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Research universities as gateways: The expanding roles of higher education institutions and their contribution to economic development

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Urban and Environmental Planning and Policy

by

Nene Osutei

Dissertation Committee:
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ABSTRACT OF THE DISSERTATION

Research universities as gateways: The expanding roles of higher education institutions and their contribution to economic development

by

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Doctor of Philosophy in Urban and Environmental Planning and Policy

University of California, Irvine, 2021

Associate Professor Jae Hong Kim, Chair

The past 30 years have witnessed a gradual expansion in the missions of many universities, and in the ways in which they contribute to local and regional economic development. While teaching and research continue to serve as the foundational core of most university missions, increased attention has been afforded to how universities, by their presence and functions, influence the spatial geographies of neighborhoods, cities, and regions. This dissertation research explores the changing roles of research universities in small and medium-sized metropolitan areas with an emphasis on their impacts across the different geographical scales by investigating associations between university presence and (1) growth in foreign-born populations; (2) the attraction and retention of highly educated residents; and (3) student-driven neighborhood change dynamics.

The findings of this dissertation extend previous studies emphasizing the increasing importance of higher education institutions to economic development activities at various scales. Results from metropolitan area level analyses demonstrate that counties with large research universities were associated with an increase in foreign-born residents following the 1990

Immigration and Naturalization Act, as well as an increase in highly educated residents in the 2000-2014 period. More specifically, while findings revealed that the presence of research universities generate significant spatial spillovers of highly educated residents from university host counties to metropolitan levels, there was little evidence of such spatially-explicit dynamics occurring amongst foreign-born residents. Furthermore, findings from neighborhood-level analyses indicated that proximity to large research university campuses may play an outsized role on the likelihood of neighborhoods undergoing studentification (i.e., student-driven neighborhood change) in the 2000-2014 period. These results may be indicative of a bifurcation of neighborhoods in university-dominant counties into wealthy and highly educated renter populations situated near the university campus, and relatively less wealthy and less educated homeowners residing on the further away from the campus or on the periphery of the county.

By exploring university contributions beyond the spheres of research, teaching, and service contributions, this dissertation presents scholars, urban planners, and policymakers with a more comprehensive portrait of the relationship between universities and their host communities. The evidence of this work suggests that the evolving role of higher education institutions, including their role as gateways for new populations, should be reflected in policymaking which seeks to leverage the locational advantages of research universities for city building or revitalization efforts. Further, policymakers and planners should also be cognizant that scale matters when considering how higher education institutions can better serve their surrounding communities. The contributions of research universities should not be thought of as monolithic or uniform, but should rather be seen as presenting different opportunities and challenges at different geographical levels.

Chapter 1. Introduction

As U.S. cities strive to develop and sustain their place within the knowledge economy, universities represent one of the most critical assets for the promotion of economic development goals. Cities have historically viewed their universities not merely as anchors institutions for the enhancement of their local workforce, but also as tools for generating and transferring technology, drawing local and foreign investment, supporting local industries, and attracting large firms and employers.

However, the past 30 years have witnessed a gradual expansion in the missions of many universities, and in the ways universities contribute to local and regional economic development (Lowman, 2010; Hurtado, 2007). While teaching and research continue to serve as the foundational core of most university missions, increased attention has been afforded to how universities, by their presence and functions, influence the social geographies of neighborhoods, cities, and regions.

The University of California, Irvine, for instance, is one of over 60 public and private university partners committed to improving economic diversity their campuses through the intentional recruitment of talented low-income students[1]. These institutions have leveraged their presence in their communities to forge partnerships with local schools, employers, and non-profit organizations to provide pathways of accessibility for historically underrepresented student populations. With growing recognition of the value of local engagement and collaboration, universities are expanding beyond traditional faculty and student community service (Hubbard, 2008; Weerts and Sandmann, 2010; Holland, 1997). Several universities are now taking an active interest in the economic development of their local communities by anchoring business and job

[1] The American Thriving Initiative is an alliance of 67 high-graduation-rate colleges and universities committed to expanding access and opportunity for low- and middle-income students.

growth around their campuses. Such trends have been particularly notable in several large and small Rust Belt communities including Duluth (University of Minnesota-Duluth), Kalamazoo (Western Michigan University), and Buffalo (University of Buffalo) among several others, where the creation of housing, health-medical complexes, and cultural amenities has revitalized previously neglected urban cores (Austin, 2017). While such efforts are often found in neighborhoods in the campus vicinity, universities and local governments are increasingly targeting areas beyond campus boundaries, in many cases to serve as anchors of revitalization in central cities.

Many city leaders and commentators have hailed the presence of large, research universities as a panacea for economic development problems, particularly in distressed regions. However, this simplification ignores many of the complexities inherent in the missions and functions of colleges and universities. Growing tensions have underscored how universities' roles as attractors of talent often intersect with concerns at the local level (e.g. interactions between student and non-student populations), regional or state level (e.g. the crowding out of in-state residents through increased out-of-state and international student enrollment), and national level (e.g. the flow of human capital from economically distressed regions into vibrant cities). Unfortunately, such dynamics may not only widen gaps in socioeconomic outcomes between cities, but also generate large discrepancies in income, health, and education indicators within cities.

It is within this context of a shifting identity and purpose among colleges and universities that this work emerges; from understanding these institutions as insular and delineated between "town" and "gown" toward discovering their potential roles as gateways which leverage their place-based characteristics to attract and retain diverse, highly educated, and skilled residents in

their communities. Therefore, questions such as "Can differences be observed in the foreign-born populations of urban areas with and without research universities?", "Are urban areas with research universities are better able to attract and retain talent than comparable areas without such institutions?" "How might the presence of a large research university influence neighborhood level change dynamics?" become necessary for a more nuanced understanding of how universities influence local and regional development and social equity dynamics. This research presents answers these questions revealing how the presence of research universities impact the social geographies of their host communities and regions.

More specifically, the next section of this dissertation is a general literature review covering multiple branches of the economic development literature pertaining to the contributions of higher education institutions. In this section I attempt to synthesize the literature concerning the central question of how do universities contribute to economic development? As the previous paragraphs have suggested there are myriad ways in which these contributions can be conceptualized. Through summarizing various perspectives in the literature, this section aims to provide readers with a thorough understanding of the theories and mechanisms behind the university contributions to economic development.

Next, three pieces of empirical studies discussing university cities and college towns as gateways for distinct and diverse populations together with their own literature review sections are presented. The first study explores the potential role of universities as a gateway for fostering ethnic diversity in small and medium-sized metropolitan areas. More specifically, this study employs multivariate and quantile regression analytical methods to assess county-level associations between foreign-born population growth and the presence of research universities following the implementation of the 1990 Immigration and Naturalization Act. Using a sample

of 258 US counties, it analyzes the relationship between foreign-born population growth and two experimental indicators of university presence and two control variables capturing university core functions. Results suggest that while a large chunk of the increase in foreign-born populations in the post-1990 period in the sample counties is attributable to the presence of educated residents, counties with a research university exhibited significantly higher ratio of foreign-born residents than counties without such institutions.

To further shed light on how universities may further serve as gateways to demographically distinct populations, the second study examines the residential location patterns of highly educated individuals to gain insights into whether small and medium-sized metropolitan areas with research universities are able to attract and retain talent more effectively than comparable areas without such institutions. While large metropolitan areas with more higher education institutions have been shown to be more successful in attracting and retaining the highly educated due to their share of knowledge-based jobs, arts and entertainment amenities, and diverse and tolerant communities, it remains unclear if small and medium-sized urban areas possessing similar qualities are also able to successfully attract the highly educated. This study tests this possibility by focusing on a group of 341 counties located within metropolitan statistical areas (MSAs) with a population between 50,000 and 500,000. These counties are sub-divided into two groups, one group of counties containing a research university (Group 1: case counties) and another without such institutions in their MSAs (Group 2: control counties). More specifically, ordinary least squares (OLS) and kernel regularized least squares (KRLS) analyses are conducted to assess differences in educational attainment levels among residents in counties with a major research university and in comparable counties without such institutions.

In contrast to the previous two studies which focus on university impacts at the county level, the third and final study examines how universities influence distinct demographic, socioeconomic, and housing changes at the neighborhood-level. Using data from a sample of 27 counties encompassing 1043 census tracts, this study explores distinct pathways of neighborhood change (from 2000 through 2014) that have taken place in US counties where higher education institutions play an important role. By using cluster analysis and multinomial logistic regression techniques, the study offers insight into the multidimensional contexts under which neighborhood change may occur in university-dominated neighborhoods.

In summary, this dissertation seeks to expand our understanding of how universities contribute to economic development by shedding light on how they may also serve as gateways for diverse and distinct populations. The three empirical studies aim to illustrate how the local and regional impacts of universities are shaped by dynamic processes of immigration, residential locational choice patterns, and neighborhood change. These studies also provide valuable lessons for planners and policymakers concerned with the challenges and opportunities higher education institutions present for developing equitable outcomes for both student and non-student populations in small and medium-sized metropolitan areas.

Chapter 2. Literature review: Universities as contributors to economic development

As economies have become more knowledge-driven, policymakers and academics have increasingly viewed universities as central players in the promotion of economic growth and development. While the basic mission of the university is education and research, their range of activities and roles extend beyond these primary functions. Moreover, the impacts of these functions may be localized in the university community or dispersed across the university's host-region.

A key mechanism through which universities influence economic development is by raising the skill level of the local workforce, or human capital, within its vicinity (Florida et al., 2008). Universities (and their host-cities or regions) accomplish this through two channels. First, the presence of a university is an important channel through which cities and regions can increase the supply of their human capital. This contribution is critical because regions with higher levels of human capital—measured as the share of the working-age population with at least a bachelor's degree—tend to be more innovative, have greater amounts of economic activity, and enjoy faster economic growth, and workers in these regions tend to be more productive and earn higher wages (Abel and Dietz, 2012). Universities play a key role in the attraction of students at local, national, and international levels. These students may decide to reside in the area of the university upon graduation and enter the local labor market. The impacts of this contribution are far-reaching given that as the clustering of highly educated individuals is considered an essential factor in economic growth as higher education is viewed as both a public and private good that generates positive externalities. Several studies have provided evidence that regions with a higher share of college-educated individuals are positively correlated with increased wages across all sectors, even for individuals who lack a college degree (Moretti 2013,

Florida, 2017). It is also important to note that even in cases where students are not retained within the local economy after graduation, large research universities can play a contributing role to the broader national economy, particularly by attracting foreign talent who may choose to relocate to other parts of country for employment upon graduation.

Second, the presence of universities can also raise the demand for human capital given their potential roles in attracting, generating, and retaining highly educated people. The presence and concentration of such individuals can generate additional opportunities to create highly skilled and high paying jobs which in turn can stimulate local economies (Abel and Dietz, 2012). Through their roles as suppliers of highly educated human capital and basic research, the university provides a competitive locational advantage for firms located near it (Anselin et al., 1997). These spillover effects occur because employers that are located near to universities have easier access to goods and services generated by the universities such as graduates. Education attainment is positively correlated with productivity thus employers located near to universities have a competitive advantage over more distantly located firms in accessing productive workers (Wolfe, 2005). The high demand for these productive and skilled workers increases the employers' willingness to pay for their labor, thus increasing the wages that university educated workers are paid. This concentration of highly educated and highly paid workers creates demand for additional services within the region generating a self-reinforcing cycle of growth.

Universities also represent an important channel through which knowledge generated in research laboratories is transferred to firms for commercialization (Bramwell and Wolfe, 2008). Firms that depend on this basic and applied research are increasingly important to the economic development of cities, as employment is increasingly found in research-driven industries such as pharmaceutical, biotechnology, and software, rather than traditional manufacturing (Moretti,

2013). Much of the research that is generated by universities is tacit in nature and deeply embedded in social and institutional procedures (Bramwell and Wolfe, 2008). The knowledge transfer process places an emphasis on highly personalized interactions between universities and other economic actors. This often takes place through interactions with university faculty and researchers in both formal and informal arrangements. It also occurs through mechanisms such as student internships which enable firms to tap into new ideas students are exposed to. Students may also be able to transfer their knowledge amongst firms as they move from placement to placement. Therefore firms located closer to source of research (i.e. university) increase the success with which the research can in absorbed into their production processes. This proximity effect of knowledge transfer is indicative of why universities are increasingly seen as a crucial element in the process of local and regional economic development, particularly in knowledge-intensive sectors (Bramwell and Wolfe, 2008).

Since the introduction of the Bayh-Dole Act in 1986 the role of universities as suppliers of scientific and technological knowledge has expanded as many universities encourage and assist faculty in seeking patents for their research (Feller, 1989). The Bayh-Dole Act coupled with the fact that some firms may be unwilling to invest in risky, unproven university research has compelled some faculty to start their own companies as a means to advance or commercialize academic discoveries. The success of companies in Silicon Valley, Boston's Route 128, and North Carolina's Research Triangle Park has compelled many civic leaders and policymakers to promote investments in resources that facilitate the growth of start-ups such as accelerators and incubators.

The formation of university spin-offs has become an attractive alternative to transferring technology to the commercial realm for several reasons. First, since many academic discoveries

are made at an early-stage, additional investment is often required from large firms to demonstrate proof of concept and viability of the business model (Thursby et al., 2001). Second, university spin-offs are seen as a means for local economies to capture the benefits of proximity to a local research university (Feldman and Stewart, 2004). Benefits from the formation of spin-offs can be seen to extend to the spin-offs themselves, and in some cases to the university and the local economy in which they are located. From a spin-off's perspective, its proximity to the university provides it with a competitive advantage and ensures that it will have access to a consistent stock of human capital as students who graduate from the university may work there during their internships and upon graduation, and thus serve as conduits of knowledge in the process. The university benefits because administrators can cite the number of spin-offs or start-ups formed as a benchmark of the university's contribution to the local economy in the forms of jobs and revenue generated.

The contribution of universities to local and regional economic development can also be understood from relatively recent theoretical perspectives, such as creative capital theory suggesting that individuals who form the basis of creative economies are often found to be located in cities with high levels of the 3Ts – technology, tolerance, and talent (Florida, 2003). The creative capital theory is distinguished from the human capital perspective through its emphasis on the work people actually perform. Universities are critical to the formation of creative capital as they make direct contributions to occupations that are identified as being associated with highly innovative and creative sectors. Much of the literature analyzing the ways through which universities raise the creativity of their surrounding regions has focused on their direct contributions through the transfer of research to industry, the production of commercial inventions and patents, and the creation and spinoff of start-up companies. These university

activities directly influence the formation of creative capital because of their association with a class of workers whose job is to create meaningful new forms (Florida, 2002).

As a result, universities' influence on creative occupations is not limited to industries typically associated with university research and development such as science, engineering, and medical but also encompasses occupations in the arts, design, music, entertainment. These industries have economic functions that are as dependent on creating new ideas or creative content as high-technology sector. Perhaps more importantly, occupations in these industries are essential because of their association with cities considered to be open-minded, ethnically diverse, and tolerant, each of which is positively correlated with high wages and productivity (Florida, 2017).

While universities were historically viewed as insular enclaves separated from the rest of the surroundings they have increasingly been characterized by their diversity and tolerance. One visible channel through which the diversity and tolerance of universities is evident is in their attraction of foreign students. Many of these students often live on the campus or near to it. This is particularly common for students with graduate degrees in science and engineering programs as there is a high demand for these skills in many of the nation's technology companies (Saxenian, 2002). Saxenian provides evidence of strong association between the number of Chinese- and Indian-born graduates from the University of California, Berkeley and the number of Chinese- and Indian-born CEOs of technologies firms in close proximity to the University. As a result of their increasing number in the Bay Area region, several ethnic associations and goods and services which cater to the needs of diaspora communities have formed, thus drawing more ethnic minorities to these local communities. For residents from outside of the region who value vibrant, welcoming, and diverse communities, the fact that university towns may be one of the

few areas outside of large metropolitan areas where foreign-born populations can be found is an important signal of tolerance and found to be essential for both attracting talent and prospering economically.

Additionally, the university's role as an educator has been expanded by many institutions who seek to provide learning opportunities to elderly or retired residents who may reside in their surrounding areas (Hu et al., 2008). The continuing education programs of some universities are sponsored by local governments and offered to senior citizens at a reduced tuition rate or free of charge. In addition to the learning opportunities, elderly population may enjoy an enhance quality of life near university campuses due to the availability of recreational resources, health services, and cultural amenities. Several universities such as the Pennsylvania State University, Iowa State University, Cornell University, Dartmouth University, Duke University, Michigan State University, Auburn University, Louisiana State University, and the University of Florida have built or began to build retirement homes or retirement facilities that invite their alumni to return to the campus communities (Hu et al, 2008). By inducing the migration of elderly population, cities with universities are able to take advantage of the demand generated by this population which is particularly important as in many cases they have savings and more disposable income than other demographic groups.

Finally, in addition to the aforementioned contributions provided through human capital formation, knowledge production, and the provision of recreational and cultural amenities, universities also provide several important non-economic contributions at the community and regional level. Within the last decade, community engagement and leadership have emerged as important channels through which universities have been able to enhance the capacity of community stakeholders to address various economic, environmental, and civic challenges,

while also promoting the idea of a fair and equitable society. While little research has measured the influence of community engagement on regional development, there are clear distinctions in the forms through which universities engage with their surrounding communities. Many of these forms of engagement reflect differences in the history, mission, culture, capacity, and challenges facing an institution (Holland and Gelmon, 1998). For instance, many of Yale University's community partnerships are tailored to address the unique disparities in health outcomes across the New Haven region.

