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An Industry-level Examination of Information Technology Outsourcing in Services and Manufacturing

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Abstract:

This study provides evidence of differential productivity impacts between the outsourcing of ongoing IT operations and the outsourcing of IT design and build activities. Additionally, this study finds differential productivity impacts between manufacturing and service sectors. Evidence shows that a large portion of IT budgets are dedicated to ongoing operations, yet ongoing operations is seldom researched. This study differentiates the impact of spending IT outsourcing related to ongoing IT operations versus spending on IT outsourcing to build new systems. Using industry-level data from twenty-five service industries and nineteen manufacturing industries for the years 1998 to 2004,I examine the impact on outsourcing ongoing operations from the design of new systems and I compare the effects in manufacturing and services. This study shows that outsourcing IT design services positively contributes to productivity, while outsourcing IT operations does not. Furthermore, this study shows that the positive impact of IT design is greater for manufacturing industries.

Keywords: IT outsourcing; business value of IT; industry-level; IT operations

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INTRODUCTION

CIOs are faced with the question of how much of an IT budget to spend on developing new systems and how much to spend supporting existing IT systems. Recent commentary (Butler and Gray 2006) in the IS literature has begun to acknowledge that the IS community has not investigated the role of IT operations, but rather has focused on issues surrounding the building of new IT systems. According to recent Bureau of Economic Analysis (BEA) data, spending IT operations accounted for 55 percent of all expenditures on outsourced IT for the period from 1998–2004. Research into the economic impacts of IT has typically focused on either (A) aggregate levels of IT expenditure or (B) levels of IT capital. Increasingly researchers have tried to address issues such as under what conditions IT spending result in what performance does and what investments are complimentary to investment in IT. Using Industry-level BEA data, this study compares the economic impact of outsourcing IT operations versus the impact of outsourcing the design of IT systems. Furthermore, the study compares the impact in manufacturing to impacts in services. Recent research has also investigated what the economic impact of outsourcing IT operations is. This study addresses the following research questions:

Does the productivity impact of outsourcing IT operations differ from the productivity impact of design/build activities?

If so, do these effects vary between manufacturing and service sectors?

These questions are important because (1) spending on IT operations is a substantial portion of the IT budget, (2) this can provide insight as to what functions to outsource, (3) this can provide further insight into what the industry-level impacts of IT spending are, and (4) this can provide insight as to what sectors benefit from what type of outsourcing.

CONCEPT DEVELOPMENT

The purpose of this study is to compare the impacts of outsourcing of IT operations and outsourcing IT design in both services and manufacturing. It is important to understand the current state of industry-level analysis, how manufacturing and services differ, and how IT operations differ from building IT systems.

Industry-level Analysis

This paper uses IT investment at the industry-level; therefore, an overview of industry-level studies should be included. IT operations have been researched indirectly through survey research on the impact of reliable systems (Butler and Gray 2006). The author was unable to find any study on the economic impact of spending on IT operations. IT outsourcing research conducted at the industry level (Han et al. 2005) and at the firm-level have shown IT outsourcing to have positive contributions to productivity (Chang and Gurbaxani 2005b). Chang and Gurbaxani (2005b) showed that firm size and cost structure impact the potential gains from outsourcing, but to date no study has disaggregated IT outsourcing.

CONTRIBUTION

This paper makes five key contributions to IS research. First, this paper shows that relative gains in output from outsourcing IT design-related services are greater than the relative gains from outsourcing ongoing IT operations. Second, this paper illustrates that the impact on productivity of IT outsourcing is different in manufacturing and services. Third, we show that outsourcing IT operations has a negative impact in manufacturing. Fourth, the paper shows outsourcing IT design has a positive impact in services, but no impact in manufacturing. Finally, this paper provides additional evidence that the impacts of IT investments vary substantially across industries and sectors.

Using U.S. industry-level data from 1998–2004, this study tests the relative impacts of IT investments on output using a Cobb-Douglas production function. This study also compares the capital forming activities of the IT function, designing and building new systems, with those activities involved in day-to-day operations. Despite the fact that it is well-known that ongoing operations comprise roughly half a typical firm’s IT expenditure, to my knowledge, this is the study to disaggregate IT expenditure this way and to look at the relative impacts of each on business value.

