Federal Reserve Bank of New York
Staff Reports

Do Colleges and Universities Increase Their Region's Human Capital?

Jaison R. Abel
Richard Deitz

Staff Report no. 401
October 2009

Do Colleges and Universities Increase Their Region's Human Capital?
Jaison R. Abel and Richard Deitz
Federal Reserve Bank of New York Staff Reports, no. 401
October 2009
JEL classification: R10, J24, O18

Abstract

We investigate whether the degree production and research and development (R&D) activities of colleges and universities are related to the amount and types of human capital present in the metropolitan areas where the institutions are located. We find that degree production has only a small positive relationship with local stocks of human capital, suggesting that migration plays an important role in the geographic distribution of human capital. Moreover, we show that spillovers from academic R&D activities tilt the structure of local labor markets toward occupations requiring innovation and technical training. These findings demonstrate that colleges and universities raise local human capital levels by increasing both the supply of and demand for skill.

Key words: human capital, higher education, knowledge spillovers, local economic development

---

Abel: Federal Reserve Bank of New York (e-mail: jaison.abel@ny.frb.org). Deitz: Federal Reserve Bank of New York (e-mail: richard.deitz@ny.frb.org). The views expressed in this paper are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

I. INTRODUCTION

Colleges and universities in the United States are increasingly being viewed as engines of local economic development. This trend has been driven by the economic success stories of places such as Silicon Valley and the Route 128 corridor around Boston, as well as the more general recognition of the transition now underway towards a more knowledge-based economy. Furthermore, there appears to be a widespread belief among policymakers, particularly in declining regions, that the retention of graduates from local colleges and universities is a promising pathway to cure their economic ills.

Indeed, the amount of human capital in a region is one the strongest predictors of sustained economic vitality. Studies of regional economies have linked higher levels of human capital to increases in population and employment growth, wages, income, and innovation (Glaeser, Scheinkman, and Shleifer 1995; Simon 1998; Carlino, Chatterjee, and Hunt 2007; Florida, Mellander, and Stolarick 2008). Moreover, larger amounts of human capital within a region have been shown to lead to more rapid reinvention and long-run economic growth (Glaeser and Saiz 2004; Glaeser 2005). These empirical findings are explained by the fact that human capital increases individual-level productivity and idea generation (Becker 1964). Thus, by extension, a higher level of human capital within a region raises regional productivity. In addition, the concentration of human capital within a region facilitates knowledge spillovers, which further enhance regional productivity, fuel innovation, and promote growth (Marshall 1890; Jacobs 1969; Lucas 1988; Romer 1990; Rauch 1993; Moretti 2004).

Given the importance of human capital to the economic performance of regional economies, there is surprisingly little research analyzing the factors that drive differences in human capital accumulation across space. This issue is of particular concern as recent research has demonstrated that a divergence in human capital levels has occurred across cities over the past several decades (Berry and Glaeser 2005). This paper seeks to shed some light on this issue by analyzing whether activities performed by colleges and universities ("higher education activities") are related to the amount and types of human capital located in metropolitan areas.

We consider two types of higher education activities that have the potential to raise local human capital levels. First, colleges and universities can increase the supply of human capital through the production of skilled labor. Newly minted graduates directly raise the human capital level in a region if they remain in the area and enter the local labor market. However, because college graduates are highly mobile (Kodrzycki 2001; Whisler et al. 2008), it is not obvious that regions producing more graduates will also have higher human capital levels as a complex set of labor supply and demand factors are at work. Second, much of the research and development (R&D) activity in the United States occurs at colleges and universities. Such activities can also raise local human capital levels if there are spillovers into the local economy that increase demand for human capital, whether such human capital is produced locally or not.

While the pathways through which these higher education activities can act to raise local human capital levels are clear, systematic empirical evidence documenting the existence and magnitude of such relationships is scarce. Indeed, because state governments are an important source of funding for U.S. higher education institutions, much of the existing literature has attempted to examine the relationship between the production of degrees and stock of college graduates from the perspective of a state government analyzing the return on its investment (Bound et al. 2004; Groen 2004).

From the standpoint of local economic development, however, a state may not be a meaningful unit of measure because it is often too large to capture the local labor markets in which colleges and universities are located. Moreover, while these studies provide insight into the extent to which colleges and universities influence the supply side of the labor market, they do not consider the role colleges and universities play in shaping the local demand for human capital through the knowledge spillovers they create.

However, the existence of highly localized spillovers between university research and high technology innovative activity is well-documented (Jaffe 1989; Acs, Audretsch, and Feldman 1991; Jaffe, Trajtenberg, and Henderson 1993; Anselin, Varga, and Acs 1997; Varga 2000; Adams 2002). Such spillovers can alter the composition of local labor markets by increasing the demand for specialized skills and by attracting business activity, such as start up firms, seeking to gain access to academic R&D or human capital (Beeson and Montgomery 1993; Audretsch, Lehmann, and Warning 2005; Woodward, Figueiredo, and Guimaraes 2006). While the existing literature demonstrates the importance of colleges and universities to specific industries, particularly those utilizing science and technology, little is known about the extent to which the activities of colleges and universities influence local economic development more generally. Recent research by Andersson, Quigley, and Wilhelmsson (2004, 2009), showing that the decentralization of higher education in Sweden yielded regional and national productivity benefits, has started to fill this void in the literature. However, this work also emphasizes the research dimension of universities, rather than the broader set of higher education activities.

By analyzing the relationships that exist between the types of activities performed by colleges and universities and local human capital levels, this paper extends the existing literature in three ways. First, our research provides new insight into the economic geography of higher education activities in the United States. We compile data on the degrees produced and R&D expenditures incurred at the metropolitan area level, and show that academic R&D activity tends to be much more geographically concentrated than degree production. Second, we provide what we believe are the first estimates of the relationship between the production and stock of human capital at the metropolitan area level, a unit of measure that closely reflects local labor markets and can account for the localized nature of knowledge spillovers. Controlling for the research intensity of metropolitan areas, we find only a small positive relationship between a metropolitan area's production and stock of human capital, suggesting that migration plays an important role in the geographic distribution of human capital. Finally, to assess the extent to which activities at colleges and universities influence the demand for human capital, we provide a detailed analysis of the occupational structure of local labor markets. We find evidence that suggests spillovers from academic R&D play an important role in shaping the demand for human capital in metropolitan areas, particularly in occupations requiring innovation and technical training. Thus, by providing a more complete understanding of the complex relationships that exist between higher education activities and local human capital levels, this research improves our understanding of whether and how local colleges and universities increase their region's human capital.

II. THE GEOGRAPHY OF HIGHER EDUCATION ACTIVITIES

Colleges and universities in the United States conferred more than 2.2 million higher education degrees in 2006. About two-thirds of these degrees were bachelor's degrees, followed by master's degrees (27 percent), and first-professional degrees or doctoral degrees (7 percent).[1] Similarly, in 2006, more than $49.6 billion was spent on R&D activities at academic institutions. We calculate the amount of this higher education activity occurring in metropolitan areas, and assess the geographic concentration of each.

A. Degree Production in Metropolitan Areas

To measure a metropolitan area's degree production, we utilize Integrated Postsecondary Education Data System (IPEDS) data published by the National Center for Education Statistics (NCES) of the U.S. Department of Education. IPEDS is a survey-based system that collects and provides data from all primary providers of postsecondary education in a number of areas, including enrollments, degree completions, faculty and staff, and finances.[2] To construct measures of degree production by metropolitan area, we map degree completion information for more than 4,000 higher education institutions to their respective metropolitan areas using zip code information, aggregating over degree types. We collect this information for the 2005-2006 and 1999-2000 academic years, and are able to assign this information to 283 metropolitan areas in the United States.[3] The metropolitan areas in our analysis housed nearly 80 percent of the population and

---

1 We omit Associates degrees from our analysis because much of the existing literature focuses on attainment of four-year college degrees and beyond to measure regional stocks of human capital.

