

**A Tale of Two Innovative Entrepreneurial Regions:
The Research Triangle and Austin**

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Elsie Echeverri-Carroll^φ

Maryann Feldman^δ

David Gibson^φ

Nichola Lowe^δ

Michael Oden^φ

(Names are in alphabetical order)

^φUniversity of Texas at Austin

^δUniversity of North Carolina at Chapel Hills

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Introduction

A search in Google Scholars for the key words *research triangle*, *Austin*, *entrepreneur* yields 1,420 academic articles. Most of these articles, however, only note in passing the importance of these two high-tech centers along with well-known Silicon Valley and Boston's Route 128. There have been no comparative studies of the Research Triangle (RT) and Austin regions even as they are frequently identified as hot-technology spots after the more legendary larger Silicon Valley and Boston cases. As Herbing and Golden (1993) note, these two high-tech regions had their beginnings in the early 1950s, grew into national prominence in the 1970s, and are the two most spectacular success stories of the Sunbelt.

The Austin and Research Triangle regions are uniquely compelling as comparative cases. At a general level these two regions constitute rare instances of areas that built up strong technology-based agglomerations in smaller urban regions with more traditional manufacturing or service sector economic bases. In each region active government and public-private sector collaborations attracted initial technology based companies and laid the foundations for the rapid subsequent growth of locally-based firms and entrepreneurs. Beginning in the 1950s, government and civic leaders in each region began to aggressively pursue outside investment from large technology-based corporations and federal research institutions to seed technology-based growth. The long-term, strategic economic-development efforts of each region began to yield results only in the late 1960s, with major locations of federal research centers (in the case of RT area) and large technology-based corporations in both cases.

Both regions own their prominence to effectively attracting large, technology-oriented manufacturing facilities, developing and strengthening key supporting institutions (top-ranked

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research universities and non-profit organizations), sustaining successful public-private collaborations, and designing policies and incentives to attract and retain large multinational companies. Today, there are vibrant technology clusters in the RT region centered in biotechnology, computer software, and other high-tech services. Austin's technology specialization is concentrated in semiconductors and microelectronics manufacturing, but also software and high-tech services.

Public Use Microdata Sample (PUMS) 2010–2014 five-year estimates of full-time employment from the American Community Survey (ACS)² evidence the specialization of the Research Triangle region³ in life sciences industries—pharmaceuticals/medicine manufacturing and scientific research and development services—which together generated about 16 percent of high-tech full-time employment in this 5-years period. Similarly, these data illustrate Austin's specialization in semiconductors and computer manufacturing industries, which accounted for 33 percent of full-time high-tech employment during this period. Each region also sports a significant position in computer and data processing services, which constituted roughly 23 percent of high technology employment in this period.

The early expansion of large biotech in the RT area and of semiconductors and computer manufacturing in Austin, enhanced by later developments in the software industry, have spurred significant entrepreneurial activity in the regions. These regional entrepreneurial ecosystems have mainly benefited from the spawning of startup founders as large corporations have relocated here (Avnimelech and Feldman 2010; Gibson and Rogers 1994; Feldman and Lowe 2014, 2015). Our interviews, site visits, and data support conclusions from the entrepreneurial literature (Cooper 1985; Dahlstrand 1997, 1999; Meyers 2004) that incumbent technology firms are a crucial source of entrepreneurial founders in both regions, and in some technology sectors, more so than regional universities, government facilities or other anchor organizations. Each region developed a large cluster of entrepreneurial technology firms that had significant ties to large technology-based multinational firms. But the entrepreneurial spawning function of the large firms was strongly complemented by durable alliances between the private and public

² The multiyear estimates reduce variability in population sizes experienced in the one-year data files and are preferable for estimates of small populations or when the precision of estimates is more important than the currency of the data (U.S. Census Bureau 2010).

³ Using IPUMS, we defined the Research Triangle Region as including Chatham, Durham, Orange, and Wake counties for 1980–2011, adding Lee for 2012, 2013, and 2014 for the five-year estimate.

sectors that built key institutions —sector-specific research and economic development centers, incubators and university-industry partnerships— that accelerated the evolution of vibrant entrepreneurial ecosystems.

