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Examining talent attraction and retention in small and medium-sized cities: Where do universities fit in?

Abstract: As universities have become more integrated into their communities and regions, their host cities have become locations of choice for the highly educated facilitating increased innovation and productivity rates in several locales. Recent transitions toward knowledge-driven economies have also intensified growing geographic divides along the lines of education and raised concerns about the possibility of brain drain in a growing number of cities/regions. This study examines the changing geography of highly educated individuals (2000-2017) with a focus on small and medium-sized U.S. metropolitan areas with and without research universities. Results indicate the continuing trend of divergence among regions, but research universities are found to complement (the lack of) talent agglomeration and generate spatial spillovers beyond the county boundaries.

Key Words: universities, small and medium-sized cities, migration, talent agglomeration

Examining talent attraction and retention in small and medium-sized cities: Where do universities fit in?

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.

2. Literature Review

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; Corcoran et al., 2010; Haussen and Uebelmesser, 2018). 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. Additionally, when examining how college-educated populations in US metropolitan areas differentially value quality-of-life indicators, Whisler et al. (2008) detected differences across the life course. They found that an abundance of cultural and recreational amenities lowered out-migration rates among young college-educated, while low crime rates and a favorable climate reduce out-migration among the middle-aged and retirees.

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.

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.

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.[1] These MSAs include a total of 341 counties which are the units of analysis in this study. Of the 341 counties, 46 (Group 1) have at least one Research-1 or Research-2 universities[2], 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.

[1] 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.

[2] 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). Auxiliary analyses, however, are additionally conducted with a broader definition of universities, including Master's-1 and Doctoral/Professional universities (i.e., two additional categories in the Carnegie Classification), to see how the results would differ if the presence (or absence) or universities were measured differently. See Appendix A for the results of these auxiliary analyses.

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 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 provided by Berry and Glaeser (2005), as shown below.

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

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 2017 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 1. The descriptive statistics for all these variables are provided in Table 2.

<< Insert Tables 1 and 2 about here >>

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), Choi and Lee (2020), Wang et al. (2020), and many other empirical studies. One of the main motivations behind this method is to reduce misspecification bias (Hainmueller and Hazlett, 2014; Ferwerda et al., 2017). Social phenomena, including the one examined in this study, might not be perfectly described as a linear function of explanatory variables. While one can handle this issue by introducing higher-order terms or interactions of explanatory variables to a (generalized) linear regression model, this approach often involves strong assumptions about the functional form and can "make the problem worse, generating false inferences about the effects of included variables" (p. 144, Hainmueller and Hazlett, 2014), making researchers seek alternative methods, such as KRLS.

As explained in Hainmueller and Hazlett (2014) and Ferwerda et al. (2017), another important advantage of KRLS is that 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. KRLS achieves this, while avoiding over-fitting, through regularization in a way that can minimize squared loss and prefers less complicated functions (p. 148, Hainmueller and Hazlett, 2014). This methodological advantage allows researchers to understand how the marginal effects of variables of interest may vary and under what circumstances the variables are more (or less) likely to matter.[3] Furthermore, it has

[3] In this sense, one could view KRLS as a method comparable to geographically weighted regression (GWR). While GWR attempts to capture nonstationary relations through local weighting, KRLS does not rely on geographical relationships between observations. Drawing from regularized least squares coming

been reported that KRLS works well with binary independent variables and a small sample size (Ferwerda et al., 2017).

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 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. Results

Table 3 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.2000-17*) , 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.

<< Insert Table 3 about here >>

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 2017 on average. Consistent with the findings of Berry and Glaeser (2005), this result suggests that counties with high initial levels of educated residents

out of the machine learning literature, KRLS provides flexible estimators, while maintaining convenience and interpretability. See Hainmueller and Hazlett (2014) and Ferwerda et al. (2017) for more details.

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 (2000-2017 vs. earlier decades), and the level of educational attainment used (graduate/professional vs. bachelor's degree).

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 17-year study period. However, county population size and the proportion of manufacturing sectors in 2000 turn out to have a negative association with the net change in the share of highly educated individuals at the county level. Other control variables, such as the shares of White, Hispanic, and foreign-born population groups, do not appear to have significant influences on the dependent variable (*HEdu.Change.2000-17*), 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 2000-2017 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 3 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 17-year period on average, pointing 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.

The results of the KRLS estimation (Table 4), 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 (+0.006) approximates the OLS estimate value (+0.007), which is about one-half of the standard deviation of the dependent variable in the sample.

<< Insert Table 4 about here >>

Although the KRLS analysis outcomes depict a somewhat narrow range of estimates, from +0.003 at the 25th percentile level to +0.007 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*, *Pop.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.

<< Insert Figure 1 about here >>

A similar pattern is detected for *Univ.CTY*, and the association appears to be even more apparent in this 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 County, CA and Lafayette Parish, 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).

<< Insert Figure 2 about here >>

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.

