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California Dreaming? Cross-Cluster Embeddedness and the Systematic Non-Emergence of the 'Next Silicon Valley'

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Abstract:
The importance of social embeddedness in economic activity is now widely accepted. Embeddedness has been shown to be particularly significant in explaining the trajectory of regional development. Nonetheless, most studies of embeddeddness and its impacts have treated each locale as an independent unit. Following recent calls for the study of cross-cluster social interactions, we look at the consistent failure of numerous localities in the United States with high potential to emulate Silicon Valley and achieve sustained success in the ICT industry. The paper contends that the answer lies in high-technology clusters being part of a larger system. Therefore, we must include in our analysis of their social structure the influence of cross-cluster embeddedness of firms and entrepreneurs. These cross-clusters dynamics lead to self-reinforcing social fragmentation in the aspiring clusters and, in time, to the creation of an industrial system in the United States based on stable dominant and subordinate (feeder) clusters. The paper expands theories of industrial clusters, focusing on social capital, networks, and embeddedness arguments, to explain a world with one predominant cluster region. It utilizes a multimethod analysis of the ICT industry centered in Atlanta, Georgia, as an empirical example to elaborate and hone these theoretical arguments.

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Introduction

In the past forty years we have come to recognize the importance of embeddedness in economic activity. Under conditions of economic embeddedness, "the behavior and institutions to be analyzed are so constrained by ongoing social relations that to construe them as independent is a grievous misunderstanding" (Granovetter 1985) and actors do not behave atomistically but, rather, are embedded in "concrete, ongoing systems of social relations" (Granovetter 1985). Embeddedness can refer to relationships between and across individuals, firms, industries, nonprofit organizations, and governments. Its impact has been shown to affect all aspects of economic behavior, from pricing and evaluating mergers and acquisitions to influencing the commercial and artistic quality of Broadway musicals to upgrading the quality of regional wines and transforming the economic fortunes of laggard communities (Haunschild 1993; Uzzi and Spiro 2005; McDermott, Corredoira et al. 2007; Safford 2009). Embedded ties can provide information benefits, allow the co-optation of sources of market constraints, provide access to critical resources, endow legitimacy and status, and shape identities (Krippner and Alvarez 2007).

One of the most consistent findings is that companies embedded within regions with favorable characteristics have a regional advantage over companies that are not (Piore and Sabel 1984; Porter 1990; Sabel 1992; Herrigel 1993; Saxenian 1994; Storper 1997; Uzzi 1999; Casper 2007). Furthermore, local embeddedness has been shown to make the difference between regional economic success and a slow decline in times of both crisis and growth (McDermott 2007; McDermott, Corredoira et al. 2007; Safford 2009). Indeed, the growing understanding of the value of local embeddedness is one of the reasons that the creation and promotion of regional clusters of innovation has become the beacon of hope for policy makers and academics who seek local economic growth.

Nonetheless, embeddedness is not only local. All individuals and firms are part of various social networks that embed them in specific economic communities, some, or even most, of which might not be local. It is, therefore, crucial that we fully understand the impacts of cross-cluster embeddedness on local economic growth. Unfortunately, there is a significant gap in the literature on these issues and there also are gaps in the literature regarding distant tie formation. While homophily, reciprocity, and repeated ties have been well studied in observation, most interorganizational networks maintain a balance between relations that bind similar entities and those that connect dissimilar entities. Our research is part of a current attempt to eliminate these shortcomings by facilitating understanding of the emergence of ties between spatially, relationally, and socio-demographically distant actors (Brass, Galaskiewicz et al. 2004; Sorenson and Stuart 2008).

In the past few decades, numerous regions have boldly announced their intention to become “the next Silicon Valley” (Bresnahan and Gambardella 2004; O'Mara 2004; Breznitz 2007; Lerner 2009). Carefully following the advice of many a scholar and consultant, local policy makers have taken measures to ensure that their regions are fully endowed with all the factors that have been pointed out as the necessary ingredients of a successful technology cluster, from a high-quality powerful research university, to specialized venture funding (Bresnahan, Gambardella et al. 2001; Cooke 2002; O'Mara 2004; Braunerhjelm and Feldman 2006; Whittington, Owen-Smith et al. 2009). Many of these local leaders have also accompanied these investments with flexible policies that include mentorship, entrepreneurial education, tax breaks and other business incentives, and dedicated incubation spaces. However, despite these efforts, very few globally successful high-technology clusters have emerged in the United States in the past four decades (Stuart and Sorenson 2003; Casper 2007; Lerner 2009).

Most academics and policy makers believe this sobering result is due to an apparent inability to completely decipher the "genetic code" of Silicon Valley.

We disagree. The true theoretical puzzle is not deciphering Silicon Valley but the exact opposite: explaining the almost universal failure of the best efforts led by the finest minds to achieve much sustained success anywhere else in the United States. Consequently, we argue that if we are to advance theory and improve policy, we must explain why such efforts have failed.

We contend that the answer lies in the fact that clusters do not develop in isolation. Attempts to develop them are locale-specific and each cluster is analyzed as an independent unit, however, they are all part of a national and international industrial system. Once we add cross-cluster interactions to our analysis, the influence of cross-cluster social embeddedness of firms and entrepreneurs becomes apparent. One of the most consistent findings of economic sociology and economic geography has been that in order to be successful in new high-technology industries, companies and individuals need to be embedded in a vibrant industrial community (Piore and Sabel 1984; Porter 1990; Sabel 1992; Herrigel 1993; Saxenian 1994; Storper 1997; Almeida and Kogut 1999; Castilla 2003; Owen-Smith and Powell 2004; Casper 2007; McDermott 2007; Whittington, Owen-Smith et al. 2009). Embedded economic actors are affected more by their relations with other actors than by abstract norms or concepts of self-interest. "A range of firm behaviors—strategies, structures, and performance—could be affected by the firm's relations with other firms" (Mizruchi 1996). However, being embedded in an industrial community does not necessarily mean being physically located in the same locale throughout the whole company life-cycle. In fact, statistically it is easier for start-ups funded outside Silicon Valley to achieve commercial success (Powell, White et al. 2005; Whittington, Owen-Smith et al. 2009).

However, to be successful, firms located in aspiring clusters need to weave themselves into the industrial communities of the more established clusters, such as those in Silicon Valley or Boston. We argue that this long-distance embeddedness has a significant negative impact on the development of a coherent industrial community in the aspiring cluster. With their limited social resources focused on what they view as a critical long-distance relationship with financiers, customers, peers, and key individuals in the dominant clusters, the amount of time and effort management invests in the local community is greatly reduced. In addition, as they become more embedded in the dominant cluster, promising firms will tend to relocate there. The result is social fragmentation of the industry in the aspiring regions.

Furthermore, this social fragmentation is self-reinforcing. Operating in an environment where companies lack a strong local community and already have at their disposal role models for success and institutionalized patterns enabling them to become embedded in the dominant cluster, promising new start-ups will, from their inception, look outside the cluster for their socio-business interactions. The result is a continuous replication and deepening of local social fragmentation. The end result of this process, we argue, is a national system of a small number of dominant clusters served by a large number of subordinate feeder clusters. These feeder clusters end up specializing in creating new companies whose full economic benefits are enjoyed by the dominant clusters.

Hence, while the majority of the current theories view the growth of clusters as an independent local social evolution, we view cluster development as part of the evolution of a national and international industrial system. For example, Sean Safford has shown how the internal history of the very different social network structures of the civil and economic leadership in Allentown, Pennsylvania, and Youngstown, Ohio, explains the divergence in their fates after the collapse of their steel industries (Safford 2009). In a different vein, Steve Casper explains the development of a new successful biotechnology cluster in San Diego by analyzing the rapid growth of cohesive social networks within the industry (Casper 2007). Very few theories account for the failure of networks, let alone the failure of cohesive networks to form where expected (Schrank and Whitford 2009). We argue that while local social interaction is of the utmost importance, the common outcome—that is, the inability of many aspiring clusters to coalesce as a cohesive social unit—is better explained by looking at cross-cluster interactions. By doing so, we can easily explain why, once a few dominant technology clusters have already established themselves in the United States, most aspiring clusters would be expected to suffer from a local technology industry that is continuously and severely socially fragmented.

To develop and substantiate our argument, the next section of the paper elaborates on the theories of industrial clusters with specific focus on social capital, networks, and embeddedness arguments. We then develop the logic of these arguments to fit a world with an exceedingly dominant cluster and develop the predictions these models would lead us to expect. In the third section we offer an extensive analysis of the history of Atlanta, Georgia, ICT industry as an empirical example to more fully flesh out our arguments and further inductively develop our theory (Eckstein 1975; Eisenhardt 1989; Ragin and Becker 1992; Gerring 2004; Alexander and Bennett 2005). This analysis is conducted using multiple research methods, including several social networking techniques, archival research, interviews, and statistical data analysis.

