The Communal Roots of Entrepreneurial-Technological Growth?  
Social Fragmentation and the Economic Stagnation of Atlanta’s IT Cluster

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Abstract

Why do some entrepreneurial high technology industrial clusters grow and prosper, while others stagnate? Even after several decades of research, we have yet to have a definitive answer. One of the main debates in the literature revolves around the importance of societal variables, such as the growth of a cohesive community, versus the importance of factor availability, such as the supply of highly-educated labor. Employing a critical case study design utilizing a multi-method research strategy to analyze the IT industry in the Atlanta metropolitan area, this paper shows that while the availability of certain factors might be necessary, without the crystallization of a cohesive social structure, they are not sufficient. More specifically we argue that unless a local high technology industry develops rich multiplex locally-centered social networks, which embed companies in the region, cluster development will stagnate. This is true even if the region is extremely rich in all the factors identified as growth inducing in the literature.

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Introduction

Why do some entrepreneurial high technology industrial clusters grow and prosper, while others stagnate?

Even after several decades of research, we have yet to have a definitive answer. One of the main debates in the literature revolves around the importance of societal variables, such as the growth of a cohesive community, versus the importance of factor availability, such as the supply of highly-educated labor or specialized venture financing. In this paper, utilizing a multi-method research strategy, we show that while factors availability might be necessary, without the crystallization of a cohesive social structure, it is not sufficient. Therefore, societal variables are crucial for long-term entrepreneurial-technological economic growth. More specifically we argue that unless a local high technology industry develops dense multiplex locally-centered social networks, which embed companies in the region, cluster development will stagnate. This is true even if the region is extremely rich in all the factors identified as important in the literature.

The extensive body of research analyzing the growth of entrepreneurial clusters can be roughly divided between two main research themes: factor-focused and structure-focused. Factor-focused researchers’ main efforts have been to look across clusters to try to identify the factors that are necessary for the development and sustaining of such technological-entrepreneurial clusters, be these factors physical, such as a leading research university (Bresnahan and Gambardella 2004; Breznitz 2007; Phan et al. 2008), less tangible, such as a critical mass of the “creative class” kind of labor (Florida 2002), or historical endowment, such as a few early successful entrepreneurs (Klepper 2007). The main assumption of this literature has been that if we would manage to discover these factors, a locale can concentrate its efforts on
acquiring them and, if successful, achieve a flare of entrepreneurial activity leading to rapid and sustained economic growth.

On the other hand, structure-focused research pays less attention to the particularities of factors and more to the structure of relationship between agents, be they firms, individuals, associations, and government within the cluster (George and Bennett 2004; Huang and Hwang 2004; Keeble et al. 1999; Lester and Piore 2004; Locke 1995; McDermott 2007; Morgan 1997; Piore and Sabel 1984; Putnam 1993; Safford 2009; Saxenian 1994). The main aim of this literature has been to define the ideal business/social structure, implying that sustained growth and success is tied more to the locale’s social-institutional structure than to the availability of specific factors.

This paper aims to answer the debate between these two research streams, and find out which of the two is not only necessary but also sufficient to induce sustained regional technological entrepreneurship growth. Since perfect experimental conditions are unavailable in the real world we employ a critical case study design to help us overcome some of these limitations (Eckstein 1975; George and Bennett 2004; Gerring 2004; Gerring 2007; King et al. 1994; Ragin 1994; Ragin and Becker 1992; Yin 1994). To do so we identified and analyze a region that tops the US metropolitan areas in terms of factors availability, has a rich history in terms of its IT industry, and still failed to achieve sustainable entrepreneurial-technological growth. Such a design allows us to carefully check whether factors identified by prior research are both necessary and sufficient.

The Atlanta IT industry is an almost perfect match for such a design: The metropolitan area has a large number of universities, including two of the top US research universities; a large highly-educated labor pool; a wealth of new technologies and entrepreneurs; Atlanta attracts the
young “creative” class from across the U.S., with a net inflow of 25- to 34-year-olds from 44 of the 49 largest U.S. metropolitan areas (Commerce 2006); in both absolute and per-capita terms the city is rich in venture capital (VC) financing; and last but not least there is a wide spread belief in both academic and policy circles that Atlanta is considered a technology-focused cluster. However, despite these strong positive characteristics, we have found that Atlanta IT industry growth is, at best, stagnant (see Figure 1). Even within the sample of new IT companies that achieved commercial success and secured institutional VC investment, as can be seen in Figure 2 below, more than forty percent chose to leave Atlanta within a few years of their founding.

<Insert Figure 1 and 2 About Here>>

Analyzing multiple datasets, utilizing both quantitative and qualitative methods of inquiry, we conclude that the failure of the Atlanta metropolitan area to achieve sustainable growth of the IT industry is the result of a lack of embeddedness of these companies in the Georgia economy, which in turn is caused by the societal fragmentation of the industry. Extrapolating this finding to other clusters, we argue that without local embeddedness and the creation of a thriving community, cluster development stagnates. Therefore, without the nourishing societal conditions, factor availability might be necessary, but is not sufficient.

The paper proceeds as follow: In Section II we engage with theory, in Section III we discuss our data and methods, in Section IV we outline the rise of the IT industry in Atlanta, in Section V we perform a factor-based analysis of Atlanta, followed by a structure-based analysis in Section VI, we then conclude and discuss future research and policy recommendations.
Theoretical Background

The British economist Alfred Marshall, analyzing the rapid and sustained growth of British industry in the 19th century, was the first to note the importance of industrial clusters and economic agglomeration (Marshall (1890) 1920). There are two main economic arguments explaining why agglomeration is economically advantageous – the ready supply of specialized resources and services, and the rapid flows of information coupled with tighter long-term collaboration between agents. Since the end of the 1970s, both the economic explanations for agglomeration and the view of clusters as critical for sustained economic growth have been cemented. Accordingly, the amount of research devoted to unlock the secrets of their success has exploded (Antonelli 2000; Cooke 2002; Kenney 2000; Koepp 2002; Krugman 1979; Lawson and Lorenz 1999; Markusen 1996; Martin and Sunley 2003; McDermott 2007; Phan et al. 2008; Piore et al. 1994; Porter 1990; Safford 2009; Saxenian 1994).

Each of the two schools of thought, factor-based and structure-based, has a list of criteria it states are necessary for a cluster to form. For the factor-based argument, these characteristics include: a high-quality, powerful research university; skilled labor pool; funding; favorable policies; city characteristics; and historical luck (Braunerhjelm and Feldman 2006; Bresnahan et al. 2001; Cooke 2002; Florida 2002; Klepper 2002; Klepper 2007; O'Mara 2004; Smilor et al. 1989).