2 The Higher Education Act of 1992 mandates the completion of IPEDS surveys for all institutions that participate in any federal student aid program. As a result, the IPEDS database captures information from virtually all higher education institutions operating in the United States. To the extent possible, we have omitted degrees conferred by institutions that primarily provide online training.

3 The metropolitan area definitions we use correspond to those provided by the Integrated Public Use Microdata Series (IPUMS), which are designed to provide the most consistently identifiable unit of geography for the 2006 American Community Survey and 2000 Census (Ruggles et al. 2008). As such, our analysis does not include colleges and universities located outside these 283 metropolitan areas. The largest institutions omitted from our analysis are Cornell University and Virginia Tech, as Ithaca, NY and Blacksburg, VA are not considered metropolitan areas under the IPUMS definition.

produced over 80 percent of the higher education degrees conferred in the United States in both years.

As Figure 1 shows, higher education degrees are produced widely across the United States, although the largest producers are located along the east and west coasts, around the Great Lakes region, and in Texas. Table 1 reports the top 20 metropolitan areas based on degree production. In almost all cases, there are a number of well-known major institutions contributing to the total degree count. At nearly 144,000 degrees, the New York metropolitan area ranks first, followed by Los Angeles, Chicago, and Boston. Also on the list are other large metropolitan areas, such as San Francisco, along with "college-town" metros such as Columbus, OH and Raleigh-Durham, NC. In total, the top 20 metropolitan areas accounted for more than 35 percent of all of the higher education degrees produced in the United States in 2006. The average metropolitan area produced around 6,500 degrees in 2006, and more than 70 metropolitan areas produced fewer than 1,000 degrees that year.

B. Academic R&D Expenditures in Metropolitan Areas

We follow a similar procedure to measure the academic R&D expenditures occurring in U.S. metropolitan areas. Here, we utilize data compiled by the National Science Foundation (NSF) Survey of Research and Development Expenditures at Universities and Colleges. This survey reports all funds spent on activities specifically organized to produce research outcomes for a wide range of disciplines, including physical sciences, life sciences, engineering, math and computer sciences, social sciences, business and management, law, education, social work, and the arts. As before, we map academic R&D expenditure information for individual higher education institutions to their respective metropolitan areas, aggregating science and non-science R&D expenditures.[4] To best match the academic years covered by our degree data, we collect this information for FY2006 and FY2000 and assign this information to the same 283 metropolitan areas as before.[5] In both years, about 90 percent of the academic R&D expenditures nationwide were by colleges and universities located in metropolitan areas.

As Figure 2 shows, the geographic distribution of academic R&D expenditures is concentrated, with large amounts of such activity located along the Boston-NY-Washington corridor, Research Triangle area, Great Lakes region, Texas, and California. The top 20 metropolitan areas based on academic R&D expenditures are also reported in Table 1. With expenditures of nearly $2.7 billion, the New York metropolitan area again ranks first, followed by Baltimore, Los Angeles, and Boston, with the rankings differing somewhat from degree production. In total, the top 20 metropolitan areas accounted for almost 50 percent of all of the academic R&D expenditures in 2006. The average metropolitan area totaled $157 million in academic R&D expenditures that year, while more than 150 metropolitan areas had less than $10 million in expenditures in 2006.

C. Comparison of Geographic Concentration of Higher Education Activities

Figures 1 and 2 suggest that academic R&D activity is more concentrated among metropolitan areas than is degree production. The geographic concentration of each higher education activity can be quantified using a locational Gini coefficient, which measures the extent to which the distribution of activity across geographic units departs

[4] The NSF does not report information for institutions with less than $150,000 in total annual R&D expenditures.

[5] Academic R&D expenditures in 2000 are adjusted to account for non-science and engineering R&D expenditures, which were not regularly reported until 2004, using metro-specific average ratios of total R&D expenditures to science and engineering R&D expenditures during the 2004-2006 period.

from an equal allocation (Krugman 1991; Audretsch and Feldman 1996). We calculate two versions of this measure of concentration: the raw Gini coefficient, which compares the distribution of each higher education activity to a hypothetical uniform distribution, and the relative Gini coefficient, which compares the distribution of each higher education activity relative to the distribution of population.[6] Locational Gini coefficient values close to zero suggest that the activity is widely dispersed across U.S. metropolitan areas or spread out in a manner similar to the distribution of population, while values close to 0.5 suggest that the activity is geographically concentrated in few places.

Locational Gini coefficients computed for the degree production and academic R&D activity taking place across metropolitan areas are reported in the bottom panel of Table 1. The raw locational Gini coefficient for degree production is 0.19 compared to 0.26 for academic R&D expenditures. Relative to the population, however, the locational Gini coefficient for degree production falls to 0.14 while that for academic R&D expenditures increases to 0.27. Thus, both measures of geographic concentration indicate that R&D activity is more concentrated than degree production.[7]

III. HIGHER EDUCATION ACTIVITIES AND LOCAL HUMAN CAPITAL

With information about the degrees produced and academic R&D activities of colleges and universities at the metropolitan area level, we next develop measures of the degree production rate, research intensity, and local specialization of higher education

---

[6] The formula used to compute locational Gini coefficients is $G_L \equiv \sum_{i=1}^{n}\sum_{j=1}^{n}|x_i - x_j|/4n(n-1)x_i$, where i and j denote U.S. metropolitan areas ($i \neq j$) and n = 283, the number of metropolitan areas included in the analysis. When calculating the raw Gini coefficients, x_i is simply the share of each activity in each metropolitan area (i.e., $X_i/\sum_{i=1}^{n} X_i$); when calculating the relative Gini coefficients, x_i is the share of each activity relative to the share of population in each metropolitan area (i.e., $(X_i/\sum_{i=1}^{n} X_i)/(P_i/\sum_{i=1}^{n} P_i)$).

[7] The geographic concentration of higher education activities was nearly identical in 2000, with raw and relative Gini coefficients of 0.19 and 0.15 for degree production and 0.26 and 0.28 for academic R&D expenditures.

activities and relate these variables to measures of the amount and types of human capital in a large cross section of metropolitan areas. Importantly, metropolitan areas are designed to include the geographic areas in which people live and work, which provides a good proxy for local labor markets and covers the geographic areas where local spillovers are most likely to be captured. As such, our analysis allows us to determine whether the human capital stock and occupational structure in a metropolitan area is related to the higher education activities carried out by its local colleges and universities. Table 2 presents descriptive statistics for the variables used in our analysis.

A. Description of Variables

Our primary measure of human capital is the proportion of the working-aged population in each metropolitan area with a college degree. We compute this variable, HCSTOCK, for the same 283 metropolitan areas described above in both 2000 and 2006.[8] While this education-based measure of human capital likely fails to capture the full array of knowledge and skills within a metropolitan area, it is a conventional measure of human capital that has been linked to a number of measures of regional vitality.

However, the activities of colleges and universities may be more important in the accumulation of some types of human capital (e.g., knowledge of biology or engineering) than others where formal education is less important (e.g., production or construction-related skills). Therefore, we also consider occupation-based measures of human capital in our analysis. Specifically, we collect occupational employment data for both 2006 and 2000, and calculate the share of workers in 21 occupation groups for a large subset of the

---

[8] 2000 data are drawn from the decennial Census (IPUMS 5% sample), while 2006 data are drawn from the American Community Survey (IPUMS 1% sample).

283 metropolitan areas in our data.[9] With this information, we are able to analyze the relationship between higher education activity and the specific types of human capital present in a local economy.

In addition, because the amount of education required differs among occupations, our analysis allows for a deeper understanding of the mechanisms through which colleges and universities influence the more conventional measure of local human capital. Table 3 provides information on the educational attainment of people working in the occupational categories included in our analysis, and shows that a clear break exists in the distribution of educational attainment across occupations. As such, we refer to "high" human capital occupations as those with an above average amount of education required and "low" human capital occupations as those with a below average amount of education required. Approximately 50 percent or more of the people in occupations classified in the "high" category have at least a college degree compared to fewer than 25 percent of the workers in the "low" category.