Theory

Economic embeddedness creates economic value through three mechanisms: trust, fine-grained information transfer, and joint problem solving (Uzzi 1999; Polanyi 2001; Seshadri and Shapira 2003). Through these three mechanisms, embeddedness reduces incentives to engage in opportunism and malfeasance (Granovetter 1985; Putnam 2001). The existence within a cluster of these vibrant social networks and high mobility enables firms to react to market developments more rapidly than their competitors. Embedded networks lead to improved information flows and better collective learning and collective action. Competitive advantage requires continual learning and innovation (Asheim and Coenen 2006), and the collective learning that takes place within thriving clusters provides a substantial advantage, because innovation is territorially embedded, and interorganizational networks facilitate collective learning (Lundvall 1992; Abrahamson and Rosenkopf 1997; Lawson and Lorenz 1999; Audia, Sorenson et al. 2001). Collective action is also linked to particular social institutions and to the development of unique cluster identity that informs investment decisions and cluster development (Romanelli and Khessina 2005; Braunerhjelm and Feldman 2006).

We contend that the reason so many aspiring technology clusters never achieve their promise is a continuous fragmentation of the locale's industrial social structure. This continuous fragmentation is the outcome of actions taken by local entrepreneurs and firms who aim to maximize their commercial success within a national industrial environment with already established dominant clusters. The impulse to locate operations where economic gain would be maximized is offset by social factors. Nonetheless, as companies are founded in one locale they quickly become embedded in the dominant region. As they seek out valuable connections, they find that proportionately more potential valuable connections are outside their own region, and as they make these valuable connections, they become more and more embedded in the dominant region (Dahl and Sorenson 2010). In order to become successful, technology companies located outside the dominant cluster must create ties outside their region, particularly within the dominant cluster region (Whittington et al. 2009). As a result, over time, companies—in part intentionally and in part by chance—become more embedded in the dominant cluster region and less embedded in their own. Just as Dahl and Sorenson note that social ties can cause individuals to be attached to locations where they have lived, social ties can also cause them to move away from these locations. Entrepreneurs find it difficult to access the information and resources they require when they reside far from the sources of these valuable inputs (Sorenson 2003). Eventually, social agents will reach a tipping point, where the value of their distant ties outweighs the value of their geographically similar ties, and the entity will make the rational decision to move. This dynamic is self-reinforcing, as the best and brightest (seeking to maximize their chances of success) continue to tie themselves to the more successful cluster, partly to compensate for the fragmented social structure of their locale. However, in so doing they perpetuate, and perhaps aggravate, the situation in their own region.

Studies of different regional technology and venture capital industries have shown these regions to have varying amounts of success. One study showed Silicon Valley's relative success over Boston in the venture capital industry. Silicon Valley exhibited more collaboration among VC firms, a larger number of investments and amount of money that stayed local, and a different structure of industry ties. Seventy percent of VCs in Silicon Valley were connected to other VCs, compared to only fifty-four percent in Boston. Also, Silicon Valley VCs had 2.81 ties on average, while Boston VCs had only 1.53 (Castilla 2003). A historical study of the biotechnology industry in San Diego showed that the management team of an early San Diego company initiated links through labor mobility that have continued to the present, allowing San Diego to exhibit a great degree of embeddedness. From data for management teams from 1978 to 2005, it was shown that by 2005, ninety-five percent of the individuals were included in the main component, with an average path length of 4.2 for the 867 individuals (Casper 2007). A study of Boston's dedicated biotechnology firms found that forty-three percent of those firms were in the main component in 1988, while seventy-two percent were in the main component in 1999. The study also showed benefits to innovation as a result of changes in local centrality (Owen-Smith and Powell 2004).

The basic assumption of most researchers on clusters who analyze them as an independent unit is that over time, with the addition of more resources, individuals, firms, and organizations, the local structure will become denser and a true industrial community will emerge. We argue the opposite: It is specifically because clusters are part of a national and international system that, in view of the fact that few dominant clusters already exist, the actual dynamic will be the recreation of social fragmentation. Locally, this social fragmentation over time should lead the aspiring cluster to reach the limits of its growth. When reproduced at a national level, we expect that such a dynamic will lead to the rise of a few dominant clusters, for which many aspiring clusters serve as satellites or feeders.

If our line of reasoning is correct, what we should expect to find in an aspiring cluster is that firms and entrepreneurs actively seek to embed themselves in the dominant cluster. They would do so through several mechanisms, aligning themselves with the status-granting organizations and individuals of the dominant cluster, where they serve as investors, board members, key customers, or strategic collaborators (Klepper 2001; Sorenson 2003; Klepper and Sleeper 2005).

Even without any active attempt at becoming embedded in the dominant cluster, a company located outside it may quickly find it is acquiring ties within the dominant cluster. Since some of these early connections extract major influence on the company's development more often than not these early ties quickly structure the company's networks (Castilla 2003). Furthermore, in the last two decades more and more VC firms have started to look outside their immediate surrounding for investment opportunities (Sorenson and Stuart 2008). However, once they locate such an opportunity many times they actively encourage their newly invested company to locate geographically propinquus to their headquarters (Fried and Hisrich 1994).

Hence, in the case of information and communication technologies (ICT), in which clear dominant clusters have been established for several decades, our arguments would lead us to expect to find a particular pattern of continuing, or even worsening, social fragmentation in the aspiring clusters. Furthermore, we would expect to see this fragmentation occurring at all levels of the ICT industry in both small and large companies, even globally successful ones, and across all facets of meaningful social interaction, such as investors or critical customers.

In addition, we expect to find similar patterns at the individual level, where the forces leading to cross-cluster embeddedness and local fragmentation might be stronger. The reason is that by operating or being embedded in a vibrant technology cluster-embedded region, individuals significantly decrease their career risk by creating numerous alternate employment options should a given startup fail or dismiss them. According to Casper, this dynamic leads already successful technology clusters to develop what Bahrami and Evans have termed “recycling mechanisms” to help preserve the value of human and physical assets previously committed to failed enterprises (Bahrami and Evans 1999; Casper 2009). This helps explain why within successful clusters leading scientists and managers would give up secure careers in established companies and university labs to work at highly risky, if potentially lucrative, startups. This is another reason that embedding in the networks of the dominant cluster becomes increasingly enticing to individuals who start firms in other locales. At its most extreme, it should lead to career patterns in which founding or managing a company in an aspiring cluster is a career advancement mechanism by which entrepreneurs tie themselves to the more dynamic labor markets of the dominant cluster.

One of the best, and probably most rational, strategies to overcome the disadvantage of locating elsewhere is for companies and individuals to tie themselves to the dominant cluster. Following this strategy on a large scale, however, leads to systemic and chronic social fragmentation of the local ICT industrial community, which in turns leads local companies and individuals to tie themselves ever more closely to more established clusters. This is a self-reinforcing sequence that leads the aspiring region to a development trajectory of a feeder cluster.

Thus, we argue that ICT cluster emergence in the United States in the past four decades has been extremely rare, not because other regions lack factors and resources that would encourage clusters' emergence, but because of the national (sometimes international) socio-business dynamics of the industry.

Research Methods and Data

Atlanta, Georgia, offers particularly rich empirical ground for a theory framing exercise. The area is abundantly endowed with all the resources deemed necessary for cluster formation: (1) The metropolitan area has numerous renowned universities and is the fourth richest in research investment in the country in absolute dollar terms; (2) It is home to a large highly educated labor pool; (3) It has a wealth of new technologies and entrepreneurs; (4) Atlanta attracts the young "creative" class from across the United States, with a net inflow of 25- to 34-year-olds from 44 of the 49 largest U.S. metropolitan areas; (5) In both absolute and per capita terms, the city is rich in venture capital (VC) financing; (6) It has a history of having several companies grow to global prominence in the respective niches; (7) Atlanta has the country's fifth-largest concentration of Fortune 500 companies, after only New York, Houston, Dallas, and Chicago, and it has consistently been in the top five since 1996. This high concentration of Fortune 500 companies ensures a strong local sophisticated demand for technology and can anchor their ICT suppliers in the area by serving as a leading customer; and (8) local policymakers are known for their sustained efforts at cluster development, which includes specialized programs to attract star scientists and amply fund them, dedicated incubators, multiple mentorship and entrepreneurial education programs, and well-established public-private technology associations (Taylor 2008).

Atlanta has played a prominent role as a case study in the development of modern social networks, power, and structure, so it is appropriate to use it as an example in social structure arguments about the concentration of economic power in the United States (Hunter 1953).

However, despite these strong positive characteristics, Atlanta's technology industry growth is, at best, stagnant, as can be seen in Figure 1. As Figure 2 illustrates, more than 40 percent of the new technology companies that achieved commercial success and secured institutional VC investment left Atlanta within a few years of being founded. In addition, Atlanta had only had five technology IPOs from 2001 to 2011, and none since 2005.

