Offshoring of Information-based Services:
Structural Breaks in Industry Life Cycles

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ABSTRACT

The emergence of widespread offshoring of information-based services is arguably one of the more transformative business phenomena of the last ten years. A growing body of research has examined the firm-level drivers and location factors (i.e., the "whys" and "wheres") of services offshoring. However, little empirical research has examined the temporal dynamics (or "whens") of services offshoring. Adopting industry life cycle theory as a framework and a Bayesian methodological approach, we explore two key research questions: (i) when do different categories of offshoring services provision change from being emergent sectors to more mature ones relative to one another? and (ii) how do different types of offshoring activity differentially progress through this sequence? Employing a database of 1,420 offshore services FDI projects, we find that the relative skill level and the information sensitivity of the specific service category are associated with the temporal sequence of industry life cycle progression such that activities with decreased information sensitivity are offshored earlier than those with greater information sensitivity. We draw implications for our findings in terms of future waves of service offshoring.

Key Words: Services offshoring; life cycle theory; empirical; Bayesian methods

1. Introduction

The emergence of widespread offshoring of information-based services is arguably one of the more transformative business phenomena of the last ten years. The confluence of extreme competitive pressures and rapid technological advances has led to what has been described as exponential growth in this area (Parkhe 2007). For example, the Gartner Group (O'Sullivan 2008) predicts that global offshoring of services will reach $100 billion in 2011, up from a projected $50 billion in 2007 (Overby 2006). While some services inherently require a physical presence (e.g., dentistry), others (including many business-to-business and business-to-consumer transactions) are largely or almost exclusively information-centered. Hence these information-based services can be disaggregated and spatially dispersed such that they are produced in one country and consumed in another, allowing even smaller firms to have a multinational sourcing network, (Di Gregorio, Musteen and Thomas 2009). Countries such as India, the Philippines, and Ireland have emerged as destinations for lower-cost provision of offshored services for clients in other parts of the world. This separation capability allows firms to substantially reconfigure the value chain of services (e.g., Grote and Täube 2007).

A growing body of theoretical and empirical work has begun to examine a number of the fundamental drivers of this phenomenon. For example, Gefen and Carmel (2008) and Levina and Vaast (2008) find that cost containment is only one of several firm considerations and that cultural factors, language, and previous client/vendor relationship have important effects (see also Bunyaratavej *et al* 2007). Authors such as Murray and Kotabe (1999) and Wang (2002) examined the role of transaction costs associated with services, arguing that the intensity and nature of transaction costs drives what and how much is offshored or outsourced. From the perspective of the developing country partner, the motivation to acquire tacit knowledge was found to be positively related to the choice of firm control mechanisms in Sino-foreign offshore outsourcing (Li *et al* 2008).

At the broader country level, Graf and Mudambi (2005) examined the impact of human capital factors and firm-specific objectives on the location decision, while Nachum and Zaheer (2005) explored

offshoring location decisions for firms as a function of whether they had high or low investments in information and communications technology. Summarizing 43 papers on IS services offshoring, King and Torkzadeh (2008) indicated that overall research on offshoring is still in a nascent phase, but that there are several emerging research streams in areas such as offshoring success factors, location determinants, and the economic value of offshoring. Thus, initial progress has been made on theoretical understandings of the drivers (i.e., the "whys") of offshoring of information-based services, as well as the location advantages (or "wheres") of offshoring.

However, very little attention has been given to what might be termed the "whens" of offshoring (Hätönen and Eriksson 2009), particularly from an empirical perspective. The timing of offshoring activity may be especially important because it is likely related to the reasons for offshoring ("whys"). The limited research on temporal aspects of offshoring activity has either centered on the effects of offshoring on a particular firm over time (e.g., Carmel and Agarwal 2002, Cata and Raghavan 2006, Weimer *et al* 2007, Cha *et al* 2008, Vivek *et al* 2008, Jensen 2009), or how the nature of offshoring changes in a particular country over time (e.g., Holmström Olsson *et al* 2008, discuss Ireland's transition from being a low-cost services offshoring provider to a moderate-cost one). These analyses have treated changes over time mainly in descriptive terms or through a case-study approach without formal testing of theory.

In this paper, we develop theory regarding the temporal evolution of different industry sectors of services offshoring. Due to the fact that little previous research exists on this topic, we draw from multiple disciplinary perspectives to propose a framework to explain when different offshoring sectors reach critical inflection points at which they transition from emergent to more established sectors. In so doing, we make three specific contributions: (i) we address a gap in the literature by providing new theory that links comparative offshoring life cycle analysis to the dynamics of international services, (ii) we provide and test hypotheses from the above theory to provide a foundation of results to support future research, and (iii) we identify information sensitivity as a key variable determining when specific services will be offshored. We also provide a methodology for examining structural breaks in count sequences

new to the life cycle literature that can be used for other inquiries in the services management disciplines and elsewhere in management.

This paper is organized as follows. We review life cycle theories and summarize more recent research that has been used to inform the offshoring phenomenon to derive our theoretical framework in Section 2. Next, we explain the data and methodology used in the paper in Section 3. We present results in Section 4, and provide discussion in Section 5.

2. Literature Review

Life cycle theories have been used to examine a range of economic, managerial and strategic phenomena (Chatzoglou and Vafeas 2000, Agarawal *et al* 2002, Brown and Venkatesh 2005). However, little of this theory has been brought to bear on services offshoring (although see Qin 2011). We review two related perspectives, product life cycle theory and industry life cycle theory, in the context of extant research on offshoring and then integrate these perspectives to derive our hypotheses related to the temporal evolution of offshoring.

2.1 Life Cycle Theories

2.1.1 Product Life Cycle Theory

Several important management theories examine the life cycles of business activities wherein temporal evolution is featured as an important component. In the strategy literature, product life cycle theory (Vernon, 1966, Hofer, 1975) has broad implications across numerous business functions, including marketing, operations, IS and R&D. As summarized in Figure 1, product life cycle theory proposes that products' evolution is characterized by four primary stages: an emergence or initial development stage with low demand, a growth stage with more rapidly expanding demand, a maturation stage, and a declining stage where interest in the product begins to dissipate. Here, demand for the product (as indicated by the *y*-axis) is a function of time. An understanding of what stage of the life cycle a product is in is important to firms because of the numerous possibilities for business-enhancing strategies which change over the life cycle. For example, Anderson and Zeithaml (1984) find the relationship between