By contrast, the University of California, Irvine's expertise and resources in environmental engineering has enable it to play a leading role in addressing critical regional environmental and sustainability-related issues such as sea-level rise and coastal impacts in California and Mexico. By providing technical assistance through research expertise, opening up space for public discourse, and building capacity of relevant community stakeholders to participate, the university may enhance the economic development of its region by contributing to areas that are typically considered non-economically productive activities such as sustainable development, self-management of health and well-being, and the reduction of various types of unfreedoms (Sen, 1999).

Chapter 3. Research universities as gateways: Foreign-born population growth in university cities and college towns

3.1. Introduction

In 2017, the foreign-born population of the United States reached its highest share since the turn of the last century at approximately 13.7 percent or 44.5 million individuals. (US Census Bureau, 2017). While immigration has been a major source of population growth and cultural change in the United States for most of its history, recent arrivals are notable as they are frequently skilled workers, moving to states with relatively low historical immigrant populations, or pursuing advance degrees. According to some estimates roughly 45 percent of newcomers who arrived since 2010 are college educated, compared with about 30 percent of those who settle in the US between 2000 and 2009. (Frey, 2017).

Shifts in immigration policy, specifically revisions in the Immigration Act of 1990, placed greater emphasis on the selection of highly skilled and professional workers for visas. In contrast to the 1965 Act which contained only two categories for occupation-based immigration and placed no restrictions on unskilled workers, the 1990 reforms capped the number of visas for unskilled workers and established five occupational-worker categories including priority workers, advanced professionals and those with exceptional abilities, and skilled workers (Espenshade, 2001). Additionally, the 1990 Act established quotas for nonimmigrant visas such as the H1-B visa which permits employers to temporarily employ foreign workers in specialty occupations (i.e. an occupation that requires highly specialized knowledge, and a bachelor's or higher degree or its equivalent as a minimum for entry into the occupation in the United States). The 1990 Act resulted in a near tripling of the number of visas granted based on occupational skills, many of which were granted to international students who had acquired degrees at US

higher education institutions and sought employment opportunities (Saxenian, 2002). Additional changes in the 1990 Act created a trial employment programs for aliens with student visa status, such as Optional Practical Training which is available to academic students upon graduation from an accredited institution (Milano, 2017).

Studies have pointed to the university-related implications of the 1990 Act, namely universities' roles as facilitators in recruiting and retaining foreign-born talent, without explicitly addressing their role in enhancing local and regional cultural and ethnic diversity. For instance, Waldorf (2011) notes that universities often handle the complicated and lengthy legal visa/green card procedures for foreign workers (e.g., faculty and staff) and their dependents. Additionally, several studies on immigrant entrepreneurship have identified the educational attainment of such individuals as integral to their success (Saxenian, 2002; Saxenian and Edulbehram, 1998; Huffman and Quigley, 2002; Hansen et al., 2003; Pink-Harper, 2015). However, there is a noticeable divide in the economic development literature between studies examining the role of universities as attractors and retainers of talent, and studies identifying positive associations between the presence of highly skilled foreign migrants and economic development.

This study empirically examines the relationship between the presence of research universities and foreign-born population growth in American counties. The research question asks whether differences in the foreign-born populations of counties with and without research universities can be observed following the implementation of the 1990 Immigration and Naturalization Act. The study aims to extend the literature pertaining to the role of universities in economic development by examining the potential of universities to serve as gateways for immigrant populations, which has largely been neglected in prior research. Little attention has

been paid to addressing the extent to which higher education institutions attract foreign-born populations and thus contribute to fostering ethnic diversity in urban areas.

3.2. Literature review

Potential associations between the presence of research universities, foreign-born populations, and economic development impacts have received scant attention in planning and policy literature. However, a few studies have found that universities may make a difference in the attraction and retention of foreign-born talent. Saxenian's (2002) research aims to quantify associations between immigrant engineers' and entrepreneurs' presence and contribution to the Silicon Valley economy in terms of immigrant employment, immigrant-run start-ups, and ethnic associations. She notes that more than half of the science and engineering degrees from the University of California, Berkeley (53%) were granted to students from China, compared with 35% in the late 1980s and only 10% in the early 1980s. The number of graduate degrees granted can be seen as a leading indicator of labor supply in Silicon Valley, as most graduates find jobs in the region's technology companies (Saxenian, 2002). National trends in graduate science, technology, and engineering degree programs mirror these trends closely and provide insights into the changing labor force and demographic composition of cities and regions with large research universities. Moreover, Saxenian's findings suggest foreign talent may provide measurable economic benefits and opportunities. As Silicon Valley's skilled immigrants create social and economic links to their home countries, they simultaneously open the markets, manufacturing, and technical skills in growing international regions to the broader business community in California.

Given their role as large employers, universities often play a facilitating role within cities when it comes to recruiting and retaining global talent. Waldorf (2011) compares the locational choice patterns of foreign and domestic human capital (i.e. individuals with a college degree or higher) at the state level by calculating a migration origin ratio (MOR) which expresses the number of in-migrants from abroad per 100 state-to-state in-migrants. Her findings shed light on several interesting nuances on the locational preferences of foreign migrant within states. For instance, in so-called 'gateway states' such as New York – or states with a greater inflow of foreign rather than state-to-state migration – she finds that the Ithaca metropolitan area, home to Cornell University, has an MOR nearly six times that of New York state and the New York–Northern New Jersey–Long Island, NY-NJ-PA metropolitan area. She uncovers a similar trend in non-gateway states such as Mississippi, West Virginia, and Montana, where metro areas with large research universities such as Hattiesburg, Morgantown, and Billings exhibit much higher MORs than their respective state averages.

Other studies have pointed to the importance of universities in the fostering of cultural diversity and tolerance for minorities more broadly, while other scholars have provided evidence of the economic benefits of cultural diversity. In their examination of universities role in the creation of technology, talent, and tolerance in a sample of 331 US metropolitan regions, Florida et al. (2006) find considerable correlation between tolerance (i.e. measures of integration, foreign-born population, and gay and lesbian population) and measures of the number of students and faculty. The authors observe that tolerance is strongly and positively correlated with the number of students, and negatively associated with both the number of faculty and metropolitan population size. In other words, larger universities have more pronounced effects on tolerance, however these effects decline with increasing population.

Ottaviano and Peri (2006) examine the effects of cultural diversity (defined as country of birth) on distribution of wages and rent in 160 US metropolitan areas during the period 1970-1990. They distinguish between cultural diversity acting as a production amenity value versus production disamenity. The former describes cases where the skills of foreign-born complement those of native workers and thus boost efficiency and productivity. The latter refers to instances where intercultural frictions reduce productivity. This study is unique in that it attempts to measure this relationship with respect to impacts on US-born people, whereas many previous studies in this area have focus on the costs associated with cultural diversity, such as communication and transaction barriers. Their key finding is that keeping every other city characteristic equal, on average, US-born workers living in cities with richer cultural diversity are paid higher wages and pay higher rents than those living in cities with poorer cultural diversity.

Ager and Bruckner (2013) examine the effects of changes in within-county cultural composition (defined as country of birth) on changes in within-county output per capita in the US counties during the period 1870-1920. This study period was chosen because it represented a period of free and open immigration, in contrast to the quota era introduced in 1921. They detect increases in cultural fractionalization of US counties to be association with significant increases in output per capita during the study period. Specifically, the effect of fractionalization on output growth is largest in counties with above-median GDP per capita. More importantly is how cultural fractionalization affects output. The authors provide evidence that the diversity of skills of the working-age population is crucial. This corresponds with cultural economics literature which finds that cultural diversity may have a positive effect on output because it increases the variety of skills, and consequently the variety of goods and services produced in an economy.

3.3. Study areas, data, and methodology

3.3.1. Study areas

To further understand the potential role of universities in fostering diversity, this study examines how the presence of universities may contribute to attracting foreign-born residents to their surrounding area. More specifically, it analyzes foreign-born population growth in a sample of US counties following the implementation of the 1990 Immigration and Naturalization Act. The sample considered includes 258 counties with a population between one and five hundred thousand in 1990. Although Anchorage Borough, Hawaii County, and Maui County fall within the established population range, these counties are excluded due to data collection limitations. The impacts of universities may vary across contexts, therefore this study focuses on a relatively homogenous condition in terms of population, even though the narrow population range does not allow one to create a perfect experimental setting. Larger counties may be subject to the dynamics of the political economy aside from those generated by a single research university. The sample counties cover all regions of the nation, including at least one county from 46 states.

The 258 sample counties are distinguished between those containing research universities and those without such institutions. In doing so, the following two dichotomic measures are used: 1) counties containing a large research university (which defines the presence of universities in a narrow manner); and 2) counties within a MSA containing a large research university (which expands the definition and includes a broader set of counties in the experimental group). Here, a research university is identified using the Carnegie Classification of Institutions of Higher Education's framework with consideration given to Research-1 (Doctoral Universities with Highest Research Activity or R1) and Research-2 (Doctoral

Universities with Higher Research Activity or R2) universities. Doctoral/Professional universities were not considered under this definition given their relatively low levels of research activity.

3.3.2. Baseline analysis

As previously discussed, the 1990 Immigration and Naturalization Act further positioned research universities as critical pathways for highly educated foreign-born individuals seeking entry into the United States. Therefore, this study employs a multivariate regression model to assess county-level associations between foreign-born population growth and the presence of research universities before and after the implementation of the 1990 Act, as shown below.

The dependent variable, growth in foreign-born population at the county level, is measured as the ratio of foreign-born population who came into the United States after and before the implementation of the 1990 Act. Specifically, this variable divides the number of foreign-born residents who entered a county in the 1995-2000 period by those entered in the 1985-1989 period. The ratio is log transformed to reduce the skewness involved. Data for each time period are derived from the 2000 US Census.

$$log(\mathrm{FB}_t/\mathrm{FB}_{t-1}) = \alpha \cdot log(FB_{t-1}) + X \cdot \beta + UNIV \cdot \theta + \varepsilon$$

where the dependent variable $log(\mathrm{FB}_t/\mathrm{FB}_{t-1})$ indicates the ratio of foreign-born residents in each county who entered the United States in the time periods before and after the 1990 Act (logged); FB_{t-1} is the total number of foreign-born residents who entered the county from 1985-89; X is a vector of residential location choice factors; $UNIV$ represents a vector of university variables; α, β, and θ are coefficients that capture the (marginal) impacts of the explanatory variables; and ε indicates the error term.

The key experimental variable of the study is university presence. As previously discussed, the economic development literature presents competing views of how university presence may be understood in terms of the impacts of their core functions being localized or dispersed across a larger geographic region. Therefore, this study utilizes two different measures of university presence to test how each may be associated with foreign-born population growth.

First, university presence at the county level is measured by computing a dummy variable, *university county*, which assigns each of the 258 counties into one of two possible groupings: Group 1: 61 counties with research universities, and Group 2: 197 counties without research universities. The literature has identified university activities such as research, teaching, and technology development generating important spillover effects, particularly in small and medium-sized regional economies (Goldstein & Drucker, 2006). Therefore, a second dummy variable, *university MSA*, is used to account for potential spillover effects of universities located outside of the sample counties of this study, but within the MSAs in which these sample counties are located. More specifically, this dummy variable categorizes each of the 258 sample counties based on whether a research university is found in any county within its MSA, regardless of that county's population size. For instance, while Marin County has no research universities within its boundaries it is located within the five-county San Francisco-Oakland-Hayward MSA which contains several research universities. This university MSA dummy variable attempts to account for the presence of universities more broadly at the MSA level.

Several control variables capturing demographic, socioeconomic, and regional characteristics which likely influence the locational preferences of foreign-born individuals are included in each of the study's model estimations. Variables capturing *educated county residents* (residents aged 25 years and older with a bachelor's degree or higher) and *research* (the number

of utility patents granted in 1990) are included, log transformed. It is important to note that these variables represent the core functions of universities (education and research) and thus allow me to check how the foreign-born population growth is influenced by these attributes and/or the presence of universities itself.

Additionally, I account for the *total number of foreign-born county residents who entered the US in the 1985-1989 period*, log transformed. Given that county population size may have a negative or positive influence on the locational preference of foreign-born individuals, I include a measure for *total number of county residents in 1990*, log transformed. I account for the racial/ethnic composition of the county with measures of *percent white* and *percent Hispanic*. The socioeconomic character and opportunities within an area can also impact the locational preferences, therefore I include measures of *home values* normalized by median household income and the *share of manufacturing employees*, log transformed. Finally, I control for variation across geographic regions, by including eight regional dummy variables as well as an amenity index measure of physical characteristics, provided by United States Department of Agriculture's Economic Research Service, enhancing a county's potential as a place to live, including warm winter, winter sun, temperate summer, low summer humidity, topographic variation, and water area. Descriptions and data sources of the variables used in the analyses are shown in Table 1.

3.3.3. Sensitivity analyses

In addition to the baseline analysis explained above, a further investigation is made in the following two ways: (1) quantile regression and (2) alternative operationalizations of the

Table 1. Variables and Data

Category	Variables	Description	Data Sources
Dependent Variable	Entrants.Ratio.1989-2000.Logged	Ratio of the number of foreign-born county residents who entered the US in 1985-89 and 1995-2000 (logged)	Census00 *a*
Control Variables	Entrants.1985-1989.Logged	Total number of foreign-born county who entered the US from 1985-89 (logged)	Census00
	Pop.1990.Logged	Total county population in 1990 (logged)	Census90 *b*
	Manuf.Share.1990	Share of manufacturing in terms of county employment	Census90
	Home.Value.1990	Median housing value for specified owner-occupied housing units in 1990 normalized by median family income in 1990	Census90
	White.Share.1990	Share of white residents in 1990	Census90
	Hispanic.Share.1990	Share of Hispanic residents of all races in 1990	Census90
	Amenity.Score.2000	Natural amenities scale (an index measuring several ecological characteristics of a county area that can enhance the location as an attractive place to live)	ERS *c*
	Census.Div.1-8	Census Division dummy variables (Baseline: Pacific Division)	US Census
University Variables	Univ.CTY	Presence of R1 or R2 universities at the county level (1 Yes; 0 No)	Carnegie *d*
	Univ.MSA	Presence of R1 or R2 universities at the MSA level (1 Yes; 0 No)	Carnegie
	Edu.Share.1990	Share of residents aged 25 and over with a bachelor's degree or higher in 1990	Census90
	Patents.1990.Logged	Total utility patents granted in 1990 (logged)	USPTO *e*
Sensitivity Analysis Variables	Entrants.Ratio.1989-2010.Logged	Ratio of foreign-born county residents who entered the US in 1980-89 and 1990-2010 (logged)	ACS *f*
	Entrants.1980-1989.Logged	Total number of foreign-born county residents who entered the US from 1980-89 (logged)	ACS
	FBorn.Change.1990-2000.Logged	Ratio of the total foreign-born population from 1990 to 2000 in each county (logged)	Census90; Census00
	FBorn.Change.1990-2010.Logged	Ratio of the total foreign-born population from 1990 to 2010 in each county (logged)	Census90; ACS
	FBorn.Pop.1990.Logged	Total foreign-born population in 1990 in each county (logged)	Census90
	FBorn.Share.Change.1990-2000	Net change in the share of foreign-born population from 1990 to 2000 in each county	Census90; Census00
	FBorn.Share.Change.1990-2010	Net change in the share of foreign-born population from 1990 to 2010 in each county	Census90; ACS
	FBorn.Share.1990	Share of foreign-born population in 1990 in each county	Census90

a US Census 2000; *b* US Census 1990; *c* Economic Research Service, US Department of Agriculture; *d* Carnegie Classification of Institutions of Higher Education; *e* US Patent and Trademark Office; *f* American Community Survey 5-year Estimates, 2006-2010

dependent variables. The first approach attempts to determine whether any variation in the effect of the *Univ.CTY* coefficient could be found in counties with varying levels of change in their ratio of foreign-born entrants between 1985-89 and 1995-2000. This is complemented by a second approach in which I estimate three additional sets of OLS models using alternative definitions of the dependent variable. The first set of estimates measure the relative change in foreign-born entrants over an extended period before and after the 1990 Act (1980 to 2010). The second and third set of estimates test alternate operationalizations of the dependent variable by measuring effects on the total foreign-born population of the county rather than those who entered at a particular time point.

3.4. Results

3.4.1. Baseline analysis estimates

Table 2 presents the results from five OLS regression estimation models that investigate whether the presence of universities is associated with a significant change in the foreign-born population entering university-dominant counties. I begin with a parsimonious model which controls for the county's initial number of foreign-born entrants in the 1985-1989 period, population, share of total employment from manufacturing, median housing value normalized by median family income, share of white residents, share of Hispanic residents of all races, and natural amenities scale score (an index measuring several ecological characteristics of a county area that can enhance the location as an attractive place to live). Census regional fixed effects variables were also added to control for regional variation. To this model I successively added the four variables capturing various aspects of university presence, enabling me to examine how the dependent variable (*Entrants.Change.1989-2000.Logged*) is associated with different measures of university presence and thus interpret the results in a more effective manner.

As shown in the table, estimations from the OLS models reveal a negative association is detected between the number of foreign-born county entrants between 1985-1989 (*Entrants.1985-1989.Logged*) and foreign-born population growth. This result suggests counties with a smaller foreign-born population are associated with a higher ratio of foreign-born residents who entered the US between the 1985-1989 and 1995-2000 periods. The magnitude of this coefficient in the full OLS estimation model (Model 5) is -0.151.