<<Insert Figure 1 and 2 about Here>>

We use a confluence of research methods within a single-case study to flesh out the dynamics of our theory, elaborate on the mechanisms, and present a real case to support our theory. To analyze the evolution of Atlanta's ICT industry and its rise and stagnation over time, we used multiple data sources to determine the composition of Atlanta's technology industry, build a dynamic history of its development path, success, limitation, company growth patterns, and its social structure. First, aggregate data of the technology industry in Georgia were gathered. The Dun and Bradstreet (D&B) Million Dollar Database and Southeast Innovations data have been merged to create a list containing most of the technology companies in Georgia(D&B). The

Southeast Innovations database was compiled by Innovations Publishing as a list of “privately owned investment-worthy companies” located in the Southeast (Innovations Publishing LLC). Because the D&B Million Dollar database includes mostly large companies and the Southeast Innovations database includes mostly small, new companies, we obtained a fuller picture of the current state of the industry in Atlanta by merging the two. The combined dataset includes 431 companies from Southeast Innovations, 412 companies from D&B, and 12 companies that appeared in both. Additional aggregate data were obtained from the County Business Patterns from the U.S. Census Bureau (U.S. Census Bureau).

We complement our analysis with a few narrow samples, which allow us to focus on specific mechanisms in cases that might have a high number of total relationships due to the success or promise of the company or industry. We created two different samples of the overall ICT industry and one niche-specific sample. The two overall samples were constructed using the *Atlanta Business Chronicle* annual publication of a “Book of Lists” (Atlanta Business Chronicle 1998-2008). For the first list, we used the top 25 VC-raising companies by quarter, which provides for each company the dollar amount of investment (summed across all investments in a given company in a given quarter), nature of business, city where the company operates, and names of investors for each company/quarter listed. We cleaned the aggregate sample, so it would contain only technology-development ICT companies, analyzing the complete nine years available (1999 through 2007) and added investors’ cities and states, the number of companies and deals (listed) for each investor, the current companies’ status and location (acquired, moved, still in Georgia, or no longer in business; as well as their current physical location and, if acquired, what company acquired them), the total amount raised by each company (includes only quarters when the company was in the top 25), number of investors in each company, number of Georgia-based investors for each company, years in which each company made the top 25, and NAICS and SIC codes for the companies.

The second list was compiled using the *Atlanta Business Chronicle's* "Tech 50" list, which enumerates the 50 best technology companies of the year in Atlanta. For each company, this list includes the rank, name, web site, and year established, as well as whether the company is public or private, for 1998 through 2002, 2005, and 2008 (Deloitte & Touche and Arthur Andersen originally compiled these data).

Lastly we conducted a more focused analysis of the health information technology and emergency medical records sub-sector (HIT). This sub-sector was chosen not only because it has been targeted by the state of Georgia as the next promising and emerging industry to arise within the Atlanta region but also because it was recognized as the most likely technology sub-industry to consider Atlanta one of its most dominant locales worldwide. Indeed, the industry's leading international organization and action group—the Healthcare Information and Management Systems Society (HIMSS)—has its origins in Atlanta. Furthermore, the Georgia Institute of Technology, Atlanta's premier engineering school, has invested heavily in the development of the field for the past three decades and was helped in the recruitment of star scientists by the Georgia Research Alliance. We defined the industry using the list of 103 companies identified by the Enterprise Innovation Institute HIT initiative.

We developed two kinds of social networks to ensure robustness as well as to check different mechanisms through which cross-cluster embeddedness leads to local social fragmentation: career affiliation and interlock networks. A career affiliation network is one in which ties between members in that network (here limited to executive team members) are created when two or more members are jointly employed in the same technology company at the same time (Uzzi and Spiro 2005). This type of network is particularly useful and essential in the technology industry, in which job mobility is considered a particularly important factor in a location's success as a cluster in the industry (Saxenian 1994; Fallick, Fleischman et al. 2006; Casper 2007).

To construct the career affiliation networks, we consulted companies' web sites, news articles, and the Internet Archive to determine the names and positions of the management team and members of the board of all the companies in 2000 and 2008. Career histories were compiled for these individuals as far back as could be found (1980 in some cases) until the present. The career history data were gathered from SEC filings, web searches, and LinkedIn. Where possible, data were cross-checked to ensure accuracy. Dyadic ties between executives are created through joint employment at the same company at the same time. In this way, ties can be created between companies only when job mobility occurs. When executives change jobs, they maintain ties with their previous company while gaining ties with their new place of employment. For this analysis, an assumption of the five-year decay rule was made, as has been used in previous studies of a similar nature (Uzzi and Spiro 2005; Fleming and Frenken 2006; Casper 2007). The five-year decay rule assumes that ties linking an individual to a company cease to exist five years after that individual moves to another company, unless the tie is renewed by subsequent employment. In the case of the HIT companies, similar data were collected on the full management teams of all 103 companies in the 2008 list. As the data from which to construct the complete sample of HIT firms in Atlanta circa 2000 were of significantly lower quality, we limited ourselves to 2008.

Apart from career affiliation, board interlocks have been shown to be one of the most important types of connections companies have and a straightforward way to provide for interorganizational collaboration and the transfer of knowledge between firms (Mizruchi and Bunting 1981; Mizruchi 1996). For example, Davis (1996), in a path-breaking study on the networks of Fortune 500 companies, showed that the type of interlocks has a marked impact on company behavior and that the most useful outside directors are other CEOs. Haunschild and Beckman have shown the influence of interlocks as a significant source of information on many critical firms' decisions, not least, mergers and acquisitions (Haunschild 1993; Haunschild and Beckman 1998; Beckman and Haunschild 2002). Marquis, in his influential work on social imprinting, has also demonstrated the usefulness of board interlock network analysis in historical tracing of local industrial dynamics (Marquis 2003). Similarly, McDermott pointed to the importance of firms' ties to other firms in cases of regional industrial upgrading (McDermott, Corredoira et al. 2007).

We used two software packages in our social network analysis—UCINET and Pajek, which are standard in social network analysis. For creating social network diagrams, Guess was also used. Within Guess, the Bin Pack and GEM algorithms were used to display the data. Finally, to better understand the dynamics of the industry and to be able to offer a richer conceptualization of the industry development and behavior, we conducted eighteen focused interviews with the founders of both public and private technology companies, heads of VC funds, state officials, and key academics.

The Rise and Stagnation of the IT Industry in Atlanta

As in Silicon Valley, Atlanta's technology industry has its roots in defense contracts. In 1941, Air Force Plant #6 was built in Marietta, an Atlanta suburb. In 1946, the Georgia Institute of Technology (Georgia Tech) expanded its graduate programs, starting the transformation that would lead it to become one of the nation's top four graduate engineering universities by the end of the twentieth century. In 1965, the formation of the Georgia Science and Technology Commission institutionalized innovation policy as one of the core pillars of economic development in Georgia.

Atlanta's first globally successful technological entrepreneurs were quick to follow. The two most celebrated companies—around which the ICT industry in metropolitan Atlanta was supposed to flourish and grow—were Scientific-Atlanta in hardware and MSA (Management Science America) in software. The two companies were formed in the 1950s and 1960s and continued to be key players at the national level in the technology industry through the 1990s and the 2000s.

In a classic story of the creation of technology startups, Scientific-Atlanta (SA) began in 1951 as a tiny university spin-off in defense-sponsored radar-related research that quickly expanded to its main source of growth—satellite and cable communication—and grew to become a multi-billion-dollar company. The company also became one of the main breeding grounds for new ventures, and CEO Glen Robinson became a leader of the local technology industry and an early promoter of policy initiatives, such as Georgia Tech's incubator – the Advanced Technology Development Center (ATDC). By 1999, SA had grown to 2,800 employees and $1.1 billion in sales. By 2005, SA, together with Motorola, was still the largest producer of set-top boxes for cable TV, employing 6,500 people in 70 countries with $1.9 billion in sales (Scientific-Atlanta 2005; Scientific-Atlanta 2005). However, in 2006 SA was acquired by California-based Cisco Systems for $6.9 billion and became the mainstay of Cisco's Video Technology Group (Atlanta Business Chronicle 2008).

MSA was founded in 1963, by five Georgia Tech graduates as a bespoke contract programming company. In 1971, MSA went bankrupt, and John P. Imlay became the CEO. Within a decade MSA became the largest software applications company in the world, listing publically on NASDAQ in 1981. However, MSA was unable to change its products and business model to fit with the ongoing transformation from mainframe to personal computing (PC) and in 1990 was acquired for $333 million (slightly above its annual revenues), by Dun & Bradstreet (Computer History Museum 2007; Atlanta Business Chronicle 2008). Nevertheless, the influence of MSA and John Imlay on the development of the technology industry in Atlanta has continued. Imlay Investment, run by MSA's former CFO Sigmund Mosley, has been Atlanta's premier seed and angel capital fund.

In the 1980s, Atlanta-based companies were prominent worldwide in the data communications technology industry. Digital Communications Associates (DCA) controlled the PC-to-mainframe market with their its hardware called IRMA, which was one of the top five largestbest-selling products in the PC industry in the 1980s. SA controlled the set-top box market;; Hayes

Microcomputer Products topped the modem market;; and Microstuf lead the modem software market with Crosstalk, a communications program that became the industry standard for modem modem-to to-computer communication. With this combination of companies, Atlanta was the leader in data communications companies for in both hardware and software. However, this dominance did not last long with: all All the above above-mentioned companies either going went bankrupt or being were acquired, without and noa new wave of local data communication companies to taketook their place; , eeven when at the a time when the data communication industry as a whole became one the fastest fastest-growing global ICT markets with because of the advent of the Internet (Reid 1986; Yates 2010).