This research also provides further evidence to support the notion that many of the differences we observe in outcomes from IT investment can be attributed to differences between industries, as opposed to differences between firms. Additionally, this study shows substantial differences between manufacturing and service sector in terms of output derived from IT investment. From a theory perspective, services are intangible, involve coproduction, and involve lots of variety. This paper illustrates how these fundamental differences lead to very different outcomes in terms of business value derived from IT outsourcing.

Industry-level studies can be categorized into three categories: (1) studies that examine the impact of IT-producing industries, (2) studies that look at the impact of IT-consumption, and (3) studies that use industry-level data to look at the macroeconomic impacts of IT. Before beginning discussions of industry-level studies, it is important to discuss relevant data issues. The most recent literature review provides an excellent overview of empirical research on the economics of IT investment and provides a point of reference for the author (Dedrick et al. 2003). This paper will not discuss the IT-consuming studies, because they were much earlier and of less relevance to this paper. Bailey and Lawrence (2001) were the first to show labor productivity growth based on the intensity of IT consumption, but the paper did not present detailed regression results. Stiroh (2002) produced the first industry-centric study to show industry-by-industry level effects of IT consumption with several measures of intensity of IT consumption and showed gains beginning in 1995 for both IT-consuming and IT-producing industries. Within information systems (IS) literature, the only published study to use industry-level data looked at the impact of IT-services industry as a proxy for outsourcing and its impact on productivity via a Cobb-Douglas production function using BEA data (Han et al. 2005). One study has looked at industry-level efficiency using a SFA approach and found that firms in more competitive markets use IT more efficiently (Chang and Gurbaxani 2005a).

Beyond the industry-centric studies, there are a series of papers that use industry-level IT investment as an input for broader analysis of macroeconomic phenomena that could inform this work in regard to potential findings, possible data sources, and relevant variables. Using BEA data from 1973–1991, Stiroh (1998) found little impact on productivity in IT-using industries, but positive impacts from IT-producing industries. Stiroh (1998) used IT capital as the measure of IT usage, but did not include a service component because the data was not available based on the SIC coding scheme. More recently, Cheng and Nault (2007) found positive downstream productivity returns to IT. IT contributions to industry-level were used to study aggregate gross output from 1987–1999 and found IT consuming to have positive effects after 1995 (Basu et al. 2001). Another series of papers compared macro-level productivity effects from IT between countries using IT related industry effects as input factors to the overall productivity functions (Basu et al. 2003; Van Ark and Inklaar 2005).

Key points are (a) few IT industry-level studies have looked at the industry-level effects of consuming IT at the industry-level, but rather have looked at the impact of IT-related industries on the macro-economy and are thus of less interest to information systems researchers, (b) few studies disaggregate the IT spending component, and (c) no existing outsourcing disaggregate the outsourcing activities.

Comparison of Manufacturing and Service Sectors

Services differ from manufacturing because of the nature of production in a service context is inherently different from production in a manufacturing context. Services exhibit the characteristics of intangibility, inseparability, and heterogeneity. Intangibility refers to the idea that services cannot be inventoried, are not readily measured, and do not even consume physical space (Shostack 1977). Inseparability refers to the idea that the consumption of a service and the production of a service often occur simultaneously (Carmen and Langeard 1980). Service production is often inseparable from consumption to such a degree that the consumer rises to the level of coproduction (Parasuraman et al. 1985). Heterogeneity refers to the idea that services often vary from day to day and customer to customer (Parasuraman et al. 1985). Services and manufacturing are different, in that in a service context the customer supplies key inputs to the production process (Brown et al. 2002). Coproduction of output that is common in services necessitates a high degree of cooperation between consumer and producer. In service industries the production process is highly contingent on the specific interactions of consumers and producers, which implies far greater uncertainty a priori in the sequence of events necessary for production of services. As a result, a high degree of uncertainty results from the coproduction found in services (Argote 1982; Jones 1987).