The natural amenity scale score (*Amenity.Score.2000*) also had a significantly negative association with the dependent variable. In other words, counties with relatively lower amenity scores had a higher ratio of foreign-born residents who entered the US between the 1985-1989 and 1995-2000 periods. The model estimates indicate that the share of total employment in manufacturing (*Manuf.Share.1990*) can play a significant role in determining the change in the ratio of foreign-born entrants in university-dominant counties in the study period. However, other control variables such as population in 1990, median housing value, share of white residents, and share of Hispanic residents of all races turn out to be insignificant at the 5% level.

Of considerable interest are the university presence variables tested: *Univ.CTY* and *Univ.MSA* indicating the presence or absence of R1-2 universities within the county and MSA, respectively, *Edu.Share.1990* representing the share of residents aged 25 and over with a graduate or professional degree in 1990, and *Patents.1990* representing the number of utility patents granted in the county in 1990. *Univ.CTY* has a significant positive association with the ratio of foreign-born residents who entered the county between 1985-89 and 1995-2000 across all five OLS estimation models. Counties with large research universities would have 34.8% higher ratio of the foreign-born residents between the two periods than those without such universities. However, the results suggest that the effect of the presence of large research

Table 2. OLS Regression Estimates: Ratio of Foreign-Born Entrants Between 1985-89 and 1995-2000 in the US

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	-0.581	-0.222	0.450	-0.265	0.519
Entrants.1985-1989.Logged	-0.140**	-0.126**	-0.157***	-0.119**	-0.151***
Pop.1990.Logged	0.168*	0.124	0.141	0.121	0.130
Manuf.Share.1990	0.898*	1.173***	1.595***	1.226***	1.660***
Home.Value.1990	0.081	0.031	-0.013	0.037	-0.007
White.Share.1990	0.082	0.168	0.034	0.190	0.039
Hispanic.Share.1990	-0.518	-0.355	-0.089	-0.373	-0.098
Amenity.Score.2000	-0.074***	-0.061***	-0.043**	-0.062***	-0.045**
Univ.CTY		0.377***	0.310***	0.407***	0.348***
Univ.MSA				-0.054	-0.077
Edu.Share.1990			0.299**		0.306**
Patents.1990.Logged			-0.009		-0.002
R-squared	0.398	0.501	0.522	0.503	0.526

*** 0.1% level, ** 1% level, * 5% level significant.; Census Region dummy variables are included in the estimation, but their estimates are not presented here for brevity.

universities on an association with the entry of foreign-born individuals does not extend beyond the county level. The coefficient on *Edu.Share.1990* was positive and significant in Model 5 (+0.306) and may reflect an influx of skilled immigrant workers or students, or the entry of immigrants to areas with a higher percentage of highly educated residents post-1990. These findings may reflect the university's role as both an attractor and producer of human capital. They also align with the findings of previous studies detecting associations between the presence of immigrant entrepreneurs in technology hubs dominated by large research universities (Saxenian & Edulbehram, 1998; Saxenian, 2000).

3.4.2. Quantile regression estimates

The results of the quantile regression analysis (Table 3), which provide estimates for each coefficient at the 25th, 50th, and 75th percentiles, are somewhat consistent with those from OLS, revealing the importance of the initial number of foreign-born entrants, share graduate/professional degree holders, and share of manufacturing sector employment. More importantly, again, the presence of large research universities (*Univ.CTY*) is found to have a significant positive effect on the change in the ratio of foreign-born entrants at the county level. *Univ.CTY* exhibits a fairly wide range of significant estimates from +0.233 at the 25th percentile level to +0.325 at the 75th percentile level, approximating the original OLS estimate value (+0.348). The association between the magnitude of the *Univ.CTY* effect at the 75th percentile and *Entrants.Change.1989-2000.Logged* deserves special attention. This finding may point to the capacity of new or growing universities to attract foreign-born residents to counties with relatively low numbers of immigrants in the pre-1990 period. Interestingly, the association between *Edu.Share.1990* and *Entrants.Change.1989-2000.Logged* at the 75th percentile is

slightly weaker than at the 50th percentile which may indicate that while several counties had a higher ratio of foreign-born residents, many of these newcomers may not have been highly educated.

3.4.3. Analysis results with alternative dependent variables

Table 4 presents an OLS estimation measuring the ratio of foreign-born population who came into the United States between 1980-89 and 2000-10 in the county using 5-year estimate data from the 2006-2010 American Community Survey. The model estimates are consistent with those in the initial estimates in Table 2 which focused on a shorter period before and after 1990. It is worth noting that although the coefficients on the main variables of interest *Univ.CTY* and *Entrants.1980-1989.Logged* show the same direction, their magnitudes are both slightly lower than those estimated in the initial OLS estimates. This may suggest that counties with universities are becoming less distinct from those without universities with regard to the number of foreign-born entrants over time.

Given that the *Edu.Share.1990* coefficient is significantly positive and the transient nature of college towns, it is possible that individuals who enter a county from abroad are highly educated and may choose to leave after an extended period (e.g. after graduation). To better understand whether university-dominant counties are more likely to retain their foreign-born entrants I also estimated the change in ratio of total foreign-born population in these counties to provide a more robust measure of the immigrant population. Separate OLS estimations were conducted for the 1990-2000 and 1990-2010 periods. Within each of these models, I use two different dependent variables: (1) net change in the total foreign-born population; and (2) net change in the share of the foreign-born population. However, in contrast to previous model

Table 3. Quantile Regression Estimates: Ratio of Foreign-Born Entrants Between 1985-89 and 1995-2000 (Model 5)

	Dependent var: Entrants.Change.1989-2000.Logged					
Variables						
	Avg.	**Std. Error**	**t-stats**	**Q25**	**Q50**	**Q75**
Intercept	0.519	0.858	0.61	0.657	0.805	1.018
Entrants.1985-1989.Logged	-0.151***	0.038	-3.96	-0.125*	-0.149**	-0.190***
Pop.1990.Logged	0.130	0.072	1.81	0.086	0.145	0.179*
Manuf.Share.1990	1.660***	0.364	4.56	1.831***	2.010***	1.601***
Home.Value.1990	-0.007	0.040	-0.18	-0.010	-0.043	-0.062
White.Share.1990	0.039	0.291	0.14	-0.100	-0.026	0.004
Hispanic.Share.1990	-0.098	0.357	-0.27	-0.324	0.089	-0.171
Amenity.Score.2000	-0.045**	0.016	-2.76	-0.026	-0.041*	-0.020
Univ.CTY	0.348***	0.062	5.57	0.233**	0.293***	0.325***
Univ.MSA	-0.077	0.054	-1.43	-0.075	-0.079	-0.006
Edu.Share.1990	0.306**	0.095	3.21	0.334**	0.478***	0.422***
Patents.1990.Logged	-0.002	0.029	-0.07	0.032	-0.025	-0.082*
R-squared	0.526					
Pseudo r-squared				0.334	0.342	0.348

*** 0.1% level, ** 1% level, * 5% level significant.; Census Region dummy variables are included in the estimation, but their estimates are not presented here for brevity.

Table 4. Sensitivity Analysis Results: Ratio of Foreign-Born Entrants Between 1980-89 and 2000-10 in the County

	Dependent var: Entrants.Change.1989-2010.Logged				
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Intercept	-0.620	-0.214	0.602	-0.228	0.685***
Entrants.1980-1989.Logged	-0.269***	-0.243***	-0.267***	-0.235***	-0.258**
Pop.1990.Logged	0.288***	0.234**	0.237**	0.229**	0.223
Manuf.Share.1990	-0.548	-0.320	0.091	-0.271	0.160
White.Share.1990	-0.181	-0.141	-0.278	-0.129	-0.279
Home.Value.1990	0.114**	0.072	0.022	0.077*	0.028
Hispanic.Share.1990	-0.438	-0.375	-0.125	-0.401	-0.149
Amenity.Score.2000	-0.074***	-0.063***	-0.044**	-0.064***	-0.046**
Univ.CTY		0.291***	0.220***	0.318***	0.257***
Univ.MSA				-0.047	-0.071
Edu.Share.1990			0.301**		0.308**
Patents.1990.Logged			-0.005		0.001
R-squared	0.464	0.522	0.545	0.524	0.548

*** 0.1% level, ** 1% level, * 5% level significant.; Census Region dummy variables are included in the estimation, but their estimates are not presented here for brevity.

estimates, the coefficient on the *Univ.CTY* variable turned out to be negative and insignificant across all model estimates for both time periods. A summary of these model estimates can be found in Appendix A.

3.5. Summary and discussion

Several economic development studies have identified associations between the critical role of universities in talent attraction and retention, however the literature does not explicitly address the university's role as a potential gateway for foreign-born individuals. This population has comprised an increasingly large share of the US population, particularly in wake of revisions to the Immigration and Naturalization Act in 1990. This study employed multivariate regression analyses to discern whether differences could be observed in foreign-born populations of counties with and without research universities in years following the implementation of the Act.

The initial OLS estimates revealed that the presence of research universities was positively associated with a higher ratio of foreign-born residents in the 1985-1989 to 1995-2000 periods, at the county level. Much of the explained variation can be accounted for by the share of educated residents, however, some variation at the county level is not solely explained by educated residents and may be attributable to the presence of universities. This finding may indicate the enhanced capacity of universities to attract foreign students and faculty in the post-1990 era and induce so-called "multiplier effects" derived from service providers and activities which target foreign-born students and university faculty (Hoffman and Hill, 2008; Steinacker, 2005).

No associations, however, were detected beyond the county at the MSA level. The insignificant effects of *Univ.MSA* may imply that there are little spillovers occurring between

university host counties and other parts of the metropolitan areas. Given that this study focused on small and medium-sized metropolitan areas, it is possible that foreign-born entrants to university counties may choose to relocate to traditional immigrant gateway cities and states (Hempstead, 2007) or pursue more abundant employment opportunities in larger metro regions.

In addition, the findings revealed that counties experiencing highest levels of change in their ratios of foreign-born entrants experienced significantly larger effects from the presence of universities. Although direct comparisons cannot be made between estimates in the original OLS estimates and sensitivity models given the difference in the dependent variable used, the association between university presence and growth in foreign-born entrants appeared to decline slightly over time at the county level, which may suggest the possibility of convergence between counties with and without research universities. In extending the analysis beyond entrants, no evidence was found at the county or metropolitan level linking the presence of universities to growth in the total number or total share of foreign-born residents between either the 1990 to 2000 or 1990 to 2010 periods. This may suggest that while university counties serve as destinations for immigrants, they are not necessarily where they reside over the long term.

This suggests that while the Immigration and Naturalization Act of 1990 may have contributed to helping attract foreign-born entrants into university-dominant counties post-1990, compared with similar counties without universities. From a policy standpoint, the critical question then becomes what can be done to better enable small and medium-sized metropolitan regions with research universities to retain immigrants once they have arrived? While college towns and their surrounding areas often possess distinctive cultural, social, and recreational environments which are prized by residents and businesses, these features can also generate negative pressures in the forms of increased housing prices, gentrification, and segregation which

can present barriers for recent immigrants or recent college graduates who wish to reside in these locales over the long-term. While many small and medium-sized metropolitan areas often pursue strategies of wooing fast-growing industries to better attract and retain residents, policies that attempt to create more diverse and labor markets and housing stock may be better positioned to provide a bridge toward the retention of immigrant populations.

Chapter 4. Examining talent attraction and retention in small and medium-sized metropolitan areas: Where do universities fit in?

4.1. Introduction

Internal migration rates in the United States have consistently ranked among the highest in the industrialized world, a phenomenon that has been evident since at least the middle of the 19th century. While farming and the need for new land drove this for most of the country's early history, the first decades of the 20th century witnessed an increasing shift in migration toward American cities. With the passage of the Morrill Act of 1862 and the establishment of a public higher education system, the geographic spread of universities reflected a broad-based belief in education as a source of self-improvement, economic advancement, and geographic and social mobility (Feller, 1989). Today, in addition to their important roles in education and research, universities are also increasingly recognized as critical players in regional economic development in the United States and many other countries. Large research universities help shape a regional environment open to new ideas and diversity. They attract students and faculty from a wide variety of racial and ethnic backgrounds, economic statuses, sexual orientations, and national origins. University communities are generally meritocratic and open to difference and eccentricity; they are places where talented people of all stripes interact in stimulating environments that encourage open thought, self-expression, new ideas, and experimentation.

Due in part to their role in degree production and research, higher education institutions provide their communities and regions with concentrations of highly educated people. Research universities, in particular, are an important channel through which cities and regions can increase the supply of their human capital. In addition to attracting highly educated faculty and staff, universities play a key role in the attraction of students at local, national and international levels.

These students may decide to reside in the area of the university upon graduation and enter the local/regional labor market. This is critical because regional growth has been shown to emerge from the clustering of highly educated and productive people (Florida, 2003; Porter, 1990/2011; Niedomysl and Hansen, 2010), although the direction of causality, often examined with the question of whether people follow jobs or jobs follow people, is not always clear and perhaps context-specific (see e.g., De Graaff et al., 2012; Kim, 2014; Hoogstra et al., 2017).

However, due to their high mobility, many college graduates may choose to relocate to cities or regions which present optimal employment prospects, thus preventing the cities in which they received their education from capturing the benefits of their human capital in many cases. At the state-level, the Rust Belt, the Midwest, and Plains states have seen large net losses in college-educated people, while coastal and Southern states have made large gains in recent years (Artz, 2011). For public research universities located in inland states, this trend is particularly concerning as a majority of college graduates receive their degrees from public universities, which are partly funded by state governments. Therefore, it can be argued that those states are effectively subsidizing other states' skilled labor forces, if they are losing more college graduates than they are attracting or retaining.

While the migration patterns of the highly educated appear distinct at the state-level, the picture is somewhat less clear at the metropolitan level. Large metropolitan areas with more higher education activity have been shown to be more successful in attracting and retaining the highly educated, but recent studies have also called attention to the rising costs of living in such cities compelling many workers to move to less expensive regions in the Sunbelt, fueling the growth of these areas (Abel and Dietz, 2012; Moretti, 2013; Florida, 2017). What remains unclear is whether small and medium-sized metropolitan areas with research universities are

better able to attract and retain talent than comparable areas without such institutions? Due to the presence of large research universities, many of these small and medium-sized metropolises possess qualities which present them as attractive residential locations to the highly educated, including a large share of knowledge-based jobs, arts and entertainment amenities, diverse and tolerant communities, and relatively affordable housing markets. An enhanced understanding of the internal migration patterns of the highly educated has important policy implications given that highly skilled people not only earn higher incomes themselves, but also generate spillover effects which raise wages for all workers in their region—irrespective of their employment sector—and make significant contributions to regional economic prosperity.

In this study, we empirically examine this important question by analyzing data for 341 counties in 193 small and medium-sized metropolitan statistical areas (MSAs) in the United States. In order to gain a nuanced understanding of the potential contribution of universities and its possible variation across regions, we employ a kernel-based regularized least squares (KRLS) approach which allows us to see point-wise estimates and their patterns of variation. The results suggest two important points with regard to the contribution of research universities to attracting or retaining highly educated individuals: 1) their ability to complement (the lack of) talent agglomeration and 2) spatial spillovers (and decentralization of highly educated people) beyond the county boundaries.

4.2. Literature review

4.2.1. The geography of human capital

The (changing) geography of human capital has gained increasing popularity over the last few decades (see e.g., Berry and Glaeser, 2005; Shapiro, 2006; Simonen and McCann, 2008). In

the economic development literature, for instance, studies have increasingly focused on various characteristics of highly educated populations who migrate into urban areas including the 18-35 year old cohort (Estiri and Krause, 2018; Moos et al., 2018), recent graduates (Fiore et al., 2015), specific degree holders or occupations (Gottlieb and Joseph, 2006; Saxenian 2000; Markusen, 2004), and foreign-born individuals (Hempstead, 2007; Saxenian and Edulbehram, 1998). Much of the attention on these specific demographic and socioeconomic characteristics has emerged in response to policy concerns over the implications of increased out-migration that has taken place in the Rust Belt and some other regions hard hit by the so-called 'brain drain'. Admittedly, the geography of human capital has also been shaped by the transnational dimension of the brain drain phenomenon and a wide variety of factors behind the international human capital flows, including pro-skills immigration policies adopted by some hosting countries (see e.g., Raghuram and Kofman, 2002; Docquier et al., 2007; Docquier and Rapoport, 2012).

In the literature, several analytical perspectives have offered competing explanations for the geographic mobility of the highly educated, but recent studies have often focused on the importance of amenities and other place-based characteristics in attracting or retaining this group of population. For instance, researchers have examined the relationship between population increases in the Sunbelt region after World War II and the productivity, (Sunbelt) amenities, and elastic housing supply there. Specifically, Mueser and Graves (1995) measured the relative importance of job opportunities versus amenities in explaining migration patterns into US counties in the period 1950-1980 and found higher winter temperatures and lower summer temperatures to be associated with higher levels of migration. Furthermore, they provided some evidence of amenity measures being slightly more important determinants of net-migration than employment-related measures. Studies focusing on the migration patterns of college-age

individuals support these findings. In an examination of undergraduate student migration decisions, for instance, Dotzel (2017) provided evidence that college migration decisions were influenced by natural amenities after controlling for institutional and regional characteristics, however these preferences might vary based on the origin state of the migrating student. Similarly, in analyzing the geographic mobility of college graduates, Kodrzycki (2001) found proximity to coastal areas appeared to account for heavy migration into Pacific states, as a high share of college-age in-migrants came from states without a seacoast.

