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Spatial and Temporal Trends in Information Technology Outsourcing

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Spatial and temporal trends in information technology outsourcing

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A B S T R A C T

Over the last two decades information technology (IT) outsourcing has grown dramatically, and has emerged as a strategic choice for firms searching for ways to control their costs and maintain a competitive edge. The mechanisms driving its growth are not fully understood though. In this research, we employ an approach that focuses on geographic, temporal, and industrial proximity in a mechanism that identifies the process underlying the diffusion of IT outsourcing across firms within the U.S from 2000 to 2010. We focus on the role that firm location plays in the diffusion process, and use space-time clustering techniques from the epidemiology literature to understand the diffusion process. We identify 38 space-time clusters based on IT outsourcing announcement data and the locations of firm headquarters among U.S.-based firms. When supplemented with additional information, such as type of services outsourced, the metropolitan area of the headquarters, and related industry information; the results offer insights into various types of diffusion processes that have been identified in the literature but have not been documented to date in the empirical manner that we have been able to do.

Keywords:
Clustering methods
Contagion effects
Economies of scale
Economies of scope
IT services
Outsourcing
Spatio-temporal analysis
Technology diffusion

1. Introduction

Over the last two decades, as corporations have searched for ways to grow and maintain their competitive edge, outsourcing has emerged as a strategic choice for achieving those goals through cost control. According to Gartner (2014), one of the leading information technology (IT) research firms, global spending for IT services was approximately $932 billion in 2013, and is expected to grow to $967 billion in 2014, a growth of 3.8% from 2013. They further predicted that the market for business process outsourcing (BPO) services would grow by 6.2% in 2013. Additionally, Gartner (2013) predicted that the five-year compound annual growth rate through 2016 for worldwide BPO would be 5.3%. As IT outsourcing and offshoring have grown, so has the presence of service providers in the domestic and international markets. Onshore and offshore IT outsourcing has made a dramatic difference across various industries, such as banking and finance, healthcare, and telecoms. It has developed from being an inexpensive way to support non-crucial services to being strategically important for businesses. While IT outsourcing has grown over time, the mechanisms driving this growth have not been clear.

IT outsourcing is a straightforward business choice, but its implementation for any particular firm is more complex. The process involves practical steps, such as identifying activities that can be outsourced within the firm, finding and interviewing external contractors, and conducting cost-benefit analyses. Other more sensitive issues are likely to emerge, such as ceding some control of the firm's business processes and initiating worker layoffs. These are difficult waters for a firm to navigate, and a firm's comfort level will likely increase when other firms lead the way. When firms imitate one another it is often the result of *agglomeration economies*. These are the benefits that firms receive from geospatial proximity to other firms. Another driver involves *contagion effects*, or knowledge transmission from close interactions.

In this article, we use spatial, temporal, and industrial proximity to explore the increasing use of IT outsourcing in the U.S. Using unique data on IT outsourcing announcements that appeared in the media between 2000 and 2010, and space-time clustering methods typically used to identify contagions, we consider the role agglomeration plays in IT outsourcing. A *space-time cluster* is defined as a set of events, such as IT outsourcing announcements,

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occurring within a limited space and time (Lilienfeld & Lilienfeld, 1980; Selvin, 1991). IT outsourcing clusters occurred in all parts of the U.S. throughout the decade, and across many different industries. Combined, these clusters give context to the process of IT outsourcing in the U.S. and indicate the many ways in which this type of business activity spreads. Our goal is to identify the patterns of IT outsourcing diffusion within space-time clusters (Ye & Carroll, 2011), and to establish whether IT outsourcing diffuses across industries in the form of *scope externalities*, or within industries in the form of *scale externalities*. We ask: How does IT outsourcing spread? What are the underlying patterns? What is the role of proximity, as geographic nearness and industry similarity, in its diffusion?

Section 2 presents the theoretical frameworks used to understand the diffusion process of IT outsourcing. Section 3 introduces the data set and methods. Section 4 presents the results and analysis, and in Section 5 we discuss the patterns, and Section 6 concludes.

2. Theoretical background

For over two decades now, academicians have been conducting research on different aspects and issues associated with IT outsourcing. There have been only a handful of studies that have looked at the issues associated with diffusion of IT outsourcing though. Loh and Venkatraman (1992) and Hu, Saunders, and Gebelt (1997) explored the sources of influence in the adoption of IT outsourcing. Mann, Kauffman, Han, and Nault (2011) evaluated the presence of contagion effects in the diffusion of IT and business process outsourcing. In addition to prior research on IT outsourcing, prior work also seeks to understand geographic dispersion for high-tech industries and the collocation of clients and vendors (Arora & Forman, 2007).

Our main goal is to understand the diffusion patterns of IT outsourcing. Towards that end we use an inter-disciplinary approach that leverages the perspectives of contagion effects theory from epidemiology and the concepts of agglomeration economies from economics to develop new insights on IT outsourcing diffusion. These two perspectives are linked by their reliance on the geographic concept of spatial proximity. We further extend the concept of proximity to include temporal and industry similarity. This theoretical approach allows us to understand the diffusion of IT outsourcing from different vantage points.

Contagion effects are defined as "the spread of a particular type of behavior through time and space as a result of a prototype or model performing that behavior and either facilitating that behavior in the observer or reducing the observer's inhibition in performing that same behavior" (Midlarsky, 1978, p. 1006). Prior literature, including Dornbusch, Park, and Claessens (2000), Midlarsky (1978), Midlarsky, Crenshaw, and Yoshida (1980), and Kauffman, Techatassanasoontorn, and Wang (2012), has shown that contagion effects can spread in different ways based on a population's predisposing factors and characteristics. They include, strong or weak ties, physical proximity, and the presence of hierarchical effects. Prior research (Mann et al., 2011) has also shown the presence of contagion effects in the diffusion of IT outsourcing within three major industries (Broadcasting and Telecommunication, Healthcare services, and banking and finance) using one such stratifier – the firm size. *Contagion effects theory* posits the connectedness of adoption events over time, and offers a more refined expression of the diffusion of innovation theory (Kauffman & Techatassanasoontorn, 2009). Contagion effects are time-bounded, and may also be affected by spatial proximity and proximity in other ways that are not physical, such as industry similarity.

Contagion effects arise in two ways. The first is external to business, industry, and geography, and is based on macroeconomic drivers (Goldstein, Kaminsky, & Reinfart, 2000). The second is spillovers due to interdependencies among market activities: aligned management interests or business activities in an industry, in a region, or across firms with similar interests. Spillovers usually involve tacit knowledge, and their transmission depends on distance. *Tacit knowledge* is ill-documented, uncodified, and can only be acquired through the process of social interaction. Consequently, knowledge spillovers may be related to the region in which the new knowledge is created (Anselin, Varga, & Acs, 1997; Feldman & Audretsch, 1999). This introduces the need for geographical proximity and encourages firms to concentrate in specific regions (Feldman, 1994).

The spatial clustering or *agglomeration* of economic activity is generally viewed as a sign of increasing returns and competitive advantage. Underlying the phenomenon of clustering are mechanisms that facilitate the interchange and flow of information between firms (Porter, 1990). These information flows or *knowledge spillovers* are sources of innovative output and productivity growth (Griliches, 1992), and also are one of the main reasons why firms collocate. Positive externalities associated with collocation may occur within or across industries, often leading to endogenous growth (Aghion & Howitt, 1998). Pavitt (1987) suggests that, due to its informal and uncodified nature, new knowledge flows more easily within a region than over great distances. As a result, there will be more knowledge spillovers in industrial centers, and this will lead to more innovative output.

