

**Maximize Your Outsourcing Benefits  
Through Complexity Arbitrage:  
or  
*"Just Because I Said it Was Complicated  
Doesn't Mean that it's Hard!"***

**Eric K. Clemons**  
clemons@wharton.upenn.edu

**Ravi Aron**  
raviaron@wharton.upenn.edu

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**1. Introduction**

Outsourcing has become not only one of the most widely discussed business phenomena, but also one of the most poorly understood. Although it is the most rapidly growing business sector in India and is fast becoming India's fastest growing export industry, there has been little coherent explanation in the academic press for why the industry is growing now; the industry began to surge without any favorable change in labor rates, labor availability, or exchange rates to explain the industry's growth. Without an explanation for the sudden growth in outsourcing, the most important of recent past trends, it is difficult to make predictions for future developments.

For a field that had apparently been "studied out" in the mid 1990s it is surprising how many unanswered questions still remain: How is outsourcing best done, through arms-length subsidiaries, joint ventures, or traditional vendors? What are the appropriate business problems domains for outsourcing and what operational functions must be kept internal? How should an outsourcing relationship be structured? Is outsourcing good or bad for the American economy? Is it good or bad for the social structure of Bangalore and the political stability of Hyderabad? We are, indeed, just beginning to understand the relationship among the nature of tasks being outsourced, the nature of

governance structures and incentives that are in place to structure outsourcing contracts, and the resulting productivity of the contracts.

This paper reports on a multi-year longitudinal study conducted in India, Mauritius, Singapore, and Manila, with comparisons of workers in these markets against in-house employees in the United States and the U.K., in order to answer very specific questions about task complexity and performance. Our principal findings suggest that there are enormous untapped opportunities for complexity arbitrage, trading against the different costs of labor that can competently deal with algorithmically complex tasks<sup>1</sup>. In particular, we find that multi-stage, computationally intensive analytical tasks can be performed superbly by engineers and technical personnel in India. There is a more-than-adequate supply of these workers, and they can be hired and trained at a cost that is discounted by as much as 75% relative to the cost of comparably trained workers in the US. As importantly, their performance levels relative to their counterparts in the US and the UK is actually superior, that is, in addition to being significantly less expensive, when provided with comparable training and comparable support technology, their unit outputs and overall quality levels are both superior.

Of course, we all know that arbitrage should not be possible. If heating oil in the US costs significantly more than bunker oil in the UK, opportunistic firms will buy bunker oil in the UK and ship it across the Atlantic. If the yen-dollar exchange rate gets out of balance relative to the dollar-yen exchange rate, FX traders will arb the differences away in seconds. When work can readily be shipped between the US and India — assignment specifications can be sent one way, and debugged code, or completed securities evaluations, or structural analyses for a suspension bridge can readily be sent the other way using the internet — large and profitable arbitrage opportunities should not remain.

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<sup>1</sup> It may be useful to provide a short explanation of why this can be viewed as arbitrage. An outsourcing vendor who contracts to deliver work to an American firm now has an obligation to deliver this work, and he has a short position in much the same way as a securities trader who has shorted US Government bonds or shares of IBM. Like the securities trader he hopes to cover his short position by obtaining the completed work at a price lower than that for which he sold the work in the US. The fact that he can do this consistently represents a source of profit that comes from arbitrage between the market for personnel who can work on complex tasks in the US and the market in India.

Our explanation for the persistence of outsourcing opportunities is both simple and compelling. A significant body of economic theory suggests that complex tasks neither can nor should be outsourced. That would limit the amount of outsourcing that would occur, as indeed it should, and the opportunity for arbitrage would not exist. That would, of course, be the end of the discussion, but for our principal observation when observing outsourcing vendors in India, Mauritius, and Singapore. Tasks that appear quite complex when assessed from the perspective of an American or British executive client considering his available domestic labor pool, will often appear far less complex to his counterparts from India, Mauritius, or Singapore facing their own very different labor pools. The fact that these tasks really are not complex when assigned to foreign workers provides an opportunity that can be exploited. The fact that American executives believed that these tasks were complex, and thus could not be assigned to foreign workers, explains why this opportunity has not yet fully been exploited. The existence of an opportunity that has not fully been perceived of course explains why this arbitrage opportunity still remains.

## **2. Economic Theory on Complexity and Outsourcing**

Although we believe that complex tasks represent a great source of economic gain in future outsourcing engagements, a considerable body of literature suggests otherwise. That is, well-developed and generally accepted theory suggests that complex tasks should, *ceteris paribus*, be retained within the firm. Before showing why this analysis may need to be modified, we will first review what has been said previously to support the conclusion that complex tasks should not be outsourced.

### **2.1. Strategic Risks**

The first reason provided to suggest that complex tasks should remain within the firm is motivated by **strategic risk**. Strategic risks are in some sense competitive or game theoretic; they result from explicit strategies of the vendor (or client) to exploit the counter-party where possible. There are three principal forms of strategic risks that may be encountered during the execution of a contract, and we address each of the three in turn.

The first form of strategic risk is the ***principal-agent problem***, which occurs any time the party that requires the work to be done (the principal) and the party actually performing the work (his agent) have incentives that are not completely aligned. The principal wants the work done to the highest possible standards, subject to other constraints, like price and investments in support. The agent may wish to work less hard (if he is doing the work himself) or to substitute less expensive and less qualified personnel (so that he can use his best staff members more profitably elsewhere) or to make less than the full investment in supporting technology (if he is paying for it himself). In brief, the principal-agent problem entails deliberate under-performance of a contracting task, while claiming full payment for performing the task to agreed standards; this sometimes is also called ***shirking*** in the outsourcing literature. This is easiest to do, of course, when the principal cannot determine precisely what the client is doing and cannot judge precisely either the quality or the quantity of the output. It is generally argued that determining the quantity and quality of output is more difficult for more complex tasks, and thus complexity exacerbates the principal-agent problem. Alchian and Demsetz provide the classic description of the principal agent problem [1]. Grossman and Hart recast the principal agent problem as providing a limitation to acquisition; they show how acquisition of a subsidiary or independent business unit recasts an independent principal as an agent, weakening his incentives and reducing the quality of his performance [9]. Williamson includes a study of the principal agent problem in his thorough analysis of the risks associated with taking work outside the hierarchy of a single firm [14]. And Clemons and Row examine the implications of improved information technology on monitoring and on the levels of shirking or substandard performance that may be anticipated as technology provides greater information transparency and reduces the information asymmetry essential for the principal-agent problem to exist [6, 7].

