W.J. Usery Workplace Research Group Paper Series

Working Paper 2008-10-1
October 2008

Why Are Smart Cities Growing? Who Moves and Who Stays

John V. Winters
Georgia State University

Georgia State University
Andrew Young School
of Policy Studies

Why Are Smart Cities Growing? Who Moves and Who Stays

John V. Winters*

October 8, 2008

Abstract

This paper examines why smart cities are growing by exploring the relationship between the college share in a city and migration to and from the city. The results suggest that the greater in-migration to smart cities is almost entirely due to persons moving to pursue higher education. Smart cities are growing because in-migrants often stay in the city after completing their education. The growth of smart cities is also mostly attributable to population redistribution within the same state and has little effect on population growth at the state level.

JEL Classification: R11, R23

Keywords: population growth, migration, human capital, college education, smart cities

*Department of Economics, Andrew Young School of Policy Studies, Georgia State University,
PO Box 3992, Atlanta, GA 30302-3992, Phone (404) 413-0268, Fax (404) 413-0270, E-mail
ecojvwx@langate.gsu.edu

1. Introduction

A considerable body of literature has shown that the stock of human capital in a metropolitan area, measured as the share of the adult population with a college degree, is a strong predictor of future population growth.[1] Berry and Glaeser (2005) also show that the share of the adult population with college degrees has increased more quickly in cities with higher initial levels of schooling.[2] There is still no consensus, however, as to why "smart cities" are growing. A popular hypothesis is that cities with high levels of human capital have higher productivity, perhaps in part due to knowledge spillovers. Several studies have shown that wages in highly educated cities are higher than in less educated cities, even after controlling for individual worker characteristics (e.g. Rauch 1993; Moretti 2004a; Glaeser and Saiz 2004), though the extent to which this represents knowledge spillovers is questioned by some.[3] Another explanation for the connection between population growth and human capital is that an educated populace makes a city more attractive and people flock to the city for the higher quality of life (Shapiro 2006).

In this paper, I explore the reasons why smart cities are growing by looking at who moves to smart cities. Smart cities are often small and mid-size metropolitan areas containing flagship state universities. This suggests that students moving to pursue higher education may play an important role in the growth of smart cities.[4] I investigate this hypothesis by examining the relationships between migration and the share of the adult population who are college graduates separately for individuals enrolled in higher education and for individuals not enrolled.

---

[1] See, for example, Glaeser, Scheinkman, and Schleifer (1995); Simon (1998, 2004); Duncan and Henderson (1999); Simon and Nardinelli (2002); Glaeser and Shapiro (2003); Glaeser and Saiz (2004); and Shapiro (2006).

[2] Throughout this paper, I use the terms city and metropolitan area interchangeably.

[3] For reviews of the literature on human capital externalities, see Moretti (2004b) Lange and Toppel (2006), and Henderson (2007).

[4] De la Garza (2008) suggests that the growth of smart cities is not solely due to the growth of college towns, but his categorization of cities as college towns is a less direct way of examining the role played by enrollment than the approach taken here.

The results suggest that nearly all of the total in-migration to high human capital cities is due to persons pursuing higher education. It seems likely, though, that many of those who move to pursue higher education will leave the metropolitan area after their education is complete, and I find that high human capital cities also have high rates of out-migration. On net, though, high human capital cities gain more people than they lose. The suggestion is that a large number of people relocate to pursue higher education and end up staying in the same city after finishing their education. This finding explains much of the population growth of smart cities in recent years.

I also find that the bulk of net migration to high human capital cities comes from within the same state. This has important implications for state policy makers. Population growth in high human capital cities does not equate to population growth at the state level. Instead, the growth of high human capital cities is largely due to population redistribution within the state.

2. A Closer Look at Smart Cities

To gain a better understanding of why smart cities are growing, it is useful to understand why some cities have initially high levels of human capital in the first place. One possibility is that cities that surround major universities will have a more educated populace. Table 1 lists the top 20 cities (out of 331) by the share of adults (age 25 and over) with at least a bachelor's degree in 1990.[5] Iowa City, Iowa tops the list with an impressive 44.0 percent of adults with college degrees, while State College, Pennsylvania ranks 20th of the 331 cities with 32.3 percent. Interestingly, a number of the most educated cities are relatively small metropolitan areas surrounding major public universities. Iowa City is home to the University of Iowa and State College is home to the Pennsylvania State University. Additionally, Boulder is home to the

---

[5] Data come from the Department of Housing and Urban Development (HUD) State of the Cities Data System based on the 1990 Census of Population and Housing.

University of Colorado, Corvallis to Oregon State University, Lawrence to the University of Kansas, Columbia to the University of Missouri, Bryan-College Station to Texas A&M, Gainesville to the University of Florida, Madison to the University of Wisconsin, Champaign-Urbana to the University of Illinois, Charlottesville to the University of Virginia, Bloomington to the University of Indiana, and Tallahassee to Florida State University.

The fact that many of the most educated cities are home to major universities suggests that much of the growth of smart cities may be attributable to the role smart cities play as centers of higher education. I explore this possibility in subsequent sections by examining the relationships between migration and the share of the adult population who are college graduates separately for individuals enrolled in higher education and for individuals not enrolled.

