

INSIDE THE TRIANGLE:  
ADVANCING RESEARCH ON ENTREPRENEURSHIP AND FIRM LOCATIONS

Mary Donegan

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Approved by:

Nichola Lowe

Todd BenDor

Maryann Feldman

T. William Lester

Daniel Rodriguez

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## ABSTRACT

Mary Donegan: Inside the Triangle: Advancing Research on Entrepreneurship and Firm Locations  
(Under the direction of Dr. Nichola Lowe)

This dissertation focuses on the sub-regional, spatial arrangements of entrepreneurial bioscience companies in the Research Triangle Park region of North Carolina. The dissertation's three papers tackle this topic in a systematic way, by (1) exploring why and how institutions develop policies that extend space-related resources to entrepreneurs, (2) analyzing the extent to which these space-related resources reshape the physical locations of entrepreneurial firms, and (3) comparing entrepreneurial establishment records from two different databases to determine which source is best for analyzing entrepreneurial firms.

The first paper, *Universities as Jurisdictionally Embedded Institutions*, uses university business incubators as a means to examine how institutions (like universities) that are embedded within multiple jurisdictions (states, counties, and cities) develop policy. Previous research has attributed policy development to two separate factors: university culture and regional characteristics. The research shows, however, that the institution's embeddedness in layers of political jurisdictions influences university cultures around entrepreneurship and development.

The dissertation's second paper, *Institutionally Bound Resources and Firm Location Decisions*, examines how UNC's policies have reshaped firm microgeographies. The entrepreneurial literature has not fully addressed the fact that many regional resources are institutionally bound, and available only to members of that institution's community. In this

paper I examine UNC's introduction of spatial, institutionally bound resources (business incubators for entrepreneurial firms), and find that these resources have disrupted previously defined spatial patterns among firms with access to these resources.

The dissertation's third paper, *How Does Database Selection Influence our Understanding of Entrepreneurial Regions?*, recreates an externally defined reference list of entrepreneurial bioscience firms in two different databases: the National Establishment Time Series database, a private database, and the Quarterly Census of Employment and Wages, a government database. This paper seeks to divide observed differences into differences that arise as the result of database design differences and those that arise as the result of private database inaccuracies. After adjusting the private data by the hypothesized driver of difference between the two databases, the paper concludes that observed differences between the two databases are driven not by private database inaccuracies, but rather by purposeful design differences between the two databases.

For my daughters

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# **1 INTRODUCTION**

## **1.1 Entrepreneurship: Regions and Bioscience Firms**

Entrepreneurial firms, especially those that develop new or innovative technologies, are central to a region's long-term economic development prospects. When linked to an existing or emerging industrial cluster, entrepreneurial firms develop products or services to complement, augment and otherwise utilize existing firms' outputs, and further the region's capacity for innovation by engendering new technologies, services, or organizational forms. Scholars have linked a region's ability to develop, attract, and retain these entrepreneurial firms to numerous regional factors, including entrenched norms or culture, available financing, the presence of supportive organizations, and a region's workforce. Together, entrepreneurial firms and their regional environments develop a unique, reciprocal relationship, tied together by an evolving, complex web of social, institutional, and economic interactions. Scholars refer to this web of interrelated resources that firms and their regions continually produce and re-produce as an entrepreneurial ecosystem (Auerswald, 2014; Feldman, Francis, & Bercovitz, 2005; Malecki, 1990; Owen-Smith & Powell, 2006; Saxenian, 1994).

While all entrepreneurial firms are likely to draw on (and contribute to) their regional ecosystem, bioscience firms may be particularly reliant on the resources of the entrepreneurial ecosystem, especially in their search for suitable physical infrastructure and in their financial dependence on regional institutional supports (Lowe, Feldman, & Kemeny, 2016; Pisano, 2006a, 2006b, 2010). Regarding physical infrastructure, bioscience firms often need to find specialized

laboratory spaces or equipment in the region. Firms involved in drug development, for example, need laboratories where workers can safely handle biological and chemical specimens. While office spaces can be “up fit” with this equipment, doing so requires considerable capital investment. Unfortunately, many bioscience firms do not have access to the capital required for these investments.

Firms can search out resources from regional institutions or venture capitalists. In North Carolina’s Research Triangle Park (RTP) region, for example, all bioscience entrepreneurs have access to resources through the North Carolina Biotech Center and the Council for Entrepreneurial Development. However, many of the physical and financial resources that are critical to entrepreneurial bioscience firms are not regional in nature. These resources are instead under the control of local jurisdictions (e.g. cities and counties), and other restricted or membership-based organizations. The University of North Carolina at Chapel Hill (UNC) and Duke University (Duke), for example, restrict many of their resources to faculty, staff, and students. Their resources are thus tied to physical or social boundaries that the institution itself sets, making these resources *institutionally bound*. These institutionally bound resources are nested within the regional ecosystem, but are not available throughout the ecosystem.

One example of an institutionally bound resource is a university business incubator. Almost all universities have business incubators in some form (Markman, Phan, Balkin, & Gianiodis, 2005). In their simplest form, business incubators are physical spaces for entrepreneurial firms, often with access to specialized equipment; many incubators include “wrap-around” services, like mentoring, networking opportunities, or assistance in developing

business plans.<sup>1</sup> Scholars typically link business incubators to commercialization, or university efforts to transfer academic research into licensed technology to larger firms, joint ventures, or entrepreneurial firms (Bøllingtoft & Ulhøi, 2005; Bradley, Hayter, & Link, 2013; Mian, 1996a, 1996b; Phan, Siegel, & Wright, 2005).

## **1.2 Putting the Local Back in the Region: Embedding Universities in Jurisdictions**

That entrepreneurship scholars remain focused on the region as a geographic level of analysis is understandable, given the importance of regional resources in entrepreneurial and industrial development. Yet, while the long arc of industrial innovation occurs at the regional scale, the reality is that each individual firm is physically rooted in a single, specific address. Entrepreneurial firms have become targets for recruitment and retention efforts, in much the same way that cities, counties, and states have long targeted corporate headquarters, factories, or other branch plants (Isserman, 1993). The targeting of entrepreneurial firms likely reflects the attractiveness of entrepreneurial companies for individual jurisdictions. Recent work, for example, has attributed much of the job growth that Birch (1987) attributed to small firms to entrepreneurial companies (Haltiwanger, Jarmin, & Miranda, 2013; Haltiwanger & Krizan, 1999), making entrepreneurial companies important to economic development's job creation goals.

Given jurisdictions' desire to keep entrepreneurial firms embedded in their boundaries, and the diverse ways in which resources are extended to firms, analyzing the entrepreneurial

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<sup>1</sup> As Bøllingtoft & Ulhøi (2005) note, the diversity of business incubators makes them difficult to classify or categorize.

ecosystem from *only* a regional perspective may miss key drivers of sub-regional location decisions. Put another way, by analyzing the entrepreneurial ecosystem at a regional level, we have said nothing about the way in which firms are arranged at sub-regional geographies. By overlooking these sub-regional geographies, we overlook the ways in which institutions (like universities) shape these sub-regional geographies. Furthermore, we do not allow for the possibility that institutions such as universities are themselves tied to these jurisdictions and align their interests with these jurisdictions. These institutions are *jurisdictionally embedded*, linked to the political boundaries in which they are located through legal, personal, and institutional ties, all of which are rooted in decades of history. Together, recognizing these points to several possibilities: (1) organizations (like universities) have bounded resources, (2) multiple jurisdictions within a region have vested interests in fostering entrepreneurial companies within their boundaries, and (3) universities may create and deploy resources in ways that are shaped by their jurisdictional embeddedness.

To the extent that there is a link between institutionally bound resources and the interests of larger jurisdictions, these institutionally bound resources can be leveraged to shift smaller-scale geographies of firms within regions. The way that these firms are distributed across a region has consequences for the jurisdictions that comprise a region and their residents. Yet, it may also have implications for regional technological innovativeness and, by extension, the health of the larger regional cluster. Scholars of knowledge spillovers and productivity gains from agglomeration have noted that benefits decay over very short (2-5 miles) distances (Arzaghi & Henderson, 2008; Kerr & Kominers, 2015; Rosenthal & Strange, 2003, 2008). If jurisdictions and institutions are using their resources to purposely pull entrepreneurial firms into



regional corners, they could be inadvertently inserting kinks or breaks into pathways of knowledge spillover.

### **1.3 Data: Limiting Our Ability to Study These Issues**

Unfortunately, available data obscures how resources and institutions may shape small-scale firm geographies. Government data is made available to the public in aggregated form, thanks to reporting restrictions that prohibit governments from releasing confidential data; the Bureau of Labor Statistics, for example, does not make data available at geographies smaller than the county level. This *aggregation* conceals individual establishment births and deaths, as well as changes in employment at each establishment. Scholars can apply to individual state governments or to national bureaus to gain access to *disaggregated* versions of this data, but agencies often deny these applications.

As an alternative, scholars have increasingly turned to private databases. Private companies compile information in their databases to sell to private companies, which in turn use them in their own economic analyses to inform business decisions. Researchers have found these private databases useful as well, since they include detailed data on individual establishment births, deaths, addresses, and employment levels. While many scholars have questioned the accuracy of data contained in these private databases (see Fleischhacker et al. (2012) for a review), scholars have also suggested that these databases may be superior to public sources for analyzing entrepreneurial activity (Neumark, Zhang, & Wall, 2005). For example, government datasets often have strict definitions for what constitutes a company, and for what counts as an employee. This means that these databases often miss significant portions of entrepreneurial

firms, which often rely on informal or contract employment. Thus, while scholars realize they need research-appropriate data to develop informed policy, it is unclear whether governments or private companies provide the best data for entrepreneurial research.

#### **1.4 Directions for Future Research**

Analyzing sub-regional entrepreneurial firm locations is an approach that has slipped between separate fields and approaches in the literature. As detailed previously in this section, while the entrepreneurial ecosystem literature has focused on firm, social, and institutional dynamics, it has done so at the regional scale. This literature has therefore not explored how institutionally bound resources may shape sub-regional geographies of firms.

Other studies that have looked at these sub-regional locational patterns tend to lose sight of institutional supports. The economics literature has recently published studies of knowledge spillovers that include analyses of sub-regional clusters. Kerr and Kominers (2015), for example, examined patents in Silicon Valley to map sub-clusters of innovation in the region. However, patents are issued to both entrepreneurial and non-entrepreneurial firms, and as a proxy for technological innovation, studies based on patents can miss firms that innovate without patenting (e.g., advanced, industry-specific service firms) and other supportive firms (e.g., contract research organizations). These and other studies examining smaller scale aspects of a region have also ignored the role of institutions—and their resources—in shaping both regional and sub-regional entrepreneurial geographies. Given the importance of these institutions in shaping long-term industrial trajectories, this is a clear oversight.

Scholars have also overlooked questions of *why* institutions have implemented specific commercialization policies. In the case of universities, for example, the literature has largely attributed commercialization efforts to culture, or the attitudes that faculty, staff, and administrators hold about the commercialization of academic research. While culture is important, fully attributing commercialization to culture, which is typically interpreted as internally-developed and defined norms of behavior, ignores how the jurisdictions in which universities are embedded shape the universities' culture and, by extension, the direction of their commercialization efforts.

In terms of data, scholars in a separate field (public health) have published a number of papers that evaluate data quality in private databases (Fleischhacker et al., 2012; Kaufman et al., 2015; Liese et al., 2010; Ma et al., 2013). Unfortunately, the results are not completely transferable. First, while location is important to both the public health and entrepreneurship fields, entrepreneurship scholars have a harder time verifying the location of companies in many fields (including bioscience). The public health studies largely focus on the locations of consumer-oriented retail food establishments, as a means to identify food deserts. These establishments rely on physical visibility to attract consumers, and as a result, their locations are easy for researchers to “ground-truth,” or verify through observation. The same cannot be said of bioscience firms, which are often tucked away inside office parks, private homes, and business incubators. This is a major disadvantage for data verification efforts. Second, these studies do not consider employment, a critical indicator for economic development researchers. Finally, few have considered historical data (Kaufman et al. (2015) is an exception).

## **1.5 Objectives of This Research and Overview of the Three Papers**

### *1.5.1 Overarching research objective*

The three papers that comprise this dissertation are linked together by their focus on sub-regional patterns of entrepreneurial firm locations. The first paper explores how the jurisdictional embeddedness of the University of North Carolina (UNC) and Duke University has shaped their respective bioscience business incubation strategies. The second paper explores how UNC's institutionally bound resources, in the form of business incubators, have shifted the locational patterns of affiliated start-up firms, pulling them closer to UNC. The third compares two different sources of entrepreneurial data, one a private database and the other a public database.

### *1.5.2 Research setting*

This dissertation's three papers are all set in the Research Triangle region of North Carolina. Three research universities—UNC, Duke, and North Carolina State University (NCSU)—define the corners of the region.<sup>2</sup> All three are research-intensive universities.<sup>3</sup> These three universities physically surround the Research Triangle Park (RTP), one of the nation's oldest research parks (Luger & Goldstein, 1991). Many of the RTP's early tenants were branch plants of large corporations or government research laboratories, leading early scholarship to regard the region as one defined by branch plants of larger corporations (Luger & Goldstein, 1991; Markusen, 1996). Recent scholarship has reframed the industry's growth in the region, and

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<sup>2</sup> As a result of their medical schools, Duke and UNC have spun off many more companies than NCSU, which does not have a medical school. Because of this, this dissertation will focus much more closely on Duke and UNC than on NCSU.

<sup>3</sup> The Carnegie Classification of Institutions of Higher Education classified each as RU/VH (research universities with very high research activity), the highest category for university research intensity (The Carnegie Foundation for the Advancement of Teaching, 2015).

in particular has recognized the roles high-profile branch plants (like GlaxoSmithKline), non-profit or quasi-public organizations (like the North Carolina Biotech Center), the state, and private incubators and accelerators have played in engendering the region's entrepreneurial ecosystem (Feldman & Lowe, 2015; Link & Scott, 2005; Lowe & Feldman, 2014; Lowe et al., 2016; McCorkle, 2012). Largely by building on these branch plants, organizations like the North Carolina Biotech Center, and the three universities, the Triangle's bioscience industry has become one of the largest in the country (Feldman & Lowe, 2011; Feser, Sweeney, & Renski, 2005; Goldstein, Feser, Freyer, Gordon, & Weinberg, 2008; Link & Scott, 2003; Lowe & Feldman, 2014; Markusen, 1996).

## **1.6 Data**

This dissertation draws on five distinct sources of data. The first four are secondary databases, while the fifth is primary data in the form of interviews. The first, the Feldman-Lowe Database, is a proprietary database developed by Drs. Maryann Feldman and Nichola Lowe at UNC. This dissertation relies on a subset of this database. This subset is comprised of more than 500 entrepreneurial bioscience firms founded in the Research Triangle Park area between 1990 and 2012. A research team continually updates these records in the database, and this dissertation draws on data related to both the firms (including the products or services they produce and their founding date) and their founders (including the number of founders each firm has and each founder's work history).

The second, The National Establishment Time Series (NETS), is a private, longitudinal, establishment-based database. The NETS is produced by Walls and Associates, and is based on

data from Dun & Bradstreet. This dissertation uses North Carolina files between 1990 and 2012, and uses data on firm addresses and the number of employees.

The third, the state of North Carolina's data from the Quarterly Census of Establishments and Wages (QCEW), is a series of yearly snapshots of all establishments in the state of North Carolina. This dissertation uses establishment-level data on firm addresses and the number of employees, between 1991 and 2010.

The fourth source includes data from the Association of University Technology Managers (AUTM). AUTM conducts yearly surveys of technology transfer offices in U.S. research universities, and compiles it into a database. This dissertation uses data on patents, start-up firms, licensing revenue, and research expenditures for Duke and UNC between 1994 and 2014.

The fifth source is comprised of interviews with entrepreneurs; staff at UNC, Duke, and other area universities; city and county planners; and real estate developers.

### *1.6.1 Paper 1: Research questions and methods*

The first paper begins with the observation that Duke and UNC—two similar universities in the same region, but in different cities and with different relationships with the state of North Carolina—have engaged in very different business incubation strategies. From there I ask three questions:

1. Why has one of these universities engaged in an expansive business incubator strategy while the other has not?

2. How has each university's unique, jurisdictionally embedded nature shaped university culture and organization as they relate to commercialization and community redevelopment?
3. How has jurisdictional embeddedness, through culture and organization, contributed to the policies that universities and their partners pursue?

I address these questions through an embedded case study of the two universities. Duke University and the University of North Carolina are in the same region, but they are in very different local jurisdictions. Their relationship with the state of North Carolina is different, too, due to Duke's status as a private university and UNC's as a public university. Through interviews with current and former staff both from these two universities and other area universities, entrepreneurs, developers, and planners, I analyze how each university's embeddedness within these jurisdictions has shaped its culture and organization with respect to commercialization and redevelopment. These cultures, in turn, have led each university to approach business incubators—a bridging activity between commercialization and redevelopment—in different ways. I supplement interviews with AUTM data on patents, university spin off companies, research expenditures, and licensing fees.

#### *1.6.2 Paper 2: Research questions and methods*

In the dissertation's second paper, I look at how UNC's provision of spatial resources has altered spatial patterns of firm locations in the Triangle region. I ask two questions:

1. Does the introduction of new, institutionally bound entrepreneurial resources fundamentally alter the pattern of firm locational decisions, such that we can observe a significant change in the geographic pattern of firm locations?
2. Do entrepreneurs embedded in a community with institutionally bound resources search for company space in a way that is different from entrepreneurs who are not embedded in the same community?

To answer these questions, the research utilizes a mixed-methods approach. I draw the sample of bioscience firms from the Feldman-Lowe database, and use location data from the NETS. Using the 2009 shift in UNC's business incubator provision, I compare the first founding locations of UNC entrepreneurial bioscience firms to the locations of non-university entrepreneurial bioscience firms, both before and after the 2009 change. The UNC-parented firms, founded by entrepreneurs who are embedded in the UNC community, have access to these institutionally bound resources between 2009 and 2012; the non-academic firms do not. Neither group has access between 1990 and 2008. I conducted interviews with entrepreneurs, UNC staff, and local planners.

### *1.6.3 Paper 3: Research questions and methods*

Paper 3 offers a comparison of the NETS and the QCEW databases as sources of data for analyzing entrepreneurial regions. In this paper, I ask the following research questions:

1. To what extent do entrepreneurial records in the QCEW and the NETS diverge for bioscience firms, and how much of this difference is driven by design differences between the two databases?



2. How might a reliance on one database over another alter our understanding of a region's entrepreneurial economy?

To answer these questions, I first create a reference list of Research Triangle area entrepreneurial bioscience firms from the Feldman-Lowe database. Next, I match entrepreneurial bioscience firms in the Triangle region of North Carolina to their corresponding records in two databases: the NETS (a private database) and the QCEW (a government database). I then use statistical tests to assess differences in the number of matched records in the two databases, their employment counts, and their founding years, and I use kernel density maps to identify differences in patterns of spatial concentration in the Triangle region between the two databases. Finally, I make a proxy adjustment for unpaid employment, which should be included in the NETS but excluded from the QCEW, and conduct these same statistical tests and maps.

## **1.7 Implications of the Research**

The first paper, by using the lens of the jurisdictionally embedded institution, is a step forward in unpacking the roots of university culture. Entrepreneurship scholars frequently attribute university commercialization patterns and strategies as either (a) the natural extension of internally developed university cultures or (b) a response to regional circumstances. By ascribing differences in university policy to culture and regional circumstances, however, scholars may have inadvertently downplayed the roles that historically determined, inter-institutional relationships, laws, and norms have played in their development. This paper links universities to the multiple political jurisdictions they sit within, including states, counties, and cities. By recognizing the importance of jurisdictional embeddedness in shaping policies at these

universities, however, the research also reinforces the idea that there is no “one size fits all” approach to *future* policy development.

The second paper, in examining how UNC’s business incubator policies have affected the locational patterns of entrepreneurial firms, reinforces the importance of institutional resources in regional development. Yet, the results also draw attention to the institutionally bound nature of a portion of the region’s resources. Institutionally bound resources have frequently been conflated with resources that are available to all entrepreneurs. By showing how only those entrepreneurs with access to the resources altered their locational behavior, the research shows the importance of critically examining resources in terms of access.

The third paper finds that purposeful differences between the QCEW and the NETS (i.e., differences in the types of companies and employees that each database includes) drive much of the observed variation between the databases, and that many observed “inaccuracies” in the NETS disappear when controlling for unpaid labor at entrepreneurial firms. These findings suggest that the databases should not be viewed as substitutes for one another. For entrepreneurial research in particular, carried out by academics as scholarly research or by practitioners trying to gain a better understanding of their entrepreneurial environment, the research suggests that private databases, which lack stringent inclusion guidelines, may be better for analyzing entrepreneurial regions.

## **2 UNIVERSITIES AS JURISDICTIONALLY EMBEDDED INSTITUTIONS**

### **2.1 Introduction**

Universities have increasingly embraced business incubation strategies as part of broader efforts towards commercializing university research, and in doing so have transformed both on- and off-campus land and buildings into spaces for academic entrepreneurs. Their widespread adoption is not surprising when we consider that research commercialization is a form of technological innovation, which Goldstein, Maier, & Luger (1995) recognize as one of eight core functions of the modern research university. Yet, business incubators are unique amongst commercialization strategies by requiring the physical construction, rehabilitation, or rededication of land or buildings. When viewed from this perspective, business incubators are also a form of capital investment, another core university function (Goldstein, Maier, & Luger, 1995). According to Perry & Wiewel (2005), university redevelopment projects, while typically thought of as being motivated by a university's need for space, are in fact frequently driven by a university's interest in redeveloping neighborhoods it perceives as distressed or unsafe. Business incubators can therefore be thought of as a bridging activity between research commercialization (as technological innovation) and land redevelopment (as capital investment) strategies.

In this paper, I conduct an embedded case study analysis of bioscience business incubator provision at two research-intensive universities: Duke University (Duke) and the University of North Carolina at Chapel Hill (UNC). This research therefore begins with a fairly

straightforward question: Why has one of these universities engaged in an expansive business incubator strategy while the other has not?

I ground the case in the concept of *jurisdictional embeddedness*, or the ways in which each university is tied to multiple, layered jurisdictions (i.e., the city, the county, the region, and the state) and their actors through personal relationships, laws, and historical organizational interactions and partnerships (see Feldman & Martin, 2005 for a related discussion of jurisdictional advantage). Each university's unique jurisdictional embeddedness shapes its culture and organization as they relate to commercialization and redevelopment.

In addressing this straightforward question about divergent business incubator provision, I also use business incubators as a lens through which I examine: (1) the extent to which jurisdictional embeddedness influences each campus's internal culture and organization, and (2) how this culture and organization shapes business incubator processes, partnerships, and locations. As bridging activities, business incubators present an ideal case. Business incubators are frequently developed with governmental partners, making them particularly susceptible to jurisdictional political pressures (Phan et al., 2005). I therefore ask two related questions: How has each university's unique, jurisdictionally embedded nature shaped university culture and organization as they relate to commercialization and community redevelopment? How has jurisdictional embeddedness, through culture and organization, contributed to the policies that universities and their partners pursue?

The analysis is based on 20 interviews with past and present officials from both universities, officials from two other area universities, local developers and planners, and academic entrepreneurs from both Duke and UNC. I also include data on each university's

commercialization activities from the Association of University Technology Managers.

I ultimately find that each university's jurisdictional embeddedness has created feedback loops that iteratively frame each university's choice sets and policy avenues, by way of influencing internal cultures and organization. I find that jurisdictional embeddedness has shaped culture and organization as it relates to both commercialization and redevelopment at both UNC and Duke. Prior, local development partnerships, and legal and cultural relationships with the state of North Carolina, have shaped internal direction and choice sets, ultimately leading to distinct approaches to business incubation.

Insights from the study will improve not only how we conceptualize the dynamics of business incubator provision, but also other bridging activities, including the continued expansion of university-linked medical centers, diverse off-campus student housing options, or the relocation of entire departments from one city to another. All of these projects are of enormous import to affected communities, impacting their tax revenues, employment bases, community milieu, and land costs, among others. The ways in which universities pursue these projects—whether to lease or buy, whether to adopt a process of community feedback or not, whether to partner with the community organizations and local government or not—have implications for community residents.