In conjunction with the early success stories of the technology industry, by the late 1970s Georgia Tech became known as the nexus of new technology initiatives, and the university's role in Atlanta's economic development became a focus for city leaders. This role was institutionalized by the end of the 1990s with the development of Technology Square—a site on the corner of Fifth and Spring streets, where the state's development agencies, Georgia Tech Enterprise Innovation Institute, ATDC, and the Georgia Tech College of Management are located. Policy initiatives to develop the local technology industry continued at an accelerated rate after the 1980s, when Atlanta developed the capacity to incubate start-ups through ATDC, local sources of VC, and a few established technology firms. In 1998, the Metro Atlanta Chamber of Commerce formally envisioned Atlanta's future as a high-technology city by establishing the "Industries of the Mind," a five-year campaign to recruit and create new technology firms (Combes 2002; Taylor 2008). In 1990, a major milestone in securing a long-term commitment to the creation and sustainment of a local "knowledge economy" was reached with the establishment of the Georgia Research Alliance.

Atlanta enjoyed a successful early history in fostering leading international companies in both hardware and software. Nevertheless, even with these early successes and the growing number of policy initiatives, Atlanta's technology industry has stagnated in the past decade, as seen in Figure 2.

Even a brief analysis of the industry reveals the rapid decline of Atlanta's large technology companies. As shown in Figure 1, very few large technology companies remain in Atlanta, the number is steadily decreasing, and even those that have had global success have been acquired by non-Georgia companies. The number of technology companies in Georgia in 2006 was less than half that in 2000. In interviews, industry leaders appeared to be acutely aware of the problems that this situation creates for continuous growth of the industry.

This pattern of companies' being acquired by out-of-state corporations is not the only source of attrition for Atlanta's technology companies. Companies have also moved their operations out of Atlanta for other reasons. For example, Appcelerator, founded by Jeff Haynie and Nolan Wright in 2006, left only two years later.

Although all players agreed that Appcelerator held a lot of promise—and the founders maintained close ties to the community—the firm was not funded by local money but by a Menlo Park (CA) VC. The reasons for this differ according to who is asked: local VCs took too long to put a deal on the table or did not have enough connections to offer, or cared far more about finance than ideas. In 2008 Appcelerator moved to Mountain View, California, because Haynie believed that by doing so he could take advantage of every option possible to help Appcelerator succeed. Moving there would offer an advantage because the area is "the heart of where things are happening today with a set of partners that have done it over and over again" (Haynie 2008).

The decline and stagnation of Atlanta's ICT industry is even more surprising as it coincided with the biggest increase in the availability of all the factors considered desirable and necessary for a technology industry to prosper. Atlanta has continued to expand as a locus of research, becoming the four-richest metropolitan area in terms of R&D dollars invested. Even in terms of VC financing, Atlanta compared favorably with all other emerging ICT clusters, such as Austin and the Research Triangle in North Carolina (PricewaterhouseCoopers ; Commerce 2006). The following analyzes the reasons for the flight of Atlanta's ICT industry, despite its positive attributes.

Results

All our analyses point to the same result: Atlanta's ICT industry is extremely socially fragmented. The number of local ties embedding companies in the area is significantly lower than one would normally expect from a random sample of similar companies in the same locale. This result is even more surprising because in Atlanta many of the companies' founders graduated from the same school, Georgia Tech.

Furthermore, as our theoretical framework predicts, promising companies tend to leave the cluster (due to either relocation or M&A) during their rapid growth stage. Finally, as suspected, over time the industry's social fragmentation is worsening across all dimensions of companies' social networks.

We started by analyzing the social structure of the overall ICT industry network. As can be seen in Figure 3, few ties are created through interlocks, with most of the industry being isolates. Furthermore, the overall structure is extremely sparse and fragile. Most of the connections are singular, that is, the movement or death of one individual would break the component. Accordingly, our analysis revealed an industry suffering from extreme social fragmentation and a low level of local embeddedness.

<<Figure 3 about here>>

Even when we added the interlock network of the overall ICT network shown in Figure 4 to investors (with ties to companies in which they invested) and lawyers (with ties to companies to which they offer services), the network remained sparsely populated, with a low number of multiple connections and low density, as seen in Figure 4.

<<Insert Figure 4 about here>>

We then looked at our various sub-samples. Analysis of the board interlocks of both the most promising and most successful companies showed a similar illustration of local fragmentation. Even the addition to the sample of Fortune 500 companies did not change the network structure. Figure 5 shows the connectivity present through board member interlocks among and between the highly successful companies and Fortune 500 companies. Even in this sample of elite companies, it is rare for board members to sit concurrently on boards of multiple companies.

Only five of the forty-six highly successful companies (11%) for which we acquired data have interlocks with Georgia-based Fortune 500 companies. Only seven of the forty-six (15%) have interlocks with other highly successful Georgian companies.

Similarly, as seen in Figure 6, the same fragmentation is present in the board interlocks of the population of highly promising Atlanta companies. Even though we would expect to see a high number of board interlocks between these VC-invested companies, since venture capitalists are considered crucial local embedders, the same level of fragmentation was found. Only twenty-eight of the seventy-three companies (38%) are connected at all.

<<Figure 5 and 6 about here>>

Nonetheless, board membership interlock analysis might not fully represent the most dynamic domains of cross-company social networks, so we added career affiliation networks to the analysis. Figure 7 shows the social network diagram of the career affiliation network of both the most promising and the most successful companies for the most recent year available, 2008, and clearly indicates a low level of connections between companies. The vast majority of companies shown are isolated. Of the sixty-one companies for which career histories of executives were available, only twenty-seven had connections to any other companies on the list. The majority of individuals are not connected to any individuals other than those with whom they worked in 2008. This is an unusual result in networks of this type (Uzzi and Spiro 2005; Casper 2007; Casper 2009).

<<Figure 7 about here>>

However, one alternative explanation for this finding is that the set of firms we are investigating is too diverse. Accordingly, we conducted the same analysis with respect to the HIT sub-sector, finding that the career affiliation social network in that industry is, if anything, even more fragmented. As seen in Figure 8, only 9.6% of the executive team members of Georgia's HIT companies were included in the largest component of the network (20 of 208). Only twelve HIT companies in Atlanta are connected to any other HIT companies through career mobility ties.

<<Figure 8 about here>>

This social fragmentation was observed by many of our interviewees. For example, a venture capitalist who invests in Atlanta and other markets addressed this fragmentation in an interview:

> In general all of the relationships I'm setting up … none of them are with Atlanta-based companies. … I don't see the law firms who are really reaching out … and the accountants are the same way. That whole ecosystem just seems to be missing, which I think in the Boston and California areas is critical for getting money; a lot of that infrastructure appears to be missing in Atlanta.

What accounts for such severe fragmentation? To answer this question, we looked at the data to see whether any specific patterns emerged. Because investors, specifically VC investors from out of state, have been repeatedly called crucial in the literature as well as in our own interviews, we looked first at their role, focusing our analysis on the sample of highly promising companies. The list included specific records of 364 different investors, but many VCs are mentioned multiple times since they have been involved in several big deals. A total of 814 VC investment events are listed for the period 1999 to 2007. Of these, 157 represented deals with Georgia venture capital firms and 657 were with VC firms outside Georgia. Of the 144 companies receiving VC investment, *only six received all their investment from Georgia-based sources*. In order to determine whether funding for more promising companies came more often from VCs outside Georgia, we ordered the location of investment by the rank of the technology companies on the list, with nine companies at each rank. As seen in Figure 9, higher-ranked companies on list of top VC deals had a smaller number of investors from Georgia.

<<Insert Figure 9 about here>>

Georgia-based investors were active in 157 deals, California investors in 125, New York and New Jersey investors in 105, and Massachusetts investors in 101. These three regions, the two dominant ICT clusters and the main financial industry hub, were by far the largest investors in Georgia-based technology companies. The next-most-frequent investor state was Pennsylvania, with 32 deals.

This behavior differs markedly from that in the dominant cluster. Silicon Valley companies famously do not seek VC that originates outside the Valley (Florida and Kenney 1990; Kenney 2000). Yet technology companies in Georgia clearly act as if they should find at least one investor outside the state. Ninety-six percent of the highly promising companies had at least one out-of-state investor (138 of the 144). Of the thirteen companies listed on the Top 25 VC Deals lists that relocated to California, six had been the recipients of California-based VC investment (46%). In the complete sample, only 57 of 144 companies had received California-based investment (40%). In an interview with the authors, one individual heavily involved in Atlanta's technology industry provided context and helped to explain this phenomenon:

> A lot of the best companies don't even look for money in Atlanta. They purposefully look for lead investors outside Atlanta for the reason that they don't believe that the Atlanta venture [capital] community has the network necessary to bring intangibles to the party. Now they typically will allow or elect to have a local VC in the syndicate of investment but very few are being led by local VCs.