The heterogeneity inherent in service processes manifests as variety that can be seen as a sign of the flexibility that is necessary for high quality (Feldman 2000). In a manufacturing environment, in contrast, variation in the sequence of tasks used in production is seen as indicative of poor quality (Oakland 1996). Empirical work on task sequencing has observed a high degree of variety in service settings (Pentland 2003). Previous studies have shown processes to be a potential source of flexibility in organizations (Feldman and Pentland 2003). Increasingly, information processing involves the use of workflow management systems, which are being used to define work processes in service industries (Fletcher et al. 2003). The ability of a service provider to deal with a wide variety of situations is a mark of high customer service (Zeithaml et al. 1990; Cronin and Taylor 1994) and a key factor in retaining customers in service environments (Keaveney 1995). Service workers must be capable of developing novel solutions to the often unique situations they frequently face. A great deal of uncertainty results from this uniqueness, often requiring much information processing and a high level of IT capital (Bowen and Ford 2002).

Prior empirical work has shown the productive effects from IT investment to be higher in manufacturing than services (Dewan and Min 1997). More recent work has shown differential impacts, between manufacturing and services, of industry-level factors on the efficient use of IT (Wimble et al. 2007). Comparisons of manufacturing and services have long observed that substitution of capital for labor is much easier in manufacturing than in services (Baumol 1967). As an example, today it takes a nurse nearly as long to change a bandage as it did a hundred years ago, but the manufacture of most products over this time has required drastically less labor. In summary, services differ strongly from manufacturing in terms of intangibility, inseparability, and heterogeneity. These differences have manifested in empirically observable differences in the effect that various input factors, both IT and non-IT, have on productivity. Key points are that (1) the "standard" economic story is often one of manufacturing and is thus more often the subject of inquiry; (2) service production is typified by intangible goods that are difficult to measure and where the consumer is highly integrated into productions sequence; (3) the prior empirical work has shown differential effects from IT investment in manufacturing and services; (4) economic theory suggests that, due to the highly variable nature of production sequences in services, it is difficult to substitute capital for labor in services.

Comparison of Operations and Design

IT operations is sometimes described as activities related to "keeping the lights on," and, as such, the focus is often on reliability. Evidence from practice suggests that a substantial portion, 55–80 percent, depending on the survey, of the typical IT budget is dedicated to ongoing operations and maintenance as opposed to new investment (David etal. 2002; Mendel and O'Neill 2006). Despite the fact that ongoing operations represents a substantial portion of IT investment, little attention has been paid to this area by IS researchers (Butler and Grey 2006). A possible lens to study this might be how the productivity impacts of expenditure on ongoing IT operations differs from expenditure on new IT capital. Substantial research on IT outsourcing has focused on the issue surrounding the design and building of new IT systems, using primarily a Transaction Cost Economics (TCE) lens. I contend that this also provides a good lens to examine differences between operations and design. I suggest that the asset specificity arises in operations as a result of interactions between components of a particular system configuration, rather than a specific product such as SAP or Oracle. Key points here are: (1) IT operations represented a substantial portion of the IT budget; (2) little, if any IS research has focused on the role of IT operations; and (3) TCE provides a theoretic lens by which to examine these differences.

THEORETIC DEVELOPMENT

In order to study the economic impacts at the industry-level, a production function is developed following a previously used framework (Han et al. 2005) to study IT outsourcing, I treat IT operations and IT design as an intermediate input using the widely used Cobb-Douglas production function,

$$Y = AK_N^{\alpha} K_{IT}^{\beta} L^{\gamma} M^{\theta} Z_O^{\delta} Z_D^{\omega}$$

where A is the technological change parameter. K_N, K_{IT}, L, M, Z_O, and Z_D are non-IT capital, IT capital, labor, non-IT services intermediate inputs, IT operations outsourcing, and IT design outsourcing. $\alpha, \beta, \gamma, \theta, \delta$ and ω are the output elasticities.

Once a production framework is established, one must examine the relevant economic forces that would impact the respective output elasticities. Two factors are most relevant for this study: (1) asset specificity and (2) uncertainty. In operations the goal is reliability. In IT systems reliability is often somewhat a function of the interactions and interdependences between systems components. The number of possible configurations is combinatorial in nature and thus is likely to be highly specific to the particular configuration of a given firm. Because the number of possible interactions between systems components is so large, it is likely that problems specific to a given configuration become apparent only after installation. The argument here is that the organizational learning necessary for effective IT operations is not only highly asset-specific, but the knowledge capital necessarily comes from experience with a particular configuration.