With respect to higher education activities, we construct three variables to measure the activities of colleges and universities located in metropolitan areas. The first variable, *DEGREES*, measures the degree production rate of a metropolitan area, and is calculated as the number of degrees produced in a metropolitan area per 100 working-aged people. On average, about 1.5 degrees are produced for every 100 working-aged people in a metropolitan area. Our second variable, *RESEARCH*, measures the research intensity of the colleges and universities in a metropolitan area, and is calculated as the

9 2000 and 2006 data are drawn from the Occupational Employment Statistics Survey published by the U.S. Bureau of Labor Statistics.

academic R&D expenditures ($10,000) per enrolled student in a metropolitan area.[10] On average, there is about $2,800 in R&D expenditures per enrollee in a metropolitan area.

Finally, for our analysis of the occupational structure of metropolitan areas, we include a measure of the local specialization of higher education activities, which categorizes the types of degrees produced, by majors, into fields that correspond to the occupational categories outlined above. These variables, $SPECIALIZATION_j$ (j = 1, …, 21), are calculated as the share of degrees produced in a metropolitan area specifically for the jth occupational category included in our analysis. To calculate these variables, we use an occupational crosswalk provided by the National Center for Education Statistics (NCES) to link the types of degree majors listed in the Classification of Instructional Programs (CIP 2000) to broad occupational categories listed in the Standard Occupational Classification (SOC) system.[11] This classification is not mutually exclusive as degree majors can feed into multiple occupational categories. We deviate from this occupational crosswalk only in the Education, Training, and Library category because the published crosswalk assumes that almost any degree recipient can become a teacher. Instead, we restrict this category to include only education and library majors.

B. Analysis of Local Human Capital Levels

To investigate the relationship between local human capital levels, the degree production rate, and research intensity of metropolitan areas, we estimate the following pooled cross-sectional model:

---

10 Enrollment data are drawn from IPEDS and represent enrollment in the fall semester of each academic year. We use Fall 2000 enrollment data for the 1999-2000 academic year as Fall 1999 data are not available.

11 The occupational crosswalk can be found at http://nces.ed.gov/pubs2002/cip2000/.

$$ln\ (HCSTOCK_{it}) = \beta_1 DEGREES_{it} + \beta_2 RESEARCH_{it} + \nu_i + \gamma_t + \varepsilon_{it} \qquad (1)$$

where i ≡ metropolitan area, t ≡ year, ν_i ≡ state fixed effects, γ_t ≡ year fixed effects, and ε_{it} ≡ error term. Here, the dependent variable, *HCSTOCK*, is the conventional measure of the stock of human capital in a metropolitan area at time t, while the independent variables, *DEGREES* and *RESEARCH*, measure the rate of *new* human capital production in a metropolitan area at time t and the research intensity of the colleges and universities in a metropolitan area at time t. The inclusion of both state and year fixed effects allow us to control for a wide array of unobserved region-specific variables affecting local human capital levels, as well as unobserved factors affecting human capital levels over time. As such, the coefficients we estimate are identified by the cross-sectional variation in the degree production rate and research intensity that exists across metropolitan areas.[12]

Care must be taken in interpreting the results of our empirical analysis of local human capital levels. Because we do not observe the flow of people between metropolitan areas, the relationship we estimate between the local production and stock of human capital may not necessarily be the direct result of college graduates remaining in the area in which they obtained their degree. While controlling for the research intensity of metropolitan areas mitigates this concern, the estimated coefficient on the local production variable should be interpreted as a *net* relationship, which may be due to locally produced graduates remaining in the area, the swapping of locally produced

[12] Due to data limitations, there are some differences in how the college and university variables are measured in 2000 and 2006. For example, IPEDS reports degree completion information differently between years and some estimation is required to account for non-science and engineering R&D in 2000. In addition, there are differences in how the occupational crosswalk classifies degree majors in each year. As a result, we are not able to analyze our data using panel data techniques. These differences do not pose a problem for cross-sectional analysis, as the variation across metropolitan areas is large and persistent.

human capital for that produced outside the region, or some combination of both. In addition, though there are good reasons to believe that differences in the degree production rate and research intensity of metropolitan areas influence local human capital levels, it is possible that there may be some endogeneity between these measures, which would result in an upward bias in our estimated coefficients. As such, we view our regression estimates as reduced form correlations in the data rather than structural parameter estimates, and interpret our results as upper bounds on the long-run relationships between higher education activities and local human capital levels.

Table 4 reports the results of our initial regression analysis as well as elasticity estimates calculated at the mean value of each higher education activity. To provide a direct link to the existing literature, we begin by estimating equation (1) focusing only on the degree production rate of metropolitan areas. As Column (1) shows, we find that the elasticity of a metropolitan area's human capital stock with respect its local degree production rate is around 0.12—one-third of that found for a cross-section of U.S. states by Bound et al. (2004).[13] Taken at face value, this point estimate suggests that a doubling of degree production is associated with a 12 percent increase in a metropolitan area's human capital stock.

However, this elasticity estimate is likely to be overstated because it does not control for the research activities at colleges and universities, which may also influence local human capital levels through spillovers into the local economy. Column (2) reports the results of our model when the research intensity of a metropolitan area is also included. Overall, the empirical model performs quite well, explaining nearly half of the

---

13 Bound et al. (2004) report state-level elasticity estimates of 0.32-0.34 using data on the number of bachelor's degrees produced per capita across the 48 continental states during the 1960 to 1990 period. When aggregating our data to the state level, we produce elasticity estimates of 0.31-0.32.

variation in human capital levels across metropolitan areas compared to around 37 percent when only degree production is considered. In addition, the expected positive relationship holds at conventional levels of significance for both higher education variables we consider. Results show that a doubling of a metropolitan area's degree production rate is associated with an 8.8 percent increase in local human capital levels, while a doubling of a metropolitan area's research intensity is associated with a 6.8 percent increase in local human capital levels.[14] These findings suggest that colleges and universities raise local human capital levels by increasing both the supply of and demand for skilled labor. Moreover, the small degree production elasticity we find indicates that migration plays an important role in the geographic distribution of human capital across metropolitan areas.

The importance of inter-metropolitan area migration in determining local human capital levels is illustrated further in Figure 3, which compares a metropolitan area's degree production rate to its net human capital consumption rate, measured as the average annual change in the number of people with at least a college degree per 100 working-aged people. The red 45-degree line indicates where the annual production and consumption of human capital is in balance. The figure shows that a large number of metropolitan areas specializing in higher education produce far more human capital than they consume. In fact, the majority of metropolitan areas—62 percent—produce more human capital than they consume, while the remaining 38 percent consume more human capital than they produce. Clearly, both labor supply and labor demand factors are at work redistributing human capital across metropolitan areas.

[14] We find nearly identical results when analyzing the 2000 and 2006 data separately, as the cross-sectional variation in human capital and higher education activities is highly persistent over this period.

C. Analysis of the Occupational Structure of Metropolitan Areas

The positive relationship between a metropolitan area's research intensity and human capital stock described above suggests that spillovers from colleges and universities act to increase the demand for skilled labor. Moreover, to the extent that a metropolitan area has more human capital when there is more higher education activity, as our analysis suggests, there may also be differences in the types of human capital present for two reasons. First, research is more likely to create knowledge spillovers in some fields than others. For example, biomedical research at a local university may provide externalities to local life science companies, but is unlikely to do so for local manufacturing plants or restaurants. Second, to the extent that opportunities exist in particular fields within a metropolitan area, an increase in labor supply from local specialization in these fields will result in higher equilibrium employment levels in these fields. In addition, specialization in particular fields may offer opportunities for knowledge spillovers in those fields, for example, if professors spread academic knowledge by serving as consultants or start businesses of their own. However, these types of relationships cannot be identified when estimating the empirical relationship on net, as above. Therefore, we next analyze how the occupational structure of metropolitan areas relates to the amount and types of higher education activities present.