3. Empirical Framework

Most studies interested in the growth of smart cities look at population growth over decennial years. Very few studies, however, examine who is moving to high human capital cities.[6] In this study, I hope to gain insight on why smart cities are growing by looking at who moves to smart cities. I look at migration directly, instead of population growth as is usually done. More specifically, I estimate:

$$(1) \qquad M_{in,j} = \beta_{in}S_j + \Gamma_{in}Z_j + \varepsilon_{in,j},$$

where $M_{in,}j$ is the rate of in-migration to city j, S_j is the share of the adult population with college degrees in the city, Z_j is a vector of other variables found in previous literature to affect city population growth, and $\varepsilon_{in,j}$ is a mean zero error term. Following previous literature, time-varying explanatory variables are measured with a ten year lag so that they are not affected by migration during the period under consideration. Because high human capital cities are often

---

[6] To my knowledge Berry and Glaeser (2005) is the only exception. In that study, they look separately at logarithmic changes in the college educated population and the non-college educated population, but they do not look specifically at migration.

centers of higher education, I also expect that the human capital level in a city will be correlated with the rate of out-migration and estimate:

(2) $M_{out, j} = \beta_{out} S_j + \Gamma_{out} Z_j + \varepsilon_{out, j}$,

where "out" subscripts the out-migration rate and its corresponding coefficients and error term. A city will grow if the rate of in-migration exceeds the rate of out-migration. Thus, I also estimate the determinants of the net migration rate, obtained by subtracting (2) from (1):

(3) $M_{net, j} = \beta_{net} S_j + \Gamma_{net} Z_j + \varepsilon_{net, j}$,

where "net" subscripts the net migration rate and its corresponding coefficients and error term.

I first estimate the migration equations for the entire population, but this tells us little about who moves to high human capital cities. I, therefore, next estimate the migration equations separately for persons age 16 and over by whether they are enrolled in higher education. Computations from the Census 2000 Integrated Public Use Microdata Series (IPUMS) reveal that roughly 16 percent of all persons age 16 and over who lived in a different city in 2000 than in 1995 were enrolled in higher education in 2000. If high human capital cities are growing because individuals move there to pursue higher education, then migration by those enrolled in college may constitute a disproportionately large share of the total in-migration to high human capital cities. To add further evidence to my story, I also estimate the migration equations separately by five year age groups. I further explore who moves to smart cities and who stays by estimating separate equations for individuals who move from within the same state and individuals who move from another state or country.

4. Data

The migration data used in this paper were constructed from the IPUMS (Ruggles et al. 2008) data for the 1980, 1990, and 2000 Censuses (5 % samples). The data for the percent of adults with a college degree, city population, median family income, and the share of employment in manufacturing come from two sources. For 1980 and 1990, the data for these variables come from the HUD State of the Cities Data System and are based on 1999 Primary Metropolitan Statistical Area definitions, while the 1970 data come from the 1972 County and City Data Book archived at the Inter-university Consortium for Political and Social Research (ICPSR) and are based on 1981 Standard Metropolitan Statistical Area definitions. Data on temperature and precipitation come primarily from the 2007 County and City Data Book where metropolitan area values were assigned based on the values for their principal cities. For cities missing information in the 2007 County and City Data Book, information was obtained from the 2000 and 1988 County and City Data Books. Metropolitan areas that crossed regions were assigned to the region in which the major principal city is located.

One complication with my analysis is that the IPUMS data do not allow identification of geographic areas with populations less than 100,000. As a result, the lowest level of identifiable geography in the IPUMS data, PUMAs in the 1990 and 2000 samples (county groups in the 1980 sample), often include both metropolitan and non-metropolitan areas.[7] I, therefore, assign each PUMA (county group in 1980) to a metropolitan area if more than 50 percent of the population of the PUMA (county group) is contained within the metropolitan area. Using this procedure, identifies 323 metropolitan areas in 2000, 298 in 1990, and 276 in 1980.

A person is considered a migrant if they lived in a different metropolitan area in the census year than they did five years prior. Gross in-migration to a city was computed by adding up the total number of migrants to a city using person weights. The same was done to compute gross out-migration from a city. Note, however, that persons who exit the country are not in the

---

[7] Note also that PUMAs of previous residence often include more than one PUMA of current residence. To have consistent metropolitan boundaries, PUMAs of current residence were aggregated to correspond with PUMAs of previous residence.

sample, and hence out-migration does not include international out-migration. Checks of robustness suggest that international out-migration has little effect on the results. Net migration was computed as gross in-migration minus gross out-migration. Gross in-migration rates are computed by dividing gross in-migration by the population of the city, defined according to PUMA (county group) boundaries consistent with the migration flows, five years prior to the census. The same is done to compute gross out-migration rates and net migration rates. When I split the migrant flows by enrollment status, age, and state of previous residence, I continue to use the total population of the city as the population base to allow for easier interpretation of each groups contribution to the overall flow.

5. Empirical Results

I first estimate the relationship between the share of adults with college degrees in 1990 and in-migration, out-migration, and net migration between 1995 and 2000.[8] Table 2 presents the results of the estimating equations both with and without additional controls. The first column of Table 2 presents the effect of the college share on the gross in-migration rate. As seen, there is a strong positive correlation between the in-migration rate and the share of adults with a college degree. The coefficient estimate of 0.522 suggests that increasing the college share by 0.1 increases the in-migration rate by .05. If, however, many of those who move to highly educated cities do so to pursue higher education, we would expect the share of adults with college degrees to be positively correlated with the out-migration rate as well. This is exactly what we find in the second column of Table 2.[9] Absent differences in fertility and mortality, a city grows if more people move to the city than leave the city.[10] Therefore, the effect of the

---

[8] Corresponding estimates for 1975-1980 and 1985-1990 are qualitatively similar and are available upon request.

[9] However, other hypotheses could also explain the high out-migration from high human capital cities.

[10] Fertility and mortality rates may also differ with the local human capital level, but I ignore such differences in this paper and instead focus on migration to and from high human capital cities.

share of adults with college degrees on the net migration rate tells us whether or not high human capital cities are growing. As seen in the third column, the correlation between the net migration rate and the college share is strongly positive. While the human capital level is correlated with both the extent to which people enter and leave the city, on net city population growth is increasing with the share of the adult population with a bachelor's degree or higher.