All studies of shirking and the principal-agent problem start with the same premise: when it is difficult or impossible to monitor an agent's activities and difficult or impossible to measure the result of those activities with precision, it is possible for the agent to invest less than full effort. The principal will attempt to provide incentives to improve the agent's desire to perform, but since observations are imperfect incentives

must of necessity be imperfect as well. This leads inevitably to imperfect observation, to imperfect incentives, and thus to the imperfect allocation of effort by the agent, or, in our case, by the outsourcing vendor.

Only one additional factor needs to be considered to understand why outsourcing complex tasks is seen as having unacceptably high risk of exploitation. The performance of complex tasks is believed to be more opaque and more difficult to observe and monitor than simple tasks. Since opaque tasks will be monitored with even less accuracy and precision, complex tasks are subject to even greater principal agent distortions. Assessing the quality with which tax returns are processed, medical X-rays are reviewed for possible tumors, or equity research and valuation is performed for high tech corporations' initial public offerings appears quite complex; in contrast, determining whether customers' inquiries are handled efficiently and politely at a call center appears to be quite easy,

The second form of strategic risk is strategic dependency and ***post-contractual opportunistic repricing*** or ***opportunistic renegotiation*** of the terms of the agreement. When one party has become dependent upon the other and cannot easily obtain a reliable alternative to continuing the relationship, then other party has considerable freedom to increase prices or unilaterally impose other changes to terms of the relationship. If I need you to operate my data center, or to operate my customer support call center, or to operate my order entry and billing systems, and if I cannot function without those operations, then I am dependent upon you. If I cannot readily find an alternative vendor to provide those operations, then my dependency upon you creates vulnerability that you can exploit.

It is generally accepted that complex tasks require task-specific and relationship-specific investments, and this in turn creates strategic risk: Unlike generic and simple tasks, complex tasks are specific to individual engagements, thus are specific to individual outsourcing relationships between a single buyer and a single seller, and whichever party makes the relationship specific investment to enable the relationship is now vulnerable. Likewise, it is generally accepted that complex tasks are difficult to source to an alternative provider, who must be trained over time and who must invest in

learning the business and in processes to support the business; hence the client, having no immediately available alternative to the current vendor, will be dependent upon the vendor and will have strategic vulnerability in future contract years.

Both observations have the same underlying cause. When a party to a contract has no readily available alternative to his current contract partner, then the partner experiences post-contractual small numbers bargaining [10, 14]. Post contractual small numbers bargaining in turn produces strategic vulnerability, since the more difficult it is to locate an alternative partner, the more dependent you become on your existing partner. This dependency can lead to extortion of concessions from the buyer, such as higher payment; this is often called "Vendor Holdup," of which numerous examples exist [11]. On rare occasions the buyer can renege on a commitment to the client, who then has no ready alternative use for or salvage value from a relationship specific investment, in which case it is the vendor and not the buyer who faces post contractual small numbers bargaining and the vendor who must accept new and unfavorable terms.

The relationship between small numbers bargaining and strategic vulnerability and the relationship between strategic vulnerability and opportunistic repricing are not recent phenomena. Numerous problems created by strategic vulnerability and opportunistic behavior are documented in Alfred Chandler's study of American business at the end of the 19th century, *The Visible Hand* [3]. Likewise, the implications of strategic vulnerability and opportunistic behavior as limitations upon outsourcing have previously been observed and documented [11, 6].

The third and final form of strategic risk is **poaching**, or the loss of control over intellectual property as a result of providing information and expertise in the course of an outsourcing relationship. Poaching is enabled by the unintended transfer of valuable expertise from client to vendor; poaching actually occurs when the vendor reuses this information for its own gain. Since poaching creates a new revenue stream for the vendor it always benefits the vendor. Since this revenue stream comes from the vendor's using the client's expertise and information in areas where it is most valuable this often entails the vendor's transferring expertise and information to the client's competitors, and thus poaching frequently damages the client. Poaching historically

has been less significant in outsourcing associated with traditional manufacturing, but it has become more important as firms engage in business process outsourcing. The most complete references on poaching are found not in the economics literature but in information strategy and studies of information-intensive outsourcing [4, 6, 7].

The fundamental idea behind poaching is that the vendor always learns from the client, and that sometimes the vendor may learn something of great value, which can later be resold to the client's competitors. The reason that outsourcing complex tasks appears more dangerous is that simple operations do not teach the vendor much, but complex operations may teach the vendor a great deal. Moreover, the client demands usually very high performance and usually provides sufficient training and support for the vendor to truly master the process and to replicate the quality of levels that the client achieves internally. Transferring complex operations to a vendor may inevitably teach the vendor too much about the client's manufacturing, or pricing strategy, or some other trade secret whose loss would create unacceptable commercial damage to the client.

## 2.2. Operational Risks

The second reason to maintain complex tasks within the client organization rather than outsourcing is the belief that **higher operational** risks are associated with complex tasks. Unlike strategic risks, operational risks do not come from deliberate or strategic behavior of the vendor. Rather they are the inevitable result of the difficulty of coordinating complex operations across great distances, with imperfect information, and with limited understanding due to cultural differences, language differences, or lack of shared context and experience.