Building from the empirical framework described above, we estimate the following pooled cross-sectional log-odds model for 21 separate occupational categories:

$$ln\left(\frac{S_{it}}{1-S_{it}}\right) = \beta_1 DEGREES_{it} + \beta_2 RESEARCH_{it} + \beta_3 SPECIALIZATION_{it} + \nu_i + \gamma_t + \varepsilon_{it} \qquad (2)$$

where $i \equiv$ metropolitan area, $t \equiv$ year, $\nu_i \equiv$ state fixed effects, $\gamma_t \equiv$ year fixed effects, and $\varepsilon_{it} \equiv$ error term. Here, the dependent variable measures the log-odds share, S, of employment in a specific occupational category, while the independent variables each measure an aspect of a metropolitan area's higher education activities. Table 5 presents the results of our occupation-based regression analysis, while Table 6 shows standardized changes to help assess the magnitude of these correlations and allow for a uniform comparison across occupational categories.

Results show a strong connection between a metropolitan area's research intensity and the presence of high human capital occupations, as a positive and significant relationship exists for seven of the ten "high" human capital occupations. This relationship is particularly pronounced for occupations requiring innovation and technical training, such as those in the categories Computer and Math; Life, Physical, and Social Sciences; Business and Financial Operations; and Architecture and Engineering. Like academic R&D, economic activity in these areas tends to cluster geographically due to the importance of knowledge spillovers. By contrast, low human capital occupations in categories such as Production; Food Preparation and Serving; Transportation and Material Moving; and Installation, Maintenance, and Repair do not appear to benefit from access to academic research. Instead, people working in many of these occupations, as well as those in education, community and social services, and healthcare, tend to be distributed in proportion to the population because the customer base for such business activity is highly localized. Since dependent variables are expressed in shares, these latter categories tend to have negative and significant coefficients that when coupled with the positive and significant coefficients on the high-human capital categories, suggest that higher education research activities tilt the occupational structure of metropolitan areas toward high human capital activities.

In terms of the degree production rate, we find a positive and significant relationship for only five of the 10 “high” human capital occupations and four of the 11 “low” human capital occupations. In particular, we find that the share of people working in the categories Life, Physical, and Social Sciences; Community and Social Services; Education, Training, and Library; Arts and Media; and those in healthcare is positively associated with degree production. These findings suggest that access to local human capital is important for businesses in these fields. By contrast, we find that the share of people working in manufacturing and goods distribution-related occupations, such as Production; Transportation and Material Moving; Construction and Extraction; and Installation, Maintenance, and Repair, is negatively associated with degree production.

Interestingly, some of the most highly skilled occupations, such as those in the Computer and Math, Architecture and Engineering, Business and Financial Operations, and Legal categories also have a negative relationship with degree production. However, these groups have a positive relationship with specialized degree production. These patterns suggest that access to field-specific human capital and proximity to specialized knowledge is important for these groups, as opposed to access to generic pools of human capital. More generally, to the extent a relationship exists at all, specialization in the production of a certain type of human capital is associated with a higher share of people working in occupations that utilize that type of human capital, but this variable is significant in only eight occupational categories.

The analysis presented in Table 6 also provides insight into how differences in the occupational structure of metropolitan areas alter local human capital levels. The bottom panel of the table shows the change in the share of workers in "high" human capital occupations arising from a one standard deviation increase in each higher education activity. Evaluated at mean employment shares, we find that a one standard deviation increase in a metropolitan area's degree production rate is associated with a 2.2 percent increase in the share of workers in "high" human capital occupations, while a one standard deviation increase in research intensity is associated with a 6.2 percent increase in the share of workers in these same occupations.

This difference in results stems in large part from the types of human capital that appear to benefit from the degree production and R&D activities of colleges and universities located in metropolitan areas. In particular, research-intensive metropolitan areas tend to have larger shares of the most highly skilled occupations (e.g., those in the categories Life, Physical, and Social Science; Legal; Computer and Math; Architecture and Engineering; Business and Financial Operations) and smaller shares of the lower-skilled occupations (e.g., those in Food Preparation and Serving; Production). By contrast, metropolitan areas specializing in the production of degrees tend to have larger shares of workers in both "high" and "low" human capital occupations, but smaller shares of many of the highest human capital-intensive occupations.

IV. CONCLUSIONS AND POLICY IMPLICATIONS

The amount of human capital within a region is a key determinant of economic vitality and long-run economic success. As the U.S. economy continues to shift away from manufacturing and the distribution of goods toward the production of ideas, the importance of human capital to a region will only grow. However, there is surprisingly little research exploring why some regions possess more human capital than others do. This paper contributes to this small but growing literature by focusing on the extent to which the amount and types of local human capital are related to the activities of colleges and universities located in metropolitan areas.

Our research demonstrates that colleges and universities help raise local human capital levels by increasing *both* the supply of and demand for skill within metropolitan areas. We find only a small positive relationship between a metropolitan area's degree production and stock of human capital at this highly localized level of geography, which clearly points to the key role migration plays in redistributing human capital across space. However, consistent with the findings of Beeson and Montgomery (1993), who focus more narrowly on science and technology occupations, we find evidence that colleges and universities alter the overall structure of local labor markets, tilting them towards occupations that more intensively utilize human capital. This outcome is particularly connected to the research intensity of metropolitan areas, as linkages between local economies and higher education institutions appear to be strongest in economic activities requiring innovation and technical training such as computers, math, and science, as well as business-related fields. Importantly, activities in these areas have been shown to be particularly important drivers of local economic development (Florida, Mellander, and Stolarick 2008).

There are a number of extensions to this research that would allow for a more complete understanding of the complex relationships that exist between the activities of colleges and universities and local human capital stocks. Disaggregating our college and university variables to explore whether the types of institutions (e.g., public or private, liberal arts or research) or kinds of degrees awarded (e.g., B.A. or Ph.D.) in metropolitan areas matters might prove particularly illuminating. Further work might also explore whether the type and quality of research conducted affects a region's human capital stock. Finally, while the results we present are persistent and robust over the period studied, as more data become available, a longitudinal analysis of metropolitan areas would provide a more controlled environment for studying the relationships we identify.

Nonetheless, we believe there are important policy implications from our findings. First, there is only a small net positive relationship between the production and stock of human capital in metropolitan areas. Thus, policymakers may have a limited ability to raise local human capital levels by solely focusing on the generic expansion and retention of local graduates. Second, we show that the types of degrees produced in a metropolitan area also matters. The production of graduates in high human capital fields, such as computers, math, and engineering, is associated with more workers in parallel occupations. Finally, our work provides new evidence on the role that academic R&D activities play in shaping local human capital levels. We find that spillovers into the local economy from such activities act to increase the demand for skilled labor, whether produced locally or imported from elsewhere. Thus, this research suggests that policies aimed at increasing a region's human capital through the expansion of local colleges and universities will be most effective if they leverage regional comparative advantages while targeting *both* the supply and demand sides of local labor markets, as doing so will help retain and attract human capital.

REFERENCES

Acs, Zoltan J., David B. Audretsch, and Maryann P. Feldman. 2001. "Real Effects of Academic Research: Comment," *American Economic Review*, 82(1), 363-367.

Adams, James D. 2002. "Comparative Localization of Academic and Industrial Spillovers," *Journal of Economic Geography*, 2(3), 253-278.

Andersson, Roland, John M. Quigley, and Mats Wilhelmsson. 2009. "Urbanization, Productivity, and Innovation: Evidence from Investment in Higher Education," *Journal of Urban Economics*, 66 (1), 2-15.

Andersson, Roland, John M. Quigley, and Mats Wilhelmsson. 2004. "University Decentralization as Regional Policy: The Swedish Experiment," *Journal of Economic Geography*, 4(4), 371-388.

Audretsch, David B., Erik E. Lehmann, and Susanne Warning. 2005. "University Spillovers and New Firm Location," *Research Policy*, 34 (7), 1113-1122.

Audretsch David B. and Maryann P. Feldman. 1996. "R&D Spillovers and the Geography of Innovation and Production," *American Economic Review*, 86(3), 630-640.

Becker, Gary S. 1964. *Human Capital*, New York: Columbia University Press.

Berry, Christopher R. and Edward L. Glaeser. 2005. "The Divergence of Human Capital Levels Across Cities," *Papers in Regional Science*, 84(3), 407-444.