In seeking to understand how location affects economic activity, empirical researchers have classified agglomeration economies into either localization economies or urbanization economies (Loesch, 1954). *Localization economies* are what Glaeser, Kallal, Scheinkman, and Shleifer (1992) define as *Marshall-Arrow-Romer* (MAR) *externalities*. They are external to the firm but internal to an industry within a geographic region and represent specialization and *economies of scale* (Arrow, 1962; Marshall, 1890; Romer, 1987). The concept of localization economies based on MAR and scale externalities is that the concentration of an industry in a region promotes knowledge spillovers among firms and facilitates innovation in the industry (Glaeser et al., 1992). This *specialization* and the related *specialized knowledge* encourages the transmission and exchange of ideas and information, whether tacit or codified, of product and processes through imitation, business interactions, and inter-firm circulation of skilled workers. In contrast, *urbanization economies* are external to industries but internal to geographic units such as cities, and represent diversity or *economies of scope* (Bathelt, Malmberg, & Maskell, 2004; Glaeser et al., 1992; Jacobs, 1969). Urbanization economies imply that the most important sources involving knowledge spillovers are external to the industry within which a firm operates. A more diverse industrial fabric in close proximity fosters opportunities to imitate, share, and recombine ideas and practices across industries. Also, the exchange of *complementary knowledge* across firms and economic agents facilitates experimentation in innovation.

Contagion and agglomeration theories can be brought together under the so-called *epidemiological triangle* (Merrill, 2013). This framework typically is used to outline the mechanisms by which a contagious disease spreads. The nodes of the triangle reference the *host* and *agent*, as well as the *environment* in which they interact. In the case of the disease malaria, for example, these nodes might reference people, a location with mosquitoes and standing water, and the malaria-causing parasite. Embedded within this framework are the concepts of direct transmission and indirect transmission of the agent to the host. Malaria is an example of *indirect transmission*, since mosquitoes are intermediary agents in the process, while influenza is airborne and typically exhibits *direct transmission* between two people within a very short distance of each other. The key difference between direct and indirect transmission for our purposes is the importance of geography. Direct transmission relies on hosts being near one another, whereas the reach of the intermediary as an agent constrains indirect transmission. With the infectious process mapped onto this framework, the key goal in epidemiology is to identify how to break one side of the triangle and thus stop the spread of the relevant contagion.

The epidemiological triangle can be applied to the transmission of business practices as well. We define the *host* as the firm. The *agent* is the business idea, which can be either positive (e.g., a business opportunity), or negative (e.g., an economic downturn). See Fig. 1 below.

If one were to discount the importance of space, then we would define *environment* as all countries in a trading region. This would be the European Union, Southeast Asia, or North America, for example. We further recognize the transmission of all ideas as being indirect, since the process occurs through the media, research, or other intermediaries.

One such example of *indirect, negative agent transmission* occurred with the spread of the currency crisis in Southeast Asia in 1997. In addition to the external shocks and spillovers, the herd behavior of global investors acted as a trigger and led to widespread loss of confidence and higher perceived risk in the region. The currency crisis spread across Southeast Asia, affecting Thailand, Malaysia, Philippines, Indonesia, and Korea (Baig and Goldfajn, 1998).

In contrast, an example of *indirect, positive agent transmission* occurred in the case of the *Kodak effect*. Prior research (Loh & Venkatraman, 1992) showed that interest in IT outsourcing escalated when IBM's Integrated Software Solutions Corporation (ISSC) made a highly-publicized announcement about its agreement with Eastman Kodak to build and operate Eastman Kodak's data center in Rochester, New York. The authors' analysis of the escalation of IT outsourcing in the early 1990s was founded on a *mixed influence perspective*, that was earlier promoted by Marketing researchers, especially Frank Bass (1969) in a seminal and often-cited article in *Management Science*. This perspective argues that diffusion takes place both through channels of communication *internal* to a firm's industry and through *external* channels, such as vendors and the media. Spatial proximity was not considered.

We are looking at the case of direct transmission of opportunities — essentially *agglomeration economies*. The spatially-close interactions allow the transmission of ideas directly between firms, even if those transmissions are the result of unexpected interactions in coffee shops and neighborhoods. Marshall (1890, p. 332) also made this epidemiological analogy when stating that business ideas and processes are “as it were in the air” and thus available to those in “near neighborhood to one another”. To some extent, a firm's choice to locate in a particular metro area or even a particular business district reflects its desire to be susceptible to new ideas. This, we think, is a way to view the firm's interest in

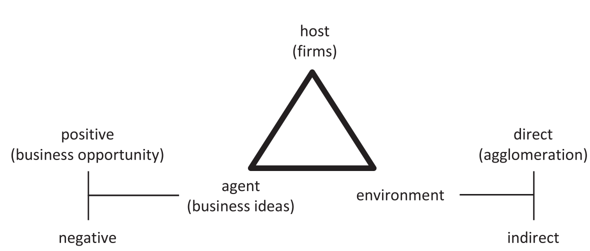


Fig. 1. Transmission of business practices.

being “infected” by the firms around it. We will use the epidemiological contagion framework to identify the presence of urbanization and localization economies in the spread of IT outsourcing methods.

3. Data, analysis procedure and method

IT outsourcing announcements are conduits for disseminating information about firms' activities through the environment in which they operate. Prior research has shown that managerial decision-making is often influenced by such information updates (Dixit & Pindyck, 1994).

3.1. Data

The data consist of announcements of IT and business process outsourcing deals between January 1, 2000 and December 31, 2010. We collected it using a full-text search of firm announcements related to IT and business process outsourcing. We used two leading news sources: *PR Newswire* and *Business Wire*. The online *Lexis/Nexis* database allowed us to search the newswires 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 257 announcements had information about IT or business process outsourcing.

Not all of the relevant details — for example, physical addresses required for analysis — were found in the company announcements, however. To collect these data, we searched other secondary sources, including 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 the independent announcements. The announcements data are at the firm level. Only announcements for clients located in the U.S. are included. We did this to maintain consistency across the industry- and firm-level data. Once we screened the data for complete information about the date of announcement, client, client industries, physical addresses of firm headquarters, type of services being outsourced, and reoccurrence, 179 observations remained.

Strategic decisions, such as IT outsourcing, are generally made at the corporate level. The strategic management literature identifies three levels of strategic decision-making; corporate, business unit and operational (Kelly & Gennard, 2007). Strategic business decisions are generally formulated and made at the Chief Executive Officer Group (CEOG) level, and sometimes at the board level or the business unit level. IT outsourcing decisions are strategic business decisions and it is common that the CEOG is usually housed at the corporate headquarters. Thus, we use the corporate headquarters location to identify the space-time clusters, and analyze the geographic and temporal aspects of IT outsourcing diffusion. Ten of the announcements involved firms whose global headquarters are located outside of the U.S. In these cases, we used their U.S. headquarters.[1]

Additionally, suppose that several IT outsourcing announcements are observed from firms in a particular industry within a space-time cluster, say banking (NAICS 522). Then, following this, there is an IT outsourcing announcement from another firm in the banking located at a reasonable distance to the first firm. It may be possible to conclude that scale externalities are at play in the diffusion of IT outsourcing in this particular case. The only pre-

[1] Repeating the analyses to be described later using only those firms with global headquarters inside the U.S. did not change the substance of the findings.

condition is that the IT outsourcing announcements from firms in both of the industries should occur relatively close in time.

