

## ARE THERE CONTAGION EFFECTS IN IT AND BUSINESS PROCESS OUTSOURCING?

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### ABSTRACT

We model the diffusion of IT outsourcing via announcements about IT outsourcing deals. We estimate a *lognormal diffusion curve* to test whether IT outsourcing follows a pure diffusion process or there are *contagion effects* involved. The methodology permits us to study the consequences of outsourcing events, especially *mega-deals* with IT contract amounts that exceeded US\$ 1 billion. Mega-deals act, we theorize, as *precipitating events* that create a strong basis for contagion effects and are likely to affect decision-making by other firms in an industry. Then, we evaluate the role of different communication channels in the diffusion process of IT outsourcing by testing for the fit of the mixed influence model at the industry level. This helps us to evaluate the consistency of evidence at two different levels of analysis. We also evaluate two flexible diffusion models: the Gompertz and Weibull models. Our results show that the diffusion patterns of IT outsourcing do not appear to be lognormal, suggesting that IT outsourcing does not follow a pure diffusion process. Instead, we find the presence of contagion effects in the diffusion of IT outsourcing. During periods of the most rapid outsourcing growth – the *contagion periods* – the actions of the large and more visible firms may provide exemplars for smaller firms, reducing their inhibitions about committing to IT outsourcing. We also find that the results of the mixed influence and the Weibull models, which provide the best fit for overall IT outsourcing diffusion patterns, are potentially indicative of the existence of spillovers that might drive the observed contagion effects at the industry level.

**Keywords.** Adoption and diffusion, Bass model, contagion effects, economic analysis, influence models, IT services, market announcements, S-curve flexible models, outsourcing, technology adoption.

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## 1. INTRODUCTION

*IT outsourcing* involves “contributions by external vendors [to] the physical and/or human resources associated with ... components of the IT infrastructure in the user organization” [34, p. 336]. Over the last two decades, IT spending and outsourcing have grown quickly and spread widely. In 2007, Gartner predicted global IT services spending to grow by 7.3% annually to US\$958 billion in 2011 [12]. Forrester Research [10] has more recently reported that IT spending in the United States will reach US\$568 billion in 2010, nearly one-third of global IT spending of US\$1.6 trillion. This includes a 3.8% gain in business process outsourcing, somewhat less than the cumulative annual growth of 10.9% from 2005 onwards that the consultancy, IDC, had been predicting [54]. Another 2010 study by Accenture [40] indicated that business process outsourcing spending has been growing more rapidly than IT outsourcing, with estimates that IT outsourcing spending will be between US\$230 and US\$250 billion, while business process outsourcing spending is likely to grow to US\$300 billion by 2012. Business process outsourcing involves IT outsourcing and contracting to a third party of software, process management, and people to operate the outsourced service [19].

The main objective of our study is to understand the underlying factors of IT outsourcing growth and establish the extent to which the spread of IT and IT-supported business process outsourcing is subject to contagion effects in their observed patterns of growth. In addition to this, we also analyze the factors that influence the diffusion of IT and business process outsourcing, and test models that help us understand the rate and patterns of diffusion at the industry level. In particular, our goal is to provide evidence for the presence of *contagion effects*. They are “the spread of a particular type of behavior through time and space as a result of a prototype or model performing the behavior and either facilitating that behavior in the observer or reducing the observer’s inhibitions against performing that same behavior” [42, p. 1006]. Contagion effects are present in the spread of diseases, and have *precipitating events* – like initial infection – that prompt diffusion across a population [43, 45]. Such precipitating events often occur at random, independent of each other and across locations [15]. We will look for evidence that runs counter to the observation that IT outsourcing will exhibit linear growth. This is similar to what we might see with the diffusion of diseases also, where predisposing factors and population characteristics lead to the non-linear, non-random spread of epidemics. This analogy provides support for understanding how diffusion of IT outsourcing has occurred at the industry level.

For nearly two decades now, academicians have been conducting research on outsourcing. Most studies have focused on a particular aspect of outsourcing. Aubert et al. [3] studied the risks that are involved, while Lacity and Willcocks [31] examined best practices in outsourcing. Loh and Venkatraman [33] are known for exploring the reasons that firms engage in outsourcing. Other research by Kern and Willcocks [29] has shown that firms tend to form focal outsourcing relationships with their IT services suppliers.

Walden [53] studied how firms deal with intellectual property rights and their division in IT outsourcing relationships, which also is likely to affect the diffusion of outsourcing practices. More recently, Goo et al. [21] evaluated the role of service level agreements in relational management of IT outsourcing, and Benaroch et al. [6] have modeled and analyzed how to price back-sourcing options in IT services outsourcing contracts. Also, Han et al. [25] have empirically evaluated the contribution of IT services outsourcing as a factor for intermediate inputs in an analysis of industry-level output and productivity, suggesting its increasing importance in the American and global economy across many different industries.

Two notable studies have explored the sources of influence in the adoption of IT outsourcing. Loh and Venkatraman [34] treated IT outsourcing as an administrative innovation and focused on the factors in its adoption using diffusion modeling at the firm level. They found that, in the adoption of IT outsourcing, internal influences and imitative behavior play a more important role compared to external influences and the mass media. The authors analyzed Eastman Kodak's widely-publicized outsourcing decision in 1989 as a critical event and found that internal influences were more pronounced in the post-Kodak regime. In this research, they coined the term *Kodak effect*, as a means to indicate the influence of one firm's outsourcing announcement on the decision-making at other firms. Another study by Hu et al. [26] used a sample of 175 firms to test for different sources of influence on the adoption of IT outsourcing. They found that the mixed influence model was more effective in characterizing the diffusion of IT outsourcing. They tested for the Kodak effect in diffusion, but found no evidence of any differences between the results of different influence models in the pre-Kodak and post-Kodak regimes, contradicting Loh and Venkatraman's [34] findings.

Our focus is on trying to understand the extent to which contagion effects drive the spread of IT outsourcing, and what are the factors that influence these contagion effects. First, we will empirically examine whether IT outsourcing follows a pure diffusion process at the firm level, by estimating a lognormal distribution. This permits us to evaluate whether there are contagion effects present in our data. Random, independently-occurring large dollar mega-deals may act as precipitating events for outsourcing contagion, and large firms may act as exemplars for smaller ones, reducing smaller firms' inhibition to outsource. We will use firm size as a stratifier, since we were able to obtain data for it for all the observations in our data set, and because it is representative of other possible stratifiers in the illustration of our methodology in this research.

Second, we will test for two flexible S-curve diffusion models and the factors that influence the adoption of IT outsourcing at the industry level. These additional tests at the industry level offer four distinct benefits. (1) Evaluating the factors that drive the contagion effects at the level of the industry is a way of providing additional evidence on the phenomenon that we are studying – through “triangulation” with

data at the more aggregate level of analysis. (2) Analyzing industry level data gives us an opportunity to evaluate models that posit different structures for the communication channels to the marketplace. In this work, we evaluate the extent to which the internal and external communication channels were active. (3) This also gave us an opportunity to showcase corroborating results with respect to other research. In particular it gives us a chance to explore the explanatory capacity of the mixed influence model as the primary evaluator of the relationships in our data, and from this, to draw conclusions about the importance of the internal communication channel relative to the external communication channel in explaining the contagion outcomes. (4) Further, it provides a basis for us to evaluate other empirical models to obtain insights into the different diffusion patterns for IT outsourcing in several different industries.

We ask: How do IT and business process outsourcing spread at the firm level? Can IT outsourcing be explained by pure diffusion with no contagion effects? Or is there a contagion process involved? What role do different communication channels play? Do mega-deals of more than US\$1 billion affect the observed patterns of diffusion? To understand the diffusion patterns and to examine whether IT outsourcing follows a pure diffusion process or there are contagion effects involved, we estimate a *lognormal diffusion curve* [1]. This permits us to gauge the consequences of outsourcing events, and the effects of different orders of magnitude in IT contract amounts. We also evaluate the sources of influence in IT outsourcing diffusion at the industry level [35, 36]. Using *firm size* as a stratifier, we will assess how firms may act as *market exemplars*, reducing a *market observer firm's* inhibitions against adopting IT outsourcing [42].

This article is laid out as follows. Section 2 presents the theory and hypotheses for this research. We discuss the theories that explain the diffusion process for outsourcing and discuss the use and efficacy of growth models in prior studies. Section 3 introduces our two data sets and analysis procedure, and the empirical model that we apply to test our proposed theory. Section 4 provides the results of our base analysis, the influence models and flexible S-curve growth models. We cover the firm and industry levels with our empirical study, as a means to gauge the extent to which our findings are consistent across the different levels of analysis. Section 5 includes a broader discussion and interpretation of what we have learned, and a summation of the main results and limitations.

## 2. THEORY

IT outsourcing and IT-related business process outsourcing account for a large share of the overall outsourcing activities related to IT, and so they are appropriate for this research. *Business process outsourcing* is the contracting of a specific business process or service to a third party, and often involves IT outsourcing [19]. It includes software, process management, and people to operate the service that is outsourced. We consider the *diffusion of innovation theory* and other precursors to *contagion effects the-*

ory to develop insights on IT outsourcing diffusion at an industry and firm level.