Despite intriguing similarities, the two regions have followed economic development trajectories that reflect significant differences in terms of technology-sectoral specialization, the role played by support institutions, sources of funding for entrepreneurs, the evolution of entrepreneurial networks, geographical dispersion, culture, and university–industrial research foci. Investigating these differences and developing a framework for comparing regional entrepreneurial dynamics will enrich our broader understanding of technology-based regional economic development. We propose that future research should integrate the work of research teams in Austin and the Research Triangle, which are been funded independently by the Kauffman Foundation. The two research groups are currently collaborating to understand their respective study regions and are working to align their efforts to build a similar database of firms, institutions, influencers, and policies to study the temporal development of innovative regional economies. The proposed study’s objective would be to compare regional entrepreneurial dynamics in both Austin and the Research Triangle over time and to develop a more nuanced theoretical understanding of the role of policy, intermediate institutions, entrepreneurial actions, and revealed comparative advantages in high-tech agglomerations. This kind of analysis will require using similar methodologies combining historical data with original data collection and structured interviews to understand differences in regional policies and institutions over time that lead to a similar output—a vibrant entrepreneurial ecosystem.

The objective of this report is to outline preliminary findings from our literature review, interviews, site visits, and data collection on similarities and differences of the two regional entrepreneurial ecosystems. Section one compares early industrial development histories of the two regions and connects them to the growth of regional specialization in specific high-tech industries. Section two presents data on high-tech full-time employment and self-employment (a rough proxy for entrepreneurial vibrancy)⁴ in Austin, the Research Triangle region, and the United States in 1980 and a multiyear estimate for 2010–2014. Section three focuses on

⁴ Self-employment status is based on the workers’ main job activity and includes owners of both unincorporated and incorporated businesses. See Fairlie and Robb (2010) for an analysis of the limitations of using self-employment data to measure number of businesses.

institutional differences across these regions. Section four expands our argument that by studying these two unique and well-recognized cases of rapid transformation into successful high-tech city-regions within a single country, we will be able to consider specific similarities and differences leading to generalizable conclusions and theory building that may not be apparent in single-case studies or in studies that compare and contrast more divergent regions.

Previous Studies of the Technology Clusters in the Research Triangle Region and Austin

When significant 1980's events served to bolster the growth of the respective high-tech industrial bases, Austin had already developed a nascent electronic and computing cluster centered on large firm technical branch manufacturing and the RT region had gained national recognition as early as the 1930s with its innovative development of medicines and pharmaceutical products. These two endogenous development processes reveal unique regional comparative advantages (probably facilitated by allocation of research dollars across different sectors at the local universities) that influenced later industrial specialization in biotech in the RT area versus microelectronics in Austin.

Early developments of the electronics industry in Austin

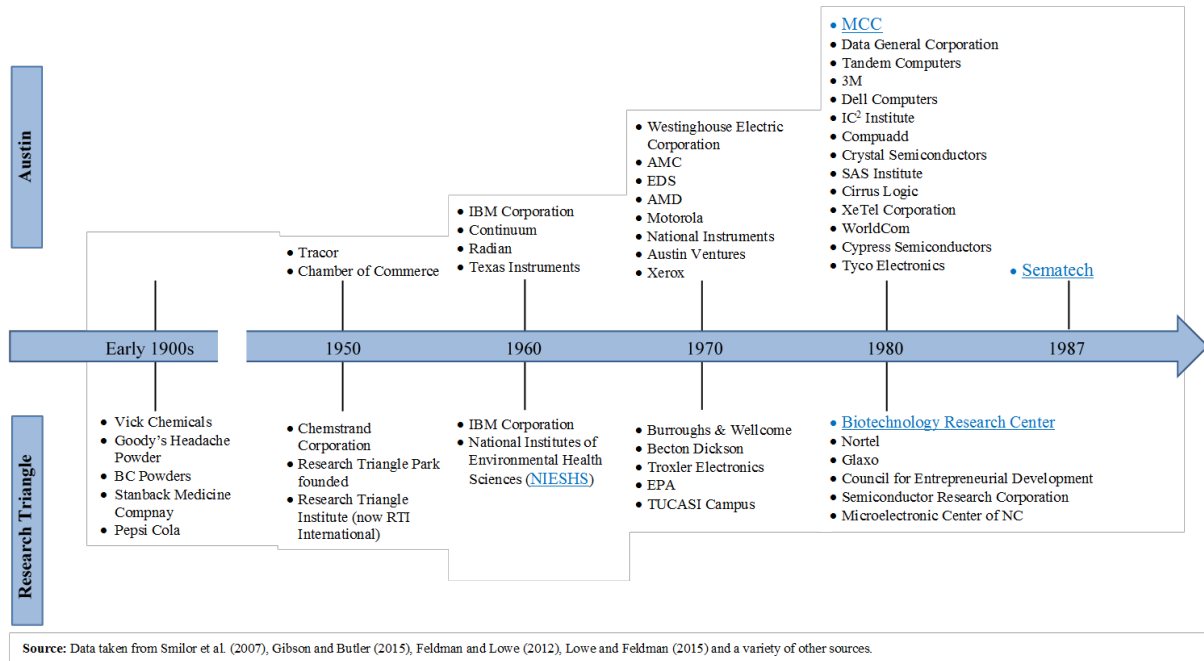
In 1994, Gibson and Rogers (1994, p. 428) note “the history of high-tech development in Austin goes back about 40 years to the birth of Tracor,” a major defense electronics contractor and the city's first homegrown *Fortune* 500 company founded in 1955. As illustrated in Figure 1, IBM came to Austin in 1967, Texas Instruments in 1969, and Tandem Computers and Data General Corporation in 1980. Tandem Computers was the dominant manufacturer of fault-tolerant computer systems, and Data General Corporation was the leader in minicomputers and one of the fastest-growing U.S. companies in the 1980s. Indeed, as highlighted by Gibson and Rogers (1994), by 1983, Austin was well on the way to becoming an emerging technopolis with high-tech employment of 22,800, representing 6.1 percent of the city's labor force, compared with 2.6 percent for Texas and 3.7 percent nationally. Similarly, Farley and Glickman (1986, p. 408) note: “the selection of Austin as the initial focus for a state-wide innovation-based strategy [referring to MCC and Sematech] was based in part on its recent emergence as a regional center