Another consideration is that if the times are too close together – for example, two days or two weeks – then it will be difficult to claim that one firm is actually responding to another's actions. We considered the years 2000–2010. During this time, IT outsourcing was already embedded in the business landscape. Thus, it may take a firm anywhere between 30 days and 120 days – and in many cases even more, if the firm is engaging in outsourcing for the first time – to go from recognizing the need to outsource to the actual announcement of an outsourcing deal. It takes time for managers to observe a competitor that has announced an IT outsourcing deal, and then to find a vendor, do the negotiation, perform due-diligence legal work, and so on, to consummate a contract. In addition, the variation in time may be influenced by the complexity of service being outsourced, whether or not the services of vendors, with whom the client has a prior relationship, are being engaged, and client company's response capabilities, etc.

Thus, to analyze the spillover effects within or across industries, we used varying levels of response time – with 30, 60, 90 and 120 days as the minimum lag-times between the outsourcing announcement of one firm that acted first, and a second that responded to it.[2]

We view *proximity* along both spatial and industrial dimensions. Industry similarity is a kind of conceptual distance between the industries that matches our spatial approach: it indicates the similarity in the contents of their activities. We implement this using the North American Industry Classification System (NAICS) codes. For instance, banking (NAICS 522) is more similar to insurance (NAICS 524) than it is to advertising services (NAICS 541) or educational services (NAICS 611). We can see this from the first two digits of the code, for example, "52", in comparison to "54" and "61" in the three-digit NAICS codes. Additionally, to understand the patterns better we also supplement NAICS codes with additional information about services being outsourced, vendor information, and metropolitan statistical area (MSA). We use three-digit 2007 NAICS codes to classify firms based on their primary business activities. In the case of diversified conglomerates such as Procter and Gamble (P&G), which has multiple NAICS codes, we either use the primary NAICS code or use the NAICS code of the relevant business unit, if that information was specified in the outsourcing announcement. This represents the *best available proxy*. (See Appendix A for further discussion related to our data collection method and validation process.)

3.2. Analysis procedure

To understand how IT outsourcing spreads, we employ a broad view of the role of industry relationships in the diffusion of IT outsourcing decisions – diffusion can happen within an industry and across industries. Instead of imposing within industry scale or between industry scope hypotheses *a priori*, we leverage information on the spatial and temporal footprints of IT outsourcing announcements across the U.S. for the eleven-year period from 2000 to 2010. This permits us to derive intra- and inter-industry relationships from the observed patterns. Fig. 2 presents an overview of the analysis procedure, and the role of space-time clustering methods.

[2] For an alternative treatment of these issues involving the characterization of *clustered adoption* of technology, and some related specification tests, the interested reader should see Au and Kauffman (2004).

3.3. Method

Keeping in mind our conceptual framework detailed in Fig. 1, we split our analysis into two levels. First, we investigate evidence of space-time clustering across the entire dataset. This analysis tests if agglomeration is a reasonable global hypothesis by measuring the tendency of IT outsourcing events to be near one another in both space and time. Second, we explore the specific patterns within observed clusters with local and hybrid methods. This analysis is intended to understand the IT outsourcing spread at finer granularity, and distinguish the influence of localization and urbanization economies.

Space-time clustering is an exploratory approach to data analysis that is rooted in the epidemiology literature (Mantel, 1967). It allows us to explore the properties of any pattern where there are both spatial and temporal stamps on each observation. This way we can pursue the goal of uncovering diffusion-type processes. A process that only exhibits temporal clustering may be indicative of a cyclical pattern that follows say, a seasonal business cycle or fluctuations in the stock market. Similarly, spatial clustering alone could point to heterogeneity in the spatial distribution of firms, for example, imagine that the process for the diffusion of IT outsourcing is concentrated in coastal cities or cities with more firms overall. In contrast, our interest, like that of epidemiologists, is focused on the diffusion or the spread of something, and the subsequent characterization of any meaningful patterns that can be observed.

The space-time analysis is split into two levels: global and local. The local analysis is intended to pick up clusters, or identify particular sets of observations that exhibit abnormally high levels of space-time interaction.

3.3.1. Global analysis

The *global analysis* begins with exploring the system as whole using the *Jacquez* (1996) *test of space-time interaction*. The test iterates over each observation in the system, that is, each IT outsourcing announcement, and counts the number of other observations that are proximate in both space and time. Proximity is determined based on nearest neighbors. The Jacquez test statistic is:

$$J_k = \sum_{i=1}^{n} \sum_{j=1}^{n} a_{ijk}^{s} a_{ijk}^{t} \tag{1}$$

where: $a_{ijk}^{s} = 1$, if observations j is a k nearest neighbor of observation i in space, and 0 otherwise; $a_{ijk}^{t} = 1$, if observations j is a k nearest neighbor of observation i in time, and 0 otherwise; n is total number of observations; and k is an integer defining proximity in terms of nearest neighbors. If $k = 5$, then $a_{ijk}^{s} = 1$ for the five observations closest to i in terms of spatial distance. Similarly, $a_{ijk}^{t} = 1$ for the five nearest neighbors in the linear time dimension; a coincidence of ones, that is, the number of events that are neighbors in both dimensions, adds one to the statistic.

One advantage of the Jacquez test over alternative space-time measures is that it is flexible in the face of spatial and temporal heterogeneity. The U.S. urban system is quite diverse with dense metropolitan areas such as New York and Chicago, and more spread out places such as Phoenix and Atlanta. A k nearest neighbor approach does not require an *a priori* definition of the spatial and temporal extent of possible interactions in terms of kilometers or days, and is to some extent adaptive to the context in which the observations are located. So the value of k remains an open question to explore for a particular data set.

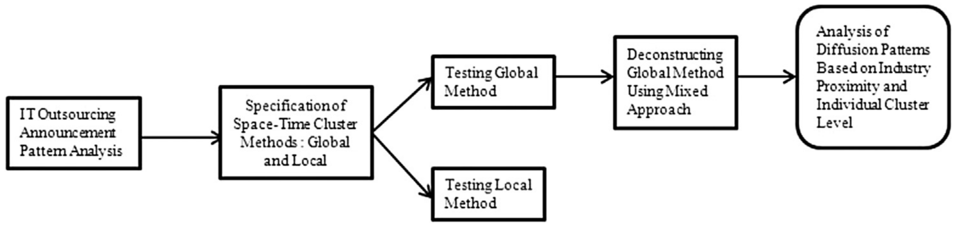


Fig. 2. Analysis procedure.

3.3.2. Local analysis

We next move onto the *local analysis*. While the study's observations are representative of U.S.-based firms whose outsourcing announcements reached the newswires, it is not representative of the IT outsourcing activity of all U.S. firms. From an epidemiological perspective, we have a set of known cases, but little information on how these cases relate to the *population at risk*, in other words, the possible firms that have been able to make IT outsourcing deals. The challenge is one of *utilization*. Some people choose to utilize a hospital when they feel ill and others do not. Similarly, certain firms choose to engage the media when they make decisions and others do not. Since we do not know the public relations strategies of firms, we cannot definitely state that our set of observations is representative of the broader population at risk. However, this should not preclude an effort to understand the patterns of firms that do make their decisions public. The *space-time permutation approach* (Kulldorff, Heffernan, Hartman, Assunção, & Mostashari, 2005) for cluster detection was developed for this kind of situation since it does not require information on the underlying population.