### 2.1. Diffusion of Innovations

The *diffusion of innovation* is the process by which information about an innovation is communicated over time among members of a social system, leading to adoption [45]. Diffusion has been shown to follow an S-shaped curve with five phases. Each represents a proportion of the total number of adopters up to some time: innovators, early adopters, early majority, late majority, and laggards. Diffusion also involves *network externalities*, representing the boost in value a participant derives from the network as others join it [46]. With interdependent demand, multiple equilibria can exist at any price. Another related concept in diffusion studies is *critical mass*, which indicates the time in the diffusion process when the number of adopters is sufficiently large to naturally sustain further growth of adoption [38]. Sometimes, critical mass is referred to as a *tipping point* because the rate of adoption increases rapidly after critical mass is reached. Mahler and Rogers [37] suggest that adoption and critical mass involve decision-making by individuals who have insight about other potential adopters, thus influencing their own decision.

Midlarsky [42, p. 1006] defines *diffusion* as “the spread of a particular type of behavior through time and space as the result of the cumulative impact of a set of statistically independent events.” Thus, a way to understand the process of IT outsourcing diffusion is to model the connectedness of the events that precede outsourcing deals. We view *randomly-occurring, independent precipitating events*, such as mega-deals, as potentially influencing the later diffusion of IT and business process outsourcing. This occurs on a *proportional basis*: the number of new outsourcing deal announcements is proportional to the number of deals that have been concluded. Hence, we assert:

- **Hypothesis 1 (The Randomly Proportional Outsourcing Diffusion Hypothesis).** *The set of responses reflecting IT outsourcing diffusion is randomly proportional to independently occurring, random precipitating events.*

### 2.2. Contagion Effects

*Contagion effects theory* posits the connectedness of adoption events over time, and offers a refined expression of the diffusion of innovation theory [28]. Contagion effects arise in two ways. The first is *spillovers* that are due to interdependencies among market activities: aligned management interests, or business activities in an industry, in a region, or across firms with similar interests or operating characteristics, etc. Another is external to business, industry and geography, and is based on macroeconomic drivers.

Another perspective for why we might observe contagion effects with IT outsourcing is *social contagion*. It occurs when organizations feel social pressure to adopt an innovation that increases in proportion to the extent of prior adoption [23, 51]. This perspective is based on social learning theory [4] and neo-institutional theory [13, 48]. *Social learning theory* posits that people engage in social learning by examining the actions of similar peers. People communicate with each other, or observe the actions of others,

as well as the consequences of those actions. They also rely on rational processing of information gained from observing their peers, which may lead to making adoption decisions similar to their peers [7].

*Neo-institutional theory* deals with the forces that lead to institutional isomorphism, which represents institutional constraints that are imposed on the firms in an organization that lead to homogeneity of structure [13]. Researchers recognize three forces that cause this: *coercive forces* arising from societal expectations, *normative forces* arising from professionalization, and *mimetic forces* arising from the tendency to imitate peers perceived to be successful under conditions of uncertainty [13, 17].

In the context of IT outsourcing within industries such as banking and finance, the IT outsourcing adoption decision is often influenced by institutional forces [2], while for small and medium firms it may be influenced by coercive, normative or mimetic forces. In the presence of social contagion, the adoption decision is contingent on a firm's own assessment of the innovation's merits, and on who the prior adopters are [17]. Thus, in an industry, large prominent firms may serve as exemplars for smaller firms, influencing their outsourcing adoption decisions. This is what we observed when IBM and Eastman Kodak entered into their IT services outsourcing contract in 1989 [24], and when Nortel Networks and PricewaterhouseCoopers signed a US\$625 million business process outsourcing deal in 2000 [18]. There was a surge in IT outsourcing announcements then, and for small and medium-sized firms, IT outsourcing all of a sudden became a desirable strategic choice. Similar waves of outsourcing have occurred when large, prominent firms have entered into large-scale IT services contracts.

Another stream of research in which contagion effects theory is relevant is political science. It is used to explain the adoption of innovations [22] and social security policy by states [9], the growth of terrorism [43], and other phenomena. Midlarsky's [42] study of urban disorders in 1960s tests whether the spread of civil disorders in small cities in the United States can be attributed to *baseline diffusion effects*, as well as *stratifying effects*. The relevant contagion effect that is proposed is the association between civil unrest in smaller cities and what has occurred in the larger cities – a large city to small city effect. This may occur even though there are differences in the critical mass of the minority populations in the smaller cities.

Contagion effects theory has been used to explain the adoption patterns of successive technology generations of analog and digital wireless phones [27]. The adoption patterns can be partly explained on the basis of stratifying effects. They are the effects of variables that influence the extent of the connection between different behaviors of the units of analysis of interest over time. In our context, evidence for contagion effects might include a significant increase in the number of IT outsourcing contract announcements in a period immediately following earlier periods with IT outsourcing announcements from large leading firms. *Leading firms* may act as models for other firms to emulate. We can assess variables that influence the observed outcomes. Such stratifiers may occur with industries, geography, firms, strategic business units, senior managers, and so on. Hence, we assert:

- **Hypothesis 2 (The Stratified Outsourcing Adoption Hypothesis):** *With contagion effects, the diffusion of outsourcing depends on the influence of variables that act as stratifiers for the settings under which specific diffusion patterns are observed.*

### 2.3. Sources of Influence

To compete successfully, it is necessary for a firm to update and adjust its strategy based on what it learns from its environment. Managerial decision-making is often influenced by such informational updates [14]. Prior research shows that a firm's decision to outsource is influenced by internal factors, such as financial constraints, its strategy and size, and its business sector. In addition, there may be factors that create external influences too. These include institutional pressures, interpersonal and media channels, and risks, such as hidden costs, the inability to control the vendor, and loss of innovative capacity. There also are benefits from cost advantages, the improved focus on the strategic use of IT, and new access to management skills that become available. Depending on which of the factors are prominent, and whether the benefits associated with outsourcing outweigh the associated risks, the firm will decide whether outsourcing offers the appropriate value proposition. Thus, to get a better understanding of how the diffusion process for outsourcing is occurring across an industry, it is important to understand the roles of the different factors that influence firm decision-making.

Based on diffusion of innovation theory, different *communication channels* often act as the conduits for the major *sources of influence* in the adoption of innovations. Three models have been extensively used to study the diffusion of innovation for marketing, telecommunication and IT, the internal influence model, the external influence model and the mixed influence model.<sup>1</sup> We will focus on the *mixed influence model*. It states that potential adopters are influenced by internal sources, especially information from current adopters, and external sources outside the adopters' social system [5, 16]. For IT outsourcing diffusion, potential adopters may be influenced by both external sources (e.g., vendors or service providers) and internal sources (e.g., competing firms), so a mixed influence model may be the best representation of the process.

**Curve Symmetry and Inflection Point for Growth.** Using the concepts of *critical mass* and the *tippling point*, Meade and Islam [41] characterize the different diffusion models, and include the location of the *inflection point for growth* and the *symmetry of the diffusion curve*. The inflection point characterizes the penetration rate of a diffusion process in terms of when peak adoption occurs. Curve symmetry captures the inter-temporal acceleration and deceleration of the diffusion rate. It is important to understand the rates and curve symmetry within an industry because these patterns give us an insight into how IT and

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<sup>1</sup> The *external influence model* suggests that the potential adopters of an innovation are influenced by information from sources external to the adopters' social system, such as the industry, economy or country [16, 36]. In the external influence model, the mass media channels are considered as the main communication channels. In contrast, the *internal influence model* suggests that an increase in the number of new adoptions is driven by influence from current adopters through their communication and interaction with potential adopters, like word of mouth.

business process outsourcing are diffusing within an industry over time. Diffusion patterns can be symmetric or asymmetric because the maximum rate of adoption can occur at any time during the diffusion process. Diffusion is symmetric when the adoption process rate is the same before and after peak adoption. Asymmetric diffusion can occur under different conditions, for instance, when rapid diffusion occurs in the initial period followed by slowing adoption during the following periods or vice versa.

Different models of diffusion vary based on their curve symmetry and inflection points for growth. The external influence model has a constant rate of growth but no inflection point. The internal and mixed influence models are symmetric; but the internal influence model has a fixed inflection point whereas the mixed influence model has a flexible inflection point. The Gompertz model is asymmetric but has a fixed inflection point. The Weibull model can be symmetric or asymmetric, and has a flexible inflection point for diffusion growth. *Flexible diffusion models* with fixed or flexible inflection points and asymmetric shapes potentially provide a better fit for the observed patterns [20, 35, 36]. For IT outsourcing across different industries we believe that the Weibull model, which is the most flexible model out of the models considered, may be able to best capture the IT outsourcing diffusion pattern.