profitability and efficiency becomes stronger in the maturity phase, while best practices for early phases often involve capital expenditures on expanding market share, initializing resources, and establishing market position.
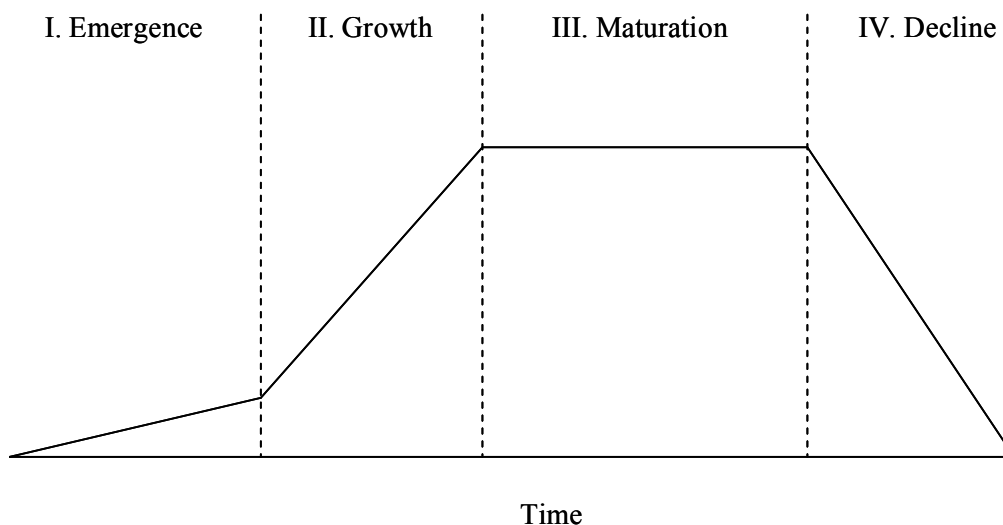
| I. Emergence | II. Growth | III. Maturation | IV. Decline |

Time

Figure 1: Four-Stage Life Cycle
Position on *y*-axis: Demand: Product life cycle (Hofer 1975); Number of firms: Industry life cycle (Strebel 1987).

2.1.2 Industry Life Cycle Theory

As products and markets evolve so must the industries that support them, leading to consideration of industry life cycles. Ansoff and Stewart (1967) provided an early perspective on how industries themselves change over time. In particular, firms could be innovative ("first to market"), early entrants ("follow the leader"), later entrants, or develop "me too" products. Similar to Ansoff and Stewart (1967), authors such as Shepherd (1975) and Strebel (1987) specify a four-stage industry life cycle typology, with the stages being emergence/development, growth/differentiation, maturity, and lastly decline/rejuvenation. In early phases, few firms enter the market but as conditions become more favorable, the number increases considerably. After some time, the long-term profit potential of the market begins to become increasingly utilized and so in the maturity phase the number of firms stabilizes. Toward the end of an industry life cycle, industry shake-outs (Willard and Cooper, 1985, Christensen *et al*, 1998) occur as a result of falling prices and dwindling demand. Hence, Figure 1 describes the industry

life cycle as well, with the distinction of the *y*-axis now representing the number of firms in the industry at a given point in time. Similar discontinuous models have been used for IS management (Porra, 1999, Sabherwal *et al* 2001, Porra *et al* 2005). For example, at the macro-level Arnott (2004) illustrates the discontinuous evolution associated with decision support systems while at the interpersonal level Jarvenpaa *et al* (2004) identify the influence of discontinuous temporal phenomena occurring in the context of trust in IT teams.

There are two competing – but related – explanations of why industries undergo these transformations. One set of explanations for such patterns centers on technological *events*, such as the emergence of a dominant design (Utterback and Abernathy, 1975) or innovation (Jovanovic, 1994). In this vein, Utterback and Abernathy (1975) and Abernathy and Utterback (1978) proposed a model based on the technological evolution of industries in the long run. In this model, the initial stage is characterized by rapid entry of new firms, with little advantage arising from larger firm size. As a dominant design emerges, exploration opportunities decrease, and product standardization allows for the exploitation of scale economies. The rate of entry decreases, while some of the incumbents experience exit. The net result is a decrease in the number of firms.

Another perspective as described in Gort and Klepper (1982) and Klepper and Graddy (1990) focuses on competitive advantage for firms of higher age and size, which depend on specific assumptions regarding product and process innovation. Gort and Klepper (1982) show the number of years and the entry and exit rates in 5 stages of industry evolution, which are defined by the rates of net entry: the first stage is characterized by entry of a few firms (1 to 3), the second by a positive net entry, in the third the entry rates equal the exit rates, in the fourth the net entry rate is negative and finally in the fifth there is a stabilization in the number of firms. Klepper and Graddy (1990) proposed that the number of firms follows a distinctive path in three stages: the first is marked by the growth in the number of firms, the second by a sharp decline and the third by a stabilization. The predictions of the life cycle hypothesis have been replicated via formal models (Klepper, 1996) as well as empirically (e.g., Klepper and Graddy, 1990).

Agarwal *et al* (2002) review the extant industry life cycle literature in detail and indicate that "a common theme throughout these theoretical expositions is the *discontinuous* transformation of competitive conditions at a particular point in an industry's evolution. This watershed is an integral aspect of evolutionary literature" (p. 976, emphasis added). Hence, at some point, there is a relatively marked and abrupt change such that industry conditions are no longer what they used to be (and may be more favorable or less favorable depending on the point in the industry life cycle). Discontinuous (i.e., step function-based) theoretical perspectives can be found elsewhere (Strebel, 1995, Tushman and Anderson, 1986), while outside of academia description of discontinuous industry events is found in the business press (Crooks 2008) and firm announcements to stakeholders (Soble 2008). In the next section we examine implications of incorporating step functions in industry life cycle theory in more detail.

2.2 Step-Function Specifications in Industry Life Cycle Theory

In industry life cycle theory, the position on the *y*-axis indicating the number of firms in the industry at a particular point in its life cycle can be further decomposed into an examination of the number of entering and exiting firms per unit of time (e.g., Agarwal *et al* 2002). Consider Stage I where the number of exits is likely to be negligible as generally firms will prefer to remain in the sector until at least the maturation period to ensure that return on investment has been maximized. Then, as indicated by Figure 1, the number of entering firms per unit of time is $(y_1 - y_0)/(t_1 - t_0)$, where $t_0 < t_1$ are arbitrary time points within Stage I and y_t is the value of *y* at time *t*. Hence, the number of entering firms per unit of time (entry rate) is constant throughout the interval as is indicated by the linear rise of the slope. Accordingly, Figure 2 shows the entry rate corresponding in time to that of Figure 1. Here, the number of new firms entering in a particular time frame $(y_{t_1} - y_{t_0})/(t_1 - t_0)$ extends horizontally. Consider next Stage II where again the number of exits is likely to be negligible (again, given entrant firms' expectations of future increases in return on investment). By the same logic, a constant entrant rate is observed although here the Stage II rate is greater than that of Stage I. Hence, by the model $(y_{t_1} - y_{t_0})/(t_1 - t_0) < (y_{t_2} - y_{t_1})/(t_2 - t_1)$ as indicated in Figure 2 where $t_1 < t_2$ occurs in Stage II. In Stage III where maturation occurs, it is likely that

