

Clusters, knowledge spillovers and new venture performance: An empirical examination[☆]

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Received 1 February 2006; received in revised form 1 February 2007; accepted 1 April 2007

Abstract

Firms in geographic regions with industry clustering have been hypothesized to possess performance advantages due to superior access to knowledge spillovers. Yet, no prior studies have directly examined the relationship between a firm's location within a cluster, knowledge spillovers and firm performance. In this study, we examine whether technological spillovers explain the performance of new ventures in cluster regions. We find that ventures located within geographic clusters absorb more knowledge from the local environment and have higher growth and innovation performance, but contrary to conventional wisdom, technological spillovers are not the contributing cause of higher performance observed for these firms.

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Keywords: Geographic clusters; New venture performance; Knowledge spillovers

1. Executive summary

Firms located within geographic clusters have been found to exhibit higher innovation performance, rates of growth and survival than do firms not located within geographic clusters. Scholars often attribute this performance to the knowledge spillovers cluster firms are able to access. Knowledge spillovers are the direct or indirect transfer of knowledge from one party to another. They are typically generated by firms engaging in innovation activities and are valued because they provide knowledge that is new, even novel to the receiving firm. By receiving technological

[☆] This research was funded in part by a grant from the Ewing Marion Kauffman Foundation and completed while the first author was on faculty at Georgia State University. The contents of this manuscript are solely the responsibility of Brett Anitra Gilbert, Patricia P. McDougall and David B. Audretsch. The authors would like to thank Pamela Barr, Olav Sorenson and participants at the Max Planck Institute for Economics Residence Week for helpful comments on earlier drafts of this work. The usual disclaimer applies.

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knowledge spillovers, firms are equipped with industry specific knowledge that empowers them to know what technological activities others have done, what they are currently doing, and the levels of success they have achieved in those activities. Technological knowledge spillovers are believed to help firms become positioned to utilize the newest technologies and in many cases to compete in the most attractive markets.

While knowledge spillovers have been confirmed to influence firm innovations, no prior research has examined if these spillovers influence a firm's ability to introduce more products to market or to realize higher levels of growth. This study serves to fill this gap in the literature and enhance understanding of the relationship between clusters, knowledge spillovers and new venture innovation and growth performance. By addressing the specific case of new ventures which have been an important element in the conversation on industry clusters, we fill a second gap in the literature because new ventures differ from established firms and may not necessarily benefit from cluster location or knowledge spillovers in the same manner. Therefore, by examining these relationships on a sample of new ventures, we are able to determine the extent to which a venture's geographic location can serve as a competitive advantage or disadvantage for new firms. We begin our arguments by providing context to explain the relationship between clusters and new venture performance. We then develop understanding of the role of knowledge spillovers and the performance advantages they can provide to new ventures. We follow with an explanation of *why* and *how* we expect knowledge spillovers within a cluster location to differentially affect new venture performance. We then examine whether the knowledge spillovers indeed have an impact on performance.

We test our hypotheses on a quintessential sample of 127 independently founded (i.e. without corporate affiliation), U.S. based, IPO new ventures. These ventures hail from many different types of U.S. geographic regions. Many of the ventures are uniquely innovative, serving as pioneers of markets and engaging in high levels of patenting innovation, making this sample particularly suitable for assessing the impact of knowledge and geographic location on venture sales growth and innovation performance. We find that ventures founded in locations with high concentrations of industry clustering have higher product innovation and sales growth activity than ventures founded in locations with limited industry clustering. The results also confirm that technological spillovers are positively and significantly related to product innovation. However, the technological spillovers the firms receive are neither conducive to higher levels of sales growth, nor entirely useful for explaining why cluster firms introduce more product innovations. Our findings challenge the notion that technological spillovers contribute to the superior performance of cluster firms and suggest that the literature may give too much emphasis to technological knowledge spillovers at the expense of other factors which may be similarly or even more important.

The findings signal to entrepreneurs the importance of observing the conditions in the founding location when deciding where to start the venture. Industry clustering in a location will indeed mean the venture will face more competition; however, competition should force the venture to become a stronger competitor and, therefore, should be viewed as a locational asset rather than liability by entrepreneurs. Moreover, the results also suggest the importance of being located within close geographic proximity to the market being served. Proximity to market will increase the demand the venture hopes to establish for its products. If a new venture is not located within an industry cluster, it is important that entrepreneurs consider whether their location has the potential to provide them with visibility to key groupings of their predominant customers. Making sure the product/service being offered meets the needs of local customers could be a strong starting point for generating the demand that will aid venture product innovation and growth efforts.

2. Introduction

Firms located within geographic clusters or geographic regions where “firms in downstream industries (that is, channels or customers); producers of complementary products; specialized infrastructure providers; government and other institutions providing specialized training, education, information, research and technical support (such as universities, think tanks, vocational training providers); and standards-setting agencies” are collocated (Porter, 1998:199), are argued to gain superior access to knowledge which enables them to establish competitive advantage (Tallman et al., 2004). The knowledge from such regions is argued to be beneficial because it enables firms to determine the technological directions other firms are taking and any new endeavors being undertaken so that the initiatives of receiving firms are appropriately aligned with industry trends (Brown and Duguid, 2000). Knowledge spillovers, especially when received from multiple sources, can help firms reduce the uncertainty that is associated with engaging in innovation activities.

Not surprisingly, there has been growing scholarly interest seeking to understand whether firms assimilate knowledge spillovers into their innovation activities. The results from this stream of research confirm that firm innovations are influenced by the innovation activities of nearby firms and provide strong evidence for the presence of knowledge spillovers (e.g. Almeida, 1996; Frost, 2001; Jaffe et al., 1993). To our surprise, however, none of this research extends the empirical examination to determine whether knowledge spillovers increase the number of innovations firms make or somehow help receiving firms to improve their performance in the marketplace. A second stream of research has emerged which attributes the higher performance of cluster firms to the knowledge spillovers they receive (Deeds et al., 1997). However, this research does not include spillovers as a predictor of performance so it is unknown to what extent spillovers actually drive firm performance. Extant literature, therefore, lacks empirical examination of the precise relationship between clusters, knowledge spillovers and firm performance.

There is also limited research which examines the implications of cluster regions for the performance of new ventures. Most research in this stream of literature focuses on established firms or their subsidiaries (e.g. Birkenshaw and Hood, 2000; Shaver and Flyer, 2000) or highly innovative firms (Deeds et al., 1997). New ventures are important to consider because they are known to be more prevalent in regions where industry clustering exists (Sorenson and Audia, 2000; Stuart and Sorenson, 2003) due to the lower costs associated with learning about the business environment for the industries of the region (Maskell, 2001). As the catalysts for innovation and job creation, new ventures are also consistently acknowledged for their role in developing and generating success for cluster regions (Malecki, 1985). If knowledge spillovers indeed benefit the performance of cluster firms as extant research suggests, then new ventures assimilating knowledge spillovers from a geographic cluster should have better understanding of the industry and technological directions and by extension, higher levels of performance than would be true of same industry new ventures located outside of a cluster.

The purpose of this study is to bridge these aforementioned streams of research focusing on knowledge spillovers on the one hand and firm performance on the other to examine the relationships between a geographic cluster location, knowledge spillovers and new venture performance. Specifically, we provide an empirical test to the implicit and widely-held assumption that knowledge spillovers impact firm performance. In addition, given that new firms are considered to be the economic engine of cluster regions and are of major concern to policy-makers, our study seeks to examine the relationship of clusters, knowledge spillovers and performance within the context of new venture firms.