The Randomly Proportional Outsourcing Diffusion Hypothesis (H1) characterizes patterns of IT outsourcing. The Stratified Outsourcing Adoption Hypothesis (H2) does this at a more fine-grained level. The observed effect could be from larger to smaller firms, or between firms in close proximity. We only consider the influence of firm size though. The flexible diffusion models with flexible curve symmetry and the inflection point allow for fitting a flexible diffusion model for the patterns across different industries. This supports our understanding of the different rates and patterns of IT and business process outsourcing diffusion across these industries.

### **3. DATA, ANALYSIS PROCEDURE AND EMPIRICAL MODEL**

#### **3.1. Data**

We used two data sets for our empirical research in this study. One data set captures IT outsourcing information at the industry level, and includes annual data for 60 non-farm industries in the U.S. private sector from 1998 to 2007. We obtained it from the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA). The industries are defined by the three-digit 1997 North American Industry Classification System (NAICS). These data show the value of output produced by one industry that is purchased and used by another industry for all possible pairs of the industries whose inputs and outputs are tracked in a given year. We measure an industry's *IT outsourcing* as services purchased from two IT services industries: Data Processing Services (NAICS 5142) and Computer Systems Design and Related Services (NAICS 5415). The most common areas for IT outsourcing are systems development and integration, software and hardware maintenance and support, and data processing and management [52]. Our



IT outsourcing measure, based on intermediate purchases from the two IT services industries, closely matches our definition of IT outsourcing.

We used *chain-type quantity indices* as deflators, a relatively standard choice, which show the growth of output or other variables over time, holding prices constant [47].<sup>2</sup> We used the industry-level data set to analyze the empirical regularities, as well as to test the influence models and other critical mass and diffusion growth inflection point models for the overall diffusion process.

The other data set consists of announcements of IT and business process outsourcing deals. We collected it from a full-text search of firm announcements related to IT and business process outsourcing between April 1, 1999 and December 31, 2008. We used two leading news sources: *PR Newswire* and *Business Wire*. We also used the online *Lexis/Nexis* database to search the news wires for announcements containing the words “deal” or “contract” or “launch” or “announcement” in the same sentence as the words “BPO” and “IT,” and “outsourcing” or “offshoring.” The search yielded 643 announcements in total, of which 295 announcements had information about IT or business process outsourcing.

Not all of the relevant details – for example, dollar amounts for the contracts required for analysis – were found in the company announcements, however. To collect these data, we searched other secondary sources, including trade journals, company websites, magazine articles, and newspaper articles. We took extra care to differentiate between independent announcements and announcements that were a part of ongoing deals, and only to include independent announcements. We collected announcement data at the firm level which involved either clients or vendors or both that were located in the U.S. We did this to maintain consistency across the industry- and firm-level data.

To test for contagion effects we used a subset of the data that had complete information required for the analysis (especially the dollar amount of the outsourcing deals that firms announced and the firm size). For this analysis, our final data set was somewhat smaller, with 80 announcements.

### 3.2. Analysis Procedure

Figure 1 shows our analysis procedure.

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We first compared the trend patterns at the firm and industry levels for four IT-intensive industries: Broadcasting and Telecommunications (NAICS 513), Banking and Finance (NAICS 521, 522, 523),

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<sup>2</sup> The BEA introduced these indices in 1996 to improve the accuracy of its estimates of the growth in real GDP by eliminating the bias present in *fixed-weight indices* that had been used. The *chain-type Fisher index* addresses the problem of choosing the base period for measures of real output and prices to which all other periods are compared. This index is the *geometric mean* of the *conventional fixed-weighted Laspeyres index*, which uses the weights of the first period in a two-period setting, and the *Paasche index*, which relies on the weights of the second period. Changes in the Fisher index are calculated using the weights of adjacent years. These annual changes are *chained* or multiplied together to form a time-series that allows for the effects of changes in relative prices and in the composition of output over time. See Landefeld and Parker [30] for additional details. More information on the sources, construction procedure, and deflators used for the industry data are given in Appendix A.

Computer Systems Design and Related Services (NAICS 5415), and Healthcare Services (NAICS 621, 622). We used industry-level IT outsourcing data, and firm-level IT and business process outsourcing announcement data. We then applied a lognormal diffusion model to explore IT outsourcing diffusion patterns at the firm level. When the lognormal diffusion model failed to adequately capture the diffusion patterns of IT outsourcing at firm level, we extended the model to test for underlying contagion effects.

To understand the effects of different sources of influence on IT outsourcing diffusion patterns at the industry level, we specified and tested the mixed influence model using non-linear least squares. We also checked the internal and external influence models, as a check on the mixed influence model's findings. In addition to the influence models, we also evaluated the Gompertz and Weibull S-curve models. We used our industry-level data to analyze the influence models because "a key aspect of the Bass model is that it addresses the market in the aggregate ... The emphasis is on total market response rather than an individual customer" [35, p. 6]. The aggregate data obtained for the four industries are more suitable for the analysis of diffusion models than the announcement data obtained across the industries. The announcement data provide incomplete information about the adoption of IT outsourcing across different industries because not all outsourcing contracts are announced to the extent they are picked up in the business press. Thus, with the announcement data it is difficult to obtain very reliable estimates for market potential and the coefficients of innovation and imitation, which are known to be highly sensitive to small variations [5].

**Analysis of Outsourcing Patterns.** We compared the observed patterns in the industry-level IT outsourcing data set with those in the announcement data. We focused on 1999 to 2007 for a few industries that have high *IT outsourcing intensity*. To measure an industry's IT outsourcing intensity, we used industry-level data and divided the amount of IT outsourcing by the amount of output created. We picked the industries that ranked high on the list. These industries also have the largest share of the worldwide IT and business process outsourcing market, according to BusinessWire [8] and Plunkett Research [44]. They include Broadcasting and Telecommunications (NAICS 5130), Banking and Finance (NAICS 5210, 5220 and 5230), Computer Systems Design and Related Services (NAICS 5415), and Healthcare Services (NAICS 621, 622).

**Empirical Model Development for Firm-Level Analysis.** We examined the overall patterns of outsourcing at the firm level over time with a methodology based on the estimation of a *lognormal diffusion model* [1, 42]. The reason for its use is its emphasis on the *proportionate effect* of the diffusion process. The lognormal distribution model has been used to describe different growth processes (e.g., personal income, gross national income, etc.). It incorporates an assumption of *independence* regarding the observations that exhibit diffusion, and a high degree of *skewness* (lack of distributional symmetry) and *leptokurtosis* (more observations near the mean of the distribution) compared to other distributions [1]. This

allows us to test whether IT outsourcing deals follow a pure diffusion process, or if a contagion effects-influenced process is appropriate. Our conjecture is that outsourcing diffusion develops over time via a mechanism in which each additional increment of outsourcing-related events is proportional to the existing size of the process, based on the current installed base of outsourcing contracts [42].

We specify the lognormal diffusion model as  $x_i - x_{i-1} = \mu_i x_{i-1}$ ,  $i = 1$  to  $n$ , where  $\mu_i$  represents a set of mutually independent random drivers for IT outsourcing growth, and  $x_i$  represents the dollar amounts associated with  $i = 1$  to  $n$  outsourcing announcements. We use the dollar amount because all the variation among the announcements and the responses to mega-deals is expressed by the different dollar amounts of the contracts.<sup>3</sup> Responses to the mega-deals are not the same across all of the industries though: some deals are small with a low-dollar value, and some deals are large with a high-dollar value. This model can be interpreted as the *change in the dollar amount of IT outsourcing as the result of an additional announcement* and is proportional to the size of the dollar amount of the IT outsourcing contract. It can be stated as the fundamental equation for a lognormal distribution [1]:  $\log x_n = \log x_0 + \mu_1 + \mu_2 + \dots + \mu_n$ .

The value of  $\log x_n$  is normally-distributed in the limit by the additive form of the central limit theorem. So  $x_n$  also is lognormally-distributed as  $f(x) = \frac{1}{x\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{\log x - m}{\sigma}\right)^2\right]$ ,  $x > 0$ , with  $m$  as the mean of  $\log x$  and standard deviation  $\sigma$ . The parameters  $m$  and  $\sigma$  can be estimated by two additional equations:

$$m = \frac{\sum_{i=1}^n \log_2 x_i}{n} \quad \text{and} \quad \sigma^2 = \frac{\sum_{i=1}^n (\log_2 x_i - m)^2}{n-1}.$$

This model gives us an opportunity to test whether the data exhibit proportional behavior. If the model does not fit the lognormal distribution, it means that IT outsourcing does not follow a pure diffusion process. Then a natural choice is to extend it to include other variables, a different functional form or different underlying assumptions to capture the true behavior.

**Empirical Model Extension for Firm-Level Analysis.** To capture the patterns of diffusion beyond the lognormal model, we transformed the equation to represent the data in longitudinal form [42]. We evaluate our data longitudinally as the *sum of the dollar amounts of outsourcing deal announcements*. These should approximate a straight line if the announcements occur randomly. We also test for the presence of a stratifying effect in diffusion for IT outsourcing. We represent this effect in terms of firm size, in particular, large and small firms. Diffusion patterns in prior studies [11, 27] suggest that such a contagion effect may come into play when we see a rapid increase in the outcome variable of interest. In this case, it is the number of outsourcing announcements following the news of a mega-deal. To test for this

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<sup>3</sup> We converted the dollar amounts of the outsourcing deals to their real dollar values in 2005 U.S. dollars, using the price deflators for industry output for the years 1998 to 2008 from the BEA, with 2005 as the base year.

kind of contagion, we analyze outsourcing announcement frequency by firm size for different time periods. We used the number of employees as a proxy for firm size.<sup>4</sup> We also checked for the over-representation or under-representation of mid-size to small firms.