the exit rate is no longer negligible and so the above mechanism changes. For the corresponding horizontal line to be observed in Figure 1, the entry and exit rates must be equivalent (e.g., Gort and Klepper, 1982). Since it is too early in the life cycle for the bulk of the exits to occur (as this happens in the decline stage), the exit rate must be moderate. Accordingly by equivalence the entry rate is moderate as in Figure 2. Finally, in the decline in Stage IV, the firm entry rate is likely to be essentially negligible as the future profit potential of the industry becomes increasingly exhausted and the bulk of the firms seek profits elsewhere. To summarize, when conceptualized in terms of entry rates as indicated in Figure 2, industry life cycle theory posits the existence of discontinuous watershed events at which rates exhibit a clear break. Denote these (*a priori* unknown) changepoints by $\tau_1, \ldots, \tau_{S-1}$, where S is the number of stages, denote the (unknown) entry rates by $\lambda_1, \ldots, \lambda_S$, and denote the indicator function by $I(\cdot)$. Then, up to an error term, the number of firms y entering at time t is given by

$$y_t = \lambda_1 I(t \leq \tau_1) + \lambda_2 I(\tau_1 < t \leq \tau_2) + \ldots + \lambda_S I(\tau_{S-1} < t). \qquad (1)$$
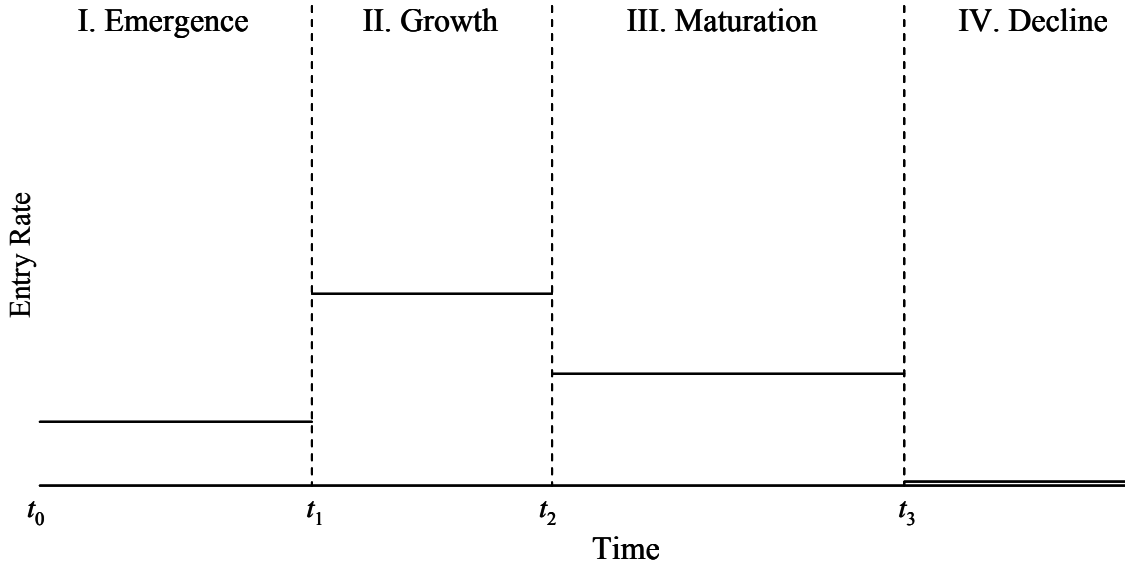

Figure 2: Four-Stage Life Cycle in Terms of Entry Rate

In particular, industry life cycle theory suggests that $S = 4$ (although this may be an empirical issue that differs across contexts), and also provides specific guidance regarding the relationship among the rates such that if r_s is the true entry rate at stage s, then $r_1 < r_2 > r_3 > r_4$.

Similar considerations as those for Figure 2 lead to the exit rate appearing as in Figure 3. Denote z_t being the number of firms exiting at time t and ω being an exit rate. Analogously,

$z_t = \omega_1 I(t \leq \tau_1) + \omega_2 I(\tau_1 < t \leq \tau_2) + \ldots + \omega_S I(\tau_{S-1} < t)$, which, while we note for completeness, in the context of the current paper is not explored in any detail. In part this is due to the newness of the information-based services offshoring phenomenon (i.e., relatively speaking at the times we consider the exit rates are likely to be less appreciable compared to the entry rates), unavailability of data (as we discuss later), as well the current paper's emphasis on examining the important earlier stages in the industry life cycle where the future profit potential is greatest.
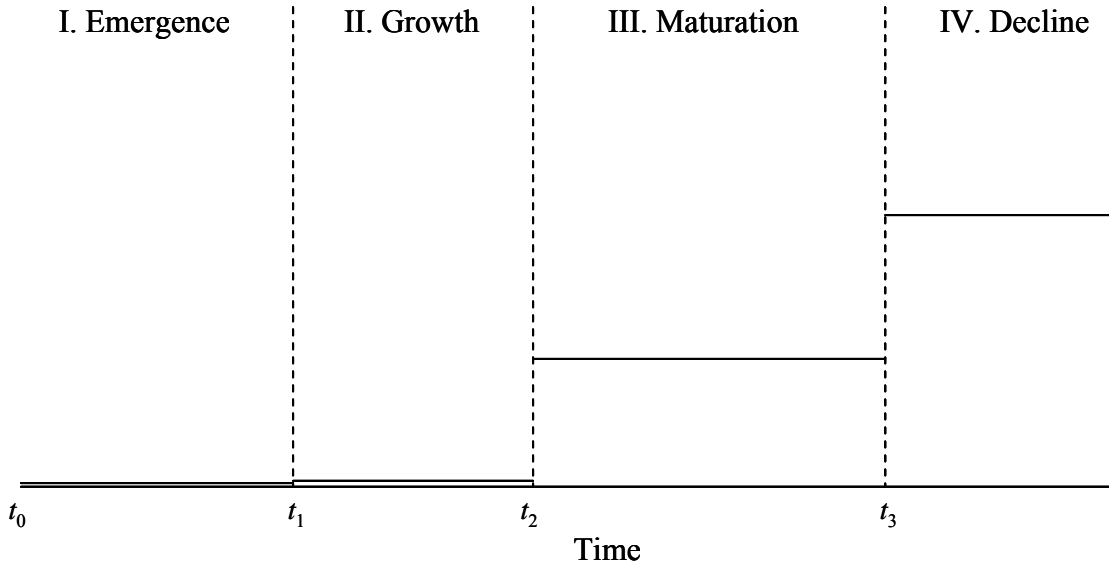

Figure 3: Four-Stage Life Cycle in Terms of Exit Rate

In summary, companies must behave strategically at each point in the industry life cycle to avoid negative outcomes such as the phenomenon of the winner's curse in outsourcing (e.g., Kern *et al* 2002).