Universities are considered essential because of the spin-offs, educated labor, and new ideas they provide (Braunerhjelm and Feldman 2006; Breznitz 2007; Breznitz et al. 2008; Smilor et al. 1989). A highly skilled labor pool is claimed to be essential for technology companies to be successful and thus for a cluster to occur. Research has shown that for technology-based companies college educated 25- to 34-year-olds (sometimes referred to as “the young and
restless”) are the essential bracket needed to provide human capital for a region’s economic future (Cortright and Coletta 2006; Florida 2002). This bracket is the most mobile and can be most easily encouraged to work in a new industry. In order for a region to have a highly skilled labor pool, it is generally also necessary for that city to exhibit certain characteristics such as a high quality of life with a wide diversity of experiences on offer (Bresnahan et al. 2001; Cortright and Coletta 2006; Florida 2002).

The availability of finance in a potential cluster is also considered essential. In particular technology-focused Venture Capital was identified as important for the development of high technology industries. Because of the higher risk, long term needs, and the complexity of ideas, only specialized financiers that possess both detailed technological knowledge and financial and management skills, are argued to be able to successfully invest in new technological ventures (Avnimelech and Teubal 2004; Gompers and Lerner 1999; Kenney 2000). Accordingly, without them there would be lack of finance and specialized skills that would inhibit the growth of the industry.

It is exactly on this point – the importance of specialized information flows and collective action – that the debate between those who sees factors as paramount, and urge for a policy makers to follow the adage: “if you build it they will come” advising governments to focus only on the resource supply side, and those who see the composition of social structure and interaction as paramount come head to head.

There is no debate that clusters are especially important for technology transfer thanks to the enhanced collective learning and information transfer between agents (Breznitz 2005; Capello 1999; Cooke and Morgan 1998; Florida 1995; Herrigel 1994; Keeble et al. 1999; Lester and Piore 2004; Lundvall 1992; Morgan 1997; Piore and Sabel 1984). However, there is a fierce
debate between scholars who contend that such interactions are spontaneous and would happen, either quickly or slowly, once all necessary factors are in place, and these scholars which argue that without the correct societal conditions sustained growth will never be achieved, no matter what factors are made available.

The idea that the social-business structure of a cluster has significant influence on the development of clusters also has its origins in Marshall’s theories, and the notion that within a cluster you have knowledge “in the air” (Marshall (1890) 1920). However, in the last few decades this idea has been tightly woven with social capital and networks theories.

Social capital theory argues that the relationships that agents have with others, in the case of the individuals with family, friends, and acquaintances and in the case of a company with other companies and organizations, constitute an important asset (Coleman 1988; Granovetter 1985; Jackman and Miller 1998; Locke 1995; Portes 1998). This asset – the social capital – can be drawn upon and leveraged for material gains. Therefore, an agent is more social capital rich if they are embedded in many different relationships that they can utilize to achieve certain goals, for example access information, prospective customers, labor pools, or finance. Another important aspect comes at the macro level–the social unit. In this level high embeddedness, defined as multiple ties and associations within a particular population, facilitates collective actions and the efficient supply of public and semi-public goods, including the rapid dissemination of knowledge (Putnam 1993). Hence, a cluster rich with social capital is also a cluster rich in public and semi-public good as well as a cluster capable of quickly organizing itself to achieve common goals. In the case of specific industries, these goals can range from the positive goals of efficient supply of specialized finance and talent, to effective lobbying.
From the point of view of a region there are three mechanisms by which social capital is highly beneficial to the development and sustainment of industrial clusters: i) social capital allows individual companies to become more successful; ii) social capital allows the industry as a whole to thrive; iii) social capital embeds companies and key individuals tightly within the local community, making it significantly harder for them to leave the region.

The importance of such business/societal structure to the success of regional industries has been extensively documented. Saxenian compares Silicon Valley and Boston’s social and business structures and points to them as the difference between their levels of success (Saxenian 1994). Similarly, Florida and Kenney argue that the differences in success between the two regions can be attributed to the possibility that networks of small firms are more effective than large integrated companies (Florida and Kenney 1990).³

In the last two decades an important tool, social network analysis, which allows researchers to measure social capital by mapping and measuring the social structure, has seen tremendous advances. We now know not only how important are specific social network structures in enabling particular agents in specific nodes of the network to achieve certain goals and mobilize resources, but we also know what kind of structures are most suitable for regional economic growth in the case of knowledge extensive industries. For example, in the case of biotechnology, Powell et al noticed that while there were differences in the networks of the biotech industries in Boston and the Bay Area, both are characterized by organizationally diverse and structurally cohesive networks (Powell et al. 2005). Using network analysis of the industry in San Diego, Casper showed that due to labor mobility within the region, it developed a large

³ Recently Fleming and Frenken tested the claims about different social structures of Boston and Silicon Valley and found that while there were no general differences in collaboration networks, there is a marked difference between the greater inter-organizational networks in the two regions (Fleming and Frenken 2006).
network of managers that had been associated with multiple companies. This network maintained its efficiency over years and was robust to failure (Casper 2007).

In the case of industrial renewal, McDermott and his co-authors used network analysis to present how in order for a cluster to be successful firms need a “public-private” network, tying them to associations, cooperatives, schools, and publicly supported institutions. Accordingly, they contend that institutions can assist firms by providing them with better networks, allowing them to improve their capabilities, and providing access to knowledge sources (McDermott et al. 2007). In a different vain, Safford clarifies the argument that networks’ density, that is high number of connections, is the most important variable. Analyzing the cases Allentown and Youngstown he showed that more important than the mere density of the networks is “that the structure of social relationships facilitate interaction—and mobilization—across social, political, and economic divisions” (Safford 2009).

Consequently, from the structure-based theory point of view for a cluster to be successful, we expect the region to have cohesive networks that are rich with multiplex connections spanning social, political, and economic divisions.

**Method and Data**

In order to achieve a firm benchmark for our analysis we compare Atlanta’s factors’ availability to those of what we term “benchmark regions” chosen based on their similar emphasis on technology—The Bay area in California, Boston Massachusetts, the Research Triangle in North Carolina, and Austin Texas. To assess whether Atlanta has a skilled labor pool, we focus on the 25- to 34-year-old age bracket, which was found to be the most mobile, hardest working, and most likely to be choosing a new career (Cortright and Coletta 2006).
Within this age group, we will also analyze its education composition, comparing Atlanta to both the benchmark regions and the U.S. average.