The remainder of the paper is laid out as follows. Section 2 provides a theoretical background. Section 3 discusses the Research Triangle region, Duke, and UNC. Section 4 lays out the case study's basic empirical strategy. Sections 5 and 6 provide a history of Duke and UNC's redevelopment, commercialization, and incubation efforts, and frame these in theories of jurisdictional embeddedness and gradual transformative change. Section 7 provides a discussion

and conclusion.

## **2.2 Theoretical Background**

The term “business incubator” is frequently used as a catch-all term, due to the fact that there is no agreed-upon classification system for business incubators (Bøllingtoft & Ulhøi, 2005; Bradley et al., 2013; Clarysse, Wright, Lockett, Van de Velde, & Vohora, 2005; Phan et al., 2005). At their most basic, business incubators are places where multiple small, entrepreneurial companies can use space. Companies frequently use space by short-term lease, often at low- or even below-market rents. More sophisticated business incubators include wrap-around services and resources to assist entrepreneurs, ranging from specialized equipment to assistance with business plans to networked mentoring with local entrepreneurs. Some are explicitly linked to venture capital or other types of funding, and some set limits on the amount of time a firm can spend in their space (Bøllingtoft & Ulhøi, 2005; Bradley et al., 2013; Meyer, 2003; Phan et al., 2005; Rothaermel, Agung, & Jiang, 2007). The lack of a standard definition or classification system has hampered the development of metrics to determine what constitutes a “successful” incubator, even as they are increasingly recognized as being instrumental in firm success (Bøllingtoft & Ulhøi, 2005).

The university-based business incubator is a distinct form of business incubator due to proximity, wraparound services provision, and access to university resources and services (Bradley et al., 2013; Mian, 1996a, 1996b; Rothaermel et al., 2007). University-based business incubators are frequently close to their parent universities, allowing for easy commutes for entrepreneurs who wish to visit both their university and entrepreneurial spaces. Within the

broader institutional structure of the research university, the wrap-around services in these spaces are geared towards academic entrepreneurs' unique limitations, including underdeveloped links to local industry and poor business-based (as opposed to scientific) knowledge. They also reflect the skills and knowledge of the broader university, including business and legal knowledge from business and law schools. Through their balance of resources and services (e.g., laboratory equipment, mentoring links to specific organizations or industries), universities can also design incubators that emphasize certain types of companies or industries. In a survey of 128 American research universities, Markman et al. (2005) found 62 percent had incubators—and that the remainder had plans to develop them.

As an economic development tool, business incubators are linked to second wave economic development theories and policies (Bradshaw & Blakely, 1999; Isserman, 1993). The presence of university-based business incubators in particular can also be traced back to the “entrepreneurial turn” in the academy, or the broader trend among universities to emphasize the commercialization of university research as part of their mission (Bøllingtoft & Ulhøi, 2005; Bradley et al., 2013; Etzkowitz, Webster, Gebhardt, & Terra, 2000; Goldstein et al., 1995; Phan et al., 2005; Rothaermel et al., 2007). However, this recognized link between the entrepreneurial university and the concomitant increase in business incubators does not help answer basic questions about university business incubators. Why do some universities aggressively engage in an expansive business incubator strategy, while others do not? Why are some business incubators off campus, while others are on campus? Why do some incubators include multiple partners and services, while others do not?

The literature suggests that regional differences play a key role in these variations. As Clarysse et al. (2005) state, in the case of well-developed entrepreneurial regions, “the region

acts as an incubator for the spin-out companies,” (p. 185). In these regions, the entrepreneurial community itself holds a wealth of knowledge and resources that can be directed towards new firms, especially firms that fall within the region’s industrial or occupational specializations. Additionally, as the region’s firms go through their life cycles—whether growth, decline, or death—newer companies are able to cycle into their abandoned spaces. Private companies, too, should see a value in building private incubators in well-developed entrepreneurial environments, where there should be a high market-based demand for these spaces. In this view, the region determines both the extent to which universities engage in business incubation and the form those business incubators take.

However, conceptualizing a university’s business incubator as the product of its region and the particularities of each university’s entrepreneurs’ needs misses two larger points. First, a university’s location in a well-developed regional entrepreneurial environment does not negate other aspects of its location. While the ecosystem may be regional in nature, a university’s communities are not limited to the region. As Charles (2003) notes, “... the university is embedded in many different types of ‘community’: some local, some global; some overlapping and interacting, some barely recognizing each other,” (p. 13). In this paper, I address three of these communities beyond the regional scale, all of which are space-based and nested within each other: the city<sup>4</sup> and the county, which frequently act in concert and are theoretically grouped together in this section, and the state.<sup>5</sup>

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<sup>4</sup> Here, I use the term city to refer to a city or town.

<sup>5</sup> Other levels—including the region and the nation—have been extensively covered elsewhere (see Rothaermel et al., 2007 for a review), and in this particular case of UNC and Duke are identical.



Feldman & Martin (2005) address these different communities in their discussion of jurisdictional advantages, or how jurisdictions can contribute to regional innovation. As they state:

“The term [jurisdiction] connotes a broader and more inclusive description of the economic assets and joint decision-making of a spatially defined system.... [T]he concept of jurisdiction implies the development of laws, regulations, norms and conventions that provide systems of governance and innovation. A jurisdiction may be broad—for example, a country, in which case the vast majority of laws and regulations are the product of the jurisdiction. Or, a jurisdiction may also be narrow—for example, a city, in which case some of the laws and regulations are self-imposed while others are imposed by a super-ordinate body.... While the animate actors in the jurisdiction do not have complete freedom of action, they certainly have a great deal of scope for decision-making and implementation” (p. 1238).

Feldman and Martin develop further these ideas in suggesting how jurisdictions with place-based assets can make distinct, positive contributions towards constructing regional clusters. Yet, the inverse of looking at how jurisdictional actors can leverage their place-based assets is to examine the very institutions that hold or encompass those assets. In this sense, while jurisdictions themselves can directly contribute to development, they can also do so—wittingly or not—by shaping the institutions that are embedded in their communities.

Second, a university’s culture and organization shape 1) the decision to pursue an incubator, 2) the organizations the university partners with (if any), 3) the location of the incubator, and 4) the industries the incubator should focus on. Yet, a university’s culture and organization are not static, but instead continually adapt their strategy and mission to the myriad of circumstances and events that impact the university. This process of incremental institutional change is what Streeck & Thelen (2005) call *gradual transformative change*, which rejects the notion of a path-dependent model of institutional evolution, including ones that emphasize

sudden shifts that are the result of unexpected exogenous shocks. Rather, the institution—especially its culture and organization—incorporates new events or information through the institution’s historically developed feedback loops. Thus, the culture and organization of the university (along with its offices, schools, and departments) are constantly changing by adapting to new events or information, but do so at a speed that is often difficult to recognize (see also Skocpol, 1992; Thelen, 2004). I argue that the direction of the university’s gradual transformative change is due, in part, to the ways in which the university continually reinterprets its core functions of capital investment (as redevelopment) and technological innovation (as commercialization) in a jurisdictionally embedded manner.

### *2.2.1 Urban redevelopment and the jurisdictionally embedded university*

Universities historically isolated themselves from the cities and counties that surround them. Many early university campuses developed around a “pastoral campus” model (Perry & Wiewel, 2005), where campuses were purposely separated from urban areas, and resisted interacting with their surrounding communities, even as these communities grew around them. However, the propensity of universities to isolate themselves changed during the “urban crisis” between 1950 and 1980. In fact, in 1959, the federal government extended the urban match portion of urban renewal funds to include universities (O’Mara, 2012, citing Parsons, 1963). Universities, particularly those in urban areas, forged new partnerships with their cities, with many embracing a leading role in both urban renewal projects and other redevelopment programs during this era. As part of these roles, universities engaged in a formal planning process outside their walls, interacting with government officials and urban planners at city and county levels. Part self-interest and part concern for the surrounding communities, these

redevelopment initiatives form the backdrop for modern town-gown relationships (Bender, 1988; O'Mara, 2012; Perry & Wiewel, 2005; Rodin, 2007).<sup>6</sup>

Recent scholarship suggests that universities continue to address perceived community needs when engaging in redevelopment efforts (Bender, 1997; Holland, 2001; Perry & Wiewel, 2005; Rodin, 2007). In examining the cases included in their edited volume, Perry & Wiewel (2005) concluded that 15 of the 22 universities engaged in redevelopment initiatives after perceiving deteriorated neighborhood conditions around them. Universities, as Strom (2005) notes, are physically tied to their communities, in ways that even large corporations are not. While universities may move individual departments or research centers, entire campuses cannot relocate. To the extent that a university's fate is tied to its ability to attract and retain students, faculty, and staff, the university and neighborhood are tied together. The motivation to redevelop a neighborhood due to perceived distress is distinct from developing for additional space, which can take place either on or off campus. In a similar vein, Lederer (2007) documented dozens of community-university partnerships aimed largely at housing and community development, and found that these community development partnerships are on the uptick.

The University of Pennsylvania (Penn), set in West Philadelphia, is a well-known example of a university-led redevelopment effort motivated not by a pressing need for space, but rather by concerns over safety and what the university perceived as a physically deteriorated neighborhood setting. In the early 1990s, the university led an ambitious redevelopment program in West Philadelphia after deciding that the city of Philadelphia and existing communitiy

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<sup>6</sup> Not all universities separated themselves from their surrounding communities; land grant universities, created to make direct contributions to economic development, are common exceptions. In general, however, elite private and public universities kept themselves apart from their surroundings.

development groups were either unwilling or unable to lead redevelopment efforts. While Penn ultimately partnered with other non-profits, the university was the primary source of plans and resources to tackle both residential and commercial development in West Philadelphia (Rodin, 2005, 2007; Strom, 2005). Holland (2001) terms this type of neighborhood-based capital investment strategy as the *engaged campus*, and considers it “responsive to (and respectful of) community-identified needs, opportunities, and goals in ways that are appropriate to the campus’ mission and academic strengths,” (p. 24).

Despite surrounding city conditions and university motivations for *current* intervention, however, the steps a university takes with each successive capital investment project are linked to historical community interactions. As O’Mara (2012) writes in her history of the university’s role in surrounding communities,

“[d]epending on time, place, economic conditions, and personal chemistry, the connection between locality and university can waver between wary goodwill and outright hostility, and it reflects fundamentally different organizational structures and institutional purposes. These relationships are strongly conditioned by past experiences and informed by policy feedbacks (e.g., Skocpol, 1992). Feedback loops can constrain university-locality relationships and the economic development initiatives that they produce” (p. 236).

In this sense, the goals of historical redevelopment efforts continue to inform the goals of modern interventions, and the ways in which universities pursued these goals in the past (through partnerships or not, in consultation with the surrounding community or not, etc.) continue to inform the ways in which universities approach development efforts. Penn, for example, acquired close to 50 percent of its modern real estate holdings in the 1960s and 1970s (Strom, 2005). Those tracts have served as the basis for its modern development footprint.

None of this is to say, however, that goals and partnerships can’t change. Returning to the

example of Penn, Strom's (2005) analysis of both Penn and Temple University's (Temple) involvement in Philadelphia, for example, contrasts how the two universities—both of which were significant forces in the city's urban renewal programs between the 1950s and 1970s—have engaged in increasingly *different* development strategies since then. Penn has linked their continued redevelopment efforts to a far more engaged process with the city of Philadelphia than Temple. Penn administrators, for example, have repeatedly sought out positions on both non-profit and governmental boards at much higher levels than Temple administrators, and have even taken part in political campaigns and transitions in Philadelphia.<sup>7</sup> These cases reveal that while history—in this case, urban renewal programs—matters, a university's interactions with local governments and non-profit organizations are not predetermined or set by rigid, path-dependent prescriptions. Rather, through iterative community interactions, universities can incrementally forge new development directions.

Yet, the Penn and Temple examples also point to the state as an additional layer of jurisdictional embeddedness. The state—in their case, Pennsylvania—shapes embeddedness in multiple ways. First, states exert considerable variation in their control over public universities, particularly when it comes to development (Austrian & Norton, 2005). For development purposes in particular, public universities often do not control their own capital investment budgets (although university-controlled real estate foundations can be a way around parts of this). The state may make decisions over the buildings that can be built or how they are financed, and land the university owns is state land. These arrangements can open up or cut off certain

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<sup>7</sup> These interactions fall under what Goldstein, Maier, & Luger (1995) call regional leadership, but these interactions can occur at far smaller scales (e.g., county and city), providing linkages between administrators and local community and governmental officials while conducting both university and non-university business.

development paths if the university is acting as the sole developer, or incentivize partnerships that allow universities to circumvent state control. Second, the state may indirectly shape the types of projects public universities engage in. Public universities are expected (sometimes explicitly through their missions, but sometimes only implicitly) to contribute to both their state's economic development and its well-being, and may view emphasizing such contributions through development as a way to preserve funding or increase goodwill in their state legislatures (Feller, 2004; Goldstein, 2010; Goldstein & Glaser, 2012; Goldstein & Luger, 1993; Lowe & Feldman, 2008). This may lead public universities to prioritize development projects that can be clearly linked to economic development, and work directly with local governments over private developers.

Private universities do not have this same complex relationship with their state legislature. Yet, the *absence* of such a relationship can leave them vulnerable to questions about their tax-exempt status, particularly when pursuing redevelopment projects or projects that their surrounding communities perceive as outside the university's core educational mission. Princeton University, for example, has been engaged in a lengthy legal battle to protect its tax-exempt status in New Jersey. As explained in *The Chronicle of Higher Education*:

“In the Princeton case... a group of property owners sued the university in 2011, challenging the tax exemption of more than a dozen university buildings. ... The property owners also contend that the university's overall tax exemption should come into question because of its distribution of royalty payments to faculty members” (Blumenstyk, 2013).

The case, *Fields v. Trustees of Princeton University*, has been working its way through the courts since 2011, with the burden of proof lying with Princeton to prove its tax-exempt status. Cases like this may incentivize universities to make arms-length development deals on any properties

that have for-profit operations in them (or that appear to be for-profit), partnering either with local governments or with private developers and taking the backseat in the development process.

The public university's unique arrangement with their state government—and the private university's lack of such an arrangement—does not invalidate the role of local government, or the complex and evolving relationships that constitute that level or jurisdictional embeddedness. Rather, a university's embeddedness within the state can flow through to its embeddedness in the local jurisdictions, reinforcing historically developed partnerships and relationships.

### *2.2.2 Research commercialization and the jurisdictionally embedded university*

A university's research commercialization efforts are linked to its internal culture and organization. Scholars have noted that early pioneers in commercializing research, including MIT and Stanford, had broad cultural and organizational support for research commercialization across faculty and staff (Clark, 1998; Roberts, 1991). Evidence of the influence of culture has been found in many additional studies (Bercovitz, Feldman, Feller, & Burton, 2001; Goldstein, 2010; Jacob, Lundqvist, & Hellsmark, 2003; Rothaermel et al., 2007). Recent research, recognizing that many of the policies or resources through which a university supports the commercialization process do not emerge from the university's technology transfer office (TTO), has focused on the roles that business and law schools provide in education, networking, mentoring, and policy development (Wright, Birley, & Mosey, 2004). In this sense, the university's organization—in terms of the schools or departments it has, and the flexibility these programs have to develop and implement commercialization programs—matters.

Yet, jurisdictional embeddedness matters here, too. The university's jurisdictional

embeddedness shapes both the ways in which research is commercialized (i.e., its “exit strategy”; Phan et al., 2005), and the university’s larger push to commercialize research, regardless of exit strategy. First, a university can accomplish the commercialization process by using a number of different exit strategies, or the ways in which the technology exits the university into the commercial marketplace. One of the two most common strategies is to transfer a technology developed in the university to a larger corporation. The other common strategy is to transfer a technology to a new company, which can be either an entrepreneurial company or a joint venture. The TTO, the office on campus that controls the transfer of the technology, is often seen as the protector of a university’s technology portfolio, with the responsibility to balance risk and return timelines (Siegel, Veugelers, & Wright, 2007). Financial returns from transferring technology to a large corporation are often considered a safer, short-term payoff strategy; transferring to an entrepreneurial company includes a longer-term payoff structure, with the chance of either a very high or low payoff for the university (Siegel et al., 2007).

In theory, TTOs balance these exit strategies to balance their portfolio (Siegel et al., 2007). Yet, from the point of view of jurisdictional embeddedness, there is a critical difference between the two options. Licensing to a large company does not guarantee that the benefits of development—including jobs, an increased tax base, and the retention of knowledge that can feed back into the region’s industrial clusters—remain in the community. These benefits can instead move to the licensees’ regions. Entrepreneurial companies, in contrast, have a much higher likelihood of remaining in the region (assuming that there is regional capacity absorptivity; see Avnimelech & Feldman, 2015). While entrepreneurs in general tend to remain in their “home” region (Dahl & Sorenson, 2009, 2012; Figueiredo, Guimarães, & Woodward, 2002), remaining in a home region is particularly common for academic entrepreneurs. These



entrepreneurs tend to treat their academic job as their “primary” job (Meyer, 2003), and therefore remain geographically tied to the community. The same state mission that influenced public universities in the previous section can be expected to influence a university’s exit strategy balance, too, with public universities emphasizing an entrepreneurial exit strategy. Private universities may, in contrast, take a more balanced approach.

### **2.3 Empirical Approach**

This study asks three interrelated questions: First, Why has UNC engaged in an expansive business incubator strategy while Duke has not? Second, how has each university’s unique, jurisdictionally embedded nature shaped university culture and organization as they relate to commercialization and community redevelopment? Third, how has jurisdictional embeddedness, through culture and organization, contributed to the policies that universities and their partners pursue?

The study design exploits the fact that both universities are in the same region. As covered in the earlier theoretical section, a well-developed entrepreneurial ecosystem can serve as the incubator (or, as is more likely, provide private business incubators; Bradley et al., 2013; Clarysse et al., 2005; Rothaermel et al., 2007). This condition has led prior studies of university engagement models to conclude that inter-regional differences frequently drive different university models (Gunasekara, 2006). While this is undoubtedly true, a focus on regional differences obscures differences that can occur on smaller scales. By focusing on one region, this paper disentangles regional drivers from those that are specific to the university and its relationship with surrounding jurisdictions. While the *entrepreneurial* literature focuses on both

the role of the region and the university, the *university redevelopment* literature focuses on a far narrower scale, typically at a neighborhood or city level (Charles, 2003; Smith, 2007). Similarly, by examining both a public and a private university in the same region, I can explore how the state of North Carolina shapes each university's approach to business incubation.

Both UNC and Duke have used business incubators, although their physical manifestations are starkly different. UNC embarked on a strategy of providing multiple business incubator spaces, including several that have served bioscience companies founded by UNC faculty and staff. These incubators provide entrepreneurs with distinct sets of resources (e.g. laboratory equipment, mentoring), are located both on and off campus, and have been developed by the university both as a single entity and in partnership with local governments. Duke, in contrast, does not currently have any business incubators that can serve faculty and staff. The university at one point had an incubator at the Pratt School of Engineering, and currently has incubators for student and social entrepreneurs.

To explore differences in business incubator strategies, the paper relies on interviews with four key sets of interview subjects: Duke University employees, UNC employees, entrepreneurs from both universities, and outside experts. These outside experts are from the Town of Chapel Hill and Orange County, the City of Durham, two other area universities, and local development companies. The paper relies on interviews with 20 of these individuals. After reaching out to several key actors at each university, whose names I gathered from informal conversations and popular press articles, interview subjects were contacted following a snowball approach. In total, I spoke with 10 with ties to UNC, Chapel Hill, or Orange County, 6 with ties to Duke or Durham, 1 with ties to both universities, and 3 outside both universities. The bulk of interviews were conducted between January 2016 and May 2016; four interviews predate this

time period. The interviews ranged from 30 minutes to 2 hours. All were semi-structured, and included questions about university culture, history, organization, and community relations. The study supplements these interviews with data from the Association of University Technology Managers (AUTM), spanning the years 1994 to 2014. This data includes information on university licensing agreements, patents, research expenditures, and start-ups formed through each university's TTO.

## **2.4 The Research Triangle Region, Duke, and UNC**

### *2.4.1 The Research Triangle region*

Duke and UNC are both in the Research Triangle region of North Carolina. The region is known for its bioscience industry, which is anchored by the Research Triangle Park and three research universities (Duke, UNC, and North Carolina State University [NCSU]). The industry has its roots in large branch plants in the Park itself, which was built by the state as a way to spur regional and state development (Luger & Goldstein, 1991; Markusen, 1996; McCorkle, 2012). In the years since the early branch plants opened in the park, the region has witnessed increasing growth in the number of entrepreneurial companies in the region, supported by numerous research institutes, quasi-governmental agencies, venture capital and angel investors, and private incubators (Feldman & Lowe, 2011; Lowe et al., 2016).

The bioscience industry in the region reflects its roots in both branch plants and the universities. According to data collected by Feldman and Lowe (2015), more than 600 bioscience companies were founded in the region between 1980 and 2015. These companies, including those that emerge from universities, have diverse needs for work spaces (Druilhe &

Garnsey, 2004). Many bioscience companies, including those that manipulate biological or chemical specimens for drug development, require specialized wet laboratory space and equipment. However, many others do not. Diagnostic companies, for example, may rely entirely on dry laboratories (i.e., computers). Numerous other companies providing specialized supports, including technical or grant writing, also operate without wet laboratories. Contract research organizations span both groups, with some conducting research requiring a wet laboratory while others do not. Finally, even companies that require wet laboratories may go through a period of time when they do not need a lab bench. For example, if a faculty member makes a discovery when conducting research on a federal research grant, they cannot use that grant money to further the technology for commercial purposes. To raise the money they need, they may decide to temporarily switch their focus and develop their business plan, and they may choose to incubate in a non-laboratory setting for a short period of time. This diversity of needs, both between bioscience companies and within the same company over time, means that entrepreneurial bioscience firms require a diverse set of resources and spaces, which can be difficult to categorize.

#### 2.4.2 *Duke and UNC*

Duke and UNC are, in many ways, very similar universities. The Carnegie Foundation for the Advancement of Teaching categorizes both universities as RU/VH—or very high research activity, their highest ranking for academic research (The Carnegie Foundation for the Advancement of Teaching, 2015). Both universities have medical schools, a key factor in attracting the faculty members who will found bioscience firms. Both have comparable numbers of graduate students and faculty members. And over the past twenty years, Duke and UNC have

maintained similar levels of medical research funding from major government funders such as the National Institutes of Health and the National Science Foundation.

Yet there are critical differences between the two universities. Duke is a private university; UNC is the state of North Carolina's flagship public university, and the leader in what is now the 16-campus University of North Carolina system (the UNC System). Duke is a relatively young university, founded in Durham in 1924 when the tobacco industrialist James Buchanan Duke infused a preexisting small college with a significant endowment. UNC was founded in 1789, making it the country's oldest public university. Duke also has substantially more resources at its disposal; as of 2015, Duke's endowment was valued at \$7.3 billion, whereas UNC's endowment was valued at \$3.0 billion (NACUBO, 2016). There are also key differences in academic foci. Duke has an engineering school, which reaches back to its founding. While UNC once had an engineering department, it was shuttered soon after the development of the UNC System in 1932 to prevent competition with North Carolina's land grant university, NCSU. However, UNC has a school of pharmacy, while Duke does not.

Additionally, while the two universities are a mere ten miles apart, downtown Durham (Duke) and downtown Chapel Hill (UNC) are distinct settings and jurisdictions. Durham's landscape is rooted in the tobacco industry. While the city of Durham has numerous residential neighborhoods, the downtown features multiple, sprawling old warehouses featuring ornate brickwork. The city had a population of 228,330 in 2010, dominating the larger county of Durham, which had a 2010 population of 267,587. Chapel Hill, in contrast, is a largely residential community. The town of Chapel Hill had a population of 57,233 in 2010, and Chapel Hill itself is less than half of the surrounding Orange County's population (133,801 in 2010). Given the university's age, the modern town developed around the university; textile and apparel

manufacturing was placed in neighboring Carrboro, another town in Orange County that is now largely residential. The state of the building stock reinforces differences between Chapel Hill and Durham. The mills in Chapel Hill's closest neighbor, Carrboro, had either been torn down or renovated by the late 1970s. Durham's redevelopment has been far slower, and didn't begin in earnest until the 1990s.