After investigating investment ties, we tried to determine whether our analysis of individuals' level of embeddedness is valid. In order to better understand how executives at Atlanta ICT companies became tied to other regions, we gathered data on the location in 2010 of executives of companies that had been considered promising in 2000. Of the 232 individuals for whom data could be found, 60 (28%) are no longer in Georgia. Their most common destinations were California (12.5%) and New York (9.4%). As job mobility in our sample was 66 percent lower than the U.S. computer industry average, such a high degree of migration of already successful executives out of the cluster is especially significant, suggesting that, for many, a job change also means leaving the Atlanta region (Fallick, Fleischman et al. 2006). This finding is strengthened by analyzing the location of board members, with the result that they often also relocated to more dominant clusters. Of the seventy-one board members of the "most promising companies" for whom locations could be ascertained, 32 percent had left Georgia.

We concluded that the fragmentation was also affected by the period of a company's growth cycle. Specifically, our analysis indicated that as companies reached their rapid expansion phase, after they have already maximized the benefits of their locale and cemented key relationships (such as those with customers, board members, and investors) with the dominant cluster, there was an acceleration of relocation of firms from the aspiring cluster to an already dominant one.

Within three years of receiving their major VC investment, more than 40 percent of these highly promising companies left Atlanta, as shown in Figure 2. Of the fifty-one companies on this list that have left Georgia, thirteen are now in California, eight in New York/New Jersey, and seven in Florida. No more than three companies relocated to other regions. In addition, the median age of VC-invested companies that have left Georgia is six years, or in the middle of what is typically the rapid expansion phase at successful technology companies.

The critical importance on these relocations of social connections, especially of out-of-state VCs, is widely understood in the industry, and it was repeatedly commented upon by our interviewees. A prominent leader of the industry who sits on several boards went as far as to comment:

> "Today I did a great service to Atlanta. I convinced a local high potential start-up to accept a local VC funding and decline one from Menlo Park. Had they taken the investment from Silicon Valley, by next year they would not have been in Atlanta, they would have moved stock, lock, and barrel to the Valley. These decisions on local versus out of state VC investments are crucial to the development of the company, do the founders become part of Atlanta, or do they pack and leave the region" (authors' interviews).

To determine whether our theory about the historical self-reinforcing process that leads to this fragmentation has merit, we analyzed the career affiliation networks of the most promising and highly successful samples in about 2000, as well as the board member interlocks of Fortune 500 and highly successful ICT companies. Figures 7 and 10 illustrate social network diagrams of the career affiliation networks of the most promising and highly successful companies for 2000 and 2008, respectively. The network shows less connectivity among companies in 2008 than in 2000. The fragmentation in connectivity of Atlanta's technology industry has been increasing over time.

<<Figure 10 about here>>

The same results appear in board interlock networks. As can be seen in Figures 5 and 11—board interlocks between and among highly successful ICT and Fortune 500 companies—social fragmentation does appear to have worsened. In Figure 11 (ca. 2000), one can see that a cluster primarily of Fortune 500 companies existed. Some of the highly successful ICT companies are also connected to this cluster. However, in Figure 5 (ca. 2008), these interlocks have largely disappeared.

<<Figure 11 about here>>

As our analyses indicate, the reality is that the industry's social fragmentation has persisted and probably even worsened across several domains. Hence, Atlanta's ICT industry is locked in a self-reinforcing dynamic that prevents it from coalescing and emerging as a coherent industrial community—a true cluster.

Conclusion

Embeddedness has been the focus of intense research in the past three decades, and we now understand its critical importance in socioeconomic life. Much of the research treats embeddedness as local in its formation and effects. Nowhere has this been more apparent than in the study of industrial clusters. Nonetheless, there is growing awareness that, with the increased globalization of economic activities, cross-cluster ties and influence are extremely important, although research on their influence is still lacking. Such research is critical for understanding many of the most theoretically important questions of socioeconomics and for designing policies on pressing matters that take embeddedness into account.

The emergence of new ICT clusters has been one of the most important questions in recent decades. This paper proposes a new way of thinking about the failure of clusters to emerge, arguing that we must understand the interlinked dynamics between cross-cluster embeddedness and local social fragmentation. By so doing, we return to the debate about cluster development two understudied factors. First is the need to inculcate a historical and dynamic understanding of ICT industrial development at the national level. Second is the fact that clusters do not develop in isolation. Hence, following in the footsteps of recent studies by Whittington et al., Powell, and Saxenian, among others, we argue that cross-cluster social relationships are crucial as local social relationships in the development trajectory of aspiring clusters (Klepper and Graddy 1990; Powell, White et al. 2005; Saxenian 2006; Kogut, Urso et al. 2007; Powell, Packalen et al. 2009; Whittington, Owen-Smith et al. 2009). With this cross-cluster embeddedness viewpoint in mind, we argue that the best explanation for the non-emergence of new ICT clusters is the influence exerted on aspiring clusters by the dominant clusters already established. Consequently, while locally focused analysis might tend to see these failures and successes as independent occurrences, our analysis comes from a national perspective, which sees these failures as integrally related to a national industrial system that consists of dominant and feeder clusters.

To support our theory, we have presented evidence from Atlanta's ICT industry. Atlanta is a region richly endowed with all the factors deemed necessary for industrial success, coupled with a long history of innovative policy implementation as well as early global leaders in the industry, yet it has nonetheless seen its ICT industry stagnate without the emergence of a coherent cluster. In conducting this analysis, we also show the merit of combining a few social network analysis techniques—namely, career affiliation and directory lists—when trying to explain the coevolution of social dynamics and structure. This multinetwork analysis approach, which aims to scrutinize the various ways in which embeddedness affects economic outcomes, has rarely been employed, and therefore this paper contributes to the well-established field of social network research. Thus, this paper should be regarded as a first step in multiple future research trajectories.

Our findings suggest two main avenues for public policy. First, new policies should be adopted that encourage and cement physical embeddedness by facilitating information sharing, securing critical beta sites and anchor customers, collective learning, access to resources, and business community building. Some examples of this could include incentives for local venture capitalists to invest in local companies; collaboration between large or medium sized local companies and small local companies that is beneficial to both parties; and creation of opportunities for companies to find local suppliers, customers, and labor.

Second, new policies should be adopted that slow or eliminate the need for cross-cluster social interactions. Venture capitalists that wish to invest in the region can be encouraged to open a local office prior to any investment. Incentives can be created to encourage companies and individuals that are footloose to stay in or move to the region. Perhaps a new set of institutions, anchored around a major organization in the community, will need to be created expressly for this purpose. Increasing local embeddedness ensures longevity in return on investment and enables transformation of these investments into successful local entrepreneurial ventures.

Taking both research and policy implications into account, two of the most promising domains for future research are, first, a comparative study of clusters and the interlinked influences between their social networks and industrial agents such as entrepreneurs, firms, and financiers.

Recent research, of which this paper is part, has revealed the critical influence of cross-cluster interaction on regional and local development. A fuller development of this literature will require the gathering, compiling, and analysis of data on cross and comparative clusters' social networks. Our theories can be developed only so far in the absence of solid and rich empirical data.

A second avenue for future research is further investigation of whether cross-cluster interactions are indeed the main driver of cluster development trajectories. If our assumptions are correct, we should see the influence of cross-cluster interaction on a panoply of ICT development, such as labor market movement, social legitimization and status-granting influences, and business model diffusion. Moreover, while in this paper we focused on the influence of such interactions on aspiring clusters, exploring the influence of such interactions on dominant clusters and their sustainability provides fertile ground for theory building and empirical research.