We then compare Atlanta’s venture capital investment and R&D funding to that of the other benchmark regions, as well as determine a list of necessary policies and compare Georgia with the other four states. To measure city business and life quality characteristics, we will look at the number of Fortune 500 companies, general city characteristics, and standard of living. Lastly we analyze Atlanta’s unique “historical luck” including having, during the 1980s, at the same time the world’s largest software application company, MSA, and one of the world’s largest telecommunication equipment makers, Scientific Atlanta, by briefly describing the early history of the IT industry in Atlanta including the origin, rise, and fall of its major companies.

Due to data availability and the different manner of the arguments, structural characteristics are much more difficult to measure. In order to analyze the success and composition of the Atlanta IT industry we used multiple data sources. 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. The D&B dataset includes the contact information, sales, employment, line of business, type of ownership, North American Industry Classification System (NAICS), board of directors, and management team for each company. The Southeast Innovations database was compiled by Innovations Publishing LLC as a list of “privately owned investment worthy companies” located in the Southeast. This database includes the names of the companies, their contact information, year of establishment, employment, stage of operation, whether or not the company is profitable, industry sector, investment capital history, revenues, management team, advisors, and a summary of their business and product. Since the D&B’s Million Dollar database includes only large companies,
and the Southeast Innovations database includes mostly small, new companies, by merging the
two we had a fuller picture of the current state of the industry in Atlanta, the combines dataset
includes 431 companies from Southeast Innovations, 412 companies from D&B, and 12
companies that appeared in both. In order to ensure that we have not missed any significant firms
we then matched this database with the Bureau of Economic Analysis regional economic
analysis ES-202 dataset which includes all Georgia companies by both Standard Industrial
Classification (SIC) and NAICS, which allowed us to ensure that we include the complete
population of firms.

Following the Southern tradition of *debutante*, and to ensure that statistical noise does not
obscure the true social network structure of the industry, we created three different samples
which are specifically biased in order to show Atlanta’s IT industry in its best. The first list is
based on the Georgia Technology Timeline that was assembled for the Georgia Technology
Celebration in 2003 by Char Baxter(Char Baxter Communications LLC 2003). The timeline
charts companies that were deemed an essential part of the growth of technology in Georgia as
well as their children. In terms of data the timeline includes the industrial sector of each
company, its parent company (where applicable), name, founding year, and location of
establishment (city). It also includes events deemed important for the technology industry in
Georgia from the 1890s to the present. We investigated each of the firms in the list using
companies’ websites, news articles, and the Internet Archives to determine what has happened to
it since founding: whether they were acquired, moved, are still active in Georgia, or are no
longer in business, and where applicable the state the company moved to or the name and
location of the acquiring company.
Two other lists of Atlanta’s annual debutantes from 1999 to 2007 were constructed using the Atlanta Business Chronicle annual publication of a “Book of Lists.” The first list we used consists of the top 25 VC-raising companies by quarter. This list provides for each company the dollar amount of investment (summed across all investments in a given company in a given quarter), the quarter, nature of business, city of company, and names of investors for each company/quarter listed. We took the nine years available of this data (1999 to 2007) and added the cities and states of investors, the number of companies and deals (listed) for each investor, where the companies are now (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 (only includes quarters where 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. In addition we consulted companies’ websites, news articles, and the Internet Archive to determine the names and positions of the management team and members of the board, advisory board, and (where applicable) the scientific board.

The second list was compiled by using the Atlanta Business Chronicles “Tech 50” list, which celebrate the best fifty Atlanta tech companies of the year. This list includes for each company the rank, name, website, year established, and whether the company is public or private for the years 1998 through 2002, 2005, and 2008 (Deloitte & Touche LLP and Arthur Andersen LLP originally compiled these data). The criteria to be included were that a company must have its headquarters in Georgia (subsidiaries are not included), at least 50 percent of the company’s revenue must be the result of development, manufacture, distribution, and sales of a proprietary high-technology product or service or the sale of a proprietary product or service delivered using
high-technology. The list of most valuable public companies includes the rank, name, website, and city of each company for the years 2000 through 2008. For both these lists, we determined their board and management team in the years 2000 and 2008. The year 2000 was chosen since this was the last year before the dotcom technology crush, and hence, allowed us to show Atlanta at its very best.

For the two time periods we collected Tech 50 companies’ board members and management team—2000 and 2008—we also compiled a list of the Fortune 500 companies located in Georgia to determine whether any Tech 50 companies shared board members or management team members with the Georgians Fortune 500 companies. The Fortune website provided these companies’ ranks, names, stock symbols, revenues, and location. To this data we added names and positions of board members and management team members from the companies’ annual reports for both 2000 and 2008. We also looked at each debutante list and revealed the network of board member and management team interlocks among these companies and between these companies and the large non-technology companies in Georgia.

We build our social networks focusing around board membership due to the fact that in analyzing meaningful intra-business social network structure, board interlocks have been shown to be one of the most important connection companies have and a straightforward way to provide for the transfer of knowledge between firms. For example, Davis, in a path breaking study regarding the networks of Fortune 500 companies showed that the types of interlocks have a marked impact on companies’ behavior, and that the most useful outside directors are other CEOs (Davis 1996). Similarly, McDermott pointed to the importance of firms’ ties to other firms (McDermott et al. 2007).
Finally, in order to better understand the dynamics of the industry and to be able to offer a richer conceptualization of the industry development and behavior we conduct eighteen focused interviews with the founders of both public and private IT companies, heads of VC funds, state officials, and key academics.

The Rise and Stagnation of the IT industry in Atlanta

In a similar way to many other technology industries in the US, Atlanta’s IT industry has its roots in WWII defense contracts. In 1941, Air Force Plant #6 was built in Marietta, an Atlanta suburb. The plant trained a workforce of 28,000, helping to convince Lockheed Aircraft Company to manufacture there, and was the beginning of the still nationally leading technology manufacturing cluster in Atlanta. On the research side development soon followed the manufacturing. In 1946 Georgia Institute of Technology (Georgia Tech) expanded its graduate programs starting the transformation that would lead it to become one of the top four graduate engineering universities in the US by the end of the 20th century. In 1965, innovation policy was institutionalized as one of the main core pillars of economic development with the formation of the Georgia Science and Technology Commission.