This study makes several contributions to extant literature. First, it provides an empirical examination of relationships which to date have been assumed, but not tested. Second, we provide an empirical test for the impact of locating within a geographic cluster, specifically for new venture performance. Third, we expect to establish whether external knowledge accessed by new ventures in cluster locations is a key factor influencing their performance, a contribution which has substantial implications for entrepreneurship policy (Gilbert et al., 2004). Fourth, by examining these relationships, we are able to validate for entrepreneurs whether their geographic location can generate a competitive advantage or disadvantage for their firms.

We begin our arguments by providing context to explain the relationship between clusters and new venture performance. We then develop understanding of the role of knowledge spillovers and the performance advantages they can provide to new ventures. We follow with an explanation of why and how we expect knowledge spillovers from cluster locations to affect new ventures operating therein relative to the spillovers ventures in other locations receive from their nearby firms. We then examine whether the knowledge spillovers indeed play a role in improving the performance of new ventures. Our theoretical model proposes three relationships. First, that a location within a geographic cluster positively impacts the performance of new ventures. Second, knowledge spillovers likewise positively impact new venture performance. Third, knowledge spillovers, which are considered to be more prevalent in cluster regions, should be an important factor explaining the levels of performance we observe for cluster new ventures. We test our hypotheses using regression and path analysis on a sample of 127 technology-based new ventures founded between the years of 1990 and 2000. Each venture undertook an initial public offering between the years of 1996 and 2000.

3. Cluster locations and the performance advantage

Geographic regions with industry clustering have been found to affect the performance of established firms operating within them. This finding has held constant across several measures of performance including new product innovation (e.g. Deeds et al., 1997), revenue growth (Canina et al., 2005), and survival (Folta et al., 2006; Sorenson and Audia, 2000; Stuart and Sorenson, 2003). According to Porter (1998), a concentration of industry activity in a

geographic region affects firm performance because the local competition within the cluster requires firms to innovate in order to remain competitive. The implication is that firms successful in innovating are more likely to survive while those unsuccessful are more likely to fail. Operating from a region with industry clustering, he argues, requires firms to be more innovative than might be true for firms operating from regions with less industry clustering. [Chung and Kanins \(2001\)](#) argue that the presence of similar firms in a geographic region creates demand externalities that lead to increased rents for local firms. They found that small firms were some of the greatest beneficiaries of the increased revenue accruing to firms operating from cluster locations. Smaller firms benefit because they are able to take advantage of the increased number of customers who are drawn to the area by the reputations of the larger firms within the region, which allows small firms to more easily present their products/services to their intended market.

In addition to the benefits that accrue based on the size of the firm, research has shown that there are other contingencies associated with receiving benefits from locations with industry clustering. [Folta et al. \(2006\)](#), for example, found that firm survival declines with cluster size, which suggests that firms in the larger clusters may be at a performance disadvantage relative to firms operating from other locations. [Shaver and Flyer \(2000\)](#) likewise found that the presence of industry clustering within the firm's location negatively influenced the survival of firms when the industry was highly geographically concentrated, however, they also noted that "weaker" firms were able to gain more from operating from cluster locations than was true of stronger firms. This research, and the research by [Chung and Kanins \(2001\)](#) suggest that new or younger firms because of their liability of newness, lack of history and established procedures and routines, and typically smaller size, may be more likely to benefit from a cluster location than would be true of established firms.

[Canina et al. \(2005\)](#) also found that clustering benefits depend on the type of firm. Established firms that operated from locations with clustering that competed with a differentiation strategy had higher performance than firms operating from similar locations that competed with low cost strategies. [Baum and Haveman \(1997\)](#) similarly found that entrepreneurs that successfully differentiated their firms from others in the cluster location had higher survival rates than was true of firms that were not well differentiated. Since entrepreneurs in cluster regions commonly differentiate their products from those of established firms in the region ([Almeida and Kogut, 1997](#)), operating from a location with industry clustering should enable cluster new ventures to receive performance benefits similar to those that accrue to differentiated firms. Moreover, their newness relative to other established firms in the region should enable them to take advantage of the reputations that other local firms have established and push upward the rates at which these firms grow relative to ventures in other geographic regions. Work by [Appold \(1995\)](#), [Folta et al. \(2006\)](#) and [Lechner and Dowling \(2003\)](#) corroborates the importance of clusters for gaining access to customers as well as prospective partners. Prospective partners are important for helping firms fulfill key strategic objectives. For example, [Lechner and Dowling \(2003\)](#) in particular noted that firms operating from cluster locations commonly partner with other nearby firms. Partners are important for helping firms realize strategic objectives and are noted for their role in aiding innovation activities ([Ahuja, 2000](#)) and growing the firm ([Weaver, 2000](#)). A new firm's location within a geographically bounded industry cluster, therefore, should have strong implications for firm innovation and growth performance. Since new and young firms may be more likely to be strongly affected by the conditions in a cluster environment, we expect to establish, as prior research on established firms has found, that the effect of clustering on the performance of new firms is positive.

H1a. Industry clustering will be positively related to new venture product innovation.

H1b. Industry clustering will be positively related to new venture sales growth.

3.1. Knowledge spillovers and the performance advantage

The arguments in the prior section provide some of the reasoning scholars have offered to explain the observed higher levels of performance for cluster firms. But scholars such as [Bell \(2005\)](#) and [Deeds et al. \(1997\)](#) suggest that cluster firm performance differs from other firms because of the easier access to knowledge spillovers that cluster firms have. Our research into this matter, however, surprisingly revealed that knowledge spillovers are neither solely confined to regions where a focal firm's industry clustering is present, nor do they only occur across firms that operate in the same industry. Therefore, in developing our arguments we examine the nature and character of knowledge spillovers in general before examining the nature and character of knowledge spillovers within a geographic cluster.

Knowledge spillovers are the direct or indirect transfer of knowledge from one party to another. As the byproduct of knowledge generated from the innovation activities of other firms in the same industry ([Audretsch, 1998](#)) or oftentimes

other industries (Feser, 2002; Jacobs, 1969), technological knowledge spillovers are valued because they represent knowledge that is new, even novel to the receiving firm. With technological knowledge spillovers, firms are equipped with industry specific knowledge that empowers them to know what technological activities others have done, what they are currently doing, and the levels of success they have achieved in those activities (Brown and Duguid, 2000). Technological knowledge spillovers help firms get positioned to utilize the newest technologies and in many cases to compete in the most attractive markets. Because they provide insight into new market opportunities entrepreneurs are argued to be the primary beneficiaries of knowledge spillovers (Audretsch and Keilbach, 2004). The foresight on the technological direction in which the industry is heading enables entrepreneurs to adapt the technologies of their new firms to those of the emerging trends and also enables them to continually improve their innovation activities.