Coordination costs increase with distance, both geographic distance and a perceived distance created by separate ownership. Historically, the farther two organizations are from each other geographically, the greater the difficulty, or expense, or time delay associated with communicating between them, and hence the greater the cost associated with explicit coordination. Sharing schedules, sharing forecasts, or sharing data on inventory on hand would be more expensive as distance increased. The advent of the internet has reduced the significance of distance as a factor in determining

communications costs, and thus has reduced communications as a source of operational risk.

Additionally, the greater the cultural differences between client and vendor the more likely it would be for instructions to be misunderstood. With the reduction in communications costs, coordination across cultural differences is now more significant than coordination across geographic distances. These cultural differences include those that result from separate national cultures, of course, but they are exacerbated by differences in terminology and practice between separate companies<sup>2</sup>. Finally, separate ownership often implies different and incompatible software. Each of these increased the difficulty of explicit coordination, and therefore increased the likelihood of delays or breakdowns in coordination [5, 12].

Additionally, operational risks are exacerbated by the difficulty of codifying instructions for development, production, and quality assurance. The problems that result are not caused by a lack of intent or desire to deliver quality work (strategic risk) but, once again, by the inability to do so. These difficulties increase as the number of steps and the complexity of computations increases [8, 13].

### **2.3. Complexity and Outsourcing**

There can be little doubt that there is an impressive body of work, all of which suggests that complex tasks cannot readily be outsourced, and which likewise suggests that the opportunities for complexity arbitrage must be more limited than we have claimed. Fortunately for our theory, and for executives wishing to receive the greatest benefit from outsourcing, when an executive refers to a task as complex, he is unlikely to mean precisely what Grossman, Hart, or Holmstrom have meant.

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<sup>2</sup> Even within the US military the instruction to "secure a facility" will have very different meanings. The air force means turn off the lights when you leave, the navy means lock things down (secure the hatches), and the army means put up a defensive perimeter. The marines do not consider a facility secured until all potential threats and sources of resistance have been neutralized. Is it any surprise that when a single term can have four different meanings to four different American career military officers a professional instruction may have different meanings to American and Indian corporate employees?

In our next section we provide several working definitions for task complexity, and then show why tasks that executives in the US or U.K. call complex may not behave precisely as Grossman, Hart, Holmstrom, Alchian, or Demsetz might have predicted.

### **3. Complexity**

Through our interviews and surveys we have determined that when an executive describes a task as complex his meaning is clear:

- It is difficult to obtain qualified staff to assign to the task
- It is difficult to train staff, and
- Consequently, it is difficult to perform the task consistently with acceptably high levels of quality and acceptably high levels of throughput even after providing training for the staff.

While this may lack mathematical precision, our executives agreed upon it. As importantly, the definition is reasonable, and it has implications that can be measured. If a task is complex then the staff to perform it are more expensive, and the levels of throughput and of quality vary with the quality and training of the staff members assigned to the task.

In our study of the relationship between complexity and the outsourcibility of tasks, we asked executives to assess tasks using the following dimensions of complexity:

1. The codifiability of the information that must be transferred so that the task can be performed reliably and with acceptable quality
2. The amount of training that must be provided to vendor workers to enable them to perform this task, a weighted combination of the duration and cost of training
3. The cost of managerial monitoring of performance levels
4. The difficulty of assessing quality and managers' level of confidence that they quality assessments would be accurate and reliable
5. The recommended educational level for vendor employees, ranging from an undergraduate degree for call center operators, through MBAs and CPAs for tax

preparation or equity research analysis, to Ph.D.s for engineer research and M.D.s for medical X-ray diagnostics

6. Revenue per vendor working assigned to the task
7. Number of different sub-tasks associated with the task
8. A single over-all measure of task complexity, used principally to assess the accuracy of ratings and the significance of different factors to individual executives in their creation of these ratings

The first step towards explaining why complexity arbitrage opportunities remain available is to show that observed complexity, as perceived by American executives considering outsourcing complex tasks, is not a reliable measure of the difficulty of outsourcing. We start with the assumption that complexity, as perceived by the outsourcing vendor is will be reliable since the vendor is the party that will actually be doing the work. We were pleased to note that there is a very high level of agreement between complexity, as perceived by vendors both in India and in Singapore. Indeed, the correlation between the observations from these two markets is close to 0.85. We then note that there is a strong negative correlation between complexity, as predicted by American and British clients, and complexity, as observed by Indian and Singapore vendors. This is sufficient to explain why complexity arbitrage opportunities exist, even if it does not tell us why the American predictions about complexity of outsourcing tasks differ so greatly from the complexity actually observed when the work is done in India and Singapore.

Figure 1 below shows the complexity rankings assigned by clients in the US and vendors in India and Singapore to the same tasks, which were called processes in the survey instrument. A quick examination of the table shows that processes that American executives classified as simple were generally viewed as relatively simple by their vendors. As we suspected, however, tasks that were viewed as complex by the American executives were generally viewed as much simpler by their vendors.

<b>Processes</b>	<b>US Firm</b>	<b>Indian BPO Firm</b>	<b>Singaporean BPO</b>
P1	2	1	2
P2	3	3	4
P3	6	2	3
P4	5	3	4
P5	7	3	2
P6	3	4	5
P7	2	7	6
P8	2	6	5
P9	4	3	4
P10	2	5	4

Figure 1 – Complexity rankings assigned to the same tasks (processes) by client executives in the US and vendor executives in India and Singapore. It is clear that client and vendor disagree on complexity rankings principally for tasks that are considered complex by the US clients.