#### *2.4.3 Business incubation at Duke and UNC*

The two universities have developed very different models of business incubation. Duke has not been directly involved in business incubator development involving its own faculty and staff. While there was a short-lived incubator in the Pratt School of Engineering, there are currently no incubators on campus that could house a bioscience company started by faculty or staff.<sup>8</sup> However, the university is considering placing one in downtown Durham over the next several years.

UNC, in contrast, has followed three distinct bioscience incubation strategies: (1) constructing or leasing off-campus space, either alone or in partnership with other entities, (2) dedicated on-campus incubation, where companies sign Facilities Use Agreements for space in incubators that have been carved out of academic buildings, and (3) ad-hoc on-campus incubation, where companies sign Facilities Use Agreements to use individual laboratory benches for their commercial purposes. The divergent approaches prompt the questions: why have these two universities, embedded within the same region and sharing numerous

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<sup>8</sup> There are incubators for student entrepreneurs, but these are typically for either pre-commercialized technology or for social entrepreneurship.

characteristics, pursued very different business incubation strategies? And to what extent has jurisdictional embeddedness shaped these divergent strategies?

## **2.5 The Case of UNC**

### *2.5.1 Development in Chapel Hill*

UNC's recent off-campus redevelopment history in Chapel Hill centers around Carolina North, a planned satellite campus. UNC owns roughly 1,000 acres of land two miles north of the university's main campus. The land currently houses a small airport and natural, wooded land, and the university wanted to redevelop 250 of these acres. While UNC owns the land, the town of Chapel Hill must approve redevelopment plans. The university and the town of Chapel Hill spent more than two decades conducting a redevelopment plan for airport, until in 2008 the town and UNC put together a taskforce to address infrastructure-related stumbling blocks that had held the plans up. Within a year of this taskforce's creation, UNC and the town reached a consensus plan, which Chapel Hill's Town Council passed.

Unfortunately for the university, Carolina North has not progressed much since that time. Alexandria Real Estate Equities, Inc., the company that had agreed to build the campus's Innovation Center, dropped its plans in 2008, citing the economy. The Center would have housed university research labs and a bioscience incubator, among other things. The North Carolina state legislature withdrew the remainder of the new campus's appropriations several years later, putting the rest of the plan on hold.

### 2.5.2 *Commercialization at UNC*

UNC was slow to develop on-campus organizational and cultural support for commercialization. Staff and scientists on campus in the 1980s and early 1990s describe the university back then as a place that was “hostile to commercialization,” (UNC Staff Member A, January 26, 2016). In 1988, following the recommendations of a 1983 study commissioned by UNC President William Friday, UNC, Duke, and NCSU formed the Triangle University Licensing Consortium, or TULCO, which was designed to handle the commercialization processes for all three universities. UNC relied on TULCO for the entirety of its operation (1988-1995) (Feldman & Goble, 2016; Goble, 2013). In fact, the university didn’t hire a full time staff member to handle commercialization until after TULCO’s collapse in 1995.

Since that time, UNC has followed a long path towards embracing commercialization on campus. This is reflected in data from the Association of University Technology Managers (AUTM) data, which collects data from TTOs at major research universities. Between 1994 and 2014, UNC increased in many measures of commercialization including patents, licensing income, and start-up formation. For example, faculty and staff disclosures of commercializable technology increased from 75 in 2004 to 156 in 2014, and US patents increased from 12 in 1994 to 36 in 2014. Table 1 summarizes UNC’s commercialization indicators from 1994-2014.

UNC’s commercialization strategy appears to be tilted towards entrepreneurship. Looking at the number of patents issued versus the number of start-ups reveals a similar trend. In 1994, UNC received 12 patents yet spun out no companies. In 2004, the university had 30 patents and 3 spin-out companies. While those three spin-offs may not be from those 30 patents, as a rough approximation, UNC spun-out 10 percent of its patents into entrepreneurial companies. That ratio was even higher in 2014, when UNC spun off 10 companies from 36



patents (28 percent). In contrast, UNC has consistently low levels of licensing income. The increase from \$0.9 million in 1994 to \$7.6 million in 2014 is a substantial percentage increase. However, when considered against the fact that the absolute increase was roughly \$6.7 million in a time period when UNC's patents rose from 10 to 36 and when its federal research expenditures increased from \$186.1 million to \$620.3 million, a \$6.7 million increase is not dramatic. Similarly, UNC's industry sponsored research rose from \$1.8 million to \$33.9 million, but remained relatively low when compared against federal grants.

**Table 2.1: UNC commercialization indicators, 1994-2014**

<b>Commercialization Indicator</b>	<b>1994</b>	<b>2004</b>	<b>2014</b>
<b>Individual Disclosures Received</b>	75	120	156
<b>US Patents Issued</b>	12	30	36
<b>Start-Ups Formed</b>	0	3	10
<b>Gross Licensing Income (in millions)</b>	\$0.9	\$3.9	\$7.6
<b>Federally-Sponsored Research (in millions)</b>	\$186.1	\$281.4	\$620.3
<b>Industry-Sponsored Research (in millions)</b>	\$1.8	\$8.3	\$33.9

The programs and policies put in place at UNC emphasize entrepreneurship, and are therefore linked to the AUTM. For example, the university created the Center of Entrepreneurial Studies in the Kenan-Flagler Business School in 1992 and Launching the Venture (a Kenan-Flagler entrepreneurial business skills program) in 1999. UNC also joined the Kauffman Campuses Initiative in 2004, which funded numerous entrepreneurial programming initiatives (see Feldman et al., 2009 for an overview of many early changes at the university). Since that Initiative's expiration in 2010, UNC has developed additional programming options, including competitions that award seed funding to proposed entrepreneurial ventures. The fact that so

many of these programs are tilted towards entrepreneurship is not surprising, given UNC's leadership under Chancellor Holden Thorpe between 2008 and 2013. Thorpe himself had been a bioscience entrepreneur, and during his tenure as chancellor pushed the university further towards entrepreneurship. In fact, one staff member involved in incubator development remarked that he referenced Thorpe's appointment whenever they encountered push-back:

"I used Holden as my kind of cover for a lot of what I did, because I could just point to the chancellor and say hey. We have a chancellor who is an entrepreneur, who believes in innovation and entrepreneurship, so therefore we should be doing these kinds of things. I think that helped grease the skids quite a bit to get some of these things through" (UNC Staff Member A, January 26, 2016).

From this perspective, while Thorpe provided leadership for entrepreneurship, his appointment gave this already developing entrepreneurial culture a chance to grow.

### 2.5.3 *Business incubators at UNC*

After Carolina North's collapse, UNC began to ramp up its on-campus, ad hoc incubation. The head of Carolina KickStart, a campus program that helps faculty commercialize their research through programming, mentorship, funding, and networking, worked to adapt Facilities Use Agreements (FUAs) into a commonplace tool for on-campus incubation. The university uses these agreements to allow outside groups to use on-campus space for their organization. University staff have adapted and streamlined these FAUs into formal agreements to allow bioscience companies to use on-campus space.<sup>9</sup>

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<sup>9</sup> The main difference between the older FUAs and the incubation FUAs is in the sign-offs. For a faculty or staff member to incubate through an FUA, numerous parties across campus have to sign off, including department heads, the university's TTO, UNC's Occupational Safety and Health Division, UNC's Facilities Services, etc.

UNC staff also looked off campus for potential business incubator locations. For example, the Director of Economic Development and Regional Engagement at the Renaissance Computing Initiative (RENCI), a UNC research institute, decided that RENCi could house an incubator.<sup>10</sup> RENCi, located roughly four miles from campus, had extra space at the time. RENCi reached out to the Director of the Center for Entrepreneurial Studies at UNC's Kenan-Flagler Business School. The two soon drew up plans for an incubator, and Carolina Launch Pad opened in late 2008. The incubator didn't have the capacity for wet laboratories, but nonetheless has housed bioscience companies. Dyzen, for example, is a web-based bioscience company that creates and tests virtual labs to maximize the efficiency of built scientific laboratories. The firm is therefore a prime example of bioscience companies that do not need wet laboratories. However, even bioscience companies that eventually moved to wet laboratory space were originally located in the incubator. Rheomics, Inc., which develops diagnostic instrumentation and analysis systems, used Carolina Launch Pad when developing its business plan and applying for grants. Without these grants, the company could not afford to lease laboratory space and develop prototypes. Thus even for more traditional bioscience companies, these incubators are instrumental in helping to successfully push them through their life cycle.

However, UNC staff didn't view Carolina Launch Pad as sufficient for bioscience companies. A Chapel Hill-based entrepreneur (who is also an adjunct professor at UNC's business school, specializing in entrepreneurship) contacted the university and the town of Chapel Hill about a 1,200 square foot storefront he owned in downtown Chapel Hill, a space he

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<sup>10</sup> The Director was aware of the demise of Carolina North's incubator. However, prior to his job at UNC, the Director had worked at Georgia Institute of Technology (Georgia Tech), a university known for both its incubators and role in downtown Atlanta's redevelopment (Youtie & Shapira, 2008). They took a "why not here" approach to incubators at UNC.

suggested would be ideal for a bioscience incubator. The university drew up plans for the space, but ultimately decided that installing wet laboratory equipment would be cost prohibitive and abandoned the plan. During this time, however, the town of Chapel Hill had also been considering building an incubator, as part of a larger strategy to support entrepreneurship in the town. The Town reached out to UNC and Orange County, and asked if they would like to partner with the town. Orange County was a particularly important partner; voters in Orange County had recently passed a sales tax increase, and roughly \$1.3 million per year of that increase is earmarked for county economic development. The county had also been independently searching for a place to put an incubator, but had been unsuccessful in finding one. Together, the Town of Chapel Hill, UNC, and Orange County partnered to create Chapel Hill's LaUNCH Chapel Hill; the university ultimately folded Carolina Launch Pad into this effort.

Unfortunately, this new incubator did not include wet laboratory space. Rather than search for additional off-campus space that could be upfitted to house wet laboratories, university staff decided to create a dedicated incubator in 6,000 square feet of space that had recently opened up on UNC's campus. LaUNCH Chapel Hill remains an off-campus business incubator without wet laboratories, and UNC continues to rely on on-campus spaces for laboratories (while continuing to look for appropriate off-campus wet laboratory incubation space).

#### *2.5.4 Business incubators as UNC's jurisdictionally embedded bridging activity*

UNC's business incubator strategies bridge two of its university functions: (1) its redevelopment path, and in particular the working partnership the university developed with the

town in the Carolina North process, and (2) its commercialization path, which is tilted towards entrepreneurship. In this section, I discuss how the university's jurisdictional embeddedness in the state of North Carolina and Chapel Hill/Orange County shaped each form at UNC.

UNC's embeddedness in the state of North Carolina may have influenced the university's predilection for entrepreneurship. As a state university, UNC has historically had a mission to contribute to economic development, a mission that became explicitly linked to a local development in 2007 (University of North Carolina Tomorrow Commission, 2007). Licensing, while creating income for a university, does not necessarily keep technological innovation in the state or the university's surrounding communities. Entrepreneurial companies tend to remain in their home regions (Avnimelech & Feldman, 2015); in this sense, UNC's business incubators can be seen as increasing *local*—as opposed to *regional*—absorptiveness. In this sense, UNC's jurisdictional embeddedness in the state of North Carolina can be linked to the steady shift in the university's commercialization towards a very specific model that emphasizes entrepreneurship.

Interestingly, UNC's recent entrepreneurial companies may require campus space more than their historical counterparts or their counterparts at Duke. Academics can choose to retain complete control over their entrepreneurial spin-outs, or they can choose to use surrogate entrepreneurs (Franklin, Wright, & Lockett, 2001). In the surrogate model, the academic entrepreneur functions primarily as a scientific founder or advisor; other founders control the daily operations of the firm, both scientific and business. UNC's model is explicitly aimed at retaining direct equity and/or royalty participation over firms, and not using entrepreneurial surrogacy. At the same time, UNC has focused on streamlining the process of spinning out an entrepreneurial company; if a faculty member wants to use his or her own technology to form a company, the university's TTO aims to spin that company out in just a few months. As one UNC

employee stated, “UNC’s policies are ‘faculty friendly,’ insofar as they allow faculty members to participate in the spinoff of firms with a university license of the technology they invent and become involved in an appropriate role in the venture moving forward,” (UNC Staff Member C, June 22, 2016).

It is possible that the combination of these two things—the academic entrepreneur’s retention of complete control, and a short spin-out timeline—may be contributing to companies that need the university for spatial resources. Given the uncertainties inherent in technology development and the related uncertain payoff structure for investors, companies based on less-developed technologies have a harder time raising funding from the private market than companies with technologies that have gone through additional proof-of-concept rounds (Lacetera, 2009). By spinning out early, and by being tied to the academics that remain employed at UNC, these companies may be tilted towards staying near the university.

UNC’s embeddedness in the state and the local community also shaped redevelopment paths. Locally, there is a clear line between the joint university-town task force around Carolina North and partnerships in incubation. Prior to that task force’s development, UNC and Chapel Hill had an uneasy relationship. The partnerships that led the Town of Chapel Hill to reach out and ultimately partner with UNC trace their lineage to the Carolina North development process (see also Goldstein & Glaser, 2012 for a discussion). Chapel Hill staff report that the partnerships they leaned on during the formation of LaUNCH Chapel Hill, which ultimately subsumed and expanded Carolina Launch Pad, were a direct result of the relationships the university built with Chapel Hill during the Carolina North process, and that LaUNCH Chapel Hill would not have occurred without Carolina North.

UNC's embeddedness in the state has also shaped the paths UNC took on business incubation. On the one hand, UNC's status as a public university gives it the flexibility to not worry about being sued over its tax-exempt status—a privilege Duke does not have. However, at the same time, the university doesn't have complete control over its facilities budget. While the university does have a development subsidiary it controls,<sup>11</sup> large capital projects are directly funded from the state, which explains how the state was able to remove the remainder of its support for Carolina North. While the most obvious link between Carolina Launch Pad and LaUNCH Chapel Hill is the local partnership tracing its roots to Carolina North, a second link could have been that UNC became far more willing to be creative in funding buildings. Reaching out directly to a major university donor to fund a leased space, for example, allowed the university to de facto lease space without involving any the university's larger bureaucracy. While LaUNCH Chapel Hill is now directly supported through UNC's Chancellor's Office (with programming provided by UNC's Kenan-Flagler Business School), that initial funding arrangement was critical for securing the university's initial involvement.

Running through both the university's commercialization and development policies is the university's decentralized organization. This recurring theme has meant that, as jurisdictional embeddedness shapes the direction of change in both commercialization and redevelopment, different pockets of campus have adapted in unique ways. UNC staff report that they have freedom to implement any policies they want within their schools or institutes, as long as the

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<sup>11</sup> In 2009, UNC purchased Carolina Square, a complex with an outdoor mall, office buildings, and residential towers that sits adjacent to the campus. The university completed the acquisition through a subsidiary of the university, a real estate development foundation that is outside the direct control of the state. In 2015, the university entered into a long-term lease with private developers to redevelop the land. Critically, UNC does not need approval from the state legislature for these moves.

money is in their budgets. In this sense, UNC's incubators are not disjointed policies, as they may appear on first glance. Rather, they share common roots in campus-wide commercialization and redevelopment cultures, and reflect how each department interprets their contribution to the university's broader commercialization and redevelopment focus and leverages their resources to do so.

## **2.6 Duke**

### *2.6.1 Development in Durham*

Duke has played a critical role in downtown Durham's redevelopment. The university's investment history reaches back to the early 1990s, when Duke began purchasing private homes in the Trinity Park neighborhood and redeveloping them. Since then, in projects ranging from the redevelopment of the American Tobacco complex in 2004 through the current 27-story downtown tower, Duke has largely followed a strategy of agreeing to lease space in buildings slated to be redeveloped by a private developer. This strategy is not an up-front cash investment, nor does it fit neatly within Goldstein et al.'s (1995) original conceptualization of capital investment. However, by agreeing to lease anchor space years in the future—and by, over time, becoming the anchor tenant that Durham developers know they can turn to in order to get a deal done—Duke has become a major back stopper of downtown development. One developer noted that while Duke has not been the only major backer, it's hard to imagine downtown Durham's redevelopment occurring *without* Duke's involvement.

Duke is now the largest tenant in Durham, leasing over one million square feet of space; that number is expected to exceed two million square feet over the next decade. Critically,



Duke's leasing strategies in downtown Durham have not been wholly motivated by needs for *additional* space, though the university has grown since those early Trinity Park investments. Rather, their increase in downtown space reflects both an increase in total space and a *redistribution* of leased space across the region. Duke has historically leased space throughout Durham's outer edges and in the Research Triangle Park. Yet over time, they have shifted their leased spaces towards downtown Durham.

### 2.6.2 *Commercialization at Duke*

In their comparison of university organizational structure and TTOs, Bercovitz et al. (2001) categorized Duke as a “low intensity incumbent” university, or one “with limited patent and licensing activities, and thus little in the form of technology transfer offices or organizational arrangements, prior to 1980” (p. 26, citing Mowery & Zedonis, 1999). While they had some internal capabilities prior to TULCO's formation, they had no real expertise on how to institute a successful research commercialization system. The university hired a full-time TTO officer when TULCO opened. Thus, while UNC relied on TULCO for the organization's entire life (1988-1995), Duke used TULCO until 1992 as an expert resource for problematic cases. Between 1988 and 1992 when they left TULCO, Duke developed their internal TTO capacity.

Since that time, Duke has increased its commercialization efforts. Between 1994 and 2014, Duke faculty disclosures increased from 98 to 162, and patents rose from 30 to 49. In contrast to UNC, however, Duke's increase in commercialization appears to be driven by licensing to existing companies (or conducting sponsored research), as opposed to entrepreneurship. Like UNC, Duke had 0 start-ups in 1994. Yet the university had only 6 start-

ups in 2014, a number that is considerably less than UNC's 10 (as a further contrast, Duke's start-up high water mark was 10 in 2004, whereas UNC's was 14 in 2013). The relatively lower numbers of start-ups is striking when considering their higher number of patents. UNC's 10 start-ups compare against 36 patents (28 percent start-up rate), whereas Duke's 6 start-ups are against 49 patents (12 percent start-up rate). Table 2 summarizes Duke's commercialization indicators from 1994-2014.

**Table 2.2: Duke commercialization indicators, 1994-2014**

<b>Commercialization Indicator</b>	<b>1994</b>	<b>2004</b>	<b>2014</b>
<b>Individual Disclosures Received</b>	98	127	162
<b>US Patents Issued</b>	30	32	49
<b>Start-Ups Formed</b>	0	10	6
<b>Gross Licensing Income (in millions)</b>	\$1.6	\$3.9	\$35.9
<b>Federally-Sponsored Research (in millions)</b>	\$148.8	\$348.0	\$558.0
<b>Industry-Sponsored Research (in millions)</b>	\$30.3	\$94.4	\$252.4

Another way to look at the emphasis on licensing (as opposed to entrepreneurship) at Duke is to look at their licensing income. Duke's licensing income rose by a substantial amount between 1994 and 2014, from \$1.6 million to \$35.9 million (in the same period, UNC's rose from \$0.9 million to \$7.9 million). Duke conducted research from federally sourced grants of \$148.8 million in 1994 to \$558 million in 2014; in this metric, Duke and UNC have consistently tracked each other. However, whereas UNC had industrial sourced research that ranged from \$1.8 million to \$33.9 million, Duke's ranged from \$30.3 million to \$252.4 million in 2014. Much of this growth is driven by the Duke Clinical Research Center, a research institute that conducts clinical trials for pharmaceutical companies in Duke's hospitals.

Like UNC, Duke has developed initiatives around commercialization. Forefront among these is Duke's Innovation & Entrepreneurship Initiative (I&E). I&E was founded in 2010 on Duke's campus, and moved to downtown Durham in 2015. While I&E is a centralized clearinghouse for existing campus and regional resources for commercialization, it does not explicitly focus on commercial entrepreneurship, as many efforts on UNC's campus do. Instead, I&E focuses broadly on translation or moving a laboratory development from a discovery towards a technology that can be patented and commercialized. Translation is agnostic with respect to the exit strategy an innovation takes. Unlike UNC, Duke does not provide grants or awards to faculty-led entrepreneurial companies. Rather, I&E connects prospective entrepreneurs to regional assets (in addition to translational grants). More recently, I&E has handled access to the Duke Angel Network, a venture fund that invests in companies funded by Duke students, alumni, faculty, staff, or parents, anywhere in the United States. Duke-affiliated individuals, and not Duke, finance the fund.

This is not to say that Duke does not have bioscience start-up companies. On the contrary, many of the region's entrepreneurial companies trace their lineage to Duke. For example, Sphinx Pharmaceuticals, one of the region's most successful bioscience start-ups, is a Duke spin-off. However, *relative to licensing, and when compared to UNC*, Duke's commercialization efforts are less tilted towards promoting entrepreneurship.

### 2.6.3 *Business incubation at Duke*

Duke does not currently have an incubator for faculty- or staff-founded bioscience companies. I&E, located in leased space on the edge of what will be Durham.ID, Durham's

planned innovation district, houses a space called the Bull Pen. While not an incubator, it is a centralized place where Duke entrepreneurs can hold meetings and draw on staff to learn about and access resources from both Duke and the larger region. The university also briefly had an incubator in their school of engineering, and currently has two incubators for student or social entrepreneurs. They are reportedly considering putting an incubator into space they will lease in a new high-rise in downtown Durham, although staff are divided in their assessment of whether that will happen.

#### *2.6.4 Business incubators as Duke's jurisdictionally embedded bridging activity*

Like UNC, Duke's business incubator strategies bridge two of its university functions: (1) its commercialization path, which is balanced between licensing and entrepreneurship, and (2) its redevelopment path, and in particular the university's role as one of Durham's go-to lessees. The university's jurisdictional embeddedness in the state of North Carolina and Durham shaped each form at Duke.

Duke's embeddedness in the state of North Carolina may have influenced the university's approach to commercialization. Duke's lack of a formal relationship with North Carolina's legislature means that the university has no clear need or mission to contribute to *state* economic development. As such, there is no need to try and tie entrepreneurial companies in place. In fact, the most recent of Duke's means of supporting entrepreneurs—the Duke Angel Network—does not necessarily favor North Carolina companies or emphasize local investment at all. Instead, as with many private universities that lack a yearly infusion of state money, a desire for a diversified revenue source drove Duke's commercialization strategy. A former employee of both

Duke and UNC said that, when Duke decided to ramp up its commercialization efforts in the 1990s, the university did so because they “needed money [from commercialization], because it wasn’t public” (Duke Staff Member A, February 18, 2016).

Duke’s jurisdictional embeddedness in the state and local community also shaped the university’s redevelopment history. In the 1990s, Duke recognized that their future was tied to Durham’s, and that they could no longer wall themselves off from downtown, as they had traditionally done. Duke’s role incrementally morphed into being Durham’s anchor lessee as a means to promote broad-based redevelopment.

Duke’s jurisdictional embeddedness has ultimately shaped the university’s use of business incubation as a bridging activity between commercialization and redevelopment. In terms of commercialization, unlike UNC, which embarked on an incubator strategy because the university perceives a need for space for entrepreneurs, Duke doesn’t have that same perceived need because entrepreneurship is not the primary focus of its commercialization efforts. In terms of redevelopment, the university has not taken a leading role in spearheading development, so forging a partnership to build an incubator would be out of character. Critically, given the size and vibrancy of Durham (vibrancy that Duke is in part responsible for, given the university’s role in agreeing to lease redeveloped buildings), the university does not have to build, manage, or promote incubators—private developers have built the incubators that provide local absorptivity. The American Underground incubator, for example, opened in American Tobacco, one of the first major projects that Duke agreed to lease significant space in. Duke’s lack of a formal relationship with the state is also important in considering its lack of a business incubator

strategy. Duke's counsel has decided that Duke can't have on campus incubation.<sup>12</sup>

If Duke does pursue a business incubator strategy in the future, there are signs that it, too, would fit within this bridging view of activities. I&E, while not an incubator, is the face of the university's commercialization efforts; it moved from its on-campus location to leased space in a converted tobacco warehouse in 2015. Should Duke decide to turn part of its leased space in the new high-rise into an incubator, that, too, will be driven by redevelopment. That high rise will sit on several downtown blocks that the developer, the city, and Duke viewed as particularly distressed and unsafe. In other words, Duke is leasing that space to continue to anchor downtown Durham's redevelopment; an incubator, if it happens in that space, is a byproduct of that redevelopment.