The contributions of technological spillovers to firm technological capabilities are well-documented in extant literature. For example, Almeida (1996) demonstrated that foreign firms often placed subsidiaries within a given location to learn of the innovation activities occurring within that geographic region. Even highly innovative subsidiaries have been found to find value from operating from a location where they were able to assimilate local knowledge. Local technological knowledge may benefit firms because knowledge requires time to travel across geographic space (Jaffe et al., 1993). Consequently, its value tends to decay as it spatially diffuses. Proximity to firms engaging in similar activities may provide more current knowledge for firm innovations than may be true when knowledge travels between firms that are distant (Almeida, 1996; Frost, 2001). The primary conduit for knowledge transfer within geographic regions is the mobility of employees therein (Almeida and Kogut, 1999). In fact, scholars such as Lee, Miller, Hancock, and Rowen (2000: 8) commonly argue that a mobile workforce facilitates “collective learning, as tacit knowledge is conveyed and shared when professional employees move from one company to another...”; “[t]he whole region gains as knowledge is spread throughout the community...” The implication of the spread of knowledge within a geographic community is that knowledge spillovers are most likely to resonate between geographically proximal firms that have at one point shared the same employee.

Local knowledge spillovers may encompass key information about new products, services or features that will be desired by the market and instill within a firm an understanding of the processes or technologies that are useful to the venture’s innovation activities either presently or in the future. Ventures prepared to assimilate the knowledge will be capable of aligning their products or services according to the emerging trend (Cohen and Levinthal, 1994). New firms assimilating knowledge of other firms’ innovation activities into their innovations increase their ability to establish sociopolitical legitimacy, which is the legitimacy that accrues as “key stakeholders, the general public, key opinion leaders, or government officials accept a venture as appropriate and right, given existing norms and laws” (Aldrich and Fiol, 1994: 648). Sociopolitical legitimacy empowers firms to transact more easily with their task environment (Thompson, 1967), and increases the likelihood they would be capable of selling products to their market (Stinchcombe, 1965). For example, Wallsten (2001) posited that the knowledge spillovers that flowed between Small Business Innovation Research award winners and applicant firms would result in applicant firms proximally located to award winners receiving awards themselves. He reasoned that knowledge flowing through the regions likely contained critical information regarding the types of innovations the SBIR program valued, successful proposal structures and general techniques for managing the relationship with SBIR constituents, which prospective recipients were able to assimilate into their proposal submission process. Firms assimilating those spillovers, thus, were able to align their proposals with stakeholder expectations. Likewise, firms aligning their technologies with those of the emerging trends realize greater marketplace success than other firms (Tegarden et al., 1999).

Conclusively, for new ventures with limited legitimacy and whose resources are comparatively limited, local technological knowledge spillovers should help them become knowledgeable of technological possibilities that have been successfully employed in at least one arena, so that they are able to offer products and services that are aligned with stakeholder expectations. Local knowledge spillovers should have strong potential to help them streamline innovation efforts and introduce to the market products with greater potential for acceptability in the marketplace. Knowledge of other firms’ innovation activities, and assimilation of that knowledge into a venture’s activities, therefore, should be instrumental in fostering a stream of innovation within the ventures (Henderson, 1994; Henderson and Cockburn, 1996; Koberg et al., 1996) which enables them to generate higher volumes of sales.

H2a. Technological knowledge spillovers will be positively related to new venture product innovation.

H2b. Technological knowledge spillovers will be positively related to new venture sales growth.

3.2. Knowledge spillovers and the cluster firm performance advantage

In the section above, we demonstrated why technological knowledge spillovers are important for innovation and sales growth performance. Because knowledge spillovers are not confined to regions where industry clustering exists (Feser, 2002) and firms operating from any location with innovation activity occurring can be the recipients of knowledge spillovers from their location (Almeida, 1996; Frost, 2001), it is necessary to understand whether technological spillovers from cluster regions differ in nature or quantity than those from other regions.

The assimilation of knowledge from the external environment requires relatedness of the knowledge to the receiving firm's core technologies (Cohen and Levinthal, 1990; Stuart, 1998). Since new firms are commonly founded close to the activities of other firms in their local environment (Baum and Haveman, 1997; Furman, 2003), the innovation activities of new firms are generally tied to the technologies of the region (Bresnahan et al., 2001; Niosi and Bas, 2001). When operating from a location where there are higher concentrations of firms engaging in similar innovation activities, the pool of firms with technological proximity from which the venture could receive technological knowledge spillovers is higher, which should make it easier for cluster new ventures to assimilate knowledge from the cluster environment into their operations than might be true of ventures operating from other regions (Rosenkopf and Nerkar, 2001). In other words, it is not that firms operating from locations with limited industry concentration will not receive spillovers from other firms in their region (Jacobs, 1969). Rather, the volume of firms from which it could receive knowledge may be less than is true of firms operating from locations with high industry clustering. Moreover, the knowledge that spills over between cluster firms is argued to contain information regarding component knowledge, which is the "specific knowledge resources, skills, and technologies that relate to identifiable parts of an organizational system..." (Tallman et al., 2004: 264). There are also "rules of coordination and cooperation" from the cluster environment which enables firms operating within them to learn about the innovations being created by other firms (Brown and Duguid, 2000) and "transform tacit capabilities into a comprehensible code" (Zander and Kogut, 1995:78). The higher level of related industry spillovers received by these firms combined with a greater ability to assimilate the knowledge should influence the innovativeness of cluster new ventures to a greater extent than would be true of ventures receiving technological knowledge spillovers from a location with less industry clustering. A venture operating from a location with less industry clustering may receive industry-specific knowledge spillovers through other means of transmission (Appleyard, 1996); however, research has shown that this transmission occurs over time (Jaffe et al., 1993), so knowledge obtained through these sources may reflect old competencies or opportunities that are no longer worth pursuing (Brown and Duguid, 2000).

A cluster location, therefore, may better facilitate the transfer of tacit knowledge which is not yet codified and best conveyed through face to face interactions. For this reason, cluster new ventures because they receive more timely information on industry trends should have stronger ability to align their product or services offerings with those occurring within the cluster, which should reflect at least one direction in which the industry is heading. As a consequence, these firms should be capable of realizing higher levels of market performance than is true of firms without knowledge of the industry's technological direction (Dooley et al., 1996; Tegarden et al., 1999; Venkatraman and Prescott, 1990). Therefore, technological knowledge gained from the industry activity within the region should enable cluster new ventures to develop capabilities that help them assess and assimilate the knowledge received (Maskell, 2001), be well positioned to identify innovation opportunities worth pursuing (Abrahamson and Rosenkopf, 1993) and recognize high growth markets in which they can exploit emerging technologies. Accordingly, given the relationship of spillovers with performance, the larger pool of technological spillovers that cluster firms receive should enable cluster new ventures to realize higher levels of performance, and, should enhance understanding of why cluster new venture performance differs from that of ventures operating from other geographic locations. Thus, we hypothesize that technological knowledge spillovers will account for a portion of the observed relationship between industry clustering and new venture performance.

Hypothesis 3a. Technological knowledge spillovers are a significant factor explaining the relationship between industry clustering and new venture product innovation.

Hypothesis 3b. Technological knowledge spillovers are a significant factor explaining the relationship between industry clustering and new venture sales growth.