	<i>US Firm</i>	<i>Indian BPO</i>	<i>Singaporean BPO</i>
<b>US Firm</b>	1		
<b>Indian BPO</b>	<b>-0.46942</b>	1	
<b>Singaporean BPO</b>	<b>-0.53564</b>	<b>0.83578</b>	1

Figure 2 – Correlation of complexity assessments among three markets, India, Singapore, and the United States. The correlation between complexity measures in the assigned by US client executives and by Indian and Singaporean vendor executives is seen to be strongly negative, while the correlation between the two vendor assessments is strongly positive.

Examining the way that western executives estimate the complexity of tasks to be outsourced does provide an explanation for why their estimates are consistently different from those of their vendors, and why there are opportunities for outsourcing tasks that they consider to be complex. In particular, there were two measures such that

western executives felt that high rankings on these dimensions led to high over-all complexity, for which observed data on the success of outsourcing provides no support.

- The western executives surveyed consistently assigned higher over-all complexity measures to tasks that were more codifiable, more algorithmically described, and more computationally demanding. As tasks went from implicit, subjective, context-dependent and verbally described to explicit, algorithmic, dependent only upon explicitly listed data, and computationally described executives felt that the tasks were inherently more complex.
- Additionally, as tasks were divided into an increasing number of steps they likewise were seen to be more complex.

Our data show that quite the reverse turns out to be true. As a task becomes more algorithmic it becomes easier to outsource to firms in India and Singapore. Likewise, tasks that can be divided into a large number of independent steps to be performed in sequence are easier to outsource to firms in these markets.

Similarly, the opportunities to outsource tasks that western firms believe to be simple targets for outsourcing may be more limited than the American executives currently believe. This is because the tasks that western executives believe to be simple involve a high degree of contextual interpretation, judgment, and subjectivity. There is a high degree of operational risk associated with these tasks because Indian workers have very different backgrounds than their American worker counterparts, very different abilities to interpret subjective cues, and very western abilities to adapt to situations where the rules and procedures cannot be fully specified in advance.

We are not suggesting that executives in either set consistently fail to understand complexity in its own market. That is, the factors that American executives believe makes a task complex would indeed make it complex to perform with locally available staff. We are claiming that American executives fail to understand the strengths and limitations of foreign labor pools, causing them to consistently and systematically over-estimate the difficulty of outsourcing computationally and analytically intensive tasks.

#### **4. Anecdotal Support for Complexity Arbitrage**

##### **4.1. When Hard Tasks Look Easy**

As noted in the previous section, there are significant differences in the way American firms and Indian vendors view the complexity of the same tasks. This suggests that outsourcing of some tasks should be avoided, even though they may appear easy to perform and easy to outsource. Likewise, it suggests that some tasks, which might appear to American firms to be too complex to perform off shore, are indeed extremely attractive targets for outsourcing or other forms of remote work.

The most obvious examples of tasks that appear straightforward in the US but are complex to source to India involve place names and names for people, especially if hand written or entered in a free-form format. Indians are not Americans, and American naming conventions are unfamiliar to many Indians. The inability to recognize the difference between a first name and a last name, the unfamiliarity of many place names, and the unfamiliarity of many abbreviations all will pose data transcription problems at the beginning of an outsourcing contract.

The small picture below represents the kind of problem that would be easy to address in the US, but that originally made personal history data transcription appear so complex when it was first transferred to India. An American clerk would immediately recognize the names of the applicants as Sean O'Malley and his wife Phoebe; the fact that one name was typed and the other written in by hand only makes it easier to interpret. The data transcription specialist in Hyderabad actually entered this as "Sean O'Malley T. Phoebe;" that is, Mr. O'Malley and his wife Phoebe ceased to be a couple and became Mr. Sean Phoebe.

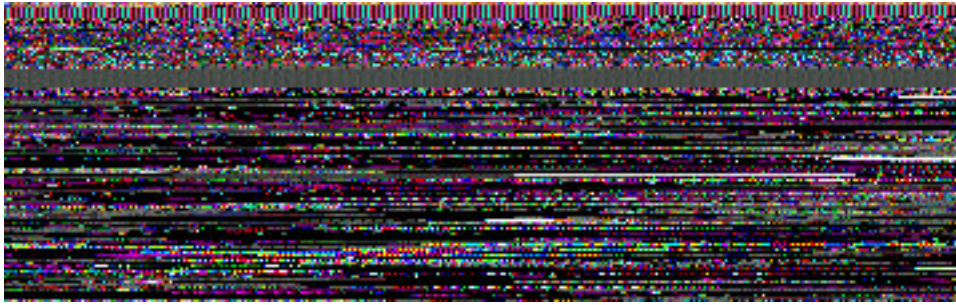


Figure 3. - A jpeg file containing a name of a married couple, sent to Hyderabad for data transcription.

Similarly, unfamiliar place names will be difficult to read from hand written data entry forms. The Upper Darby region of Philadelphia will not be familiar to residents of other parts of the US, to say nothing of residents of other countries. Recognizing the name written in the jpg file below was not difficult for a Philadelphia researcher studying data entry in Hyderabad, but it initially proved very challenging to the local Hyderabad data entry staff.



Figure 4. - Recognizing a place name will be relatively straightforward for natives of the region, and somewhat more difficult for data entry personnel who are not local to the region.

Numerous other examples provide anecdotal support for the idea that simple data transcription tasks can be surprisingly complex. Data entry personnel learned quickly that names like "Duke's Iron Works" indicated a firm that was likely to have left a legacy of industrial pollution due to the accumulation of slag and the resulting contamination of ground water. They were surprised to learn that the very similar sounding name, "The Iron Duke," was in all likelihood a pub, not a heavy industrial site, and not a source of industrial pollution. Americans have come to recognize any sequence of digits having the form 215-898-6423 as a phone number and to recognize

any set of digits such as 173-39-9537 as a social security number. In most of the rest of the world, outside of the United States and Canada, both area codes and phone numbers will vary in length depending on where in the country the phone is located. Consequently, while an American worker will seldom confuse a phone number with a social security number, having the two located adjacent on a data entry form proved quite problematic for Indian data entry personnel working with forms that originated in the US. Errors involving transcribing these fields were particularly important since the social security number was also used as the account locator, making errors especially significant.