As seen in the fourth, fifth, and sixth columns of Table 2, adding additional controls actually increases the coefficients on the human capital variable. The in-migration coefficient increases from 0.522 to 0.735, the out-migration coefficient increases from 0.310 to 0.435, and the net-migration coefficient increases from 0.212 to 0.300. The additional controls also appear to have an important effect on migration and growth. Population and median family income in 1990 appear to have a negative effect on in-migration, out-migration, and net migration, though the effect of family income on net migration is not significant. Increases in the average January daily low temperature increase both the in-migration rate and the net migration rate. Similarly, increases in average July daily high temperature have a significantly positive effect on net migration. Both are consistent with the on-going movement of population in the U.S. from colder to warmer places. None of the remaining variables has a significant effect on net migration, though they do occasionally have a significant effect on in-migration or out-migration. Henceforth, I discuss only the results for the share of adults with a college degree, and the results for the additional explanatory variables are relegated to the appendix.

5.1 Migration by Enrollment in Higher Education

The growth of high human capital cities may be partially attributable to the fact that high human capital cities are often centered around large flagship state universities. Flagship universities are likely to draw students from all over the state and to some extent from other states and countries (Alm and Winters 2007). I next estimate the separate effects of the human capital level on migration rates of persons enrolled in higher education and persons not enrolled. Data limitations only allow us to know whether an individual is enrolled in the year of the sample (e.g. 2000), so our estimates may understate the role that enrollment plays in the growth of smart cities. Measuring migration over a five year period makes this especially possible as some people are likely to complete degrees in four years or less and stay in the city after completing their degree. Note also that the migration rates in this section include only people age 16 and over. However, including persons under 16 in the not enrolled group does little to change the results.

The upper panel (A) of Table 3 presents the results for migration by enrollment between 1995 and 2000. According to the results, the share of adults with at least a bachelor's degree has a strong positive correlation with the in-migration of persons enrolled in college. For persons not enrolled in college, the share of college educated adults has only a small positive effect on in-migration that is not statistically significant. This is an interesting result. People are moving in large numbers to high human capital cities, but persons pursuing higher education represent the overwhelming majority of such migrants. This is perhaps even more impressive given that persons enrolled in higher education represented only about 16 percent of all migrants age 16 and over between 1995 and 2000.

The results from Table 2 also suggested that high human capital cities have high rates of out-migration. Looking separately at out-migration rates by college enrollment tells us who is leaving smart cities. As seen in the second and fifth columns of Table 3, the human capital level in a city significantly increases the out-migration of both those enrolled in higher education and those who are not. The effect, however, is much larger for those not enrolled. The suggestion seems to be that individuals move to high human capital cities for higher education, but many of them leave after completing their education. Consistent with this hypothesis, the share of adults who are college educated is positively correlated with the net migration rate of those enrolled, but negatively correlated with the net migration rate of those not enrolled. Note, however, that the net migration coefficient for the enrolled is larger in absolute value than the coefficient for those not enrolled, consistent with our finding in Table 2 that overall net migration is increasing with the level of human capital. In other words, high human capital cities are growing faster than less skilled cities.

Panels B and C of Table 3 replicate the results in Panel A using migration between 1985 and 1990 and 1975 and 1980, respectively. In Panel B independent variables are measured as of 1980, and in Panel C, independent variables are measured as of 1970. The results for the human capital variable in Panels B and C are qualitatively similar to those in Panel A with one exception. For in-migration between 1985 and 1990, the coefficient for those not enrolled is statistically significant and larger than in the other years. The effect, however, is still much smaller than the effect for those who are enrolled. Furthermore, "not enrolled" likely includes some persons who previously were enrolled and stayed in the city after completing their education. The results for 1975-1980 and 1985-1990 reaffirm the importance that enrollment has played in the growth of high human capital cities.

5.2 Migration by Age Group

As further evidence of why smart cities are growing, I next look at migration by five year age groups between 1995 and 2000. Table 4 presents the results for the effect of the share of adults with a college degree on in-migration, out-migration, and net migration, but the regressions also contain the other variables included previously. The full results are available upon request. I discuss the main results from Table 4 only briefly.

Evidence in the previous section suggests that individuals are moving to smart cities primarily for higher education. This suggests that the age distribution of persons moving to high human capital is likely to be skewed towards persons in their primary college-going years. Table 4 confirms this expectation. In-migration to high human capital cities is highest for the 20-24 age group followed by the 15-19 and 24-29 age groups. Older and younger age groups have much lower rates of in-migration to high human capital cities and some are even negative.

Previous evidence also suggests that workers often leave after completing their education. Thus we might expect there to be higher rates of out-migration from high human capital cities for persons in age groups for which people are likely to have recently completed a degree (or perhaps dropped out of school). The out-migration estimates in Table 4 again confirm this hypothesis. The effect on out-migration is highest for persons in the 25-29 age group followed by persons in the 30-34 and 20-24 age groups.

The results in the third column of Table 4 suggest that on net high human capital cities are gaining workers in their peak college-going years (15-19 and 20-24) and losing workers who have recently finished their education (25-29 and 30-34). However, the inflow of the younger cohorts exceeds the outflow of the older cohorts. Thus, looking at migration by age provides further evidence that smart cities are growing because some of the individuals who move for higher education stay in the city after completing their education.

5.3 Migration by Previous Residence

I next examine whether smart cities are growing by gaining migrants from other states and countries or by gaining migrants from within the same state. We might expect much of the migration to smart cities to come from within the same state since smart cities often contain large state universities that get a large share of their enrollment from within the state. In Table 5 I estimate the effect of the human capital level in a city on migration separately for persons who moved from within the same state and for persons who did not.[11] The results in the first and fourth columns suggest that roughly 63 percent of the differential gross in-migration to high human capital cities is from persons within the same state. The remaining portion results from persons moving from other states and other counties. The results in the second and fifth columns, however, suggest that high human capital cities lose about as many people to other areas within the same state as they do to areas outside of the state. As a result, the effect of the local human capital stock on positive net migration is largely attributable to persons moving from within the same state as shown in the third and sixth columns. According to the estimates, within state moves account for more than 78 percent of the effect of the human capital stock on total net migration, and we cannot reject the hypothesis that net migration from areas outside the state is unaffected by the local human capital level. Importantly, this suggests that population growth in high human capital cities may not result in population growth at the state level. Similarly, Burtless (2004) shows that the strong positive correlation between the human capital stock and future population growth found across metropolitan areas does not hold at the state level, at least for the period from 1990 through 2000. His estimates suggest that the share of college educated adults in a state has virtually no effect on future population growth in the state.