4. Methodology

To test the proposed relationships, we required a sample of performance-oriented new ventures with multiple years of performance data, geographic dispersion across the U.S., and a dependency on knowledge for their activities. Like other new venture performance studies (e.g. Amason et al., 2006; Arthurs and Busenitz, 2006; Kelley and Rice, 2002), we rely upon a sample of IPO technology-based ventures as these firms are argued to undertake an IPO to raise the capital needed to finance growth objectives (Jain and Kini, 1994). This characteristic makes it possible to confidently presume the firms had performance objectives they desired to achieve. Many new technology-related IPO firms of the 1990's created products with technologies centered on the Internet which, in the early 1990's, was in an ubiquitous commercialization phase (see Rai et al., 1998 for a historical analysis on the emergence of the internet). Firms with internet technologies during this time period were facing legitimization of the industry, making the 1990's a time when knowledge of other firms' technological activities would have been crucial for positioning the firms for marketplace success (Tegarden et al., 1999). Prior to 1995, there were few IPOs undertaken by new ventures, which following prior research (e.g. Biggadike (1976), McDougall, Robinson, and DeNisi (1992) we define as ventures less than eight years of age. For these reasons as well as other data availability and analysis concerns, we drew a sample of independent new ventures which were founded between 1990 and 2000, and which undertook their IPO between the years of 1996 and 2000. We limit our analysis to information technology industry firms specifically in the computer programming and services, software, and system integration and design industries (SIC codes 7370–7371, 7372 and 7373 respectively). In addition to the fact that these industry sectors were undergoing a period of redefinition due to the Internet, several practical considerations drove selection of these industry sectors. These sectors produced a large collection of firms in related activities that were geographically dispersed across the country, rather than concentrated in a few locations. The IPO ventures in our sample originated from high technology regions such as San Jose, CA and Boston, MA but also from lesser known regions such as Albuquerque, NM and Providence, Rhode Island. The geographic distribution of the sample relative to all IPO's from these industry sectors was correlated at .98, suggesting that the sample is similarly distributed across the U.S. as all other IPO's from these industry sectors as a whole.

Because IPO firms represent an elite sample of firms to utilize, we considered how these firms compared to other firms in these industry sectors. IPO firms are considerably larger than the average firm in these industry sectors. The average number of workers employed by this sample during the year of IPO is 290. According to the County Business Patterns data, firms of this size represent less than 1% of all firms in these sectors. Geographically, firms with more than 250 employees are in 37 of the 50 states and also in the District of Columbia. With the exception of the firms headquartered in the District of Columbia and Rhode Island, all other firms in our sample were from the top states with firms of more than 250 employees. These data suggest that our data are similarly distributed across the U.S. as other large firms in the 7370–7373 sectors. Even still, we acknowledge that our sample may not be entirely representative even of all large firms in these sectors. By selecting IPO firms we recognize that our measures of growth and innovation performance will be restricted in range by virtue of the fact that we have excluded any firms that did not undertake an IPO (Winship and Mare, 1992). Given this sample of firms, we would expect the values to be skewed towards higher rather than lower values. Even still, the variability of performance for IPO firms ensures there will be variance in these measures of performance (Ritter, 1991). We reflect on the implications of our sample biases in our Discussion section.

Our final sample size consists of 127 independently founded (i.e. without corporate affiliation) IPO new ventures. The sample was limited to this number because these firms had the desired two years of performance data available. We obtained data from Compustat and compared our sample to all other publicly-held firms in these industry sectors that existed between the years of 1996 and 2000. The average sales for firms in our sample during the year of IPO were \$57 million, compared to \$55.7 million for other public software sector firms. The venture with the lowest sales volume as of the year it went public was Intervu, with sales of \$144,000. On the other end, Priceline, the venture with the highest sales volume reached \$482 million. Like Priceline, many of the ventures in this sample are uniquely innovative. For example, Ariba, Inc. is a pioneer in the use of intranets and the internet in automating operations resource management. Digimarc Corporation had been awarded 126 patents for its digital watermarking, personal identification and related technologies solution between its founding in 1995 and in 2001, the last year its performance data were collected. The average number of employees for our sample was 290, compared to 384 for other public firms in these industries. As would be expected given their young age, these ventures have fewer employees than other publicly-held software sector firms, but differ only moderately from other publicly-held firms in these industry sectors on sales. These ventures appear to be representative of the average publicly-held firm in these industries, an elite accomplishment given their

young age. However, as is typical of new ventures, most of the firms in our sample were unprofitable as of the year they went public. In fact, only 15 of the firms had positive net incomes as of their IPO year. For firms that were almost four years old at the time they went public, this finding may confirm that although similar to other publicly held software firms across several dimensions, true to their young age they still struggled to stabilize their operations. We find this sample of ventures to be particularly suitable for assessing whether location influences performance and whether that knowledge plays a role in the effect.

4.1. Operationalizations

4.1.1. Independent variable

Since extant research has argued (e.g. Bresnahan et al., 2001) and found (e.g. Folta et al., 2006) that the size of a cluster has implications for observed firm outcomes, it was important for our research to examine ventures located in geographic locations with varying levels of industry clustering rather than use a single cluster location (e.g. like Baum and Haveman, 1997; Feldman, 2001; Molina-Morales et al., 2002; Sull, 2001) or experts to identify the cluster locations (Bresnahan et al., 2001; Deeds et al., 1997). For our measure of industry clustering we obtained data from the Cluster Mapping Project (Cluster Mapping Project, 2003), an initiative of the Institute for Strategy and Competitiveness at the Harvard Business School. The logic behind this measure is that industries that share externalities will be collocated geographically (see the Cluster Mapping Project website or Porter (2003) for more information). The Cluster Mapping Project determines collocation by examining the employment correlations of industries and where those industries tend to cluster. Industries that are commonly collocated in geographic space are grouped together and classified as a cluster. For each industry cluster, the Institute for Strategy and Competitiveness determines the amount of employment represented by all industries within that cluster group. It then determines the percentage of that industry clustering group that is present within the region relative to the amount that is present in the U.S. as a whole. This system enables us to identify locations with higher (such as in the Silicon Valley and Route 128 areas) or lower shares of information technology (IT) industry cluster employment (such as in regions where the cluster may still be emerging). We use this measure to assess the share of IT industry clustering that is present in the metropolitan statistical areas (MSA) during the year in which the ventures in our sample were founded. The year of founding is used because the founding decisions of the ventures create the “dna” from which imprinting occurs (Bamford et al., 2000). Therefore, the state of industry clustering during the venture’s founding year will affect how that venture develops and grows. The year of founding is also the preferred point in time to use because temporally it precedes our measure of knowledge spillovers.

4.1.2. Intermediating variable

Technological knowledge spillovers are difficult to capture because they are often transferred via communications between parties. Even so, knowledge spillovers are argued to be “observable” when there is a high degree of patent citations belonging to firms located within the venture’s metropolitan area (Almeida, 1996; Frost, 2001; Jaffe et al., 1993). An important qualification is that not all knowledge spillovers result in an invention that is registered at the patent office. However, other studies have generally found that the rather limited (observable) measure of patented inventions mirrors (unobservable) knowledge flows in innovative activity. For example, Acs, Audretsch, and Feldman (1992) used a measure of new product innovations to duplicate Jaffe’s (1989) study linking the propensity for patents to geographically cluster around knowledge inputs, such as R&D, and found the results remained virtually identical. Similarly, Audretsch and Feldman (1996) used the same measure of innovative output to show that innovative activity geographically clusters around R&D inputs. Thus, there is compelling evidence that the more direct measure of innovative activity that incorporates knowledge flows leads to non-patented inventions as well as patented inventions, and generally reflects the same behavior when only patented inventions can be observed. We use patenting activity to determine knowledge spillovers but incorporate a control to capture other knowledge flows that may occur from venture R&D activity. This measure is explained in greater detail in the control section below.