Beeson, Patricia and Edward Montgomery. 1993. "The Effects of Colleges and Universities on Local Labor Markets," *Review of Economics and Statistics*, 75(4), 753-761.

Bound, John, Jeffrey Groen, Gabor Kezdi, and Sarah Turner. 2004. "Trade in University Training: Cross-State Variation in the Production and Stock of College-Educated Labor," *Journal of Econometrics*, 121(1-2), 143-171.

Carlino, Gerald A., Satyajit Chatterjee, and Robert M. Hunt. 2007. "Urban Density and the Rate of Invention," *Journal of Urban Economics*, 61(3), 389-419.

Florida, Richard, Charlotta Mellander, and Kevin Stolarick. 2008. "Inside the Black Box of Regional Development—Human Capital, the Creative Class, and Tolerance," *Journal of Economic Geography*, 8(5), 615-649.

Glaeser, Edward L. 2005. "Reinventing Boston: 1640-2003," *Journal of Economic Geography*, 5(2), 119-153.

Glaeser, Edward L. and Albert Saiz. 2004. "The Rise of the Skilled City," *Brookings-Wharton Papers on Urban Affairs*, 5, 47-94.

Glaeser, Edward L., Jose A. Scheinkman, and Andrei Shleifer. 1995. "Economic Growth in a Cross-Section of Cities," *Journal of Monetary Economics*, 36(1), 117-143.

Groen, Jeffrey A. 2004. "The Effect of College Location on Migration of College-Educated Labor," *Journal of Econometrics*, 121(1-2), 125-142.

Jacobs, Jane. 1969. *The Economy of Cities*, New York: Vintage.

Jaffe, Adam B., Manuel Trajtenberg, and Rebecca Henderson. 1993. "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations," *Quarterly Journal of Economics*, 108(3), 577-598.

Jaffe, Adam B. 1989. "Real Effects of Academic Research," *American Economic Review*, 75(5), 957-970.

Kodrzycki, Yolanda K. 2001. "Migration of Recent College Graduates: Evidence from the National Longitudinal Survey of Youth," *New England Economic Review*, 1, 13-34.

Krugman, Paul. 1991. *Geography and Trade*, Cambridge, MA: The MIT Press.

Lucas, Robert E. 1988. "On the Mechanics of Economic Development," *Journal of Monetary Economics*, 22(1), 3-42.

Marshall, Alfred. 1890. *Principles of Economics*, London: Macmillan.

Moretti, Enrico. 2004. "Estimating the Social Return to Higher Education: Evidence from Longitudinal and Repeated Cross-Sectional Data," *Journal of Econometrics*, 121(1-2), 175-212.

National Science Foundation, Division of Science Resources Statistics. 2008. *Academic Research and Development Expenditures: FY 2007*. Detailed Statistical Tables NSF 09-303. Arlington, VA, available at http://www.nsf.gov/statistics/nsf09303/.

Rauch, James E. 1993. "Productivity Gains from Geographic Concentration of Human Capital: Evidence from the Cities," *Journal of Urban Economics*, 34(3), 380-400.

Ruggles, Steven, Matthew Sobek, Trent Alexander, Catherine A. Fitch, Ronald Goeken, Patricia Kelly Hall, Miriam King, and Chad Ronnander. 2008. *Integrated Public Use Microdata Series: Version 4.0* [Machine-readable database], Minneapolis, MN: Minnesota Population Center [producer and distributor]: United States Census (2000), American Community Survey (2006), available at http://usa.ipums.org/usa/.

Romer, Paul M. 1990. "Endogenous Technological Change," *Journal of Political Economy*, 98(5), S71-S102.

Simon, Curtis J. 1998. "Human Capital and Metropolitan Employment Growth," *Journal of Urban Economics*, 43(2), 223-243.

U.S. Department of Education, National Center for Education Statistics, *Integrated Postsecondary Education Data System (IPEDS)*, 2000 and 2006 Completions Survey, available at http://nces.ed.gov/ipeds/.

U.S. Department of Education, National Center for Education Statistics, *Digest of Education Statistics: 2007*, available at http://nces.ed.gov/digest/d07/.

Varga, Attila. 2000. "Local Academic Knowledge Transfers and the Concentration of Economic Activity," *Journal of Regional Science*, 40(2), 289-309.

Whisler, Ronald L., Brigitte S. Waldorf, Gordon F. Mulligan, and David A. Plane. 2008. "Quality of Life and the Migration of the College-Educated: A Life-Course Approach," *Growth and Change*, 39(1), 58-94.

Woodward, Douglas, Octavio Figueiredo, and Paulo Guimaraes. 2006. "Beyond Silicon Valley: University R&D and High-Technology Location," *Journal of Urban Economics*, 60(1), 15-32.

Table 1: Geographic Distribution and Concentration of Higher Education Activities in U.S. Metropolitan Areas, 2006

Degrees Produced		Academic R&D Expenditures	
A. Summary of Geographic Distribution			
Top 20 Metropolitan Areas	Number	Top 20 Metropolitan Areas	$M
New York-Northeastern NJ	143,971	New York-Northeastern NJ	2,688.71
Los Angeles-Long Beach, CA	89,311	Baltimore, MD	2,076.56
Chicago, IL	68,321	Los Angeles-Long Beach, CA	2,013.16
Boston, MA-NH	59,032	Boston, MA-NH	1,759.29
Washington, DC/MD/VA	48,525	San Francisco-Oakland-Vallejo, CA	1,522.06
Philadelphia, PA/NJ	45,986	Raleigh-Durham, NC	1,448.56
San Francisco-Oakland-Vallejo, CA	31,604	Chicago, IL	1,291.74
Minneapolis-St. Paul, MN	31,315	Houston-Brazoria, TX	1,261.81
Dallas-Fort Worth, TX	30,603	Philadelphia, PA/NJ	1,027.42
San Diego, CA	25,905	Atlanta, GA	910.66
Atlanta, GA	24,955	Madison, WI	904.79
St. Louis, MO-IL	24,616	Ann Arbor, MI	844.44
Denver-Boulder, CO	24,186	San Diego, CA	841.96
Baltimore, MD	21,388	Washington, DC/MD/VA	827.74
Pittsburgh, PA	21,233	Seattle-Everett, WA	809.65
Austin, TX	20,564	Pittsburgh, PA	759.04
Phoenix, AZ	20,461	San Jose, CA	743.21
Columbus, OH	18,968	Columbus, OH	663.81
Raleigh-Durham, NC	18,880	State College, PA	656.63
Seattle-Everett, WA	18,101	St. Louis, MO-IL	655.63
Mean Value	6,480	Mean Value	157.13
Total in U.S. Metropolitan Areas	1,833,969	Total in U.S. Metropolitan Areas	44,468.70
Total in U.S.	2,223,029	Total in U.S.	49,639.97
Percentage in Metropolitan Areas	82.5%	Percentage in Metropolitan Areas	89.6%
B. Measures of Geographic Concentration			
Raw Locational Gini	0.192	Raw Locational Gini	0.258
Relative Locational Gini	0.143	Relative Locational Gini	0.267

Notes: Degrees Produced includes Bachelors, Masters, Doctoral, and First-Professional degrees awarded by Title IV postsecondary institutions. Academic R&D Expenditures is expressed in millions of dollars.

Sources: Integrated Postsecondary Education Data System (IPEDS) and Digest of Education Statistics, National Center for Education Statistics, U.S. Department of Education; Academic Research and Development Expenditures: Fiscal Year 2007, Detailed Statistical Tables, Report 09-303, National Science Foundation (NSF); American Community Survey (2006), U.S. Bureau of Census, IPUMS 1% Sample.