We specify the dollar amount associated with announcements  $i = 1$  to  $n$  as  $x_i$ , with  $\mu_i$  representing the random precipitating event, the *mega-deals*,  $x_1 = k_1 e^{\mu_1}$ ,  $x_2 = k_2 e^{\mu_2}$ , ...,  $x_n = k_n e^{\mu_n}$ , where  $k_i$  is a *proportionality constant* between the dollar amount and the exponential function. Multiplying terms by one another

gives  $\prod_{i=1}^n x_i = \prod_{i=1}^n [k_i e^{\mu_i}] = \left[ \prod_{i=1}^n k_i \right] e^{\mu_i} = (k_1 k_2, \dots, k_n) e^{\mu_1 + \mu_2 + \dots + \mu_n}$ . Taking the log results in

$\log(x_1 x_2 \dots x_n) = \sum_{i=1}^n \log x_i = k'(\mu_1 + \mu_2 + \dots + \mu_n)$ , where  $k'$  is the value of proportionality constant after taking the log. Precipitating incidents occur in time order, so that  $\mu_n$  occurs after  $\mu_{n-1}$ . Thus we know

that  $\sum_{i=1}^n \log x_i = k''t$ , so the logs of the dollar amounts of the outsourcing deals are proportional to time,

where  $k''$  is the value of the proportionality constant after taking the sum of the log values.

**Industry-Level Analysis.** We next analyze the effect of different sources of influence on IT outsourcing diffusion patterns at the industry level. It is important to understand the role of different communication channels in the diffusion process, because this gives us insight into firm-to-firm interactions within an industry and how the diffusion process works in different industries over time. Learning about the influence of different communication channels helps us recognize how the contagion is spreading within an industry also, which may come as a result of external stimuli or internal interactions – or a combination of both. Further, testing for the two flexible S-curve models will shed light on the diffusion patterns of IT outsourcing for different industries, and whether the diffusion patterns are symmetric or asymmetric. We also can learn whether they are left-skewed or right-skewed, which may indicate the propensity towards early adoption or late adoption. Finally, testing for the influential factors and diffusion patterns at the industry level provides us with additional evidence about the contagion effects at the more aggregate level of analysis, and this can help to build a “weight of evidence” beyond the firm-level analysis.

We focus on the four groups of IT-intensive industries discussed earlier. Under the *mixed influence model*, the focus of our estimation work, the rate of diffusion is driven by internal and external influences

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<sup>4</sup> We classified the firms into the following firm size categories, based on the proxy, number of employees: *extra small* with less than 1,000 employees; *small* with greater than 1,000 but less than 10,000 employees; *medium* with more than 10,000 but less than 50,000 employees; *large* with greater than 50,000 but less than 100,000 employees; and *extra large* with greater than 100,000 employees.

[35].<sup>5</sup> The mixed influence model is  $N(t) = dN(t) / dt = [p + qN(t)] [m - N(t)]$ . Solving this equation gives us the functional form for the model [50]:  $N(t) = [1 - \exp(-(p + q)t)] / [1 + (p/q) \exp(-(p + q)t)]$ .

**Industry-Level Analysis of Curve Symmetry and Inflection Point.** Continuing to analyze the different diffusion patterns at the industry level, we estimate two additional models for the four IT-intensive industries discussed earlier. The diffusion rate equation for the Gompertz model is given by  $dN(t) / dt = qN(t) [\log m - \log N(t)]$ , where  $dN(t) / dt$  is the number of adopters at time  $t$ ,  $N(t)$  is the cumulative number of adoptions at time  $t$ ,  $q$  is the coefficient of internal influence, and  $m$  is the market potential. The solution of the rate equation for the Gompertz model is given by  $N(t) = m \exp [-(\log(m/N_0) \exp(-q(t - t_0)))]$ . The functional form of the Weibull model, in contrast, is  $dN(t) / dt = m(\beta / \alpha)(t / \alpha)^{\beta-1} e^{-(t/\alpha)^\beta}$ , where  $dN(t) / dt$  is the number of adopters at time  $t$ ,  $m$  is the market potential,  $\alpha$  is the parameter for scale and  $\beta$  for shape [49]. The solution of the rate equation for the Weibull model is  $N(t) = m(1 - e^{-(t/\alpha)^\beta})$ .

#### 4. RESULTS AND DISCUSSION

We first present the results of our analysis of outsourcing patterns using both firm-level and industry-level data. We also will present the results of evaluating the Randomly Proportional Outsourcing Diffusion Hypothesis (H1) based on the firm-level announcement data. We test it via the lognormal diffusion model, which evaluates the overall diffusion pattern of IT outsourcing at the firm level. To capture the underlying contagion effects, we then will test the Stratified Outsourcing Adoption Hypothesis (H2) using firm-level data and discuss the results. Following that and using the industry-level IT outsourcing data, we will evaluate the fit of the mixed influence model at the industry level. We also evaluate the Gompertz and Weibull models to test curve symmetry and the inflection point for growth. We also discuss the results and their implications.

##### 4.1. Results of Analysis of Outsourcing Patterns at the Firm and Industry Levels

We compared the patterns in the industry-level IT outsourcing data to those associated with the firm-level announcement data in the four IT-intensive industries we defined above. We focused on 1999 to 2007. (See Figures 2, 3 and 4.)

INSERT FIGURES 2, 3 AND 4 ABOUT HERE

The industry-level data show that there was growth in total outsourcing from 1999 to 2000, and then a

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<sup>5</sup> Under the *internal influence model*, the rate of adoption depends on the extent of previous adoption in the social system [16, 35, 36]. The diffusion rate is  $dN(t)/dt = qN(t)[m-N(t)]$ , where  $dN(t)/dt$  is the number of adopters at time  $t$ ,  $N(t)$  is the cumulative number of adoptions at time  $t$ ,  $q$  is the coefficient of internal influence, and  $m$  is the market potential. Solving the diffusion rate equation gives us the following functional form,  $N(t) = m / [1 + ((m - m_0) / m_0) \exp(-qmt)]$ , where  $m_0$  is the number of adopters in the initial period. Under the *external influence model*, the rate of diffusion at time  $t$  is dependent only on the number of potential adopters [34, 35]. The diffusion rate is  $dN(t)/dt = p[m-N(t)]$ , where  $p$  is the coefficient of external influence. When we rearrange the terms of this equation, we obtain  $N(t) = m[1 - \exp(-pt)]$ .

decline from 2000 to 2002, after which we again observe steady growth. At the firm-level, there were similar patterns, except for 2001 to 2002, where we observed growth in the number of announcements. These observations suggest that IT outsourcing has been growing in the IT-intensive industries from 2003 onwards, and the outsourcing announcement data generally reflect the industry trends, except in 2001-2002.

Somewhat different patterns emerged when we compared the four IT-intensive industries. IT outsourcing spending in Healthcare Services, and Broadcasting and Telecommunications grew linearly over the period. In contrast, IT outsourcing spending in the Computer Systems Design and Related Services industry hardly grew, while the Banking and Finance industry's spending grew through the Year 2000 (Y2K) systems expenditures, but then fell sharply for two years as the financial markets absorbed the shocks of the September 11, 2001 terrorist attacks, and economic growth stalled.

#### 4.2. Results of Firm-Level Analysis

**The Randomly Proportional Outsourcing Diffusion Hypothesis (H1) Results.** To test this hypothesis, we used firm-level deal announcement data collected from 1999 to 2008. We used log base 10 arithmetic values for the U.S. dollar amounts to define the announcement categories:  $10^5$  for \$100,000 to \$1,000,000,  $10^6$  for \$1,000,000 to \$10,000,000, etc. (See Table 1.)

INSERT TABLE 1 ABOUT HERE

All outsourcing contract announcements had a value of more than \$100,000 or  $10^5$  dollars. We selected the beginning points of each range to represent the log values. This choice doesn't affect the conclusions that we draw, since it applies to all IT outsourcing deal dollar ranges. The values of  $\log x_i$  are normally-distributed, which is necessary to implement the  $\chi^2$  test. We report values obtained with  $k - 3$  degrees of freedom, with  $k$  representing the number of categories. The  $\chi^2$  test was significant at  $p < 0.05$ . Thus we rejected the null hypothesis that our data follow a lognormal distribution. For the US\$ categories  $10^5$  (\$100,000 - 1,000,000) and  $10^6$  (\$1,000,000 - 10,000,000), the observed values were higher than the expected values.