## **2.7 Discussion and Conclusion**

In this paper, I looked at why two universities in the same region have engaged in very different business incubation strategies. Studies examining business incubators (and commercialization more broadly) have pointed to both university culture and to the region as key determinants to their form and function (Clarysse et al., 2005). In this paper, I unpacked these determinants by drawing on the concept of jurisdictional embeddedness. In addition to asking why these two universities engaged in such different patterns, I therefore also posed two additional questions: How has each university's unique, jurisdictionally embedded nature shaped

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<sup>12</sup> Duke may be particularly sensitive on this point. In 2003, the university was found guilty of patent infringement in well-known court case, *Duke v. Madey*. That court case serves as the legal basis for the current case against Princeton.

its commercialization and community redevelopment strategies? How has jurisdictional embeddedness contributed to the policies that universities and their partners pursue?

Both UNC's expansive business incubator adoption strategy and Duke's lack of such a strategy can be linked to their starkly different jurisdictionally embedded natures. Their jurisdictionally embedded natures shaped commercialization cultures by altering incentives for entrepreneurship and licensing, and shaped redevelopment cultures by prodding both into partnerships of different forms. UNC's reliance on on-campus incubation and partnered off-campus incubation reflects the university's emphasis on entrepreneurship, freedom over how to use on-campus spaces, and strong partnerships with the surrounding town and county, all of which developed over decades of gradual, embedded cultural change. Duke's lack of a clear or consistent strategy similarly reflects the university's more balanced approach to commercialization, constraints over how to use on-campus spaces, and anchor lessee partnership strategy in downtown redevelopment.

The study has takeaways for planning and policymaking, for both universities and the jurisdictions that house them. Through analyzing two very successful universities, this research reinforces the notion that there is no one-size-fits-all approach when considering policies. Universities choose strategies in ways that are shaped by the interests, laws, and historical relationships formed with the jurisdictions in which the university is embedded. From a university perspective, the study points to a need to reflect on internal and external opportunities. UNC, perhaps due to the university's decentralized structure, quickly adapted to the demise of Carolina North's Innovation Center by leveraging UNC's spatial and financial (donor) resources, and also by turning to previously developed partnerships with surrounding jurisdictions. From a city or county perspective, the study suggests that partnership patterns can be nurtured and

changed, and then can be leveraged to create successful strategies of cooperation. While Duke and UNC have taken different paths, both have roles in their communities.

From the perspective of both research and practice, this paper suggests that jurisdictions need to be included as a relevant scale of analysis. Feldman & Martin (2005) addressed the ways in which jurisdictions can use their assets to build regional clusters built upon innovation. In a similar vein, this work shows how jurisdictions have shaped the institutions that are within their borders, through historically developed laws and relationships. Yet, it also suggests that both universities have directly (in the case of UNC) and indirectly (in the case of Duke) focused on *local*, and not *regional*, absorptive capacity. Whether these resources ultimately shape where firms locate within a region remains to be seen. The region's bioscience industry has historically been located in and around the Research Triangle Park, which is itself centrally located between the region's three universities. This has made the industry regional, in the truest sense of the word. If the provision of incubators on the outer edges of the Triangle succeed in shifting firm locations further away from the Park, this has implications both for communities but also, potentially, for the flow of knowledge between bioscience companies (Arzaghi & Henderson, 2008; Kerr & Kominers, 2015; Rosenthal & Strange, 2003, 2008).

Finally, while previous scholars have noted how differences between public and private universities spill over into commercialization policies (Feller, 2004), entrepreneurial scholars have typically mentioned these differences in passing. To my knowledge, no paper focused on university commercialization has addressed this issue at length (the redevelopment literature, on the other hand, has). The results of this paper, however, suggest that these differences are pervasive, and need to be pulled to the forefront of the commercialization literature.



### **3 INSTITUTIONALLY BOUND RESOURCES AND FIRM LOCATION DECISIONS**

#### **3.1 Introduction**

The physical location an entrepreneur chooses for a new company is a popular topic of research. This is especially true for entrepreneurial start-up companies in innovative industries, which both scholars and policymakers regard as a cornerstone of long-term economic development (Acs, 2006; Acs et al., 2008; Acs & Armington, 2004; Audretsch, Keilback, & Lehmann, 2006). Over the past several decades, scholars have produced a significant literature examining the relationships between a region's economic and social attributes and its entrepreneurial ecosystem (Baker & Nelson, 2005; Beckman & Burton, 2008; Burton, Sorensen, & Beckman, 2002; Chatterji, 2009; Clarysse, Tartaria, & Saltera, 2011; Feldman et al., 2005; Powell et al., 2011; Saxenian, 1994). The entrepreneurial ecosystem, in these writings, is an interconnected and continually evolving web of relationships and resources, permeating all corners of a region's distinct geographic space, and laying the groundwork for the region's ability to support successful entrepreneurial firms (Auerswald, 2014, 2015; Feld, 2012; Mack & Mayer, 2015). The health of this ecosystem contributes to the number of companies founded in a region, their long-term prospects, and their ability to create innovative products and services. In turn, a region's firms, entrepreneurs, employees, regional actors and institutions contribute to the ecosystem's resource base (Auerswald, 2014, 2015; Feldman et al., 2005; Saxenian, 1994).

Yet, this regional perspective on attributes of the entrepreneurial ecosystem rarely critically examines the fact that a region's entrepreneurial firms—even those within the same industry—are not homogeneously distributed across the region. This is despite the fact that intra-regional entrepreneurial geography is lumpy, and displays evolving geographic patterns of entrepreneurial firms (Mack & Credit, Forthcoming; Renski, 2008; Stangler & Bell-Masterson, 2015; Stough, Haynes, & Campbell Jr., 1998). The fact that the existence of these microgeographies has gone largely without remark in the entrepreneurial literature reflects the fact that many of the factors that distinguish the entrepreneurial ecosystems literature from its roots in the firm location literature—including the importance of regional institutions—have not been applied to studies of intra-regional microgeographies. Rather, microgeographies are often implicitly assumed to be products of exogenous forces—like market rents and a region's transportation infrastructure—and not a reflection of deeper forces within the ecosystem. While problematic for the literature, this implicit assumption is also problematic for local policymakers and practitioners, who are left unclear as to what role, if any, they can effectively play in shaping small-scale geographies.

A critical examination of the literature suggests that the factors that have shaped the entrepreneurial ecosystem—including the unique roles that resource-rich institutions and regional actors play in shaping each ecosystem as it evolves over time—may also shape microgeographies. First, the unique resources that define each entrepreneurial ecosystem—including “harder” resources like funding and the physical space for start-up firms, as well as “softer” resources like mentoring from previous entrepreneurs and business counseling—are not equally available to each entrepreneur or firm in the region. Many of these resources are instead institutionally bound, extended to only those subsets of entrepreneurs and firms that are

embedded within a distinct community defined by the institution (Bradley, Hayter, & Link, 2013; Lockett, Wright, & Franklin, 2003; Rothaermel, Agung, & Jiang, 2007; Siegel, Veugelers, & Wright, 2007). Examples here include firms started by academics, who have access to resources from their university, or firms started by former employees of a larger firm, who have access to resources from the larger firm (Agarwal, Echambadi, Franco, & Sarkar, 2004; Bradley et al., 2013; Chatterji, 2009; Rothaermel et al., 2007). Second, the actors that shape the regional ecosystem's long-term prospects are not necessarily active across an entire region. In fact, they are often constrained to the small-scale political or institutional geographies in which they are embedded, such as local chambers of commerce or universities. These organizations often have clear interests in the economic success of local, smaller-scale geographic areas, too (Bercovitz et al., 2001; Drucker & Kass, 2015; Gaffikin & Perry, 2009; Perry & Wiewel, 2005; Singh & Marx, 2013).

Taken together, these points suggest that while traditional factors from the firm location literature (such as exogenously determined rents or transportation infrastructure) may be important in shaping entrepreneurial firm location decisions, they are not the only forces shaping entrepreneurial microgeographies. The resources and interests of local institutions matter, too. Ultimately, these institutionally bound resources influence the locational choice sets from which entrepreneurs make selections (Stam, 2007). Without recognizing the role these resources play, our model of the entrepreneurial region—one that is geographically distinct from other regions—is, itself, incomplete and theoretically aspatial.

Two interrelated questions are important for unpacking the foundations of entrepreneurial microgeographies: First, does the introduction of new, institutionally bound resources fundamentally alter the pattern of firm locational decisions, such that we can observe a

significant change in the geographic pattern of firm locations? Second, do entrepreneurs embedded in a community with institutionally bound resources search for company space in a way that is different from entrepreneurs who are not embedded in the same community?

I answer these questions by examining the first locations of entrepreneurial bioscience firms founded between 1990 and 2012 in the Research Triangle region of North Carolina. Bioscience firms are an ideal case study. Entrepreneurial firms in the industry often require unique laboratory spaces that can be difficult to find. Their entrepreneurs emerge from both the university and industry, and as such have access to different sets of resources. These firms are also frequent targets of recruitment and retention efforts, meaning that resources are extended to them from diverse sources. This is particularly true in the Research Triangle region, where the long-recognized bioscience cluster has been slowly moving away from its branch plant roots to a mix of larger and smaller firms (Lowe & Feldman, 2014; Lowe et al., 2016; Luger & Goldstein, 1991; Markusen, 1996; McCorkle, 2012; Rohe, 2012).

I use a mixed-method case study approach, and integrate three sources of data: the Feldman-Lowe database, a proprietary database housed at the University of North Carolina at Chapel Hill (UNC) that contains detailed firm and founder information (Feldman & Lowe, 2015); the National Establishment Time Series database (NETS), an establishment database based on Dun & Bradstreet data that contains detailed location information; and interviews with 25 entrepreneurs and university or local officials.

Using the 2009 shift in formal UNC resources regarding the provision of space for entrepreneurial companies, I compare the first founding locations of 82 UNC-parented entrepreneurial bioscience firms to the locations of 241 non-university-parented entrepreneurial

bioscience firms, both before and after the 2009 change. The UNC-parented firms, founded by entrepreneurs who are embedded in the UNC community, have access to these institutionally bound resources between 2009 and 2012; the non-academic firms do not.

The research findings suggest that UNC's strategies, which provide on- and off-campus space for companies linked to UNC, have influenced entrepreneurial firm location patterns by pulling them closer to the university. Interviews reveal that this shift is in fact due to the presence of these specialized spatial resources, and that entrepreneurs learned of these spaces through on-campus entrepreneurial networks.

By highlighting the importance of institutional work histories, institutionally bound resources, and the implementation of entrepreneurial policies, the findings deepen our understanding of the entrepreneurial ecosystem. Universities are not just regional anchors of innovation, but are themselves major players in shaping where in the region firms locate. Recognizing the process and policies through which universities shape microgeographies opens the door to further research on the ways universities shape the region's entrepreneurial ecosystem. For planning practitioners, the findings suggest an effective path for embedding nascent entrepreneurial firms in the community, giving local communities the opportunity to develop targeted, complementary retention policies for these firms as they grow.

The remainder of this paper is outlined as follows. Section 2 introduces the theoretical framework for the study and Section 3 presents the Research Triangle bioscience case study. I describe the study's empirical strategy, data, and methodologies in Sections 4 and 5. Section 6 includes the results of the models and interviews. I conclude with implications for entrepreneurship literature and policy in Section 7.

### **3.2 Entrepreneurial Firm Locations and University Parentage**

While entrepreneurs face a myriad of challenges when founding a company, one of the most basic is securing physical space. This is an especially pressing concern for bioscience firms, which exist in an industry with high fixed costs, an uncertain and long-term payoff structure, haphazard funding, and a frequent need for specialized lab space that is both expensive and difficult to find (see Pisano, 2006a, 2006b, 2010 for a general discussion of challenges in the bioscience industry). Yet the mechanics of how entrepreneurs find locations for their firms and how these mechanics in turn shape sub-regional microgeographies of firms is not something that the literature has addressed well. This section reviews the existing literature on firm location, social networks, and access to institutionally bound resources, while identifying gaps in the application of these literatures to explain microgeographies in the entrepreneurial ecosystem.

#### *3.2.1 Firm location literature*

Traditionally, scholars have approached questions about where firms locate by drawing on the firm location literature framework. With roots that can be traced back to Weber (1929 [1909]) and von Thünen (1966 [1826]); see Sorenson & Audia, 2000, and Sorenson, 2003 for a lengthy historical discussion), the entrepreneurial firm location literature has evolved to include four key assumptions: 1) entrepreneurs are profit-maximizers, 2) they choose the location that maximizes their expected profits, 3) they consider and evaluate all possible location alternatives, and 4) the order in which they evaluate the alternatives does not influence the ultimate selection (for recent reviews of this literature and additional assumptions, see Arauzo-Carod, Liviano-

Solis, & Majón-Antolín, 2010; Blair & Premus, 1987; Guimarães, Figueiredo, & Woodward, 2004).

Yet, the literature on a key entrepreneurial segment in the bioscience industry—academic entrepreneurs, or entrepreneurs with work histories at research universities—suggests that the firm location literature is an inappropriate theoretical framework. Academic entrepreneurs are unique in that their primary job is usually not (and may never be) at their entrepreneurial company. They are first and foremost university employees, an arrangement that led Meyer (2003) to remark that they are less “academic entrepreneurs” and more “entrepreneurial academics.” Perhaps as a result of the secondary nature of their entrepreneurial experience, many academic entrepreneurs found companies not because of a desire for profit but rather for academic prestige and recognition, and as a stepping stone in the broader advancement of their academic careers (Cassar, 2007; Lockett & Wright, 2005). This means that a key segment of bioscience entrepreneurs violate assumptions (1) and (2) of the basic firm location framework.

Academic entrepreneurs’ departure from a basic profit maximization motivation is not the only problem with using the firm location literature as a theoretical basis. Scholars suggest that firms do not consider all possible locations (assumption 3; see Hayter, 1997). Collecting and analyzing a full set of information on every potential option can be an expensive, time-consuming, and overwhelming process. As a result, both individuals and organizations facing a range of decisions employ decision-making shortcuts known as *heuristics* (see Leong & Hensher, 2012, for a review). A key aspect of heuristics is the bounding of choice sets that occurs as individuals weigh options. For example, in Simon’s (1955) satisficing, the first choice that meets a set of criteria is selected, typically resulting in a situation in which not all choices are examined. Additionally, given that entrepreneurs may not consider all choices, the order in

which they examine alternatives is critical (violating assumption 4; Leong & Hensher, 2012). Together, these points reinforce the notion that the traditional firm location literature does not provide a valid framework for evaluating the entire entrepreneurial community in the biosciences, and is not appropriate.

### 3.2.2 *Social networks*

An alternative approach to studying how entrepreneurs choose locations for their firms is rooted in the social capital and social networks literature. Entrepreneurial scholars note the importance of social networks in almost all aspects of entrepreneurial firm development, from giving firms access to scientific knowledge, to helping them find and hire skilled labor, to providing managerial expertise, to connecting them with local venture capitalists and other funders. These networks feature social capital, which is both activated and built on through continued social interactions between network members. Ultimately, well-connected firms with access to boundary-spanning networks (i.e., networks that are not insular or limited to a specific community) have better chances at success than firms without access to these networks (for reviews, see Bradley et al., 2013; Djokovic & Souitaris, 2008; Phan, Siegel, & Wright, 2005; Rothaermel et al., 2007).

Since entrepreneurs need to be embedded in their networks to benefit from them, scholars have also suggested that the promise of network-related benefits helps keep entrepreneurs in their home region—even when that home region is not the “best” region for entrepreneurial firms in a particular industry (Dahl & Sorenson, 2009; Figueiredo et al., 2002; Heblich & Slavtchev, 2014; Sorenson, 2003; Sorenson & Audia, 2000; Stuart & Sorenson, 2003; Zucker, Darby, &



Armstrong, 1998). Building on the early work by Granovetter (1973, 1985), Piore & Sabel (1984), Saxenian (1994), and Lin (2002), researchers suggest that entrepreneurial activity is constrained to the entrepreneur's region due to the geographic reach of prior social relations and the knowledge that they contain (Dahl & Sorenson, 2009; Figueiredo et al., 2002; Sorenson, 2003; Sorenson & Audia, 2000; Stam, 2007; Stuart & Sorenson, 2003). The bulk of entrepreneurs will therefore choose a location that either the entrepreneur knew about before founding the company, or that they learned about through networks comprised of family, friends, and professional acquaintances (Stam, 2007). Thus, the expectation of using the network keeps entrepreneurs in their region, and one of the first ways entrepreneurs use their networks is to help them find physical space.

Relying on personal knowledge of locations or knowledge that can be accessed through networks does not necessarily mean that an entrepreneur will not consider all potential locations. They could potentially reach into the far corners of their network and gather information on each and every possible location before making a decision. Yet, there is still a cost associated with considering alternatives, so entrepreneurs are expected to only consider a small number of alternatives (Figueiredo et al., 2002; Stam, 2007). Bioscience in particular is thought to be particularly susceptible to the financial pressures that lead entrepreneurs to turn to networks when searching for locations. As Pisano notes, "only a tiny fraction of biotech companies have ever been profitable or generated positive cash flows," (Pisano, 2006a, p. 2), and new bioscience firms in particular "often face decades or more of highly risky and highly uncertain research before they even hope to earn a profit," (Pisano, 2010, p. 466).

Entrepreneurial location options also depend on the richness of their networks, which varies. At their worst, for example, university networks are insular, and comprised of individuals

with few interactions with outside industry (i.e., not boundary-spanning). Knowledge gained through these interactions remains isolated from others within the university (Markman, Siegel, & Wright, 2008). Overcoming this requires university-based individuals who can span the boundary between academia and industry (Markman et al., 2008; Tushman & Scanlan, 1981), and integrate (or, at the very least, navigate) the differing language, norms, and goals that occur in industry and in the university. At their best, a university's networks would allow members to fully benefit from two different yet connected sets of networks: those available to them as a result of their membership in a university, and those available to them as a result of their membership in the region's larger industry (Bøllingtoft & Ulhøi, 2005; Djokovic & Souitaris, 2008; Lockett et al., 2003; O'Shea, Allen, Chevalier, & Roche, 2005; Rappert, Webster, & Charles, 1999).

### *3.2.3 Access to institutionally bound resources*

As members of their universities, academic entrepreneurs are embedded within large, resource-rich institutions. They are therefore distinct from other area entrepreneurs in that they have access through their university networks to these institutionally bound resources, which their non-academic counterparts cannot access. These resources have grown as part of the "entrepreneurial turn" in the academy, or the shift from the university's older missions of teaching and research to include the commercialization of university research (Etzkowitz et al., 2000; Goldstein et al., 1995; Rothaermel et al., 2007). These resources include increased translational or start-up funding, courses or seminars on entrepreneurial skills like marketing or creating a business plan, and physical spaces for entrepreneurs to operate their company, among others.

In terms of providing space, one of the most common resources is a business incubator for start-up firms (Goldstein et al., 1995; Mian, 1996a, 1996b). There are many forms of business incubators with varying amounts of support or assistance for entrepreneurial companies during their development (Bøllingtoft & Ulhøi, 2005). At their most basic, they provide space for emerging companies, often at low rents. Thus entrepreneurs from the university tend to have more options than their non-academic peers, and in particular choices that are often less expensive and come with additional linked resources.

Recognizing the existence and importance of institutionally bound resources does not negate the role of networks in choosing a location. If anything, the importance of institutionally bound resources in the entrepreneur's process of choosing a location reinforces the importance of these networks. Entrepreneurs still have to navigate networks, even when they are members of a community, in order to access its resources. In other words, the academic entrepreneur will only have access to these on-campus networks if they are pointed towards them through their on-campus networks.

### **3.3 Bioscience in the Triangle and at UNC**

The bioscience industry in the Triangle region is one of the largest in the country (Feldman & Lowe, 2011; Feser, Sweeney, & Renski, 2005; Goldstein, Feser, Freyer, Gordon, & Weinberg, 2008; Link & Scott, 2003; Markusen, 1996). The development of the industry reaches back to state-led efforts in the founding of the Research Triangle Park (RTP), the North Carolina Biotech Center, and the eventual recruitment of satellite branch plants to the area (Feldman & Lowe, 2011; Link & Scott, 2003; Lowe & Feldman, 2014; Luger & Goldstein, 1991; Markusen,

1996). Early scholarship focused on the region's status as a satellite branch plant (Luger & Goldstein, 1991; Markusen, 1996). However, recent scholarship has emphasized the growing entrepreneurial environment in the region, and in particular, the role that high-profile branch plants (like GlaxoSmithKline), non-profit or quasi-public organizations (including the Council for Entrepreneurial Development and the North Carolina Biotech Center), the state (via SBIR match awards and recruitment efforts), and private incubators and accelerators (e.g. First Flight Venture Center in the Research Triangle Park) have played in its development (Feldman & Lowe, 2015; Link & Scott, 2005; Lowe & Feldman, 2014; Lowe et al., 2016; McCorkle, 2012). Lowe, Feldman, & Kemeny (2016), for example, detail how the Triangle's institutionally resource-rich environment benefited firms along their development path. In short, these writings suggest that in the four decades since the region's first entrepreneurial bioscience company, Embrex, was founded in 1978, the ecosystem has developed in such a way as to provide firms with varied and layered resources they can draw on during their development (Feldman et al., 2005; Feldman & Lowe, 2015; Lowe & Feldman, 2014; Lowe et al., 2016).

While the entrepreneurial environment in the larger ecosystem has changed over the study time period, so, too, has the climate inside UNC. In the early 1980s, all three universities lagged behind research intensive peers in terms of commercializing that research (Goble, 2013). In 1983, UNC President William Friday created a technology transfer committee, which commissioned a study to determine the best path forward for the development of technology transfer for the entire UNC system. Ultimately, the presidents of Duke, UNC, and NCSU decided to form a joint licensing group in 1986. In 1988, the Triangle University Licensing Consortium—or TULCO, as it came to be known—opened its doors (for a thorough history of TULCO, see Feldman & Goble, 2016, and Goble, 2013). These university partners have played

an increasingly large role in the development of the region (Goldstein, 2005; Rohe, 2012), and are now a leading source of bioscience entrepreneurs (Feldman & Lowe, 2015; Lowe et al., 2016).

Despite President Friday's initiative, at the time of TULCO's formation, UNC still had what Goble (2013) describes as "a non-existent internal entrepreneurial culture, and no internal experience or capabilities for technology marketing and licensing," (p. 111). A scientist on campus during the mid- to late-1980s was less sanguine, characterizing the university as being "hostile to commercialization" (UNC Staff Member A, January 26, 2016). At the time of TULCO's disbandment in 1995, UNC still did not have a fully staffed technology transfer office (Goble, 2013). Reflecting on UNC's lack of progress during this time, a former UNC employee commented that, "UNC was still ...coming to grips with what it meant to be in the tech transfer business... [and they] continued still to struggle, culturally [and] philosophically, with just how deeply involved they wanted to be," (UNC Staff Member B, February 18, 2016). Unsurprisingly, as of TULCO's disbandment in 1995, the university had no formal policies to provide space for entrepreneurs.