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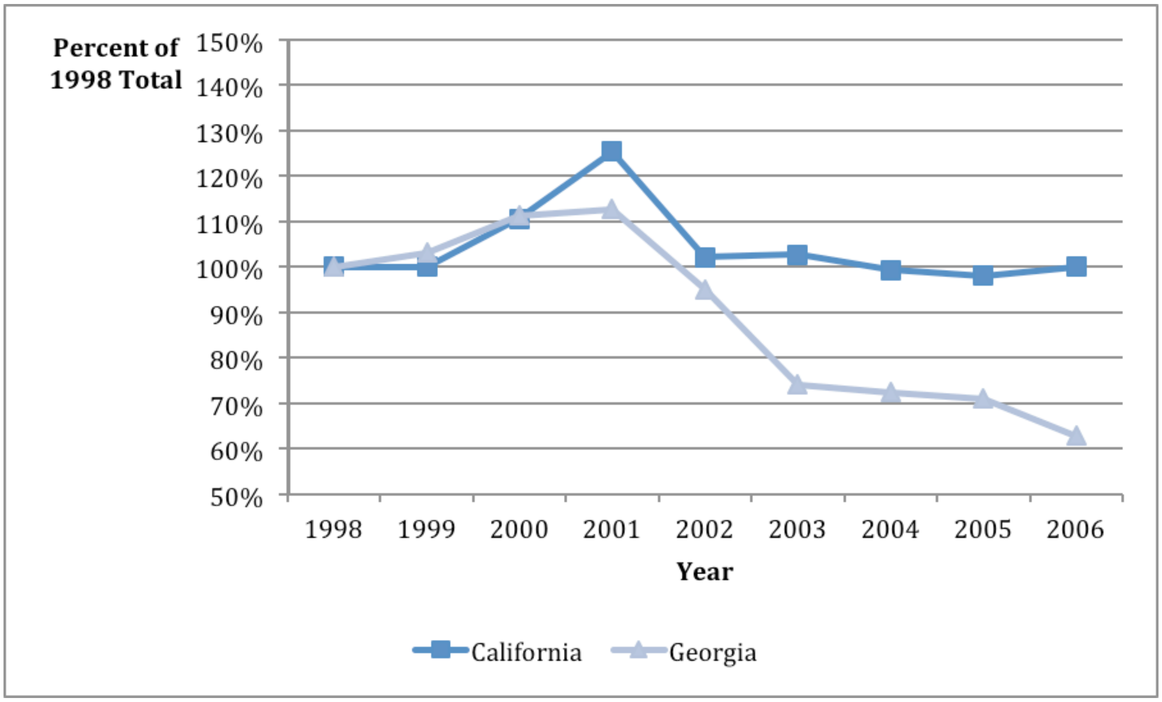
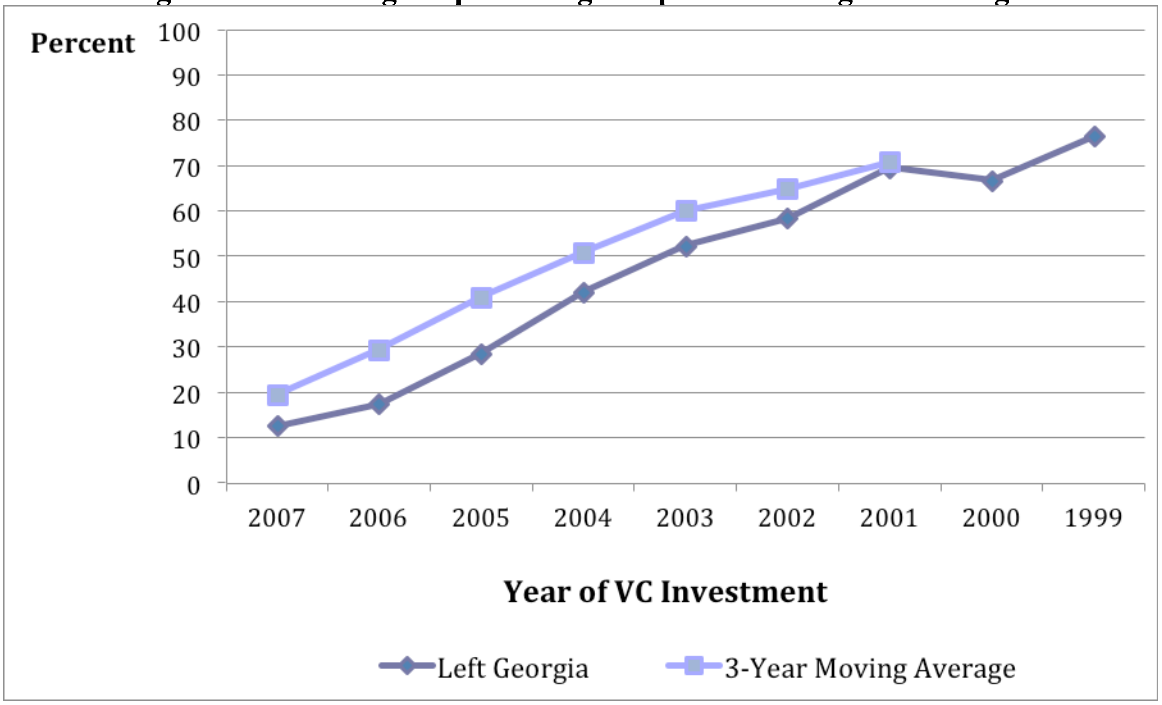
Figures

Figure 1: Technology companies with 250 or more employees, 1998-2006



Source: County Business Patterns (U.S. Census Bureau).

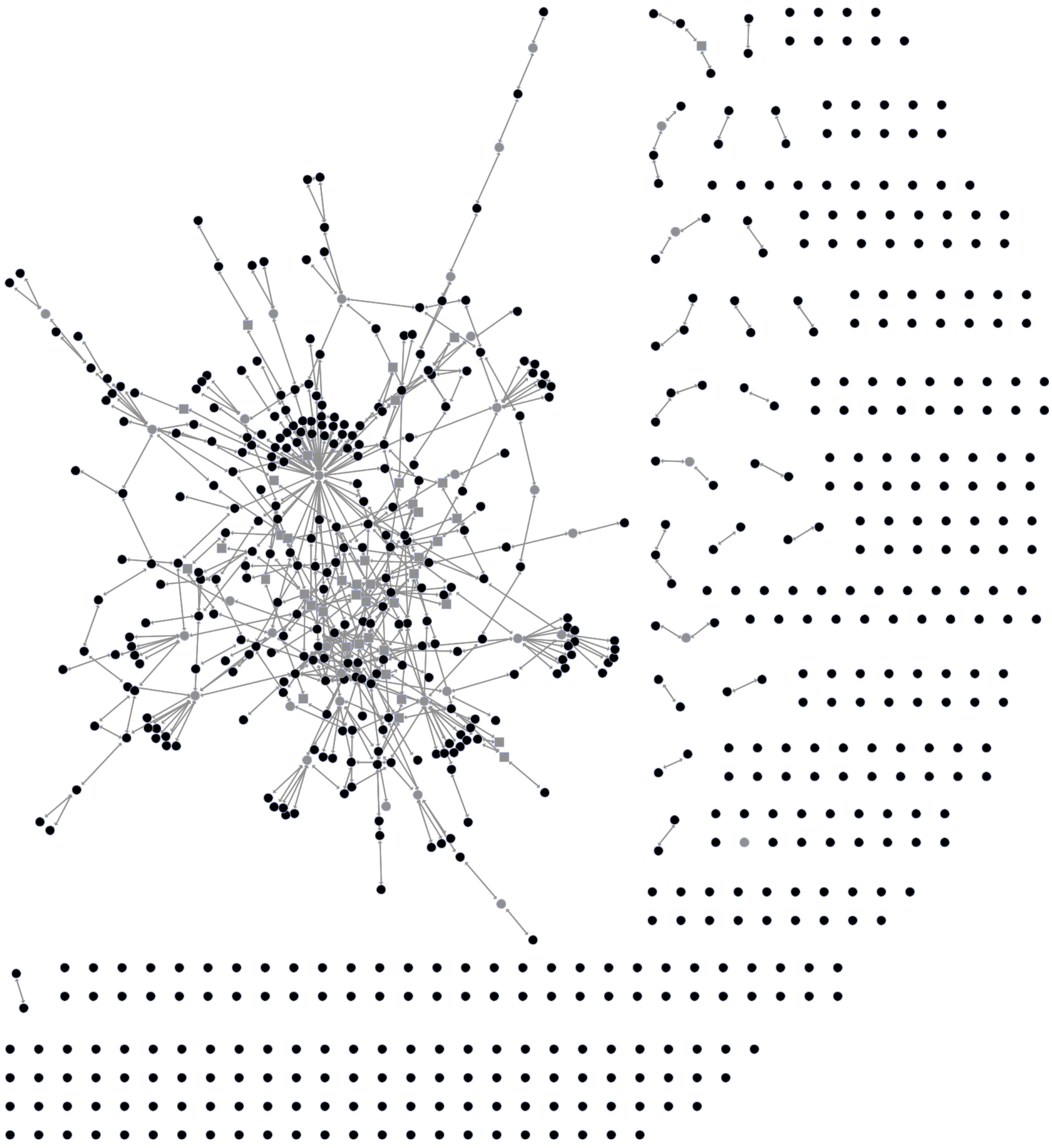
Figure 2: Percentage of promising companies no longer in Georgia



Source: Atlanta Business Chronicle; Internet Archive (Atlanta Business Chronicle, 1998-2008).
Data collected in October 2008.