In contrast, the observed values in the middle range of US\$1 million to US\$1 billion were under-represented. The under-representation of US\$1 billion-plus deals can be explained on the basis of industry trends. In the IT outsourcing industry, not many mega-deals have been signed. Those that have been signed encompass services contracts for multiple locations across multiple nations and sometimes even multiple business functions. The number of vendors that can provide such large-scale services based in the U.S. is small, as suggested by our data. Our results indicate that the lognormal distribution is not capable of characterizing the diffusion patterns of IT outsourcing for the data and time period that we used, even though the lognormal model is generally appropriate for representing over-dispersed data. Our data may be over-dispersed beyond the range of a lognormal distribution, making it unsuitable. Another possibility is that some other process is at work, so the combination of multiple processes makes a single pat-

tern-based representation of the lognormal model ineffective.

**Stratified Outsourcing Adoption Hypothesis (H2) Results.** To test for contagion effects due to firm size, we analyzed outsourcing announcement frequency by firm size for different time periods. We used the number of employees for firm size and checked for over-representation or under-representation of mid-size to small firms based on a cutoff of 76,000 employees. We tested whether the proportion of smaller firms was greater in the contagion periods compared to the non-contagion periods, as suggested by the theory. Contagion periods are the time periods where we observed rapid increase in the number of announcements following either mega-deal announcements or multiple announcements above US\$100 million. We saw a greater proportion of smaller firms in the contagion periods. (See Table 2.)

INSERT TABLE 2 ABOUT HERE

Out of the 295 announcements in this study, 80 had complete information related to the dollar amount of the deal. This permitted us to identify their log range for outsourcing deal size, and simultaneously enabled us to include them in this part of the study. We used the  $\chi^2$  test of independence [32] to establish the contagion period for the firm size effect, as indicated by the higher frequency of smaller firms. The null hypothesis that the number of small firms (31) and the number of large firms (9) were not different statistically can be rejected ( $\chi^2 = 5.36, p < 0.02$ ). We evaluated other values for the firm size stratifier associated with a different number of employees as the criterion level for large and small firms. For example, we found that splitting the data based on the number of employees less than or greater 76,000 in the firm was the appropriate level for this stratifier.

### 4.3. Results of Industry-Level Analysis

**Sources of the Influence Results.** To test for the fit of the mixed influence models, we used data for the four IT-intensive industries from 1999-2007 and non-linear least squares estimation [50].<sup>6</sup> We report full results for the mixed influence model using ordinary least squares (OLS) estimation, our base case results. We used the estimation results for the  $m$ ,  $p$ , and  $q$  parameters as starting values for the non-linear estimations of the model, as a means to assure convergence for the parameter estimates. We assessed model performance based on *model fit* via the proportion of variance explained by adjusted- $R^2$  and the overall model quality using the  $F$  test values. We only report the results of the mixed-influence model; the internal and external influence models did not always converge.

Table 3 shows our results.<sup>7</sup> The first part of the table presents the OLS results for the mixed influence model, and the partial results using non-linear estimation. The second part of the table presents the esti-

<sup>6</sup> We used the Levenberg-Marquardt method instead of the more standard Gauss or Newton-Raphson methods. This is appropriate for estimation when model the parameters may be highly correlated [39], so it was a safe choice for our data set and others that involve the influence models.

<sup>7</sup> We were unable to establish estimation results for internal and external models due to the lack of convergence of the non-linear estimation algorithm. Because the sample size was small, we used the estimation technique of bootstrapping with replacement to see if we could obtain results, but our capability to do so was mixed.

mation results for the Gompertz and Weibull models using non-linear estimation.

INSERT TABLE 3 ABOUT HERE

**Critical Mass and Flexible Inflection Point for Growth Results.** To test for the fit at the industry level of the critical mass and flexible growth inflection point models with the Gompertz and Weibull models, we again used non-linear estimation. Our empirical evidence based on the  $R^2$  values and the significance of the estimated parameters suggests that the Gompertz model and the Weibull model offer equally good fit for all four industries. The adjusted- $R^2$  values of 0.99 were high for both the models and the estimated parameters were significant at a 0.01 level. We were unable to get conclusive results from the comparative analysis of the  $R^2$  values and the significance of the estimated coefficients. So we used the *root mean square error* (RMSE) to further evaluate goodness of fit. The model that has the lowest RMSE value is our best model to explain the diffusion pattern for IT outsourcing. Based on our comparison of the RMSE values, the Weibull model provides the best fit for the diffusion pattern of IT outsourcing across different industries.

The Weibull model has two parameters,  $\alpha$  for scale and  $\beta$  for shape. Based on the estimated value of  $\beta$  that we obtained, the diffusion curves for all four industries appear to be left-skewed. This means that their inflection points for growth occur before the 50% level of possible IT outsourcing contracts are observed. Further, it suggests that the growth curves are relatively flat, based on the high values of  $\alpha$  and  $\beta$ . The Weibull model provides a better fit because it allows for the diffusion curve to be asymmetric and the location of the inflection point for growth to be flexible. The Gompertz curve, in contrast, allows for an asymmetrically-shaped curve but has a fixed inflection point.

**Discussion of Industry-Level Results.** Based on the OLS estimates, the mixed influence model provides a good fit for diffusion of outsourcing in Broadcasting and Telecommunications (adj.- $R^2 = 0.96$ ), the Healthcare Services industry (adj.- $R^2 = 0.98$ ) and Banking and Finance (adj.- $R^2 = 0.63$ ). These results indicate that the mixed influence model captures the effects of the sources of influence on the overall diffusion patterns of IT outsourcing. The non-linear estimation results for the mixed influence model for Computer Design and Related Services showed the values of the external influence parameter ( $p = 0.007$ , 0.05 significance level) and the internal influence parameter ( $q = 0.257$ , 0.05 significance level). For the Healthcare Services industry, the values of the external influence parameter ( $p = 0.092$ , 0.05 significance level) and the internal influence parameter ( $q = 0.178$ , 0.05 significance level) also were significant.

Since the estimated values of  $p$  are smaller than the estimated values of  $q$  in all three industries, it appears that the internal influence channel via word of mouth plays a bigger role in the diffusion of IT outsourcing than the external influence channel does via the mass media. The values of the internal influence  $q$  parameter estimates (ranging from  $q = 0.14$  to  $0.17$ ) obtained from OLS and the Gompertz model estimation were significant. The values of the potential market parameter  $m$  varied for all of the indus-



tries across all of the models. Since not every model has all the same parameters, we cannot draw strong conclusions from this observation though.

## **5. CONCLUSION**

Explaining diffusion patterns of IT and business process outsourcing in their many observed forms has been of long-standing interest to business leaders, policy-makers and researchers. Our focus has been on understanding this from the perspective of contagion effects theory.

### **5.1. Main Findings**

In the first part of our study, we asserted that the diffusion patterns for IT and business process outsourcing will be randomly proportionate to the set of announcements that occurred in the market, and that these are responses to prior precipitating events. This makes observed diffusion non-linear. We also asserted that, in the presence of contagion effects, the diffusion of IT outsourcing from large firms to small firms will depend on the extent of outsourcing penetration in large firms.

We obtained evidence to show that the diffusion of IT outsourcing is not distributed lognormally, contrary to what would be indicated in the absence of any contagion effects. Instead, our analysis showed the presence of other underlying drivers that do not allow the diffusion pattern to be lognormal. So we analyzed the frequency of outsourcing announcements based on firm size and observed that there was an increase in the frequency of smaller firms announcing outsourcing deals during periods of contagion for outsourcing deals, suggesting that outsourcing deals cannot be explained by a pure diffusion process that does not include any consideration of contagion effects. We were able to obtain such evidence for the presence of a contagion effect with a stratifying variable that captured relative firm size in our data set.

In the second part of the study, we evaluated the roles of different sources of influence on the overall diffusion patterns of IT outsourcing at the industry level. There were four reasons why we included an empirical evaluation of the industry-level data. First, we felt that analyzing data relative to similar issues at a different level of analysis would strengthen our findings and ability to draw conclusions. Second, the analysis of industry-level data gave us an additional opportunity to study where contagion effects in the diffusion of IT outsourcing seemed to play a role. Third, we also were able to learn about how different influential internal and external drivers related to the various patterns of diffusion that we observed. And fourth, we were able to obtain contrasting information about the symmetric and asymmetric patterns of diffusion of IT and business process outsourcing across different industries.

Our evaluation of the mixed influence model associated with the Bass model, along with the Gompertz and Weibull models, yielded insights on the underlying influences on the diffusion process that shaped the visible patterns. We also used both symmetric and asymmetric growth curve models as a means to offer somewhat richer representations of the underlying dynamics of the diffusion process in the

context of IT outsourcing. We examined models with fixed and flexible inflection points too. The model with the flexible inflection point allowed growth to vary for different levels of diffusion penetration across different industries.