of high-tech manufacturing and research and development. Electronics-related industries in Austin has increased sharply in recent years, supplementing its traditional important employers, the state government and the University of Texas.”

Two homegrown computer upstarts include Dell Computer Corporation, a personal computer marketer started in 1984 that expanded into a full-blown PC manufacturer with more than 1,000 employees and sales exceeding \$300 million in 1993, and CompuAdd, begun in 1982, which blossomed into a national producer and marketer of PCs and related products in 1993, with a workforce of almost 1,000 and sales of over \$400 million. The development of semiconductor industries was rooted in the location of Motorola in 1974 and the subsequent attraction of other large microprocessor manufacturing facilities such as Advanced Micro Devices in 1979. The early build-up of computer and microelectronics manufacturing was strengthened with the successful location of MCC in Austin in 1983, which brought a \$65 million annual budget for research in microelectronics and computer technology, and Sematech’s consortium of 13 semiconductor manufacturers in 1988 to develop new manufacturing technologies for the semiconductor industry. Substantial oil revenues allowed the University of Texas at Austin (UT-Austin) to hire away world-class researchers from other institutions (Cunningham and Jones 2013).⁵

⁵ William Cunningham served as the University of Texas at Austin’s president from 1985 to 1992 and as the UT System’s Chancellor from 1993 to 2000.

Figure 1. Austin and Research Triangle Region Early Comparative Advantages



Early Development of the Pharmaceutical Industry in North Carolina

In the 1950s, the governor of North Carolina recognized the need for other industries that paid higher wages beyond its homegrown manufacturing trio (furniture, textiles, and tobacco). Governor Luther Hughes' efforts eventually led to the formation of an industrial research park on the pine-covered land that occupied the area surrounded by the "triangle" of three universities—the University of North Carolina (UNC) in Chapel Hill, Duke University in Durham, and North Carolina State University in Raleigh. The creation of North Carolina's Research Triangle Park would ultimately shift the geographical center of entrepreneurial activity from cities like High-Point and Greensboro in the Piedmont Region to cities like Durham, Chapel Hill, and Raleigh, home to the state's largest state-funded research universities.

Although the Research Triangle Park (RTP) was formally organized in 1958, IBM and the National Institute of Environmental Health Sciences (NIEHS) located there in 1965 and served as the crucial first anchors putting RTP on the map among major player as a place to

locate R&D facilities (McCorkle 2012). UK-based Burroughs Wellcome was one of the first life science firms to locate a research facility in the RTP, which also functioned as its US headquarters until its merger with Glaxo in 1995. New Jersey based Becton, Dickinson & Company soon followed suit in 1972, establishing the Becton, Dickinson Research Center on East Davis Drive in RTP to provide basic research and development support for improving manufacturing and process methods in health sciences and biological safety. Other life science anchors included Glaxo, Biogen, Corning Bio, Eisai and in medical devices, Edward Weck & Co., along with international agricultural giants, BASF, Bayer and CIBA-GEIGY that would eventually use recombinant DNA techniques to develop applications in agricultural biotechnology. The state-funded North Carolina Biotechnology Center, created in 1981 and with its base in the RTP, became a crucial accelerator of biopharmaceutical industry growth in the RT area (Lowe and Feldman 2015; Feldman and Lowe 2011).