Table 2: Descriptive Statistics

Variable	Mean	Std Dev	Minimum	Maximum
A. Human Capital Variables				
Human Capital Stock	26.27	8.31	10.39	58.25
Share of Employment in:				
Management (N=537)	4.94	1.45	1.91	10.54
Business and Financial Operations (N=535)	3.45	1.28	1.25	9.98
Computer and Math (N=522)	1.72	1.25	0.19	9.14
Architecture and Engineering (N=528)	1.76	0.98	0.45	8.06
Life, Physical, and Social Science (N=517)	0.76	0.46	0.11	3.46
Community and Social Services (N=532)	1.28	0.45	0.48	3.24
Legal (N=517)	0.60	0.29	0.10	2.19
Education, Training, and Library (N=499)	6.27	1.81	0.33	18.26
Arts, Design, Entertainment, Sports, and Media (N=536)	1.04	0.37	0.27	3.33
Healthcare Practitioners and Technical (N=526)	5.29	1.23	2.05	12.04
Healthcare Support (N=533)	2.69	0.76	1.07	7.78
Protective Service (N=522)	2.18	0.73	5.31	0.69
Food Preparation and Serving (N=538)	8.80	1.67	5.03	16.30
Building and Grounds Cleaning (N=537)	3.36	0.72	1.88	8.11
Personal Care and Service (N=536)	2.27	0.92	0.79	9.05
Sales (N=538)	10.79	1.29	6.74	15.33
Office and Administrative Support (N=538)	17.20	1.95	11.82	26.29
Construction and Extraction (N=538)	5.09	1.48	2.40	12.59
Installation, Maintenance, and Repair (N=537)	4.28	0.77	2.71	8.86
Production (N=536)	8.90	4.56	1.76	36.20
Transportation and Material Moving (N=533)	7.32	1.84	3.13	16.60
B. College and University Variables				
Degree Production Rate	1.52	2.09	0.00	14.75
Research Intensity	0.28	0.47	0.00	5.20
Local Specialization in:				
Management (N=537)	30.74	14.16	0.00	100.00
Business and Financial Operations (N=535)	16.68	10.26	0.00	100.00
Computer and Math (N=522)	4.46	2.92	0.00	21.63
Architecture and Engineering (N=528)	4.04	4.80	0.00	31.23
Life, Physical, and Social Science (N=517)	17.75	9.99	0.00	100.00
Community and Social Services (N=532)	3.55	4.67	0.00	66.67
Legal (N=517)	1.43	2.47	0.00	24.46
Education, Training, and Library (N=499)	11.42	8.89	0.00	71.47
Arts, Design, Entertainment, Sports, and Media (N=536)	9.35	8.05	0.00	100.00
Healthcare Practitioners and Technical (N=526)	8.77	11.05	0.00	100.00
Healthcare Support (N=533)	0.03	0.21	0.00	3.01
Protective Service (N=522)	1.92	2.31	0.00	18.27
Food Preparation and Serving (N=538)	0.03	0.23	0.00	3.30
Building and Grounds Cleaning (N=537)	0.03	0.14	0.00	1.72
Personal Care and Service (N=536)	1.80	1.80	0.00	9.17
Sales (N=538)	0.47	0.89	0.00	6.52
Office and Administrative Support (N=538)	0.23	0.73	0.00	7.47
Construction and Extraction (N=538)	0.01	0.05	0.00	0.85
Installation, Maintenance, and Repair (N=537)	0.18	0.95	0.00	19.06
Production (N=536)	0.37	1.79	0.00	33.33
Transportation and Material Moving (N=533)	0.13	1.37	0.00	23.03

Notes: Descriptive statistics are for 2000 and 2006 combined. Human Capital Stock represents the percentage of each metropolitan area's working-aged population (i.e., 25+) with at least a four-year degree. Share of Employment is calculated using occupation-level information, and excludes Farming, Fishing, and Forestry occupations. Degree Production Rate is expressed as the number of degrees produced per 100 working-aged people. Research Intensity is measured as Academic R&D Expenditures ($10,000) Per Enrollee. Local Specialization is calculated using information on the higher education degrees associated with each occupational category. Based on 566 observations unless otherwise noted.

Sources: Integrated Postsecondary Education Data System (IPEDS), National Center for Education Statistics, U.S. Department of Education; Academic Research and Development Expenditures: Fiscal Year 2007, Detailed Statistical Tables, Report 09-303, National Science Foundation (NSF); Occupational Employment Statistics Survey, U.S. Bureau of Labor Statistics;United States Census (2000), U.S. Bureau of Census, IPUMS 5% Sample; American Community Survey (2006), U.S. Bureau of Census, IPUMS 1% Sample.

Table 3: High and Low Human Capital Occupations Based on Educational Attainment

Classification	Occupational Category	% with at least BA
High	Life, Physical, and Social Science	76.3
	Legal	76.1
	Education, Training, and Library	73.5
	Community and Social Services	66.9
	Computer and Math	63.2
	Architecture and Engineering	60.2
	Business and Financial Operations	58.8
	Healthcare Practitioners and Technical	54.4
	Arts, Design, Entertainment, Sports, and Media	51.3
	Management	48.8
Low	Sales	23.6
	Protective Service	19.4
	Office and Administrative Support	15.5
	Personal Care and Service	12.3
	Healthcare Support	8.8
	Installation, Maintenance, and Repair	6.8
	Production	6.2
	Transportation and Material Moving	6.1
	Food Preparation and Serving	5.9
	Construction and Extraction	5.4
	Building and Grounds Clearing	5.1
	Total Among All Occupations	26.4

Source: American Community Survey (2006), U.S. Bureau of Census, IPUMS 1% Sample.

Table 4: Human Capital Stock Regression Results

	(1)		(2)	
	Point Estimate	Elasticity at Mean	Point Estimate	Elasticity at Mean
Degree Production Rate	0.080 ***	0.122	0.058 ***	0.088
	(15.40)		(8.09)	
Research Intensity	--	--	0.243 ***	0.068
			(4.68)	
Adj R-squared	0.371		0.481	
N	566		566	

Notes: Dependent variable is the natural logarithm of human capital stock. Models include state and year fixed effects. ***, **, and * denote significance at the .01, .05, and .10 levels, respectively. *t*-statistics in parentheses; computed using robust standard errors.