The goal of the local approach is to identify specific announcements that, as a group, are located close together in both space and time as a cluster. The method is best visualized as operating on the data in a *space-time cube*, in which the *base* is the spatial dimension and the *height* of the cube represents time. The algorithm then defines a relatively small *space-time cylinder*, again with the base representing the spatial dimension and height time, and places the cylinder within the space-time cube. The typical approach is to first iterate over a finite number of geographical grid points, and then increase the circle radius from zero to some maximum value (Kulldorff et al., 2005). In this way, both small and large circles are considered, all of which overlap with many other circles.

Additionally, for each center and radius of the circular cylinder base, the algorithm iterates over all possible temporal cylinder lengths. This means that cylinders that are *geographically large and temporally short* (forming a flat disc), those that are *geographically small and temporally long* (forming a pole), and every combination in between are considered. Thus, if the number of announcements within this cylinder is higher than expected based on the underlying probability model, then those observations form a potential cluster. (See Kulldorff et al. (2005) for a fuller discussion.)

4. Results and analysis

We next present the individual temporal and spatial patterns that our modeling approach reveals. Then, we discuss the space-time interactions results observed at the global, local and mixed levels based on the IT outsourcing announcement data. Finally, we use proximity information for the firms to evaluate the diffusion patterns for IT outsourcing announcements within the identified space-time clusters.

4.1. Spatial and temporal patterns

Fig. 3 has a map of the U.S. with each announcement represented by a circle. As might be expected, announcements follow an *urban hierarchy*: more announcements originated in and around larger cities. This straightforward two-dimensional presentation of the data masks the temporal dimension.

Fig. 4 brings the temporal dimension into view, allowing for a greater understanding of the space-time patterns in the data. Fig. 4a repeats the presentation in Fig. 3 to form a point of reference. Fig. 4d is a *space-time cube*, in which the base represents the longitude and latitude, and the height represents time in days in this case. Fig. 4b and c presents views of the cube from its sides, these can help inform our understanding of the interaction of space and time. Fig. 4b presents latitude on the vertical axis and time on the horizontal axis. We observed no north-south trends in the data relative to time. Fig. 4c presents time on the vertical axis and longitude on the horizontal axis. Again, there are no pronounced east-west trends in the data with respect to time either. The earliest three announcements happened in the east, but this may not be indicative of a trend. Based on these maps, a general increase in activity over time, excluding the latter recessionary period is clear, but there is little indication of national-scale diffusion patterns. For example, we do not see the northeast leading in IT services outsourcing actions and the south or the west following later. These results may be an artifact of the time frame chosen for the analysis. IT outsourcing started in earnest twenty to twenty five years ago and is embedded in the business landscape of the entire country. It may have had a spatial trend over the decade 1985 to 1994, but the original patterns are gone and not in our data.

4.2. Space-time cluster identification

4.2.1. Global analysis

As we mentioned above, the k-nearest neighbor approach does not require an *a priori* definition of the spatial and temporal extent of possible interactions in terms of kilometers or days. It is adaptive to the context in which the observations are located. Fig. 5 presents the pseudo p-values for the Jacquez test at varying levels of k after the data have been aggregated to a monthly level. Lacking an analytic distribution for the Jacquez statistic, our study follows Jacquez's (1996) recommendation to use a permutation-based inference approach that randomizes the input data, and recomputes the statistic for that randomization. This randomization step is repeated 999 times to construct an empirical distribution.

The null hypothesis is that the actual data came from a random process. This hypothesis will be rejected if the actual Jacquez test statistic is extreme relative to this distribution. If the critical value is set at $\alpha = 0.05$, the Jacquez test identifies significant space-time interaction for values of k ranging from 2 to 13, with $k = 4$ and 5 falling above the 0.05 threshold for significance.

There is a *multiple testing problem* related to testing a range of k

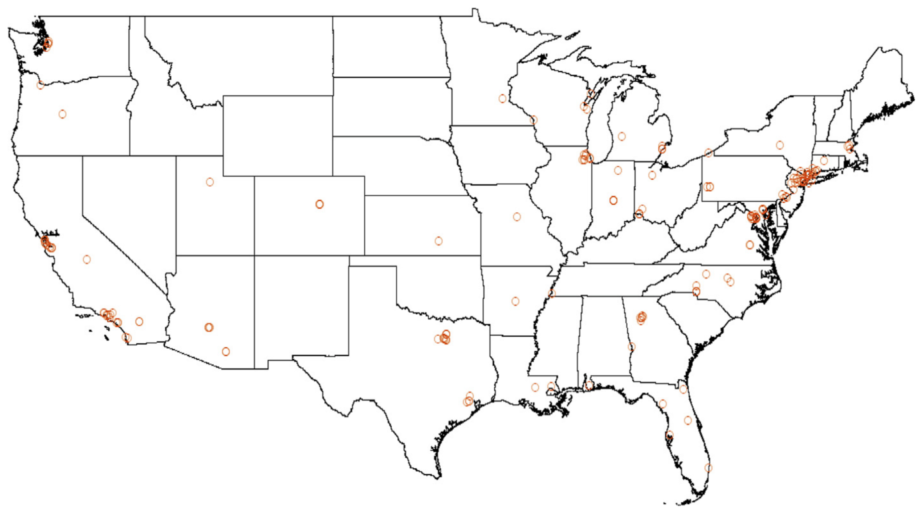
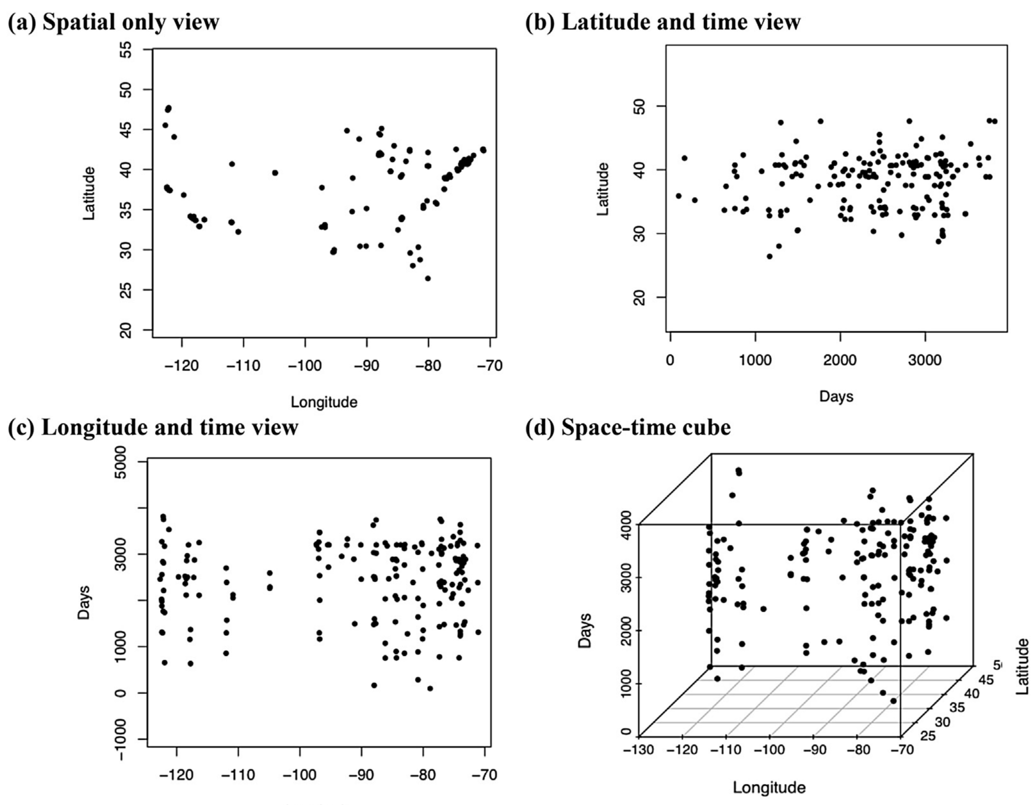


Fig. 3. IT outsourcing announcements, 2000–2010.