We also obtained evidence that the mixed influence model was able to capture quite well the effects of the different communication channels on the diffusion patterns of IT outsourcing for three out of four industries: Broadcasting and Telecommunication, Healthcare Services, and Banking and Finance. We confirmed prior knowledge that existing users and the mass media influence adoption behavior in these industries. The Gompertz and Weibull models fit all the industries' diffusion patterns fairly well. The significant value of the internal influence parameter obtained using the Gompertz model estimation indicated that IT outsourcing adoption behavior across all four industries was influenced by word-of-mouth. Based on the estimated parameters of the best-fitting Weibull model, we found that the adoption process was asymmetric, left-skewed and flat. There more rapid adoption in the initial stages of diffusion than later. This suggests that firms across all four industries were predisposed to adopt IT outsourcing during the earlier stages of the diffusion process, a sign of contagion effects.

## **5.2. Theoretical and Practical Implications**

This study's results have theoretical and practical implications. To the best of our knowledge, this is the first study that has applied contagion effects theory to examine the diffusion patterns of IT outsourcing. We also explored whether the observed adoption patterns are stratified by firm size. By doing so we could examine whether the growth patterns for IT outsourcing fit the expectations of a relatively simple baseline model or there are contagion effects involved. We established the presence of contagion effects in the diffusion of IT and business process outsourcing using firm- and industry-level data.

A challenge in this type of field research on outsourcing is the difficulty of obtaining data. We created a data set that provides a different vantage point for the analysis of contagion effects-driven IT outsourcing diffusion. Our lognormal model was based on an empirical modeling analogy from medical epidemiology and political science, and offered some new analysis ideas. Our results, which establish the presence of hierarchical contagion effects in the diffusion of IT and business process outsourcing, have useful implications. Vendors stand to gain by making public information about their contracts and deals, especially if their clients are high in profile, or their contract deals are high in value. To take advantage of the contagion effects, vendors should optimize their pricing strategy and better equip themselves by scaling their operations to meet the increased demand. Since understanding the diffusion process is crucial for the timing of outsourcing decisions, clients can take advantage of this knowledge too. They can leverage economies of scale, if they decide to outsource when the IT and business process outsourcing contagion is spreading.

Prior studies have suggested that diffusion processes are more likely to follow some asymmetric S-

curve rather than a symmetric curve [20, 35, 36]. It may take longer to get a diffusion process started than it does for diffusion to tail off and the market to get saturated, which induces S-curve asymmetry. Our industry-level analysis suggested evidence of an asymmetric diffusion process for some industries. Thus, it was appropriate to test for the fit capabilities of the flexible growth inflection point diffusion models, such as the Gompertz and Weibull models.

In our context of IT and business process outsourcing, the results of Gompertz and Weibull models indicated *spillovers* associated with contagion effects theory. With spillovers, contagion effects arise due to interdependencies among market activities, such as aligned management interests, or business activities in an industry, in a region, or across firms with similar interests. Further, our results showed that internal communication channels appear to play a more prominent role. The results of the Weibull model indicated that diffusion is faster early on. This might mean that across all four industries some of the firms were predisposed towards IT outsourcing (as also indicated in our IT outsourcing announcement data), and other firms after a short period of time tended to imitate the behavior of the early adopters. This is consistent with the inflection point for growth occurring before the 50% penetration point.

### 5.3. Limitations

We note some limitations of the present research. First, our results are based on outsourcing contract announcements and contract details from two well-accepted news sources. It is likely that not all outsourcing contract announcements and details are covered by these sources. Also, because the announcement rate and time are dependent on corporate guidelines, there might be a time lag between the time when the contract is actually signed and the announcement is released. Still, because our data represent macro-level industry trends, excluding such contracts would not adversely affect our results.

Second, we focused on firm size as our main stratifier for observing contagion effects. There are other possible factors that can be used to analyze the contagion effect, such geographic location, industry, international linkages, IT-intensity, and managerial structure. Firm size is measurable and valid based on our field study observations, and consistent with control variables used in other research on firm strategy [11]. Exploring other factors as stratifiers for contagion effects in IT outsourcing is a worthwhile direction for future research.

## REFERENCES

- [1] J. Aitchison, J.A.C. Brown, Lognormal distribution: with special reference to its use in economics, Cambridge University Press, Cambridge, UK, 1957.
- [2] S. Ang, L. Cummings, Strategic response to institutional influences on information systems outsourcing, *Organization Science* (8) (3) (1997).
- [3] B.A. Aubert, M. Patry, S. Rivard, Assessing the risk of IT outsourcing, in R. Sprague (ed.), *Proceedings of the 31st Hawaii International Conference on Systems Science*, IEEE Computer Society Press, Los Alamitos, CA, 1998.

- [4] A. Bandura, *Social Learning Theory*, Prentice-Hall, Englewood Cliffs, NJ, 1977.
- [5] F.M. Bass, A new product growth for model consumer durables, *Management Science* 5 (5) (1969).
- [6] M. Benaroch, Q. Dai, R.J. Kauffman, Should we go our own way? Backsourcing flexibility in IT services contracts. *Journal of Management Information Systems* 26 (4) (2010).
- [7] S. Bikhchandani, D. Hirschleifer, I. Welch, A theory of fads, fashion, custom and cultural change as informational cascades, *Journal of Political Economy* 100 (5) (1992).
- [8] BusinessWire. IDC study identifies BPO adoption trends across top five vertical industries (August 25, 2004) ([findarticles.com/p/articles/mi\\_m0EIN/is\\_2004\\_August\\_25/ai\\_n6168308](http://findarticles.com/p/articles/mi_m0EIN/is_2004_August_25/ai_n6168308)).
- [9] D. Collier, R.E. Messick, Prerequisites versus diffusion: testing alternative explanations of social security adoption, *American Political Science Review* 69(4) (1975).
- [10] Decision Support Trends Staff, Forrester: IT spending to rebound in 2010, *Decision Support Trends*, Cambridge, MA (January 14, 2010) ([www.sdexec.com/web/online/Decision-Support-Trends/Forrester--IT-Spending-To-Rebound-In-2010/16\\$11957](http://www.sdexec.com/web/online/Decision-Support-Trends/Forrester--IT-Spending-To-Rebound-In-2010/16$11957)).
- [11] W.H. DeLone, Firm size and the characteristics of computer use, *MIS Quarterly* 5(4) (1981).
- [12] R. De Souza, K. Hale, Y. Adachi, F. Ng, Dataquest insight: IT services forecast, worldwide, 2004-2011, *Gartner Dataquest* (August 20, 2007) ([www.gartner.com/Display Document?id=512914&ref=g\\_sitelink](http://www.gartner.com/Display Document?id=512914&ref=g_sitelink)).
- [13] P.J. DiMaggio, W.W. Powell. The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields, *American Sociological Review* 48 (2) (1983).
- [14] A. Dixit, R.S. Pindyck, *Investment under Uncertainty*, Princeton University Press, Princeton, NJ, 1994.
- [15] R. Dornbusch, Y.C. Park, S. Claessens, Contagion: understanding how it spreads, *World Bank Research Observer* 15 (2) (2000).
- [16] B.L. Dos Santos, K. Peffers, Competitor and vendor influence on the adoption of innovative applications in electronic commerce, *Information and Management* 34 (3) (1998).
- [17] R.G. Fichman, Going beyond the dominant paradigm of information technology innovation research: emerging concepts and methods, *Journal of the Association for Information Systems* 5 (8) (2004).
- [18] T. Foran, Employees key to IT outsourcing deals. *IT World Canada* (May 18, 2000) ([www.itworldcanada.com/news/employees-key-to-outsourcing-deals/133488-pg2](http://www.itworldcanada.com/news/employees-key-to-outsourcing-deals/133488-pg2)).
- [19] E. Fraenheim, IT firms expand from PCs to payroll, *CNetNews.com* (January 14, 2003) ([news.cnet.com/2100-1001-980495.html](http://news.cnet.com/2100-1001-980495.html)).
- [20] P.A. Geroski, Models of technology diffusion, *Research Policy* 29 (4-5) (2000).
- [21] J. Goo, R. Kishore, H.R. Rao, K. Nam, The role of service level agreements in relational management of information technology outsourcing: an empirical study, *MIS Quarterly* 33 (1) (2009).
- [22] V. Gray, Innovation in the states: a diffusion study, *American Political Science Review* 67 (4) (1973).
- [23] H.R. Greve, Jumping ship: the diffusion of strategy abandonment, *Administrative Science Quarterly* 40 (3) (1995).
- [24] J.K. Halvey, The top 24 IT outsourcing transactions, *HRO Today* 2 (1) (2003).
- [25] K. Han, R.J. Kauffman, B.R. Nault, Returns to information technology outsourcing, *Information*

Systems Research (2010), in press.

