lacity and Hirschheim [1993]
7	**Project Importance** (*Proj_Imp*)	Measured using one questionnaire item and was provided by the business unit manager

Table 2 Continued
Variable Descriptions

Variable		Description and Measurement
8	**Client Reputation** (*Reputation)*	Measured using one questionnaire item and was provided by the business unit manager
9	**Future Business Potential** (*Future*)	Measured using one questionnaire item and was provided by the business unit manager. The three variables - Project Importance, Reputation and Future Business Potential, being single item measures are susceptible to measurement error
10	**Client Size** *(Cl-Size)*	Measured as the number of employees of the client organization. Since we are assessing the impact of client size as a bargaining variable, we measure the number of employees of the parent company, where applicable, rather than the immediate unit. For example, if a subsidiary of General Electric outsources to India, then the client size variable measures the number of employees in General Electric rather than the subsidiary
11	**Competition** (*Compet_Client, Compet_Vendor*)	Measured using two questionnaire items measured on a 5-point Likert scale. Although we planned to combine the two measures into one composite measure, they refer to different market phenomena that need not be correlated. Therefore, we used them individually in subsequent analysis. By competition in the client country, we refer to the presence of alternatives in the client country. By competition in the vendor country, we refer to the other developers in the vendor country, i.e. India
12	**Number of Prior Projects** (*Prior)*	The number of previous projects completed by the vendor for the same client and is a count variable
13	**Contract type** (*Contract*)	Contract type is binary, Fixed Price and Time and Materials

Table 3
Questionnaire Items and Factor Loadings

Factor	Questionnaire Items	Factor Loadings
Requirements Uncertainty	There was a clearly known way to convert client needs into requirements specifications	0.79
	Established processes could be relied upon to convert client needs into requirements specifications	0.89
	There was a clearly known way to develop software that would meet these functional requirements	0.90
	There were established procedures and practices that could be relied upon to develop software to meet these requirements	0.91
	Cronbach's Alpha = 0.90 *% Variance explained by first factor = 0.77*	
Human Resources - Training	It was difficult to hire trained people for this project	0.80
	There was a shortage of trained people for this project in the company	0.81
	It was difficult to provide training to employees in the skills required for this project	0.86
	Cronbach's Alpha = 0.76 *% Variance explained by first factor = 0.68*	
Client MIS Experience	The client's MIS department was very experienced with handling outsourcing projects	0.70
	The client MIS was technically capable of managing outsourced projects like the present one	0.87
	The client company had a very capable MIS department	0.82
	The project could have been as successfully executed by the MIS department of the client organization	0.70
	Cronbach's Alpha = 0.77 *% Variance explained by first factor = 0.61*	

Factor	Questionnaire Items	Factor Loadings
Client Experience	The client company was very experienced with the process of outsourcing software for its operations A significant part of the client's IT needs were outsourced to various vendors, both onshore and offshore *Cronbach's Alpha = 0.56* *% Variance explained by first factor = 0.68*	0.82 0.82
Human Resources – Turnover	Employee turnover from the project teams was a major problem during the execution of this project It was difficult to retain people with the skills required for this project within the company *Cronbach's Alpha = 0.73* *% Variance explained by first factor = 0.78*	0.88 0.88
Future Business	Prospects for future projects for your company from this client were high (Agree / Don't Agree)	
Project Importance	This project was very important to the client's business	
Client Reputation	The client had a strong and favorable reputation in the software industry in India	
Competition	What was the level of competition amongst other offshore softw developers for this project? What was the level of competition amongst software developers other countries or in the client's home country for this project?	