Of course, it is unlikely that TULCO alone would have been able to change UNC's historical unease with commercialization in such a short time. Institutional change—including changing a university's culture, norms, and policies towards commercialization and entrepreneurship—takes time, and is almost always incremental (Bercovitz & Feldman, 2008; Feldman et al., 2005; Kenney & Patton, 2006; Mahoney & Thelen, 2010; Sotarauta & Pulkkinen, 2011; Streeck & Thelen, 2005). In fact, the university initiated numerous programs during and after TULCO, including the creation of a Center of Entrepreneurial Studies in the Kenan-Flagler Business School in 1992, the founding of Launching the Venture (a Kenan-Flagler program to

help students, faculty, and staff gain the business skills they need to start a company) in 1999, and joining the Kauffman Campuses Initiative in 2004, among others (see Feldman et al., 2009 for an overview of these and other changes). In the particular case of space for entrepreneurs, however, there is a distinction between slow, incremental changes in a university's culture, and the culmination of these numerous small-scale shifts that ultimately contribute to a change in formal resources.

In the fall of 2008, a key aspect of Carolina North—UNC's planned 250-acre mixed-use expansion, located just two miles north of the main campus in Chapel Hill—fell apart. UNC had partnered with Alexandria Real Estate Equities, Inc., to build an Innovation Center as part of the expansion campus. This Innovation Center was slated to house the university's technology transfer offices and an entrepreneurial business incubator; underscoring its importance to the university, the Innovation Center was scheduled to be the first building constructed on the site (Goldstein & Glaser, 2012). Alexandria put the project on indefinite hold in late 2008, citing economic concerns (Carolina Alumni Review, 2008). The loss of long-awaited space, which had involved years of negotiations with the town of Chapel Hill, was a blow to the university.

In adapting to this loss, university staff searched for other options within the university's existing resource base. UNC staff developed three different forms of business incubation: (1) off campus incubation, (2) dedicated on-campus incubation, and (3) ad hoc on-campus incubation. Carolina Launch Pad, the off-campus incubation option, opened in leased space in Chapel Hill, roughly four miles from UNC's main campus.<sup>13</sup> Both on-campus options relied on Facilities Use

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<sup>13</sup> As explained in Chapter 2 of this dissertation, UNC ultimately partnered with the town of Chapel Hill and Orange County and moved Carolina Launch Pad to downtown Chapel Hill.

Agreements (FUAs)—or agreements between private companies and the university that give the companies permission to use campus space and equipment for up to one year. Companies who could not officially locate on UNC’s campus before 2009 in any great number could as of that year.<sup>14</sup> The FUAs were used to develop small spaces in UNC campus buildings to act as formal incubators, a move that would eventually be called “dedicated incubation” on campus. The FUAs were also used for “ad hoc” incubation (Rose & Patterson, 2016), where space is carved out in a piecemeal fashion in buildings across campus.

The institutionally bound resources put in place at UNC in 2009 geographically bound companies to UNC and Chapel Hill. Any shift in the microgeographies of UNC firms founded between 2009 and 2012 should therefore result in movement toward the university.

### **3.4 Empirical Strategy**

In this paper, I test the hypothesis that UNC’s provision of institutionally bound resources—in this case, three forms of business incubators—has reshaped the geography of firms emerging from the university (from here, “UNC-parented firms”) in the 2009-2012 time period, pulling the average firm closer to campus when compared to UNC firms before 2009. However, there are two potential confounders.

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However, the rebranded LaUNCH Chapel Hill did not open until 2013, after the conclusion of this paper’s study period.

<sup>14</sup> The FUAs for bioscience companies are similar agreements to those signed by any non-university organizations, such as boy scouts or churches. The true shift for companies is that they became a formal strategy for bioscience incubation, and as such, additional offices—including UNC’s OTT, its Conflict of Interest department, its Environmental Health and Safety Office—have to sign off. While companies had been able to use FUAs prior to 2009, staff streamlined their use and began to promote them after 2008.

First, it is likely that firms founded by UNC faculty have always located close to UNC, regardless of the availability of UNC resources. Given the dual-career nature of academic entrepreneurs (Lacetera, 2009; Meyer, 2003), it is likely that this subset of entrepreneurs will *always* want to remain close to their academic campus to make their two-job commute easier. Similarly, Dahl & Sorenson's (2009) conclusion that entrepreneurs prefer locations where they can be close to family and friends may also explain why entrepreneurs would not choose a longer commute when a closer location was available, *ceteris paribus*. I therefore compare locations of UNC-parented firms in the 2009-2012 time period to locations of UNC-parented firms in the 1990-2008 time period to control for the likelihood that academic entrepreneurs have always been (and will always be) closer to UNC than their non-academic counterparts.

Second, as previously mentioned, the Triangle region has resources available to all firms (i.e., resources that are not institutionally bound). These resources have changed over the study period, too. Firms founded by UNC employees would have access not only to UNC resources, but also to this broader set of resources. The First Flight Venture Center incubator has existed in the RTP since 1991. New spaces—like BD BioVenture Center and the Hamner Biosciences Accelerator, both in the RTP—have opened in the region. Older spaces—like the Liggett & Myers Tobacco Company Research Building in downtown Durham, where many bioscience companies started in the 1990s—closed during the time period to undergo renovations. I control for this by using a comparison group: entrepreneurial bioscience firms comprised solely of non-academic founders (non-university-parented firms). I compare the spatial shift among UNC-parented firms to the shift among these firms.

Ultimately, a statistically significant shift inwards towards UNC amongst the firms with a UNC entrepreneur—and the lack of a similar trend amongst the non-academic firms—would



suggest that access to the post-2009, institutionally bound resources has, in fact, changed the geography of UNC firms. Interviews with firms that specifically mention the importance of business incubators would reinforce the finding.

### **3.5 Study Data and Methodology**

To assess the role of institutionally bound resources in shaping entrepreneurial firm locations, this paper relies on data from a number of different sources. Secondary data comes from the Feldman-Lowe database, a proprietary database housed at the University of North Carolina at Chapel Hill with continually updated records of firms in the Research Triangle Park region and their entrepreneurs, and the National Establishment Time Series (the NETS). Primary data for the study is comprised of interviews with entrepreneurs, current and former staff sources at UNC, and sources from outside the university who were otherwise considered to have knowledge of the university and the region.

#### *3.5.1 Sample selection*

I identified the sample of entrepreneurial bioscience firms using the Feldman-Lowe database. Information in the database comes from a variety of sources, including LinkedIn, incubator tenant lists, university technology transfer offices, company websites, Secretary of State filings, newspaper articles, press releases, etc. See Feldman and Lowe (2015) for an in-depth discussion of the database, its construction, and content validation guidelines.

I used four fields from the database: entry type, entry location, date established, and company description. Entry type is a drop-down field, and distinguishes entrepreneurial firms

and other types of companies or establishments (e.g. branch plants, joint partnerships).<sup>15</sup> Entry location is also a drop-down field, and includes options to record the first known location for a firm or establishment. The two most common options are the 13-County Triangle Region and Other North Carolina.<sup>16</sup> While the Triangle region in the database is defined as a thirteen-country region to reflect state planning regions,<sup>17</sup> there are also notes in the database indicating the specific county in which a company was first established. The date established field contains a calendar so that users can enter the specific date that an establishment opened; in cases where only the year is known, the user selects January 1. The company description field is a text field with unlimited characters, where researchers can enter information related to company history, business activities, product and product development, company partnerships, etc.

Using the entry type, entry location, date established, and description fields, I narrowed the companies down to bioscience companies founded in the three-county Research Triangle region between 1990 and 2012. Since this study relies on locational data from the NETS, I further limited the study to firms that were matched to establishment-level records in the NETS;

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<sup>15</sup> The entry type drop down options are exhaustive and mutually exclusive, and are used to record the company type as it was at the time of entry into the state of North Carolina. The most commonly used options are: entrepreneurial startup, non-entrepreneurial spin-out from existing company, entrepreneurial relocation or recruitment from out of state, joint partnership, merger or acquisition activity, and de novo branch plant.

<sup>16</sup> The drop-down contains a third and rarely used entry, Outside North Carolina, for out of state entrepreneurial firms with some links to North Carolina. These entries typically reflect firms started by North Carolina “serial entrepreneurs” who found multiple companies, but locate some of these out of state.

<sup>17</sup> The thirteen counties are Chatham, Durham, Franklin, Granville, Harnett, Johnston, Lee, Moore, Orange, Person, Vance, Wake, and Warren. However, as all but five of the entrepreneurial companies are founded in the core three counties of Durham, Orange, and Wake, we chose to focus on the core.

see Chapter 4 of this dissertation for a discussion of this process, the NETS data, and the relationship between entrepreneurial firms and their establishment records.

### 3.5.2 *Separating academic and non-academic firms*

The Feldman-Lowe database also allows users to add founders for each firm. For each founder, a user can add extensive work history information, including the company or institution of each prior work episode, the title of each position held, and the state and end date. I used this founder information to identify firms with any founder who started work at one of the three research-intensive universities (Duke, UNC, and NCSU) prior to founding the company.<sup>18</sup> I considered companies with at least one founder with a work history at UNC to be an UNC-parented firm, even if the same founder (or another founder) had worked at Duke or NCSU.

I developed a control sample using the remaining firms after removing firms with founders who had worked at Duke, NCSU, or Duke and NCSU. UNC is not the only university in the region to have undertaken entrepreneurial policies during the study period. Including firms with links to these other schools might introduce bias into the control group. This control group is comprised of *non-university-parented firms*, founded by individuals without known ties to the three area universities.

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<sup>18</sup> These three universities are the only three universities classified as RU/VH (research universities with very high research activity) by the Carnegie Classification of Institutions of Higher Education, the highest category for university research intensity (The Carnegie Foundation for the Advancement of Teaching, 2015). While the three-county Triangle region has additional colleges and universities, none of these are considered RU/VH universities, and only one company in the sample includes a founder work history at an additional area college or university.

### *3.5.3 Identifying company locations and creating distance measures*

Given that UNC's policies surrounding entrepreneurial space focus on moving firms closer to or onto campus, investigating microgeographies requires determining how close firms are to campus. Members of a research team matched sample firms to establishment-level records in the NETS (see Chapter 4 in this dissertation for a discussion of this method, and for a broader discussion of the NETS as a source of data for entrepreneurial studies). I identified each company's first known address using the Address First file in the NETS, which provides the establishment's first known address. Given that the sample firms are in the biosciences, I used a centroid for the UNC's hospital complex on the flagship campus in Chapel Hill as a proxy for UNC's location. I measured the distance between each firm's initial address and UNC's location, in feet. All geocoding was done using batch geocoding services from Texas A&M Geoservices.<sup>19</sup>

### *3.5.4 Testing for microgeographies*

To test for changes in microgeographies among UNC-parented firms, I conducted four statistical tests: two "between-group" tests and two "within-group" tests. The between-group tests compare the average distance of UNC-parented firms from UNC to the average distance of non-university-parented firms from UNC, first in the 1990-2008 time period and next in the 2009-2012 time period. I expected UNC-parented firms to be closer to UNC by a statistically significant amount, both in the 1990-2008 and the 2009-2012 time period.

The within-group tests compared the average distance of UNC-parented firms from UNC in the 1990-2008 time period to the average distance of UNC-parented firms from UNC in the

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<sup>19</sup> Available at <http://geoservices.tamu.edu/Services/Geocode/>

2009-2012 time period. Then, I compared the average distance of non-university-parented firms from UNC in the 1990-2008 time period to the average distance of non-university-parented firms from UNC in the 2009-2012 time period. I expected that the later UNC firms were founded closer to the university, and that the difference would be statistically significant. I hypothesized that there would be no statistically significant change in the distance of non-university-parented firms from UNC.

Initial tests showed the distances of both the UNC-parented and non-university-parented firms are not normally distributed, and are instead right-skewed. Since a 2-sample t-test requires normal interval data, I used Wilcoxon Mann Whitney tests to establish if there were differences between the groups of firms. Using Wilcoxon Mann Whitney, I was able to test for significance in the relationship between an ordinal independent variable (e.g., a “0” for UNC-parented firms founded between 1990 and 2008, and a “1” for UNC-parented firms founded between 2009 and 2012) and a non-normal, interval dependent variable (distance in feet from UNC). Since the test can only accommodate two groups of firms at a time, I ran the test four separate times.

### *3.5.5 Interviews*

I conducted semi-structured interviews with entrepreneurs from 18 Triangle firms. I selected firms using a stratified sampling approach, ultimately drawing entrepreneurs from four subgroups: 6 entrepreneurs from UNC-parented firms founded between 1990 and 2009, 6 from UNC-parented firms founded between 2009 and 2012, 3 from non-university-parented firms founded between 1990 and 2009, and 3 from non-university-parented firms founded between 2009 and 2012. I also interviewed 7 key actors in the region: 4 current or former UNC

employees and 3 individuals with no university ties, but who were otherwise considered experts on UNC's entrepreneurial history. Two key UNC staff members were identified from prior research projects, and I identified the remaining 7 using a snowball approach.

From these interviews, I expected to find evidence that entrepreneurs—across the UNC and non-university groups, and in both time periods—consistently relied on their networks to find locations. However, I also expected that the networks UNC-parented firms used would point entrepreneurs towards institutionally bound UNC incubator resources.

### **3.6 Results**

Descriptive statistics are listed below in Table 3.1. There are three clear trends in the data. First, in both the 1990-2008 and 2009-2012 time periods, UNC-parented firms are located closer to campus when compared to non-university-parented firms. Second, in both sets of companies, firms founded in the 2009-2012 time period chose locations closer to UNC than they did in the 1990-2008 time period. Third, the change in distances of the UNC-parented firms is much larger (a decrease of almost 16,000 feet, or three miles) than the change in distances for non-university-parented firms (a decrease of more than 5,000 feet, or one mile).

Tables 3.2 and 3.3 present the results of four different Wilcoxon Mann Whitney tests. Table 3.2 presents between-group test statistics (i.e., UNC-parented vs. non-university-parented). Separately, in both the 1990-2008 and 2009-2012 time periods, there is a statistically significant difference between the average distance of UNC-parented firms to UNC and the average distance of non-university-parented firms to UNC. In other words, UNC-parented firms are

consistently closer to UNC than the non-university-parented firms, and this is a statistically significant difference in both time periods. These were the expected results.

**Table 3.1: Descriptive statistics, entrepreneurial bioscience firms and distance from UNC (in feet)**

<b>Firm Parentage</b>	<b>Time period</b>	<b>Firms</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min.</b>	<b>Max.</b>
<b>UNC</b>	1990-2008	56	48,024	32,415	2,470	136,745
	2009-2012	26	32,296	41,089	6,181	162,354
<b>Non-university</b>	1990-2008	218	75,141	36,349	6,420	159,875
	2009-2012	23	69,668	38,738	8,796	154,563

**Table 3.2: Between-group test statistics, measuring difference in distance (feet) to UNC**

<b>Study period</b>	<b>Mean Distance by Firm Parentage</b>		<b>Wilcoxon Two-Sample Statistic</b>	<b>Two-sided Pr &gt;  Z </b>
	<b>Non-university</b>	<b>UNC</b>		
<b>1990-2008</b>	75,141	48,024	-5.0348	<.0001
<b>2009-2012</b>	69,668	32,296	3.4559	0.0005

Table 3.3 presents the within-group test statistics (i.e., 1990-2008 vs. 2009-2012). Between the 1990-2008 and 2009-2012 time periods, there is a statistically significant difference in the average distance of UNC-parented firms to UNC. Yet, there is no corresponding statistically significant change in the non-university-parented firms' average distance from UNC. In other words, while UNC-parented firms shifted inwards to UNC by a statistically significant amount, non-university-parented firms did not. These were the expected results.

Together, the results reinforce the paper's hypothesis: that UNC's 2009 business incubator spaces have pulled companies closer to campus.

**Table 3.3: Within-group test statistics, measuring difference in distance (feet) to UNC**

Firm Parentage	Mean Distance by Study Period		Wilcoxon Two-Sample Statistic	Two-sided Pr >  Z
	1990-2008	2009-2012		
UNC	48,024	32,296	-3.0146	0.0034
Non-university	75,141	69,668	-0.7327	0.4644

### 3.6.1 Interview results

Interview results revealed several key themes useful for explaining the causal factors behind these divergent trends. As expected, these themes point to both the importance of networks in finding space, and the role of institutionally bound resources in the 2009-2012 time period. The interviews also suggested the possibility of two trends that were not anticipated: 1) the university resources may be altering how firms think about what constitutes their physical location, and 2) UNC's longer cultural shift towards accepting and promoting entrepreneurship may have led companies to spin out from the university at earlier stages in their technology's development, and this in turn may be influencing the types of spaces entrepreneurs consider and need.



### 3.6.2 *Missing university networks and resources, 1990-2008*

As previously mentioned, UNC has not always been supportive of entrepreneurship. The 1990-2008 time period spans the TULCO years, when the university was still “hostile to commercialization,” to the 2000s, when UNC had a functioning technology transfer office (or TTO, the office on campus that manages patenting or licensing, and transfers this technology to outside businesses) and supportive policies. It is therefore not surprising that the university networks played different roles in helping entrepreneurs find space over time.

Early UNC-affiliated entrepreneurs reported mixed interactions with university staff, and none of these early entrepreneurs received help from the university in securing off-campus space. As one entrepreneur from a firm founded in 1994 told us, when their technology reached a point in 1993 where they were doing more contract commercial work on campus than the then-current dean was comfortable with, the dean informed the professor in charge of the lab that they had to start a company off campus and stop using university office space for their work. The founders received no help from UNC—they were not required to go through its Office of Technology Transfer (OTT)—and instead found funding from a large pharmaceutical company with whom they had previously worked, and settled in an office in Raleigh (Entrepreneur A, January 19, 2016).

A second early UNC-affiliated entrepreneur, who founded a company in 2000, reported that UNC’s OTT was “obstructionist,” and while they ultimately found space close to the university, they did so only after consulting with “everybody.” Interestingly, however, the roots of the 2009 change were felt even then, as the entrepreneur reported contacts at UNC’s Kenan-Flagler Business School—the home of 1999’s Launching the Venture—were very helpful. In this

case, however, both the obstructionist OTT and the more helpful Kenan-Flagler were not willing or able to assist in finding space (Entrepreneur B, January 28, 2016).

A third UNC-affiliated entrepreneur, in 2001, reported that while UNC's OTT was supportive and reasonable in patent work and legal support, there was no discussion of space. While clearly reflecting the incremental change in the cultural acceptance of commercialization on campus, this finding also reinforces how this acceptance had not always carried through to the provision of space—or, perhaps, even the idea of helping an entrepreneur find space. Instead, the entrepreneur relied on networks outside of the university—a “little system” of contacts that seems far more developed than that of the entrepreneur in the previous year. As they stated,

“I ... knew a[n] industrial realtor locally. We were very familiar with the KeyStone [Corporation, a Raleigh real estate developer] folks. And I was on very good terms with the fellow who was running it in the day. And they showed us space that we almost instantly took. [The company] was never going to be a big company . . . . The vision was that it was never [going] to be more than 25 people . . . and then [it would be] acquired eventually” (Entrepreneur C, January 20, 2016).

They acquired their first space while securing four million dollars of financing (a substantial amount for an entrepreneurial bioscience firm). They also needed to be centrally located for their ex-pharmaceutical employees from Raleigh, Apex, and Cary (all on the other side of the Research Triangle Park from UNC). In this sense, this third company is the exception to which Stam (2007) refers when he describes the entrepreneur with sufficient capital and prospects, who is able to go out and easily secure an ideal space. This capital allowed this entrepreneurial company to choose a location with image in mind, too, a luxury that many entrepreneurial companies don't have; as they stated, “in those days there was always cachet to having an RTP address . . . having a post office box in RTP was considered to be important in that day” (Entrepreneur C, January 20, 2016).

The stories of these three entrepreneurs also reveal how deep and boundary-spanning their networks were, even when UNC location support was not very strong. Their networks included UNC's OTT and Kenan-Flagler, but also private pharmaceutical companies, private real estate companies, etc. In many ways this third company's ease in finding space is atypical for an academic entrepreneur; they were unique among the five early UNC-parented founders I interviewed in that they had solid funding and connections to outside industry. Their access to robust outside resources and networks underscores how disconnected the others were through UNC's networks.

### *3.6.3 University networks and institutionally bound resources, 2009-2012*

While the first set of companies did not learn about space through their on-campus networks, companies formed between 2009 and 2012 did. Four of the five companies founded after 2009 located in UNC-affiliated spaces, and the fifth found space through a UNC contact. Additionally, none of these four founders report looking elsewhere for space. Two were in the off-campus UNC-affiliated incubator, and two used on campus FUA spaces. All four of these firms reported learning of these spaces through university resources.

One company in this set that did not locate in an UNC-affiliated space. However, they did use university networks to access their space, and benefited from the boundary-spanning networks that UNC has worked hard to institute on campus. The firm went to First Flight Venture Center (an older incubator in the Research Triangle Park) after a Launching the Venture mentor, who had previously worked there, suggested it. Using university-based networks to learn about off-campus spaces is a change from the pre-2009 years, when entrepreneurs largely

searched on their own or relied on non-university networks for space. As was the case with the third pre-2009 entrepreneur, this entrepreneur, too, had some external funding (Entrepreneur D, July 1, 2014).

#### *3.6.4 Non-university firms*

Four of the six non-university entrepreneurs relied on realtors when searching for their space. Only two of these entrepreneurs did not use a realtor. Of these two, one conducted their search entirely online, with no outside assistance or insight from former colleagues. This entrepreneur also reported knowing very little about their options before beginning their web search. Only one entrepreneur in this group reported relying on either personal knowledge or colleagues to find space. Their reliance on realtors could reflect a need for more specialized spaces. Of the four that relied on realtors, one needed space to house an animal vivarium (an enclosed space to hold animals for pharmaceutical research). Another was vigilant about worker safety and including specialized equipment for this safety, and found the region's older incubators lacking.

Still, the reliance on realtors is particularly striking given that many of these entrepreneurs had worked for years in and around the RTP, in close proximity to the locations of the region's largest incubators and office parks. As the one entrepreneur who didn't use a realtor suggested, the RTP was their "home turf," and there was no need to hire someone. The fact that five of six entrepreneurs drew knowledge of potential sites not from personal knowledge or networks, but instead from realtors, contradicts the literature.

### 3.6.5 *Uncovering microgeographies: NETS data vs. interview data*

This study specifically looks at how UNC's business incubators, as spaces the university provides for its entrepreneurs, altered the locations of firms, and in so doing reshaped the microgeographies of firms in the region. Both the statistical tests and interviews offer evidence in support of this argument. However, looking at the NETS data alone would have suggested that neither of the two firms that used UNC's on-campus, FUA-based incubators had their first locations on campus, and that one of two companies that used the off-campus incubator started in that space.<sup>20</sup> This is due to a larger phenomenon the interviews uncovered: in 9 of the 18 interviews, entrepreneurs reported first addresses that did not match data provided in the NETS first address file.

The difference between what the NETS provides as a company's first location and what interview subjects report appears to hinge upon how each interprets a company's first location. In interviews, founders frequently equate their company's first location to their first laboratory location. In many cases, this laboratory appears in the NETS as the company's first address. Yet, in many others, it doesn't. Asking entrepreneurs about addresses that appear in the NETS, however, reveals one of two things. First, some entrepreneurs report forming their company before having laboratory space, and using their home offices when applying for the research grants that will eventually pay for their laboratory spaces, or focusing on non-core aspects of their business (e.g., technical writing or consulting vs. drug development). In other cases, entrepreneurs used their laboratory spaces for scientific research while simultaneously using

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<sup>20</sup> The NETS is not alone in having difficulty recognizing university-based incubator spaces. Company records in North Carolina's Secretary of State (SoS) online document depository, which has company articles of incorporation and annual reports that include physical locations, do not include the incubator addresses as first addresses, either.

their home offices for all non-business aspects of their company. For both groups, the entrepreneur recorded their (or their co-founder's) home address in SoS filings, and likely did so on other filings (e.g., patents, SBIR awards).

A non-university-parented contract research organization illustrates both of these. The contract research organization is now known as one that is involved in drug development, and conducts the bulk of their business in their wet laboratory. The founder reported that their initial location was in Cary, in an office building they upfitted with laboratory equipment. Yet, when asked about the nearby residential Cary address recorded in the NETS (and the SoS), the founder reported:

“I started the business by working out of my home until I found adequate space. I did consulting only, since I had no capabilities for lab work.... I spent almost 8 months looking for suitable lab space” (Entrepreneur E, April 28, 2016).