In recent decades, this has involved determinations regarding retaining production in-house versus outsourcing production. It has been recognized that the offshoring sourcing decision itself has become a crucial strategic issue (Dossani and Kenney 2003, Kotabe and Murray 2004, Koh *et al* 2004). Accordingly we now review key features of the services offshoring literature with regard to the timing of relocating services offshore.

2.3 Task Skill Level and the Temporal Evolution of Offshoring

The dynamics of offshoring of information-based services at a broad level are driven by many of the same competitive efficiency pressures as those of manufacturing offshoring. Many of the services that are offshored are not completely new or radically innovative by nature[1]. Rather the services themselves, in many instances, are already largely standardized. Consistent with product life-cycle theory, competition is intensified in the case where products are already standardized (Vernon, 1966). Hence, we would expect competitive pressures drive firms to offshore to locations where they are able to produce services with appropriately qualified personnel but at a discounted cost (Bunyaratavej *et al* 2007).

In a related vein, Knickerbocker (1973) introduced the concept of oligopolistic reaction to explain patterns in foreign direct investments (FDI). He explained that firms (followers) are likely to match the foreign investment moves of rivals (leaders) by investing in the same countries, often within very short time periods. Combining insights from the product life-cycle and Knickerbocker's observations regarding the conditions in which firms move abroad in tandem as a result of oligopolistic competition, we expect that firms whose principal services provision are standardized would tend to offshore the range of services concurrently or within a relatively short period of time. However, several distinctive features are present in information-based services which lead to important offshoring-related differences vis-à-vis manufacturing (Seidmann and Sundarajajan, 1997, Karmarkar and Apte 2007). These include the electronic nature of the provision of services, the ability to readily relocate services provision around the world given that appropriate information/communication linkages are in place, and the particular rele-

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[1] In most cases what is new is the concomitant industry phenomenon: namely, industry's relocation of activities that were previously performed in home countries.

vance of language commonalities and culture. Yet perhaps the most regularly discussed difference between services and manufacturing offshoring is the importance of skill sets and the centrality of highly educated and commensurately skilled labor (Dossani and Kenney 2003, Nicholson and Sahay 2004, Pfannenstein and Tsai 2004, Stack and Downing 2005, Davis *et al* 2006, Lewin and Peeters 2006, Jain *et al* 2008, Kumbakara 2008, Stringfellow *et al* 2008, Srivastava *et al* 2008).

Kotabe and Murray (2004) report that much of the offshore outsourcing literature has explained increased levels of outsourcing activities by using a core competency concept, that is, firms seek to shed their non-core functions through offshoring – captive or contracted (see also Pfannenstein and Tsai 2004). Firms will therefore prefer to retain only the most unique and valuable skill sets and seek out service providers for important but non-core skill sets. Here the corporate functions which are least core to the firm would *ceteris paribus* be the earliest candidates for outsourcing. Marlin (2005) describes practitioner evidence of this phenomenon, reporting that executives in financial services had indicated that the offshoring of low value-added services was well underway with higher value-added services expected to increasingly follow. From a related perspective, studies of global IT offshoring indicates that lower skilled and more standardized jobs are more easily moved across country borders than are high skill jobs (Aspray *et al* 2006, Mithas and Whitaker 2007) suggesting that lower skill jobs may be focus of earlier rounds of offshoring. This is in part due to the relative scarcity of higher skilled personnel offshore as well as the difficulty in retention of skilled personnel offshore. In bridging the influences of broader life cycle factors tempered by new concerns in the area of information-based services, we argue the broader industry-wide dynamics likely follow a trend of offshoring lower skilled service activities first and then higher skilled activities later. Hence, we hypothesize:

HYPOTHESIS 1: *In aggregate, the stage shifts (e.g., emergence-to-growth, growth-to-maturation watershed events) for the offshoring of lower skill service activities will occur earlier than the stage shifts for the offshoring of higher skill service activities.*

2.4 Information Sensitivity and the Temporal Evolution of Offshoring

We observe that firms are cognizant that information is an important asset that must be safeguarded. Given the information-based nature of many services, we propose that the information sensitivity of the services will also have a bearing on when offshoring occurs. We discuss this as follows.

One of the most regularly discussed risks of offshoring of services is associated with the transfer of sensitive internal firm information to a third party (Carmel and Agarwal 2002, Kliem 2004, Tafti 2005, Aspray *et al* 2006, Dhar and Balakrishnan 2006). From a managerial perspective, Lewin and Couto (2007) find that data security is the second most prevalent worry of offshoring managers, with the first being service quality. In particular, information that is both exclusively *internal* to the firm and highly strategically valuable is that which has high information sensitivity (Broderick 2001). Services with high information sensitivity involve key intellectual property (Temouri *et al* 2010) or enterprise-wide tools such as software designed to run mission-critical business functions, to support or constitute products sold by the firm, and/or facilitate decision-making regarding important business activities. Firms incur appreciable risk when offshoring highly sensitive information (Currie *et al* 2008) because if these assets are inadequately handled or secured, damage to the firm is likely to be swift and extensive. The firm may be partially crippled without vital functions or in contrast competitors may be able to directly obtain important insights regarding firm functioning, facilitating asset appropriation.

By contrast, firm activities with reduced information sensitivity involve information that is at least partly external to the firm itself or data that can be reconstituted. At the extreme, public domain information would have virtually no sensitivity to the firm, as if lost it could be easily recovered or newly retrieved. Firm activities with low information sensitivity might also therefore include basic information arising from interaction with mass market consumers. For example, the loss of a single individual (mass market) customer's order history would likely have minimal effect on the primary functioning of the firm. Alternatively, loss of such information in a technical support context could even be recovered through the question-and-answer process with the customer, or through a customer re-registering with the firm.