Despite these difficulties, real savings may still be possible even when outsourcing data transcription. In part, this is due to the differences in wage rates between client and vendor labor markets. More importantly, with the level of talent and motivation that can be obtained from Indian workers, performance on these tasks can improve dramatically over time. The CEO of the vendor firm cited in examples 1-3 above initially considered attempting to terminate the contract because initial performance levels were so unacceptably low (as viewed by the client) and costs were so unprofitably high (as viewed by the vendor). However, ultimately his staff became sufficiently familiar with their client's requirements that performance exceeded the levels that the client had been able to obtain domestically. To underscore this point, the client began to send personnel to Hyderabad, India to observe and learn from the vendor, in order to replicate the vendor's quality levels in their own internal operations.

#### **4.2. When Easy Tasks Look Hard**

Some tasks that appear to be complex and that are analytically intimidating to many workers in the US may not be difficult to staff in India. India has a large number of extremely well educated engineers who can perform well-specified algorithmic analyses. Potential employees with the necessary training might not be available to perform this work in the US, since more interesting jobs were historically available to them. And yet, there are large numbers of potential employees in India who are delighted to be working in their fields of specialty for a prestigious US employer.

We observed numerous examples of highly structured tasks that initially appeared quite difficult to outsource, but that were well suited to outsourcing. These tasks were performed with high levels of quality, produced significant economic savings for the client firm, and were considered valuable and successful business relationships by both client and vendor.

- InfoTech does engine design for a major American manufacturer of jet engines for commercial aircraft, which are used by airlines around the world. The engines must be designed to achieve objectives on a wide range of conditions, including fuel economy, carbon monoxide emission levels, nitrous and nitric oxide emission levels, peak engine power, and throttle responsiveness. The engine company provide InfoTech the results of a small number of tests, each of which includes hundreds of thousands of observations. That is, a small number of prototype engines are constructed and tested. The results of the tests include many observations per second, for a period of several minutes, including both measurements for the performance objectives listed above as well as measurements for temperature and pressure. InfoTech personnel first design software to model engine performance and tunes the model until it accurately reflects the results of the tests; when it can do so, it is considered a reliable simulator of engine operation. InfoTech personnel then modify the engine design, changing shape and other parameters, to improve performance on the design criteria; that is, InfoTech personnel construct and test simulated engines rather than real physical prototypes. When an "ideal" engine design is available, it is then passed back to the engine manufacturer so that a physical prototype can be designed and tested. While the work is complex enough to require graduate level training in fluid dynamics, computer simulation, and combustion engineering, it does not require an understanding of local context and behavior. Client and vendor both consider the contract extremely successful.
- A number of major US and UK financial services firms have begun outsourcing routine financial analysis, such as equity research, and bond ratings, to firms in India. While the work is extremely quantitative, it is, once again, highly formulaic. Indeed, an alternative approach, explored over a decade ago by

Moody's, was to use expert systems software to assist in bond rating, looking for firms' where balance sheet or income statement results looked significantly different from averages for their industries. Interestingly, the most difficult part of the task to outsource was the writing of the final report and capturing the neutral-sounding tone that would be the client firm in its own reports. The vendor reported being told that "US firms never use terminology such as '...as can be seen from the working capital burn rate, the firm is clearly headed toward bankruptcy' or '... this firm's phenomenal market penetration and depth of capital assets, notably cash reserves, make it the finest ever airline company that cannot be ever challenged in the near future...'" Having Indian analysts bury such inappropriate sounding statements in footnotes or in paragraphs deep in the body of the report made the statements difficult to detect, and when they were not caught they caused significant erosion in the credibility of the analysis and of the report among client users. Ultimately, these research specialists have been given pick lists of adjectives to work with now, and intelligent "sentence architecture checking software mechanisms" are being developed to detect and note hyperbole and other violation of the client's conventions on the permitted tone for research reports. Note that the actual quantitative analysis was straightforward and was easy to outsource. The writing of the surrounding text proved to be more difficult, because it was based on non-quantitative, culture-specific understanding. When the necessary rules were developed and the writing was likewise made formulaic, it, too, became easy to outsource.

- A UK firm developed unique software to help a home buyer, or a provider of mortgage funds that would be used to purchase a home, determine if the home had been built on suitable ground. Sometimes this could be relatively simple to assess, as would be true when the immediate previous use of the land had been for a chemical storage facility, a petrol station, or some other potential source of long-lasting underground pollution. Other times this might be far more difficult, and might entail reviewing the history of the site over several decades, or even over several centuries, for recurring problems, like collapsing sink-holes. In order to develop the database that underlies their product and supports their

software, the UK firm obtained access to several centuries of highly detailed maps that covered all of England, Scotland, Ireland, and Wales. Digitized images of these maps were sent to Hyderabad, where employees converted them to a common scale and a common coordinate system and then hand-encoded a representation of every feature on every map. Some, like geographic features (pond or lake) or well understood building (home, hospital, train station) were easy to encode. Others - commercial establishments with names that were unfamiliar to Hyderabad employees, like The Iron Duke, were more difficult to encode without coaching from the London-based client. The client commented on how very easy it was to staff the project, finding and training over 200 employees in Hyderabad who were capable of doing the necessary mathematical transformations and the encoding. The client likewise commented on how many problems, surprisingly, were created by the need to understand names. In the end the client was delighted with the work, in part because of how very easy it was to complete the encoding, once a simple set of rules was developed to make this process as formulaic as the algebraic transformations needed to convert the maps to a common scale and coordinate system.