Figure 3: Interlocks network in Atlanta's ICT industry, 2008

Figure 4: Interlocks network including investors and law firms of Atlanta's ICT companies, 2008



Legend: *black circles:* companies, *grey squares*: investors, *gray circles:* legal

Figure 5: Interlocks network most successful (black circles) and Fortune 500 companies (grey squares), 2008

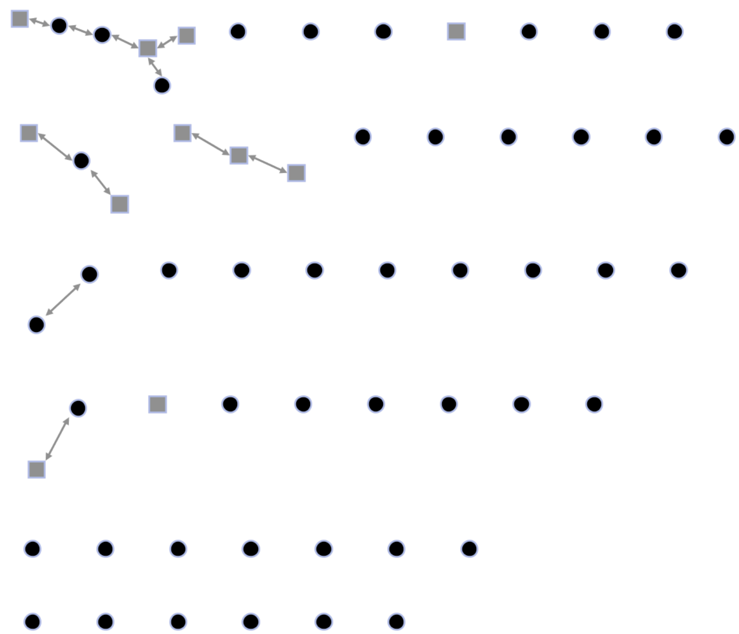


Figure 6: Interlocks network most promising companies, 2008

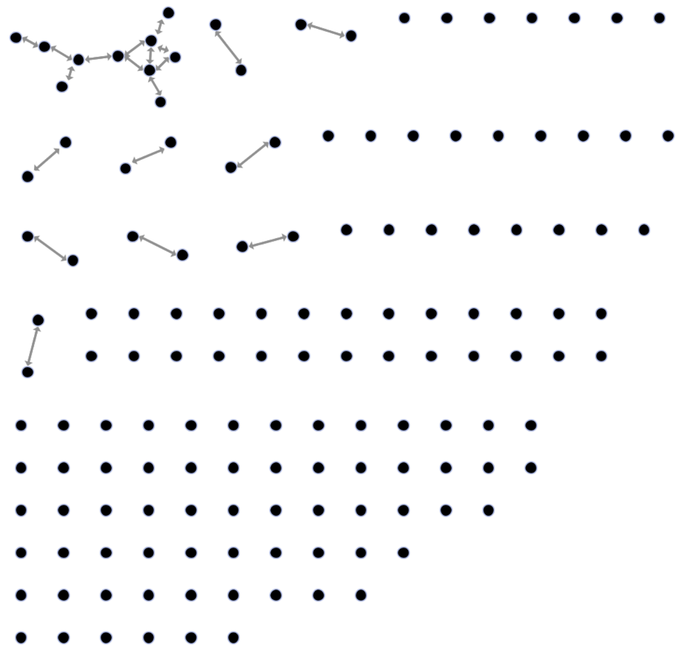


Figure 7: Career affiliation network most promising and highly successful, 2008

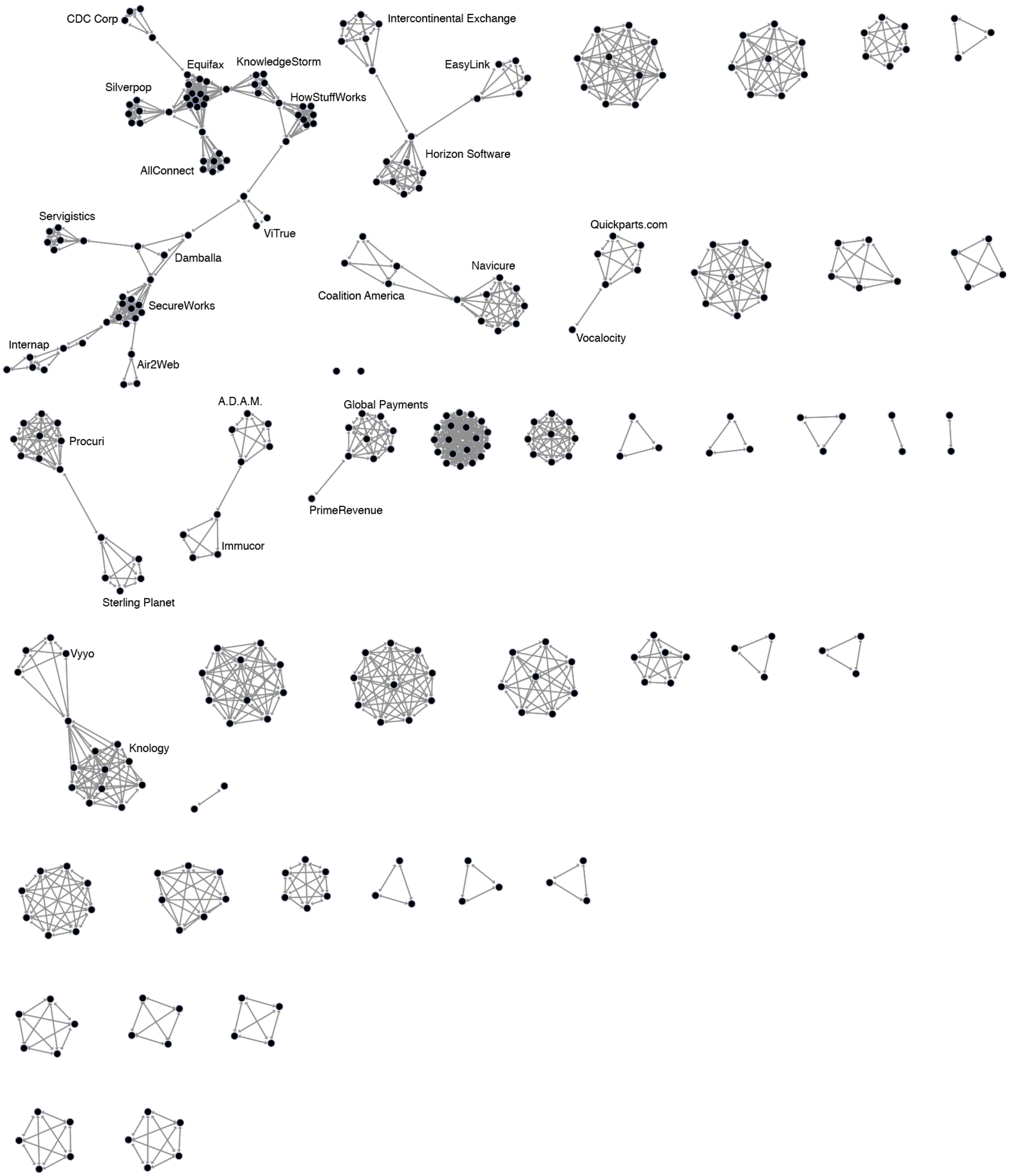


Figure 8: Career affiliation network of Atlanta health information technology (HIT) companies, 2008