Although firms exhibit differential preferences in patenting their innovations (Argyres, 1996), patenting activities are important for firms that rely upon product innovations (Kelley and Rice, 2002). Patenting of software-based technologies in particular has grown in importance over the years (McQueen and Olsson, 2003), making this activity important for innovating software-related technology firms. The U.S. Patent and Trade Office’s online patent database was used to identify each patent awarded to the ventures in the sample from founding through the second year after

IPO. The respective counties and metropolitan areas were identified for the city of each cited patent's assignee, or inventor(s) when no assignee was named. Citations listed in the venture's patent application to firms in the venture's MSA were coded with a "1", and the process repeated for each citation on every patent awarded to the venture. The citations represent the patented innovations that existed when the venture's patented innovation was filed.

To avoid artificially inflating the results when multiple citations existed for a given firm in the venture's MSA, or deflating the results when multiple citations were made to a firm outside of the venture's economic area, we excluded duplicate citations as well as self citations (e.g. Frost, 2001; Jaffe et al., 1993). As cited patents can belong to any related invention patented during the U.S. Patent and Trade Office's existence, we limited the time period from which patent citations would be included to citations received within four years of the patent's filed date. Since Jaffe et al. (1993) found that time increased the likelihood of firms outside a local region citing a patent, this step was necessary to ensure the spillover of knowledge was not masked. Most patents were awarded within two to four years of their filed date. With filed patent applications only becoming available on the U.S. Patent and Trade Office website after November of 2000 (U.S. Patent and Trade Office, 2003), and the information not readily available prior to that time, it seemed reasonable to presume that a patent citation to a patent owner in the venture's local area within four years of the venture's patent filed date more likely reflected a spillover of knowledge than would be true of citations to older patents.

Like other samples for which patent data were utilized (e.g. Kelley and Rice, 2002), 60% of the ventures in this sample held patents during the time period under consideration. In this sample there were 75 patenting firms and 52 non-patenting firms. However, of the 75 firms holding patents, 25 did not have citations to other firms in their MSA. For these 25 firms, the industry knowledge assimilation value as measured in this study would have been zero. To distinguish between non-patenting ventures, patenting firms without citations to local firms, and patenting firms with citations to local firms, the proportion value for each venture was added to a dummy variable indicating whether the firm engaged in patenting activities. A non-patenting firm received a zero for the patenting dummy, a zero for the number of patent citations to local companies, and thus a zero value for its knowledge spillover value. A patenting firm without citations to firms in its local area received a 1 for its patenting value but a zero for its proportion of citations from the local area for a knowledge spillover value of 1.0. A patenting firm with citations to other firms within its local area received a knowledge spillover value equal to 1 plus the respective proportion value. To ensure that inclusion of this dummy variable did not unduly influence the results, we ran supplemental analyses with only the firms that had patented innovations. The direction of the relationships was as predicted in the hypotheses, but given the size of the sample and corresponding low power of the test, we found no statistical significance. Since deleting the non-patenting firms did not change the nature of the relationship, and we desired to preserve the power of the test, we only report the results for the full sample of firms.

4.1.3. *Dependent variables*

We examine two separate measures of new venture performance—growth and product innovation. Relative growth in sales from the year of IPO through the second year after IPO is our measure of growth performance. These data were sourced from the Compustat database, and all firms in the sample generated sales during the time period analyzed. For our measure of product innovation, we use all new and enhanced products introduced during the two years after the firm went public to reflect the overall product innovation activity of the firms during the time period of interest.

The time period subsequent to IPO is preferred to assessing their innovation activity at a particular age because firms of the same age can still vary substantially in their development. By evaluating the period after the firms went public, we are assessing the performance of firms after they have undertaken a similar event and would likely have been facing similar conditions, namely adjusting to the publicly held organizational form. The two year time period was determined primarily because many software firms are acquired shortly after IPO making it difficult to assess the performance of firms for a longer period of time. The two year window maximized the number of firms we could analyze for the study. The name of each announced product introduction was recorded to ensure products were not counted more than once. During the two year time period, on average, these firms made 10 product introduction announcements for a total of 1326 total announcements. Product introduction data were sourced from press release statements archived in the Lexis–Nexis database.

4.1.4. *Control variables*

We include controls for several variables which may influence the performance of the firms. Because older firms would have a longer period of time over which to develop and market innovations, in the analyses we control for the

age of the firms as of the year of IPO. Likewise, firms whose R&D activity is extensive should have stronger ability to assimilate knowledge from the external environment and introduce products to the market. We control for the R&D Intensity of the firms as of the year of IPO. A firm's ability to create patented inventions may also affect its ability to introduce products to the marketplace. We control for this capability by including the number of patents the venture held as of the year of IPO. We also recognized that the proceeds the firm received from its IPO should enable the firm to aggressively pursue growth and innovation objectives. Thus, we control for the proceeds the firm gathered during its IPO. Larger firms may have greater resources and ability to introduce more products to the market. Their size might enable them to manage a higher volume of products than would be true of smaller firms. We include a control for the size of the firm by measuring the number of employees the firm had as of the year of IPO.

We also include a set of control variables which enables us to partial out differences that might have resulted in growth or innovation due to the market in which the venture operated or the two year time period following the year in which the IPO was undertaken. There were eight markets in which these firms operated, however, we found that only the internet service providers, other, and information technology services differed significantly from all other market sectors. We use individual dummy variables to represent each of these markets. In contrast, the ecommerce, web portals and online communities and information management systems firms were significantly different from the other markets, but not significantly different from one another. These three markets were combined into one dummy variable. The internet, other and custom software development firms were collapsed into one dummy variable for the same reason. The "other" market variable serves as the reference category in all analyses. Dummy variables representing each year of IPO between 1996 and 2000 are also used with the year 1996 as our reference category.

4.2. Analyses

We implemented path analyses to test the relationships of interest. Due to the fact that systems such as LISREL 8.7 cannot accommodate data with continuous and ordinal variables, and, therefore, provided no incremental benefit above running separate regressions analyses, we run all regression analyses in Stata 8.1. As [Baron and Kenny \(1986\)](#) suggest, we first determine whether the relationships between industry clustering and our measures of product innovation and sales growth performance are likely directly or indirectly mediated by the knowledge spillovers firms received (H1a and H1b). For the product innovation model, we use a negative binomial regression analysis because the variable is a count variable. For the sales growth model we use OLS regression analysis because our growth variable is continuous. For the relationship between the mediator and dependent variables (H2a and H2b), we use negative binomial and OLS regression respectively. The sales growth variable had two outlier values which were more than three standard deviations below the mean. One firm had sales that declined to 82% of prior sales levels during this two year time period while the other declined to 71% of prior sales level. These records were winsorized and rescaled down to the sales growth decline for the lowest percentile which, in this sample was -41%.

4.3. Results

Correlations, means and standard deviations for this sample of firms are presented in [Table 1](#). The correlations indicate that industry clustering and technological knowledge spillovers have strong positive relationships with product innovation, but weaker relationships with the sales growth of the firms. As would be expected, it also shows that industry clustering and technological knowledge spillovers are positively correlated, indicating that ventures operating from locations with higher industry clustering incorporate more technological knowledge from the local area into their innovations. Estimates of the regression analyses are presented in [Tables 2 and 3](#) for innovation and growth models respectively. In each table, Model 1 is the control model and Models 2–4 the tests of the hypothesized relationships.