Building on this rich ground Atlanta’s first globally successful technological entrepreneurs were quick to follow. The two most celebrated companies, around which the IT industry in the Atlanta metropolitan area was supposed to flourish and grow, were Scientific-Atlanta Inc. in hardware and MSA (Management Science America) in software.

In a classic story of the creation of the new IT startups, Scientific-Atlanta began as a tiny university spin-off in defense-sponsored radar-related research that grew to become a multi-billion company. Scientific-Atlanta was incorporated in October 1951 to manufacture and sell products developed at Georgia Tech and supply part-time work for some faculty and graduate
students (Combes 2002). Led by an extraordinary entrepreneur, Glen Robinson, the first and for awhile the only fulltime employee of the company, Scientific Atlanta survived its first years on the ability of Robinson to bring contracts and employ himself in various unrelated work, such as servicing equipment in local hospitals, to sponsor the company. Scientific Atlanta quickly expanded its business toward building antennas to test telecommunication equipment and then to its main source of growth—satellite and cable communication. The company also became one of the main breeding grounds for new ventures, and Glen Robinson himself became a leader of the local IT industry and an early promoter of policy initiatives, such as Georgia Tech’s incubator – the Advanced Technology Development Center (ATDC). By 1999, Scientific Atlanta grew to have 2,800 employees and $1.1 billion in sales. By 2005, Scientific-Atlanta, together with Motorola, was still the biggest set-top boxes for Cable TV employing 6,500 people in 70 countries with $1.9 billion in sales. However, it became clear that the firm was unable to expand its market and had significant difficulties selling its equipment to telephone companies, which were fast becoming dominant players in their quest for triple-play (Scientific-Atlanta 2005a; Scientific-Atlanta 2005b). Consequently, in 2006, Scientific-Atlanta was acquired by California-based Cisco Systems for $6.9 billion, and became the main stay of Cisco’s Video Technology Group (Chronicle 2008).

In 1963, the software company Management Science America, Inc. (MSA) was founded by five Georgia Tech graduates as a bespoke contract programming company. In 1971, MSA went bankrupt, and the main creditor brought John P. Imlay as the CEO in an attempt to salvage the company. Imlay quickly focused the company on mainframe products and within a decade MSA was the largest software applications company in the world and listed itself NASDAQ in 1981. However, MSA was unable to change its products and business model to fit with the on-
going transformation from mainframe to the personal computing (PC) and by 1990 was acquired for $333 million, or slightly above its annual revenues, by Dun & Bradstreet to became Dun & Bradstreet Software Services, Inc (Chronicle 2008; Museum 2007). Nevertheless, the influence of MSA and John Imlay on the development of the IT industry in Atlanta has continued to this day. Imlay Investment, run by MSA’s former CFO Sigmund Mosley, has become Atlanta’s premier seed and angel capital fund.

In conjuncture with the early success stories of the Industry, by the late 1970s Georgia Tech became known as the nexus of new technology initiatives, and the university role in the economic development of the city became a strong focus for the city leaders. This role was institutionalized by the end of the 1990s with the beginning of development of Technology Square—a site on the corner of 5th and Spring streets where the state’s development agencies, Georgia Tech Enterprise Innovation Institute (formerly known as the Economic Development Institute), ATDC, and the Georgia Tech College of Management are located. Policy initiatives to develop the local IT industry continued at an accelerated rate since the 1980s with Atlanta developing the capacity to attract entrepreneurs 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 lead to the creation of new technology firms (Combes 2002; Taylor 2008). In 1990, a major mile stone in securing the long-term commitment of the state to the creation and sustainment of a local “knowledge economy” was reached with the creation of the Georgia Research Alliance, and in 1999 the Yamacraw Initiative to fast track the building of the semiconductor industry in Atlanta commenced operations. Nevertheless, even with these early successes and the growing number of policy initiatives, as we have seen in
figures 1 through 4, the IT industry of Atlanta has stagnated in the last decade with many of the most promising young companies opting to leave the area altogether.

As we have seen, Atlanta had a quite successful early history in having globally leading early companies in both hardware and software. However, no sustained cluster seems to have grown in Atlanta. The size of the industry has not grown and as a matter of fact diminished; currently there is no local entrepreneurial technological company of consequence. Indeed, after MSA and Scientific Atlanta, only one company grew from Atlanta to briefly becoming a global leader in its niche – Internet Security Systems (ISS). The story of ISS repeats the pattern of MSA and Scientific Atlanta, a sole company growing alone to become a world leader in a new market niche, only to stumble and end being acquired without ever managing to become an anchor of a local IT cluster. It is therefore worthwhile to briefly visit ISS’s history before analyzing the current status of Atlanta’s IT industry.

In 1992, Christopher Klaus, then a student at Georgia Tech, released a freeware he called Internet Security Scanner. In 1994, he founded Internet Security Systems (ISS) and began selling Internet Scanner before being joined by Thomas Noonan in 1995. In 1996, the company received $3.6 million in its first round of venture capital from Sigma Partners Boston fund. In 1996 and 1997, the company developed more products, acquired additional venture capital, and opened offices in Belgium, Japan, the UK, and France. In 1998, ISS became public on NASDAQ and using its new financial muscle acquired several companies in the US and Europe. By 2004, ISS employed more than 1200 people in 20 countries, had revenues of $290 million, and its technologies were in use by over 12,000 organizations (iss.net 2007). However, ISS was never able to cement its position as one of the top three Internet Security companies and by 2006 opted to sell itself to IBM for $1.3 billion. The acquisition of ISS has also become a symbolic
low point for Atlanta’s entrepreneurial IT industry – since 2006 there are no longer any independent Atlanta IT companies listed on NASDAQ.

Indeed even a brief analysis of the industry shows the rapid and constant demise of Atlanta’s large IT companies. As shown in Figure 3 below there are only few large technology companies remaining in Atlanta, the number of large technology companies is steadily declining, and even those that have had global success were acquired by non-Georgia companies.

<<Insert figure 3 about here>>

In 2003, at the Georgia Technology Celebration, the “Georgia Technology Timeline”, a diagram showing famous Georgia technology companies and their spin-offs was presented (Char Baxter Communications LLC 2003). Those gathered believed that Georgia has indeed become a successful technology cluster. However, what they failed to recognize was the erosion of that cluster that still persist today. The history of these companies span decades, using the ones for which information could be found we have plotted Figure 4. Of these famous and important Georgian companies, only 52% are still located in Georgia. The other 48% have either moved out of Georgia or been acquired by non-Georgian companies.