Note: The sub-figures (a), (b), and (c) present two-dimensional views of the space-time cube in (d).

Fig. 4. Space-time views of IT outsourcing announcements.

values though. The standard methods do not permit them to be tested together. Jacquez (1996) proposed a combined test in response. It permits the analyst to perform a test that spans a range of *k* values, and assesses their joint significance. This test returned a *p*-value of 0.001 for values of *k* from 2 to 13, corroborating our earlier finding that this range of *k* values points to significant space-time interactions in IT outsourcing announcements when the data has been aggregated to a monthly level.[3] Fig. 6a and b translate these values of *k* into kilometers and months to contextualize the results for the IT outsourcing announcement data.

These magnitudes are computed as the average distance or time between space-time pairs, for those observations *i* and *j*, where

[3] The computations were conducted using the open-source Python Spatial Analysis Library (PySAL), supplemented by the authors' implementation of the Jacquez combined test in Python.

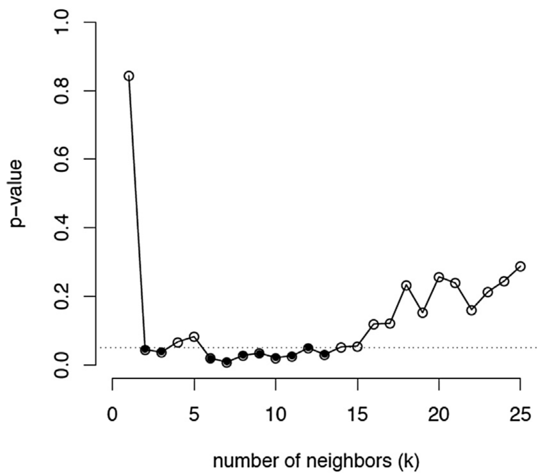


Fig. 5. *p*-values of the Jacquez test statistic for selected values of *k*.

conferences or social engagements. This might result in information sharing that economists call *cheap talk*. Another scenario may be characterized as *unobservable vendor actions*. A vendor or a group of vendors may have focused on developing services market share in a region at some point in time in the past. What we observe in terms of IT outsourcing announcements in the market around that region are the various responses of companies that were stimulated to think about IT outsourcing some time earlier – maybe 2, 3, or even 6 months earlier. The variation in timing of announcements by client firms can be a result of vendor stimuli, as well as clients' response capabilities.

Apart from the very close-in-time observations, some of these temporal results, when combined with the spatial results, point to some sort of space-time pattern. Though we did not find any statistically significant local clusters, in the following section, we decompose the global measures to understand the underlying patterns driving the high-level finding of space-time clustering in the announcements.[4]

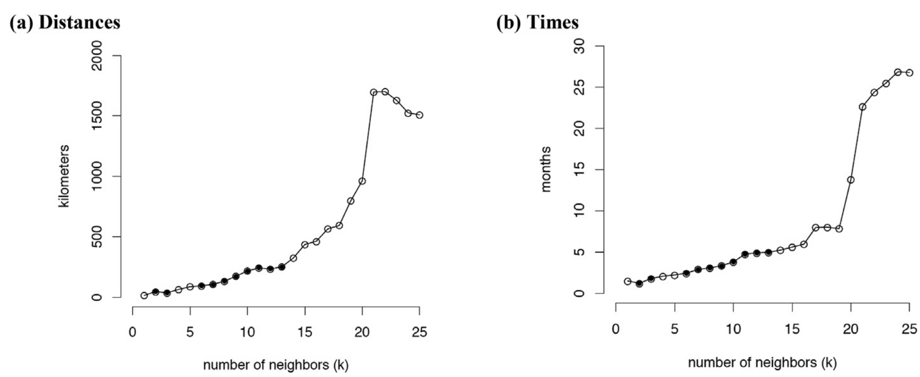


Fig. 6. Distances and times associated with the Jacquez test statistic for selected values of *k*.

$a^s_{ijk} = 1$ and $a^t_{ijk} = 1$ (Malizia and Mack, 2012). The smallest significant distance is 37.1 km ($k = 3$) and the largest is 251.5 km ($k = 13$). This is a broad range of distances. At the low end, it reflects an intra-metropolitan area scale, and at the high end, it points to inter-metropolitan area interactions. While an average interaction distance of 251 km is quite large and certainly extends beyond the range that can be explained through regular face-to-face interactions, it points toward other underlying factors. Some of the underlying factors influencing the diffusion behavior may be hierarchical effects, strong or weak ties between firms across industries and geography, and indirect channels of communication. From a temporal standpoint, interactions ranging from 1.2 months ($k = 2$) to 4.98 months ($k = 13$) were observed. Short time frames may point to simultaneity of IT outsourcing actions, rather than any direct interactions between firms that are substantive outside of the media. Some lead time is needed to get an IT outsourcing decision to the point of a public announcement, and, some more time will be needed for firms to respond to the announcement as a stimulus, and then do something on their own.

To understand how this might work, consider the following. It likely takes at least one month or more to do a vendor search, another month to figure out the legal contracting and compliance issues, and then additional follow-on negotiation. So differences in time of a few days or weeks, or even a month, will not be easy to justify on the basis of the usual logic of business operations. One scenario is that physical proximity is linking the firms in ways that cannot be directly observed. An example may be informal exchanges of information between employees of firms at local

4.2.2. *Hybrid analysis*

With a small set of observations, spanning a large geographic area and eleven years of time, it is unclear if the lack of local clusters is a substantive result or an artifact of data size. To explore this case further, we employed a *hybrid analysis approach* offered by Malizia and Mack (2012) that blends the global and local perspectives on space-time clustering. Given that significant global clustering is observed, our intention is to better understand the process driving this result. The authors' approach deconstructs the global Jacquez test into the clusters of observations; in this sense, it pulls apart the global measure and presents the local pieces for closer investigation.

Clusters are defined in a two-step process based on Equation (1). For each announcement, all other announcements that are k nearest neighbors to it, in *both* space and time, are grouped together with it. When two or more *groups* share an announcement(s), they are merged in the second step to form a *cluster*. As can be seen in Fig. 7a, average cluster size increases slowly from 2.0 to 4.3 announcements per cluster for values of k from 1 to 16; but increases rapidly thereafter as group overlap results in larger clusters. All the global Jacquez values in this rapidly increasing zone are statistically insignificant (unfilled points in the figure). Fig. 7b shows the corresponding results for the total number of clusters. The number of clusters forms an inverted-U shape that peaks at 48

[4] We analyzed local clusters using SatScan (Kulldorff, 2009) and identified seven clusters with none significant.