Hypothesis 1a predicted that industry clustering would positively influence new venture product innovation. Model 2 of [Table 2](#) demonstrates that even after controlling for other influential variables, industry clustering has a positive and significant relationship with product innovation at a $p < .05$ level of significance. These results provide support for Hypothesis 1a. Hypothesis 1b predicted that industry clustering would positively influence venture growth. Model 2 of [Table 3](#) shows that after including the controls, industry clustering positively and significantly influences venture sales growth at a $p < .05$ level of significance providing support for H1b. These results confirm that industry clustering strongly influences new venture product innovation and sales growth.

Table 1
Variable correlations, means and standard deviations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Means	10.44	0.18	0.05	0.64	3.80	0.29	0.57	3.47	59.67	0.36	0.38	0.08	0.11	0.08	0.15	0.20	0.44	0.13
Minimum	0.00	−0.42	0.00	0.00	1.00	0.02	0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	44.00	0.97	0.14	1.50	8.00	0.87	11.82	35.00	234.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
S.D.	8.85	0.27	0.04	0.54	1.63	0.21	1.29	5.70	41.34	0.48	0.49	0.27	0.31	0.27	0.36	0.40	0.50	0.34
1 Product innovation	1.00																	
2 Sales growth	0.10	1.00																
3 Industry clustering	0.23**	0.13	1.00															
4 Knowledge spillovers	0.25**	0.08	0.38***	1.00														
5 Age at Ipo	0.08	−0.31***	−0.05	0.05	1.00													
6 Size (employees)	0.04	0.01	0.03	−0.03	−0.14	1.00												
7 R&D intensity	−0.10	0.27**	−0.04	0.09	−0.14	−0.19*	1.00											
8 Patents	0.13	0.05	0.13	0.50***	0.04	−0.09	0.05	1.00										
9 Ipo proceeds	0.02	0.09	0.12	0.12	−0.18*	0.33***	0.06	0.06	1.00									
10 Ecommerce— portals, information management systems	−0.01	0.06	0.20*	0.04	0.03	−0.10	0.07	−0.13	0.07	1.00								
11 Internet—other custom system design	0.22*	−0.08	0.05	0.07	0.01	−0.07	0.03	0.12	−0.06	−0.59***	1.00							
12 Information technology services	−0.25**	−0.02	−0.16†	−0.24**	−0.05	0.27**	−0.12	−0.15†	−0.17†	−0.22*	−0.23**	1.00						
13 Other	0.01	−0.06	−0.11	0.07	0.07	−0.07	−0.03	0.25**	−0.02	−0.26**	−0.27**	−0.10	1.00					
14 1996 IPO	−0.08	−0.01	0.09	0.10	−0.13	−0.06	−0.05	−0.01	−0.24**	0.02	0.07	0.02	−0.10	1.00				
15 1997 IPO	−0.01	0.24**	−0.20*	−0.07	−0.06	−0.05	0.15†	0.11	−0.27**	−0.22*	0.04	0.21*	0.06	−0.12	1.00			
16 1998 IPO	0.00	0.07	0.07	−0.20*	0.05	−0.04	−0.12	−0.15†	−0.19*	−0.17†	0.15†	0.00	0.02	−0.14	−0.21*	1.00		
17 1999 IPO	−0.02	−0.05	−0.05	0.16†	0.05	0.04	0.04	0.11	0.31***	0.22*	−0.14	−0.08	−0.11	−0.26**	−0.37***	−0.44***	1.00	
18 2000 IPO	0.12	−0.26**	−0.26**	−0.01	0.03	0.08	−0.02	−0.09	0.25**	0.09	−0.07	−0.11	0.16†	−0.11	−0.16†	−0.19*	−0.35***	1.00

p-values: †*p* = .10, **p* = .05, ***p* = .01, and ****p* = .001.

Table 2

Innovation models, negative binomial with robust estimation

	Model 1		Model 2		Model 3		Model 4	
	β	z	β	z	β	z	β	z
Age at Ipo	0.01	0.22	0.02	0.37	0.01	0.23	0.02	0.36
R&D intensity	−0.12	−3.19***	−0.11	−3.00**	−0.13	−3.10**	−0.12	−2.99**
Patents	0.02	1.74†	0.02	1.55	0.004	0.44	0.00	0.53
Ipo proceeds	−0.002	−0.81	−0.002	−0.71	−0.002	−0.63	0.00	−.59
Size (employees)	0.7	1.81†	0.69	1.74†	0.63	1.59	0.64	1.6
Ecommerce—portals, information management systems	0.33	1.82†	0.21	1.09	0.33	1.89†	0.24	1.28
Internet—other custom system design	0.47	2.61**	0.39	2.11*	0.46	2.67**	0.40	2.27*
Information technology services	−1.23	−3.37***	−1.24	−3.48***	−1.09	−2.86**	−1.13	−3.04**
1997 IPO	0.47	1.22	0.69	1.99*	0.66	1.70†	0.77	2.17*
1998 IPO	0.35	0.88	0.51	1.53	0.48	1.27	0.57	1.68†
1999 IPO	0.32	0.87	0.42	1.35	0.41	1.16	0.46	1.46
2000 IPO	0.58	1.4	0.68	1.86†	0.66	1.64†	0.71	1.95*
Industry clustering			3.87	2.24*			2.98	1.65†
Knowledge spillovers					0.34	2.14*	0.25	1.53
Constant	1.57	3.54***	1.31	3.28***	1.29	2.96**	1.16	2.85**
Log-likelihood	−413.27		−410.90		−411.1		−409.83	

p-values: † $p < .10$, * $p < .05$, ** $p < .01$, and *** $p < .001$.

Hypothesis 2a predicted that technological knowledge spillovers would be positively related to new venture product innovation. Model 3 of Table 2 shows a positive and significant relationship of technological spillovers and product innovation ($p < .05$) and provides support for H2a. Model 3 of Table 3, however shows a positive but non-significant relationship of technological spillovers with venture sales growth. We fail to find support for H2b, which predicted a positive relationship between technological knowledge spillovers and sales growth.

In evaluating the influence of technological spillovers on the relationship between industry clustering and product innovation, thereby testing H3a, we use estimates from Model 4 of Table 2 which assesses the influence of the mediating variable on the dependent variable when the independent variable is also controlled in the model. Model 4 of Table 2 shows the coefficient for industry clustering is smaller and with weaker significance than was true when technological spillovers were not controlled. Also of importance to note is that technological knowledge spillovers lose their