<Insert Figure 4 about here>>

Nonetheless, even with both the overall state of the industry shown in figures 1 to 3 and the more self-selected important companies in figure 4, we felt that we need to consider a more recent and not self-selected sample of the most successful new Atlanta’s IT companies. For that reasons we compiled a graph of the complete population of Atlanta Business Chronicle’s list of “Top 25 Venture Capital Deals” for each year from 1999 to 2007. The result are, alas, similar
with 42% of the companies leaving Georgia as can be seen in figure 5 below. Notice that these companies were funded between 1999 and 2007, and hence 42% is probably significantly understating the amount of company leakage out of Georgia, a conclusion that is supported by the finding reported earlier in Figure 1 showing that more than 40% of the Top 25 VC backed companies leave Atlanta within three years.

<<Insert Figure 5 about here>>

It is interesting to see to where these companies move, as Table 1 shows the two main locations for these companies are California, the leading technological cluster, and the NYC/NJ area, the leading financial cluster. These two clusters are also prominent as sources for VC capital for Atlanta’s technology industry as can be seen in Table 2.

<<Insert Table 1 and 2 about here>>

It is therefore of interest to understand what led Atlanta’s IT industry from being one of the most promising clusters in the early 1980s to such continuous stagnation. The next two sections of the paper analyze the city and the industry in accordance to both the factor-based argument and the structure-based arguments in order to look for a likely explanation.

**Factor-Based Analysis of Atlanta**

*Research University*

As can be seen in Table 3 below, Atlanta certainly has a high-quality, powerful engineering-oriented research university in Georgia Tech, which has been constantly ranked one of the top ten public universities (currently number seven), as well as one of the top four engineering schools for both undergraduate and graduate education.
(U.S. News and World Report 2009). In addition Atlanta is the home to Emory University, whose medical school has a close connection with the Center for Disease Control (CDC) which is also located in the city, and the many science and technology-related programs at other universities around the metropolitan area. Therefore, Atlanta is richly supplied in terms of academic research and education.

<<Insert Table 3 about here>>

Labor Pool

As shown in Table 4, Atlanta’s young adult population is better educated than the urban U.S. average, with 36% of this bracket holding a 4-year degree or higher, compared to the national metropolitan average of 30%. While Boston and San Francisco outscore Atlanta on this statistic, Atlanta has shown great improvement over the past decade, increasing its population in this key bracket by 46.2% and increasing its market share by 0.796%. This is more than any of the other 50 largest U.S. metropolitan areas as can be seen in Tables 5 and 6.

<<Insert Tables 4-6 about here>>

Funding

Atlanta has seen no lack in funding. In terms of institutional venture capital investment Atlanta is on par with that of the Research Triangle in North Carolina and Austin, Texas, particularly in the start-up and seed stages of investment, as can be seen in Figures 6 and 7. The strength of Atlanta’s universities also contributes to funding for technology. With $731 million annually Atlanta has the 4th highest research expenditures in the nation (Commerce 2006).

<<Insert Figures 6-7 About here>>
City Characteristics

Atlanta is home to the 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. Metro Atlanta is home to 9 Fortune 500 companies; (Georgia is home to 11). In comparison San Francisco is listed only in the eleventh place in the ranking, and Boston does not even make it to the top nineteen (Fortune 2008). Atlanta’s main airport—the Hartsfield-Jackson Atlanta International Airport—is the busiest American airport and is the primary hub for both Delta Air Lines and AirTran.

Atlanta is the main city in the ninth most populous U.S. metropolitan statistical area with a total population of more than five million in 2007 (U.S. Census Bureau 2008). Metropolitan Atlanta has also been growing rapidly, with an estimated 24.3% of growth in just the last seven years. Atlanta ranks fourth on the Gay Index and fourteenth on composite diversity of the fifty metropolitan areas (Florida 2005). Indeed the gay pride parade in Atlanta is so prominent that firms such as Deloitte and Touche compete to be its major sponsors.

Atlanta was host to the 1996 Summer Olympics. Dormitories, Centennial Olympic Park, and the stadium that would later become Turner Field were built for the Olympics. The city is also home to the world’s largest aquarium, and has a central well kept park in the Piedmont Park which is a 189-acre park in central Atlanta and the home to the Atlanta Botanical Garden. For the arts, Atlanta’s organizations and venues include the Atlanta Symphony Orchestra, Atlanta Opera, Atlanta Ballet, Fox Theatre, the High Museum of Art, the Center for Puppetry Arts (the nation’s largest organization for puppetry), and multiple music venues. Georgia’s music industry is also substantial, with a direct revenue of $476.19 million and 6,091 jobs, as well as an economic impact of $997 million and 11,032 jobs (Rushton and Thomas 2005).
Jermaine Dupri’s So So Def Records and artists like T.I., Ludacris, and OutKast, Atlanta is known as the hip-hop capital of the south.

In terms of professional sports Atlanta has a team in each of the four major U.S. leagues: The Braves in Major League Baseball; The Atlanta Hawks in the National Basketball Association; the Atlanta Thrashers in the National Hockey League; and the Atlanta Falcons in the National Football League. Each of these teams has its own stadium, which not only doubles as a venue to major music concerts, but also ensures that Atlanta is annually home to major college sports events.

Summary

Looking at Atlanta’s richness among all these factors, it appears that Atlanta scores extremely high on each and every variable identified as important by factor-based theories. Yet despite being so factor rich, Atlanta has faced a prolonged and constant failure to form a viable technological-entrepreneurial cluster. Consequently, it seems as if factor-based theories do not hold the key for understanding. Therefore, we need to look for an explanation in a different set of theories. The next section considers Atlanta’s societal structure to determine whether it holds the key to explaining the puzzle of Atlanta.