---

[11] For metropolitan areas that crossed state boundaries, I considered the move to be within state if the portion of the metropolitan area in which the individual lived was in the same state as that in which they moved to or from. For example, a person moving from Topeka, Kansas to Kansas City, Kansas would be classified as an in-state mover. However, someone moving from Topeka to Kansas City, Missouri would be classified as an interstate mover, even though Kansas City, Kansas and Kansas City, Missouri are in the same metropolitan area. The same holds for out-migration as well.

These findings have important implications for policy makers. High human capital cities are growing primarily by gaining young people pursuing higher education from other areas within the same state. Thus, the growth of smart cities partially involves an intrastate "brain drain" from areas without higher education institutions to areas with higher education institutions. Over time, this can have important effects in redistributing skilled workers within a state. If the current pattern continues to hold, areas with a comparative advantage in higher education will continue to thrive while areas that offer little higher education opportunities are likely to be less successful.

5.4. Migration by U.S. Born

One concern discussed above is that we do not observe people who leave the country. If large numbers of students come to the U.S. for higher education and then leave once their education is complete, my estimates will overstate the growth effects of human capital and will over-attribute growth to persons moving for higher education. To see if this is driving the results I re-estimate the migration by enrollment equations for the 1995-2000 period including only persons born in the U.S. The results are reported in Table 6. Comparing the results to Panel A of Table 3, the coefficients on the share of adults with a college degree decrease slightly in all columns, but the results are qualitatively the same. The bulk of those moving to smart cities are enrolled in college, the bulk of those leaving smart cities are not, and smart cities gain more people than they lose causing them to grow.

5.5. Increased Enrollment as an Alternative Explanation

The evidence thus far has been interpreted to suggest that smart cities are growing because many of the people who move to high human capital cities to pursue higher education end up staying in the city after their education is complete. An alternative explanation that could also be consistent with the evidence in previous sections is that high human capital cities are growing because they have experienced larger increases in enrollment (and hence higher rates of in-migration) in higher education than low human capital cities. In other words, increased enrollment could cause population growth even if all students leave the city after completing their education. To examine this possibility, I look at changes in the number of people in a city by college enrollment between 1990 and 2000 using data from the USA Counties database with metropolitan areas now measured as New England County Metropolitan Areas (NECMA) in New England and PMSA/MSAs outside of New England according to 1999 metropolitan area definitions. More specifically, I estimate:

$$(4) \qquad (Pop_{enr,j,t+1} - Pop_{enr,j,t})/ Pop_{j,t} = \beta_{enr}S_{j,t} + \Gamma_{enr}Z_{j,t} + \varepsilon_{enr,j},$$

and

$$(5) \qquad (Pop_{not,j,t+1} - Pop_{not,j,t})/ Pop_{j,t} = \beta_{not}S_{j,t} + \Gamma_{not}Z_{j,t} + \varepsilon_{not,j},$$

where $Pop_{enr,j,t+1}$ is the number of people in city j enrolled in higher education in time t+1, $Pop_{not,j,t+1}$ is the number of people in city j not enrolled in higher education in time t+1, $Pop_{j,t}$ is the total population in city j in time t, and Z is the vector of additional explanatory variables included previously.

The total effect of the human capital stock on population growth is equal to the sum of β_{enr} and β_{not} in (4) and (5). If the growth of high human capital cities is entirely due to increases in enrollment without at least some student in-migrants staying after completing their education, then β_{not} should equal zero. The results from (4) and (5) are reported in Table 7. The results suggest that high human capital cities experience larger increases in the numbers of both enrolled persons and non-enrolled persons than low human capital cities. More than 75 percent of the total effect, however, is attributable to changes in the number of people not enrolled.[12] Thus, while the growth of smart cities is partially attributable to greater increases in enrollment in smart cities, the bulk of the growth of smart cities is not. The largest source of population growth for smart cities appears to be that a large number of persons move to high human capital cities for higher education and then stay in the city after their education is complete.

6. Discussion

A question not fully answered in this paper is why people stay in high human capital cities after completing their education. Perhaps smart cities are more desirable because of higher wages or higher quality of life. If so, why are non-students not moving to smart cities in large numbers? Agglomeration economies such as knowledge spillovers may partially explain why wages are higher in smart cities, but do not explain why non-students are not moving to smart cities.

One hypothesis consistent with the work of DaVanzo (1983), Berry and Glaeser (2005), Boyd et al. (2005), Krupka (2007), and Krupka and Smith (2008) that might explain these findings is that some individuals stay after completing their education because of location-specific human capital. After living in a city for a few years, individuals may have gained knowledge that makes them more productive locally than elsewhere. Networks with professors and other students and employment experience with local companies through internships and student working might make some recent graduates more productive locally. Along these lines, Berry and Glaeser (2005) develop a model where entrepreneurs are relatively immobile because

---

[12] Note, however, that the total effect of the college share on population growth in Table 7 (0.399) is less than twice the effect of the college share on net migration in the last column of Table 2 (0.300). This may partially result from much larger coefficients on amenities and region dummies in the second column of Table 7 suggesting that amenities may have played a greater role in population growth between 1990 and 1995. When the regressions in Table 7 are estimated with only the college share as an explanatory variable, the total effect (0.400) is roughly twice that of the coefficient for net migration in the third column of Table 2. Also, the share of population growth attributed to increased enrollment falls to less than 12 percent when only the college share is included as an explanatory variable.

their innovations are location-specific. Thus, existing residents may be more productive in a city than people who have never lived there.