Mohr (1996) provided an early indication that the more information-intensive the industry, the greater the information management challenge faced by firms in the industry. For example, financial firms,

important contributors to global services offshoring, have been argued to have elevated information sensitivity because of their heavy reliance on IS (Goodhue and Straub, 1991). Yeh and Chang (2007) find similar high information sensitivity for the retailing/service sector. Individual case studies described in Chua and Pan (2008) and Vivek *et al* (2008) also describe the adoption of time-phased IS services offshoring strategies in financial firms, software providers and aviation services providers due the sensitive nature of the work involved. These firms offshored low sensitivity activities first, followed by increasingly sensitive activities. Yet it remains to be seen if this pattern holds more broadly or is confined to particular case studies. Generalizing from these individual events, we argue that the industry-wide evolution of low information sensitivity services will likely occur comparatively earlier than services with high information sensitivity due to intra-firm concerns about the security of information assets. If this is so, the watershed events of different sectors of information-based services' industry life cycles would occur not all at once but at different times. Again in part as a result of the fact that widespread offshoring is a relatively recent phenomenon, we do not focus on the decline phase. We instead focus on the earlier parts of the industry life cycles and accordingly hypothesize:

> HYPOTHESIS 2: *In aggregate, the stage shifts for the offshoring of service activities with lower information sensitivity will occur earlier than the stage shifts for the offshoring of service activities with higher information sensitivity.*

In the following section we describe our data and the methodologies we use to assess when the stage shifts (as indicated by breaks in entry rates in Figure 2) of the different sector life cycles occur.

3. Data and Models

3.1 Data

The data for the study were extracted from the fDiMarkets database of over 36,000 worldwide foreign direct investment (FDI) projects. The database is owned by the Financial Times and FDI project information contained in the database is generated from daily search-string queries on nearly 9,000 global

media sources. We utilized five full calendar years in our data set and hence examined projects from January, 2002 to December, 2006.

FDI projects involving manufacturing and other non-services-based activities were excluded in order to retain only projects involving the provision of services. We retained only projects involving the three major sectors of services offshoring indicated in UNCTAD (2004): customer support centers (e.g., customer technical support, help desks, customer relationship management, and information services), IS services centers (e.g., software design, software development, and applications testing), and shared services centers (e.g., claims and payroll processing, transaction processing, and data processing).

There were 1,420 such projects worldwide in the period 2002-2006. While we retained all projects regardless of home country (40 such home countries worldwide in the current data[2]), the U.S. and the U.K. accounted for the majority of the projects (55% and 8% respectively), with Germany, France and Sweden rounding out the top five services offshoring nations (7%, 5%, and 3% of the sample respectively) during the time period. There were 86 destination (or host) countries in the data set (which we do not list for reasons of brevity): the top 5 host countries were India, Canada, the U.K., Ireland, and the Philippines (20%, 8%, 7%, 5%, 5% respectively). As for the global distribution of host countries for services offshoring projects, the U.S.-based subset of our distribution corresponded well with the independently generated U.S.-based distribution of Carmel and Agarwal (2002, p. 75)[3].

In terms of the skill level per worker provided by the functions associated with the three categories of customer support centers, IS services centers, and shared services centers, we use wages as a proxy for relative skill. 2006 U.S. annual salary averages compiled by the Bureau of Labor Statistics (2006) reveal that call center employees (Standard Occupation Classification: 41-9041) earn $24,760 on average, workers in shared services professions (e.g., claims and payroll processing clerks, bookkeeping

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[2] The complete listing of home countries is as follows: Australia, Austria, Belarus, Belgium, Bermuda, Canada, China, the Czech Republic, Denmark, Egypt, Finland, France, Germany, Hong Kong, Hungary, India, Ireland, Israel, Italy, Japan, Jordan, Kuwait, Malaysia, Mexico, the Netherlands, Norway, Portugal, Qatar, Russia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Turkey, the U.A.E., the U.K., and the U.S.A.

[3] We note that it is conventional in empirical research to include descriptive statistics and correlation matrices for X (the predictor variables). However, here the model specification is such that X (the location of the changepoints) is

processing clerks, data entry keyers, with Standard Occupation Classifications: 43-3031, 43-3051, 43-9021, 43-9041) earn \$29,480, and IT services employees (computer programmers, computer software engineers, computer support specialists with Standard Occupation Classifications: 15-1021, 15-1031, 15-1032, 15-1041) earn \$69,097. We note here that two of the shared services professions (43-9021, 43-9041) have annual salaries less than that of call center employees, while the other two (43-3031, 43-3051) have greater salaries. Thus, call centers and shared services centers appear to be relatively lower skill activities as compared to IT services. This definition is consistent with industry practices described in Mudambi and Venzin (2010) where low skill functions (such as generating structured industry reports and repackaging data) are compensated less than are high skill functions (such as providing strategic advisory services for mergers and acquisitions).

As for information sensitivity, from the previous discussion IT services with its development of key internal intellectual property and facilitation of mission-critical activities has higher relative information sensitivity (e.g., Temouri *et al* 2010). Compromise of these capabilities could eliminate firm competitive advantage (Mohr, 1996) or bring the enterprise to a halt. Firm activities with moderate information sensitivity involve processes that are again internal to the firm but have less extensive strategic value. This includes more day-to-day administrative tasks required for the continuing maintenance of firm functioning. Hence, shared services which involve routine processing of large volumes of internal firm information such as accounting, claims, billing, payroll and human resources data would thus have moderate information sensitivity. Davamanirajan *et al* (2006) confirm that information such as employee compensation and profit margin are considered sensitive in financial firms. However, compromise of this information may be less crippling than that of the information systems themselves. Call center data which may derive from externally arising consumer product information queries, help requests or individual purchases would have lower information sensitivity as previously discussed (Mudambi and Venzin 2010).

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a priori unknown and effectively latent, and thus must be estimated from the data. Accordingly, no *a priori* descriptive statistics for *X* are available and the corresponding table is omitted.

3.2 Models

The utility of the Bayesian framework in investigating management phenomena has recently been discussed by authors such as Hansen, Perry and Reese (2004) and Hahn and Doh (2006). Here, an additional benefit is that the Bayesian framework permits simultaneous model comparison of an arbitrary number of non-nested models as opposed to the classical pairwise model comparison of nested models. This capability is utilized below wherein four non-nested models per sector are simultaneously compared (see Table 1).

We employ structural break Poisson models with unknown changepoints (Carlin *et al*, 1992, Chib, 1998). Empirical life cycle research has often used survival models (Bayus and Agarwal 2007) based on known cohorts (e.g., Klepper and Graddy, 1996), but the approach used here departs from this approach by treating the changepoints as a set of *unknowns* to be estimated from the data. Computational details appear in an Appendix.

Here, y_t is the count of the number of initiated offshoring projects in month t, where t ranges from 1 to N. The stage-specific rate parameter, λ_s, is the estimated rate given that y_t is in stage s. There are a total of $S = H + 1$ stages where H is the number of structural breaks or changepoints estimated in the model. Hence the graphical depiction of our results in Figure 4 corresponds with the conceptualization shown in Figure 2. In specifying the Gamma priors in (3), locally uniform priors were used such that $\alpha = 1$ and $\beta = 0.01$. Alternative locally uniform prior specifications made little relative difference in the estimation results. For models with 1 or more changepoints, $\boldsymbol{\tau} = \{\tau_1, \ldots, \tau_H\}$ was given a multivariate hypergeometric prior as in (4), which (as is discussed in an Appendix) results from the non-informative assumption that the changepoints are equally likely to occur at any particular time. For example, in the case of $H = 1$ break, the prior for τ_1 reduces to the discrete uniform on $\{1, 2, \ldots, N\}$ with mass $1/N$ at each point.

