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Abstract

Researchers have consistently shown that the stock of human capital in an area, measured as the share of the adult population with a college degree, is a strong predictor of future population growth. This paper examines this relationship for U.S. non-metropolitan counties and posits that student migration for higher education may play an important role. Students often move to an area for college and then stay in the area after their education is complete, causing the area's educated population to grow. Empirical evidence suggests that student migration explains nearly all of the greater in-migration to highly educated non-metropolitan counties. Implications for non-metropolitan brain drain are discussed.

JEL Classification: R11, R23

Keywords: population growth, migration, human capital, non-metropolitan counties, college

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Introduction

Local population growth has been a subject of considerable interest to both academics and policymakers and is an important indicator of an area's desirability. For both metropolitan and non-metropolitan areas, a growing population signals that an area is a desirable place to live and work. Researchers have suggested that a number of characteristics have important effects on an area's population growth by affecting its desirability to current and prospective residents. Early researchers such as Carlino and Mills (1987) recognized the importance of local employment prospects and natural amenities. More recent research has investigated the relationship between the local human capital stock and local population growth. Overwhelmingly, these researchers have found strong and consistent evidence that the share of adults in an area with a college degree is positively correlated with local population growth for cities (Glaeser, Scheinkman, & Shleifer, 1995; Simon, 1998), counties (Clark & Murphy, 1996; Partridge, Rickman, Ali, & Olfert, 2008a), and metropolitan areas (Glaeser & Saiz, 2004; Glaeser & Shapiro, 2003; Gottlieb & Fogarty, 2003; Simon & Nardinelli, 2002).[1] Similarly, Berry and Glaeser (2005), Waldorf (2009), and Whisler, Waldorf, Mulligan, and Plane (2008) suggest that an areas ability to attract and retain a well-educated workforce depends positively on its existing level of human capital.

This relationship between the share of college educated workers and local population growth is thought to be due in part to the many other beneficial effects that educated workers have on their local labor markets. For one, researchers have suggested that educated workers make other workers in the area more productive. Consistent with this reasoning, a number of studies have shown that wages in an area increase with the local level of human capital, even after controlling for a worker's own level of human capital (e.g., Iranzo & Peri, 2009; Moretti, 2004a; Rauch, 1993).[2] This notion also receives support from the literature on the geographic localization of patent citations and its relationship with university research (Adams, 2002; Audretsch & Feldman, 1996; Jaffe, 1989; Jaffe, Trajtenberg, & Henderson, 1993). Other researchers have also suggested that educated workers improve the quality of life in the local area by facilitating the existence of endogenous consumer amenities such as parks, theaters, museums, and tolerance of others (Florida, 2002; Shapiro, 2006).

A separate explanation advanced recently by Winters (2010) is that the connection between human capital and population growth is largely due to the growth of areas that are centers of higher education.[3] Areas that have major colleges and universities receive considerable in-migration from students pursuing higher education. This is especially true for flagship state universities that bring in students from all over the state and from other states and countries (Alm & Winters, 2009). Many of the students who move to an area for higher education are likely to leave the area after their education is complete, but a significant number may develop location-specific human capital and stay in the area after their schooling is complete. The ability of centers of higher education to retain ex-students causes both population growth and an increase in the average level of human capital. Winters investigates this explanation for metropolitan areas by separately examining the effect of human capital on the migration rates of those enrolled in higher education and those not enrolled in higher education. Winters finds that the majority of the differential in-migration to high human capital metropolitan areas is attributable to persons enrolled in higher education.

This paper builds on the work of Winters (2010) and others by investigating the importance of student migration in the relationship between human capital and population growth for non-metropolitan counties in the U.S. Non-metropolitan areas are often different from metropolitan areas in important ways, and thus a separate study that focuses on non-metropolitan areas seems warranted. In particular, non-metropolitan areas may face greater challenges in attracting and retaining educated workers. Young, college-educated workers may often be attracted to large metropolitan areas because they offer higher wages and thicker markets for skilled labor (Chen & Rosenthal, 2008; Elvery, 2010; Plane & Jurjevich, 2009). Artz (2003) and others argue that "brain drain" is a very real problem for many non-metropolitan areas of the U.S. On the whole, non-metropolitan areas are not keeping up with metropolitan areas in the share of their populations with college degrees and this trend threatens the economic survival of these areas. Carr and Kefalas (2009) go even further to suggest that rural brain drain and the hollowing out of Middle America are harmful to the nation as a whole. Importantly though, there is considerable diversity in brain drain outcomes among non-metropolitan areas. A number of non-metropolitan counties have actually experienced a "brain gain" and seen their college graduate shares increase at even faster rates than the average metropolitan county (Artz). By examining the role of student migration in non-metropolitan county population growth, this paper offers insight into the importance of higher education institutions in attracting educated persons to non-metropolitan areas.