In the Research Triangle Park, companies conduct research and development (R&D) in a quiet rural setting. Manufacturing was initially prohibited within the Park's official limits, although eventually a Northern section of the park was opened to select manufacturing activities, thereby offering greater flexibility to biopharmaceutical manufacturers, like Biogen, Eisai, CIBA-GEIGY, as well as other technology firms, most notably IBM. A life science entrepreneurial economy eventually developed in concentric rings around the park, in a variety of satellite commercial facilities and older, reconfigured industrial spaces (Feldman 2014). Admittedly home-grown pharmaceutical and related firms existed in North Carolina in earlier decades, which as noted by Mac McCorkle included "inventions of North Carolina shop pharmacists ... Vick Chemicals, Goody's Headache Powder, B.C. Powders, the Stanback Medicine Company, and Pepsi Cola" (2012, pp. 504–505). But research by Feldman and Lowe (2014, 2015), indicate the modern life science genesis of the Research Triangle region is a story of attracting large multinational firms to locate their R&D operations and then encouraging start-up firm formation in the wake of large-scale corporate mergers and acquisitions, layoffs, and restructuring.

Success in securing the location of new, technology-based facilities in the RTP and the Austin region was in part based on location factors: low land costs, availability of large numbers of university-educated workers at relatively low wages, good transportation infrastructure, and

access to growing Southern and Southwestern markets (Davis 1994; Glasmeier 1991; Oden and Yilmaz 2006). However, numerous other state capital–university centers in the United States could boast similar locational attributes. In the Austin and the RT area cases what stood out was the energetic, durable, and coherent economic development initiatives spurred by public and private sector leaders and institutions. The central role of business, civic, and university collaboration around industrial development and the targeting of sectors that could leverage the comparative advantages of the regions helped move Austin and the RT region into the top ranks of high-tech cities.

Empirical Evidence of Vibrant Entrepreneurial Ecosystems

Our primary data source is the Census IPUMS 5% samples from 1980 plus the American Community Survey (ACS) IPUMS 2009–2014 multiyear sample (Ruggles et al. 2015).⁶ We choose these data sets to achieve large-enough samples to precisely decompose employment data by main high-tech industries in Austin and the Research Triangle.⁷ We limit our analysis to men and women ages 25 to 54 who report working at least 40 weeks, 35 usual hours per week.⁸ To select high-tech NAICs we followed a study by Hecker (2005) from the Bureau of Labor Statistics and defined the high-tech sectors based on NAICS industries with the largest national shares of STEM (science, technology, engineering, and math) workers. Hecker’s definition has become the standard in academic literature (Decker et al. 2015). The list of high-tech NAICs is presented in Table A1 in the appendix.

Table 1 shows that between 1980 and the 2014 five-year average, the software industry had exploded in both regions, creating full-time employment opportunities for more than 200,000 in both areas in the 2014-five-year period.⁹ Semiconductors and computer manufacturing continued to be the top high-tech manufacturing industries in Austin, while

⁶ ACS data after 2007 include only information on weeks worked in intervals instead of exact weeks worked.

⁷ The CPS does not provide sufficient sample sizes and geographic detail to be the optimal data set for our analysis.

⁸ As noted by Baum-Snow and Pavan (2013), measurement error is a justification for using full-time, full-year workers. Baum-Snow and Neal (2009) demonstrate that the census and ACS data appear to contain false reports of part-time hours. More specifically, some of these errors involve false reports of daily hours worked instead of usual weekly hours.

⁹ In the 1980 Census, there was not yet a separate category for Professional and Commercial Equipment and Supplies. The 1980 Census mostly grouped this category into Miscellaneous Wholesale Durable Goods category (IND1990=532), but according to the IPUMS team, there is not a way to confirm this with absolute certainty.

pharmaceutical and medicine continued to be the top high-tech manufacturing sector in the RT area. Scientific research and development services, probably highly linked to the pharmaceutical and medicine manufacturing industry, also grew very fast in the RT area.