Structure-Based Analysis of Atlanta

To discern the strength of Atlanta’s networks, we mapped the social networks and compare them to an ideal type whereby the majority of companies studied are linked to each other through multiple connections and with no “gatekeeper,” which if removed causes the network to fracture. In order for a successful technology cluster to arise in Atlanta, companies would need to become locally embedded and remain in the region.
Initially we analyzed the large sample including all the companies in our merged dataset. The data we had on these companies were incomplete, as many are private and preferred not to share with us which VCs had invested in them or what law firms they used. Nonetheless, after a few months of work we managed to construct the social network configuration for 691 companies shown below. As can be seen in Figure 8 the majority of companies do not have even one connection to any other company. We then added into the network their investors, on the assumption that even if the companies are not directly connected sharing an investor is a major secondary conduit. As Figure 9 shows adding the investors did not change the overall picture in any meaningful way. We then opted to add another important source of secondary connections and put the legal advisers of these technology firms into the analysis. The results, reported in Figure 10 revealed that even when we added both VC and law firms into the network the vast majority of companies are entirely un-connected and of these that are connected, 109 (fifty four percent of these with any connection) have only one connection, and only twenty nine percent of the companies have any company-to-company connections. The density of the network, that is the proportion of possible ties that actually occur, is 0.0019. As reported in Table 7, the mean degree of actors included in the analysis was 0.184, the mean closeness 0.224, and the mean betweenness 0.112.4

These results are as far as one can imagine from the ideal structure needed in a successful as it is depicted by theory, especially when we consider the long history and large number of technology firms in Atlanta.

<<Insert Figure 8-10 and Table 7 here>>

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4 Due to the large number of isolates, the closeness measure is imprecise. Also some of the companies did not provide their legal counsel and/or investors when surveyed.
Nonetheless, it might very well be that the reason we had such a fragmented network is that the overall sample suffers from statistical noise as it includes too many small companies that have yet to secure capital and get embedded within the larger community. We therefore moved to our debutante samples to allow the industry to reveal itself in its best. The first list we created and analyzed consists of the top venture capital deals from 1999 to 2007. Again the most striking finding is that the majority of the companies in this list of successful technology companies shared no board or management members with other companies on the list (see Figure 11—the points represent companies and the lines represent a shared board or management member between those companies). As important as these interlocks are, we would expect there to be more than twenty overall connections between 141 companies. It should be kept in mind that these are the companies that have reached a level of success in Georgia. These are the firms that have secured significant amount of professional VC funding without being asked to relocate out of Atlanta. The companies that have been less fortunate are not even included in the analyses.

<<Insert Figure 11 here>>

Therefore, based on the analysis so far we have to conclude that unfortunately for the industry and for Atlanta as a whole, most of these companies not only have to struggle alone, but also have nothing to embed them to the local community. Only a small percentage of these companies are connected to any other companies. Of those that are, the connections are few.

Nevertheless, while this is the list of the most promising technology companies in Atlanta, it might still be that these companies are too young to be truly part of the high technology industrial community of the city. Therefore, to double-check our findings, we analyzed our second, biased toward the already well established, debutante sample of technology firms – Atlanta’s best 50 technology companies. Alas, our mapping of the board interlocks of
the most valuable technology companies in Atlanta also reveals very few connections between them. In fact, the fragmentation and isolation of the industry is multi-faceted since many technology companies have no interlocks either with Fortune 500 companies or with other technology companies. These connections are far fewer and provide less embeddedness than the idealized networks of theory, or the networks found in other, more successful regional industries (Casper 2007; Fleming and Frenken 2006; Florida and Kenney 1990; Kenney 2000; Safford 2009; Saxenian 1994).

In order to ensure, yet again, that we have not in some way misrepresented the true social structure of the industry, we opted to compare our analysis of the current situation to the one in 2000, the year before the dot com technology bubble burst. The results, if anything, showed that the social fragmentation of the industry is becoming more severe as time progress. As can be seen in Figures 12 and 13, both the connections between technology companies and between them and Georgia’s Fortune 500 companies have decreased over time.

<<Insert Figures 12-13 here>>

As we have seen in Figure 3 earlier, large technology companies in Atlanta are becoming scarce. Also, the large companies that do exist in Atlanta do not have a history of investing in local technology or of acquiring local companies. While Atlanta’s past contains some major successes, those companies have ceased to exist, and hence, are not there to help new companies create new successes. While, as can be seen in Figure 14, Atlanta has a wealth of startups,

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5 For the year 2000, we found lists of board members and management teams for 27 of the Tech 50 and most valuable technology companies. For the year 2008, we found data for 46 of the Tech 50 and most valuable technology companies. There were 12 Fortune 500 companies located in Georgia in 2000 and 11 in 2008; board members and management were found for all of these.
entrepreneurs, new ideas, and funding, there is no social structure in place to help those companies grow while remaining in Atlanta.


<<insert Figure 14 here>>

Analyzing the societal structure of the technology industry in Atlanta has revealed that Atlanta’s technology companies are not embedded in a thriving local community. That societal fragmentation might actually be augmented, ironically, by the richness of Atlanta in the “Young and Restless” population age bracket. Just as these individuals did not feel ties to the area they came from (making them mobile in the first place), they seldom have any stronger ties to Atlanta. Ergo, they are still very mobile and prepared to move again if a good opportunity arises elsewhere. Atlanta companies are also not locally embedded by venture capitalists, one of the main loci of networks in Silicon Valley and Boston. In Atlanta, VCs often lack local connections that would help tie a company to the region. Since many of the VCs investing in Atlanta are out-of-state, even when they have essential connections, they are not local. Interestingly such societal fragmentation persisted even when Atlanta had several major IT companies operating from the city for a prolonged period of time. It is therefore becoming apparent that in Atlanta richness in resources has not enabled the high technology industry to overcome societal fragmentation and grow into a sustained technological-entrepreneurial cluster. Hence, from the public policy point of view, it might well be the time to focus more attention on the social structural variables if Atlanta is to gain the maximum economic growth benefits of its massive investment in physical and educational infrastructure.

Currently Atlanta’s start-up community provides good technologies and a good start for technology companies, but alone this is insufficient for cluster formation and sustainability. The
societal fragmentation of the industry means that when companies face an external incentive to leave Atlanta, they have no reason to stay. The ties that bind Atlanta’s high technology companies to the city are very sparse indeed.

**Conclusion**

Using a critical case study research design, employing both quantitative and qualitative methods to analyze Atlanta’s high technology industry this paper has shown that without social structure, no amount of excellent supply of factors would help. Resources are necessary, but insufficient for cluster creation and growth to occur. If a technological-entrepreneurial cluster is to arise new companies must have more reasons to stay in a location then to move. The most direct way to do this is by improving the social networks of the industry. A true industrial community, rich in social capital, must form to make Atlanta’s high technology industry thriving and “sticky” in the same time (Markusen 1996).