The founder had incorporated their company and begun working for clients, but did not retroactively recognize that this had been their first location.

From a statistical standpoint, there appear to be both random and non-random mismatches between the NETS and interview addresses. Among the non-university-parented firms, the mismatch between NETS addresses and interview addresses appears random and results in little overall spatial movement, since the direction and distance of address changes with respect to UNC cancel each other out. This makes sense. These entrepreneurs lived and worked around the RTP, and chose locations around the Park, too. Among UNC-parented firms founded between 1990 and 2008, the interview addresses are consistently further away from UNC than their NETS counterparts. Again, this makes sense, given that before 2009 there was a dearth of space in and around UNC.

However, the reverse is true for UNC-parented firms founded between 2009 and 2012, when replacing NETS addresses with interview-revealed first addresses results in a much stronger shift in microgeographies toward UNC from the earlier period. The same conclusion remains: the business incubator policies undertaken by UNC led 2009-2012 UNC entrepreneurs to found their firms closer to campus than UNC firms founded between 1990-2008.

### **3.7 Discussion and Conclusion**

The results show that while UNC-parented firms have always been closer to campus, the university's increased emphasis on institutionally bound resources—in this case, business incubators—had profound spatial implications for the region. UNC-parented firms founded between 2009 and 2012 were closer to UNC than UNC-parented firms founded between 1990 and 2008, and the difference is statistically significant. There was no corresponding statistically significant shift among non-university-parented firms. Interviews, too, revealed the importance of the institutionally bound resources in shaping where entrepreneurs locate, and four of five UNC-parented firms from this time period reported using UNC resources. Together, these findings indicate that the institutionally bound resources can shape microgeographies of firms.

Yet, the study also suggests that while the interview results are consistent with the quantitative results, they are not drawing on the same data. In half of all companies, the address included as a company's NETS first address file did not match what respondents reported as the company's first address. This is a separate, unexpected finding. The mismatch between NETS and interview addresses suggests that scholars relying on the NETS may be making two implicit (and unrecognized) assumptions about single-establishment entrepreneurial firms: (1) that

business and scientific work occur in the same location, and (2) that business and scientific work begin at the same point in time. Firms in this study routinely violated one or both of these assumptions. However, it is important to note that their violation of these assumptions does not question the accuracy of addresses in the NETS; NETS addresses were all confirmed in interviews. Rather, this finding suggests that as researchers seek to identify microgeographies or assess the impact of policies on location decisions, they should question their assumptions about the organization of entrepreneurial firms. This unexpected finding also has implications for how we use data to study relocations; the NETS, for example, might suggest that a change in address from a home to a laboratory is a move. More work is needed on how entrepreneurial firms use different portions of the region as they organize their work and grow, especially given the recent push to concentrate entrepreneurial firms in industrial district-driven microgeographies (Drucker & Kass, 2015; Katz & Wagner, 2014).

Another unexpected finding concerns the lack of reliance on networks to find spaces. Of all firm groups, only UNC-parented firms founded between 2009 and 2012 consistently found space through networks. For this group, the reliance on networks and how these networks linked entrepreneurs to institutionally bound resources reflects UNC's longer effort to staff the university with boundary-spanning mentors. However, the reliance that non-university-parented firms had on realtors or independent, non-informed searches is puzzling, and does not fit with the broader literature.

One policy takeaway from the study is that entrepreneurial firms respond to available business incubator spaces. However, it is important to note that this study only looked at these firms' first locations. Business incubator space is temporary, and does not necessarily predict long-term location decisions. That said, business incubators may represent the first of many steps



to embed an entrepreneurial firm in place. While business recruitment and retention incentives have long been associated with larger industrial firms (Isserman, 1993), economic incentives are increasingly used to recruit entrepreneurial companies to defined geographies. For example, Orange County, which became a partner organization when Carolina Launch Pad was folded into LaUNCH Carolina in downtown Chapel Hill in 2013, has strategically linked county economic development grants to companies transitioning out of the incubator. Recruitment and retention efforts come with broader sets of questions—including whether they represent the best use of resources. Yet this work shows how incubators can alter firm location patterns, and be linked to larger economic development strategies.

## **4      HOW DOES DATABASE SELECTION INFLUENCE OUR UNDERSTANDING OF ENTREPRENEURIAL REGIONS?**

### **4.1   Introduction**

Scholars, planners, and policymakers alike recognize the difficulty in fostering vibrant entrepreneurial regions, even as they recognize entrepreneurship—particularly in high-tech or innovative industries—as a critical foundation for long-term economic development (Audretsch et al., 2006; Malizia & Feser, 1999). This difficulty is reflected in scholars’ recent likening of a region’s entrepreneurial environment to an ecosystem, one that emerges from a complex and evolving web of social and economic ties between regional actors and institutions (Audretsch & Peña-Legazkue, 2012; Auerswald, 2014, 2015; Feld, 2012; Feldman, 2014; Isenberg, 2010; Saxenian, 1994). Fully understanding both regional ecosystems and the policies and circumstances upon which they are built requires an enormous amount of data (Stangler & Bell-Masterson, 2015). Detailed industrial data—i.e. longitudinal records of individual establishments’ births and deaths, employment levels, addresses, and wages—is critical. Ideally, this type of longitudinal industrial data can be married to other types of disambiguated data—such as that on key regional actors, institutional activities, or transformative regional events—to test both theories on regional ecosystem development and the effectiveness of policy interventions. Ultimately, this type of analysis holds the promise of allowing us to model ecosystems in such a way as to both further develop our theories on entrepreneurial regions and

improve regional entrepreneurial policies (Auerswald, 2014, 2015; Feldman & Lowe, 2015; Lowe, Feldman, & Kemeny, 2016; Stangler & Bell-Masterson, 2015).

Unfortunately, two major issues limit our ability to incorporate detailed industrial data into our models of entrepreneurial regions: (1) our collective and long-standing inability to access the fine-grained, government-produced industrial data and (2) data quality concerns with the growing catalog of readily available, privately developed alternative data sources. Researchers unable to access government sources have increasingly relied on these alternative sources without full comprehension of the scale and scope of the inaccuracies. Recent research suggests that inaccuracies in these sources may bias study conclusions and policy recommendations (see, for example, Fleischhacker et al., 2012, Liese et al., 2010, and Ma et al., 2013).

In this paper, I argue that the biases attributed to private data sources may not be as severe as the recent consensus suggests, particularly for researchers focused on entrepreneurship. Using an externally defined reference list of entrepreneurial bioscience firms in North Carolina's Research Triangle Park (RTP) region, I compare matched records of establishment-level data from a well-known government source for industrial and employment data (the Quarterly Census of Employment and Wages [QCEW]) against matched records from a leading private alternative (the National Establishment Time Series database [NETS]). Using these databases, I ask the questions: To what extent do entrepreneurial records in the QCEW and the NETS diverge, and how much of this difference is driven by design differences between the two databases? How might a reliance on one database over another alter our understanding of a region's entrepreneurial economy?

By analyzing differences in establishment inclusions in each database, the timing and trend of establishment births, initial employment levels, and spatial patterns of entrepreneurial establishments within the region, I find that the NETS captures more establishments than the QCEW, with earlier founding years, higher levels of employment per company, and greater spatial diffusion across the RTP region. However, adjusting the NETS data with a proxy for unpaid employment removes all statistically significant measures of bias from the data, with the exception of differences in employment.

Ultimately, the results show that conflating inaccuracies in the NETS with differences that arise as a result of purposeful database design decisions at both the NETS and the QCEW decreases our understanding of both true inaccuracies in the databases and the appropriateness of each database for specific research questions. These findings bolster earlier work from Neumark et al. (2005), whose results suggest that the NETS is an ideal source of data for studies focusing on entrepreneurship. The findings also suggest that other literatures' conclusions about the inappropriateness of secondary databases (like those from the public health field; see Fleischhacker et al., 2012, Liese et al., 2010, and Ma et al., 2013) may not be fully applicable to entrepreneurial research.

Bioscience in the RTP region provides an ideal case study. The region has one of the largest bioscience clusters in the country (Feldman & Lowe, 2011; Feser, Sweeney, & Renski, 2005; Goldstein, Feser, Freyer, Gordon, & Weinberg, 2008; Markusen, 1996). Scholars have historically presented the industry and the region as one that is overly reliant on branch plants for growth (Luger & Goldstein, 1991; Markusen, 1996). Only in recent years have studies recognized the region's entrepreneurial nature, particularly in the biosciences (Feldman & Lowe, 2015; McCorkle, 2012). The results from this study underscore how relying on a rigid

governmental database designed to measure formal employment relationships might retract from these revisionary studies, and paint a picture of the region with fewer companies and employment, and a tighter spatial spread across the region.

The remainder of the paper is laid out as follows. Section 2 outlines theoretical and practical differences between the QCEW and the NETS, particularly as they relate to entrepreneurial firms, and summarizes key pieces in the literature that assess the accuracy of the NETS. Section 3 introduces the bioscience industry in North Carolina's Research Triangle. Section 4 provides an overview of the study data, while Section 5 describes the study's methodology to assess differences between the databases. Sections 6 and 7 provide results, which are discussed in Section 8. The conclusion in Section 9 discusses the study's implications for entrepreneurial research.

#### **4.2 The QCEW and the NETS: A Comparison**

The Quarterly Census of Employment and Wages (QCEW) is the product of a partnership between the federal government's Bureau of Labor Statistics (BLS) and each State Employment Security Agency (SESA).<sup>2122</sup> Each state uses the QCEW as a record of jobs eligible

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<sup>21</sup> Specific agency names vary by state and often change over time. North Carolina's Employment Security Commission collected the data used in this study; following an administrative merger, the data is currently collected and housed at the state's Department of Commerce.

<sup>22</sup> For an in-depth discussion of the QCEW, and the process SESAs take to collect and compile the data, see Spear (2011).

for unemployment insurance (UI) at each establishment.<sup>23</sup> SESAs collect data on establishments' addresses,<sup>24</sup> monthly employment, NAICS codes, and wages. They then send their collected information to the BLS, which in turn releases the data to the public.

However, the data the BLS releases to the public is not equivalent to the data it receives from SESAs. To protect confidentiality the BLS *aggregates* QCEW data to county, metropolitan, state, and national geographic areas, concealing gross establishment additions and closures, establishment-level employment changes, and physical relocations. Users can filter the data by NAICS code, but the BLS occasionally suppresses employment and average wage data to protect establishment confidentiality. In practice, suppression occurs when there are too few establishments in a selected geography's NAICS code or when too few establishments dominate the category.<sup>25</sup> Together, geographic aggregation and data suppression preclude research on a host of topics, with entrepreneurship key among these.

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<sup>23</sup> While the QCEW is typically considered an establishment-level database, companies can choose to consolidate reporting from multiple locations in a state to a single establishment (see Bureau of Labor Statistics, 2010, 2016). This is not a problem for this study; the focus on the first known location of entrepreneurial companies means we can assume firms are single-establishment at the time of their birth.

<sup>24</sup> Collected addresses vary by state. North Carolina, for example, collected each establishment's physical (location) address and address for unemployment claims between 1990 and 1996, and only added a mailing address in 1997. However, fields are frequently blank.

<sup>25</sup> County Business Pattern (CBP) is a popular alternative to the QCEW, as the data aggregates to the geographically-smaller zip-code level. However, CBP data has an additional year's delay, pulls from a smaller percentage of establishments, lacks wage data, and does not solve the problem of concealing gross establishment and establishment changes and relocations. Finally, as a database that is aggregated to a smaller geographic level and contains fewer establishments relative to the QCEW, it is prone to intense data suppression (though there have been efforts to fill in the suppressed data; see Bureau of Labor Statistics, 2010, 2016).

Since both researchers and practitioners alike have found it difficult to access the *disaggregated* data collected by SESAs, researchers have increasingly embraced private databases.<sup>26</sup> The National Establishment Time Series (NETS) is a leading alternative to the QCEW. The NETS is a private dataset, built by Walls & Associates using Dun & Bradstreet data (D&B). Like the QCEW, D&B includes information on establishment location and employment levels; unlike the QCEW, D&B does not include wage information. Further unlike the QCEW, which receives its information directly from businesses, D&B culls their information from court filings, press releases, newspaper articles, and state filings, and further supplements with more than 100 million phone calls to companies (Neumark et al., 2005). D&B cannot compel companies to answer questions. Yet, by not promising confidentiality, D&B can release data in its raw form without any geographic aggregation or suppression. This serves the purposes of its customers; while QCEW exists to track establishments that must pay UI, D&B sells its information to businesses for marketing and decision-making purposes. Walls & Associates is a unique user of the D&B data, creating a longitudinal database from the yearly snapshots.<sup>27</sup>

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<sup>26</sup> Researchers can apply to use QCEW data through the BLS or through states. Each organization has different application processes and success rates. While researchers have used these alternative sources in the past, the number and diversity of researchers using them has increased thanks to the proliferation of these databases, improved database structure, increased accessibility, and perceived improvements in data quality (Kunkle, 2011; Neumark, Zhang, & Wall, 2005).

<sup>27</sup> Walls & Associates also adds information on changes in corporate parentage, and keeps careful track of establishment relocations and addresses; currently, the NETS data has over 300 variables.

#### *4.2.1 Accuracy of D&B and the NETS*

Over the past decade, the NETS has been used to assess the impact of living wages laws on employment outcomes (Lester, 2011), differences in employment growth rates amongst small and large establishments (Neumark, Wall, & Zhang, 2011), the role state-level development incentives play in employment growth (Lester, Lowe, & Freyer, 2012), and the importance of local ownership in small firm growth (Fleming & Goetz, 2011). Additionally, its source D&B data has been used extensively in assessments of food deserts by researchers in the public health field (see, for example, Fleischhacker et al., 2012; Kaufman et al., 2015; Liese et al., 2010, 2013; Ma et al., 2013; Powell et al., 2011).

Yet, even as an increasingly diverse field of researchers and practitioners turn to private establishment-based data sources, there are lingering questions about the appropriateness of their use, most often due to concerns about the quality of the data. A number of studies have assessed the accuracy of data contained in D&B and, by extension, the NETS. Early criticisms of D&B data focused on the low “match rate,” or the low percentage of matching records researchers found for companies drawn from externally defined reference lists. Many of these studies drew their reference lists from ES-202 data (the name of the QCEW’s predecessor database). Birley (1984), for example, found D&B captured just four percent of new ES-202 businesses founded between 1977 and 1982 in St. Joseph County, Missouri. In their study of new businesses in Durham County, North Carolina, Aldrich, Kalleberg, Marsden, & Cassell (1989) found D&B files missed 58 percent of new businesses in the ES-202 files and 90 percent of new businesses found by enumeration (e.g. from the phone book, field observation, Chamber of Commerce filings). Critically, however, they suggest that the ES-202 performed no better, missing 56 percent of new businesses identified through D&B files and 86 percent of businesses identified



through enumeration. They also found that D&B tracked well with data on founding dates and initial employment levels gathered via enumeration.

Yet, as Neumark et al. (2005) note, both studies were conducted before a critical 1992 infusion of new data into D&B. Using only post-1992 data and robust methods to ensure that reference lists were as accurate as possible, Neumark et al. (2005) found a 95 percent match rate in the NETS for verified new business from a reference database of bioscience companies, with 75 percent of the NETS records having the correct founding year and 92 percent being within two years. They also found that while the NETS had much higher levels of employment when compared to corresponding industrial and geographic slices in aggregated QCEW data, the majority of employment excess could be removed by subtracting one employee per company, which they used as a proxy for non-wage entrepreneurial labor. Ultimately, many researchers conducting economic research have concluded that the NETS data is a viable alternative to government databases for studies of long-term trends, and that for entrepreneurship studies in particular, it may be superior given its capture of non-wage labor relations (Kolko & Neumark, 2007; Kunkle, 2011; Neumark et al., 2011, 2005).

Recent research in the public health field has been less sanguine towards alternative data sources. To assess the accuracy of alternative data sources, these studies rely on extensive “ground-truthing,” or undertaking an extensive physical census of the study area, and then comparing the ground-truthed results to alternative data. The majority of these studies have been on food deserts, or areas lacking food establishments. In their carefully identified list of food establishments in American Indian communities in North Carolina, Fleischhacker et al. (2012) found that D&B had consistently low scores on various measures of accuracy, particularly when compared against Reference USA (a similar alternative database). Ma et al. (2013) found that

D&B identified fewer low food access areas than both InfoUSA (another alternative database) and a reference database. Liese et al. (2013) found that D&B both undercounted and overcounted different types of food establishments to varying degrees, and Liese et al. (2010) found that the D&B only located food establishments within 100 meters of the correct location approximately 29 percent of the time. Consensus among these studies is that secondary data sources are not appropriate for identifying geographically and business-count sensitive food deserts, and that ground-truthing remains the preferred method (see also Powell et al., 2011).

Unfortunately, the robust studies conducted in the public health field contain a series of potential shortcomings when applied to entrepreneurial research. First, the methods used to both identify and ground-truth businesses limit their assessments to particular industrial categories, including bioscience. Food establishments rely on physical visibility for their long-term viability, making a physical census a valid way to assess their existence and location. In contrast, companies not aimed at the general public do not need to have a solid physical presence; many entrepreneurial companies are housed in business parks or home offices, often without physical markers. Ground-truthing these companies through a physical census would be difficult if not impossible.

Second, these studies do not compare either the D&B or the NETS data against disaggregated versions of secondary databases like the QCEW, which itself many have gaps or inaccuracies.<sup>28</sup> Both Fleischhacker et al. (2012) and Liese et al. (2010) found that government-produced secondary sources from North Carolina's Department of Agriculture and Consumer Services and South Carolina's Department of Health and Environmental Control, respectively,

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<sup>28</sup> As a source of unemployment data, not all QCEW files contain information on a physical location; the UI address is often all that is included in QCEW files, and even that can be missing.

performed poorly, pointing to the possibility that data gaps or inaccuracies in alternative databases might be present in government databases, too.

Third, as the goal of the bulk of these recent studies has been to assess the accuracy of the existence and location of food establishments, they have not focused on employment, a core metric in economic development studies. Fourth, with the exception of Kaufman et al. (2015), they have not focused on longitudinal data. Gathering data on employment and historical locations is not possible through ground-truthing alone.

#### 4.2.2 *Inclusion criteria in the QCEW and the NETS*

One common conclusion from the literature is that alternative database deviations from either ground-truthed data or other government databases are a result of inaccuracies in alternative databases (for an exception, see Neumark et al., 2005). Yet, while alternative databases undoubtedly have inaccuracies, divergent database design practices influence database contents—and ultimately, the comparability between databases. By exploring differences in the design of the QCEW and the NETS—that is, the workers and companies each database intends to include, and the data collection methods they employ to capture this data—we can begin to separate inaccuracies from *purposeful differences* between the two databases. Decisions made by the D&B (and therefore the NETS) and the QCEW drive the latter.

As a record of jobs employers must pay unemployment insurance on, the QCEW only includes data on workers covered by either state unemployment insurance laws or by the Unemployment Compensation for Federal Employees program (UI, collectively). To be included in the QCEW, these *covered workers* must be either working or receiving payment for work

performed in the pay period that includes the twelfth of the month.<sup>29</sup> The BLS estimates that 98 percent of paid workers are included in the QCEW (BLS handbook of methods, 1997). However, two key portions of the workforce are not eligible for UI and are therefore purposely excluded from the QCEW: the unincorporated self-employed and unpaid workers. The incorporated self-employed must pay unemployment insurance on their own wage labor to be eligible for UI; the unincorporated self-employed do not pay unemployment insurance and are therefore not eligible for UI.<sup>30</sup> In 2009, seven percent of the US workforce fell into the category of unincorporated self-employed (Hipple, 2010).<sup>31</sup> Unpaid workers, by nature of not receiving wages for their work, are not eligible for unemployment pay.

In contrast to the QCEW, D&B asks companies how many people work at an establishment, with no respect to their payment arrangement (Neumark et al., 2011). As a result, D&B—and by extension, the NETS—has a much broader definition of employment.

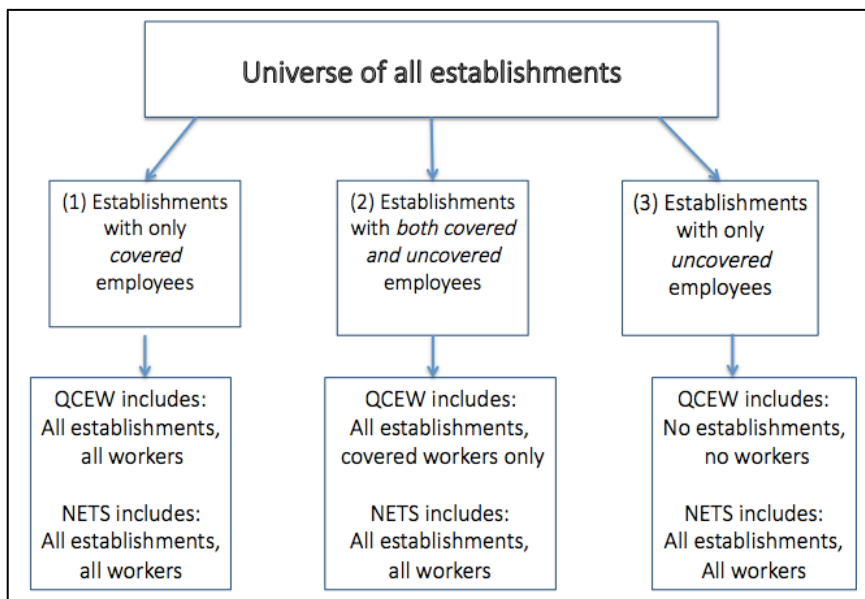
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<sup>29</sup> This criteria includes workers on paid sick leave and vacation but not workers on furlough or unpaid absence.

<sup>30</sup> Further, the incorporated self-employed work at incorporated firms, and the unincorporated self-employed work at firms that have not been incorporated.

<sup>31</sup> It is possible that estimates of unincorporated self-employment are undercounted. Official statistics capture a worker's *primary* job, not his or her *secondary* job. In 2009, 1.9 million workers held a second self-employed job (Hipple, 2010). Still, the number of unincorporated self-employed workers has been falling for the past forty years, due to both shifts out of agriculture and an increasing ease to incorporate a business.

**Figure 4.1: Establishments and Workers Included in the QCEW and the NETS**



These *purposeful differences* in included workers extend beyond employment counts, as Figure 1 illustrates. The QCEW captures all establishments and workers in incorporated businesses comprised entirely of covered workers (box 1). The database also captures all establishments that employ any covered workers, but only captures the covered portion of the workers at these establishments (box 2). The QCEW does not include any establishments without covered workers (box 3). In contrast, the NETS should include any establishment with a DUNS number (the unique number assigned to any establishment in the D&B database) and any reported workers.

Because of these differences, research comparing the NETS to the QCEW cannot assume that all observed differences between the two databases are the result of NETS inaccuracies, nor can it assume that data in the QCEW represents a “correct” version of the region’s economy. This is particularly true for scholars of entrepreneurial businesses, which have higher levels of unpaid and unincorporated self-employed workers than larger companies (Kunkle, 2011;

Neumark et al., 2005). Instead, differences between the NETS and the QCEW analyzed in ways that, to the best of our abilities, break down (a) what the NETS *should* include and what it *actually* includes, and (b) differences between the NETS and the QCEW that are the result of purposeful differences in database design.

### **4.3 North Carolina's bioscience industry**

North Carolina's bioscience industry is long-established in the Research Triangle region, and has been identified as one of the largest in the country (e.g., Feldman & Lowe, 2011; Feser, Sweeney, & Renski, 2005; Goldstein, Feser, Freyer, Gordon, & Weinberg, 2008; Markusen, 1996). Researchers have traditionally characterized the industry's regional development as the result of a state-led effort that resulted in the founding of the Research Triangle Park (RTP) and the eventual recruitment of satellite branch plants (Luger & Goldstein, 1991; Markusen, 1996). More recent scholarship has reframed the development of the region in a number of ways, including an increased recognition of the region's entrepreneurial tradition (Feldman & Lowe, 2015; McCorkle, 2012). As such, numerous studies have focused on the trajectory of the region's shift from a region defined by a satellite office park to one with a burgeoning entrepreneurial scene (Feldman & Lowe, 2011; Lowe & Feldman, 2014; Lowe, Feldman, & Kemeny, 2016).