Recent migrants may also develop location-specific human capital in consumption. Having completed their education, people may stay in the same city because they have developed friendships and a taste for local amenities that makes living in the city more enjoyable. Thus, the quality of life in a city may be higher for existing residents than for individuals who have never lived in the city.

7. Conclusion

This paper examines why smart cities are growing by examining who moves to smart cities. I find that in-migration to smart cities is almost entirely accounted for by persons enrolled in higher education suggesting that individuals are moving to smart cities for education. Upon completing their education, however, not all persons leave the city to which they have recently moved. Many appear to stay in the city after their education is complete causing smart cities to grow faster than low human capital cities. Evidence also suggests that smart cities are growing primarily by gaining people from other areas within the same state and not from areas outside the state. Location-specific human capital in both production and consumption may explain why recent migrants stay after completing their education, but non-students are not moving to smart cities in large numbers.

References

Alm, James and John V. Winters, “Distance and Intrastate College Student Migration,” Mimeo, (2007).

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

Black, Duncan, and Vernon Henderson, “A Theory of Urban Growth,” *Journal of Political Economy* 107:2 (1999), 252–284.

Boyd, Donald, Hamilton Lankford, Susanna Loeb, and James Wyckoff, “The Draw of Home: How Teachers’ Preferences for Proximity Disadvantage Urban Schools,” *Journal of Policy Analysis and Management* 24:1 (2005), 113–132.

Burtless, Gary, “Comment on The Rise of the Skilled City,” *Brookings-Wharton Papers on Urban Affairs* (2004), 95-99.

DaVanzo, Julie, “Repeat Migration in the United States: Who Moves Back and Who Moves On?” *The Review of Economics and Statistics*, 65:4 (1983), 552–559.

De la Garza, Adrián G., “Do Smart Cities Grow Faster?” Mimeo, (2008).

Glaeser, Edward L. and Albert Saiz, “The rise of the Skilled City,” *Brookings-Wharton Papers on Urban Affairs* (2004), 47–94.

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

Glaeser, Edward L., and Jesse M. Shapiro, “Urban Growth in the 1990s: Is City Living Back?” *Journal of Regional Science* 43:1 (2003), 139–165.

Henderson, J. Vernon, “Understanding Knowledge Spillovers,” *Regional Science and Urban Economics* 37:4 (2007), 497–508.

Krupka, Douglas J., “Location-Specific Human Capital, Location Choice and Amenity Demand,” IZA Discussion Paper no. 2987 (2007).

Krupka, Douglas J. and William J. Smith, “Amenities, Migration, and Location-Specific Human Capital,” Mimeo, (2008).

Lange, Fabian, and Robert Topel, “The Social Value of Education and Human Capital” (Chapter 8), in E. Hanushek and F. Welch, (Eds.), *Handbook of the Economics of Education* (Elsevier, 2006).

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

______ “Human Capital Externalities in Cities” (chapter 8), in J. Vernon Henderson and Jacques-Franois Thisse (Eds.), *Handbook of Urban and Regional Economics* (North Holland–Elsevier, 2004b).

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

Ruggles, Steven, Matthew Sobek, Trent Alexander, Catherine A. Fitch, Ronald Goeken, Patricia Kelly Hall, Miriam King, and Chad Ronnander. Integrated Public Use Microdata Series: Version 4.0 [Machine-readable database]. Minneapolis, MN: Minnesota Population Center [producer and distributor], 2008.Shapiro, Jesse M., “Smart Cities: Quality of Life, Productivity, and the Growth Effects of Human Capital,” *The Review of Economics and Statistics*, 88:2, 324–335.

Simon, Curtis J., “Human Capital and Metropolitan Employment Growth,” *Journal of Urban Economics* 43:2 (1998), 223–243.

______ “Industrial Reallocation across U.S. Cities, 1977–97,” *Journal of Urban Economics* 56:1 (2004), 119–143.

Simon, Curtis J. and Clark Nardinelli, “Human Capital and the Rise of American Cities, 1900–1990,” *Regional Science and Urban Economics* 32:1 (2002), 59–96.

U.S. Department of Commerce, Bureau of the Census, *County and City Data Book* (Washington, DC: U.S. Bureau of the Census, 1988).

______ *County and City Data Book* (Washington, DC: U.S. Bureau of the Census, 2000).

______ *County and City Data Book* (Washington, DC: U.S. Bureau of the Census, 2007).

______ *County and City Data Book Consolidated File: County Data, 1947-1977*, ICPSR version, Washington, DC: U.S. Dept. of Commerce, Bureau of the Census [producer], 1978, Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2008-04-01.

U.S. Department of Commerce, Bureau of the Census, *USA Counties*, http://www.census.gov/support/DataDownload.htm/ Accessed August 7, 2008.

U.S. Department of Housing and Urban Development, *State of the Cities Data System*, http://socds.huduser.org/ Accessed September 7, 2008.