For instance, the past 20 years have witnessed a gradual expansion in the missions of many universities, and in the ways universities contribute to local and regional economic development (Miller et al., 2021; Lowman, 2010). Many universities and local governments are increasingly taking an active interest in the economic development of their local communities by anchoring housing, health-medical complexes, and cultural amenities near their college campuses often with the intention of potentially attracting and retaining highly educated residents. Such trends have been notable in several college counties from our sample including Kalamazoo County, MI (Western Michigan University), St. Louis County, MN (University of Minnesota-Duluth), and Dane County, WI (University of Wisconsin-Madison).

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 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 2000-2017 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.2000-17*) 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 2017.

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, while a broader definition of universities was additionally tested in auxiliary analyses presented in Appendix A. A nuanced understanding of university effects 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. This study is also limited in that it did not address to what extent the growth of highly educated individuals in university areas can be attributable to the expansion of university employees as opposed to other mechanisms. Moreover, the findings from our analysis based on small and medium-sized MSAs between 2000 and 2017 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. Future studies may also explore the evolving roles of higher education institutions in shaping the process of regional growth convergence.

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Appendix A

To check the robustness of our results, we conducted auxiliary analyses with alternative definitions of universities and highly educated individuals. Table A1 presents results where the dependent variable is the change in bachelor, graduate, and professional degree holders over the 2000-17 period, capturing a broader definition of highly educated individuals than the dependent variable used in the baseline OLS and KRLS models. Tables A2 and A3 present results using two dichotomous *Univ* variables reflecting a broader definition of university presence or absence which includes not only Research-1 and Research-2 universities, but also two additional classifications of non-Research-1 or Research-2 universities: Masters 1 and Doctoral/Professional universities. All classifications are based upon the Carnegie Classification of Institutions of Higher Education. Tables A4 and A5 present models that separate the two broadly defined *Univ* variables into four variables measuring the presence or absence of Research 1-2 universities (RUniv) and non-Research 1-2 universities (NRUniv) within the county and the MSA. Please note that Table A2 is the same as Table A4, except for the separation of the broadly defined Univ variables. Table A3 is similarly distinguished from Table A5. Tables A4 and A5 show that Research 1-2 universities matter, as indicated by the RUniv.MSA coefficients. While MSAs with non-Research 1-2 universities showed no significant effect on the net change of degree holders over the 2000-17 period, MSAs with Research 1-2 universities were associated with a significantly larger share of bachelor, graduate, and professional degree holders over the same period.

Table A1. Estimation Results – Net Change in Bachelor, Graduate, and Professional degree holders, 2000-17

Variables	**OLS**		**KRLS**				
	Est coeff.	**t-stats.**	**Avg.**	**t-stats.**	**Q25**	**Q50**	**Q75**
Univ.CTY	-0.015 *	-2.584	-0.002	-0.969	-0.006	-0.003	0.002
Univ.MSA	0.015 ***	3.595	0.008 **	2.799	0.005	0.008	0.010

*** 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.

Table A2. Estimation Results – Net Change in Graduate and Professional degree holders, 2000-17 (using a broader definition of universities)

Variables	OLS		KRLS				
	Est coeff.	**t-stats.**	**Avg.**	**t-stats.**	**Q25**	**Q50**	**Q75**
Univ.CTY	-0.002	-0.700	-0.002	-1.333	-0.004	-0.002	0.000
Univ.MSA	0.004 *	2.126	0.003 *	2.083	0.001	0.003	0.005

*** 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.

Table A3. Estimation Results – Net Change in Bachelor, Graduate, and Professional degree holders, 2000-17 (using a broader definition of universities)

Variables	OLS		KRLS				
	Est coeff.	**t-stats.**	**Avg.**	**t-stats.**	**Q25**	**Q50**	**Q75**
Univ.CTY	-0.007	-1.768	-0.005	-1.825	-0.008	-0.005	0.001
Univ.MSA	0.010 **	3.093	0.007 **	2.985	0.003	0.008	0.011

*** 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.

Table A4. Estimation Results – Net Change in Graduate and Professional degree holders, 2000-17

Variables	OLS		KRLS				
	Est coeff.	**t-stats.**	**Avg.**	**t-stats.**	**Q25**	**Q50**	**Q75**
RUniv.CTY	-0.004	-1.292	-0.002	-0.166	-0.002	0.000	0.002
RUniv.MSA	0.008 ***	3.374	0.005 **	3.258	0.003	0.005	0.007
NRUniv.CTY	-0.001	-0.411	-0.001	-0.864	-0.002	-0.001	0.000
NRUniv.MSA	0.001	0.624	0.001	0.836	0.000	0.001	0.003

*** 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.

Table A5. Estimation Results – Net Change in Bachelor, Graduate, and Professional degree holders, 2000-17

Variables	OLS		KRLS				
	Est coeff.	**t-stats.**	**Avg.**	**t-stats.**	**Q25**	**Q50**	**Q75**
RUniv.CTY	-0.015 **	-2.703	-0.002	-0.947	-0.006	0.002	0.002
RUniv.MSA	0.016 ***	3.772	0.008 **	2.999	0.005	0.008	0.011
NRUniv.CTY	-0.005	-1.183	-0.003	-1.127	-0.005	-0.002	0.000
NRUniv.MSA	0.005	1.712	0.004	1.614	0.001	0.003	0.006

*** 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.