### **4.4 Study Data**

The study draws data from three main sources. The first is the Feldman-Lowe database, a proprietary database of entrepreneurial firms housed at the University of North Carolina at Chapel Hill (Feldman & Lowe, 2015). The study relies on eight fields from the database:

company name, additional names, company addresses, entry type, entry location, date established, company description, and total founders. Company name is the name of the company at its founding. The additional names field includes all other names the company has gone by throughout its life. The company addresses field includes common addresses the company has used in its life. Entry type is an exhaustive and mutually exclusive drop-down field, and can be used to identify entrepreneurial firms (as “entrepreneurial start-up”) from other types of firms or establishments in the database (e.g. de novo branch plants, entrepreneurial relocations, joint partnerships).<sup>32</sup> Entry location is also an exhaustive and mutually exclusive drop-down field. For entrepreneurial firms, entry location records where a firm was located when it was founded. There are three options in this field: the 13-County Triangle Region, Other North Carolina, and Outside North Carolina.<sup>33</sup> The date established field features a calendar, recording the firm’s earliest known date of existence. The company description field allows unlimited text. Here, researchers enter information related to company history, past and current business activities, product development, changes in company strategies, etc. Finally, the total founders field is a sum of the total number of founders associated with each entrepreneurial startup.

As outlined in Feldman & Lowe (2015), the data in this database is the culmination of a multi-year and continuous data collection effort. Firms are identified from a variety of sources, including publications or lists of companies provided by universities and incubators, shared data

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<sup>32</sup> The options in this drop down are exhaustive and mutually exclusive. Entrepreneurial start-up is amongst the most commonly used selections.

<sup>33</sup> The Outside North Carolina option is rarely used, and is for out of state entrepreneurial firms that have some links to North Carolina. For example, the larger research project tracks “serial entrepreneurs” who founded multiple companies. If one of these entrepreneurs founds multiple companies in North Carolina but one outside of the state, that latter firm would be included in the database as Outside North Carolina.

from local quasi-public or non-profit organizations (e.g., North Carolina Biotech Center and the Council for Entrepreneurial Development), newspaper articles, interviews, etc. Data is identified from multiple sources; examples of these sources include LinkedIn, in-person interviews, Secretary of State filings, patent filings, incubator tenant lists, technology transfer office filings, and membership or event attendance lists from local entrepreneurial and industry organizations.

The majority of the database's bioscience firms are engaged in traditional life science, pharmaceutical, or medical device activities, including early to mid-stage drug development, drug commercialization, contract research, medical device development, and drug and device manufacturing. However, this industry also includes companies that engage in less traditional but supportive activities, including the development of drug management software and specialized law and consulting.<sup>34</sup> Including this wide range of firms is a more holistic approach than one based on using industrial codes (e.g., NAICS) to define an industry, and an accurate representation of the region's entrepreneurial environment of bioscience start-up firms.

The second data source is the 2013 North Carolina NETS database, a private establishment-based database. This database contains records for all establishments located in the state of North Carolina at any point between 1989 and 2012. The study uses 1991 to 2010 data from three of the 13 files that comprise this database: the first address file, the move summary file, and the employment file. The first address file provides both the company name and the establishment's first known street addresses. The move summary file provides a record of every major move the establishment made in the time period. The employment file provides the yearly

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<sup>34</sup> The North Carolina Biotechnology Center, a key source of data in the Feldman-Lowe database, labels these companies "bioassets."



employment count for an establishment. All files have a DUNS number to link establishment records together.

The study also uses 20 yearly establishment-level QCEW records (1991-2010) provided by North Carolina's Department of Commerce. Each file contains a company legal name, a company DBA name (for "does business as"), the year's monthly employment counts, and quarterly addresses. In some years, each establishment listed in the QCEW has two addresses: physical address and mailing address. In other years, establishments have a third address: unemployment insurance address.

Finally, while the Feldman-Lowe database contains information on entrepreneurial companies or firms, each of the two secondary databases is establishment-based. The two terms are distinct; an establishment refers to a single physical location of a business unit, and a firm (or company) is often comprised of multiple establishments. However, since this study only considers the first location, employment levels, and founding date of an entrepreneurial firm, the firm is equivalent to the firm's single, original establishment. Following Neumark et al. (2005), I use the terms business and establishment interchangeably, and use firm and company to refer to the larger (and potentially multi-establishment) entities.

#### **4.5 Study Methodology**

The research's overarching approach is to develop a 20-year reference list of entrepreneurial bioscience firms, recreate that reference list in each of the two secondary databases, and compare the results from the secondary databases to each other. In an effort to separate inaccuracies in the NETS from differences driven by purposeful differences in database

design, the study adjusts the NETS data using a proxy for unpaid employment before comparing the two databases again. Each of these methods is addressed in turn below.

#### *4.5.1 Reference list development*

The research starts with an externally defined, fully vetted reference list of the region's entrepreneurial firms in the bioscience industry. Relying on a fully triangulated reference list avoids a common pitfall that many older studies identified: the list used to test private data sources (e.g. phone books, government lists) is often itself inaccurate, leading to problematic assessments of alternative data sources (Aldrich et al., 1989; Fleischhacker et al., 2012; Liese et al., 2010; Neumark et al., 2005).

The Feldman-Lowe database provides reference list data. The reference list includes entrepreneurial bioscience firms, which are defined as business entities started from scratch by one of more entrepreneurs. As such, the reference list excludes new, non-entrepreneurial firms (e.g. firms founded as joint ventures between two existing firms, firms created as a result of corporate demerger). I identified the reference list firms through the "entrepreneurial start-up" option in the entry type field, which narrows the list down to entrepreneurial firms, and the company description field, which I used to identify firms that fell within the biosciences.

Firms must also have had their first location in one of the thirteen counties that North Carolina's state government considers the Research Triangle Region. I identified these through the "13-County Triangle Region" option in the entry location field. I further narrowed the list down through the date established field, including only those firms founded between January 1, 1991, and December 31, 2010.

The reference database identified a total of 509 entrepreneurial bioscience firms that meet these criteria. For each of these, I gathered the company name, company aliases, company addresses, and total founders to use in the analysis.

#### *4.5.2 Finding reference list matches in the QCEW and the NETS*

Matching companies from a reference list to their corresponding records in secondary sources presents significant challenges. At best, minor name changes (e.g., shifts from LLC to Inc.) and common roots (e.g. gene- or bio- or Triangle) make matching time-consuming. At worst, major historical name changes that are the result of company events (including mergers and acquisitions) can make matches from a reference list to a secondary source impossible. Additionally, both the QCEW and NETS shorten names to fit into variable character constraints (e.g. management to mngmnt).

To increase the success of matches, the research team devoted significant effort towards collecting alternate names for firms and entering them into the additional names field in the Feldman-Lowe database. To match the reference list firms to their records in the secondary databases, I ran all of a company's names—from both the company name and additional names fields—through an algorithm in SAS. This algorithm returned the top ten establishment matches from the secondary database (both the NETS and all of the QCEW files, separately) for each name a reference list company had.<sup>35</sup> For work in the QCEW, this meant running the algorithm

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<sup>35</sup> The algorithm relied on COMPGED function in SAS, which in turn is based on the Levenshtein distance between two string variables (see Staum, 2007 for a discussion of the function and its use in fuzzy matching). The algorithm calculated the distance between the company name from the reference list and each company name in the secondary list (the QCEW

twice for each year: first with the QCEW record's legal name, and a second time with the QCEW record's DBA name. For each of the algorithm's ten returned records (or *potential matches*), I gathered all known addresses from the secondary databases. In the NETS, this meant collecting all corresponding addresses from the first address and company moves files. In the QCEW, this meant collecting physical addresses, mailing addresses, and unemployment insurance addresses (where available).

The research team then compared (1) the potential matches from a secondary database, and all of the associated addresses from that database, against (2) the company name, additional names, and company addresses fields from the reference list. If a researcher deemed a potential match a full match, they coded the potential match as a "2." They coded potential matches that were clearly not matches (e.g., the names were not similar and there were no overlapping addresses) as "0." However, they also coded potential matches they were unsure of as "1." This tended to happen when a company had a common or vague name (e.g., XS, Inc., a company that provides data management services to life science companies) and when none of the reference list addresses matched addresses from the secondary database.

Potential matches that researchers coded as "2" or "1" received a second round of blind coding from another researcher. If both researchers coded a potential match as a "2," I considered it a match. If either researcher gave the potential match a "1," then the potential match required more research. This typically required research into additional addresses. This frequently happened with older companies, when the addresses returned from the secondary

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or the NETS). The algorithm then sorted the numerical distances from smallest to largest, and returned the ten companies with the smallest numerical distances. Tests showed that this method of matching was faster than manual searching (i.e. searching for key words) and returned a higher number of matches. The algorithm is available upon request.

database did not match any addresses from the Feldman-Lowe database but when the names were very close or identical. Two researchers conducted research on these companies independently, recorded their results as either a “2” for a resolved match or a “0” for no match, and recorded all of the sources they used in their research. In the rare cases when this research resulted in conflicting match recommendations, I consulted the websites each researcher used and made a final decision.

#### *4.5.3 Methods of comparing data between the databases*

Key indicators of the entrepreneurial environment in the Triangle’s bioscience industry include: the number of companies from the reference database found in each secondary database; the initial employment levels found in the secondary databases; the founding years identified in the secondary databases; and the founding locations identified in the secondary databases.

First, I compare the number of reference list establishments found in the NETS to the number of reference list establishments found in the QCEW. Testing whether a reference list firm has a corresponding establishment in each database is akin to testing a binary outcome of matched pairs. A reference firm’s inclusion as an establishment in the QCEW is a matched pair to that same firm’s inclusion as an establishment in the NETS. Each reference list firm is assigned a “1” if it appears in the NETS and a “0” if it does not, and is assigned the same values in a separate variable field for appearing in the QCEW. A McNemar test is a commonly used test for matched binary outcomes, and ascertains whether the number of companies included in the QCEW is significantly different from the number included in the NETS. Given the broader

inclusion guidelines of the NETS, the NETS is expected to include significantly more reference list firms than the QCEW.

Next, I compare initial employment counts, or the first known employment at each establishment in the NETS and the QCEW. I am only able to test differences using those reference list firms that appear in both the QCEW and the NETS. Separate plots of QCEW and NETS first-year employment data show that the data in each is right-skewed. This means that a paired t-test, which requires data be normally distributed, is inappropriate. I use a Wilcoxon signed rank sum test instead. This test is commonly used for non-normal interval data. I use it here to assess whether there is a significant difference between the initial establishment employment numbers in the QCEW and the NETS. Given inclusion guidelines in the two databases, the NETS should have a statistically significantly higher average employment count than the QCEW.

I next compare the founding years of reference list companies. The year a company first had employment was approximated to be its database-identified founding year.<sup>36</sup> Business listings in the NETS are expected to have earlier founding years than listings in the QCEW, since that the NETS has looser inclusion requirements (i.e., it does not require having a formal, wage-paying employment relationship with an employee). However, there should be similar trends in both databases. That is, the number of business listings in each database should be increasing at the same growth rate over the study's 20 year time period. The study employs a Chow test to assess whether trend lines for both databases display structural differences.

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<sup>36</sup> While the NETS contains a field for a firm's founding date, the QCEW does not. I used the first year of employment to be consistent.

Separate kernel density maps assess spatial concentrations of the QCEW and NETS entrepreneurial environments, respectively.<sup>37</sup> The NETS is expected to show greater diffusion than the QCEW, since many of the companies started in residential locations or smaller laboratories and moved to larger spaces as they hired workers. Street addresses from both databases were turned into geocoordinates using the Texas A&M Geoservices online batch geocoding software.<sup>38</sup>

#### 4.5.4 *Adjusting the NETS data*

The driving purpose of this study is to separate measurement error in the NETS from purposeful differences that are the result of divergent database design criteria. The research therefore includes a key adjustment to the NETS employment data, the effects of which ripple through to comparisons of business inclusion, business founding year, and location. In their comparison of NETS and QCEW employment data, Neumark et al. (2005) subtracted one employee per company as a proxy for unpaid entrepreneurial employees. In this study, I subtract each company's known number of founders from each year's employment numbers in the NETS.

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<sup>37</sup> The study uses the first available quarterly address associated with the month's employment from the QCEW. In almost all cases, the address is the physical address and is available in the same quarter as the employment. However, 24 (8.7 percent) of the matched business listings did not have a physical address. In these cases, an establishment's unemployment address was used. While these addresses are often different for larger firms that outsource their payroll or human resources, the majority of entrepreneurial businesses with both physical and unemployment addresses record the same address in each.

<sup>38</sup> Available at <http://geoservices.tamu.edu/Services/Geocode/>. While the NETS data contains latitude and longitudes, the QCEW does not. Unfortunately, many of the NETS addresses are only geocoded to the zip code level. This is relatively common in the NETS, as many of the addresses are "messy" (i.e., they contain incorrectly spelled or truncated street names, incorrect city names (such as the Research Triangle Park instead of Durham or Morrisville), mismatched address and zip code data, etc. For better accuracy, I cleaned and used the address data.

The first year with positive, non-zero employment is the adjusted founding year, the positive employment in that founding year is the adjusted first year employment.<sup>39</sup> The establishment's address in that adjusted year is considered the first adjusted location. Businesses that never have positive, non-zero employment are given a "0" for adjusted inclusion in the NETS and are excluded from any further analysis. This adjustment is the closest approximation to removing the differences between the databases that are the result of divergent database designs; once entrepreneurial employment is subtracted from the NETS, the remaining differences between the NETS and the QCEW are more likely to be the result of inaccuracies.

The adjustment should lower the average firm's employment numbers in the NETS, remove many NETS business listings from the matched NETS list of firms, and result in a later average NETS founding date. The adjustment should also make business locations in the NETS more concentrated, due to both listing attrition and founding year convergence.<sup>40</sup> After these adjustments, there should be no statistically significant differences between the NETS and QCEW data.

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<sup>39</sup> While it is not necessarily the case that entrepreneurs do not receive wage labor, previous research suggests it is likely (Kunkle, 2011; Neumark et al., 2005).

<sup>40</sup> The NETS only includes relocations it deems "significant moves," which it defines as relocations that include changes in both the zip code and street (Walls and Associates, National Establishment Time-Series (NETS) Database: 2012 Database Description). While this policy is intended to prevent clerical errors and zip code changes from being classified as relocations, the sizeable number of bioscience establishments located on major streets in and around the Research Triangle Park (e.g. Davis Drive, T.W. Alexander Drive, Chapel-Hill Durham Boulevard) might undercount real moves along these roads.



## 4.6 Results: Raw NETS and Raw QCEW Data

### 4.6.1 Number of entrepreneurial firms

The reference list of bioscience entrepreneurial start-ups contains 509 firms. Of the 509 firms, 404 (79.3 percent) were matched to establishment records in the NETS, the QCEW, or both. As expected given the NETS and the QCEW's different inclusion guidelines, a larger number of entrepreneurial companies were matched to records in the NETS than in the QCEW. Of the 509 bioscience firms, 381 (74.9 percent) were matched to records in the NETS, whereas only 273 (or 53.6 percent) were matched to records in the QCEW (see Table 1). Just 250 of the 509 firms (49.1 percent) were found in both databases. As expected, the McNemar chi2 statistic suggests that the proportions of the reference database found in the NETS and the QCEW are statistically significant from one another.

**Table 4.1: Entrepreneurial Start-up Firms in the QCEW and the NETS**

	NETS	QCEW
<b>Firms</b>	381	273
<b>McNemar's S</b>	75.7403	
<b>Pr&gt;S</b>	<0.0001	

### 4.6.2 Employment

On average, the firms in the NETS had higher levels of employment than the firms in the QCEW. The 381 firms in the NETS had, on average, 1.1 more employees per firm than the 277 firms in the QCEW (5.7 vs. 4.6, respectively; see Table 2).

Comparing reference list firms with establishment matches in each database provides a direct comparison of employment numbers. The 250 firms in both the NETS and the QCEW

have average employment of 7.2 and 4.7, respectively. A Wilcoxon signed-rank test suggests there is a statistically significant difference between these employment rates.

**Table 4.2: Employment Statistics, QCEW and NETS**

	NETS	QCEW	Matched NETS	Matched QCEW
<b>Firms</b>	381	273	250	250
<b>Average employment</b>	5.7	4.6	7.2	4.7
<b>Standard deviation</b>	8.1	8.0	9.3	8.1
<b>Minimum</b>	1	1	1	1
<b>Maximum</b>	66	89	66	89
<b>Wilcoxon signed-rank test S-statistic</b>	N/A		5899.5	
<b>Wilcoxon signed-rank test <math>Pr \geq  S </math></b>	N/A		<0.0001	

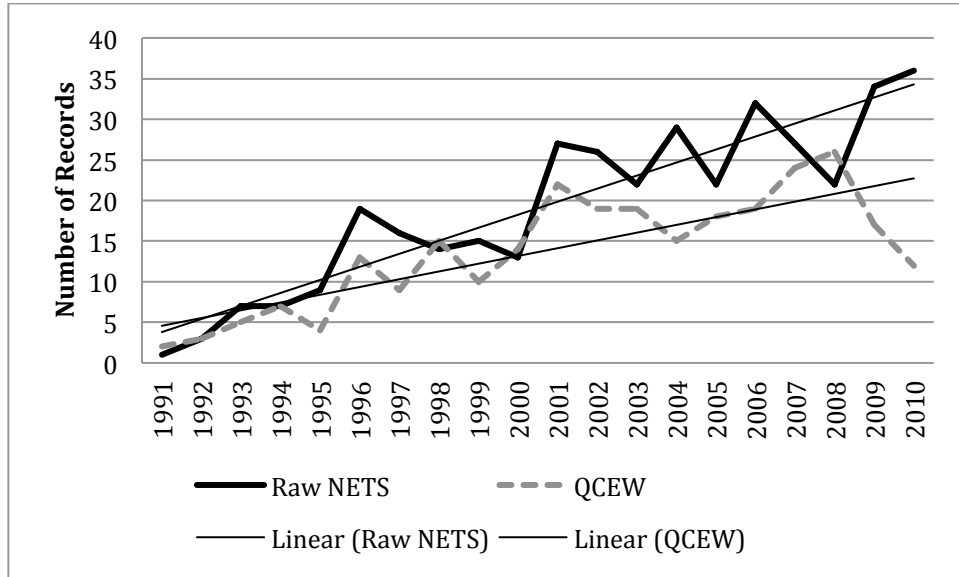
#### 4.6.3 Firm births over time

The distribution of firm births over time resulted in different entrepreneurial birth trends in the region. Of the 250 entrepreneurial companies matched to business records in both the QCEW and the NETS, only 88 (35.2 percent) were recorded as being founded in the same year. As expected, of the remaining 162 establishments, 119 (47.6 percent of 250) had an earlier founding year recorded in the NETS and just 43 (17.2 percent of 250) had an earlier founding year recorded in the QCEW. For firms with establishment matches in each database, the average firm was founded 0.6 years earlier in the NETS than in the QCEW.

Figure 2 shows the number of firms founded per year in the QCEW and the NETS, respectively, and their trend lines. While the two databases have similar starting points (with 17 and 18 records found in the first four years of the QCEW and NETS databases, respectively), over time the number of reference list firms with records found in the NETS has increased at a

much faster rate than those found in the QCEW (see Figure 2). A Chow test indicates that there is a structural difference for the NETS and the QCEW ( $F=6.35$ ,  $Pr>F$  0.0044).

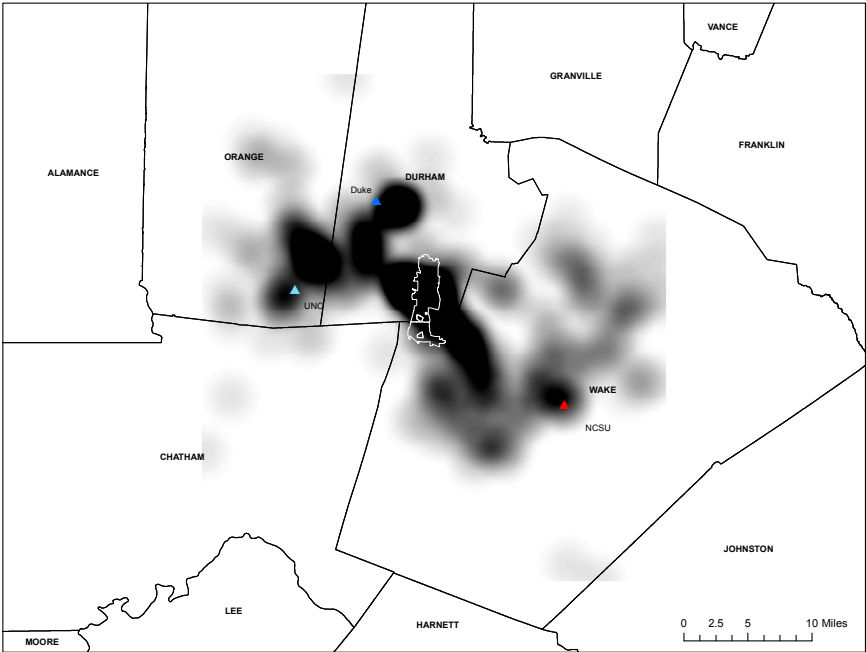
**Figure 4.2: Earliest Record Date of Reference List Firms, QCEW and Raw NETS**



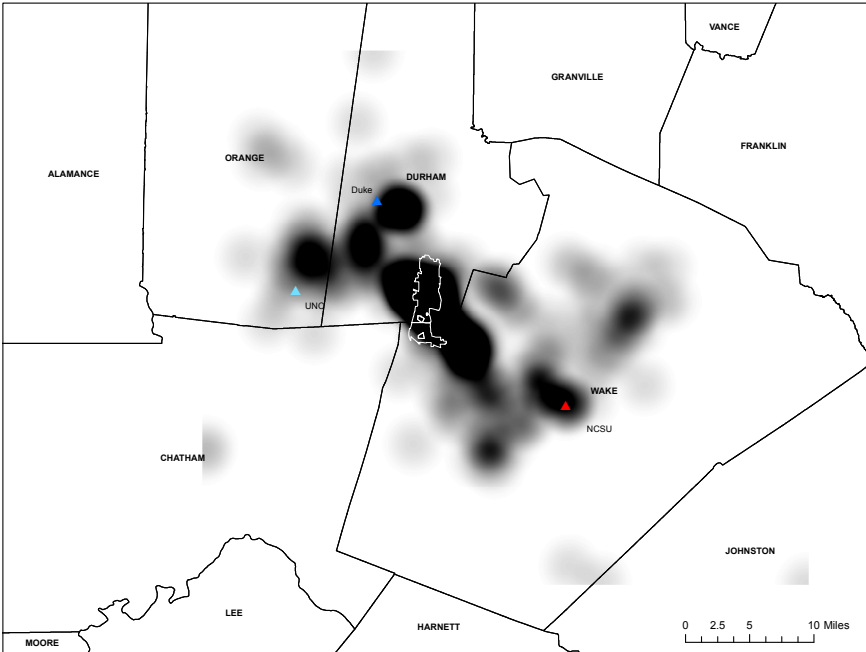
#### 4.6.4 Location

Figures 3 and 4 show the locations of all 381 NETS and 273 QCEW establishments in the Triangle region, respectively, and their locational relationships to the Research Triangle Park. Duke University is a dark blue triangle to the northwest of the RTP, UNC is a light blue triangle to the west, and North Carolina State University is a red triangle to the east. Establishments in both the QCEW and the NETS are heavily concentrated in the Research Triangle Park, in the center of the maps. However, while both maps show firms radiating out from this area, NETS firms are also more diffused around the region, with stronger concentrations of firms to around each of the three research universities.