Table 1: The 20 Most Educated Cities in 1990

Rank	MSA/PMSA	% with Bachelor's Degree or Higher
1	Iowa City, IA MSA	44.0
2	Stamford-Norwalk, CT PMSA	43.1
3	Boulder-Longmont, CO PMSA	42.8
4	Corvallis, OR MSA	41.3
5	Lawrence, KS MSA	38.4
6	Washington, DC-MD-VA-WV PMSA	37.0
7	Columbia, MO MSA	36.5
8	Bryan-College Station, TX MSA	35.8
9	Danbury, CT PMSA	35.8
10	Santa Fe, NM MSA	35.7
11	San Francisco, CA PMSA	34.9
12	Gainesville, FL MSA	34.6
13	Madison, WI MSA	34.2
14	Champaign-Urbana, IL MSA	34.1
15	Charlottesville, VA MSA	33.3
16	Bloomington, IN MSA	32.9
17	San Jose, CA PMSA	32.6
18	Tallahassee, FL MSA	32.4
19	Boston, MA-NH PMSA	32.3
20	State College, PA MSA	32.3

Table 2: Migration to and from Metropolitan Areas, 1995-2000

	In	Out	Net	In	Out	Net
Share with bachelor's degree	0.522**	0.310**	0.212**	0.735**	0.435**	0.300**
	(0.066)	(0.043)	(0.039)	(0.089)	(0.057)	(0.063)
Population				-0.022**	-0.016**	-0.006**
				(0.004)	(0.003)	(0.002)
Median family income				-0.002*	-0.002**	-0.000
				(0.001)	(0.001)	(0.001)
Manufacturing share				-0.073	-0.109**	0.036
				(0.056)	(0.041)	(0.044)
January temperature				0.102*	0.005	0.097*
				(0.044)	(0.026)	(0.038)
July temperature				0.120	-0.063	0.183*
				(0.075)	(0.041)	(0.072)
Precipitation				0.032	-0.007	0.040
				(0.038)	(0.028)	(0.026)
Midwest				0.023**	0.015**	0.007
				(0.008)	(0.006)	(0.006)
South				0.017	0.016*	0.001
				(0.010)	(0.008)	(0.008)
West				0.038*	0.021	0.017
				(0.015)	(0.011)	(0.011)
Constant	0.086**	0.099**	-0.013	-0.029	0.205**	-0.234**
	(0.013)	(0.009)	(0.008)	(0.076)	(0.046)	(0.069)
R^2	0.21	0.17	0.09	0.49	0.45	0.29

Notes: All regressions contain 323 PMSA/MSA observations. Time-varying explanatory variables are measured as of 1990. Huber-White robust standard errors in parentheses.

* Significant at 5%; ** Significant at 1%.

Table 3: Migration by Enrollment in Higher Education

	Enrolled in Higher Education			Not Enrolled in Higher Education		
	In	Out	Net	In	Out	Net
A. 1995-2000						
Share with bachelor's degree	0.654**	0.080**	0.574**	0.075	0.349**	-0.274**
	(0.073)	(0.011)	(0.064)	(0.052)	(0.042)	(0.063)
Observations	323	323	323	323	323	323
R^2	0.59	0.47	0.55	0.35	0.48	0.30
B. 1985-1990						
Share with bachelor's degree	0.714**	0.090**	0.624**	0.182**	0.351**	-0.168*
	(0.076)	(0.010)	(0.071)	(0.067)	(0.047)	(0.080)
Observations	298	298	298	298	298	298
R^2	0.62	0.56	0.56	0.38	0.48	0.30
C. 1975-1980						
Share with bachelor's degree	0.916**	0.114**	0.802**	0.039	0.491**	-0.452**
	(0.096)	(0.020)	(0.087)	(0.128)	(0.098)	(0.084)
Observations	276	276	276	276	276	276
R^2	0.49	0.10	0.56	0.17	0.07	0.41

Notes: All regressions also contain additional controls for population, median family income, manufacturing share, January temperature, July temperature, precipitation and region dummy variables with time-varying explanatory variables measured as of the previous decennial census. Huber-White robust standard errors in parentheses.
* Significant at 5%; ** Significant at 1%.

Table 4: Results of Human Capital Stock on Migration by Age Group, 1995-2000

	In	Out	Net
Age 5-9	0.004	0.005	-0.002
	(0.005)	(0.006)	(0.005)
Age 10-14	0.001	0.001	-0.000
	(0.004)	(0.004)	(0.005)
Age 15-19	0.167**	-0.007	0.173**
	(0.020)	(0.003)	(0.021)
Age 20-24	0.420**	0.064**	0.356**
	(0.050)	(0.012)	(0.040)
Age 25-29	0.105**	0.248**	-0.144**
	(0.010)	(0.033)	(0.029)
Age 30-34	0.039**	0.087**	-0.049**
	(0.007)	(0.009)	(0.010)
Age 35-39	0.017**	0.029**	-0.012
	(0.006)	(0.005)	(0.006)
Age 40-44	0.011*	0.013**	-0.002
	(0.005)	(0.004)	(0.005)
Age 45-49	0.013**	0.006*	0.006
	(0.005)	(0.003)	(0.005)
Age 50-54	0.003	0.006*	-0.003
	(0.005)	(0.002)	(0.005)
Age 55-59	-0.005	0.001	-0.007
	(0.005)	(0.002)	(0.005)
Age 60-64	-0.013*	-0.001	-0.011*
	(0.005)	(0.001)	(0.005)
Age 65-69	-0.012**	-0.004**	-0.008*
	(0.004)	(0.001)	(0.004)
Age 70-74	-0.007*	-0.004*	-0.003
	(0.003)	(0.002)	(0.002)
Age 75-79	-0.005*	-0.003*	-0.002
	(0.002)	(0.001)	(0.001)
Age 80-84	-0.001	-0.004**	0.003*
	(0.001)	(0.001)	(0.001)
Age 85+	-0.000	-0.004**	0.003*
	(0.001)	(0.001)	(0.001)

Notes: All regressions contain 323 PMSA/MSA observations and the additional explanatory variables included in Table 2. Time-varying explanatory variables are measured as of 1990. Huber-White robust standard errors in parentheses.

* Significant at 5%; ** Significant at 1%.

Table 5: Migration by Previous Residence, 1995-2000

	Same State			Different State or Country		
	In	Out	Net	In	Out	Net
Share with bachelor's degree	0.460**	0.225**	0.236**	0.275**	0.210**	0.065
	(0.083)	(0.054)	(0.049)	(0.073)	(0.047)	(0.056)
R^2	0.35	0.29	0.23	0.29	0.31	0.27

Notes: All regressions contain 323 PMSA/MSA observations and the additional explanatory variables included in Table 2. Time-varying explanatory variables are measured as of 1990. Huber-White robust standard errors in parentheses.