- [26] Q. Hu, C. Saunders, M. Gebelt, Diffusion of information systems outsourcing: A reevaluation of influence sources, *Information Systems Research* 8 (3) (1997).
- [27] R.J. Kauffman, A.A. Techatassanasoontorn, The global diffusion patterns of successive technology generations: the case of analog and digital wireless phone growth. International Conference on Information and Communications Technology, University of California, Berkeley, CA, May 2006.
- [28] R.J. Kauffman, A.A. Techatassanasoontorn, Understanding early diffusion of wireless phones, *Telecommunications Policy* 33 (8) (2009).
- [29] T. Kern, L. Willcocks, Exploring relationships in IT outsourcing: the interaction approach, *European Journal of Information Systems* 11 (1) (2002).
- [30] J.S. Landefeld, R.P. Parker, BEA's chain indexes, time series, and measure of long-term economic growth, *Survey of Current Business*, U.S. Department of Commerce, Washington, DC, May 1997.
- [31] M.C. Lacity, L.P. Willcocks, An empirical investigation of IT sourcing practices: lessons from experience, *MIS Quarterly* 22 (3) (1998).
- [32] E.L. Lehman, J.P. Romano, *Testing statistical hypothesis*, 3<sup>rd</sup> ed., Springer, New York, NY, 2005.
- [33] L. Loh, N. Venkatraman, Determinants of IT outsourcing: a cross-sectional analysis, *Journal of Management Information Systems* 9 (1) (1992a).
- [34] L. Loh, N. Venkatraman, Diffusion of IT outsourcing: influence sources and the Kodak effect, *Information Systems Research* 3 (4) (1992b).
- [35] V. Mahajan, E. Muller, F.M. Bass, New product diffusion models in marketing: a review and directions for research, *Journal of Marketing* 54 (1) (1990).
- [36] V. Mahajan, R. Peterson, *Models for Innovation Diffusion*, Sage, Beverly Hills, CA, 1985.
- [37] A. Mahler, E.M. Rogers, The diffusion of interactive communication innovations and the critical mass: the adoption of telecommunication services by German banks, *Telecommunications Policy* 23 (10-11) (1999).
- [38] M.L. Markus, Toward a critical mass theory of interactive media, *Communications Research* 14 (5) (1987).
- [39] D. Marquardt, An algorithm for least-squares estimation of nonlinear parameters, *SIAM Journal of Applied Mathematics* 11 (1963).
- [40] L. McCartney, Six BPO trends you should be tracking, *CIOZone*, Great Neck, NY (January 15, 2010) ([www.ciozone.com/mobile\\_demo/index.php?cid=6555](http://www.ciozone.com/mobile_demo/index.php?cid=6555)).
- [41] N. Meade, T. Islam, Technological forecasting: model selection, model stability, and combining models, *Management Science* 44 (8) (1998).
- [42] M.I. Midlarsky, Analyzing diffusion and contagion effects: the urban disorders of 1960s, *American Political Science Review* 72 (3) (1978).
- [43] M.I. Midlarsky, M. Crenshaw, F. Yoshida, Why violence spreads: the contagion of international terrorism, *International Studies Quarterly*, 24, (2) (1980).
- [44] PlunkettResearch.com. Industry statistics 2009. Houston, TX (August 22, 2010) ([www.plunkett-research.com/Industries/OutsourcingOffshoring/OutsourcingOffshoringStatistics/tabid/182/Default.aspx](http://www.plunkett-research.com/Industries/OutsourcingOffshoring/OutsourcingOffshoringStatistics/tabid/182/Default.aspx)).
- [45] E. Rogers, *Diffusion of Innovations*, 5<sup>th</sup> ed., Free Press, New York, NY, 2003.

- [46] J. Rohlfs, A theory of interdependent demand for a communications service, *Bell Journal of Economics and Management Science* 5 (1) (1974).
- [47] R.D. Rossiter, Fisher ideal indexes in the national income and product accounts, *Journal of Economic Education* 31 (4) (2000).
- [48] B. Rowan, Organizational structure and institutional environment: the case of public schools, *Administrative Science Quarterly* 27 (2) (1977).
- [49] N.M. Sharif, N.M. Islam, The Weibull distribution as a general model for forecasting technological change, *Technological Forecasting and Social Change* 18 (3) (1980).
- [50] V. Srinivasan, C.H. Mason, Nonlinear least squares estimation of new product diffusion models. *Marketing Science* 5 (2) (1986).
- [51] T.H. Teo, K.K. Wei, I. Benbasat, Predicting intention to adopt interorganizational linkages: an institutional perspective, *MIS Quarterly* 27 (1) (2003).
- [52] Toolbox.com, ITtoolbox outsourcing survey. White paper, Scottsdale, AZ (October 8, 2004) ([hosteddocs.ittoolbox.com/dell1\\_survey.pdf](http://hosteddocs.ittoolbox.com/dell1_survey.pdf)).
- [53] E. Walden, Intellectual property rights and cannibalization in information technology outsourcing contracts, *MIS Quarterly* 29 (4) (2005).
- [54] ZDNet Research, Worldwide BPO market to grow at 10.9% a year, ZDNet.com (October 24, 2005) ([blogs.zdnet.com/ITFacts/?p=9278](http://blogs.zdnet.com/ITFacts/?p=9278)).

**Table 1. IT Outsourcing Predicted Distributions for Deals in US\$, 1999-2008**

OUTSOURCING DEAL RANGE	LOG <sub>10</sub> US\$	FREQUENCY	EXPECTED FREQUENCY
10 <sup>5</sup> : US\$100,000-1,000,000	5	11	2.74
10 <sup>6</sup> : US\$1,000,000-\$10,000,000	6	16	12.54
10 <sup>7</sup> : US\$10,000,000-\$100,000,000	7	24	26.18
10 <sup>8</sup> : US\$100,000,000-\$1,000,000,000	8	21	24.98
10 <sup>9</sup> : US\$1,000,000,000-10,000,000,000	9	8	10.89

**Notes.** Lognormal distribution of dollar amounts for outsourcing deals; 80 announcements total; mean by deal range of 7.44 in log base 10 format. Std. dev. = 1.13.  $\chi^2 = 27.37$  with 2 d.f. ( $p < .05$ ).

**Table 2. Announcement Frequency by Firm Size for Outsourcing Deal Sizes**

PERIODS	FIRMS WITH < 76,000 EMPLOYEES	FIRMS WITH > 76,000 EMPLOYEES
Contagion (2001-2004, 2006-2007)	31	9
Non-contagion (1999-2000, 2005 and 2008)	9	10

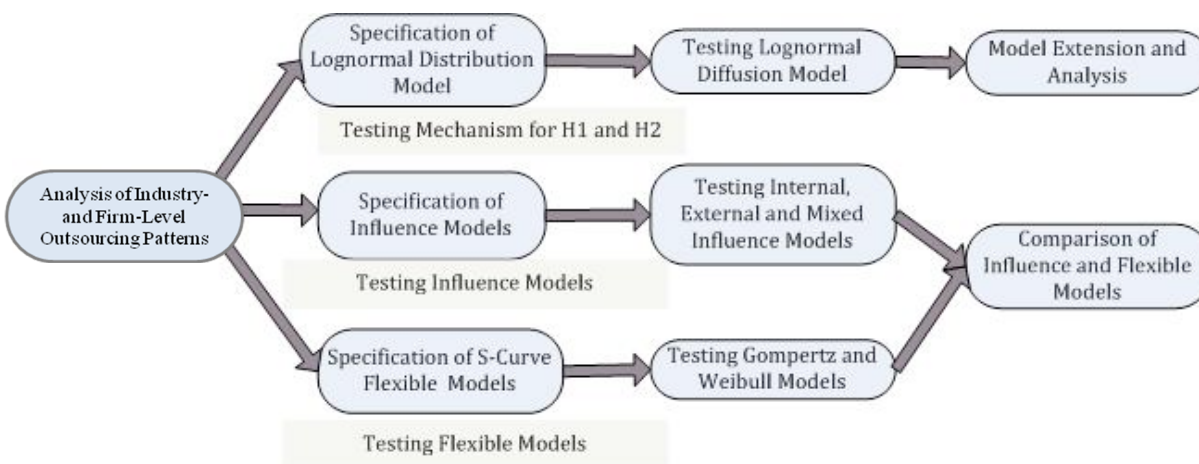
**Notes.**  $\chi^2 = 5.36$ , 1 d.f.,  $p < .05$ . There are 21 announcements in the data set for which no client information was available, and so we did not include them. 59 observations were used for the  $\chi^2$  test of independence.