**Figure 4.3: Kernel Density Map of Bioscience Industry Firms in the NETS**



**Figure 4.4: Kernel Density Map of Bioscience Industry Firms in the QCEW**



Of the 250 companies in both the NETS and the QCEW, 120 (48 percent) had the same recorded first address, and an additional 45 (18 percent) had records within 1600 meters of each other, for a total of 165 companies (66 percent) with first locations within a mile of one another. On average, matched companies were 1676 meters apart.

## **4.7 Results: Adjusted NETS and Raw QCEW**

### *4.7.1 Number of entrepreneurial firms*

Adjusting the NETS by entrepreneurial employment is expected to bring the NETS and QCEW data more in line. Of the 381 firms matched to records in the NETS, 103 had employment below or equal to the number of founders. Removing these firms brings the adjusted number of matched companies in the NETS to 278—meaning that the adjusted NETS data has just one more firm than the 273 matched QCEW firms. After this adjustment, a McNemar test shows no statistically significant difference between the numbers of firms captured by establishment listings in each database.

### *4.7.2 Employment*

Adjusting the number of employees at NETS business listings by each firm's number of entrepreneurs *increases* the average initial number of employees at each firm, from 5.7 employees per business to 6.1 employees per business. Statistically significant differences in employment remain between the matched NETS and QCEW business listings.

**Table 4.3: Entrepreneurial Start-up Firms in the QCEW and the NETS, using Adjusted NETS Data**

	Raw NETS	QCEW	Adjusted NETS	QCEW
<b>Firms</b>	381	273	278	273
<b>McNemar's S</b>	75.7403		0.1969	
<b>Pr&gt;S</b>	<0.0001		0.7228	

**Table 4.4: Employment Statistics, QCEW and NETS, using Adjusted NETS Data**

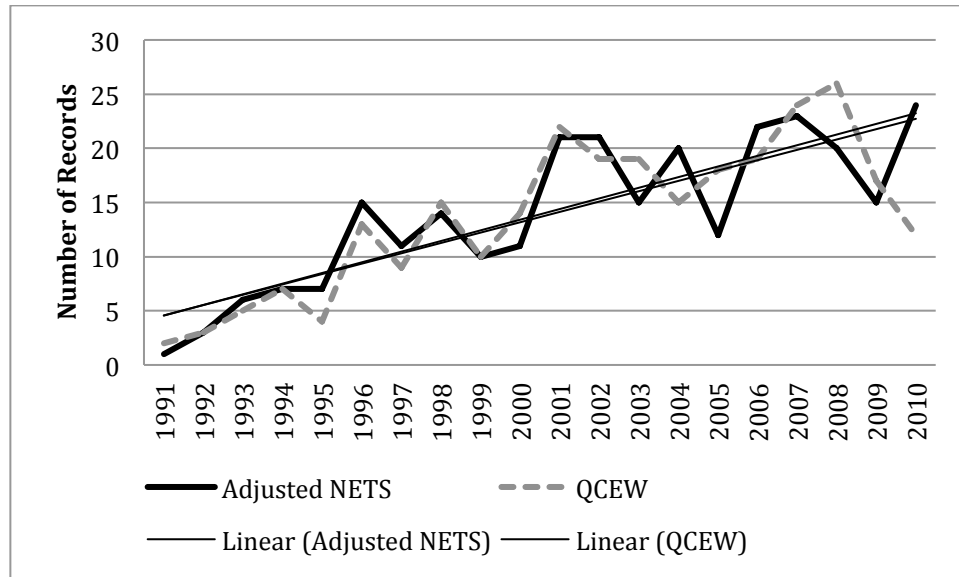
	Raw NETS	Adjusted NETS	QCEW	Matched Adjusted NETS	Matched QCEW
<b>Firms</b>	381	278	273	212	212
<b>Average employment</b>	5.7	6.1	4.6	6.9	5.1
<b>Standard deviation</b>	8.1	8.8	8.0	9.6	8.6
<b>Minimum</b>	1	1	1	1	1
<b>Maximum</b>	66	64	89	64	89
<b>Wilcoxon signed-rank test S-statistic</b>	N/A			3262.5	
<b>Wilcoxon signed-rank test Pr&gt;= S </b>	N/A			<0.0001	

#### 4.7.3 Firm births over time

Even after adjusting the NETS data, business records appear earlier in the NETS than they do in the QCEW. Out of 212 matched establishment pairs found in both databases, 71 (33.5 percent) were recorded in the same year. Eighty-six (40.1 percent) had earlier business listings in the NETS, and 55 had earlier listings in the QCEW. The average firm appeared 0.3 years earlier in the adjusted NETS data than in the QCEW, halving the 0.6 years earlier when using the unadjusted NETS data. Adjusting the NETS data removes statistical evidence of temporal trends in the founding years; Figure 5 shows the number of records of reference list establishment found per year in the QCEW and in the adjusted NETS, along with trend lines. A Chow test

indicates that there is no evidence of a structural difference for the NETS and the QCEW ( $F=0.01$ ,  $\Pr>F$  0.9934).

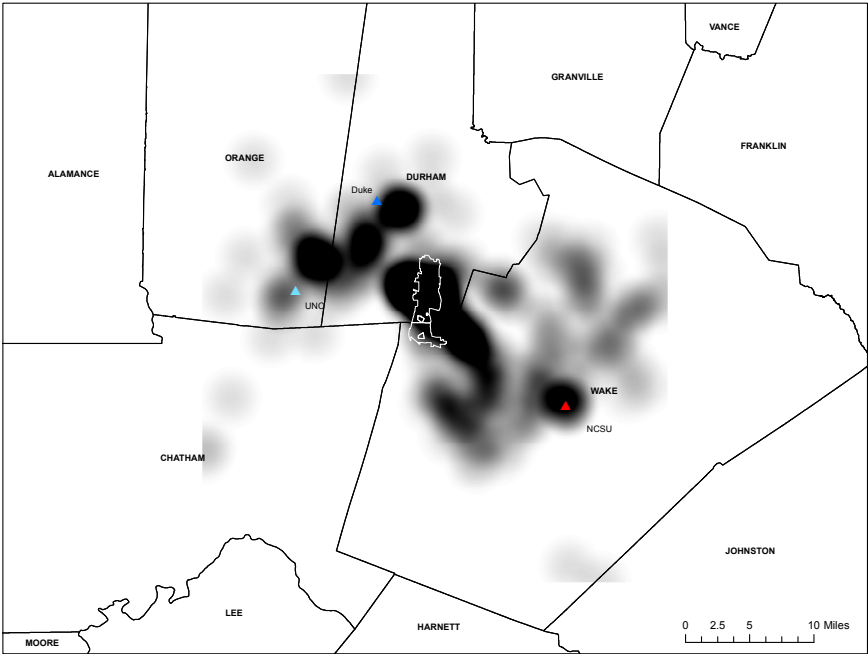
**Figure 4.5: Earliest Record Date of Reference List Firms, QCEW and Adjusted NETS**



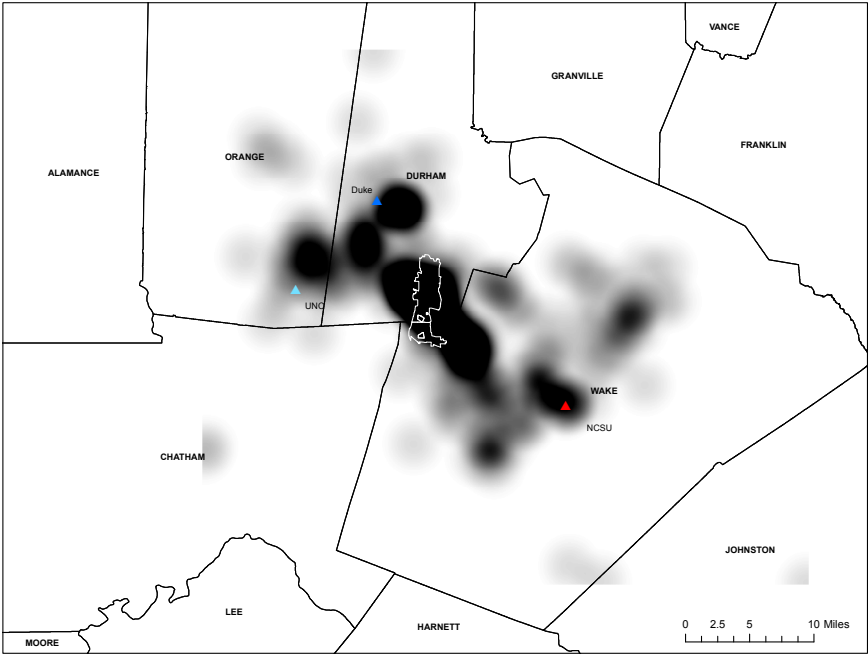
#### 4.7.4 Location

Figures 6 and 7 show the locations of all 278 NETS and 273 QCEW establishments in the Triangle region, respectively. Establishments remain concentrated around the Research Triangle Park, in the center of the maps. Yet the two maps are fairly similar, with the most notable discrepancy being the greater sprawl of firms in Wake County in the NETS map. In the comparison of the reduced NETS sample with QCEW matched business listings, 103 of 212 companies (48.6 percent) are in the same location. An additional 42 (19.8 percent) are within 1600 meters of each other. In total, 77.8 percent of companies have initial business listings within 1600 meters of each other.

**Figure 4.6: Kernel Density Map of Bioscience Industry Firms in the Adjusted NETS**



**Figure 4.7: Kernel Density Map of Bioscience Industry Firms in the QCEW**





## 4.8 Discussion

Reference list firm records found in the NETS database paint a picture of the Research Triangle region's entrepreneurial ecosystem that is considerably different from the corresponding QCEW picture. As expected, the NETS contains statistically significantly greater numbers of reference list business listings than the QCEW (381 vs. 278, respectively), with significantly greater founding employment numbers (7.2 vs. 4.7 in the 250 matched firm records that appear in both the NETS and the QCEW, respectively). This is consistent with expectations given the databases' different inclusion guidelines, such as the NETS's reliance on a far broader definition of "employee" than the QCEW and the lower threshold for inclusion (registration with D&B for the NETS vs. having covered employees for the QCEW).

Adjusting the NETS data by subtracting entrepreneurial employment removes some of these differences, but not all of them. The number of firms with business listings in the NETS drops from 381 to 278 after making this adjustment, a difference from the QCEW's 273 that is not statistically significant. Yet, while the gap between founding employment numbers narrows, dropping to 6.9 and 5.1 in the reduced sample of 212 matched records found in both the adjusted NETS and the QCEW, respectively, that difference remains statistically significant. This could be due to inaccuracies in the NETS data. However, this difference could also reflect the nature of employment in a high-tech industry—namely, that even mature companies do not fully rely on workers covered by unemployment insurance. Indeed, the entrepreneurship literature suggests that high-technology firms in particular continue to rely on academic contract work and consulting as a strategy to maintain access to cutting-edge academic research (Lam, 2007).

The findings from comparing founding years in the raw NETS and the QCEW records are somewhat surprising. The results confirm that, as expected, listings that appear in both

databases appear earlier in the NETS. In the case of the raw NETS and the QCEW, the average firm appears 0.6 years earlier in the NETS. However, the finding of statistically significant structural differences between the NETS and the QCEW records was not expected. It could be that these structural differences also reflect the changing nature of the region's industry, and specifically, an increase in independent consulting firms or other service-oriented bioscience companies (as opposed to bioscience companies developing therapeutics or devices). These companies have yet to be picked up by the QCEW, and may never be. The fact that this structural difference is no longer significant after adjusting the NETS data lends credence to the idea that it is the underlying structure of firms in the region that is changing—and not a change in the NETS ability to capture firms in the database.

Entrepreneurial establishments' first locations display a more dispersed spatial pattern across the region when relying on NETS data than when relying on QCEW data—though almost all of these differences appear to fade away when comparing the adjusted NETS data against the QCEW data. An examination of the addresses in the NETS suggests that the greater diffusion may be the result of firms using residential addresses, which may represent unincorporated businesses run out of an entrepreneur's home.

Still, the fact that less than half of the records in the QCEW and the NETS share the same address—and that only three-quarters are within a mile of each other—should give pause to researchers relying on this data. Comparing addresses in both the QCEW and the NETS to addresses in North Carolina's Secretary of State database suggests that both of this study's secondary databases use addresses that were, at some point, used in Secretary of State filings, though with no clear pattern. It is therefore unclear which database has the “correct” business listing, or if it is even possible to make such a determination. While the NETS gathers their data

from a variety of sources, making it susceptible to errors, of the 278 addresses used for QCEW data, 24 (or 8.7 percent) of records did not have a street address at any point in time. What is more likely is that different databases capture different spatial portions of a firm. A contract research firm, for example, may hire an employee to manipulate chemical or biological specimens in a laboratory while the founder conducts computer-based pharmacological research (where a researcher runs statistical models to detect drug interactions) from a home office. It is unclear which of these two addresses is the “correct” street address for a firm, and entrepreneurs could file different addresses with different agencies.

#### **4.9 Conclusion**

This paper suggests that while there are significant differences between the NETS and the QCEW, it is incorrect to ascribe the entirety of these differences to inaccuracies in the NETS. Through adjusting the NETS data, the paper reveals the extent to which purposeful differences in database design drive data divergence. This is especially true for the higher number of establishment records found in NETS, differences in timing of firm births in the NETS and the QCEW, and aggregate spatial patterns in the region. These differences fall away after adjusting NETS for a proxy for unpaid employment. Thus while the two databases paint very different pictures of the region, these differences are not necessarily the result of inaccuracies in the NETS, and are instead driven largely by design differences.

By unpacking differences between the NETS and the QCEW, the study also reinforces the fact that the two databases cannot be viewed as close substitutes for one another. This is particularly true when considering employment. Given looser thresholds for firm and employee

inclusion, the NETS may better reflect the fluidity of a region's entrepreneurial ecosystem. As a result, the NETS may be a better choice for researchers asking entrepreneurial research questions or for practitioners trying to gain a deeper understanding of their region's entrepreneurial environment. In contrast, the QCEW's strict and formal inclusion guidelines may lend the database to research questions about changes in formal employment practices, or for questions about large corporations. In this sense, the findings should not be interpreted as an indictment of the NETS or as an argument that the QCEW has "correct" data, or vice versa.

The research also suggests that differences between the two could be exploited. For example, how many firms transition from informal employee arrangements to paying unemployment insurance on employee wages? Questions like this are critical as economies turn to entrepreneurship as a policy mechanism to replace declining industrial sectors—and as an extension, may be replacing protected employment relations with working arrangements that do not have unemployment protections built in. More work exploring not just how these databases may act as substitutes, but how they can also act as complements in both research and practice, is needed.

## 5 CONCLUSION

### 5.1 Introduction

Entrepreneurship scholars have made great strides in recognizing the role that institutions—and their resources—play in the formation, development, and success or failure of regions and their industries. A variety of universities, non-profit organizations, and quasi-public organizations have enacted entrepreneurial policies in the hopes of furthering economic development through entrepreneurship. Yet, entrepreneurship scholars have largely ignored questions about *why* institutions adopt particular entrepreneurial strategies, *how* resources linked to these institutions and made available to only select entrepreneurs may shape sub-regional spatial patterns (i.e. microgeographies of firms), and *what* data we should use when answering questions about entrepreneurial regions. The papers that make up this dissertation include questions that address these points in turn.

### 5.2 Summary of research findings

The first paper explored why two universities undertook divergent business incubator strategies. The literature has largely linked business incubator adoption to factors internal to the university (like the university's commercialization culture), or external factors (like the strength of the regional entrepreneurial environment). Scholars have also traditionally viewed business incubators as commercialization strategies, but have not sufficiently linked their adoption to

broader redevelopment strategies. In this paper, I classified business incubators as a bridging activity between commercialization and redevelopment. I then used the lens of jurisdictional embeddedness to examine how pressures from jurisdictions—towns, cities, counties, and states—shaped each university’s culture as it relates to commercialization and redevelopment. I ultimately found that the literature has paid insufficient attention to political jurisdictions. In this view, while each institution’s business incubator strategy is an extension of its redevelopment and commercialization cultures, the jurisdictions in which the institutions are embedded have shaped those cultures. In the specific case of UNC and Duke, UNC’s relationship with the state as a public university and its recent interactions with the surrounding town and county led it to create incubators on campus and partner with local governments and a private donor to create an off-campus incubator. In contrast, Duke’s lack of affiliation with the state and its long tradition of acting as Durham’s anchor lessee have led the university to abstain from creating true business incubators.

The dissertation’s second paper asks the question: does the introduction of new, institutionally bound resources fundamentally alter the pattern of entrepreneurial firm locational decisions? The entrepreneurial literature recognizes both the importance of regional resources and that some of these resources are not accessible to all entrepreneurs. However, the literature has not analyzed how institutionally bound resources may shape firm location patterns within the region. In this paper I examined how UNC’s introduction of spatial, institutionally bound resources (in the form of a set of business incubators) may have caused a shift in the location of UNC firms. I found evidence in support of this shift from both statistical tests and interviews with university staff, entrepreneurs, and local planners. However, discrepancies in listed addresses suggest that either entrepreneurs didn’t recognize their home-based offices as official

firm locations, or didn't recognize their firm's functionality before moving to a laboratory. Whether this phenomenon is restricted to bioscience firms or reflects more commonplace patterns in entrepreneurial firm location data remains to be seen; implications are discussed later in this chapter.

In the third paper, I examined how reliance on different databases—one (the NETS) developed by a private company, the other (the QCEW) developed by a state government—may lead to different interpretations of a region's entrepreneurial environment. By drawing on a reference list of firms from a proprietary database and then analyzing the matched records of these firms in two external databases, I found that there are critical differences in how a user would characterize the region's entrepreneurial environment if they relied on one or the other. The private database had more establishments from the reference list firms, greater founding employment numbers, earlier founding years, and a more spatially dispersed pattern of firms in the region. Using a proxy for unpaid employment—the hypothesized driver of difference between the two databases—removed much of this difference, suggesting that differences between the two databases are driven not by inaccuracies in the private database, but rather by purposeful design differences between the two databases. I ultimately conclude that the NETS is a superior database for entrepreneurial research.

### **5.3 Significance of the research for research and policy development**

The first paper links universities to the multiple political jurisdictions in which they are embedded: states, counties, and cities. By ascribing differences in university policy to culture or regional circumstance, scholars have inadvertently downplayed the roles that historically

determined, inter-institutional relationships, laws, and norms have played in their development. By recognizing the importance of jurisdictional embeddedness in shaping policies at these universities, the research reinforces that there is no “one size fits all” approach to future policy development within universities; both have been successful, even with their starkly different strategies. Similarly, the disparate jurisdictionally embedded natures of Duke and UNC suggest that jurisdictions that house resource-rich institutions can find paths to build policies (i.e., jurisdictional advantage; see Feldman & Martin, 2005), built on preexisting patterns of relationships and partnerships.

The second paper provides evidence of the impact that institutionally bound resources play in a region’s development. For researchers, the paper suggests that it is important to recognize that hard institutional resources (like business incubators) are constrained to populations that the institution itself defines, and that interventions typically associated with recruiting or retaining large branch plants may be occurring with entrepreneurial companies. For policymakers, the paper provides evidence for the effectiveness of a business incubator strategy in reshaping entrepreneurial microgeographies.

The third paper’s findings—that many of the differences between the two were driven by purposeful differences between the databases, and not necessarily by inaccuracies—suggests that scholars should not consider private databases (like the NETS) and government databases (like the QCEW) as substitutes for one another. For those studying entrepreneurial firms, either for the creation of academic research or in conjunction with crafting informed policy, the research suggests that databases without stringent inclusion guidelines (e.g., the NETS) may be better for analyzing entrepreneurial regions. By including more firms in earlier years, the NETS offers a more dynamic assessments of a region’s needs and potential.



## 5.4 Limitations of the research

### 5.4.1 *Threats to external validity: Setting*

All three dissertation papers focus on one industry (bioscience) in one region (the Research Triangle Park region of North Carolina); two of the three focus on elite universities (Duke and UNC). All of these settings—the industry, the region, and the universities—are unique. The dissertation’s broad conclusions—such as the importance of considering jurisdictional embeddedness when examining institutional decision making, or the fact that the NETS captures a far deeper regional entrepreneurial environment than the QCEW—will likely hold in other regions, industries, or institutions. However, others—such as the findings on institutionally bound resources shaping locational decisions—may not hold in institutional or regional settings that lack universities or otherwise do not have expansive supporting resources.

### 5.4.2 *Threats to external validity: Treatment*

In terms of the *treatment*, this dissertation’s second paper considered UNC’s business incubators to be a treatment for UNC-parented firms. However, given the wide range of business incubator types, it is unclear if the results of this treatment are linked to the business incubators or concurrent structural changes in the commercialization process. As mentioned in Chapters 2 and 3, UNC instituted numerous other entrepreneurial programs in the years leading up to and following its creation of business incubators. These other programs could have driven the change in spatial patterns, too. For example, as explained in Chapter 2, the university has pushed for academics to retain control over the companies and has sped up the process of spinning out

companies. It could be that these companies would have shifted closer to the university after 2009, regardless of the business incubator strategy. In this case, the results—that firms founded between 2009-2012 chose locations that were, on average, closer to UNC’s campus than firms founded between 1990-2008 chose—are not affected. A study that included similar universities with similar business incubators but different concurrent organizational changes would be necessary to tease potential confounders apart.

#### *5.4.3 Threats to construct validity: Inexact proxy for entrepreneurship*

This dissertation’s third paper relied on a proxy for unpaid employment. This proxy is the number of recorded founders in each company. This number is an inexact approximation, since I don’t actually know how many unpaid workers were at each firm. On the one hand, if the Feldman-Lowe database missed firm founders, this proxy could be an undercount. On the other hand, not all founders work at their entrepreneurial companies, so the proxy could be an overcount of the number of unpaid workers at each company. Depending on the direction of error (i.e., undercount or overcount), the proxy count may have either led to a comparison that was, on average, too conservative in its adjustment of the NETS or too aggressive.

### **5.5 Implications for future research**

First, there needs to be more research on resources, and in particular, why institutions develop them and how they shape the larger region. While this dissertation focused on business incubators, those resources represent a tiny portion of larger university resources, and universities themselves are not representative of a region’s institutions. Given the continued

devolution and decentralization of economic development policy (Block, 2008; Schrank & Whitford, 2009), it is likely that institutions and smaller political jurisdictions will have increasing control over economic development policy. How and why these institutions develop and implement policies, and who has access to the resources these policies include, has implications for residents of those communities, for entrepreneurs, and ultimately for regional development.

Second, the differences between Duke and UNC that emerged from this dissertation's first paper suggest that the entrepreneurial literature needs to pay more attention to differences between public and private universities. These differences could be shaping commercialization outcomes in ways that the literature has not yet fully explored (e.g., difference in "exit strategies," business incubator type).

Third, interviews throughout this work highlighted that cities and counties are turning to recruitment and retention packages for entrepreneurial companies. These incentive packages, long linked to large industrial recruitment and retention efforts, are subjects of debates both within the literature and in the practice. While scholars have traditionally viewed entrepreneurial development as an endogenous development strategy (and thus, implicitly, outside the realm of recruitment and retention efforts), this is clearly not the case. Entrepreneurial recruitment and retention as an economic development strategy needs to be addressed.

Fourth, the study's overall findings on the NETS data—from both Chapters 3 and 4—are somewhat mixed. Chapter 4's findings suggest that, on aggregate, the NETS is the best option for entrepreneurial research. Those that remain (like employment) may be caused by the unique nature of bioscience; examining employment differences with another industry that is less

affected by contract work would be advisable. In Chapter 3, the NETS addresses were not incorrect; entrepreneurs agreed that they had, in fact, used the addresses on company documents. However, the fact that so many NETS addresses reflected business offices—and not laboratories—is problematic for both researchers and practitioners. These address discrepancies suggest that there may be more endemic problems in how we think about entrepreneurial spaces, and how we use data to study and talk about those spaces. Researchers and practitioners, when looking at locational data to analyze or develop policy, likely believe that they are looking at laboratory locations—not the location of the business office, which is itself not a true establishment. More work is needed on issues surrounding how single-establishment entrepreneurial firms geographically divide their work in a region, and how that division is reflected in the data we use.

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