In designing new systems, such as an ERP implementation, many of the activities often occur only once at design time and are specific to implementation. System implementation necessitates specific, but rarely used human capital. In this case, outsourcing creates economies of specialization, since firms do not have to acquire rarely used, but valuable labor (Clemons et al. 2000). In operations, it is likely, for the reasons cited, that the knowledge is specific to a particular system and thus outsourcing this function would provide little advantage. This leads to the following:

H1: Outsourcing IT design will improve output more than outsourcing IT operations.

In service industries the customer is exposed to the production process in real-time, but in manufacturing the production process is delayed by transportation and inventory. IT operations are often concerned with system reliability. In service industries system outages result in direct customer impacts, but in manufacturing the impact of poor reliability are insulated by inventory. For example, if a travel agent is unable to access a reservation system, the customer is directly impacted and no service is provided. By contrast, in manufacturing, if an assembly plant is shut down because of a system error, the customer will probably not be directly impacted because inventory provides a degree of managerial slack, which leads to the following:

H2: The impact of outsourcing IT operations in manufacturing will be different than the impact of outsourcing IT operations in services.

Because the ongoing nature of IT operations creates highly specific assets in the form of processes specific to a given system configuration, this gives rise to vulnerabilities (Williamson 1983). The presence of these vulnerabilities leads to the following two hypotheses:

H3a: Outsourcing IT operations will have a negative impact in manufacturing.

H3b: Outsourcing IT operations will have a negative impact in services.

Although IT design activities often require highly specialized skills because the IT design transactions are inherently project-oriented, non-ongoing tasks of the asset specificity is highly contractible and does not give rise to vulnerabilities. Through aggregation the IT design outsourcer is able to create economies of specialization (Clemons et al. 2000). The absence of vulnerabilities and the presence of specialization effects lead to the following two hypotheses:

H4a: Outsourcing IT design will have a positive impact in manufacturing.

H4b: Outsourcing IT design will have a positive impact in services.

IT design is essentially a capital formation process, and it has been shown that service industries have higher skilled workers than manufacturing. Griliches (1969) first proposed the idea of capital–skill complementarities, which states that capital and worker skill have super-additive effects. The concept of capital–skill complementarity leads to the following:

H5: Outsourcing IT design in services will have a greater positive impact than outsourcing IT design in manufacturing.

METHODOLOGY

The data from this study came from the BEA input-output tables and the BEA fixed-asset tables. The data covers twenty-five service industries and nineteen manufacturing industries for the years 1998 to 2004. The non-IT capital and IT-capital data come from the BEA fixed asset table. The labor and output data comes from the BEA input-output tables. Industries 5415 "Computer systems design and related services" and 514 "Information and data processing services" represent the intermediate inputs for outsourced IT design and outsourced IT operations respectively. The remaining intermediate inputs were the sum of all inputs that are not among those mentioned above. Intermediate input of IT capital is included in the non-outsourcing intermediate input. All the data is in real, inflation-adjusted, dollars.

Table 1: Descriptive Statistics of Manufacturing Data

	K	L	ITK	M	OPS	DES
Mean	87600.24	46343.57	5743.835	32443.30	612.8271	592.9293
Median	71665.00	33149.20	2668.000	20654.80	311.8000	128.1000
Std. Dev.	59617.47	30878.76	7072.930	28845.75	590.0083	1121.466

Table 2: Descriptive Statistics of Service Data

	K	L	ITK	M	OPS	DES
Mean	146788.6	96533.36	21278.71	88416.72	1600.128	1155.056
Median	78387.00	75996.00	8092.000	65343.80	1181.400	1085.200
Std. Dev.	164664.8	78077.77	44762.99	77270.34	1616.045	1274.899

To estimate the production function,I take the natural log of equation 1 to yield the following to be estimated:

$$y = \beta_0 + \beta_1 K + \beta_2 L + \beta_3 ITK + \beta_4 OPS + \beta_5 DES + \beta_6 M + \varepsilon$$