Glaeser and Tobio (2007) also acknowledged the population growth in the South and Sunbelt prior to 1970 being driven by the association between warmth and productivity. However, their analysis of 135 US metropolitan regions found the expansion of housing supply and increases in economic productivity in these regions since 1970s to be far more important factors in driving the Sunbelt population growth than sun-related amenities. They noted that rises in real wages after 1970 across the South are indicative a lower willingness to pay for sun-related amenities relative to willingness to pay in the non-South. Moreover, the authors also identified a significant drop in housing prices during this period in places with hot Julys, suggesting that if sun-related amenities had been a key determinant of population growth in the Sunbelt home prices should have increased faster than wages. Other studies have also demonstrated that the interactions between housing supply, land use regulations, and local labor markets are important determinants of regional patterns of migration and employment growth (see e.g., Glaeser et al., 2006; Saks, 2008; Kim and Hewings, 2012).

These explanations, putting emphasis on the importance of amenities or housing, have been challenged by other scholars. Among others, Storper and Scott (2009) examined various waves of migratory patterns and contended that none of these migrations occurred in advance of

the production capabilities found in the region. As such, the wave of migration to the Sunbelt cities, were not due to natural or man-made amenities or increases in housing supply but rather to the emergence of high-technology production centers, particularly in California in the 1960s and 1970s. As the factor stocks, production networks, skills, and resources of Rust Belt cities were of little relevance to this new economic structure, they began to lose residents and decline. Moretti (2013) offered support for this claim in noting the correlated decline in manufacturing jobs and population growth, particularly across Rust Belt cities between 2000 and 2010. The loss of manufacturing jobs was notable as it appeared to contribute to declines in service and construction sector employment, both of which were historically attractive sources of high-paying jobs for both college and non-college educated workers.

Universities, particularly those focused on intensive research, create knowledge inputs through basic and applied research. Contributions to the stock of knowledge can add value to a region in the form of human capital. This perspective was introduced by Porter's (1990/2011) landmark theory on the determinants of competitive economic advantages of particular industries and their geographic locations. In contrast to traditional explanations of regional competitiveness being rooted in factors such as land, labor, or natural resource endowments, he emphasized the importance of "clusters" in explaining why certain cities or regions could have developed competitive advantages over others.

This notion was echoed in the work of Berry and Glaeser (2005) who reported that places with higher stocks of human capital were able to attract more skilled residents over time in the U.S. This positive association was found to be strong over the 1970-2000 period and pointed to skill divergence among metropolitan areas over time as skilled entrepreneurs and managers disproportionately hired skilled labor (p.423). The authors also found a rising trend in returns to

skill, in the form of wages and income, to play an important role in the share of highly educated residents and their sorting across metropolitan areas over this period. Other authors have attempted to discern whether differences in initial shares of residents with varying levels of higher education might influence the share of educated residents in a region over time. For instance, Betz et al. (2016) found that the initial shares of residents with bachelor's degrees to be an important pulling factor for growth in graduate degree holders in MSAs in the 2000-2010 period. However, they reported that the initial shares of graduate/professional degree holders did not create the same force of agglomeration over the same period, suggesting that postgraduate degree holders might act as substitutes, rather than complements, for one another under certain conditions. The authors also detected a strong tendency for college graduates to locate in places with large populations in certain contexts, possibly to take advantage of thicker labor markets with diverse employment opportunities.

4.2.2. Human capital and universities

A relatively small number of studies have paid more explicit attention to the (potential) roles of universities in shaping the dynamics. In their examination of how universities can contribute to local economies, Hoffman and Hill (2009) invoked Porter's cluster theory to trace the connection between the presence of research universities and the attraction of skilled labor and industries. The authors identified two reasons why university research programs could generate local economic impacts. First, research universities can influence factor input conditions through their graduate programs. The availability of scientific labor is an important concern for managers of industrial laboratories, and they may choose to locate their labs in an area where local universities can provide a steady supply of highly qualified science and

engineering graduates (see e.g. Saxenian, 2002). In many cases the presence of large firms serves to further attract more migrants to locate to the area, a process which ultimately becomes self-reinforcing. Second, because of a variety of local attachments students may develop while in school, young professionals often prefer to remain in the vicinity of their graduate school, which further suggests that large urban areas with universities are better positioned to retain their locally-educated skilled workers.

Abel and Dietz (2012) examined the relationship between university degree production in metropolitan areas and the specific types of high human capital occupations present in these economies. Their results showed a strong connection between a metropolitan area's research intensity and the presence of seven out of ten 'high' human capital occupations. This relationship was particularly pronounced for occupations requiring innovation and technical training, such as those in computer and math; life, physical and social sciences; business and financial operations; and architecture and engineering.

Like academic research and development, economic activities in these areas tend to cluster geographically, consistent with the external effect mechanism of human capital described earlier. The spillover effects that arise from the clustering of basic research and R&D activities are critical for cities, as they can mitigate the potential loss of locally educated graduates in competition with other regions. This is because the research activities of colleges and universities can provide a local benefit that is anchored to the city or region, given the importance of physical proximity in the transmission of knowledge spillovers. Abel and Dietz's (2012) analysis suggested that these benefits might be realized in part by creating opportunities for local businesses to retain and attract skilled workers, whether produced in the area or elsewhere, which results in higher local human capital levels.

Historically, the people who lived near universities—students pursuing their degrees—were often viewed as relatively transient, they left when they graduated. Today, neighborhoods surrounding universities are often locations of choice for what Florida (2003) describes as the creative class, even when many of those attracted to the area have no specific connection to the university per se (Florida, 2017). It has been increasingly suggested that cities that are poised to become economic winners are those that are best able to attract the creative class workers. Companies follow people, and in some cases, are started by them. People are not simply looking for climactic or natural amenities, but communities that provide high-quality experiences, openness to diversity, and the opportunity to validate their identities as creative people (Florida, 2003).

It should be noted, however, that other empirical studies have found the impact of creative occupations on successful local and regional economic development to be more nuanced, or limited relative to other potential determinants such as housing preferences or education attainment. These studies have also highlighted potential inconsistencies or confusion that can arise in attempting to classify broad occupational groupings as "creative". An analysis of the regional distribution of diverse occupational groups in Germany by Kratke (2010) revealed that while the regional concentration of scientifically and technologically creative occupational groups display a significantly positive impact on regional economic development, this was not evident in other creative occupations in the finance and real estate sectors. Similarly, Boschma and Fristch (2009) observed a positive association between creative class occupations and employment growth in several European countries including Germany and the Netherlands, however this result is confounded by the effect of employees with high levels of education on

patenting activity (a proxy measure of economic growth) being stronger than that of creative core and creative professional occupations.

Other studies, however, have focused on the migration patterns of young educated adults, due in part to the important role this demographic can play in the relationship between human capital and population growth. Winters (2011) investigated the determinants of growth in "smart cities", which are often centers of higher education, and detected that a significant share of population growth in the 1995-2000 period was attributable to individuals who moved to high human capital cities for higher education and then stayed in the city after completing their education. The author provides evidence indicating that this growth may be driven by the in-migration of younger residents pursuing higher education opportunities from within the same state, rather than outside the state. In Finland, Haapanen and Tervo (2012) tackled this issue from the viewpoint of the residential duration of university graduates. Contrary to their expectations, they found that most graduates do not move from their region of studies within 10 years of graduating. However, they also noted significant regional differences, as students who graduated from universities in growth centers were found to be more likely to remain in these regions over time, in contrast to graduates from universities in peripheral regions.

4.3. Study areas, data, and methodology

This study focuses on 193 small and medium-sized MSAs with a 2000 population between 50,000 and 500,000 using the 1999 MSA definitions provided by the US Office of Management and Budget.[2] These MSAs include a total of 341 counties which are the units of

[2] This includes all MSAs, but Anchorage, AK and metropolitan areas in Puerto Rico (excluded due to limited data availability), with a 2000 population in the range of 50,000-500,000.

analysis in this study. Of the 341 counties, 46 (Group 1) have at least one Research-1 or Research-2 universities[3], and none of these counties are in the same MSA, meaning that there are 46 MSAs having research universities. The remaining 295 counties do not have such higher education institutions within their county boundaries, even though 32 of the 295 (Group 2) are located in the 46 R1-2 university MSAs and thus treated differently from the other 263 counties (Group 3) in our analysis explained below.

Group 1 includes many college towns, such as Madison, WI MSA, Tallahassee, FL MSA, and Champaign-Urbana, IL MSA. In these areas, students form a significant proportion of their populations (with faculty and staff members and other affiliated employees forming another significant population segment). As noted above, these counties are drawn from small or medium-sized MSAs with a population between 50,000 and 500,000 in 2000. While cities such as Austin, Texas and Tempe, Arizona possess many cultural attributes common to these college towns, they also exist within a large and diverse political economy and therefore lack some of the distinct demographic and socioeconomic characteristics prevalent in university-dominant counties such as having a large proportion of residents who are transient, foreign-born, younger, highly educated, living in renter-occupied housing units, or working in the higher education industry (Gumprecht, 2003). Including such large and economically diverse study areas would limit our ability to precisely capture the influence of research universities. Focusing on small and medium-sized MSAs is also warranted to support economic development of these regions which often involves unique opportunities and challenges, including those that arise in

[3] Using the Carnegie Classification of Institutions of Higher Education's definitions, consideration is given to Research-1 (Doctoral Universities with Highest Research Activity) and Research-2 (Doctoral Universities with Higher Research Activity) universities. The focus on these universities is due to their ability to generate large numbers of graduates, their role as large employers, and their role in the residential location preferences of the highly educated within their host-regions (Goldstein and Drucker, 2006; Florida et al., 2006).

competition with bigger regions (see e.g., Kelly et al., 2017; Erickcek and McKinney, 2006; Sánchez-Moral et al., 2018).

In contrast, Groups 2 and 3 represent 295 counties without either Research-1 or Research-2 universities. While Group 2 (32 counties) could have an influence of R1-2 universities located in nearby counties in their MSAs, Group 3 (263 counties) can be viewed as control cases given the absence of research universities at the MSA level. These Group 3 counties include a diverse set of US counties, including both growing and declining areas across states. The overall sample (341 counties in 193 MSAs) cover all regions of the nation, including at least one county from 46 states.

To examine how the presence of research universities can make a difference in attracting or retaining highly educated individuals, we employ a multivariate regression model, building on one in Berry and Glaeser (2005) study on divergence of human capital levels across cities, shown below.

$$\Delta y_{t\sim t+1} = \alpha \cdot y_t + X \cdot \beta + UNIV \cdot \theta + \varepsilon$$

where the dependent variable $\Delta y_{t\sim t+1}$ indicates the net change in the share of residents (aged 25 and over) with a graduate or professional degree from 2000 to 2014 in each county; y_t is the share of such highly educated residents in 2000 (the initial year); X is a vector of residential location choice factors; $UNIV$ represents a vector of university variables; α, β, and θ are coefficients that capture the (marginal) impacts of the explanatory variables; and ε indicates the error term.

Our focus is on graduate and professional degree holders not only because of the direct applicability of these degrees to the primary functions of large research universities but also because of their importance in knowledge-based economies. In this study, $UNIV$ is measured

using two dichotomic variables indicating the presence (1) or absence (0) of Research-1 or Research-2 universities within the county and the MSA in 2000: *Univ.CTY* and *Univ.MSA*. Although not perfect, these two variables together enabled us to differentiate the three groups of counties described above and to capture how the presence of R1-2 institutions can contribute to attracting or retaining highly educated individuals. For the control variables (X), we consider a range of residential location choice factors which have been found to push or pull these individuals in the literature (see e.g., Berry and Glaeser, 2005; Betz et al., 2016) including population size, the percentage of manufacturing, per capita income, demographic compositions, and natural amenities, as summarized in Table 5. The descriptive statistics for all these variables are provided in Table 6.

The model is first estimated by OLS, as done in many previous studies. It is important to note, however, that we also employ an innovative multivariate model estimation technique, KRLS (Hainmueller and Hazlett, 2014) which has recently been adopted by Hipp et al. (2017), Kim (2019), and other empirical studies. This approach offers several methodological advantages, as explained in Hainmueller and Hazlett (2014) and Ferwerda et al. (2017). First, it enables the estimation of marginal effects of each independent variable at each data point in covariate space thereby mitigating the unpractical constant marginal effects assumption of linear regression. Second, the functional form assumption of KRLS is relatively flexible compared with generalized linear regression models, which reduces misspecification bias that can arise from omitting an important function or guessing the functional form. Moreover, it enables one to identify potential covariates which moderate the relationship between the dependent and experimental variables. In this study, we take advantage of KRLS with the aforementioned methodological merits and use it to examine how the potential contribution of universities can

Table 5. Variables and Data Sources

Category	Variables	Description	Data sources
Dependent variable	HEdu.Change.2000-14	Net change in the proportion of residents aged 25 and over with a graduate or professional degree from 2000 to 2014 in each county	Census00 [a], ACS1216 [b]
University variables	Univ.CTY	Presence of R1 or R2 universities at the county level (1 Yes, 0 No)	Carnegie [c]
	Univ.MSA	Presence of R1 or R2 universities at the MSA level (1 Yes, 0 No)	Carnegie
Other explanatory variables	HEdu.Pct.2000	Proportion of residents aged 25 and over with a graduate or professional degree in 2000	Census00
	Pop.2000.Logged	Total county population in 2000 (logged)	Census00
	Manuf.Pct.2000	Share of manufacturing in terms of county employment	REA [d]
	PCI.2000.Logged	County per capita income in 2000 (logged)	REA
	White.Pct.2000	Proportion of white residents in 2000	Census00
	Hspanic.Pct.2000	Proportion of Hispanic residents of all races in 2000	Census00
	FBorn.Pct.2000	Proportion of foreign-born residents in 2000	Census00
	Amenity.Score.2000	Natural amenities scale (an index measuring several ecological characteristics of a county area that can enhance the location as an attractive place to live)	ERS [e]
	Census.Div.1-8	Census Division dummy variables (Baseline: Pacific Division)	US Census

[a] US Census 2000; [b] American Community Survey 5-year Estimates, 2012-2016; [c] Carnegie Classification of Institutions of Higher Education; [d] Regional Economic Accounts, US Bureau of Economic Analysis; [e] Economic Research Service, US Department of Agriculture.

Table 6. Descriptive Statistics

Variables	Sample	*n*	Mean	St.Dev.	Min	Max
HEdu.Change.2000-14	All	341	0.020	0.013	-0.009	0.074
	Group 1	46	0.023	0.011	0.003	0.053
	Group 2	32	0.027	0.017	0.000	0.074
	Group 3	263	0.018	0.012	-0.009	0.072
Univ.CTY	All	341	0.135	0.342	0.000	1.000
Univ.MSA	All	341	0.229	0.421	0.000	1.000
HEdu.Pct.2000	All	341	0.072	0.039	0.019	0.361
	Group 1	46	0.127	0.048	0.035	0.231
	Group 2	32	0.070	0.028	0.029	0.171
	Group 3	263	0.063	0.029	0.019	0.361
Pop.2000.Logged	All	341	11.418	0.848	8.707	13.090
Manuf.Pct.2000	All	341	0.135	0.081	0.002	0.438
PCI.2000.Logged	All	341	10.135	0.161	9.643	10.740
White.Pct.2000	All	341	0.839	0.133	0.373	0.990
Hspanic.Pct.2000	All	341	0.061	0.118	0.004	0.943
FBorn.Pct.2000	All	341	0.040	0.045	0.003	0.290
Amenity.Score.2000	All	341	0.117	2.352	-5.400	10.970

vary across contexts, as shown in the following section. Of particular interest is the way in which the presence of universities interacts with other conditions in attracting more graduate and professional degree holders into the area.

4.4. Results

Table 7 presents the results from OLS estimation. The left side of the table shows the estimated coefficients for the main model (i.e., equation #1), while we provide the OLS estimation results for an additional model where the dependent variable is *HEdu.Pct.2000* (instead of *HEdu.Change.2000-14*) , as they enable us to see how the explanatory variables are associated with each county's proportion of highly educated individuals on a single time point (year 2000) and thus interpret the results in a more effective manner.

As shown in the table, the OLS estimates show the share college-educated adults in 2000 to have a significant positive association with the change in the share of graduate or professional degree holders between 2000 and 2014 on average. Consistent with the findings of Berry and Glaeser (2005), this result suggests that counties with high initial levels of educated residents have been able to attract more human capital over time, indicating "human capital divergence" (p.411, Berry and Glaeser, 2005) across counties or regions. The magnitude of this coefficient from our OLS estimation (+0.053) is relatively smaller than what Berry and Glaeser (2005) reported, perhaps due to several differences between the studies, including our focus on small and medium-sized MSAs, unit of analysis (county vs. MSAs), study period (2000-2014 vs. earlier decades), and the level of educational attainment used (graduate/professional vs. bachelor's degree). A one-point increase in the share of college-educated adults is associated

Table 7. OLS Estimation Results

Variables	Dependent var.: HEdu.Change.2000-14			Dependent var.: HEdu.Pct.2000		
	Est. coeff.	**Std. error**	**t-stats.**	**Est. Coeff.**	**Std. error**	**t-stats.**
Intercept	-0.230 ***	0.046	-4.981	-0.975 ***	0.101	-9.629
Univ.CTY	-0.005	0.003	-1.839	0.047 ***	0.007	7.114
Univ.MSA	0.006 **	0.002	3.064	0.005	0.005	0.896
HEdu.Pct.2000	0.053 *	0.022	2.363			
Pop.2000.Logged	-0.002	0.001	-1.785	-0.002	0.002	-0.769
Manuf.Pct.2000	-0.016	0.008	-1.940	-0.091 ***	0.020	-4.529
PCI.2000.Logged	0.026 ***	0.005	5.334	0.104 ***	0.011	9.824
White.Pct.2000	0.000	0.000	0.317	0.000	0.000	0.173
Hspanic.Pct.2000	0.000	0.000	0.043	0.000	0.000	-0.775
FBorn.Pct.2000	0.000	0.000	-0.863	0.001	0.001	1.691
Amenity.Score.2000	0.000	0.000	0.626	-0.001	0.001	-0.517
R-squared	0.375			0.567		

*** 0.1% level, ** 1% level, * 5% level significant.; Census Region dummy variables are included in the estimation, but their estimates are not presented here for brevity.

with a 0.053 unit increase in the net change in the proportion of college-educated adults between 2000 and 2014.