For each of these examples, positions were surprisingly easy to fill, with professionals employed at a wage rate that represented at least a 70% discount relative to the cost of comparably trained US professionals. Worker productivity was high, and the all-in costs of outsourcing represented a significant source of savings for client firms, as will be discussed in the following section.

## **5. Statistical Evidence on Cost Comparisons**

Based on our longitudinal studies, we are able to provide an analysis of the comparative performance of Indian and Singaporean workers relative to American and British workers performing the same tasks, and to observe differences based on the relative complexity of those tasks. Figure 5 provides graphs that demonstrate the levels of productivity over time, as a function of job complexity. It is clear that at least for some tasks that western firms consider quite complex, Indian workers do appear to have an advantage. Moreover, comparing surveys of management at western and Indian

locations helps explain this difference in performance. We note that for a large class of highly quantitative, well-specified analytical tasks we observe extreme divergence in the assessment of task complexity. Western firms see the tasks as highly complex because of the training and complex mathematical skills that must be mastered. Indian firms see the tasks as relatively simple because there are no subjective assessments required and no unscripted and unpredictable interactions with the customers of their western clients. Both assessments are, of course, correct, and it is this difference in the assessment of complexity that permits profitable complexity arbitrage as western clients outsource routine analyses to Indian vendors.

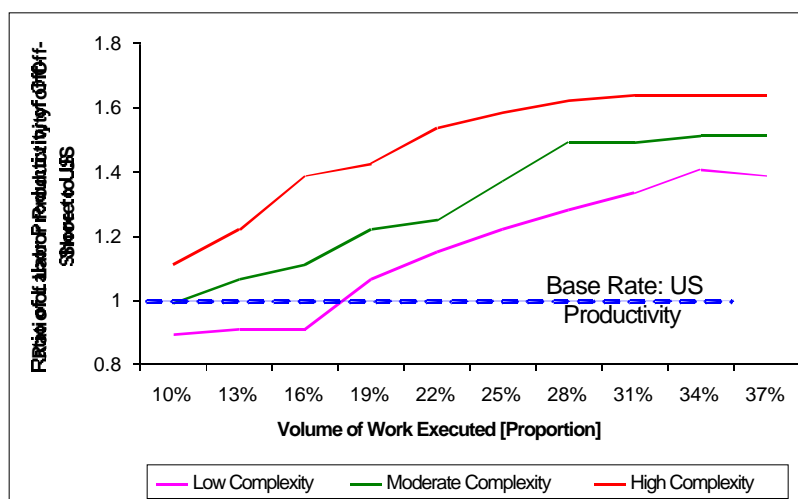


Figure 5. - Worker productivity over time, measured against the performance of home-country workers, as a function of task complexity. The total factor productivity of labor is calculated for both groups of workers for the three kinds of processes. Then the ratio of these two processes is computed at different process volumes for each of the three kinds of process.

Our findings show that figure 5 actually understates the relative advantage available from outsourcing tasks that western executives consider to be highly complex, since figure 5 only reflects the relative productivity levels of workers on different tasks. Our early data from Indian and Singaporean labor markets show that the relative cost of the most highly trained workers is more deeply discounted relative to the US than is the cost of less skilled workers. This is shown in figure 6A below. Not only do the workers

on the most complex outsourcing tasks enjoy a greater productivity advantage relative to the west than their less skilled colleagues, they also are available at a more significant discount before productivity differences are factored in. Combining a more deeply discounted hourly cost with higher unit outputs provides an even greater advantage for vendor personnel on complex tasks.

The cost of capital needed to enable workers to perform their jobs is roughly comparable across both markets, but represents a greater percentage of total cost in markets where labor costs are lower. At present, the facilities in which outsourcing work is performed in India or Singapore very closely resemble their equivalents in the west. Perhaps to reassure visiting executives from the home office, the physical plants for call centers for AOL or Dell in Bangalore and Hyderabad are virtually indistinguishable from their counter-parts in the west. Engineers need similar equipment regardless of where in the world they are working. While the capital cost per work station per year may be largely equivalent in absolute terms, it represents a much higher percentage of annual expense in markets where labor costs are lower. As importantly, capital costs are a higher percentage of total costs for those tasks for which labor is less expensive. This is shown in figure 6B below, where the relative discounts for workers on high complexity and low complexity tasks are compared.

<u>Complexity</u>	<u>Western Client</u>	<u>Vendor</u>	<u>Discount</u>
<b>Low</b>	<b>1</b>	<b>29 %</b>	<b>71 %</b>
<b>High</b>	<b>1</b>	<b>22 %</b>	<b>78 %</b>

Figure 6A – The relative labor costs for workers on high complexity and low complexity tasks. The cost of western workers at the client’s organizations are normalized to 1. Note that the discounts are larger for vendor workers assigned to more complex tasks.

<u>Complexity</u>	<u>Western Client</u>	<u>Vendor</u>	<u>Discount</u>
<b>Low</b>	<b>1</b>	<b>26%</b>	<b>74%</b>
<b>High</b>	<b>1</b>	<b>19%</b>	<b>81 %</b>

Figure 6B – The relative fully loaded costs for workers on high complexity and low complexity tasks, including both labor-related costs and the costs of capital. The cost of western workers at the client’s organizations are normalized to 1. Note that the discounts remain larger for vendor workers assigned to more complex tasks, but that they are even greater than the discounts shown in figure 6A.

Of course, while the relative cost advantage of the vendor outsourcing highly complex tasks may be significantly greater than the vendor’s advantage in outsourcing low complexity tasks, the prices charged are determined by range of market conditions<sup>3</sup>.