4. Results

We report results for models with $H = \{0, 1, 2, 3\}$ changepoints corresponding to the maximum possible number of changepoints indicated by industry life cycle theory (see Figure 2); additional analyses with $H = 4$ provided very little evidence for this category of model. Table 1 shows the posterior model probabilities for the models given equivalent model prior probabilities. Each row of the table displays the results for a particular sector. We obtained posterior model probabilities via the marginal likelihood method of Chib (1995, see Appendix for details).

Table 1: Posterior Model Probabilities and Log Marginal Likelihoods

by Sector and Number of Changepoints

	Posterior Model Probability				Log Marginal Likelihood			
	No break	1 break	2 breaks	3 breaks	No break	1 break	2 breaks	3 breaks
Call Centers	0.8292	0.0884	0.0489	0.0336	-182.1	-184.3	-184.9	-185.3
Shared Service Centers	0.0000	0.7204	0.2232	0.0564	-165.9	-156.2	-157.3	-158.7
IT Service Centers	0.0000	0.7499	0.2410	0.0091	-184.8	-137.9	-139.1	-142.3

Figure 4 presents the monthly entry rates by service type. Since the raw data is proprietary and must be purchased from the vendor, we have added a small amount of random jitter to the monthly entry counts plotted in Figure 4. However, all parameter estimates plotted are for the original unjittered data. Results for call centers, a low skill services sector with less information sensitivity, suggest that no break occurred during the study time period (see also Figure 4a). The posterior odds-ratio[4] for the no break model as compared to the next most likely model, the 1 break model, was 9.4:1. With the equivalent model prior probabilities, the ratio is also the Bayes factor. This value of the Bayes factor constitutes substantial evidence on Jeffreys' (1961, p. 460) scale, supporting the 1 break model over the no break model. By contrast, we see clear evidence of at least one break for shared services centers and for IT services centers. For example, the Bayes factor for the 1 break model versus the no break model was over 16,700:1 in both the shared service center and IT service center sectors, constituting decisive rejection of

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[4] Obtainable as the exponentiated difference of the log marginal likelihoods.

the no break model. The best supported model for shared service centers was the 1 break model (see Figure 4b); similar results were obtained for IT service centers (see Figure 4c).

We also discuss the 95% posterior credible intervals for the locations of the breaks. For shared services centers, the 95% posterior credible interval ranges somewhat more widely from December 2002 to October 2004, reflecting greater uncertainty associated with the location of the break. The most probable location for the break is May 2003 (as indicated by a vertical dashed line in Figure 4b). For IT services centers, the 95% posterior credible interval ranges from December 2003 to May 2004. The most probable location for the break is March 2004.

(a)

(b)

(c)
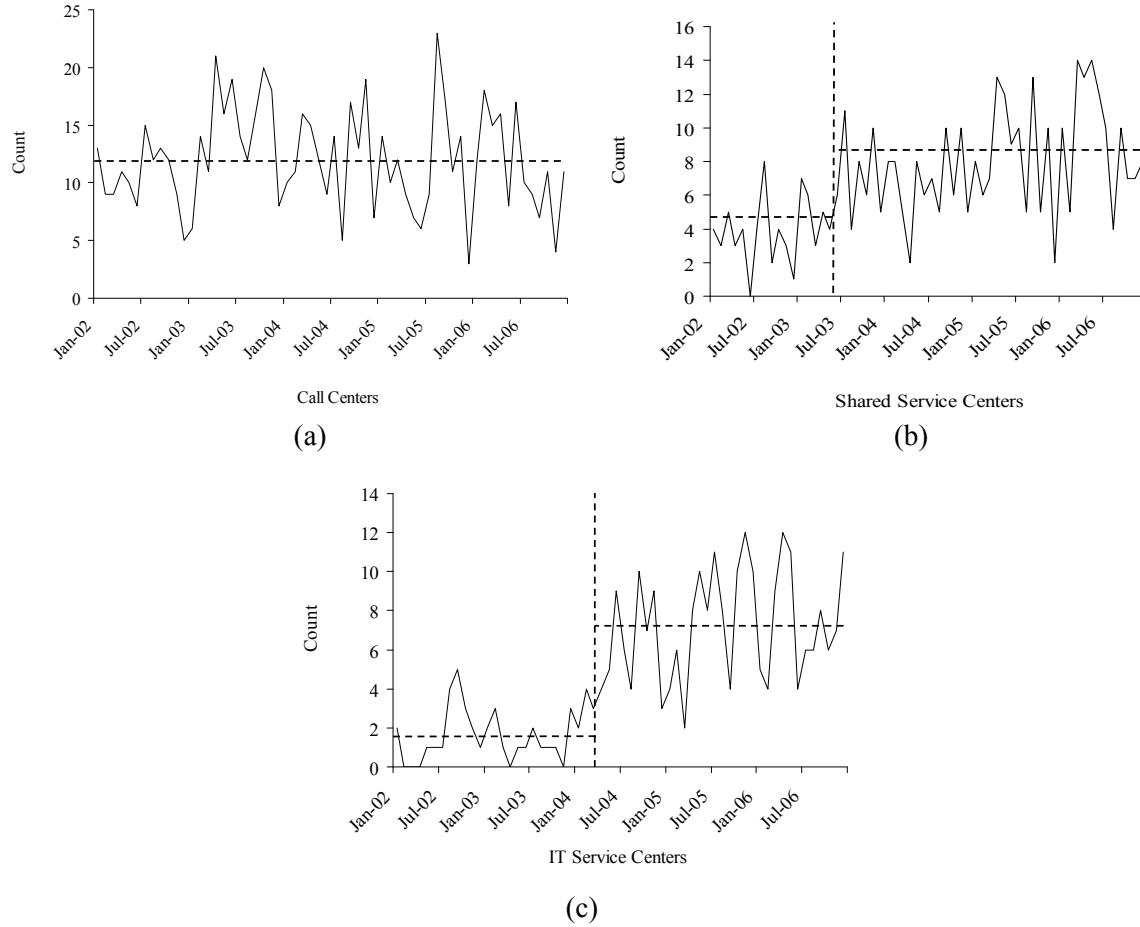
Vertical dashed line – estimated changepoint; horizontal dashed lines – estimated entry rates

Figure 4: Monthly Offshore FDI Project Entries by Service Type: 2002-2006. (Random jitter added)

Table 2 displays the parameter estimates of the entry rates by sector; these are indicated with dashed horizontal lines in the corresponding parts of Figure 4. For call centers, the posterior mean of the distribution of the rate parameter is 12.12, which can be used as the point estimate of the monthly entry rate for offshore FDI projects in this sector. There is only one rate throughout the series given the previous evidence favoring the no-break model. Hence, as displayed in Figure 4a, the entry rate across the time period 2002-2006 for offshore call centers appears to be described as constant at roughly 12 per month subject to random fluctuation. For shared services centers, the point estimate for the initial rate is 4.09, while after the structural break the subsequent rate nearly doubles to the value of 8.06. For IT

service centers, the change is even more pronounced. The initial rate is estimated as 1.69 offshore IT service center FDI projects per month, while after the break it is 7.21 per month.