Table 3

Growth models, OLS with robust estimation

	Model 1		Model 2		Model 3		Model 4	
	β	t	β	t	β	t	β	t
Age at Ipo	−0.04	−2.62**	−0.04	−2.44*	−0.04	−2.68**	−0.04	−2.44*
R&D intensity	0.04	2.08*	0.04	2.33*	0.04	2.00*	0.04	2.21*
Patents	0.002	0.58	0.00	0.07	−0.001	−0.22	−0.001	−0.16
Ipo proceeds	0.001	1.91†	0.001	1.90†	0.001	1.90†	0.001	1.89†
Size (employees)	0.02	0.20	0.01	0.09	0.01	0.13	0.01	0.07
Ecommerce—portals, information management systems	0.06	1.11	0.03	0.44	0.06	1.08	0.03	0.46
Internet—other custom system design	−0.05	−0.85	−0.07	−1.36	−0.05	−0.88	−0.07	−1.34
Information technology services	−0.06	−0.77	−0.06	−0.80	−0.05	−0.56	−0.06	−0.72
1997 IPO	0.16	2.11*	0.19	2.49*	0.18	2.27*	0.2	2.52*
1998 IPO	0.08	1.03	0.10	1.42	0.10	1.21	0.11	1.43
1999 IPO	−0.07	−0.93	−0.06	−0.92	−0.06	−0.78	−0.06	−0.86
2000 IPO	−0.24	−3.34***	−0.23	−3.30***	−0.22	−3.14**	−0.23	−3.23**
Industry clustering			1.33	2.54*			1.27	2.07*
Knowledge spillovers					0.05	1.08	0.02	0.34
Constant	0.24	2.62**	0.19	1.95†	0.21	2.17*	0.18	1.85†
R-square	0.30		0.34		0.31		0.34	
Root MSE	0.24		0.23		0.24		0.23	
F	4.85***		5.01***		4.81***		4.98***	

p-values: † $p < .10$, * $p < .05$, ** $p < .01$, and *** $p < .001$.

significance with product innovation altogether. We examined whether this finding could be the result of multicollinearity between the variables. The correlation between industry clustering and technological knowledge spillovers is .38, meaning each variable only accounts for 14% of the variance in the other. Our test of the variance inflation factor reported values less than 4 for all variables, which confirms collinearity is not a concern. We interpret these results as suggesting that although technological knowledge spillovers account for some of the reason why cluster firms have higher product innovation, there are other important factors that contribute to explaining the innovation behavior of cluster new ventures. The non-significance of technological knowledge spillovers when industry clustering is controlled may also suggest that they do not provide the level of utility to firm innovation performance that extant theory suggests. These results clearly show that other factors are also important and fail to provide support for Hypothesis 3a.

We also failed to find support for Hypothesis 3b, which predicted that technological spillovers would explain the industry clustering and sales growth relationship. Model 4 of Table 3 shows that although the coefficient for industry clustering is reduced in size with technological spillovers controlled, it remains a significant predictor of new venture growth at the $p < .05$ level. Technological spillovers, on the other hand, lose size and remain a non-significant factor. This finding suggests that other factors are more important than technological knowledge spillovers for explaining the growth of cluster new ventures.

5. Discussion

Our study provides empirical confirmation that performance benefits accrue to new ventures founded within geographic cluster locations. In this regard, it validates the importance of geographic cluster regions for entrepreneurs as well as policy makers. However, our results challenge conventional wisdom which suggests it is the superior access to knowledge spillovers, in particular technological spillovers, that serves as the basis for performance advantages for cluster firms (Deeds et al., 1997; Tallman et al., 2004). While we did observe that technological knowledge spillovers are more common in cluster firms and empirically found that technological knowledge spillovers positively and significantly influence new venture product innovation, technological knowledge spillovers received by cluster firms were not entirely useful for explaining why cluster firms introduce more product innovations. Clearly, there are other concerns besides the assimilation of technological knowledge spillovers that contribute to the product innovation performance of cluster firms. The nature of the knowledge received and the process by which it is reconciled with the firm's existing information streams may be important factors that influence how the knowledge is deployed in the firm (Branzei and Vertinsky, 2006). The developmental processes firms utilize may need to be seriously considered in future research. We also argued that the technological knowledge spillovers firms receive into their operations would enable the ventures to gain the competencies needed to innovate and create products with features desired by the marketplace; however, in examining the relationship of technological knowledge spillover with sales growth we found no support for this premise. Our findings suggest that extant literature may give too much emphasis to technological knowledge spillovers at the expense of other factors which may be similarly or more important.

One rationale we provided to explain why clusters would influence new venture growth and innovation was that competition in such regions force firms to be competitive (Porter, 1998). Ventures founded under such conditions are required to quickly ramp up their innovation competencies and routines (March, 1991), and thus may have more accelerated development than may be true of ventures operating from other geographic regions. These firms may benefit to a greater extent from the institutional environment created by virtue of the science parks in the region which assist in the transfer of knowledge between firms (Tan, 2006) which aids their long term success (Phan et al., 2005). Interestingly, our analysis confirms that cluster new ventures incorporate technological knowledge of other firm's innovations into their operations to a greater extent than other new ventures, but while the spillovers model suggests a positive relationship with product innovation, when industry clustering is controlled in the full model spillovers lose their significant effect on product innovation. Technological knowledge spillovers, therefore, may play a secondary role to other factors which help cluster new ventures succeed under such competitive conditions. It may be that these firms are able to innovate more because they have superior internal development capabilities (Branzei and Vertinsky, 2006). Whether these capabilities are tied to the technological knowledge spillovers the firms receive is an empirical question that needs to be determined. Future research may wish to examine the learning behaviors of cluster new ventures and how they differ from other new ventures.

It may also be interesting to understand how the source of knowledge received into the firm's operations influences the entrepreneurial opportunities pursued and their outcomes. For example, Ravasi and Turati (2005) found that the

prior knowledge and the extent to which the prior knowledge enabled the entrepreneur to control the development process, influenced the success of new entrepreneurial projects undertaken. This research suggests the importance of developing deeper understanding of the prior knowledge held by the firm and its interaction with new generated knowledge (e.g. [Branzei and Vertinsky, 2006](#)). [Dew, Velamuri, and Venkataram \(2004\)](#) distinguish between contingent knowledge, which is knowledge deriving from an agent's place in time and space, idiosyncratic knowledge, or knowledge deriving by virtue of the agent being the agent, and specialized knowledge, which is knowledge deriving from an agent's educational training and or professional experience. It would be interesting to consider the extent to which these forms of knowledge are region-specific ([Venkataraman, 2004](#)) and how that influences the overall development of the firms. It would also be interesting to observe how these forms of knowledge interact to produce the final outcomes in the firms. Knowledge is the catalyst that leads to the recognition of entrepreneurial opportunities ([Dew et al., 2004](#)), yet technological knowledge spillovers took a secondary role to the cluster environment in influencing venture performance. It is important to understand how other forms of knowledge differ for firms located within and outside of cluster locations.

We also argued that cluster regions may generate demand to a greater extent than is achievable when the firm operates from other geographic regions ([Chung and Kanins, 2001](#)). As [Venkataraman \(2004:165\)](#) argued, large markets create “natural laboratories for testing and introducing new ideas cost-effectively.” Early access to the marketplace may provide the firm with faster feedback on the functionality of the products, which can either create the need for additional product development or help the entrepreneur discern when abandonment of the innovation should occur. For some customers, feedback will go to improving existing products rather than creating opportunities for new products ([Christensen, 1997](#)). For ventures such as software firms, which offer products that may need to be upgraded to keep customers using them, enhancements to existing products typically, are not growth-generating opportunities. If the knowledge that such cluster firms receive is incorporated into existing products to a greater extent than new products, we should not expect our empirical analysis to reflect a relationship of knowledge spillovers with the growth of the firms. Future empirical research is needed which enhances understanding of whether technological knowledge spillovers are more useful for new or existing products. It would also be interesting for future research to tease out whether knowledge spillovers provide insight into new ways of doing things or if they increase awareness of new markets that can be served. Likewise, we suspect there is room for scholars to make an important contribution to the field by examining whether entrepreneurs whose ventures are launched on the foundation of knowledge spillovers are creating more innovative technologies for new markets or better technologies for existing markets.