* Significant at 5%; ** Significant at 1%.

Table 6: Migration of U.S. Born by Enrollment, 1995-2000

	Enrolled in Higher Education			Not Enrolled in Higher Education		
	In	Out	Net	In	Out	Net
Share with bachelor's degree	0.579**	0.069**	0.510**	0.056	0.307**	-0.251**
	(0.065)	(0.010)	(0.057)	(0.047)	(0.039)	(0.055)
R^2	0.59	0.48	0.55	0.33	0.50	0.26

Notes: All regressions contain 323 PMSA/MSA observations and the additional explanatory variables included in Table 2. Time-varying explanatory variables are measured as of 1990. Huber-White robust standard errors in parentheses.

* Significant at 5%; ** Significant at 1%.

Table 7: Population Growth by Enrollment in Higher Education, 1990-2000

	Enrolled	Not Enrolled
Share with bachelor's degree	0.097**	0.302*
	(0.022)	(0.127)
R^2	0.29	0.38

Notes: All regressions contain 318 NECMA/PMSA/MSA observations and the additional explanatory variables in Table 2. Time-varying explanatory variables are measured as of 1990. Huber-White robust standard errors in parentheses. See text for details on computation of population growth by enrollment.

* Significant at 5%; ** Significant at 1%.

Table A1: Additional Results for Table 3, Panel A (1995-2000)

	Enrolled in Higher Education			Not Enrolled in Higher Education		
	In	Out	Net	In	Out	Net
Population	-0.007**	-0.002**	-0.005**	-0.012**	-0.012**	-0.001
	(0.001)	(0.000)	(0.001)	(0.002)	(0.002)	(0.002)
Median family income	-0.004**	-0.000**	-0.004**	0.002**	-0.001**	0.003**
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
Manufacturing share	0.070**	-0.008	0.078**	-0.131**	-0.071*	-0.060
	(0.025)	(0.006)	(0.023)	(0.044)	(0.028)	(0.038)
January Temperature	0.049*	-0.006	0.055**	0.060	0.017	0.043
	(0.021)	(0.004)	(0.019)	(0.033)	(0.018)	(0.032)
July Temperature	-0.011	-0.023**	0.011	0.085	-0.040	0.124*
	(0.035)	(0.006)	(0.032)	(0.052)	(0.029)	(0.054)
Precipitation	0.004	0.001	0.003	0.024	-0.004	0.028
	(0.016)	(0.004)	(0.015)	(0.027)	(0.019)	(0.021)
Midwest	0.007	0.002**	0.004	0.013*	0.009*	0.004
	(0.005)	(0.001)	(0.005)	(0.005)	(0.004)	(0.005)
South	-0.020**	0.001	-0.021**	0.029**	0.008	0.021**
	(0.006)	(0.001)	(0.006)	(0.008)	(0.006)	(0.007)
West	-0.015	0.002	-0.017*	0.040**	0.011	0.029**
	(0.009)	(0.002)	(0.008)	(0.011)	(0.008)	(0.010)
Constant	0.040	0.041**	-0.001	-0.043	0.137**	-0.180**
	(0.038)	(0.007)	(0.036)	(0.052)	(0.032)	(0.052)

* Significant at 5%; ** Significant at 1%.

Table A2: Additional Results for Table 3, Panel B (1985-1990)

	Enrolled in Higher Education			Not Enrolled in Higher Education		
	In	Out	Net	In	Out	Net
Population	-0.007**	-0.002**	-0.005**	-0.012**	-0.011**	-0.001
	(0.002)	(0.000)	(0.001)	(0.002)	(0.003)	(0.002)
Median family income	-0.008**	-0.000	-0.007**	-0.003	-0.001	-0.001
	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)
Manufacturing share	0.045*	-0.008*	0.054**	-0.126**	-0.090**	-0.036
	(0.020)	(0.004)	(0.020)	(0.041)	(0.026)	(0.038)
January Temperature	0.022	-0.009*	0.031	0.192**	0.010	0.182**
	(0.019)	(0.004)	(0.018)	(0.042)	(0.021)	(0.040)
July Temperature	-0.000	-0.015**	0.015	-0.038	-0.043	0.005
	(0.034)	(0.006)	(0.033)	(0.065)	(0.036)	(0.059)
Precipitation	0.005	-0.002	0.007	0.027	-0.020	0.047
	(0.016)	(0.003)	(0.015)	(0.035)	(0.019)	(0.029)
Midwest	0.021**	0.001	0.020**	-0.001	0.005	-0.006
	(0.006)	(0.001)	(0.005)	(0.007)	(0.004)	(0.006)
South	-0.013*	-0.000	-0.013*	-0.017	0.007	-0.023**
	(0.005)	(0.001)	(0.005)	(0.009)	(0.006)	(0.008)
West	-0.010	-0.000	-0.010	0.019	0.005	0.014
	(0.008)	(0.001)	(0.008)	(0.014)	(0.008)	(0.012)
Constant	0.056	0.033**	0.024	0.162*	0.152**	0.010
	(0.041)	(0.007)	(0.041)	(0.075)	(0.040)	(0.062)

* Significant at 5%; ** Significant at 1%.