In reviewing the findings, the evidence suggests that call centers remained in a single stage of the industry life cycle throughout the period 2002-2006. Determination of what phase this sector was in is therefore not completely unambiguous because the entirety of the life cycle and the associated breaks are unavailable for examination. However, it is common in the changepoint literature to refer to events contemporaneous to the study so as to identify possible causes and to better place the results in context (see for example Whittaker and Frühwirth-Schnatter, 1994, Chen and Gupta, 1997). We therefore provide additional context for the patterns observed with respect to the sectors.

Table 2: Parameter Estimates for Models with Highest Posterior Probability by Service Type

	Initial Rate λ_1			Subsequent Rate λ_2			Change-point τ_1		
	Mean	S.D.	95% Interval	Mean	S.D.	95% Interval	Mean	S.D.	95% Interval
Call Centers	12.12	0.448	(11.25-13.01)	—	—	—	—	—	—
Shared Service Centers	4.09	0.640	(3.00-5.56)	8.06	0.511	(7.16-9.19)	18.30	4.993	(12-34)
IT Service Centers	1.69	0.272	(1.19-2.26)	7.21	0.481	(6.30-8.19)	26.56	1.273	(24-29)

Given the 2002-2006 time period of the study it is possible that the offshore call center sector had already passed the slow-moving emergence stage prior to January 2002 and entered the growth stage in light of the more elevated entry rates as in Figure 4a. This perspective is corroborated by recent results from a large-scale Booz & Co./Duke survey (Couto *et al* 2008) in which managers indicated the growth in call centers has been elevated but steady beginning at about 1998-1999. Hence, we expect the break from emergence to growth in call centers to have occurred in advance of the study period available here. With regard to shared services centers and IT service centers, determination of the initial and subsequent stages

could be open to some interpretation. Nevertheless, given the considerably lower rates associated with the initial stage versus the subsequent stage, in both cases we observe $\lambda_1 < \lambda_2$ which is consistent with the first stage being emergence and the second being growth. Moreover, we observe that the most probable location for the shared services center sector break being in May 2003, whereas that for the IT services center sector being March 2004. Partial corroborating historical evidence for the location of the breaks can be taken from the fact that services offshoring of jobs (particularly IT and white collar jobs) was a contentious public issue in the U.S. in the months leading up to 2004 presidential election. Thus, the breaks can be ordered as follows: call center sector – before 2002, shared services sector – May 2003, IT services center sector – March 2004.

We test our hypotheses with Bayes factors as follows. Denote the stacked data as $\boldsymbol{Y}^{\mathrm{T}} = (Y_c^{\mathrm{T}}, Y_d^{\mathrm{T}}, Y_q^{\mathrm{T}})$ where the superscript denotes the transpose operation and Y_c, Y_d, and Y_q denote the data for call centers, shared service centers, and IT service centers respectively. For Hypothesis 1, we test the null model that $\tau_c = \tau_d = \tau_q$ versus the alternative model $(\tau_c = \tau_d) \neq \tau_q$. The null model indicates that the standardized services considered here have life cycles which are yoked together such that shifts (changepoints) all occur at the same time. We allow the two λ parameters per service type to be free so as to allow for the fact that rates may differ because of greater demand for some services as compared to others. Hence, the null model corresponds to the perspective discussed in §2.3 that standardized services should be offshored at the same time. The alternative model indicates that lower skill activities (call centers and shared services) with essentially equivalent skill levels (as proxied by wages) would be offshored at essentially the same time, while higher skill activities would occur later. We label this alternative model as the Skill model below.

For Hypothesis 2, we may again take the null hypothesis as before, while the alternative is that $\tau_c \neq \tau_d \neq \tau_q$. In the current situation, the most probable location for τ_c as indicated above is that it occurred in advance of the study period. Accordingly we only estimate λ_1 for this model and leave τ_c unestimated as in the first set of results in Table 2. We call this model the Information Sensitivity model below.

The posterior probabilities in Table 3 indicate that the Bayes factor of the Skill model versus the null model is a rather modest 2.6:1, providing no support for Hypothesis 1. However, for Hypothesis 2 the Bayes factor of the Information Sensitivity model against the null is 70.4:1; thus, Hypothesis 2 is supported. Note that in the Bayesian approach there is flexibility in considering which model may be the null for comparison against others – hence, we may also compare the Skill model to the Information Sensitivity model. Here, the 26.6:1 Bayes factor supports the Information Sensitivity model considerably more than the Skill model.

Table 3: Posterior Model Probabilities and Log Marginal Likelihoods

	Posterior Model Probability	Log Marginal Likelihood
Null Model	0.0135	-482.5
Skill Model	0.0357	-481.5
Information Sensitivity Model	0.9508	-478.2

5. Discussion

5.1 Implications for Research

In this paper, we have explored the stages of three types of information-based services offshoring using industry life cycle theory and explained the determinants of the sequencing of these stages according to the skill and information sensitivity levels of these services. Although advances in technology allows firms to break apart the services value chain and rethink where they may perform services most efficiently, firms also clearly need to consider the risks of offshoring above and beyond the relevant traditional offshoring decision factors such as wages, quality of workers, and the impact of culture that have been discussed to date in the offshoring literature. Consistent with Hypothesis 2, the life cycle stages associated with the offshoring of less sensitive services appears to occur earlier while the offshoring stages for services which have moderate/higher sensitivity skill requirements occur later. There is some weak support for the role of skill as well; however, at least in the sectors considered here,

information sensitivity appears to play a more important role than activity skill level, suggesting that in initial offshoring phases firms tend to be more risk averse. Hence, the current research contributes to the offshoring literature by bridging industry life cycle theory with services offshoring theory to generate what appears to be the first such theoretical linkage that has been empirically examined, as well as the first such theory explaining sector-specific evolution in services offshoring.