Operational risks, the errors caused by those risks, and the costs associated with those errors yield the final factor where considering the relative costs of outsourcing different types of tasks. Our data show that the error rates for subjective, context specific tasks are relatively high, while the error rates for computationally intensive analytical tasks are significantly lower; to relate these observations back to our dimensions of complexity, tasks that have highly codifiable requirements have fewer errors and lower operational risk. Moreover, the likelihood that errors are detected in time to avoid costly problems likewise is better for highly codifiable, computationally intensive analytical tasks than it is for subjective, context specific tasks. That means that the error rates for those tasks that western executives called complex are actually lower, errors are more easily detected and corrected, and the costs that result from correcting those errors is lower<sup>4</sup>. This is shown in figure 7, the all in cost of outsourcing a unit of work, for both simple and complex tasks. As the graphs show, the potential savings are

<sup>3</sup> At present the prices charged to American clients do not appear to fully reflect the savings that can be achieved. A partial explanation is that clients are not confident in vendors’ ability to handle complex tasks and limit themselves to a small subset of the vendors; this lack of full competition limits price pressure on these vendors.

<sup>4</sup> While we do not have sufficient data for us to say that the cost of undetected errors is higher for one class of process than for the other, we do know that the average number of errors that slip through error checking is higher for non-codifiable tasks.

greatest for complex tasks, where the ratio of costs from outsourcing to costs of internal processing are most favorable.

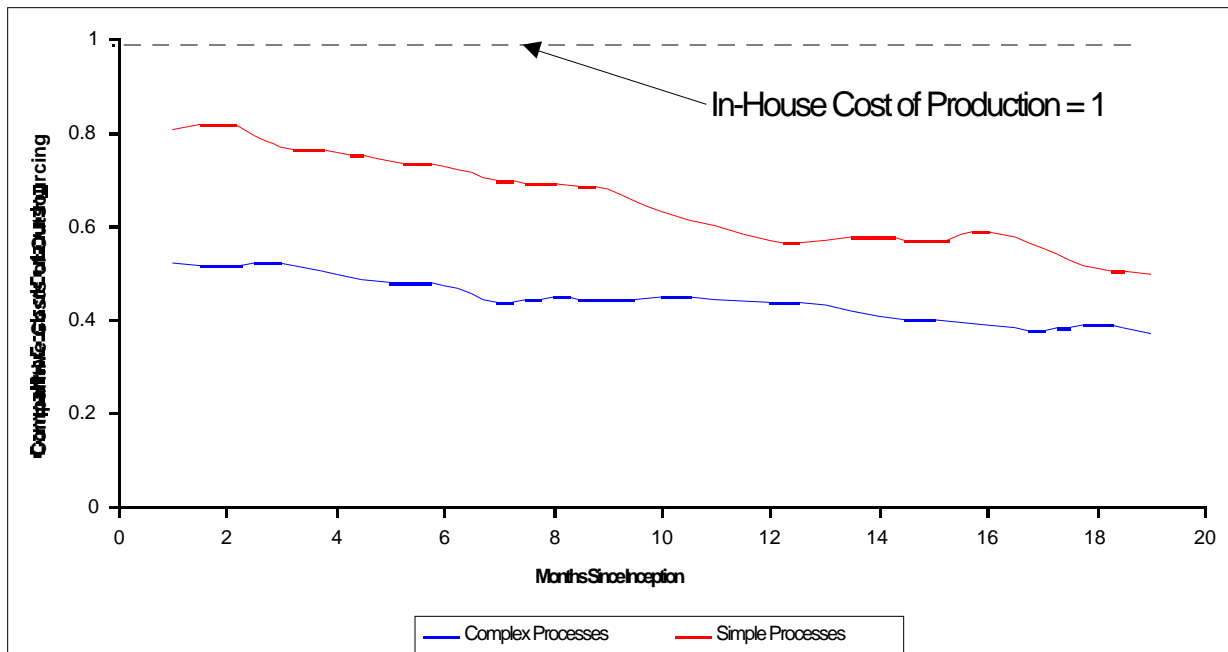


Figure 7 - This figure shows that the fully loaded all-inclusive cost of a unit of work is lower relative to western client workers for higher complexity tasks than it is for lower complexity tasks.

## 6. Theoretical Support

Clearly the empirical evidence supports the anecdotes and leads one to conclude that complexity arbitrage is indeed occurring, and that despite the strong theoretical arguments against outsourcing complex tasks, at present complex tasks are indeed the most promising candidates for outsourcing. How can we reconcile the theoretical arguments against outsourcing complex work with the empirical observations that it is being done, and being done quite successfully?

The best explanation we have for why complexity does not limit the ability to outsource work is that the tasks that western executives call complex really are not. This, of course, runs the risk of being no more than a tautological argument, indeed no more than mere sophistry, unless we can provide some support. In brief, western executives tend to call tasks complex if they load heavily on the two dimensions we highlighted

originally - the number of independent steps and computational or analytical intensity. Indian executives, in contrast, tend to consider tasks to be complex if they cannot be divided into simple independent steps and if they cannot be specified as unambiguous computational or analytical subtasks. As noted above in section 3, there is a strong correlation among the complexity assessments assigned by vendors, and a strong negative correlation between the complexity assessments assigned by clients and those assigned by vendors. Why, then, should we reject the western executives' ranking of complexity and use the Indian executives' assessment instead? We do so because, quite, because it is the Indian executive who is going to have to provide the staff, train them, assign work to them, and assess its output. It is the Indian executives' assessment of whether the work will be seen as complex that is relevant<sup>5</sup>.