Our final argument for why clusters should influence new venture performance ties back to the ability of entrepreneurs to differentiate their firms from other firms in the region ([Baum and Haveman, 1997](#); [Canina et al., 2005](#)). Industry clustering facilitates differentiation behavior by enabling entrepreneurs to recognize gaps in existing product offerings and introduce a line of products that fill the gap they observed ([Sorenson and Audia, 2000](#)). Differentiated products often meet the needs of niche markets, which can result in higher levels of performance for differentiating firms. Our research design did not enable examination of the extent to which the venture's products were differentiated to a greater extent than those of ventures in other regions. Future research which seeks to explore the nature of products developed by cluster new ventures would also produce important insights for the field.

Although we found that industry clustering positively influences the ability of ventures to generate sales, our conclusion that the technological knowledge spillovers are not the contributing cause for this result is an interesting one. One possible explanation is that it is not the technological knowledge that benefits but rather the market knowledge that comes from the cluster location that yields stronger effects on venture growth. A second explanation could be that technological spillovers influence economic results indirectly through other factors, such as new products introduced. It may also be that the greater ability of cluster firms to access strategic partners ([Lechner and Dowling, 2003](#)) enables them to find many outlets through which to sell their products. Clearly, there are many other factors which could explain the sales growth of firms in cluster locations. Research which identifies and examines these factors will make significant contributions to the field.

5.1. Implications for entrepreneurs and policy

Our results highlight the importance of the venture's founding location for future performance outcomes and signal to entrepreneurs the importance of considering the conditions in the founding location when deciding where to start the venture. Industry clustering in a location will indeed mean the venture will face more competition; however,

entrepreneurs should view competition positively as it is a factor with potential to make it a more viable competitor (Barnett and McKendrick, 2004). These results may also signify the importance of being close to the market being served. Proximity to market will increase the demand the venture hopes to establish for its products. If not located in an industry cluster, entrepreneurs should consider emulating some of the qualities that are naturally present in cluster locations. For example, it is important that entrepreneurs consider whether their location has the potential to provide them with visibility to key groupings of their predominant customers or the close relationships with key firms in the location. Making certain the product/service being offered meets the needs of local customers could be a strong starting point for generating the demand that will aid venture product innovation and growth efforts.

We also recognize that technological knowledge from the local area has potential to make a firm's product innovations stronger. Entrepreneurs, therefore, must do all that they can to link their venture to the activities of the region so that their products or technologies are in-sync with other firms in the region. While it may not be possible for firms operating from outside cluster regions to receive knowledge to the same extent as firms operating from regions where industry clustering exists, our results suggest that some knowledge of other firms' innovation activities is better than none. Establishing relationships with local governmental, university or trade associations to increase the influx of technological knowledge into their operations will likely provide substantial rewards to receiving firms. Utilizing local employee training centers may align the firm's processes with others within the region potentially by strengthening the firms' awareness of practices at other firms and improving their ability to assimilate the knowledge into their own operations.

From a policy standpoint, geographic cluster regions are attractive instruments that policy officials use for development because these regions create an environment with high levels of startup activity (Malecki, 1985) which results in regional job creation (Gilbert et al., 2004). Our results suggest that policy officials may want to consider concentrating similar industry activity in close proximity to foster competition and knowledge spillover effects. The importance of knowledge spillovers for product innovation performance points to the importance of putting sufficient knowledge transfer mechanisms in place. Knowledge spillovers help new firms understand the product innovations that are possible. Focused incubators may play important roles in this process as well as university policies towards technology commercialization. For geographic regions lacking university presence, community training programs to develop the skill set of employees within the region, which increases their mobility, may be particularly important for creating an environment where knowledge spreads between firms within the region (Almeida and Kogut, 1999).

5.2. Implications for theory and future research suggestions

By demonstrating higher performance of cluster new ventures relative to ventures operating from other locations, our results corroborate those found in other studies of cluster firm performance. However, this study provides important new insights not found in previous research by showing that technological knowledge spillovers may not increase firm performance to the degree that extant theory currently suggests. Technological knowledge spillovers were confirmed as important for product innovation but not for growth, and only when industry clustering was not factored into the equation. The overpowering effect of industry clustering on product innovation suggests that either other clustering dynamics are far more important than technological knowledge spillovers, or that there is a complex set of dynamics that combine to contribute to cluster firm advantage that is undetectable when only a single factor is considered.³ Future researchers should draw upon other theories of clustering dynamics to explain differential levels of performance for the firms. There may be a need to combine several factors when attempting to explain the performance of the firms. Moreover, our results also show the importance of measuring the potential effects independent of and alongside of industry clustering to determine the overall effect. Such fine-grained analyses will enlighten understanding of the underlying dynamics of the cluster region that are creating more successful firms.

Extant research also tends to focus primarily on the influence of technological knowledge spillovers to the exclusion of other forms of knowledge spillovers. Unfortunately, this research is no exception to that observed trend. We do posit, however, that market knowledge spillovers may be different in nature and effect on firm performance, especially for market-based measures such as growth. For this reason, such non-technical knowledge spillovers may be a better explanatory factor explicating the nature of the relationship between industry clustering and growth. We encourage future researchers to begin identifying and measuring other forms of knowledge spillovers in future studies on cluster firms.

³ The authors would like to thank one of the reviewers for making this important observation.

5.3. Limitations

Although our results confirm that industry clustering positively affects the product innovation and sales growth performance of this sample of new ventures, we would be remiss to not acknowledge that these results are based on an elite sample of new firms. IPO firms must overcome many hurdles before they are able to become a publicly-traded firm. Firms that undertake an IPO may be higher performing firms than other firms. However, in evaluating the survival statistics of this group of firms, we did not find our statistics to differ substantially from those of other new firms. We found that 33% were acquired on average within five years of going public; 12% went bankrupt or failed on average within four years of going public; and 55% continued operations as of the end of December 2006. Another limitation is that some scholars (e.g. Folta et al., 2006) have suggested that entrepreneurs operating from cluster locations may require higher performance thresholds to stay in business, which would mean that surviving cluster firms will exhibit a superior performance than would their counterparts located outside of a cluster. We did our best to address this limitation by using several control variables to attempt to partial out performance differences for the firms. We must acknowledge that our research design does not allow us to speak to privately held or smaller firms or even to determine the extent to which industry clustering or knowledge spillovers prevents or slows venture failure. We encourage population level studies of geographic cluster firms to assess the overall impact for all firms.

In prior sections, we alluded to the limitations associated with patent citations as our measure of spillovers. As a measure of spillover, it captures the extent to which firms are able to assimilate novel information into their operations. Even so, it will be important for future research to use other measures and operationalizations of spillovers which enables the researcher to capture a broader set of influential innovations as well as a larger set of available spillovers. We also used a unique time period where redefinition of knowledge was occurring due to the growth of the internet. Knowledge may have been more important during this time period than may be true of others. There is a need for research which explores other industrial contexts at various industry stages.

6. Conclusion

Our results corroborate what Shaver and Flyer (2000) suggest: industry clustering in a geographic region improves the innovation performance of “weaker firms,” in this case new ventures confronted with high uncertainty. Even so, knowledge spillovers alone do not provide the entire explanation for cluster firm performance. Consequently, a full understanding of what factors lead to higher performance for cluster firms remains elusive to the field. We hope this research inspires other researchers to join us in addressing unresolved questions concerning the implications of cluster locations for new venture performance.

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