The research also provides a response to recent calls in the industry life cycle literature for methods that can be used to empirically distinguish the phases of industry life cycles by identifying the starting and ending points of the phases (McGahan, Argyres, and Baum 2004). While in some cases in the strategy and management literatures breakpoints may be known, in many others they are *a priori* unknown and must be estimated as we do here. At the methodological level, the research introduces a methodology new to the literatures discussed that allows for testing of existing theories in new non-nested ways while permitting formal model comparisons for the assessment of life cycle stages. The research also provides the novel methodological utilization of Bayesian structural break models for Poisson data in life cycle research. Finally, the research extends recent research on offshoring of information-intensive services (Mithas and Whitaker 2007) by empirically investigating the heretofore unexamined temporal nature of the offshoring of these services.

5.2 Implications for Practice

At the practitioner or the firm level, the study offers an understanding of the mechanisms by which different sectors of a broader industry evolve, which in turn enhances the firm to position itself more optimally by entering markets at more opportune times. For managers, an awareness of which types of services will likely progress earlier versus later through a life cycle will assist in the strategic determination of decisions such as timing of entries and exits. As for the sectors we examine here, elevated entry rates were observed for all three sectors by the end of 2006, suggesting that growth stage was in progress and that long-term profit potential for these sectors was still being observed by firms globally. However, firms should expect the maturation phase of the call center sector to occur earliest,

and so looking toward the long-term investment in other higher-valued added sectors may be more rewarding assuming that relevant risks are mitigated.

Our research also has implications for later-arriving offshoring firms. To be able to compete with existing firms, they will likely need to move up the value chain and attract higher skill-based services since it is likely that increasingly high skilled services will be offshored. An alternative approach would be to provide wide range of services from low to high skill services since the future profitability of the lower-skill portion of the sector may already have been increasingly utilized.

5.3 Limitations and Directions for Future Research

Considering the limitations of the research and future avenues for research, the time period of 2002-2006 associated with the data source offers limited insight into the emergent phase of the call center sector. While past research (Carmel and Agarwal 2002, Carmel and Nicholson 2005, Erber and Sayed-Ahmed 2005) suggests pre-2000 IS offshoring occurred on a considerably smaller scale than post-2000 offshoring, and had a more limited Y2K-centric scope (Qu and Brocklehurst 2003), a more definitive empirical determination awaits future research. This limitation of the data, we believe, is well-counterbalanced by its considerable strengths of being worldwide in scope and being derived from actual firm offshoring activities (as opposed to managerial perceptions). Hence the current research results arise from the actual global evolutions of the offshore sectors described, providing useful insight into this important phenomenon.

Future research should also examine offshoring as it moves into the maturation stage and decline stages, which also are unavailable at the present time of writing. An examination of exit rates would also be interesting for future research; however, these were not available in the current data set. Another interesting possibility would be to look at the temporal evolution of the sizes or dollar-values of offshoring projects over time as opposed to the evolution of the number of projects over time. Unfortunately, the current data has very high rates of missing data with regard to these variables, and so we leave these inquiries for future research. Furthermore, more macro-level factors pertinent to industry entry rates such as host country capacity and the diffusion of technological innovations are undoubtedly

crucial. Here we have sought to understand how industries have evolved given that such macro-level factors exist, rather than examine the direct impact of the macro factors on industries.

One possible limitation of the study is that the entry rates may not be truly constant over time, although this seems not too implausible in the current context as Figures 4a-4c display. Nonetheless, future research could examine whether the change in the rate is itself changing, namely, as to whether rates are accelerating or decelerating, by entering higher-order temporal terms in the model. We leave this as an opportunity for future research as we have intentionally sought in this work to directly utilize established life cycle theories as discussed in §2.1.

Additional possibilities for future inquiry would involve the interaction of particular sectors in particular countries, or conducting managerial survey research on possible future shifts in offshoring (Lewin and Couto 2007, Lewin *et al* 2008). While we have examined global activity here, different evolutionary trajectories are likely to be found within particular countries. For example, in Vietnam the call center sector may still be in an emerging, or even pre-emerging, stage. Because of data limitations, we point out that this study is not a study of outliers (e.g., Andriani and McKelvey 2007) in that we do not seek to examine the offshoring sequences of the specific cases of a few extremely early entrants. Rather we look at the broader mass of the sectors considered and seek to examine if and when there are major shifts in aggregate trends. Finally, while we consider four-stage life cycle theory here, the methodology described can be used for life cycle approaches where the number of stages is known *a priori* to be other than four, and also (by using Bayes factors) when the number of stages is *a priori* unknown and must be estimated from the data.

Appendix

In this appendix, we briefly review the details of the model and Bayesian model comparison. Parameter estimation in the analyses was conducted via Markov chain Monte Carlo. Results here are based on runs of 100,000 iterations of the Markov chain after a 1,000 iteration burn-in had transpired. Additional runs with alternative numbers of iterations and differing burn-in lengths provided substantively identical

results as convergence to the posterior was rapid.

The Bayesian framework requires the specification of the likelihood and priors. Accordingly, we have:

$$y_t \sim \text{Poisson } (\lambda_j), \qquad\qquad\qquad (2)$$
$$\lambda_j \sim \text{Gamma } (\alpha, \beta), \qquad\qquad\qquad (3)$$
$$\tau \sim \text{Multivariate Hypergeometric } (N, H). \qquad (4)$$

Note that with the Poisson likelihood in (2) and the Gamma prior in (3), the conditional posterior for λ_s is

$$p(\lambda_s|Y,\tau) \sim \text{Gamma}(\alpha + \sum_{t=1}^{N} \phi_{ts} y_t \, , \beta + n_s), \qquad\qquad (5)$$

where ϕ_{ts} is the indicator function taking the value 1 if y_t is in stage s and zero otherwise as detailed in (1), while n_s is the number of observations in stage s. Accordingly, (5) can be obtained by Gibbs sampling. Next, we consider the prior for τ by examining the order statistics of a uniform discrete distribution on the changepoints sampled without replacement. If we consider all changepoints simultaneously and all changepoints are equally likely, then

$$p(\tau) = \binom{N}{H}^{-1}. \qquad\qquad\qquad (4)$$

Bayes factors for model comparison can be obtained from the exponentiated difference of two models' log marginal likelihoods. Here, we use Chib's (1995) method for determining log marginal likelihoods, $\ln p(Y)$. Write the collection of parameters as θ and then fix these to particular values θ^*. Then Bayes' rule can be rewritten as $\ln p(Y) = \ln p(Y/\theta^*) + \ln p(\theta^*) - \ln \hat{p}(\theta^*|Y)$, where $\hat{p}(\theta^*|Y)$ is an estimate of the posterior density. Of the terms on the right-hand side, the first is available directly from (2) while the second is available from (3) and (4). Chib (1995) shows the final term on the right-hand side can be obtained by running the Markov chain to find values with high posterior density (such as the posterior means or modes) for the blocks of parameters sequentially. With these quantities, we form θ^* and the log marginal likelihood is obtained.

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