Table 5: Occupational Structure Regression Results

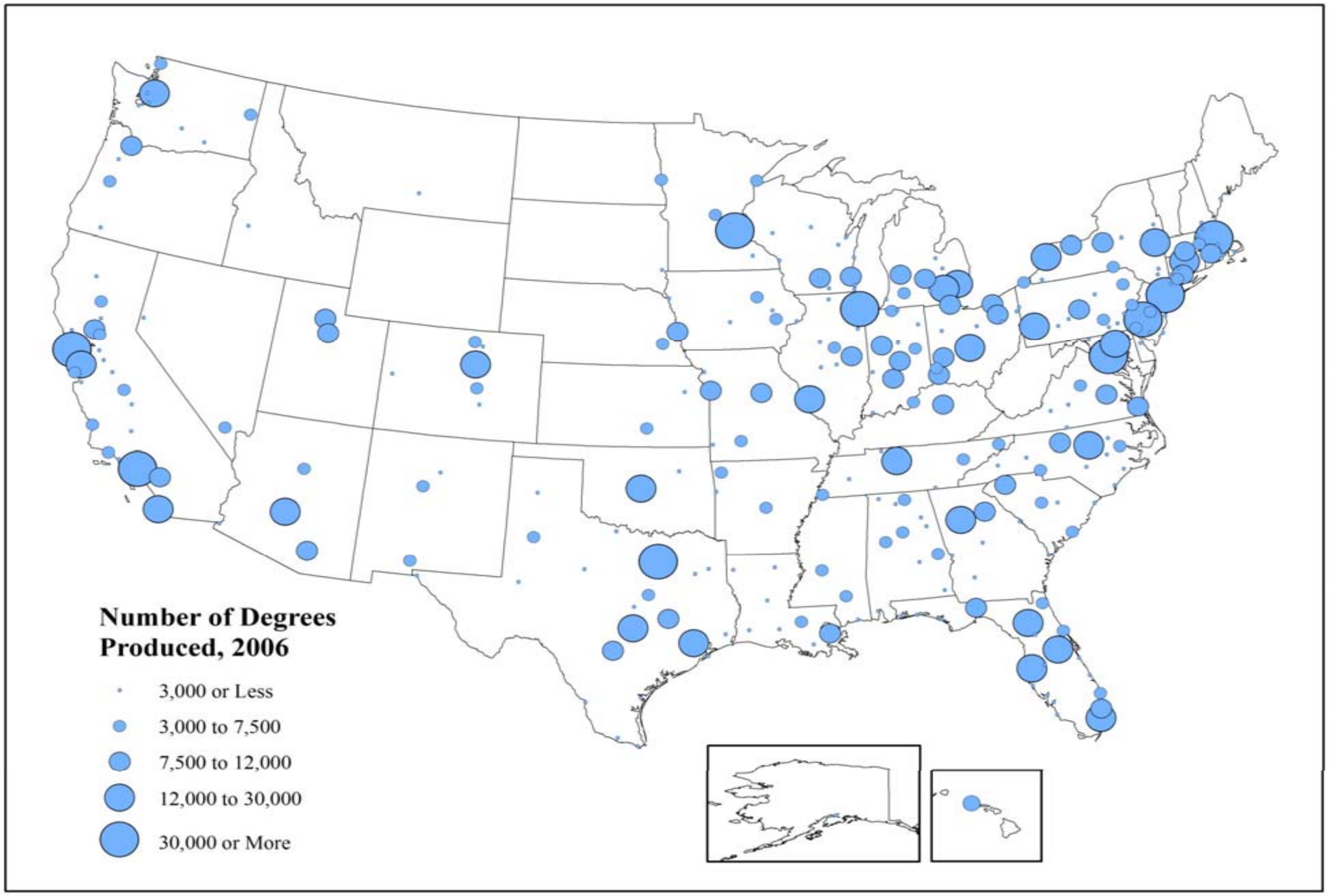
Occupational Category	Degree Production Rate	Research Intensity	Local Specialization	Adj. R-squared	N
Life, Physical, and Social Science	0.031 **	0.581 ***	-0.002	0.42	517
	(2.17)	(11.84)	(-0.87)		
Legal	-0.023 **	0.268 ***	0.051 **	0.27	517
	(-2.37)	(3.69)	(2.58)		
Education, Training, and Library	0.068 *	-0.055	-0.001	0.30	499
	(1.89)	(-0.56)	(-0.11)		
Community and Social Services	0.021 ***	-0.084 *	0.004 *	0.41	532
	(2.98)	(-1.83)	(1.87)		
Computer and Math	-0.019	0.700 ***	0.066 ***	0.39	522
	(-1.48)	(8.72)	(6.08)		
Architecture and Engineering	-0.058 ***	0.291 ***	0.035 ***	0.30	528
	(-5.16)	(4.65)	(5.54)		
Business and Financial Operations	-0.028 ***	0.299 ***	0.002	0.31	535
	(-3.30)	(7.78)	(1.27)		
Healthcare Practitioner and Technical	0.020 **	-0.073 ***	0.001	0.18	526
	(2.42)	(-2.60)	(1.04)		
Arts, Design, Entertainment, Sports, and Media	0.016 **	0.233 ***	0.004	0.32	536
	(2.14)	(4.70)	(1.53)		
Management	-0.013 ***	0.164 ***	0.002 **	0.68	537
	(-2.69)	(7.70)	(2.16)		
Sales	-0.002	-0.042 ***	-0.001	0.21	538
	(-0.51)	(-3.32)	(-0.24)		
Protective Service	-0.033 ***	0.047	0.003	0.38	522
	(-4.61)	(1.64)	(0.48)		
Office and Administrative Support	0.002	0.042 ***	0.005	0.25	538
	(0.55)	(2.75)	(0.43)		
Personal Care and Service	0.015 *	-0.009	0.009	0.36	536
	(1.74)	(-0.33)	(1.15)		
Healthcare Support	0.012 *	-0.172 ***	0.086 ***	0.25	533
	(1.86)	(-4.60)	(2.86)		
Installation, Maintenance, and Repair	-0.019 ***	-0.071 ***	0.006 *	0.34	537
	(-4.58)	(-3.89)	(1.92)		
Production	-0.026 ***	-0.167 ***	-0.004	0.49	536
	(-3.05)	(-4.69)	(-0.91)		
Transportation and Material Moving	-0.026 ***	-0.089 ***	-0.002	0.31	533
	(-5.18)	(-3.68)	(-0.43)		
Food Preparation and Serving	0.027 ***	-0.101 ***	-0.003	0.23	538
	(5.30)	(-2.82)	(-0.09)		
Construction & Extraction	-0.014 **	-0.032	-0.142	0.41	538
	(-2.28)	(-1.39)	(-1.50)		
Building and Grounds Cleaning	0.012 ***	-0.026	0.112 **	0.28	537
	(2.71)	(-1.45)	(2.18)		

Notes: Dependent variable for each regression is the log-odds share of workers in stated occupational category. Models include state and year fixed effects. ***, **, and * denote significance at the .01, .05, and .10 levels, respectively. *t*-statistics in parentheses; computed using robust standard errors.

Table 6: Change in Occupational Structure from Standardized Changes in Higher Education Activities