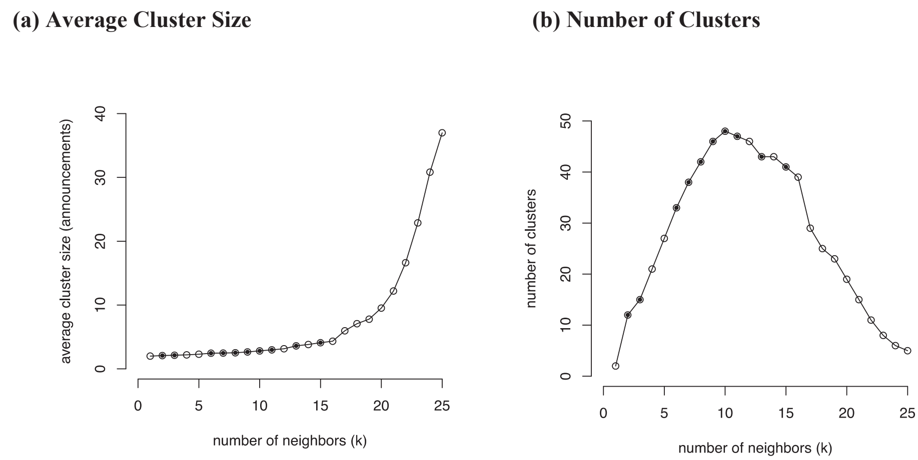


Fig. 7. Distances and times associated with the Jacquez test statistic for selected values of k.

clusters when $k = 10$. After the peak, cluster merging begins to dominate the pattern, thus blurring potential interpretations of individual clusters.

The broad objective is to understand the relationship of scale and scope externalities on IT outsourcing decisions, and so a low value of k is needed to reflect the importance of proximity. Based on the results from Figs. 5–7, a detailed cluster analysis was conducted at the $k = 7$ scale (average distance = 106 km and average time = 2.8 months), which corresponds to the most significant Jacquez value in Fig. 5, a zone of stable average cluster size (Fig. 7a), and a case where clusters are not so large as to overlap with one another (Fig. 7b). At this scale, 38 clusters were identified. We present the details of these clusters in Table 1, and a visual representation in Fig. 8.

We consider thirty days or more time-lag between outsourcing announcements to analyze the scale or scope externalities effect. The majority of the clusters contained two announcements, with the largest containing five (Cluster 20). The majority of clusters are located within a single MSA, with thirteen spanning two MSAs and three clusters that include announcements from non-metro areas (Clusters 7, 28, and 30). Most clusters span less than five months. Those that exceed five months are mostly located at the ends of the study period, corresponding to the limited number of announcements at the temporal extremes.

4.3. Spatial and industrial context of space-time clusters

To further understand agglomeration effects, we looked at the industrial distribution within clusters. In seven clusters (2, 9, 15, 26, 31, 35, and 37) out of 38, the observations belonged to the same industry based on three-digit NAICS codes. To see if there were commonalities in the services that were being outsourced, we considered the types of functions being outsourced. Three clusters (2, 9, and 31) had observations that belonged to the same industry and for which similar services were outsourced.

In one case (Cluster 31), the same vendor provided the services for all four firms and these firms outsourced similar services. In another case (Cluster 9), the same type of service was outsourced but to different vendors. (See Fig. 9.) These cells are indicators of *localization economies*. They are external to the firm but internal to an industry within a geographic region. In our data, we do not see many clusters in this category. This type of specialization – economies of scale – encourages transmission and exchange of ideas and information, of products and processes through imitation, and business interactions and inter-firm circulation of skilled workers.

Also, for four clusters (1, 3, 4, and 5), although the observations belonged to different industries, similar functions were outsourced. The rest had neither the industry nor the outsourced functionality in common and are indicative of *urbanization economies*. These are external to industries but internal to geographic units such as cities, and represent diversity or economies of scope. As discussed earlier, we know that urbanization economies imply that the most important sources involving knowledge spillovers are external to the industry within which a firm operates. A more diverse industrial fabric in close proximity fosters opportunities to imitate, share, and recombine ideas and practices across industries.

Cluster 2 is an exemplar of the upper-left cell in Fig. 9. The cluster is comprised of IT outsourcing announcements from two telecom competitors headquartered in the Atlanta–Sandy Springs-Marietta MSA. Cox Communications, a provider of cable television, broadband, and phone services and BellSouth, a provider of fixed-line and wireless phone services and broadband services, had announcements within six months of one another (January 28, 2002 and June 14, 2002), are located less than 20 km from each other, and outsourced the same function, third party verification services, to the same vendor firm. This type of pair is indicative of localization economies in the telecom industry in the region. Cluster 4 represents the lower-left cell; the IT outsourcing announcements were from two firms that belong to different industries: the data processing and insurance industries. Both had announcements within four months of one another – March 13, 2003 and July 1, 2003 – and both outsourced the same function – document management services – to the same vendor. This type of pair is indicative of urbanization economies in the industry in the region.

We further explored agglomeration based on the MSA. We recognized four MSAs based on the highest frequency of IT outsourcing announcements and space-time clusters observed. These MSAs are: Atlanta–Sandy Springs-Marietta (GA), Chicago-Naperville-Joliet (IL-IN-WI), New York-Northern New Jersey–Long Island (NY-NJ-PA), and Washington-Arlington-Alexandria (DC-VA-MD-WV). Next we discuss the details of two of the four MSAs: Atlanta–Sandy Springs-Marietta (GA) and Washington-Arlington-Alexandria (DC-VA-MD-WV). (The details for the other two MSAs are in Appendix B.)

4.3.1. Atlanta–Sandy Springs-Marietta (GA)

Also known as Metro Atlanta, this is the most populous metro area in the state of Georgia and the ninth largest MSA in the United States. The main industries in this MSA are hospitality, health services, manufacturing, business services and education. Three

Table 1
IT outsourcing space-time clusters.