Again consistent with Berry and Glaeser (2005) and other studies, the model estimates indicate that the level of per capita income (*PCI.2000.Logged*) can play a significant role in determining the net change in the share of graduate or professional degree holders over the 14-year study period. However, county population size and the proportion of manufacturing sectors in 2000 turn out to be insignificant at the 5% level. Other control variables, such as the shares of White, Hispanic, and foreign-born population groups, also do not appear to have significant influences on the dependent variable (*HEdu.Change.2000-14*), when the model is estimated by OLS.

Of interest are the effects of the two university variables tested: *Univ.CTY* and *Univ.MSA* indicating the presence or absence of R1-2 universities within the county and MSA, respectively. Interestingly, the model estimation results suggest the effects of the presence of such large research universities on the change in the share of highly educated individuals over time vary across geographic scale. *Univ.CTY* turns out to have an insignificant association with the change in graduate/professional degree holders over the 2000-2014 period, although it was positively and significantly associated with the share of highly educated adults in 2000 (as shown on the right side of Table 7 presenting the results of the model estimation with *HEdu.Pct.2000* as the dependent variable). By contrast, *Univ.MSA* yields a significant positive effect on the net change over the 14-year period on average. The presence of universities at the MSA level is associated with a 0.006 unit increase in the net change in the proportion of college-educated adults between 2000 and 2014. This result points to the possibility of spatial spillovers of human capital beyond a university county's boundaries into the broader metropolitan region. It should be noted that

Univ.CTY=1 and *Univ.MSA*=1 were assigned to the Group 1 counties where a R1-2 institution is located and, thus, the insignificance of the *Univ.CTY*'s coefficient does not mean that the presence of universities had no effect on these counties, even though it suggests that they (Group 1) were not more successful in attracting or retaining highly educated individuals during our study period than neighboring Group 2 counties (with *Univ.CTY*=0 and *Univ.MSA*=1).

The results of the KRLS estimation (Table 8), which provide pointwise estimates for each coefficient, are somewhat consistent with those from OLS, revealing the importance of the initial share of graduate/professional degree holders and per capita income. More importantly, again, we find the presence of large research universities (*Univ.MSA*) to have a significant positive effect on the change in the share of highly educated individuals at the MSA level. The average value of the estimate (+0.004) approximates the OLS estimate value (+0.006).

Although the KRLS analysis outcomes depict a somewhat narrow range of estimates, from +0.002 at the 25th percentile level to +0.005 at the 75th percentile level, an examination of the patterns of the pointwise estimates reveals how the *Univ.MSA* effect varies across counties with varying initial conditions. It is found that the effect tends to be larger in areas where *HEdu.Pct.2000*, *PCI.2000.Logged*, and *FBorn.Pct.2000* values are low (Figure 1). The negative association pattern between the magnitude of the *Univ.MSA* effect and *HEdu.Pct.2000* deserves special attention. This finding indicates that the contribution of a large research university is likely to be larger in areas with a smaller proportion of highly educated individuals in the initial year. In other words, research universities may play an important role as a complement or substitute for small and medium-sized metropolitan regions lacking talent agglomeration compared with similar regions already containing concentrations of human capital. A similar pattern is detected for *Univ.CTY*, and the association appears to be even more apparent in this

Table 8. KRLS Estimation Results

Variables	Dependent var.: HEdu.Change.2000-14					
	Avg.	**Std. error**	**t-stats.**	**Q25**	**Q50**	**Q75**
Univ.CTY	-0.001	0.001	-0.719	-0.003	-0.001	0.001
Univ.MSA	0.004 *	0.001	2.526	0.002	0.004	0.005
HEdu.Pct.2000	0.045 ***	0.012	3.736	0.028	0.044	0.061
Pop.2000.Logged	-0.001 *	0.000	-2.227	-0.002	-0.001	0.000
Manuf.Pct.2000	-0.009	0.005	-1.724	-0.017	-0.010	-0.001
PCI.2000.Logged	0.020 ***	0.003	7.243	0.014	0.022	0.026
White.Pct.2000	0.001	0.003	0.322	-0.004	0.001	0.005
Hspanic.Pct.2000	-0.007 **	0.003	-2.717	-0.011	-0.007	-0.004
FBorn.Pct.2000	-0.008	0.009	-0.913	-0.017	-0.009	0.000
Amenity.Score.2000	0.000	0.000	0.797	0.000	0.000	0.000
R-squared	0.474					

*** 0.1% level, ** 1% level, * 5% level significant.; Avg: Average marginal effects; Q25, Q50, Q75: Quartiles of the marginal effects at the 25th, 50th, and 75th percentiles.; Census Region dummy variables are included in the estimation, but their estimates are not presented here for brevity.

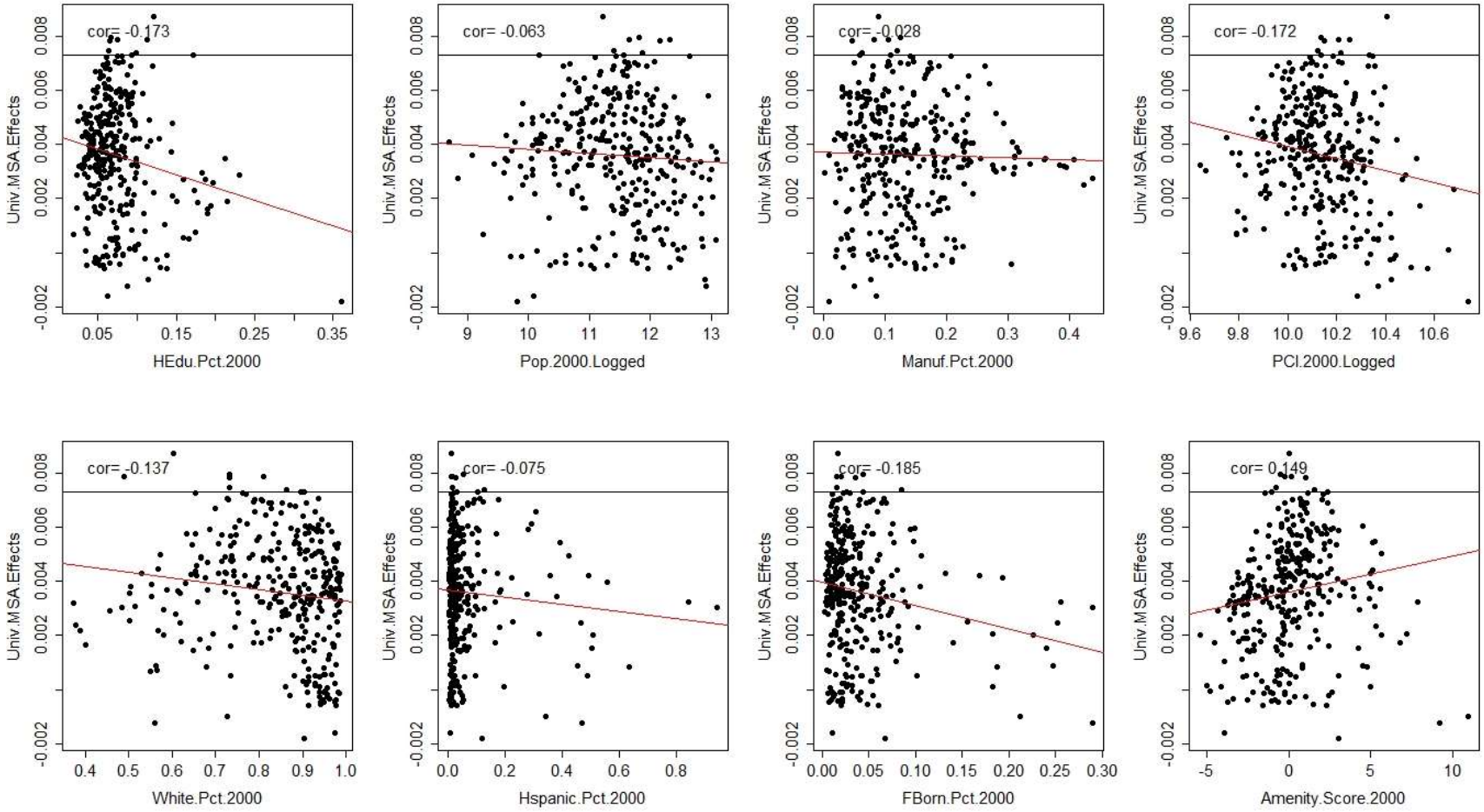

Figure 1. Varying Effects of Univ.MSA

case (Figure 2). While the average KRLS coefficient on *Univ.CTY* is not significant (consistent with the OLS result), the point-wise estimates show a clear negative relationship with *HEdu.Pct.2000*. That is, the marginal benefit of research universities tends to be larger when talent agglomeration is initially absent (as in, for instance, Merced, CA and Lafayette, LA in our sample). The universities may possess an ability to complement the lack of talent agglomeration, as noted above, and perform a critical role in initially attracting highly educated individuals into their counties, despite the decentralization of these individuals beyond the university-dominant county boundaries over time. In a broad sense, this finding is in line with Goldstein and Drucker's (2006) finding that "universities may be able to act as a substitute for agglomeration economies." (p.22).

It is important to note that, compared to OLS, the KRLS estimation shows a larger R-squared, indicating that this new estimation approach explains a much greater extent of the variation in the dependent variable by taking into account the nonlinearities and interactions between variables. This R-squared improvement may also imply that changes in the share of highly educated residents cannot be easily explained through a simple aggregation of the independent variables' fixed effects. Rather, the contributions of (research) universities to talent attraction/retention (and regional economic prosperity, more broadly) are perhaps determined by the complex mechanism in which one determinant's impact is highly dependent on other factors.

4.5. Summary and discussion

In an attempt to gain an enhanced understanding of the contributions of research universities to the location choice patterns and dynamics of the highly educated, we have analyzed possible variations in the share of graduate/professional degree holders across regions

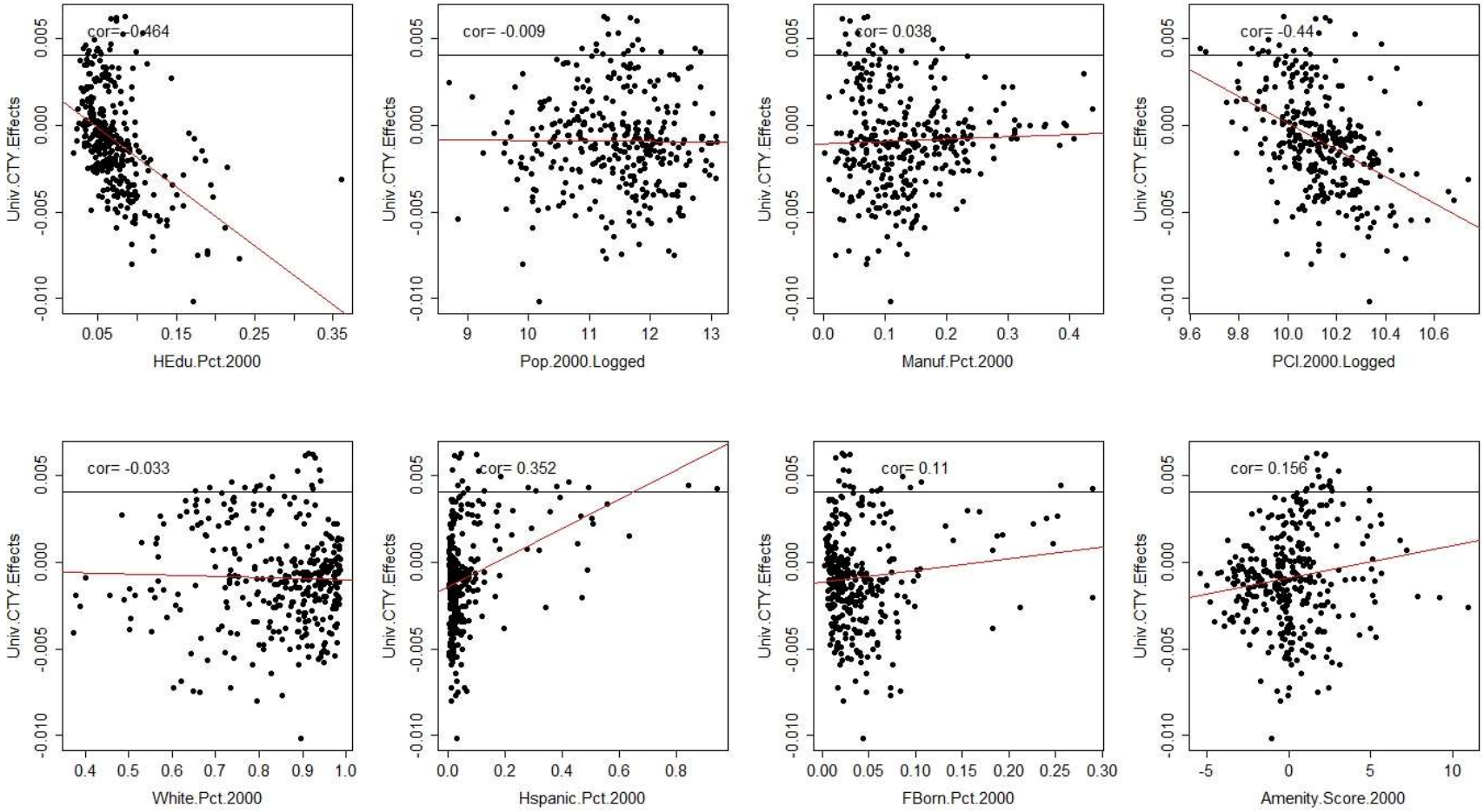

Figure 2. Varying Effects of Univ.CTY

with and without large research universities. More specifically, the present study focused on 193 small and medium-sized MSAs, in which universities can possibly play a critical role in producing and drawing human capital into their counties or broader regions. These MSAs contained 341 counties which served as the units of analysis in this study.

According to our results, counties with Research-1 or Research-2 universities have a significantly larger share of graduate or professional degree holders than counties without such institutions, when analyzing patterns in 2000. Furthermore, this pattern appears to have been strengthened over the 2000-2014 period not only through the self-reinforcing process (detected here in the form of a positive, significant impact of *HEdu.Pct.2000* on *HEdu.Change.2000-14*) but also through the contribution of universities (captured in the form of a positive, significant impact of *Univ.MSA*). We found, however, no evidence of an additional benefit *Univ.CTY* could bring into the Group 1 counties. This finding indicates spatial spillovers to the MSA level (or decentralization of highly educated residents from university host counties to adjacent counties), as MSAs containing universities within any of their constituent counties exhibit a significantly positive increase in their counties' shares of graduate/professional degree holders between 2000 and 2014.

A KRLS estimation complemented the OLS regression by showing how such effects of the presence of R1-2 universities would vary across counties. This approach significantly improved the explanatory power of our multivariate model and produced results largely consistent with the OLS estimates, particularly with regards to the self-reinforcing dynamics of talent attraction. However, the KRLS results revealed a more complex nature of this pattern. Among others, the presence of universities was found to have a stronger effect on talent attraction in counties with lower initial shares of highly educated residents (and lower initial

levels of per capita income), suggesting that their presence may serve a complementary or substitutive role in counties lacking talent agglomerations.

Our results also raise important policy implications. First, the findings provide additional support for state governments to reduce the cost burden of higher education to their residents who seek advanced degrees. Reduced spending on higher education may help to balance state budgets in the short-term but may drive away younger people intent on pursuing higher education in their home-state due to the high cost. Second, local and state governments may consider collaborating with universities to explore the expansion of flagship campuses into metropolitan areas deprived of university-level graduate or professional programs as a means of potentially attracting and retaining educated individuals. Finally, the findings also lend support for local and state governments leveraging (or strengthening) existing relationships with local higher education institutions to facilitate internship, career training, or professional development opportunities with local employers, which may further increase the probability that graduates remain in the area upon graduation.

We should acknowledge some limitations of this study. The multivariate regression in this study relied on a singular conceptualization of university presence. A nuanced understanding of university presence could be obtained with more elaborated measurements of universities taken from the economic development literature, such as campus acreage, enrollment size, number of employees, research grant funding dollars, and endowments. Moreover, the findings from our analysis based on small and medium-sized MSAs between 2000 and 2014 should be interpreted or generalized with caution to other geographies or time periods. Finally, while our county-level analysis afforded us the breadth in data availability across several indicators, it precluded us from capturing individual-level attributes and dynamics.