Table 1

Number of full-time, full-year workers for selected high-tech sectors in Austin, the Research Triangle, and the U.S. in 1980 and 2014-5y

Sectors		Austin		Research Triangle		United States	
		1980 (Thousands)	2014-5y (Thousands)	1980 (Thousands)	2014-5y (Thousands)	1980 (Hundred Thousands)	2014-5y (Hundred Thousands)
High-Tech Manufacturing	Semiconductor and electrical equipment manufacturing	5.67	19.76	3.52	5.03	10.88	8.95
	Computers and related equipment manufacturing	2.8	13.26	6.34	3.11	3.76	1.93
	Pharmaceutical and medicine manufacturing	0.24	0.99	1.24	7.06	1.86	4.16
	Communication equipment manufacturing	4.18	1.18	1.66	1.02	5.23	1.46
High-Tech Services	Computer and data processing services	1.10	29.14	1.38	19.46	2.95	18.33
	Architectural, engineering, and related services	1.88	8.90	1.38	5.25	4.60	11.68
	Scientific research and development services	1.04	3.42	1.30	8.80	2.90	4.78
	Professional and commercial equipment and supply merchant wholesalers (Dell)	0.00	3.08	0.00	2.12	0.00	3.08
Other High-Tech Services	Management, scientific, and technical consulting services	0.64	9.87	1.06	4.81	2.11	10.47
	Telecommunications and Internet service providers	2.62	6.92	3.30	4.65	10.46	9.68
Total High-Tech Industry		28.72	128.42	32.14	84.13	105.36	144.26

Source: Authors' calculations using the US Census and ACS from IPUMS.

As already indicated, the successful attraction of large, technically oriented corporate research and manufacturing operations was crucial in spawning vibrant entrepreneurial ecosystems in these regions. An analysis of self-employment data from our sample displays evidence of this phenomenon. Table 2 shows the “entrepreneurship rate” —number of full-time self-employed workers per 100,000 full-time workers in each region or the country—by main high-tech sectors in Austin, the RT area, and the United States. The vibrancy of Austin and the RT area high-tech entrepreneurial ecosystems is evident when their sector-specific entrepreneurship rates are compared with the rate of entrepreneurship in the United States. In Austin, the rate of entrepreneurship in the semiconductor and electrical equipment manufacturing sector is more than twice the U.S. rate in the 2014 five-year period. Similarly, the computer and

related equipment manufacturing sector produces entrepreneurs at a rate that is four times the national rate for this sector. The pharmaceutical and medical manufacturing sector has 10 times as many entrepreneurs for every 100,000 full time workers in the Research Triangle area than in the United States. The scientific research and development services sector has an entrepreneurship rate that is more than three times the U.S. rate in both regions.

Table 2

Number of full-time, full-year, self-employed workers per 100,000 for selected high-tech sectors in Austin, the Research Triangle, and the U.S. in 1980 and 2014-5y.

Sectors		Austin		Research Triangle		United States	
		1980	2014-5y	1980	2014-5y	1980	2014-5y
High-Tech Manufacturing	Semiconductor and electrical equipment manufacturing	22.17	22.66	0.00	8.49	14.20	11.39
	Computers and related equipment manufacturing	0.00	4.90	9.79	0.00	2.74	1.42
	Pharmaceutical and medicine manufacturing	0.00	1.84	0.00	24.69	1.09	2.34
	Communication equipment manufacturing	11.09	1.23	9.79	18.00	4.35	1.84
High-Tech Services	Computer and data processing services	11.09	265.67	29.38	244.54	22.70	144.77
	Architectural, engineering, and related services	155.21	122.65	88.15	121.37	96.20	100.88
	Scientific research and development services	33.26	46.09	0.00	43.46	8.67	13.41
	Professional and commercial equipment and supply merchant wholesalers (Dell)	0.00	23.12	0.00	16.97	0.00	17.90
Other High-Tech Services	Management, scientific, and technical consulting services	99.78	346.37	68.56	249.43	74.51	220.20
	Telecommunications and Internet service providers	0.00	7.50	9.79	15.17	3.20	8.49
Self-Employed in High-Tech Industry per 100,000		609.76	1126.39	303.62	944.49	440.16	713.99

Source: Authors' calculations using the US Census and ACS from IPUMS.

A remarkable feature of each region is how they built the institutional capacities to evolve and consistently stimulate new investment and industrial development off their initial success in attracting external federal or corporate investment. By the 1990s each region sported substantial agglomerations in multiple high technology sectors and had clearly expanded the scale, scope and innovative power of their technology-oriented regional economies. In the subsequent decades these foundations supported the robust growth of entrepreneurship and business formation in technology based areas as suggested in the contemporary data.