**Table 3. Influence Model Estimation Results by Industry**

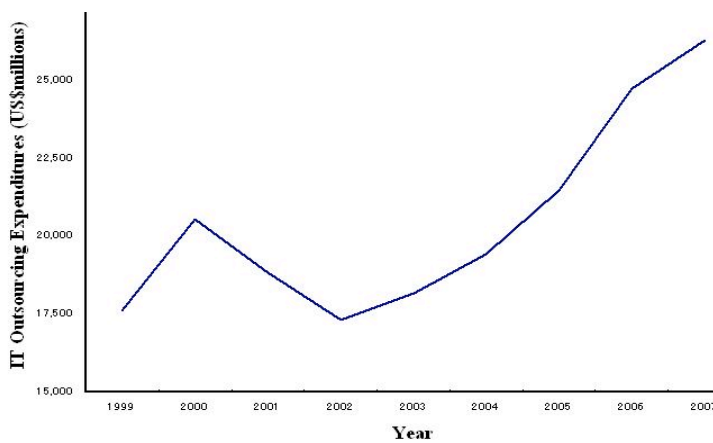
INDUSTRIES BY NAICS CODES	INFLUENCE MODEL VARIABLES				
	<i>M</i>	<i>P</i>	<i>Q</i>	Adj.- <i>R</i> <sup>2</sup>	<i>F</i>
<b>Mixed Influence Model (Estimated Using Ordinary Least Squares)</b>					
Broadcasting and Telecom	29,921	0.08**	0.14**	0.96	106.40***
Banking and Finance	80,191	0.11**	0.03**	0.63	7.91**
Comp. Sys. Design and Related Services	22,536	0.12	0.06	0.13	1.64
Healthcare Services	51,708	0.08***	0.15***	0.98	355.46***
<b>Mixed Influence Model (Estimated Using Non-Linear Least Squares)</b>					
Broadcasting and Telecom	33,475**	0.099**	0.267**	N.A.	294***
Banking and Finance	94,640**	0.026**	0.118**		136.2***
Comp. Sys. Design and Related Services	26,005**	0.007**	0.257**		649.9***
Healthcare Services	62,152**	0.092**	0.178**		455.2***
<b>Gompertz Model</b>					
	<i>m</i>	<i>p</i>	<i>q</i>	Adj. <i>R</i> <sup>2</sup>	RMSE
Broadcasting and Telecom	69,639***	N.A.	0.150***	0.99	654.4
Banking and Finance	216,881***		0.131***	0.99	2293.5
Comp. Sys. Design and Related Services	41,604***		0.167***	0.99	570.5
Healthcare Services	130,085***		0.143***	0.99	1,108.8
<b>Weibull Model</b>					
	<i>m</i>	<i>α</i>	<i>β</i>	Adj. <i>R</i> <sup>2</sup>	RMSE
Broadcasting and Telecom	15,900,000***	6,572,090***	1.15***	0.99	142.3
Banking and Finance	611,000,000***	41,839***	1.06***	0.99	2188.1
Comp. Sys. Design and Related Services	29,200,000***	15,749***	0.96***	0.99	155.3
Healthcare Services	638,000,000***	13,100,000***	1.15***	0.99	305.0

**Notes.** *m* is the market potential, *p* is the coefficient of external influence, and *q* is the coefficient of internal influence. We report the significance via the *F*-values for all models for which estimation was possible. The *F*-values of the mixed influence model were significant at 0.01 level and the parameter values were significant at 0.05 level, except for Healthcare Services (NAICS 621, 622) using OLS estimation, where the parameter values were significant at 0.01 level. We were unable to obtain coefficient estimates due to lack of convergence of the non-linear least squares estimation using both the Newton-Raphson method and the Levenberg-Marquardt methods in some cases [39]. For the Weibull model, *α* is the scale parameter and *β* is the shape parameter. For the Gompertz and Weibull models, we report the root mean squared error (RMSE) values and the adjusted-*R*<sup>2</sup> values. The estimated values of the Gompertz and Weibull model were all significant at the 0.01 level.

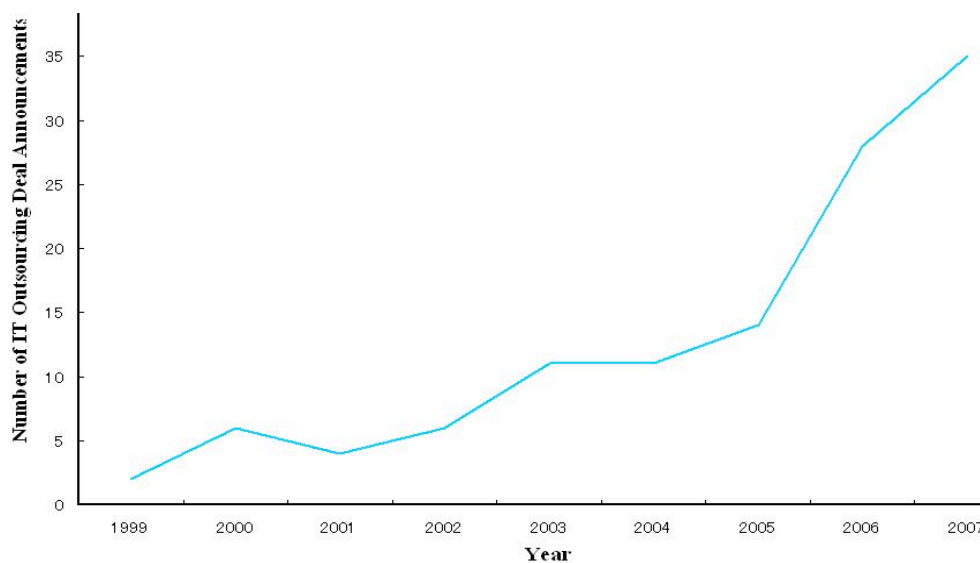
**Figure 1. Empirical Analysis Procedure**



**Figure 2. Total IT Outsourcing in US\$ in Four IT-Intensive NAICS Industries by Year, 1999-2007**

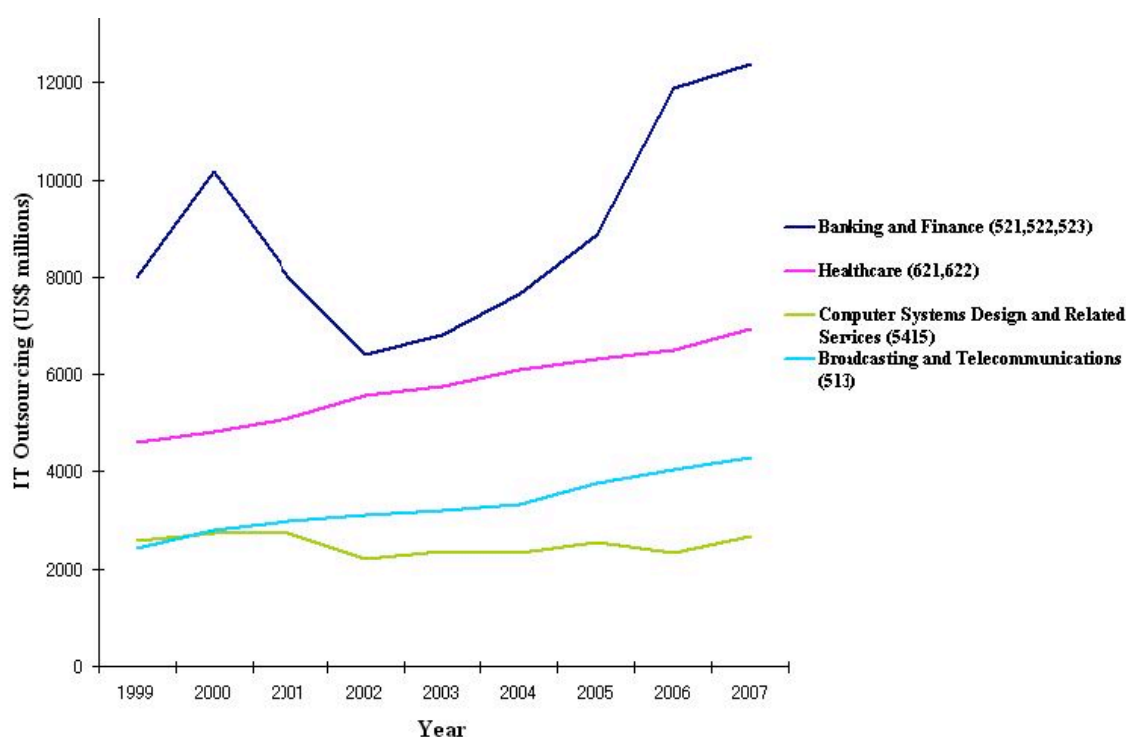


**Figure 3. IT Outsourcing Deals in the U.S. in Four IT-Intensive NAICS Industries, 1999-2007**





**Figure 4. IT Outsourcing in Four IT-Intensive Industries in US\$, by NAICS Industry, 1999-2007**



#### Appendix A. Data Sources and Construction Procedure

VARIABLE	BEA SOURCE	CONSTRUCTION PROCEDURE	DEFLATOR
Output	Industry accounts	Gross output by industry in 2000 US\$	Chain-type quantity index for outputs
IT capital	Fixed asset data	Net stock of information processing equipment and software (computer and peripheral equipment, communication, photocopy equipment, office/accounting equipment, software), by industry, 2000 US\$	Chain-type quantity index for fixed assets by type
Non-IT capital	Fixed asset data	Net stock of private fixed assets, excluding information processing equipment and software by industry, 2000 US\$	
Labor	Industry accounts; BLS employment statistics	Total full-time equivalent employees by industry multiplied by average annual work hours of 2,080 hours	None
IT outsourcing	KLEMS intermediate use estimates	Sum of an industry's intermediate inputs purchased from NAICS 5142 (Data Processing Services), NAICS 5415 (Computer Systems Design and Related Services), in 2000 US\$	Chain-type quantity index for intermediate inputs
Non-IT services intermediate inputs	BEA industry use tables	Industry's total intermediate inputs, excluding purchased IT services, in 2000 US\$	Chain-type quantity index for intermediate inputs