Cluster	#	NAICS	MSA	Month	Km
1	2	334, 511, 522	Durham NC, Charlotte-Gastonia-Concord NC-SC	7	193
2	2	515, 517, 334	Atlanta—Sandy Springs-Marietta GA	6	16
3	2	445, 447, 481	Dallas-Fort Worth—Arlington TX	5	8
4	2	518, 524	Miami-Fort Lauderdale, FL, Tampa-St. Pete-Clearwater FL	5	301
5	3	923, 524	New York-Northern New Jersey—Long Island NY-NJ-PA	3	1
6	2	454, 334, 335, 336	Bridgeport-Stamford-Norwalk CT	3	19
7	2	926, 517	Baton Rouge LA, Non-Metro	1	326
8	4	452, 541, 334, 524, 488	SF-Oakland-Fremont San Jose-Sunnyvale-Santa Clara CA	6	32
9	2	524	Pittsburgh PA, Wash-Arlington-Alexandria, DC, VA-MD-WV	2	276
10	2	312, 311, 541	New York-Northern New Jersey—Long Island NY-NJ-PA	1	6
11	3	522, 454, 512	Riverside-San Bernardino-Ontario CA, Tucson AZ	2.33	360
12	2	325, 621	Philadelphia-Camden-Wilmington PA-NJ-DE-MD	4	23
13	2	523, 621, 622	Denver—Aurora CO	2	4
14	3	334, 336, 721	Washington-Arlington-Alexandria DC-VA-MD-WV	3	20
15	4	522	Chicago-Naperville-Joliet IL-IN-WI, Grand Rapids—Wyoming MI, Green Bay WI	2.17	199
16	3	517, 923, 522	Los Angeles-Long Beach—Santa Ana CA	1.67	26
17	2	722, 721	Atlanta—Sandy Springs-Marietta GA	2	2
18	2	522, 524	Denver—Aurora CO, Phoenix-Mesa-Scottsdale AZ	4	931
19	2	336, 524	Detroit-Warren-Livonia MI, Erie PA	3	245
20	5	522, 541, 524, 511, 454	Bridgeport-Stamford-Norwalk CT, NY-N. NJ-Long Island NY-NJ-PA	2.8	39
21	2	541, 522	New York-Northern NJ-Long Island NY-NJ-PA	1	3
22	4	541, 325, 524	New York-Northern NJ-Long Island NY-NJ-PA, Trenton—Ewing NJ, Poughkeepsie-Newburgh-Middletown NY	1.5	62
23	2	541, 511	Columbus GA-AL, Atlanta—Sandy Springs-Marietta GA	1	164
24	2	524, 522, 541	La Crosse WI-MN, Minneapolis-St. Paul—Bloomington MN-WI	3	195
25	3	922, 921, 524	Washington-Arlington-Alexandria DC-VA-MD-WV	1.67	1
26	2	522	Charlotte-Gastonia-Concord NC-SC, Raleigh—Cary NC	1	206
27	2	519, 311, 312	Chicago-Naperville-Joliet IL-IN-WI	1	35
28	2	541, 339	Detroit-Warren-Livonia MI, Non-Metro	3	260
29	2	519, 524	Balt.-Towson MD, Wash.-Arlington-Alexandria DC-VA-MD-WV	3	58
30	2	54, 531	New York-Northern NJ, Long Island NY-NJ-PA, Non-Metro	1	207
31	4	522	Houston-Baytown-Sugar Land TX, N. Orleans-Metairie-Kenner LA	1	269
32	2	522, 512, 454	LA-Long Beach—Santa Ana CA, Riverside-San Bern.-Ontario CA	2	165
33	2	312, 311, 518	Dallas-Fort Worth—Arlington TX	1	2
34	2	522, 523	New York-Northern New Jersey—Long Island NY-NJ-PA	6	6
35	2	336	Chicago-Naperville-Joliet IL-IN-WI	4	39
36	4	211, 213, 928, 927, 921	Washington-Arlington-Alexandria DC-VA-MD-WV	5.67	2
37	2	541, 443, 511	Seattle-Tacoma-Bellevue WA	3	12
38	2	325, 311, 312, 523	New York-Northern New Jersey—Long Island NY-NJ-PA	1	15

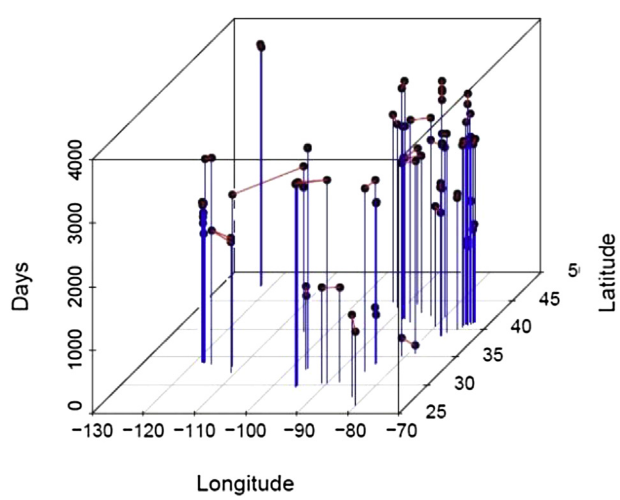


Fig. 8. IT outsourcing space-time clusters.

Similar Outsourced Function

Same Industry	Yes	No
Yes	3	3
No	4	28

Fig. 9. Industry and IT outsourcing function interactions.

space-time clusters (2, 17 and 23) were identified within this MSA. Cluster 2 is comprised of an announcement from Cox Communications and BellSouth (NAICS 517). Cluster 17 includes announcements from Church's Chicken and Inter-Continental Hotels (NAICS 722 and 721). Cluster 23 comprised of announcements from Business Software, Inc. and Magnum Communications, Ltd. (NAICS 541 and 511). For two of the clusters (2 and 17), the announcements belonged to not only the same industry or closely related industries, but also the firms were located less than twenty kilometers from each other. Additionally, the types of services outsourced were also very similar. They include third party verification services in case of Cluster 2, and internal corporate functions for accounting and human resources in the case of Cluster 17. This is indicative of localization economies.

4.3.2. *Washington-Arlington-Alexandria (DC-VA-MD-WV)*

The U.S. Federal Government provides the underlying basis for the economy in this region. It is also home to many major research universities, think tanks and non-profit organizations. Major industries include biotechnology and defense contracting. Five space-time clusters (9, 14, 25, 29, and 36) were identified in this MSA. Cluster 9 had announcements from Gateway Health Plan and TIAA-CREF (NAICS 524). Both firms in this cluster not only belong to the same industry, but also outsourced the same type of services. This was administrative services, but the services were provided by different vendors.

Cluster 14 had announcements from Lockheed Martin Corporation and Crestline Hotels & Resorts (NAICS 334 and 721). Cluster 25 included announcements from the U.S. Department of Justice, a federal agency, and the Council for Affordable Quality Healthcare (CAQH) (NAICS 922, 921, and 524). Cluster 29 had announcements from Project MUSE (a joint collaboration of Johns Hopkins University Press and the Milton S. Eisenhower Library at Johns Hopkins University), and the Nolan Financial Group (NAICS 519 and 524). Finally, Cluster 36 is comprised of announcements from the Federal Government, Statoil, the Federal Bureau of Investigation (FBI), and the National Aeronautics and Space Administration (NASA) (NAICS 522, 211, 928, and 927). The announcements in Clusters 25 and 29 fell within four months of each other in March to July 2008, and also were from firms that belonged to the same industry. Within Cluster 14, although the firms belonged to three different industries, the announcements were within three months of each other and the firms were located within twenty kilometers of each other. Additionally, the types of services outsourced were very similar. All three firms outsourced internal corporate functions, including customer support, back office support, and accounting. This pattern may be indicative of urbanization economies.

5. Discussion

Agglomeration economies can be measured in terms of the colocation of firms (e.g., Ellison and Glaeser, 1997), but it can also be measured as the colocation of ideas. We take the latter approach by applying space-time clustering to the spread IT outsourcing. While this is one specific case, this framework could be applied to the transmission of any business idea. The factors that motivate some firms to adopt a particular business practice and others to pass are without question diverse and difficult to quantify. In our analysis of IT outsourcing announcements, we blended quantitative spatial and temporal data on the decision to outsource along with the more qualitative context in which the decisions were made. We see this approach as mirroring the actual decision processes that firms use.

As a business strategy or process, IT outsourcing may be one of the most general available. Unlike an innovative medical procedure or any other similar specialized processes, IT outsourcing can be used by firms in any industry; and the types of activities that can be outsourced is continually growing. This flexibility is manifest in Fig. 9, which shows that the majority of clusters are *cross-industry clusters*. This implies that urbanization economies are at play in spread of IT outsourcing. We see this as being driven by the diverse set of business activities that can be outsourced. All types of industries can take advantage of this in some way or another. We also see that clusters tend to occur in larger metropolitan areas, but that those regions with the most clusters are not necessarily the largest regions in the country. So overall, region size plays a role, but is not the sole contributor to the clusters.