Substantial Differences in Institutional Capacity

The sources that have supported the entrepreneurial ecosystem are radically different among these regions but, as a set, equally successful in promoting entrepreneurial activity. These are some of the most significant institutional differences:

1. *Role played by intermediate support organizations*—The Research Triangle region’s success is strongly linked to an industry-specific support organization, the North Carolina Biotechnology Center, which has played a historically significant role in strengthening research activities at local universities and connecting them with industry researchers (Feldman and Lowe 2011). Moreover, this organization has been successful in balancing support of entrepreneurial activities with that provided to large organizations (Lowe and Feldman 2015). As part of that effort, the North Carolina Biotechnology Center conducts outreach to identify recruitment opportunities in biosciences and fields requests for recruitment incentives on behalf of the State’s Department of Commerce, with the latter ultimately making decisions on large-scale incentive awards (Lowe 2014). The Biotechnology Center also coordinates biotechnology workforce development support from community colleges and university-based bioscience training facilities (Lowe 2007).

In contrast, there is no unique state-supported sector-specific institution in Austin with the capacity to fund research, conduct training, provide industry-university linkages, and promote both large firms and entrepreneurs. In Austin, these functions are not sector specific and are dispersed in a myriad of institutions. For instance, the University of Texas at Austin has a unit that specializes in promoting university-industry relationships including collaborative research projects (Office of Industry Engagement). The state of Texas created the Texas Enterprise Fund in 2004 to provide monetary incentives to companies that want to relocate to the state. There are industry-specific councils such as the Austin Technology Council (the old Austin Software Council), Wireless Council, Clean Energy Council, and BioAustin that are privately funded. There has never been a similar organization in Austin like the North Carolina Biotechnology Research Center

that centralize and coordinate a diversity of support components for sector-specific firms of all sizes and origins.

2. *Different sources of funding for entrepreneurs*—Based on interviews in Austin and a two-and-a-half-day visit to the Research Triangle, we hypothesize that both regions lack significant endogenous venture capital investment. As Feldman (2014) notes, rather than traditional venture capital (VC), the RT region has attracted proportionally more corporate VC. This form of capital seeks out strategic technologies and promising opportunities related to the corporation. The outcome is likely to be acquisition rather than pursuing initial public offerings (IPO). As Feldman notes, acquisition by the corporate investor may not be a bad outcome if it brings additional investment and retains jobs. Thus, using conventional measures such as venture capital investment raised or number of IPOs in the region does not rank high-tech areas well. The RT area is a prosperous place, due to a more varied financing model. In contrast, there is a strong community of angel investors in Austin that have been very important as a source of not only funds but also knowledge for startups (interview with Bob Metcalfe and Louise Epstein).
3. *Contrasting patterns of geographical dispersion*—There are notable differences in the geographical landscape of these two regions. Research Triangle denotes a more dispersed urban conurbation centered around three cities: Durham, Chapel Hill, and Raleigh, the state capital. Austin is a more centralized urban region with the state capital and state university abutting the central business district in the core city. These distinct urban forms may be associated with interaction and collaboration or more concentrated cultural and artistic activity.

As Storper (2013, p. 41) notes, “it’s the human relationships and ‘untraded interdependences’ in them, supported through a lot of face-to-face contacts that are the high-cost glue holding them to places and one another.” A key to understanding innovative clusters’ economic performance and change is to know how the actor-networks that affect innovations are formed, maintain, reshaped, or eliminated. However,

the Research Triangle Park continues to be a bucolic rural community in which large companies are separated by gates and extensions of pine tree lands that are not conducive to face-to-face interaction (interview with Michael Pittman, VP of Marketing and Communication for RTP). The original idea of the RTP design was to ensure seclusion and the protection of intellectual property. Its isolated car-dependent environment is no longer optimal for spurring innovation and attracting young talent (Katz and Wagner 2014).

It seems the RT area offers an example of networks facilitated by the creation of institutions funded by state government. An example, the North Carolina Biotechnology Center serves as a bridge between large companies, startups, and universities. In Lowe and Feldman's (2015) words: "The case study of North Carolina's Biotechnology Center thus demonstrates the value of interactions between seemingly disconnected areas of economic development." In contrast, the actor-networks in Austin cross different industry sectors and are facilitated by geographic proximity of specific agents who are able to make the connections in these networks, in what is called "brokering" by Feldman and Zoller (2012).