Nonetheless, the present study provides additional insights into how the presence of large research universities may shape their social geographies. Moreover, there have been limited attempts to understand how small and medium-sized MSAs have been impacted by the presence of such institutions, and this area should receive more attention, as done in this study. The findings presented here do highlight the importance of research universities, particularly in regions which may be deprived of human capital and/or have more difficulties in attracting talents due to the lack of agglomeration economies. Future research that incorporates an extended time period or alternative conceptualizations of university presence would shed more light on this important mechanism.

Chapter 5. Diverging pathways of neighborhood change in US college towns

5.1. Introduction

While there is widespread recognition that higher education institutions often influence local and regional economic development through their knowledge spillovers, research, and human capital creation, much less attention has been paid to their potential impact on neighborhood change dynamics. The implications of these potential changes are reflected in the urban policy agendas of several municipal and regional government plans which have sought to leverage the existence of their community college and universities in revitalization strategies within their central business districts (Friedman, 2009; Winling, 2018; Baldwin, 2021).

Many of the country's largest and deeply-rooted higher education institutions were intentional located in rural settings, in part to isolate students from the negative impacts of urban environments of the mid to late 1800s but also to provide abundant land for substantial expansion (Diner, 2017). Increased federal spending on higher education institutions and suburban development during the first half of the 20th century would later serve to move job growth, knowledge creation, and economic opportunities away from many central cities in post-war period. Additionally, large urban universities were often integral partners in slum clearance and urban removal program which exacerbated already fraught internal tensions, creating distinct dichotomies of spatial geography: working vs. professional class, non-academic population vs. the university community, and “town” vs. “gown” (Whitling, 2017; Martin, Smith, and Phillips, 2005).

Emerging practices in community building among universities and community colleges that formerly tried to isolate themselves from their surrounding neighborhoods have resulted in many institutions finding their urban locations to be an asset not only in attracting and retaining

the newest generation of college students, but also in luring highly educated professionals from other cities. Given many universities' affiliations with scientific and technological research institutions, anchor institutions in medicine and the arts, and partner institutions at the primary and secondary school levels, universities have played as an indispensable role in shaping the locational prerogatives of their students who, upon graduation, are often able to take advantage of clustered employment, housing, and cultural amenity opportunities around college campus neighborhoods (Florida, 2017, pg. 123; Markusen and Schrock, 2006).

Neighborhoods surrounding universities and community colleges have also become an increasingly important channel through which cities and private developers have attempted to draw in highly educated individuals who have no specific connection to the university per se. This pattern has been most pronounced around research universities in urban areas, and often involves mixed-use luxury rental projects implicitly targeted at young professionals rather students or recent graduates. Notable examples can be found throughout the country, around college campuses nestled within large metro areas such as the University of Pennsylvania and the University of Chicago, but also around traditional college towns in smaller cities such as Arizona State University in Tempe or Texas A&M University in College Station.

More broadly, the benefits that may be leveraged from the expansion of higher education institutions raises important land-use planning concerns about the future of university-community relations across cities. For universities, the prospect of privately-developed amenity-rich luxury housing within the school's footprint may make it easier to recruit young faculty members at no cost to the school. However such housing options will likely be unaffordable for large segments of students. With student enrollments outpacing the construction of on-campus housing at many universities and community colleges, students are increasingly resorting to off-

campus accommodations (which in some housing markets are more affordable but distant from campus) or purpose-build student accommodations which although closer to campus may be situated within non-student communities. Tensions between student and non-student populations are possible in either case due to the impacts of restructured housing composition, increasing rents, residential displacement, social-spatial segregation, and increased traffic congestion or strain on public transit infrastructure.

As higher education institutions have widened the scope of their traditional mandates of research and teaching to include community engagement, technological commercialization, and real-estate development, they have also expanded their physical footprint, in many cases inducing neighborhood-level changes within their cities. The question then becomes what exactly do neighborhood-level changes look like in jurisdictions with large research universities?. Although a few studies focused on the United Kingdom have explored how college students influence housing markets (McDowell, 1978; Macintyre, 2003), there has been a dearth of research which examines the neighborhood dynamics in college towns in a comprehensive fashion. A small body of neighborhood-level research on the impact of universities on US housing markets has produced mixed findings, noting that while the presence of campus can influence housing values, these impacts were highly contextual and differed depending on university type (public or private), physical size, and the physical state of the dormitories with respect to the state of the buildings in the neighborhood (Cortes, 2004).

This study provides a neighborhood-level examination of the studentification phenomenon through cluster analysis and logistic regression modelling. It develops a typology of distinct forms of neighborhood change dynamics by accounting for the demographic, socioeconomic and housing context in counties with small and medium-sized MSAs where higher education

institutions play an important role. Various branches of the economic development literature have emphasized particular mechanisms through which this occurs at the local and regional levels, however considerably less attention has been given to patterns occurring at the neighborhood-level. Additionally, this work provides several insights into these trends in college towns located in small and medium-sized metropolitan areas.

5.2 Literature Review

Studentification describes distinct social, economic, physical, and cultural changes within college towns and university cities which are associated with and driven by the seasonal in-migration of post-secondary student populations to a nearby institution (Smith, 2002; Smith, 2004). Studentification has been examined using various methodologies primarily within the United Kingdom context, with studies revealing studentifying neighborhoods as typically defined by the replacement or displacement of a group of established permanent residents with a transient, generally young and single, middle-class social grouping. One of the key features of this *social* or *demographic* dimension of studentification is the increased segregation of social groups within restructuring neighborhoods (Smith, Sage, and Balsdon, 2014).

In recent years, studies on residential displacement have focused increasingly on the linkages between the migration patterns of young and highly educated people and residential change in cities. In contrast to resident of gentrifying neighborhoods, who typically form medium and long-term residential attachment, residents of studentifying neighborhoods typically reside in a neighborhood only for the duration of the academic year or their period of study. It thus comes as little surprise that Sage et al. (2012) found that areas in London, England with highest clustering of new residents in the 2006-2009 period included those areas with: (1) the

largest private-rental housing sectors in the city; and (2) the highest proportion of 18 to 30 year olds. However, Smith (2004) has noted that processes of studentification are aligned to forms of gentrification which are instigated by pioneering institutional agents such as small-scale property owners and investors who recognize an opportunity for profit-maximization, primarily in locations near university campuses.

Aside from the social impact of displacement, several researchers have noted important *cultural* dimensions of studentification, particularly as established residents who are able to remain within their neighborhoods become impacted by shifts in the character of neighborhoods. Several case studies have pointed to the increasing population densities of studentifying neighborhoods as triggering several secondary effects that impact the quality of life of non-student populations. Secondary impacts such as noise nuisance, unkempt outdoor spaces, and the lack of space for parking which can lead to the removal of landscaping exacerbate the ways in which the processes of studentification transform the visual aesthetic and identity of neighborhoods (Smith et al. 2014; Sage et al., 2012a; Sage et al. 2012b). Other research has also pointed to the transformative influence of student populations on the amenities and infrastructure of their host communities. For example, generic changes in the retail market may emerge as businesses will find it profitable to cater toward student clientele rather than to the needs to established residents (Hubbard, 2008). This may generate an increase in the economic growth of the local economy but it may cause some established residents to perceive a reduction in their quality of life.

A *physical* or *housing* dimension of student-driven neighborhood change has been identified in the neighborhood change literature, this associates studentification with an initial upgrading of the external physical environment as properties are converted into multi-family

housing units (Smith, 2004). This can subsequently lead to a downgrading of the physical environment, depending on the local context. Change in the physical appearance of residences was cited in one neighborhood of Bristol, England where the University of Bristol has recently expanded. Members of the non-student community note that minimal investment by absentee landlords and lack of care by student occupants reduces the quality of the housing stock and blights the area, ultimately impacts their own investments in their homes. The transition of neighborhoods into blight further distinguishes the some studentifying neighborhoods from gentrifying and revitalized communities as landlords may often intentionally degrade areas to encourage established households to 'sell up' and move out of the ensuing student ghetto (Smith, 2004). It is important to note however that blighted residential student neighborhoods may exist within larger communities undergoing physical upgrades or investment (e.g. new commercial establishments or improved public transportation linkages).

Other researchers have also pointed to an *economic* dimension of studentification which is tied to the reconstitution of housing stock to cater to student populations and an escalation of property prices (Smith et al 2014). This restructuring of the housing stock gives rise to a tenure profile which is dominated by shared private-rented short-term tenancies, and decreasing levels of owner-occupation. Rugg et al., 2000 have shown that college town neighborhoods with high shares of rental-occupancy units may be prone to studentification (Rugg et al., 2000). Ehlenz (2017) has also demonstrated that university-neighborhood tracts that experienced revitalization efforts (such as the development of housing, commercial uses, and public amenities) were associated with significant positive changes in median home values. Studentification is a unique problem because theoretically the influx of students may provide many neglected neighborhoods with precisely the kinds of resources they have lacked: concentrations of highly educated

individuals who according to several studies generate various positive spillover effects for the local economies that would benefit extant residents. However, the very presence of these highly educated individuals induces inflationary pressures on housing markets whereby current residents are often forced to move because they can no longer afford to live in their current neighborhoods.

5.3 Study areas, data and methodology

5.3.1 Study areas

The study focuses on a sample set of 27 counties which are home to a major research university (Research-1 or Research-2 institution). The sample set of counties has been derived by first identifying counties with major research universities located within a metropolitan statistical area (MSA) with a population between 50,000 and 500,000 residents using US Census Bureau 2000 definitions. Counties containing major research universities within large MSAs (500,000 residents or greater) were then excluded because these counties may be subject to dynamics of the political economy aside from those generated by their university. Only counties with a student proportion greater than ten percent were used as final cases. Student enrollment data was compiled from the US Department of Education's Integrated Postsecondary Education Data System (IPEDS). The student population proportion was calculated by dividing the Fall 2000 enrollment for each university (including undergraduate graduate, and professional students) by the year 2000 county population.

The focus on research universities is due to their ability to generate large numbers of graduates and their role as large employers within their host-regions (Goldstein & Drucker, 2006). The presence of a research university has also been demonstrated to play an important

role in the residential location choice. While ample research has shown that areas with high proportions of young adults are frequently located in the vicinity of major educational institutions (Moos, 2006; Florida, 2006; Florida, 2017; Moretti, 2013), increased campus expansions have also raised concerns over gentrification and displacement as inequitable outcomes for the surrounding neighborhood. The decision to analyze universities in 27 counties was based on the need to examine areas with substantial college-age populations – a key indicator of studentification, while also generating sufficient data points to meaningfully identify spatial trends. The counties, universities, and their respective populations are summarized in Table 9.

The candidate universities were selected using the Carnegie Classification of Institutions of Higher Education's definitions. All universities not classified as Research-1 (Doctoral Universities with Highest Research Activity) or Research-2 (Doctoral Universities with Higher Research Activity) were eliminated. Some of the candidate universities are nationally and internationally recognized institutions (University of Illinois, Penn State University). Ten of the selected areas in the sample can be defined as *college towns* because the cultures they create "exert a dominant influence over the character of the community" (Gumprecht, 2003, p. 51). The remaining 17 schools are large public institutions with student enrollments ranging from 11,031 (University of North Dakota) to 49,493 (Michigan State University), thus generating substantial influence in their host communities.

Data for the demographic, socioeconomic, and housing variables were compiled from the Neighborhood Change Database (NCDB) by Geolytics and US Census Bureau. The sample set of 27 counties that are home to a major public research university encompass a total of 1043 census tracts which served as the units of analysis. The year 2000 is selected as the starting point

Table 9. Study Areas: University-dominant Counties

Metropolitan statistical area (MSA)	County	State	University	Number of census tracts (2000)[a]	County pop. (2000)[a]	University student pop. (2000)[b]	Student share of county pop.
1. Auburn--Opelika, AL MSA	Lee	AL	Auburn University*	26	115,092	21,860	18.99%
2. Tuscaloosa, AL MSA	Tuscaloosa	AL	University of Alabama	47	164,875	19,318	11.72%
3. Fayetteville--Springdale--Rogers, AR MSA	Washington	AR	University of Arkansas	32	116,320	15,346	13.19%
4. Flagstaff, AZ--UT MSA	Coconino	AZ	Northern Arizona University	27	157,715	19,964	12.66%
5. Fort Collins--Loveland, CO MSA	Larimer	CO	Colorado State University	71	251,494	26,807	10.66%
6. Gainesville, FL MSA	Alachua	FL	University of Florida*	53	217,955	45,114	20.70%
7. Tallahassee, FL MSA	Leon	FL	Florida State University	64	239,452	33,971	14.19%
8. Athens, GA MSA	Clarke	GA	University of Georgia*	28	101,489	31,288	30.83%
9. Iowa City, IA MSA	Johnson	IA	University of Iowa*	24	111,006	28,311	25.50%
10. Champaign--Urbana, IL MSA	Champaign	IL	University of Illinois at Urbana–Champaign*	38	179,669	38,465	21.41%
11. Bloomington--Normal, IL MSA	McLean	IL	Illinois State University*	40	150,433	20,755	13.80%
12. Muncie, IN MSA	Delaware	IN	Ball State University	29	118,769	19,004	16.00%
13. Bloomington, IN MSA	Monroe	IN	Indiana University Bloomington*	27	120,563	37,076	30.75%
14. Lafayette, IN MSA	Tippecanoe	IN	Purdue University	32	148,955	37,871	25.42%
15. Lawrence, KS MSA	Douglas	KS	University of Kansas	21	99,962	25,920	25.93%
16. Lansing--East Lansing, MI MSA	Ingham	MI	Michigan State University	70	279,320	49,493	17.72%
17. Kalamazoo--Battle Creek, MI MSA	Kalamazoo	MI	Western Michigan University	57	238,603	28,657	12.01%
18. Columbia, MO MSA	Boone	MO	University of Missouri	27	72,604	23,244	32.01%
19. Hattiesburg, MS MSA	Forrest	MS	University of Southern Mississippi	16	135,454	14,509	10.71%
20. Missoula, MT MSA	Missoula	MT	University of Montana*	20	95,802	12,413	12.96%
21. Greenville, NC MSA	Pitt	NC	East Carolina University	32	133,798	18,750	14.01%
22. Grand Forks, ND--MN MSA	Grand Forks	ND	University of North Dakota	17	66,109	11,031	16.69%
23. Corvallis, OR MSA	Benton	OR	Oregon State University*	17	78,153	16,788	21.48%
24. State College, PA MSA	Centre	PA	Pennsylvania State University*	27	135,758	40,571	29.88%
25. Bryan--College Station, TX MSA	Brazos	TX	Texas A&M University*	39	152,415	44,026	28.89%
26. Lubbock, TX MSA	Lubbock	TX	Texas Tech University	63	242,628	24,557	10.12%
27. Madison, WI MSA	Dane	WI	University of Wisconsin–Madison	99	426,526	43,209	10.13%

* traditional college-towns as defined by Gumprecht (2003);
Sources: *a*: Neighborhood Change Database, Geolytics; *b*: U.S. Department of Education, National Center for Education Statistics

to capture the emergence and growth of university-based property development and neighborhood revitalization strategies in the 1990s. In many respects these strategies can be viewed as a response by municipalities and universities to central city disinvestment in the 1970s and 1980s (Ehlenz, 2016).

The studentification literature describes several dimensions and processes under which neighborhood change may occur. I have grouped these into three categories of tract-level indicators: demographic, socioeconomic, and housing characteristics which are used in both parts of my analysis. This conceptualization is emerged in the theories of the Chicago School, but is increasingly used in recent neighborhood change studies of college and university communities (Smith, 2004; Ehlenz, 2017; and Moos et al. 2018). First, demographic variables will account for the *share of college-aged population*. This variable is a proxy measure for college-age residents in a census tract. International students, whose enrollment at US universities have increased following revisions to the Immigration and Naturalization Act in 1990, may also have an impact on the cultural milieu of neighborhoods. I therefore included a measure of the *share of foreign-born residents*.

Second, to measure to socioeconomic dimension of student-driven neighborhood change I included variables for the *share of renter-occupied units* and *median home values (normalized by income)*. These variables reflect the recommodification of single-family housing for students and the escalating property prices associated with studentifying neighborhoods.

Finally, studentification is associated with an initial upgrading of the external physical environment and housing stock through the conversion of existing properties or the construction of purpose-built student accommodations. This can subsequently lead to a downgrading of the physical environment, depending on the local context (Smith, 2004). To account for the possibility of changes in physical characteristics impacting neighborhood change, I included measures for the *share of*

housing units after 2009 and the *county tract distance from a university campus.* The full list of variables can be found in Table 10.

This analysis aimed to better understand the trajectories of neighborhood change that have occurred in counties home to large public research universities. There is widespread agreement that the dimensions of urban change do not occur in isolation, however research on urban changes associated with the presence of higher education institutions have often focused on individual phenomena in isolation, such as impacts on housing values, in-migration of student populations, or new-build accommodations, without paying adequate attention to the possibly interactions between neighborhood characteristics and contextual factors.

This analysis had two main objectives. The first was to create a statistically valid typology of neighborhood change in university-dominated tracts in the United States over a 14-year period. Cluster analysis was therefore employed to group university tracts according to their similarity in demographic, socioeconomic, and housing indicators from 2000 through 2014. This initial procedure is exploratory and served to establish a classification of neighborhood types under which studentification might occur.