Additionally, these results imply that groups facilitating interactions between diverse industries are likely to be in the best position to help transmit information on IT outsourcing successes and best practices. These groups typically take the form of chambers of commerce or regional economic development authorities. Other such groups could be: (1) industry organizations that promote standards and the diffusion of new managerial and technology practices; (2) vendors who seek to communicate the success of the diffusion of new managerial practices that tend to favor their own approaches with technology and management approaches; and (3) other organizations that have some ties to governments, and may be or may not be government agencies.

We recognize that outsourcing may be perceived as the polar opposite of the stated goals of these types of groups, which seek to expand the employment base of their region. However, outsourcing may be the necessary action a firm takes to save money and remain viable in a highly competitive economic landscape. Also some outsourcing events involved the transfer of services to a firm within the same region (Clusters 3, 5, and 27), likely resulting in a negligible loss of jobs. If the alternatives are outsourcing one piece of a firm's operation or losing the firm, then flexibility will be needed from local officials as the industrial landscape evolves over time (Malecki, 2014). The spatial proximity of firms can help lower the barrier to information transfer, and make the overall regional economy stronger.

6. Conclusion

We employed an exploratory approach that focused on geographic, temporal, and industrial proximity as a mechanism for identifying the processes underlying the diffusion of IT outsourcing within the U.S. We know that IT outsourcing spreads via mixed communication channels: the behavior of potential adopters is influenced by those who have already adopted IT outsourcing, as well as by the mass media and other external factors such as vendors. Our focus was specifically on the role space plays in the process, and the potential that IT outsourcing spreads through a contagion type process. In this context, we borrowed methods from the epidemiology literature and were able to identify significant global space-time clustering in IT outsourcing announcements in the U.S over the years 2000–2010. To the best of our knowledge our study is the first such study that uses epidemiology methods to explore and test for the concepts of *urbanization and localization economies*. From there we identified 38 clusters based on announcements located close in both space and time, and described their industrial composition in the context of the metropolitan areas in which they are located.

A study of this type is particularly challenging since we are not able to identify the true underlying motivations for the diffusion pattern. Even a direct survey of corporate decision makers would have been unlikely to identify all the influences for an IT outsourcing decision due to the multiple streams of information that corporate leaders typically receive. We suspect few decisions are the result of a single “eureka!” moment. Instead, they evolve from a variety of influences, including the spatial context in which the decision maker operates. In this article, we used a set of observations that is representative of U.S.-based firms whose outsourcing announcements reached the newswires, even though it may not be entirely representative of the IT outsourcing activity of all firms within the U.S. over the time period that we studied. From this limited set of 179 announcements over eleven years, we have been able to tease out specific cases that appear to follow theoretical diffusion processes based on urbanization and localization economies. Due to the size and source of our data, we are not able to make definitive statements on the nature of IT outsourcing diffusion in the U.S. overall. However, the specific examples we identified make a compelling case for further research, and motivate our broader contention that geographic space plays a role in the growth of IT outsourcing within the U.S.

We see a number of avenues for building on the present research. A data set of the type we collected stretching back to the 1980s would likely show a clearer pattern of spatial diffusion as the idea spread from the initial innovators to other locations and industries. With more data, multivariate regression can identify the influence of covariates such as employment density, industry diversity, and education levels in the decision process. A case–control type set-up is also useful to probe the reasons why one firm chose to outsource, while a similar firm did not. Finally, an inverse analysis can be conducted to identify the spatial diffusion and motivation of overseas vendors. Additionally, another avenue could be to develop the theoretical aspects and direction of this paper further, and explore the conceptual gaps of different theoretical perspectives used in understanding the spread of IT outsourcing across space and over time. This would allow us to build upon the unique multi-disciplinary perspective employed in the current study.

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Appendix A. Data collection and validation process

Our data collection method was adopted from the *event study* literature. This method of data collection is extensively used in the fields of Accounting, Business Information Systems and Finance to measure the impact of corporate control changes or corporate refocusing or to assess the impact of managerial decision making (McWilliams & Siegel, 1997). Within this method of data collection the validation of process is determined by the following three assumptions: (1) markets are efficient; (2) the event was unanticipated; and (3) there were no confounding effects during the *event window* in which the impacts were measured (Bowman, 1983; Subramani & Walden, 1999). While collecting data for our study, we focused on ensuring that the event was unanticipated, so no prior information was available, and there were no confounding effects. For our purposes, we assumed that market efficiency was present (in spite of the fact that this differs from the typical interpretation used by Finance and Accounting scholars). This is because the purpose of this study was to conduct exploratory analysis of diffusion patterns and not about the impact of IT outsourcing announcements on stock prices.

Appendix B. Additional results on Metropolitan Statistical Areas (MSAs)

MSA	Description
Chicago-Naperville-Joliet (IL-IN-WI)	This MSA is home to the corporate headquarters of 57 Fortune 1000 companies, including Boeing, Discover Financial Services, United Airlines and McDonald's, representing a diverse group of industries. Three space-time clusters (15, 27, and 35) were identified within this MSA. Cluster 15 comprised of announcements from American Financial Services and Allstate Bank, Denmark State Bank, and Allstate Insurance Company (NAICS 522). Cluster 27 includes announcements from Tribune Publishing, subsidiary of the Tribune Company and Sara Lee Corporation (NAICS 519 and 311). Cluster 35 is comprised of announcements from Boeing and Navistar (NAICS 336). Two out of the three clusters had announcements from firms that belonged to the same industry (Clusters 15 and 35) and two firms belonging to Cluster 27, although they outsourced different services – Tribune Publishing for the accounting function and Sara Lee for the IT infrastructure function. Both used the same vendor to provide their services. In the case of Cluster 35, the patterns may be indicative of localization economies because the firms are located less than 40 km from each other and the announcements had a lag-time of about four months.
New York-Northern New Jersey–Long Island (NY-NJ-PA)	This MSA is also known as Greater New York or Tri-State Area, and it consists of New York City and the surrounding region. It is the most populous metropolitan area in United States and is a center for international banking and commerce. The other leading industries are manufacturing, real estate, finance, biotechnology, education, entertainment and news media. Seven space-time clusters (5, 10, 20, 21, 22, 30, 34, and 38) were identified within this MSA. Cluster 21 is comprised of IT outsourcing announcements from Nielsen and Deutsche Bank (NAICS 541 and 522), Cluster 20 is comprised of announcements from MasterCard, Butler International, Wilton Re, SLM holdings, and the Reader's Digest Association (NAICS 522, 541, 524, 454, and 511), and Cluster 22 is comprised of announcements from York Insurance Services group, LiveTechnology Holdings, Merck & Co., and RadPharm (NAICS 524, 325, and 541). None of the firms within the clusters belonged to the same industry (except Cluster 22), but at least one firm in each cluster belonged to either the banking industry or the insurance industry. The banking and insurance industries are more similar to each other, and additionally, the announcements are temporally close to each other. In this case, we cannot say with certainty that the announcement from Deutsche Bank influenced the outsourcing decision of MasterCard or York Insurance group. The time lag between announcements is about a month. Keeping this time window in mind, and also looking at the physical proximity of the firms, this pattern may be indicative of localization economies in the banking and insurance industries in the region.

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