The *2015 Kauffman Index Report* rated the Austin MSA as the number-one U.S. city for technology innovation startups. The Research Triangle region is missing from the Kauffman rankings because government provided data are reported separately for the Raleigh-Cary and Durham-Chapel Hill MSAs (email exchange between Maryann Feldman and Arnobio Morelix from the Kauffman Foundation). The Milken Institute ranked Austin as number two and Raleigh-Cary as number five among the top 25 best-performing metropolitan areas in the United States in 2014 (DeVol et. Al. 2015). Joining the two MSAs into one will probably move the Research Triangle area close to Austin in the rankings.¹⁰

¹⁰ The Annual Survey of Entrepreneurs (ASE), that will be released this summer, will provide solid data for both regions. This is a public-private partnership between the Census Bureau, the Ewing Marion Kauffman Foundation, and the Minority Development Agency (MBDA). For the 2014 ASE, the selected module asks questions about business innovation and R&D activities.

4. *Rich Linkages with the Silicon Valley*—Austin has strong historical linkages with Silicon Valley, while the Research Triangle has linkages with a more diversified set of technology regions. An indicator of the close exchange of ideas between San Jose and Austin can be found in the increasing availability of direct flights between the two regions. Echeverri-Carroll and Ayala (2004) note that America Airlines (AA) made news in the fall of 1992 when it initiated direct flights from Austin to San Jose. In what became known as “nerd birds,” these direct flights number three per day in 2004 and claimed the highest laptop-per-passenger ratio in the airline industry. It also became the most profitable direct flight route for AA in the 1990s (interview with John Welsh, Director of the Austin Chamber of Commerce at that time). The Research Triangle area networks extend not only to California but also to New York and Boston and other high-tech regions (interview with Lizzy Hazeltine, the Startup Factory in Raleigh).

Echeverri-Carroll and Brennan (1999) interviewed CEOs and managers of 23 high-tech firms in Austin, Dallas, Fort Worth, Houston and San Antonio and mailed 1,700 surveys to high-tech firms in the 1990s, receiving responses from 374 firms. They were testing the relative importance of local attributes to firms’ product innovation and found that fast innovators gave the highest score to availability of direct flights. They concluded that whether the sources of knowledge relevant for innovations are local or non-local may be determined by whether the city in which the innovative firm is located is ranked high or low in the hierarchy of high-tech cities. LeSage and Fischer (2012) found empirical support for this hypothesis.

5. *Cultural Differences*—The liberal attitude in Austin embodied in its slogan “Keep Austin weird” contrasts with the conservative culture in North Carolina. Avnimelech and Feldman (2010) question whether the conservative culture is hindering development of new homegrown companies. They suggest that while attracting centers of leading corporations is important, a precondition for rapid indigenous sustainable growth of a local cluster is the appearance of a few successful homegrown companies. Moreover, they believe these successful homegrown companies often become local role models and a main source of spinoffs.

6. *Relative sectoral allocation of research dollars*—In 2016, *U.S. News and World Report* ranked Duke University School of Medicine eighth in the nation in research and the computer science department at the University of Texas at Austin ninth in the nation.¹¹ According to our interview with Greg Pogue (IC² Institute associate director and Ph.D. in biology), the RT region’s confluence of three universities, in which Duke and UNC’s medical schools ranked very high in this type of research and NC State ranked very high in agricultural research, attracted large biotech companies that got involved in research very early in the region. Agriculture and pharmaceutical companies’ presence in the RT region resulted from agricultural research and tobacco research in the 1980s. Tobacco products and research in the 1980s were very valuable, as tobacco was the only plant that could be transformed by the process of adding a new gene and planting it in the field. Many large biotech firms located facilities there, sponsoring research at universities and engaging in collaborative research. Medical research at Duke Medical School also attracted a lot of pharmaceutical firms and collaborative university-industry relationships.

Austin is only now building the Dell medical school and has built a strong computer science and electronics departments at the University of Texas. Electronics and microelectronics research was important at UT–Austin even before MCC. Smilor et al. (1987) reported the funding levels for organized research units at UT–Austin in 1987. These data show that excluding the Center for Electromechanics, which captured 38 percent of the total budget, electronics and microelectronics research centers captured 15 percent of this budget.

Conclusions

The high-tech growth in both Austin and the Research Triangle region is the outcome of an economic development strategy founded on attracting large technology-oriented firms to locate in the region. Large corporations have not only provided employment and knowledge

¹¹ <http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-medical-schools/research-rankings?int=af3309&int=b3b50a&int=b14409>

spillovers but also created a pool of skilled labor, generating a further round of economic growth through local startup creation. Both cases of regional development demonstrate that recruitment of big out-of-state and international businesses can be an essential foundation to the growth of a homegrown entrepreneurial sector in regions that start with a relatively weak industrial base. These two regions offer considerable opportunity to study how in spite of differences in geography, sources of networks, culture, and history, they managed to become the most spectacular success stories of the Sunbelt. Understanding how these differences mold entrepreneurial pathways could help researchers and practitioners to extrapolate lessons for other regions and contribute to building entrepreneurial theory.