The empirical results suggest that virtually all of the relationship between human capital and non-metropolitan county in-migration between 1995 and 2000 is due to the in-migration of students enrolled in higher education. Persons not enrolled in higher education are not moving to high human capital counties in large numbers. The results, therefore, suggest that the local level of human capital causes non-metropolitan counties to grow because of students moving in for higher education and then staying after their education is complete. Furthermore, when we remove "college towns" from the analysis the effect of the local human capital level on net migration is virtually zero. That is the growth of high human capital non-metropolitan counties is driven by college towns. These results also suggest that non-metropolitan areas with a strong presence of higher education institutions are likely to be much more successful at growing their share of college graduates than areas without good access to higher education.

Theoretical Framework

Following a large literature beginning with Sjaastad (1962), this paper views migration as an investment in human capital. Individuals maximize expected utility and choose to move to a new area if it gives them greater utility than their previous location and the utility difference is large enough to compensate for the costs of moving. If moving costs are sufficiently small, individuals will move to the location that gives them the highest possible utility. Importantly though, the attractiveness of a particular location will vary across individuals. For example, several researchers have suggested that the young and the elderly are attracted to different locations (e.g., Chen & Rosenthal, 2008; Clark & Hunter, 1992; Conway & Rork, 2006; Plane & Heins, 2003; Plane & Jurjevich, 2009). Young people are generally attracted to areas with high wages and a strong labor market, while the elderly often prefer areas with nice natural amenities but a low cost of living. Similarly, individuals will differ in the benefit they receive from living in an area with a high level of human capital.

Following Winters (2010) this paper argues that students pursuing higher education are more likely than non-students to move to a high human capital area, because they are often centers of higher education. Several college town counties rank near the top of the list of non-metropolitan counties in the share of adults with a college degree. These include but are not limited to counties that contain universities such as Washington State University, the University of Wyoming, Kansas State University, Montana State University, Mississippi State University, Oklahoma State University, and Southern Illinois University Carbondale. Consequently, persons enrolled in higher education may make up a large share of the in-migration to high human capital counties, because they are the ones who most benefit from moving to a college town.

Many of the students who move to college towns in large numbers are likely to leave the area once they complete their education. They will often move back to previous residences or move on to new locations.[4] However, previous literature suggests that many people who move to an area for higher education will stay there after they are done with school (Blackwell, Cobb, & Weinberg, 2002; Groen, 2004; Groen & White, 2004; Hickman, 2009; Huffman & Quigley, 2002).[5] This likely occurs because students often develop location-specific human capital in the area where they attend college (Berry & Glaeser, 2005; DaVanzo, 1983; Krupka, 2009). After a few years of college, recent in-migrants may have gained human capital that makes them more productive locally than elsewhere. This might include networks with professors and peers as well as relationships with local employers through student working and internships. Individuals may also develop location-specific human capital in consumption; they may have created valuable friendships and acquired a taste for local amenities (e.g., live college sports) in the area where they attended college.

If location-specific human capital frequently motivates recent in-migrants to remain in the area where they completed their education, areas with a considerable university presence are likely to grow faster than those without, and student migration will play an important role in this growth. Furthermore, the growth will be from highly educated individuals, and the average level of human capital in the area is also likely to increase. Thus the growth of areas may be strongly affected by their ability to attract and retain individuals pursuing higher education.

Empirical Methods

This study examines the relationship between human capital and population growth by estimating several migration equations for non-metropolitan counties in the U.S. between 1995 and 2000.[6] More specifically, the following in-migration, out-migration, and net migration equations are estimated:

(1) $$M_{in} = \beta_{in}S + \Gamma_{in}Z + \mu_{in},$$

$$\mu_{in} = \lambda_{in}W\mu_{in} + \varepsilon_{in},$$

(2) $$M_{out} = \beta_{out}S + \Gamma_{out}Z + \mu_{out},$$

$$\mu_{out} = \lambda_{out}W\mu_{out} + \varepsilon_{out},$$

(3) $$M_{net} = \beta_{net}S + \Gamma_{net}Z + \mu_{net},$$

$$\mu_{net} = \lambda_{net}W\mu_{net} + \varepsilon_{net},$$

where M_{in} is the county in-migration rate, M_{out} is the out-migration rate, M_{net} is the net migration rate, S is the share of the adult population with college degrees in a county, Z is a matrix of other variables found in previous literature to affect local population growth, μ_{in}, μ_{out}, and μ_{net} are spatially autocorrelated error terms, W is a spatial weighting matrix, λ_{in}, λ_{out}, and λ_{net} are spatial error coefficients, and ε_{in}, ε_{out}, and ε_{net} are mean zero error terms. For the results presented, W is structured as a row-standardized matrix with weights based on the inverse of their distance to a given county and a cutoff of 100 miles; that is, nearer counties are given greater weight than more distant counties and counties more than 100 miles away are given zero weight. The main results, however, are robust to several alternative specifications of the spatial weight matrix.