Table 10. Variables and Data

Variables	Description	Data Sources
White.Share	Share of White population in 2000	NCDB [b]
White.Change	Change in the White population share from 2000 to 2014	NCDB & ACS [c]
Black.Share	Share of African American population in 2000	NCDB
Black.Change	Change in the share of African American population from 2000 to 2014	NCDB & ACS
Asian.Share	Share of Asian population in 2000	NCDB
Asian.Change	Change in the share of Asian population from 2000 to 2014	NCDB & ACS
Hispanic.Share	Share of Hispanic population in 2000	NCDB
Hispanic.Change	Change in the Hispanic population share from 2000 to 2014	NCDB & ACS
College.Age.Share	Share of population aged 25-44 in 2000	NCDB
College.Age.Change [a]	Change in the share of population aged 25-44 from 2000-2014	NCDB & ACS
Bach.Edu.Share	Share of population aged 25 and over with bachelor's degree in 2000	NCDB
Bach.Edu.Change	Change in the share of population aged 25 and over with bachelor's degree from 2000 to 2014	NCDB & ACS
Grad.Edu.Share	Share of population aged 25 and over with graduate or professional degree in 2000	NCDB
Grad.Edu.Change	Change in the share of population aged 25 and over with graduate or professional degree from 2000 to 2014	NCDB & ACS
Foreign.Share	Share of foreign-born population in 2000	NCDB
Foreign.Change [a]	Change in the share of foreign-born population from 2000 to 2014	NCDB & ACS
Unemployment.Rate	Unemployment rate in 2000	NCDB
Unemployment.Rate.Change	Change in the unemployment rate from 2000 to 2014	NCDB & ACS
Home.Value	Median housing value for specified owner-occupied housing units in 2000 normalized by median family income in 1999	NCDB
Home.Value.Change [a]	Change in the median housing value for specified owner-occupied housing units from 2000 to 2014 normalized by median family income in 1999	NCDB & ACS
Owner.Share	Share of owner-occupied housing units in 2000	NCDB
Owner.Change	Change in the share of owner-occupied housing units from 2000 to 2014	NCDB & ACS
Renter.Share	Share of renter-occupied housing units in 2000	NCDB
Renter.Change [a]	Change in the share of renter-occupied housing units from 2000 to 2014	NCDB & ACS
Built.Before.1939.Share	Share of housings built before 1940	NCDB
Built.1940–1949.Share	Share of housings built between 1940 and 1949	NCDB
Built.1950–1959.Share	Share of housings built between 1950 and 1959	NCDB
Built.1960–1969.Share	Share of housings built between 1960 and 1969	NCDB
Built.After.2009.Share [a]	Share of housing units built from 2010 to 2014	ACS
Distance.UNIV [a]	Tract distance to the county's university (miles)	TIGER [d]

a Variables used in the cluster analysis; *b* Neighborhood Change Database, Geolytics; *c* American Community Survey 5-year Estimates, 2012-2016; *d* US Census Bureau TIGER/Line Shapefiles Note: County fixed effects dummy variables indicating where the tract is located are not listed here for brevity.

The second objective of this study was to explore the factors behind the probability of tract membership into a particular classifications of neighborhood change. A multinomial logistic regression model was estimated using a set of control variables derived from the studentification literature. These variables are taken from the year 2000 and were not used in the initial cluster analysis and served as a means of predicting cluster group membership over the 14-year period based on a range of neighborhood characteristics identified in 2000. Logistic regression was deemed suitable for this analysis given that it enables the prediction of a nominal dependent variable. The eight classes derived from my cluster analysis served as the categories for the dependent variable in the logistic regression analysis. The logistic regression will help to determine whether interactions among the control variables influence membership in any particular class.

5.3.2. Cluster analysis

Cluster analysis grouped the 1043 census tracts according to their similarity across three studentification variable categories. The clustering technique is a multivariate statistical procedure that gathers data about a sample of objects and attempts to reorganize them into relatively homogenous groups (Everitt, 1980). In this analysis z-scores were calculated for all demographic, socioeconomic, and housing variables to facilitate comparability, with each z-score generated by comparing a tract's value on a particular variable with the average for that variable in that county for that year only. I compared the z-scores in each of these dimensions to determine if clustering is more significant in one compared to another. The higher (or lower) the z-score, the stronger the intensity of the clustering. A z-score near zero indicates no apparent clustering. Positive or negative z-scores indicate clustering of high or low values, respectively.

Six variables, representing the demographic, socioeconomic, and housing environment dimensions of studentification as described in the literature were used: 1) share of college-aged

population; 2) share of foreign-born residents; 3) share of renter-occupied units; 4) median home value (normalized by income); 5) share of housing units after 2009; and 6) the county tract distance from a university campus. This approach has been utilized in previous studies of neighborhood change (Mikelbank, 2011; Delmelle, 2015) to ensure temporal and spatial comparison of study areas. A variant of this approach is comparing a tract's value on a particular variable with the average for that variable in all contiguous tracts for that Census year only. Under these conditions a high or low z-score for a particular variable could suggest proximity to a university campus playing a role in neighborhood change.

5.3.3. Logistic Regression

Logistic regression is a procedure used to predict a dependent variable given one or more independent variables. In the context of this study, the logistic regression serves to determine the probability of membership of the 1043 census tracts into the observed clusters based on year 2000 explanatory variables. The variables include basic demographic and socioeconomic indicators capturing racial, education attainment, and unemployment rate composition. Additionally, the model considers several housing vintage variables given the significance of housing age to neighborhood development cycles (Tong & Kim, 2019; Lucy & Phillips, 2006). More specifically, the following four proportion variables are included to capture when each neighborhood was initially developed and how this development is associated with neighborhood change dynamics between 2000 and 2014: *Built.Before.1939.Share*, *Built.1940–1949.Shar*e, *Built.1950–1959.Share*, and *Built.1960–1969.Share*. The results of the logistic regression analysis are used to examine how demographic and socioeconomic variables at a certain time point are associated with specific patterns of studentification observed over time (as identified by the cluster analysis).

5.4. Results

5.4.1. Cluster analysis outcomes

Using census tract level data between 2000 and 2014 from 27 counties which contain a major research university (Research-1 or Research-2 institution), a cluster analysis was performed using indicators derived from the studentification literature as described in the previous section. The proportion of tracts per county analyzed range from Dane County, Wisconsin (9.5% 99 out of 1043) to Forrest County, Mississippi (1.5% = 16 out of 1043).

The cluster analysis distributed the 1043 census tracts into eight distinct classes, as summarized in Table 11. The largest grouping (Class #8) contains 244 tracts, while the smallest (Class #3) contains 23 tracts. The summary distribution of county tracts by class can be found in Table 12. While the classes each represent unique pathways of neighborhood change, two classes (Class #1 and #5) can be considered archetypes of studentification (i.e. student-driven neighborhood change). In some cases, the remaining classes exhibited negligible change across several indicators studentification, or attributes commonly associated with other forms of neighborhood change such as gentrification.

Class #1 tracts contain 105 out of 1043 tracts and exemplifies many of the attributes commonly associated with studentifying neighborhoods. First, during the 14-year period tracts in this class also experienced the largest change in the share of college-age students (approximately +4.6 percentage points). Second, this class also features the largest net increase in renter-occupied units (+7 percentage points) possibly reflecting the high residential turnover patterns found in university communities. Additionally, increases in other demographic, socioeconomic, and housing related indicators of studentification are evident in tracts in this class, including foreign-born residents (+3 percentage points), housing units built after 2009 (+5 percentage points), and median home value. It is important

Table 11. Descriptive Statistics

Variables	Class #1	Class #2	Class #3	Class #4	Class #5	Class #6	Class #7	Class #8
Used in Cluster Analysis								
College.Age.Change	0.047	0.000	0.036	0.011	0.020	0.005	-0.061	0.006
Foreign.Change	0.030	0.055	0.001	0.002	0.012	0.013	0.060	0.009
Home.Value.Change	4.499	0.733	5.825	0.651	1.718	0.635	1.254	0.791
Renter.Change	0.072	0.047	0.016	0.004	0.049	0.026	0.016	0.040
Built.After.2009.Share	0.049	0.090	0.073	0.014	0.023	0.041	0.005	0.003
Distance.UNIV	1.470	5.729	41.333	13.113	2.526	9.782	2.733	3.622
Not Used in Cluster Analysis								
White.Share	0.779	0.795	0.615	0.921	0.742	0.867	0.756	0.789
White.Change	-0.031	-0.068	-0.010	-0.008	-0.030	-0.022	-0.065	-0.039
Black.Share	0.123	0.127	0.046	0.039	0.166	0.082	0.134	0.133
Black.Change	0.005	0.013	-0.004	0.006	0.010	0.005	0.032	0.025
Asian.Share	0.043	0.021	0.026	0.007	0.030	0.012	0.037	0.021
Asian.Change	0.026	0.032	0.005	0.001	0.014	0.010	0.035	0.005
Hispanic.Share	0.059	0.072	0.046	0.030	0.065	0.048	0.086	0.063
Hispanic.Change	0.024	0.057	0.014	0.019	0.026	0.025	0.043	0.035
College.Age.Share	0.321	0.092	0.161	0.050	0.168	0.058	0.186	0.092
Bach.Edu.Share	0.250	0.212	0.166	0.162	0.226	0.184	0.235	0.195
Bach.Edu.Change	0.004	0.036	0.014	0.036	0.012	0.033	-0.008	0.015
Grad.Edu.Share	0.226	0.141	0.137	0.089	0.184	0.103	0.193	0.138
Grad.Edu.Change	0.025	0.044	0.006	0.021	0.026	0.032	0.025	0.013
Foreign.Share	0.074	0.051	0.044	0.018	0.068	0.032	0.071	0.049
Unemployment.Rate	0.080	0.043	0.132	0.035	0.063	0.038	0.067	0.049
Unemployment.Rate.Change	-0.031	-0.009	-0.077	0.000	-0.013	-0.002	-0.022	0.001
Home.Value	3.202	2.360	3.132	2.169	2.443	2.192	2.260	1.953
Owner.Share	0.331	0.677	0.546	0.804	0.483	0.768	0.448	0.634
Owner.Change	-0.072	-0.047	-0.016	-0.004	-0.049	-0.026	-0.015	-0.040
Renter.Share	0.669	0.323	0.454	0.196	0.517	0.232	0.551	0.366
Built.Before.1939.Share	0.124	0.049	0.063	0.157	0.103	0.077	0.101	0.133
Built.1940–1949.Share	0.063	0.026	0.031	0.045	0.060	0.032	0.052	0.074
Built.1950–1959.Share	0.109	0.057	0.078	0.080	0.117	0.067	0.106	0.154
Built.1960–1969.Share	0.147	0.097	0.130	0.115	0.152	0.107	0.151	0.160

Table 12. Distribution of the Number of Tracts by County

County	Tracts	Class #1	Class #2	Class #3	Class #4	Class #5	Class #6	Class #7	Class #8
Lee, AL	26	5	7	2	2	0	8	1	1
Tuscaloosa, AL	47	8	6	0	8	10	9	1	5
Washington, AR	32	2	9	0	3	4	9	0	5
Coconino, AZ	27	2	1	12	3	7	0	1	1
Larimer, CO	71	11	8	2	12	12	14	1	11
Alachua, FL	53	7	7	0	3	9	11	7	9
Leon, FL	64	5	5	0	7	16	10	5	16
Clarke, GA	28	5	0	0	0	9	0	7	7
Johnson, IA	24	3	5	1	0	5	6	1	3
Champaign, IL	38	3	4	1	4	5	9	3	9
McLean, IL	40	1	4	0	10	5	3	2	15
Delaware, IN	29	1	0	0	6	5	1	1	15
Monroe, IN	27	2	1	1	6	5	4	3	5
Tippecanoe, IN	32	5	2	0	3	5	5	2	10
Douglas, KS	21	2	1	0	6	6	2	2	2
Ingham, MI	70	2	3	0	9	12	4	4	36
Kalamazoo, MI	57	2	1	1	12	5	6	4	26
Boone, MO	27	3	3	0	4	6	6	0	5
Forrest, MS	16	0	1	0	1	3	3	2	6
Missoula, MT	20	3	1	0	5	9	1	0	1
Pitt, NC	32	6	4	2	2	3	11	1	3
Grand Forks, ND	17	3	1	0	4	4	2	0	3
Benton, OR	17	4	0	0	2	4	3	1	3
Centre, PA	27	4	1	0	8	4	7	3	0
Brazos, TX	39	8	9	1	0	9	5	6	1
Lubbock, TX	63	3	11	0	4	6	10	6	23
Dane, WI	99	5	10	0	19	14	21	7	23
Total Number of Tracts	1043	105	105	23	143	182	170	71	244

to note that tracts in this class are characterized as having the shortest distance to university campuses (approximately 1.5 miles) and are therefore likely encompass or adjoin the university campus.

Although tracts in Class #2 contain the largest share of housing units built after 2009 (approximately 9%), a feature common to neighborhoods undergoing studentifcation or gentrification more broadly, other indicators of studentification were not as apparent. There is a relatively large increase in the change in renter-occupied units and foreign-born residents, however normalized median home value is among the lowest of all classes and most crucially, there has been negligible change in the college-age population. Class #3 was not representative of the entire sample of counties in this study as it included 23 out of 1043 tracts. Over half of these tracts were from Coconino County, Arizona which is the second-largest county by area in the US. Consequently, tracts in this class were located at approximately 41.3 miles away from university campuses on average, the furthest of all groups.

Class #4 tracts can be considered the least representative of patterns of studentification. This class includes 143 out of 1043 tracts (approximately 14%) which are located roughly 13 miles from university campuses. On average they contain the smallest change in renter-occupied housing units over the study period (<0.1 percentage points), as well as relatively small increases in the share of newly constructed housing units (+0.1 percentage points), foreign-born residents (<0.1 percentage points), or college-age residents (+0.1 percentage points). The lack of evidence of studentification in tracts at this distance from a university campus appears to reflect the spatially-explicit dynamic of student-driven neighborhood change.

Class #5 contains approximately 17% of all tracts in the study. Like Class #1, tracts in this class are located close to university campuses, at roughly 2.5 miles on average, hinting at possible patterns of studentification. This is supported by relatively large increase in renter-occupied units (+2.3 percentage

points), college-age residents (+2 percentage points) and normalized median home values. This finding, combined with the characteristics of Class #1 discussed above, appears to suggest that the proximity to campus is an important factor shaping the neighborhood change dynamics in these counties. In other words, studentification can be seen as a location-dependent phenomenon that induces spatial restructuring of the places.

Class #6 also contains a sizeable portion of study tracts at roughly 16 percent of all tracts. Comparatively, these tracts are distinct from university campuses at approximately 10 miles. Although they have experienced moderate increases in newly built housing units, the low increases in college-age residents, foreign-born residents, and renter-occupied units suggest this class is not typical of studentification. Additionally, tracts within the class experienced the smallest increase in normalized median home value over the 14-year study period. Class #7 includes tracts that are roughly 2.7 miles away from university campuses. The class is notable due in part to the fact that it is the only class in which the college-age population decreased. Tracts within the class experienced the largest increase in foreign-born residents of all classes along with moderate increases in normalized median home values and renter-occupied units.This class is also worth noting as it demonstrates that the neighborhood change dynamics within university-dominant counties are much more diverse than what is explained by studentification. However, although some neighborhood tracts in close proximity to university campuses may not exhibit signs of student-driven neighborhood change, the importance of proximity should not be discounted given that studentification dynamics were not detected in outlying tracts (i.e. Classes # 4 and #6).

Class #8 contains roughly 23% of all tracts, the largest of any class. While the tracts are located approximately 3.6 miles away from university campuses on average, they reveal many of the same patterns identified in Class #4, including relatively small changes in college-age residents, foreign-born

residents, and normalized median home values. The share of housing units built after 2009 was also the lowest of any class, further indicating that this class is not representative of studentification.

5.4.2. Logistic regression outcomes

Based on the cluster analysis outcomes, a multinomial logistic regression model was estimated to examine how a census tract's demographic and socioeconomic characteristics in the initial year (i.e. 2000) were associated with the probability of it being associated with any one of the eight determined classes. The logistic regression model results are presented in Table 13.