Let us examine the risk profile of those tasks that Indian executives believe are not complex. In particular, let us attempt to determine if these tasks can safely be outsourced. We start by addressing strategic risks. If a task can be divided into stages, and each stage is algorithmic, then each stage has an observable outcome and a correct answer. Checking is relatively straightforward, performance can be measured, and principal agent issues should not create contractual problems. Likewise, if a task can be specified as an unambiguous sequence of well described steps and is not seen as complex by vendors, then locating alternative service providers should not be difficult and vendor holdup is unlikely to create contractual problems. Moreover, when the computational and analytical steps are specified and the explicit data required for the steps are available, operational risks should not be significantly higher as a result of outsourcing.

In contrast, those tasks that western executives describe as simple are more difficult to describe; what is the appropriate response for a customer who is angry about the way his previous service order was handled. Output is more difficult to observe - what

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<sup>5</sup> There is one sense in which the American executives' inability to estimate complexity is relevant even when they are persuaded to allow a task to be outsourced. When American executives are concerned that a task may be difficult for the vendor to perform, or that error checking and other quality may be difficult to implement, then the client often insists on excessive levels of inspection during the early stages of the contract. Over time, the client gains confidence and allows the vendor more freedom in implementation of the contract. While this does not alter our conclusion that complex tasks can be outsourced most effectively, it does reduce the cost savings available from doing so.

constitutes a unit of work for an employee fielding such calls, and what constitutes a high quality performance of work? Principal agent concerns now become very real. Training is difficult, and entails everything from working on an acceptable "neutral" American accent to watching videos and understanding the humor of American sit-coms like "Friends" or "Seinfeld". With specialized training required, it is more difficult to find an alternative service provider quickly, and vendor holdup becomes a concern as well. Finally, with the large amount of information needed to process a unit of work and the amount of information required simply to replicate the context automatically available to a client employee when he reports to work, operational risk becomes significant.

In brief, strategic and operational risks are lower for the tasks that western executives term complex, and they are higher for the tasks that western executives call simple. When risk considerations are combined with cost considerations, it is now obvious why opportunities to outsource complex tasks are so attractive. However, with western resistance to outsourcing of tasks that appear complex, it is also clear why many of these opportunities have not yet been exploited.

## **7. Disclaimer**

In this paper we have not addressed the risk of poaching, that is, the risk that outsourcing complex tasks will create unacceptable loss of intellectual property. When a task has been divided into a sequence of steps, and the computational or algorithmic processes behind each step have been fully specified, then the understanding of a task has been fully transferred from the client to the vendor. If this is a task with considerable economic value - like the ability to make a drug or pesticide that is covered by trade secret rather than patent - then transferring the expertise may be quite dangerous for the client. Tasks that cannot be fully described computationally may be harder to transfer to the vendor and thus may represent less risk.

The data that we captured for this paper do not reflect the long term costs associated with loss of competitive advantage resulting from the loss of control over intellectual property. Since the data do not reflect these costs, these costs are not factored into our

analysis of the relative advantage of outsourcing simple and complex tasks. There are ways to manage this risk in some contexts, which we address in a companion paper [2].

## **8. Conclusions**

Our research shows that despite expectations to the contrary, tasks that western executives consider most complex are often the most appropriate tasks for outsourcing.

- The ratio of the vendor's worker productivity to the client's own productivity is better for high complexity tasks than for low complexity tasks, in absolute terms (output per unit time).
- The productivity advantage becomes even greater when the different costs of workers for high complexity and low complexity tasks is used to adjust productivity figures. When the total costs are compared, including both wages and capital equipment, the savings from outsourcing complex tasks clearly are greater than the complexity from outsourcing low complexity tasks.
- Error rates are lower for high complexity tasks than for low complexity tasks, given the computational and replicable nature of the high complexity work, and inspection costs are lower, given the unambiguous nature of a correct output.
- Finally, when the costs of inspection and error correction are included, and when the down-stream expenses associated with uncorrected errors are factored in, the cost advantage of high complexity tasks becomes most significant.

In summary, our data suggest that the total percentage savings that can be expected from outsourcing high complexity tasks ranges from 37% to 84%, where expected savings may average 64%. In contrast, the total savings available from outsourcing low complexity tasks is a somewhat lower, ranging from 16% to 61%, with expected savings of 38%.

Moreover, complex tasks do not appear to be more risky. For reasons described above, they do not appear to be subject to higher degrees of opportunistic behavior. Because output can readily be measured and evaluated, principal-agent problems (shirking) are not extreme. Because skilled workers are available for computationally intensive analytical work, opportunistic repricing (vendor holdup) likewise appears limited.

Finally, because modern telecommunications technology permits transferring of the data required for these computationally intensive tasks, but since no current technology can bridge cultural gaps or provide context-specific understanding in unscripted human interactions, the operational risks are lower for analytical tasks than for other forms of work.

### **8.1. Ongoing Research Efforts**

Our multi-year study is continuing, and we hope to address additional issues over time. At present we are exploring the following:

- The relationship between intensity of monitoring and performance of vendor personnel across different levels of task complexity
- The relationship between severity of penalty clauses for errors and imperfect output and the vendor performance levels that result, across different levels of task complexity
- The relationship between task performance and governance structure. Are complex tasks best performed when the vendor is a traditional (independent) third party, a captive (wholly owned) subsidiary, or an equity joint venture. Additionally, we are studying the performance implications of governance using an extended organizational form, in which the vendor is independent of the client but decision rights and management of the contract is in some sense shared between the two organizations.

### **8.2 Implications of Our Research**

We note that this work has two important implications:

- More complex tasks are also more expensive to perform in domestic western markets. To the extent that these tasks can be safely and inexpensively outsourced abroad, the savings available from outsourcing may be even larger than currently believed.
- More complex tasks are often more rewarding for the domestic workers who perform them, both in terms of direct and immediate financial compensation and of job satisfaction and in terms of long term career opportunities. To the extent

that these tasks can be safely and inexpensively outsourced abroad, the domestic political disruption from outsourcing may be greater in western economies than currently believed.

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