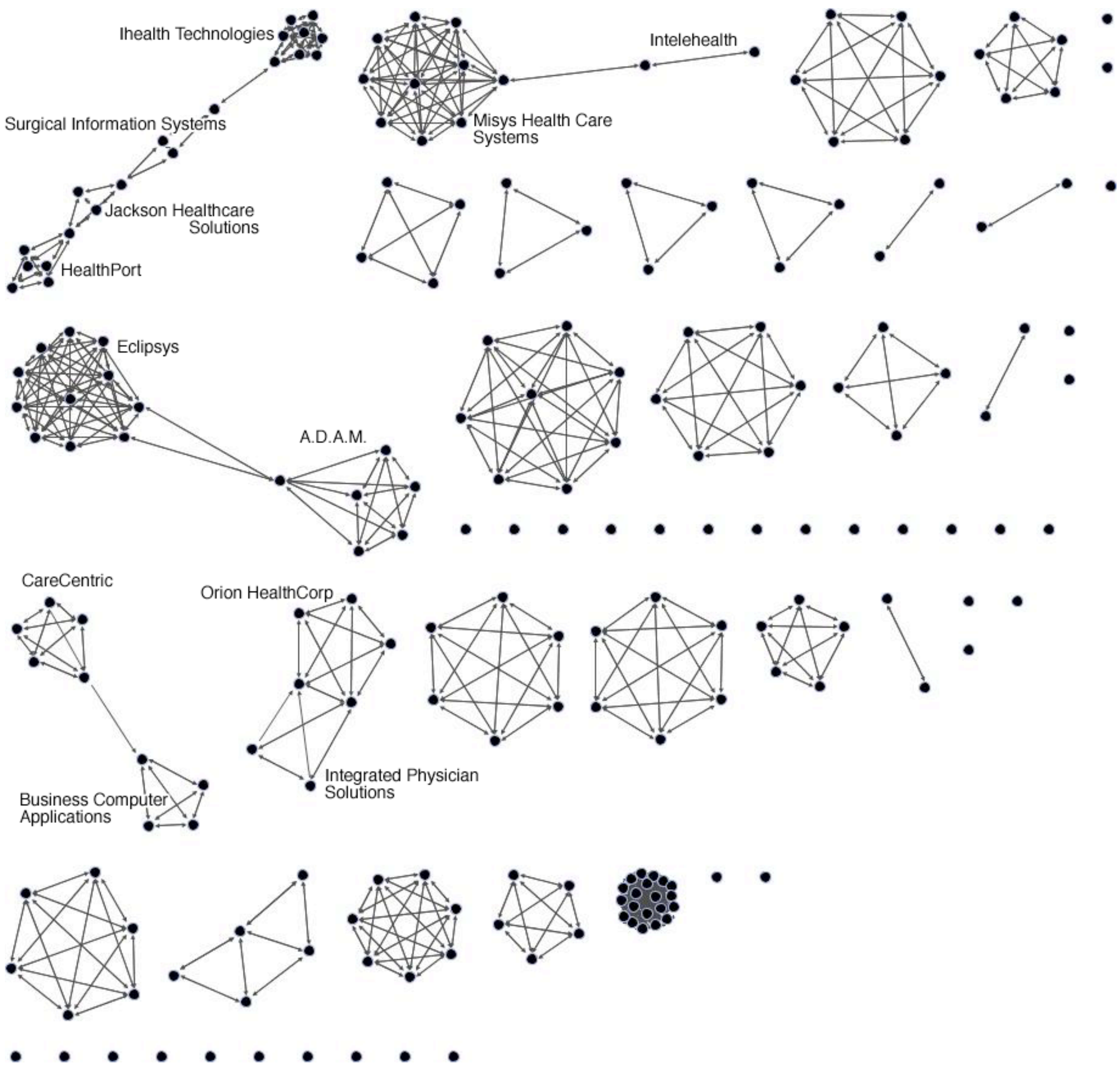
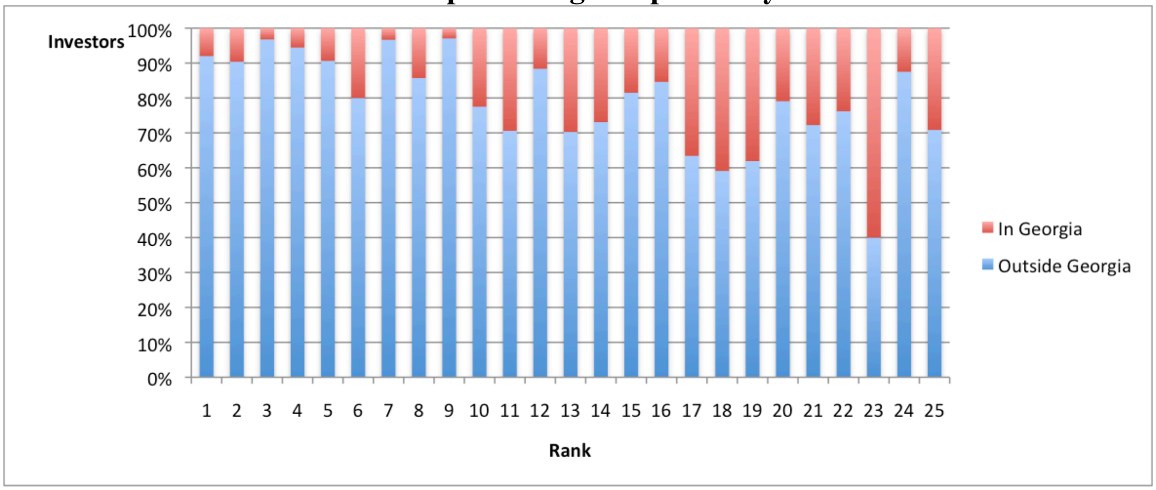


Figure 9: Investor locations of most promising companies by rank 1999-2007



Source: Atlanta Business Chronicles, annual book of lists, 1999-2007.

Figure 10: Career affiliation network most promising and highly successful, 2000

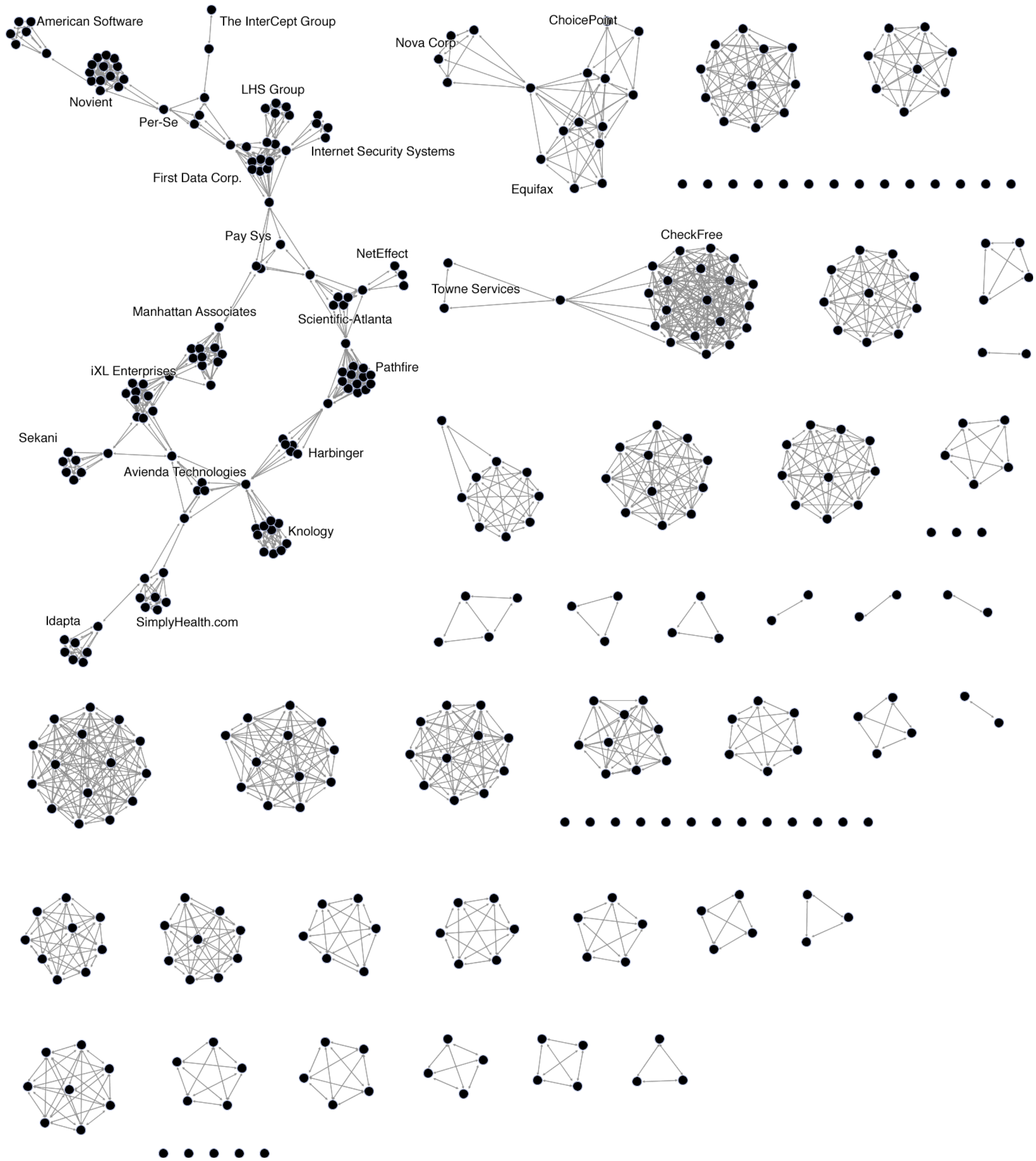
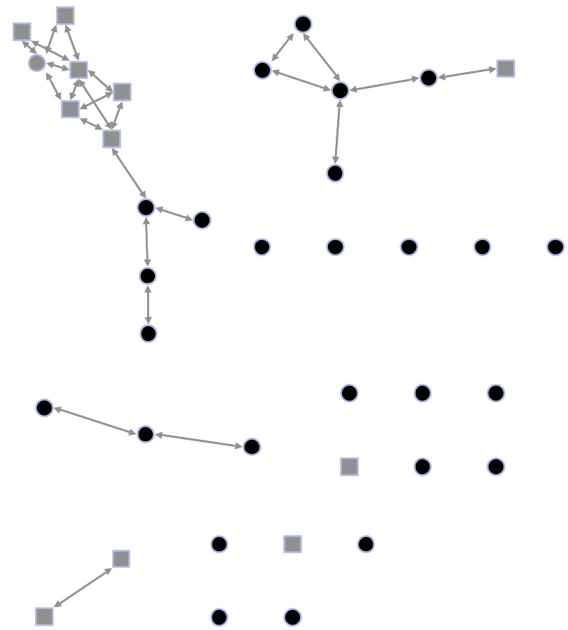


Figure 11: Interlocks network highly successful (black circles) and Fortune 500 companies (grey squares), 2000



Note: Bell South is depicted as a grey circle because it appeared in both the Tech 50 and Fortune 500 in 2000.