Table 4 - Summary Statistics
N = 93

Variable	Unit / Scale	Mean	Std Dev	Min	Max
MIS Experience	5-Point scale	3.121	0.850	1.0	5.0
Client Experience	5-Point scale	3.101	0.989	1.0	5.0
Effort	Person-days	995.21	1345.74	31.00	8100.00
Requirements Uncertainty	5-Point scale	2.192	1.023	1.0	5.0
HRR Training Risk	5-Point scale	2.559	0.967	1.0	5.0
Project Importance	5-Point scale	4.070	0.864	1.0	5.0
Client Reputation	5-Point scale	2.694	1.272	1.0	5.0
Future Business	5-Point scale	1.777	0.942	2.0	5.0
Client Size	No. of employees	65779	85712	110	30800
Competition-Vendor Country	5-Point scale	2.530	1.264	1.0	5.0
Competition-Client Country	5-Point scale	2.542	1.046	2.0	5.0
Prior Projects	No. of projects	7.858	13.147	0	24
Project Type	Categorical (1-3)	1.24	0.62	0	2.0
Contract	Binary	0.40	0.49	0	1.0
Project Duration	Calendar days	356.46	290.73	27.00	1320.00
Employee Turnover	5-point scale	1.902	0.804	1.0	4.5
Team Size	# of people	9.102	8.269	3.0	50
Project Profit	'000s, Indian Rs	191.41	528.34	-22.43	4125.40

Table 5 - Probit Analysis Results

Contract : 0 – Time and Materials, 1 – Fixed Price N = 93

Variable	Coefficient	Standard Error	Pr(|Z|>z)
Requirements Uncertainty	-0.90	0.33	**0.006**
Effort	-0.42	0.21	**0.05**
Human Res – Training	-0.90	0.28	**0.001**
MIS Experience	0.80	0.29	**0.006**
Client Experience	0.22	0.21	0.27
Client Reputation	0.05	0.16	0.73
Future Business	0.30	0.19	0.10
Client Size	0.59	0.26	**0.02**
Project Importance	-0.58	0.27	**0.03**
Competition (vendor)	-1.37	0.34	**0.0001**
Competition (client)	0.83	0.32	**0.01**
Number of Prior Projects	-0.08	0.02	**0.001**
Project Type	-0.80	0.36	**0.02**

-2 Log L = 62.90
Model Fit = 57.46 with 12 DF, significant at p < 0.01
Association of Predicted Probabilities and Observed Responses = 90.2 %

Table 6 - Summary of Results - Contract Model

Hypothesis	Variable	Expected Beta	Supported Y/N
Hyp. 1	Req. Uncertainty	Negative	Yes
Hyp. 2	Effort	Negative	Yes
Hyp. 3	HRR Training Risk	Negative	Yes
Hyp. 4	MIS Experience	Positive	Yes
Hyp. 5	Client Experience	Positive	n.s
Hyp. 6	Client Reputation	Positive	n.s
Hyp. 7	Future Business	Positive	n.s
Hyp. 8	Client Size	Positive	Yes
Hyp. 9	Project Importance	Negative	Yes
Hyp. 10	Competition-Client	Positive	No
Hyp. 10	Competition-Vendor	Positive	Yes
Hyp. 11	Prior Projects	Negative	Yes

ns - Not significant

Table 7
Heckman Two-stage Estimation
Regression of Information Variables, Contract
And Development Factors on Vendor Profits
N = 93

Variable	Parameter	Std Error	p-value
Intercept	1243.96	562.04	0.02
Effort	321.10	43.25	**0.0001**
Project Type	-127.67	72.27	0.07
Requirements Uncertainty	-155.08	51.10	**0.002**
Human Resources - Training	70.02	57.20	0.22
Prior Projects for Client	-19.33	5.16	**0.0002**
Competition - Offshore	-351.23	76.03	**0.0001**
Competition - Onshore	162.23	61.06	**0.007**
Project Importance	-132.67	53.05	**0.01**
Client Reputation	-30.99	35.41	0.39
Future Business	27.07	43.37	0.53
Client Size	90.01	54.41	0.09
Client Experience	-0.658	58.38	0.99
MIS Experience	184.89	78.77	**0.01**
Contract	-748.14	237.74	**0.001**
Employee Turnover	-38.97	50.67	0.44
Team Size	12.57	4.65	**0.006**
Project Duration	0.355	0.14	**0.01**
Lambda	313.71	142.35	**0.027**

Model F = 10.83, 18 df, Significant at p < 0.01
R-Square = 0.72
Adjusted R-Square = 0.65