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Appendix

Table 1A

2002 and 2012 NAICS codes for top 10 High-Tech sectors in terms of employment

Sectors		NAICS 2002	NAICS 2012
High-Tech Manufacturing	Semiconductor and electrical equipment manufacturing	3344, 3346, 3353	3344, 3346, 3353
	Computers and related equipment manufacturing	3341	3341
	Pharmaceutical and medicine manufacturing	3254	3254
	Communication equipment manufacturing	3342, 3343	3342, 3343
High-Tech Services	Computer and data processing services	5182, 5112, 5415	5182, 5112, 5415
	Architectural, engineering, and related services	5413	5413
	Scientific research and development services	5417	5417
	Professional and commercial equipment and supply merchant wholesalers (Dell)	4234	4234
Other High-Tech Services	Management, scientific, and technical consulting services	5416	5416
	Telecommunications and internet service providers	5171, 5172, 5173, 5174, 5179, 5181, (5161)	5171, 5172, 5174, 5179, 5191

Source: Authors' calculations using the US Census and ACS from IPUMS.

**UT Austin Research Team – RT Area Visit
Sunday, February 28 – Tuesday, March 1**

Sunday, February 28 – Reception

- **6:00pm Open House at Maryann Feldman's Home**
1306 Mason Farm Rd. Chapel Hill, 27514

Monday, February 29 – UNC Chapel Hill and RTP

- **9-11am Database Overview at RENCI with RENCI staff and RTP Project Staff**
100 Europa Drive, Suite 540, Chapel Hill, NC 27517

9:00 Bill Little Memorial Database Introduction – Maryann Feldman & Nichola Lowe
9:15 Database Training: Company Research – Allison Forbes & Keagan Sacripanti
9:45 Database Training: Founders Research – Paige Clayton
10:30 Database background details and Q & A – Oleg Kapeljushnik
10:45 Visualizations – Sidharth Thakur

- **11:15-12pm NETS Data Overview and Opportunities**
Odum Institute, Davis Library, 208 Raleigh Street. Chapel Hill, 27514

Host: Philip McDaniel (GIS Librarian, Digital Research Services, UNC Libraries)

- **12:15-1:15pm Lunch delivered by Sandwich**
1789 Venture Lab, 173 E. Franklin Street. Chapel Hill, 27514

Guest: Rachel Seidman (Associate Director, Southern Oral History Program)
12:30 Funding Wearable Technology Development in RTP
Katherine Manweiler (Undergraduate Student, Public Policy)
12:40 Categorization of Firms and Hybrid Analysis
Grayson Berger (Undergraduate Student, Public Policy)

- **1:45-3:15pm The Frontier at RTP Foundation**
800 Park Offices Drive. Research Triangle Park, 27709

Host: Michael Pittman (VP of Marketing & Communications, RTP Foundation)

- **3:30-4:15pm First Flight**
2 Davis Drive, Durham, 27709

Host: Andy Schwab (President, First Flight)

- 4:30-7:00pm Venture Philanthropy Panel at NC Biotech Center
15 TW Alexander Drive. Research Triangle Park, 27709

Panel starts at 4:30pm; Reception and networking at 6pm

- 7:30pm Dinner at An Cuisine (Reservation for 5)
2800 Renaissance Park Place. Cary, 27513

Tuesday, March 1 – Raleigh and Durham

- 9:00 -11am NCSU Centennial Campus Tour
1017 Main Campus Drive, Raleigh, NC 27606
Conference room #1101: 1st floor of Partners 1 building (Parking deck is next door)

Hosts: Leah Burton (Director, Centennial Campus Partnership Office & Industry Alliances); and Jennifer Capps (Director of Academic Programs for the Entrepreneurship Initiative)

- 11:15am Lunch at Irregardless Café (reservation for 6)
901 W Morgan Street. Raleigh, 27603

Guest: Cathy Innes (Director of Business & Innovation, NCSU)

- 1:00pm Startup Factory
American Underground (Market Campus), 212 W Main St. Durham, 27701

Host: Lizzy Hazeltine (Venture Associate, The Startup Factory)

- 3:00pm American Underground
American Underground (American Tobacco Campus), 318 Blackwell St., Durham, 27701

Host: Jesica Averhart (Director of Community Partnerships, American Underground)

- 5:30 pm Rapped Up Dinner, Wrap-up, and Lessons Learned at Counting House (Reservation for 6)
111 Corcoran Street. Durham, 27701