Table A3: Additional Results for Table 3, Panel C (1975-1980)

	Enrolled in Higher Education			Not Enrolled in Higher Education		
	In	Out	Net	In	Out	Net
Population	-0.003*	-0.000	-0.003*	-0.010**	-0.002	-0.008**
	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)	(0.003)
Median family income	-0.011**	0.000	-0.012**	0.006	-0.001	0.007*
	(0.003)	(0.001)	(0.003)	(0.005)	(0.004)	(0.003)
Manufacturing share	0.089**	0.013	0.076**	-0.133	0.007	-0.140**
	(0.029)	(0.014)	(0.023)	(0.088)	(0.068)	(0.042)
January Temperature	0.000	0.003	-0.002	0.202*	0.055	0.147*
	(0.020)	(0.008)	(0.017)	(0.084)	(0.045)	(0.064)
July Temperature	0.006	-0.028*	0.033	-0.075	-0.093	0.018
	(0.036)	(0.012)	(0.033)	(0.101)	(0.067)	(0.074)
Precipitation	0.023	0.001	0.022	0.023	0.003	0.020
	(0.014)	(0.008)	(0.013)	(0.061)	(0.046)	(0.032)
Midwest	0.016*	0.008*	0.008	0.047*	0.050*	-0.004
	(0.007)	(0.004)	(0.006)	(0.019)	(0.021)	(0.007)
South	-0.009	0.005	-0.014*	0.057*	0.035	0.022*
	(0.008)	(0.004)	(0.006)	(0.026)	(0.021)	(0.011)
West	0.003	0.001	0.001	0.073**	0.025	0.047**
	(0.008)	(0.003)	(0.007)	(0.026)	(0.016)	(0.017)
Constant	0.004	0.024	-0.021	0.090	0.129	-0.040
	(0.045)	(0.014)	(0.042)	(0.115)	(0.078)	(0.078)

* Significant at 5%; ** Significant at 1%.

Table A4: Additional Results for Table 5

	Same State			Different State or Country		
	In	Out	Net	In	Out	Net
Population	-0.018**	-0.012**	-0.006**	-0.004*	-0.004**	-0.000
	(0.003)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)
Median family income	-0.002**	-0.001*	-0.001*	0.000	-0.001	0.001
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
Manufacturing share	0.041	0.047	-0.005	-0.114*	-0.155**	0.041
	(0.033)	(0.024)	(0.025)	(0.054)	(0.040)	(0.039)
January Temperature	0.127**	0.111**	0.017	-0.025	-0.105**	0.080*
	(0.036)	(0.027)	(0.023)	(0.035)	(0.031)	(0.033)
July Temperature	-0.029	-0.064	0.036	0.149	0.001	0.147*
	(0.056)	(0.039)	(0.043)	(0.085)	(0.046)	(0.065)
Precipitation	-0.032	-0.051*	0.019	0.064*	0.043	0.021
	(0.028)	(0.022)	(0.016)	(0.032)	(0.024)	(0.020)
Midwest	0.013	0.010*	0.003	0.010	0.005	0.005
	(0.006)	(0.004)	(0.004)	(0.006)	(0.004)	(0.005)
South	-0.016	-0.001	-0.015*	0.033**	0.018*	0.016*
	(0.009)	(0.006)	(0.006)	(0.009)	(0.008)	(0.007)
West	-0.011	-0.008	-0.003	0.050**	0.030**	0.020*
	(0.012)	(0.009)	(0.008)	(0.012)	(0.009)	(0.009)
Constant	0.074	0.111**	-0.037	-0.103	0.095*	-0.197**
	(0.058)	(0.038)	(0.043)	(0.077)	(0.047)	(0.058)

* Significant at 5%; ** Significant at 1%.

Table A5: Additional Results for Table 6

	Enrolled in Higher Education			Not Enrolled in Higher Education		
	In	Out	Net	In	Out	Net
Population	-0.006**	-0.002**	-0.004**	-0.013**	-0.012**	-0.002
	(0.001)	(0.000)	(0.001)	(0.002)	(0.002)	(0.001)
Median family income	-0.004**	-0.000**	-0.003**	0.001	-0.001**	0.002**
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Manufacturing share	0.060*	-0.007	0.067**	-0.126**	-0.067**	-0.059
	(0.023)	(0.005)	(0.022)	(0.038)	(0.025)	(0.032)
January Temperature	0.032	-0.010**	0.042*	-0.018	-0.030	0.012
	(0.019)	(0.004)	(0.017)	(0.030)	(0.018)	(0.026)
July Temperature	-0.009	-0.021**	0.012	0.048	-0.025	0.073
	(0.031)	(0.005)	(0.029)	(0.045)	(0.028)	(0.042)
Precipitation	0.007	0.002	0.004	0.054*	0.020	0.035*
	(0.015)	(0.004)	(0.014)	(0.026)	(0.019)	(0.017)
Midwest	0.007	0.003**	0.004	0.018**	0.014**	0.005
	(0.004)	(0.001)	(0.004)	(0.005)	(0.004)	(0.004)
South	-0.016**	0.002	-0.018**	0.036**	0.016**	0.021**
	(0.006)	(0.001)	(0.005)	(0.007)	(0.005)	(0.006)
West	-0.012	0.002	-0.015*	0.044**	0.018*	0.026**
	(0.008)	(0.002)	(0.007)	(0.010)	(0.008)	(0.008)
Constant	0.040	0.039**	0.001	0.014	0.118**	-0.105*
	(0.034)	(0.006)	(0.032)	(0.047)	(0.031)	(0.042)

* Significant at 5%; ** Significant at 1%.

Table A6: Additional Results for Table 7

	Enrolled	Not Enrolled
Population	-0.001*	-0.007
	(0.000)	(0.005)
Median family income	-0.001**	0.003
	(0.000)	(0.002)
Manufacturing share	0.011	-0.011
	(0.010)	(0.099)
January Temperature	0.016*	0.143
	(0.007)	(0.090)
July Temperature	0.032*	0.668**
	(0.016)	(0.173)
Precipitation	-0.002	-0.073
	(0.008)	(0.071)
Midwest	0.001	0.031*
	(0.001)	(0.012)
South	0.000	0.049*
	(0.002)	(0.019)
West	0.003	0.098**
	(0.003)	(0.030)
Constant	-0.030	-0.647**
	(0.015)	(0.171)

* Significant at 5%; ** Significant at 1%.