Due to the cross-sectional nature of the data,I checked for heteroskedasticity using the White Heteroskedasticity Test with cross-terms on all regressions and corrected for it using White Heteroskedasticity-Consistent Standard Errors (WHCSE) where indicated. Regressions were performed using the ordinary least squares (OLS) method using EViews. Regressions were checked for autocorrelation using the Durbin-Watson test, and no auto correlation was found. Also, a year variable was added, but found to be not significant. Because the sample size is different and I believe the variance will also be different between manufacturing and service sector, which would violate Gauss-Markov assumptions, I conduct two separate regression analyses rather than a single analysis using binary interactions.

RESULTS

The regression results are presented in Table 3. Model fit was good for both models, with over 93 percent of variance explained in both cases.

		Manufacturing			**Services**	
Variable	**Elasticity**	**t-Statistic**	**Prob.**	**Elasticity**	**t-Statistic**	**Prob.**
C	2.749196	4.833733	0.0000	0.870544	3.175995	0.0018
LOG(K)	0.068435	1.300241	0.1959	0.114639	4.592537	0.0000
LOG(L)	0.102529	1.558518	0.1216	0.309557	7.719862	0.0000
LOG(ITK)	0.025401	0.708342	0.4800	-0.09956	-3.73819	0.0003
LOG(OPS)	-0.17844	-2.116	0.0363	-0.02464	-0.62903	0.5302
LOG(DES)	0.04542	1.703234	0.0910	0.118214	3.393922	0.0009
LOG(M)	0.800708	9.438403	0.0000	0.631981	15.23116	0.0000
R-squared		0.943951		R-squared		0.930746
Adjusted R-squared		0.941282		Adjusted R-squared		0.928273
Durbin-Watson stat		2.006442		Durbin-Watson stat		2.056531
F-statistic		353.6727		F-statistic		376.3097
Prob(F-statistic)		0		Prob(F-statistic)		0

A summary of findings is presented in Table 4. All production functions are shown to be significant overall and explain the large amount of variation in the output.

Hypothesis	**Findings**	**Support?**
H1: Outsourcing IT design will improve output more than outsourcing IT operations.	Design positive and significant in both cases, operations negative in one case and insignificant in another	Yes
H2: The impact of outsourcing IT operations in manufacturing will be different than the impact of outsourcing IT operations in services.	Operations negative and significant in manufacturing, but insignificant in services	Yes
H3a: Outsourcing IT operations will have a negative impact in manufacturing.	Significant at 5%	Yes
H3b: Outsourcing IT operations will have a negative impact in services.	Negative coefficient, but insignificant	No
H4a: Outsourcing IT design will have a positive impact in manufacturing.	Positive at 10%	No
H4b: Outsourcing IT design will have a positive impact in services.	Positive at 1%	Yes
H5: Outsourcing IT design in services will have a greater positive impact than outsourcing IT design in manufacturing.	F-test indicated they are different at 5%	Yes

All hypotheses were tested at 5 percent significance. Support is found for all hypotheses except hypothesis 3b. For 3b the resulting coefficient was negative,as predicted, but was not significant. Based on the theoretical framework provided, this implies that there are some potentially unusual asset-specificity issues that arise from outsourcing IT operations and that capital–skill complementarity plays a role in the impact of outsourcing IT design. It is worth noting for future research that, after the intermediate effects of IT outsourcing are factored into the analysis, the impact of IT capital becomes insignificant in manufacturing and negative in services.

DISCUSSION AND CONCLUSION

This study investigates several areas of the literature that have been either unexplored or under-explored. Evidence shows that a large portion of IT budgets are dedicated to ongoing operations. This study is the first I know of that attempts to differentiate spending on ongoing IT operations from spending to build new systems. It is found that outsourcing of IT design positively contributes to productivity, but outsourcing of IT operations does not. Also, the impact of IT outsourcing in service sectors is found to be different than the impact in manufacturing. This study is important because (1) it investigates the economic impact of spending on IT operations;(2) it provides insight regarding what functions to outsource;(3) it provides further insight into what the industry-level impacts of IT spending are; and (4) it provides insight regarding what sectors benefit from what type of outsourcing.

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