Nonetheless, a significant amount of future research needs to be done both on the relationship between business-social structure and entrepreneurial growth, and on the particular case of Atlanta. In terms of the first, an important venue for future research is comparing our finding in Atlanta with other potential emerging regions in the US. Such a research would allow us to answer to critical questions: i) are similar social structure common in other regions that experienced stagnation of technological entrepreneurship while bequeathed with factor richness? ii) Are the main causes for such structures internal to the cluster or part of the cluster’s interactions with the national and international environment? Indeed the second question leads to two critical questions with regards to the structure-based arguments – how do specific structures come into being, and how amendable are they to change? What are the interactions between social networks and the wider institutional environment in which they are situated? In the
specific case of Atlanta an historical process tracing analysis aiming to answer this question is especially promising since it can not only resolve central questions for social science, but also suggest a set of new policies to deliver growth.

In terms of the policy implication of this paper, it suggests that there are two main avenues for public policy. First, new policies encouraging information sharing, collective learning, access to resources, and business community building should be enacted. In the specific case of the Atlanta metropolitan area it might very well be that a new set of institutions, anchored around one of the major organizations in the community, such as Georgia Tech, needs to be created expressly for this purpose. In particular, attention should be given to ensure that current and future large Atlanta companies (technology or non-technology) are encouraged to maintain close connections within Atlanta’s high technology industry. On that front personal involvement of top executives from Atlanta’s leading companies is to be especially promoted.

A second venue of action for both Atlanta and other similar clusters would be to allow and stimulate the development of a more local VC industry. Since VCs are crucial in shaping the social network of the companies in their portfolio, spurring a closer embeddedness of the VC industry in the metropolitan area will be key factor in any efforts to grow a thriving technological-entrepreneurship community in the city. This is especially imperative in the case of Atlanta where the vast majority of investment is coming out of state.

The main finding of this paper – societal variables are as important, if not more so, for technological entrepreneurial growth as factor availability – is pertinent to the current economic crisis and policy formulation. If there is one lesson to be learned from the research we have done, it is that investing solely in physical infrastructure, and even in research, without ensuring the sustainment of the social structure that would enable these investments to be transformed into
successful entrepreneurial ventures, would yield only long-term disappointment. We contend, therefore, that it would behoove policy-makers to start thinking more seriously about the health of their business community and the ability of individuals and organization to succeed in economic undertakings while staying part of it, and mayhap to concentrate less on capital investment alone.
Figure 1: Technology as a Percent of Georgia Total, 1998-2006

Source: County Business Patterns (U.S. Census Bureau)
Figure 2: Percentage of VC-invested companies no longer in Georgia

Figure 3: Technology companies in Georgia with 1,000 or more employees

Source: County Business Patterns
Figure 4: Current location of companies listed on The Georgia Technology Timeline

Sources: Char Baxter’s The Georgia Technology Timeline; Internet Archive, current location as of 2008 (Char Baxter Communications LLC 2003).
Figure 5: Current location of companies listed on top 25 VC deals lists, 1999-2007.

Sources: Atlanta Business Chronicle; Internet Archive.
Table 1: Destinations of companies that moved out of Georgia or were acquired by a non-Georgia company

<table>
<thead>
<tr>
<th>Destination</th>
<th>Number of companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>13</td>
</tr>
<tr>
<td>New York/New Jersey</td>
<td>8</td>
</tr>
<tr>
<td>Florida</td>
<td>7</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>2</td>
</tr>
<tr>
<td>North Carolina</td>
<td>2</td>
</tr>
<tr>
<td>Tennessee</td>
<td>2</td>
</tr>
<tr>
<td>Virginia</td>
<td>2</td>
</tr>
<tr>
<td>Colorado</td>
<td>1</td>
</tr>
<tr>
<td>Kentucky</td>
<td>1</td>
</tr>
<tr>
<td>Minnesota</td>
<td>1</td>
</tr>
<tr>
<td>Nebraska</td>
<td>1</td>
</tr>
<tr>
<td>Oregon</td>
<td>1</td>
</tr>
<tr>
<td>Texas</td>
<td>1</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>1</td>
</tr>
<tr>
<td>International</td>
<td>8</td>
</tr>
</tbody>
</table>

Sources: Atlanta Business Chronicle; Internet Archive.
<table>
<thead>
<tr>
<th>Location of Investor</th>
<th>Number of Deals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Georgia</td>
<td>157</td>
</tr>
<tr>
<td>California</td>
<td>125</td>
</tr>
<tr>
<td>New York/New Jersey</td>
<td>105</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>101</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>32</td>
</tr>
<tr>
<td>Connecticut</td>
<td>28</td>
</tr>
<tr>
<td>Maryland</td>
<td>26</td>
</tr>
<tr>
<td>North Carolina</td>
<td>25</td>
</tr>
<tr>
<td>Illinois</td>
<td>23</td>
</tr>
<tr>
<td>Tennessee</td>
<td>22</td>
</tr>
<tr>
<td>Florida</td>
<td>20</td>
</tr>
<tr>
<td>Virginia</td>
<td>16</td>
</tr>
<tr>
<td>Minnesota</td>
<td>11</td>
</tr>
<tr>
<td>Texas</td>
<td>11</td>
</tr>
<tr>
<td>Ohio</td>
<td>10</td>
</tr>
<tr>
<td>Washington</td>
<td>10</td>
</tr>
<tr>
<td>Colorado</td>
<td>8</td>
</tr>
<tr>
<td>Alabama</td>
<td>7</td>
</tr>
<tr>
<td>District of Columbia</td>
<td>7</td>
</tr>
<tr>
<td>Michigan</td>
<td>6</td>
</tr>
<tr>
<td>Delaware</td>
<td>4</td>
</tr>
<tr>
<td>South Carolina</td>
<td>3</td>
</tr>
<tr>
<td>Utah</td>
<td>3</td>
</tr>
<tr>
<td>Indiana</td>
<td>2</td>
</tr>
<tr>
<td>International</td>
<td>50</td>
</tr>
</tbody>
</table>

Sources: Atlanta Business Chronicle; Internet Archive.
Table 3: R&D and graduate student figures, select universities

<table>
<thead>
<tr>
<th>University</th>
<th>R&amp;D Expenditure, 2006</th>
<th>S&amp;E and Health Grad Students, 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ranking</td>
<td>Thousands</td>
</tr>
<tr>
<td>Stanford</td>
<td>8</td>
<td>679,196</td>
</tr>
<tr>
<td>Duke</td>
<td>10</td>
<td>657,080</td>
</tr>
<tr>
<td>MIT</td>
<td>14</td>
<td>600,748</td>
</tr>
<tr>
<td>UNC-Chapel Hill</td>
<td>31</td>
<td>443,790</td>
</tr>
<tr>
<td>Georgia Tech</td>
<td>32</td>
<td>440,898</td>
</tr>
<tr>
<td>UT-Austin</td>
<td>33</td>
<td>431,398</td>
</tr>
<tr>
<td>NC State</td>
<td>51</td>
<td>330,936</td>
</tr>
</tbody>
</table>