The model illustrates the conditions which may make it more likely for college town census tracts to follow any one of the identified pathways of student-driven neighborhood change. For instance, relative to Class #8 tracts (the baseline group), having a higher proportion of owner-occupied housing units in the initial year was found to be significantly associated with classes with greater distance from universities campuses (e.g. Classes #4 or #6), whereas it was linked to a decreased odds ratio in Classes #1 and #5 which both contain tracts in close proximity to universities. Residents' level of education attainment was also found to be a significant determining factor behind class membership. While tracts with a high proportion of residents with graduate or professional degrees in the initial year (*Grad.Edu.Share*) were found to be associated with an increased probability of following the first, fifth, and seventh pathways (two of which typify highly studentified tracts located near to college campus), they decreased the likelihood of being associated with Classes # 4 and #6 which includes more distantly located neighborhoods. A similar pattern is noted when observing probabilities associated with tracts containing residents with a bachelor's degree in the initial year (*Bach.Edu.Share*). This condition significantly reduced the probability of membership in Classes #3 and #4, while increasing the likelihood of neighborhoods following the seventh and eighth pathways. The unemployment rate, the

Table 13. Multinomial Logistic Regression Outcomes

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Variables	**Class #1**	**Class #2**	**Class #3**	**Class #4**	**Class #5**	**Class #6**	**Class #7**
Intercept	5.076	-0.564	10.068	-7.384	-12.823	-13.280	12.833
White.Share	-1.334	3.808	-0.217	7.719	-3.642	15.737*	-11.552
Black.Share	-2.864	3.888	-26.477*	1.969	-2.197	11.487	-13.667*
Asian.Share	-8.291	1.874	38.337*	-26.963	-6.418	3.259	-12.896
Hispanic.Share	-0.250	3.587	-35.643**	0.183	0.329	10.016	-3.951
Owner.Share	-8.863***	0.769	-3.524	7.396***	-3.840***	4.743***	-4.209***
Bach.Edu.Share	-2.845	0.619	-25.918**	-8.337*	1.175	1.819	1.553
Grad.Edu.Share	12.967***	-3.335	-5.111	-10.445**	7.685***	-15.514***	5.255*
Unemployment.Rate	11.399*	2.990	49.137***	-17.697	8.405	-2.099	12.914**
Built.Before.1939.Share	-0.002	-0.002	0.002	0.003***	-0.001	0.000	-0.002
Built.1940–1949.Share	0.005	-0.002	-0.002	-0.006	0.002	-0.007*	0.000
Built.1950–1959.Share	-0.001	-0.005*	0.010	-0.002	0.000	-0.001	-0.002
Built.1960–1969.Share	-0.002	-0.002	-0.007	0.001	0.000	0.000	-0.001
R-squared	0.368						

*** 0.1% level, ** 1% level, * 5% level significant.; Baseline: Class #8;
County fixed effects dummy variables are included in the estimation, but their estimates are not presented here for brevity.

share of Hispanic residents, and several housing vintage variables appeared to be associated with some of the probabilities, while most of the demographic indicators turned out to be insignificant predictors in explaining distinct pathways of studentification.

The results of Model #5 reveal the factors which could contribute to neighborhoods being categorized as Class #5 which is representative of several dimensions of studentification including relatively high shares of college-age residents, renter-occupied units, and median home values as well as adjacency to university campuses. Neighborhoods with a large share of residents with advanced degrees had a significantly greater likelihood of being associated as a Class #5 tract. The results also showed that neighborhoods with owner-occupied units were less likely to be found among Class #5 tracts.

5.5 Summary and discussion

This study used a two-step analytical process to investigate student-driven neighborhood change dynamics in college towns between 2000 and 2014. More specifically, it worked to uncover the role proximity plays in determining how studentification (i.e. student-driven neighborhood change) unfolds in 27 US counties with substantial shares of student populations. I conducted exploratory analyses to better discern how determinants of studentification could be distinguished and classified across US college towns. I also examined additional indicators to shed light on the importance of context and how certain neighborhood conditions may inform specific paths of neighborhood change.

Through cluster analysis eight distinct pathways of neighborhood change were unveiled, however not all of these can be described as conventional forms of studentification. More specifically, one of the eight pathways, Class #7, illustrated the possibility of neighborhoods

existing near to a university campus yet experiencing decreases in college-age residents, negligible changes in renter-occupied units, and newly built housing units, all of which is inconsistent with prevailing notions of studentification. Classes which contained tracts located at the greatest distance from a university campus (e.g., Classes #4 and #6) exhibited a much more distinct non-studentified trajectory including smaller increases in normalized home values relative to neighborhoods adjacent to a university campus. From these results it was apparent that neighborhood change dynamics were diverse in terms of changes to home values, renter population, and college-age residents among other indicators.

However, this study did determine strong evidence of studentification in neighborhoods within the immediately vicinity of university campuses, suggesting that proximity does indeed matters in terms of explaining pathways of neighborhood change dynamics. On average, neighborhood tracts with shortest distance to a university campus exhibited the greatest trajectory of change across the demographic, socioeconomic, and housing indicators measured. For instance, Class #1 (which includes 105 tracts) reveals the many of the hallmarks to common to neighborhoods undergoing studentification as described by (Smith, 2002). Tracts in this grouping abutted the university campus and experienced relatively large increases in college-aged and foreign-born residents, renters, new housing units, and median home values. The logistic regression analysis supported these findings by illustrating that tracts with higher share of owner-occupied units were less likely to be found in this class. Taken together, these results may reflect the growth in luxury off-campus student accommodations that have proliferated in college towns in North American and many parts of Europe, as well as growth in high-priced rental housing near college campuses targeting young professionals.

The spatially dependent nature of studentification processes was also evident when observing more distantly located tracts, which were found to contain higher shares of owner-occupied units and lower shares of residents with a bachelor's degree potentially influencing the change trajectory in these types of neighborhoods. This suggests that university-dominant counties may have experienced a bifurcation of their residential populations over the 14-year period into a wealthy and highly educated renter population situated near the university campus, alongside a relatively less wealthy and less educated homeowners residing on the periphery of the county. This finding also reflects the social dimension of studentification described by Smith (2004) whereby new patterns of social concentration and segregation are created through the "replacement or displacement of a group of permanently established permanent residents with a transient, young and single, and middle-class social grouping."

Such insights highlight the need for further research on the spatially dependent nature of neighborhood change within college towns to provide a more complete understanding of the context-specific effects of university presence. Given that a substantial number of highly studentified neighborhood tracts were found very near university campuses, future research may need to uncover the extent to which properties in these communities are owned by these institutions to support efforts of local policymakers and universities in bridging potential town and gown divides. As college campus, particularly large research universities, continue to play increasingly active roles in land acquisition and redevelopment within their cities, planners and policymakers are encouraged to monitor the potential impacts of these initiatives on housing costs, segregation, and residential displacement.

Chapter 6. Conclusion

Modern research universities embody a range of missions and organizational goals that differently affect their surrounding regions, ranging from the traditional functions of research, teaching and public service to increasingly active roles in urban development, community engagement, and technological innovation. Many local leaders and policymakers have tried to embrace an increased university presence within their jurisdictions as potential catalysts for economic development and revitalization. However, this perspective neglects many of the challenges that stem from the missions and aspirations most colleges and universities, particularly for those located in small and medium-sized metropolitan areas which may lack the presence of other prominent anchor institutions. At the community level, many college leaders are increasingly caught between the need to house growing student populations while simultaneously serving and engaging the non-student populations within the extended physical communities. Such conflicting priorities have exacerbated longstanding "town and gown" in college towns across the county. Similarly, at the state level the university's role as a "public good" has come under scrutiny as state university systems are forced to weigh their obligations toward providing a pathway to higher education for their residents with the goal of diversifying their student body by way of out-of-state and international students. Finally, at the national level, the functional and cultural contributions of large research universities in perpetuating a so-called "brain drain" and neighborhood change dynamics by siphoning talent from economically distressed regions into cities has also become an important flashpoint in recent decades.

This dissertation research explored the changing roles of research universities in small and medium-sized metropolitan areas with an emphasis on their impacts across the aforementioned geographical scales by investigating associations between university presence

and (1) growth in foreign-born populations; (2) the attraction and retention of highly educated residents; and (3) student-driven neighborhood change dynamics. By investigating these associations, this work argues that our understandings of university contributions to local and regional economic development can extend beyond their core functions of research, teaching, and service to also reflect their role as a gateway for diverse, highly educated, and skilled populations.

Several studies have highlighted the role of US universities in the success of foreign-born professionals and immigrant entrepreneurs. There is also widespread agreement among economic development scholars that universities do play an important role in attracting talent into cities. Chapter 3 investigated both phenomena by testing whether differences in the rate of change in the foreign-born populations of 258 counties with and without research universities could be observed following the implementation of the 1990 Immigration and Naturalization Act. The results of multivariate regression analyses examining truncated and extended periods before and after the implementation of the 1990 Act provided evidence of a higher ratio of foreign-born entrants in the post-1990 period at the county level. However, the findings provided no indication of this pattern in surrounding counties indicating that there were little spillover effects. To better examine the effect of university presence on counties with varying levels of change in their foreign-born population, I applied quantile regression analyses. The results of this work revealed the effect of university presence to be strongest in counties that experienced highest level of relative increase in their foreign-born population, possibly reflecting the unique ability of new or growing universities to attract foreign-born residents to counties with relatively low numbers of immigrants in the pre-1990 period.

Chapter 4 further explored universities' roles in attracting distinct populations into their localities by examining the changing geography of highly educated individuals. Focusing on 341 counties across small and medium-sized U.S. metropolitan areas with and without research universities from 2000 to 2014, the study analyzed variations in the share of graduate/professional degree holders within counties using both traditional and newly emerging (KRLS) multivariate regression modeling approaches. The results highlight two important points with regard to the contribution of research universities in attracting or retaining highly educated individuals. First, the decentralization of highly educated residents from university host counties to adjacent counties within the same metropolitan area is suggestive of a university-induced spatial spillover effect. Second, the presence of universities was found to have a stronger effect on talent attraction in counties with lower initial shares of highly educated residents, suggesting that they might play an important role in small and medium-sized metropolitan areas which lacked agglomerations of talent initially.

Neighborhoods abutting college campuses have become an increasingly important gateway through which municipal landowners and private developers have attempted to draw in new students and professionals. In Chapter 5, I examined whether the likelihood of a neighborhood undergoing studentification (i.e. student-driven neighborhood change) is a function of proximity to a university campus by accounting for the demographic, socioeconomic and housing context in US counties where higher education institutions play an important role. In this work, I analyzed data for over 1,000 census tracts in 27 university-dominant counties in small and medium-sized metropolitan areas in the 2000-2014 period to identify distinct patterns of neighborhood change using a two-step process. I began by employing cluster analysis modelling to distribute the sample census tracts into eight distinct classes, each representing a

unique pathway of neighborhood change in college towns in different parts of the US. While all but one of the eight classes showed an increase in the college-age population (a key indicators of studentification), classes which contained tracts in close proximity to a university campus exhibited substantial changes across several indicators of studentification. Furthermore, the results highlight the spatially dependent nature of studentification across the county as more distantly located tracts were found to be less likely to experience substantial increases across key studentification indicators including the share of college-age residents, foreign-born residents, median home value, and renter-occupied units. In addition, the increased likelihood of residents in these parts of the county having lower levels of education and higher homeownership rates (relative to those living adjacent to college campuses) may be further indication of a bifurcation of university-dominant counties into a wealthy and highly educated renter population situated near the university campus, alongside a relatively less wealthy and less educated residents on the periphery of the county.

Given the centrality of housing markets to neighborhood change dynamics in college towns, it will become increasingly important for university and local leaders to acknowledge how patterns of university land acquisition and consumption may shape sociopolitical changes within college towns. Tensions between absentee landlords who may be incentivized by profit-motives and student populations driven by local concerns (e.g. housing affordability) could have galvanizing effect on civic participation, particularly in small and medium-sized jurisdictions where universities play an outsized role.

The evolving role of universities toward increased corporatization, greater online delivery formats, as well as the changing definitions of "college student" may impact the quirky, transient, ethnically diverse character which many observers associate as hallmarks of college

towns. Increases in the cost of on-campus housing or off-campus rental units could have disproportionately adverse effects on students of color who may be priced out of the university housing market and compelled to live further away from campus. Similarly, the increased reliance on online course delivery and distance learning has been viewed as a way to potentially increase the affordability and accessibility of higher education (e.g., among working professionals or mature students). However, if a larger share of adults choose to pursue a university degree without being physically present on college campuses this could reduce the customer base for local service providers and amenities, such as cafes, restaurants, and entertainment venues who are highly dependent on local student residents.

I should acknowledge that this work had several limitations, which can point the way for future research. Foremost among these limitations was the reliance on a singular operationalization for the measurement of university presence. A comprehensive understanding of university presence could be obtained with more elaborated measurements of universities taken from the economic development literature, such as campus acreage, enrollment size, number of employees, research grant funding dollars, and endowments. It should be noted however that while these measures could provide more nuance in understanding the contributions of research universities to local and regional economic development, they are highly reflective of traditional core contributions of universities (i.e. research, teaching, and service) which this work attempted to move beyond.

Future research on the contributions of universities should attempt to include university measures which capture the multi-dimensional impacts of their presence within their immediate communities, including but not limited to their real estate holdings, policing presence, and the economic diversity of their student populations. Additionally, this work intentionally focused on

dynamics in university-dominant counties in small and medium-sized metropolitan areas, as these places did not contain large employers or other anchor institutions which could influence the attraction of foreign-born and highly skilled individuals. However, subsequent studies on this topic may need to pay more attention to how universities' contributions as gateways may differ in the presence of other anchor institutions in larger metropolitan areas for example, or in rural areas that may lack many of the amenities and resources commonly found around urban and suburban college campus.

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Appendix. Sensitivity Analysis Results for Chapter 3

Table 1. Net Change in Total Foreign-Born Population from 1990-2000 in the County

	Dependent var: FBorn.Change.1990-2000.Logged				
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Intercept	-0.126	-0.136	0.456	-0.100	0.418
FBorn.Pop.1990.Logged	-0.089	-0.088	-0.119*	-0.098*	-0.124*
Pop.1990.Logged	0.087	0.088	0.094	0.095	0.101
Manuf.Share.1990	1.961***	1.948***	2.082***	1.868***	2.035***
Home.Value.1990	0.063	0.065*	0.036	0.059	0.033
White.Share.1990	0.290	0.284	0.167	0.263	0.165
Hispanic.Share.1990	0.333	0.319	0.512	0.347	0.520
Amenity.Score.2000	-0.061***	-0.062***	-0.050***	-0.060***	-0.048**
Univ.CTY		-0.022	-0.063	-0.052	-0.083
Univ.MSA				0.056	0.041
Edu.Share.1990			0.174*		0.169*
Patents.1990.Logged			0.008		0.005
R-squared	0.507	0.507	0.520	0.511	0.521

*** 0.1% level, ** 1% level, * 5% level significant.; Census Region dummy variables are included in the estimation, but their estimates are not presented here for brevity.

Table 2. Net Change in Total Foreign-Born Population from 1990-2010 in the County

	Dependent var: FBorn.Change.1990-2010.Logged				
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Intercept	1.648	1.625	2.161	1.648	2.129
FBorn.Pop.1990.Logged	-0.217**	-0.215**	-0.242**	-0.223	-0.246**
Pop.1990.Logged	0.093	0.095	0.082	0.101	0.088
Manuf.Share.1990	1.198*	1.152*	1.093	1.082*	1.052
Home.Value.1990	0.038	0.046	0.032	0.041	0.029
White.Share.1990	0.081	0.061	-0.048	0.043	-0.051
Hispanic.Share.1990	-0.896	-0.946	-0.817	-0.923	-0.811
Amenity.Score.2000	-0.026	-0.028	-0.023	-0.026	-0.022
Univ.CTY		-0.071	-0.093	-0.096	-0.109
Univ.MSA				0.047	0.034
Edu.Share.1990			0.059		0.056
Patents.1990.Logged			0.027		0.024
R-squared	0.427	0.429	0.431	0.430	0.432

*** 0.1% level, ** 1% level, * 5% level significant.; Census Region dummy variables are included in the estimation, but their estimates are not presented here for brevity.

Table 3. Net Change in the Share of Foreign-Born Population from 1990-2000 in the County

	Dependent var: FBorn.Share.Change.1990-2000				
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Intercept	-0.069*	-0.069*	-0.049	-0.068*	-0.049
FBorn.Share.1990	0.169***	0.169***	0.154**	0.167***	0.154**
Pop.1990.Logged	0.007**	0.007**	0.007**	0.007**	0.007**
Manuf.Share.1990	0.062***	0.061***	0.075***	0.061***	0.075***
Home.Value.1990	0.004**	0.005**	0.003	0.004**	0.003
White.Share.1990	-0.019	-0.019	-0.023	-0.019	-0.023
Hispanic.Share.1990	-0.086***	-0.086***	-0.078***	-0.086***	-0.078***
Amenity.Score.2000	-0.002**	-0.002**	-0.001*	-0.002**	-0.001*
Univ.CTY		-0.001	-0.003	-0.001	-0.003
Univ.MSA				0.001	0.000
Edu.Share.1990			0.009*		0.009*
Patents.1990.Logged			-0.001		-0.001
R-squared	0.324	0.326	0.340	0.345	0.340

*** 0.1% level, ** 1% level, * 5% level significant.; Census Region dummy variables are included in the estimation, but their estimates are not presented here for brevity.

Table 4. Net Change in the Share of Foreign-Born Population from 1990-2010 in the County

	Dependent var: FBorn.Share.Change.1990-2010				
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Intercept	0.189	0.182	0.234	0.180	0.235
FBorn.Share.1990	0.363	0.362	0.339	0.367	0.346
Pop.1990.Logged	-0.003	-0.002	-0.007	-0.002	-0.007
Manuf.Share.1990	0.021	0.012	-0.012	0.014	-0.009
Home.Value.1990	-0.008	-0.006	-0.006	-0.006	-0.006
White.Share.1990	-0.121*	-0.124*	-0.134*	-0.123*	-0.133*
Hispanic.Share.1990	-0.325***	-0.333***	-0.329***	-0.334***	-0.330***
Amenity.Score.2000	0.004	0.004	0.003	0.004	0.003
Univ.CTY		-0.013	-0.012	-0.012	-0.011
Univ.MSA				-0.002	-0.003
Edu.Share.1990			-0.008		-0.008
Patents.1990			0.005		0.005
R-squared	0.117	0.129	0.124	0.122	0.124

*** 0.1% level, ** 1% level, * 5% level significant.; Census Region dummy variables are included in the estimation, but their estimates are not presented here for brevity.