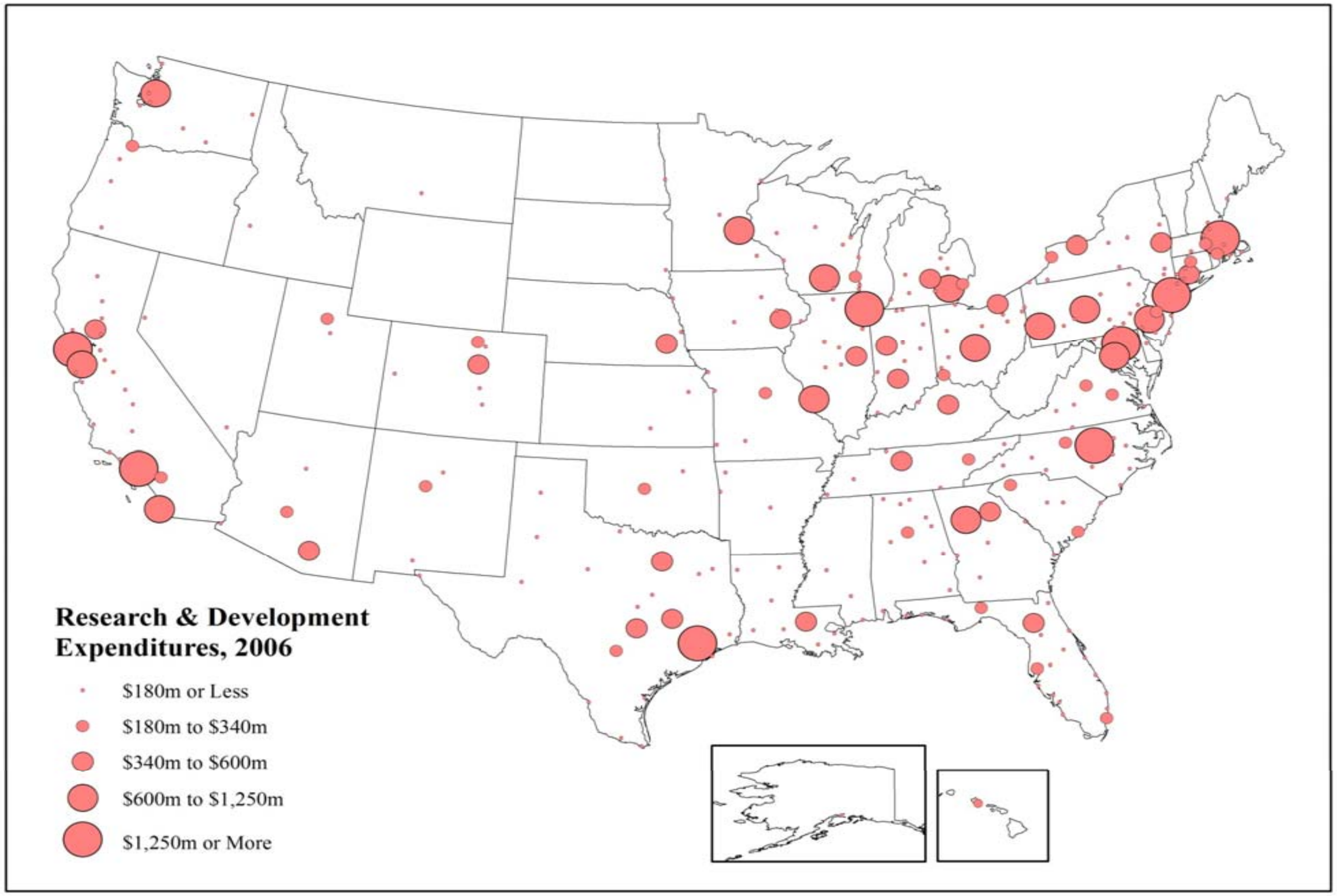
Human Capital Classification	Occupational Category	Mean Employment Share	One Standard Deviation Change in Degree Production Rate	Projected Employment Share	One Standard Deviation Change in Research Intensity	Projected Employment Share	One Standard Deviation Change in Local Specialization	Projected Employment Share
High	Life, Physical, and Social Science	0.76	6.44%	0.81	27.57%	0.97	-1.94%	0.75
	Legal	0.60	-4.80%	0.57	12.69%	0.67	12.48%	0.67
	Education, Training, and Library	6.27	14.17%	7.16	-2.61%	6.11	-0.52%	6.24
	Community and Social Services	1.28	4.39%	1.34	-3.98%	1.23	1.99%	1.31
	Computer and Math	1.72	-4.02%	1.65	33.18%	2.29	19.32%	2.06
	Architecture and Engineering	1.76	-12.04%	1.55	13.80%	2.01	16.76%	2.06
	Business and Financial Operations	3.45	-5.81%	3.25	14.18%	3.94	2.42%	3.53
	Healthcare Practitioner and Technical	5.29	4.09%	5.50	-3.44%	5.10	1.19%	5.35
	Arts, Design, Entertainment, Sports, and Media	1.04	3.32%	1.08	11.06%	1.16	2.90%	1.07
	Management	4.94	-2.69%	4.81	7.79%	5.32	2.24%	5.05
Low	Sales	10.79	-0.39%	10.75	-1.99%	10.58	-0.12%	10.78
	Protective Service	2.18	-6.98%	2.03	2.22%	2.23	0.64%	2.19
	Office and Administrative Support	17.20	0.33%	17.26	2.00%	17.55	0.37%	17.26
	Personal Care and Service	2.27	3.07%	2.34	-0.42%	2.26	1.71%	2.31
	Healthcare Support	2.69	2.42%	2.75	-8.18%	2.47	1.83%	2.74
	Installation, Maintenance, and Repair	4.28	-3.91%	4.11	-3.37%	4.14	0.56%	4.30
	Production	8.90	-5.42%	8.41	-7.91%	8.19	-0.79%	8.83
	Transportation and Material Moving	7.32	-5.33%	6.93	-4.22%	7.01	-0.24%	7.31
	Food Preparation and Serving	8.80	5.64%	9.30	-4.79%	8.38	-0.07%	8.80
	Construction and Extraction	5.09	-2.83%	4.94	-1.52%	5.01	-0.73%	5.05
	Building and Grounds Cleaning	3.36	2.55%	3.44	-1.25%	3.32	1.57%	3.41
	Share of High Human Capital Occupations	27.11		27.71		28.81		28.08
	Percentage Change from Mean Share	--		2.2%		6.2%		3.6%

Figure 1: Geographic Distribution of Higher Education Degrees Produced in U.S. Metropolitan Areas, 2006



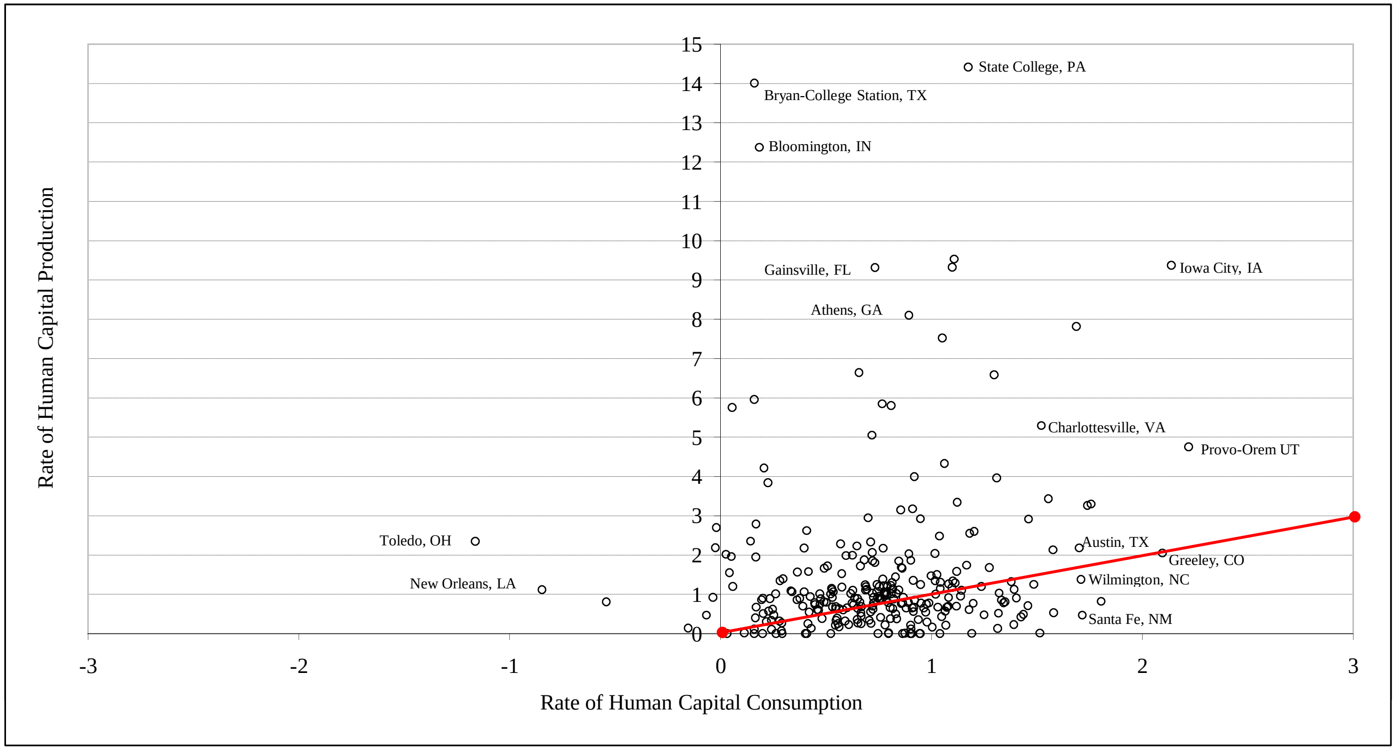
Source: IPEDS, National Center for Education Statistics.

Figure 2: Geographic Distribution of Academic R&D Expenditures in U.S. Metropolitan Areas, 2006



Source: Academic R&D Expenditures, National Science Foundation.

Figure 3: Balance of Human Capital Production and Consumption in U.S. Metropolitan Areas, 2000-2006



Notes: Rate of Human Capital Production is calculated as the average annual number of higher education degrees produced per 100 working-aged people in a metropolitan area. Rate of Human Capital Consumption is calculated as the average annual change in the number of people with at least a college degree per 100 working-aged people in a metropolitan area. Metropolitan areas above the red 45-degree line are net exporters (i.e., production > consumption), while those below the red 45-degree line are net importers (i.e, production < consumption) of human capital. Based on 283 metropolitan areas.

Sources: Integrated Postsecondary Education Data System (IPEDS), National Center for Education Statistics, U.S. Department of Education; United States Census (2000), U.S. Bureau of Census, IPUMS 5% Sample; American Community Survey (2006), U.S. Bureau of Cenus, IPUMS 1% Sample.