Source: NSF (National Science Foundation 2005; National Science Foundation 2007)
### Table 4: College Educated Population, 2000

<table>
<thead>
<tr>
<th>Rank</th>
<th>Metropolitan Area</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Raleigh-Durham-Chapel Hill, NC MSA</td>
<td>45.2%</td>
</tr>
<tr>
<td>2</td>
<td>Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA</td>
<td>43.2%</td>
</tr>
<tr>
<td>3</td>
<td>San Francisco-Oakland-San Jose</td>
<td>41.3%</td>
</tr>
<tr>
<td>6</td>
<td>Austin-San Marcos, TX MSA</td>
<td>38.9%</td>
</tr>
<tr>
<td>9</td>
<td>Atlanta, GA MSA</td>
<td>35.7%</td>
</tr>
<tr>
<td>19</td>
<td>Charlotte-Gastonia-Rock Hill, NC-SC MSA</td>
<td>32.3%</td>
</tr>
</tbody>
</table>

Source: (Cortright and Coletta 2006), Table 21 [Atlanta]

### Table 5: Change in Market Share of College Educated Population, 1990-2000

<table>
<thead>
<tr>
<th>Rank</th>
<th>Metropolitan Area</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Atlanta, GA MSA</td>
<td>0.796%</td>
</tr>
<tr>
<td>2</td>
<td>San Francisco-Oakland-San Jose, CA CMSA</td>
<td>0.526%</td>
</tr>
<tr>
<td>5</td>
<td>Austin-San Marcos, TX MSA</td>
<td>0.329%</td>
</tr>
<tr>
<td>7</td>
<td>Charlotte-Gastonia-Rock Hill, NC-SC MSA</td>
<td>0.300%</td>
</tr>
<tr>
<td>10</td>
<td>Raleigh-Durham-Chapel Hill, NC MSA</td>
<td>0.292%</td>
</tr>
<tr>
<td>48</td>
<td>Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA</td>
<td>-0.488%</td>
</tr>
</tbody>
</table>

Source: (Cortright and Coletta 2006), Table 23 [Atlanta & Providence]

### Table 6: Change in College Educated Population, 1990-2000

<table>
<thead>
<tr>
<th>Rank</th>
<th>Metropolitan Area</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Charlotte-Gastonia-Rock Hill, NC-SC MSA</td>
<td>56.6%</td>
</tr>
<tr>
<td>3</td>
<td>Austin-San Marcos, TX MSA</td>
<td>56.2%</td>
</tr>
<tr>
<td>5</td>
<td>Atlanta, GA MSA</td>
<td>46.2%</td>
</tr>
<tr>
<td>9</td>
<td>Raleigh-Durham-Chapel Hill, NC MSA</td>
<td>37.1%</td>
</tr>
<tr>
<td>40</td>
<td>Boston-Worcester-Lawrence, MA-NH-ME-CT CMSA</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

Source: (Cortright and Coletta 2006), Table 22 [Atlanta & Providence]

[Note for tables: when a MSA or CMSA is not mentioned in a table, it does not qualify for either the top five or bottom five of the fifty largest metropolitan areas. Areas for the middle forty are included when provided in reports.]
Figure 6: Venture capital investment by stage, millions of dollars, 1995-2005

Source: PWC MoneyTree (PricewaterhouseCoopers)
Figure 7: Total venture capital investment, dollars per capita for the period of 1995 to 2005

Source: PWC MoneyTree
Figure 8: Social network of 691 Georgia technology companies

Sources: D&B Million Dollar Database, SEInnovations (D&B; Innovations Publishing LLC)
Figure 9: Social network including 42 investors of 691 Georgia technology companies

Sources: D&B Million Dollar Database, SEInnovations
Figure read: *white squares*: VCs, *black circles*: companies
Figure 10: Social network including 42 investors and 35 law firms out of 691 Georgia technology companies

Sources: D&B Million Dollar Database, SEInnovations
Figure read: white squares: VCs, black circles: companies, gray rectangles: legal
<table>
<thead>
<tr>
<th></th>
<th>Degree</th>
<th>Closeness</th>
<th>Betweenness</th>
<th>Eigenvector</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>0.184</td>
<td>0.224</td>
<td>0.112</td>
<td>-1.527</td>
</tr>
<tr>
<td><strong>Std Dev</strong></td>
<td>0.396</td>
<td>0.037</td>
<td>0.492</td>
<td>4.869</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td>141.069</td>
<td>91.342</td>
<td>86.129</td>
<td>-1172.696</td>
</tr>
<tr>
<td><strong>Variance</strong></td>
<td>0.157</td>
<td>0.001</td>
<td>0.242</td>
<td>23.710</td>
</tr>
<tr>
<td><strong>SSQ</strong></td>
<td>146.221</td>
<td>21.016</td>
<td>195.238</td>
<td>20000.004</td>
</tr>
<tr>
<td><strong>MCSSQ</strong></td>
<td>120.309</td>
<td>0.566</td>
<td>185.579</td>
<td>18209.359</td>
</tr>
<tr>
<td><strong>Euc Norm</strong></td>
<td>12.092</td>
<td>4.584</td>
<td>13.973</td>
<td>141.421</td>
</tr>
<tr>
<td><strong>Minimum</strong></td>
<td>0.000</td>
<td>0.130</td>
<td>0.000</td>
<td>-96.055</td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>7.953</td>
<td>0.239</td>
<td>11.692</td>
<td>0.000</td>
</tr>
</tbody>
</table>
Figure 11: Management team and board member connections between companies (top 25 VC deals 1999-2007)

Figure 12: Management team and board member interlocks, 2000

Source: Atlanta Business Chronicle Book of Lists; companies’ annual reports
Figure read: white square: Fortune 500, black circle: technology, gray circle: BellSouth
Figure 13: Management team and board member interlocks, 2008

Source: Atlanta Business Chronicle Book of Lists; companies’ annual reports
Figure read: white square: Fortune 500, black circle: technology
Figure 14: Number of technology companies in Georgia with 1 to 4 employees, by year.

Source: County Business Patterns
References


D&B Million Dollar Database.


Innovations Publishing LLC Southeast Innovations.


PricewaterhouseCoopers MoneyTree Report.