Because of the spatial error correlation, the equations are estimated using Maximum Likelihood (ML) instead of Ordinary Least Squares (OLS) (Anselin, 1988).[7]

Because high human capital areas are often centers of higher education, β_{in} is expected to be positive, suggesting that a disproportionately large number of people are moving to high human capital counties. Similarly, if many people leave an area after completing their education, we also expect human capital to be associated with high rates of out-migration, so β_{out} is expected to be positive as well. However, some people will likely stay in an area after completing their education causing β_{in} to exceed β_{out} and the local population to grow. Therefore it is expected that β_{net} will also be positive.

The migration equations above are first estimated for the entire population to gauge the overall effects. Migration equations are then estimated separately for persons age 16 and over by whether they are currently enrolled in higher education. Analysis of Census 2000 County-to-County Migration files reveals that 15 percent of all persons age 16 and over living in a different county in 2000 than in 1995 were enrolled in higher education in 2000. If the relationship between human capital and population growth is largely due to persons enrolled in higher education, then the effect of human capital on the in-migration rate of those enrolled should be disproportionately large. As a further test of the hypothesis advanced, this paper also estimates separate migration equations for five year age groups. The expectation is that persons in their peak college-going years may represent a disproportionately large share of the relationship between the local human capital level and in-migration.

Data

The migration data in this paper come from the Census 2000 County-to-County Migration files. This dataset includes only internal migrants; international in-migrants and out-migrants are not included. A person is considered a migrant if they lived in a different county in 2000 than they did in 1995. While defining a person's place of residence is straightforward for most people, it is a bit more complicated for some young people away at college. In a sense, some such students have two residences: the place where they reside while attending school and the place where they reside in between school sessions, often being their parents' residence. The Census questionnaire instructed respondents that students away at college are to be counted as residents of the places where they attend college and not their parents' residences. Unfortunately though, there could still be some misreporting of residences, especially prior residences of persons who were enrolled in college five years prior to the census. If so, the effects of the college share on out-migration may be understated and the effects of the college share on net migration may be overstated. To partially address this concern, we also briefly look at the effect of the share of adults with a college degree on population growth.

Gross in-migration to an area is computed as the sum of all persons in a county who lived in another county in the U.S. five years prior. Gross out-migration is the sum of all persons who lived in a given county in 1995, but lived in a different county in the U.S. in 2000. Net migration is computed as gross in-migration minus gross out-migration. Gross in-migration rates for non-metropolitan counties are computed by dividing gross in-migration by the estimated population of the county in 1995. Gross out-migration rates and net migration rates are computed similarly. When the migration rates are computed separately by enrollment status or by age, the total population of the county continues to be used as the population base. This is done to allow for easier interpretation of each groups' contribution to the overall migration rate.

Data for the explanatory variables in the regressions come from several sources. Time-varying explanatory variables are measured as of 1990, so that they are not affected by migration during the period under consideration. The share of the adult population in a county with a college degree comes from the USA Counties database. Several additional explanatory variables are also computed from USA Counties data. These include the county population, per capita income, and the share of employment in manufacturing. The quantity and quality of natural amenities is expected to affect non-metropolitan migration (Gottlieb & Joseph, 2006; McGranahan, 1999; McGranahan, Wojan, & Lambert, 2010; Rappaport, 2007), and data on several natural amenities are obtained from the USDA Economic Research Service (ERS). These include the mean January temperature, mean January sun hours, mean July temperature, mean July relative humidity, the percent of the county area that is covered by water, and a topography score that ranges from 1 to 24 with higher values indicating a more mountainous topography. Partridge et al. (2008a, b, c) suggest that population growth for non-metropolitan areas may depend on proximity to urban areas, in part because close proximity makes rural-to-urban commuting a more viable option (Partridge, Ali, & Olfert, 2010). Therefore, this paper also includes as explanatory variables the population of the nearest metropolitan area, the distance to the nearest metropolitan area, the distance to the nearest metropolitan area with a population of at least 250,000, the distance to the nearest metropolitan area with a population of at least 500,000, and the distance to the nearest metropolitan area with a population of at least 1,500,000. Finally, indicator variables for the Midwest, South, and West regions are also included.

(Table 1 about here)

Summary statistics for the main variables used in this study are presented in Table 1. The sample includes 2,004 non-metropolitan counties in the contiguous United States. Several variables have been rescaled to aid the presentation of results. The reported summary statistics reflect the scaling used in the regressions to follow. The mean in-migration and out-migration rates for the total population are both about 0.18 indicating that on average about 18 percent of a non-metropolitan county's population lived in a different county in 2000 than they did in 1995. The summary statistics also indicate that for the average county, migration of those not enrolled is a considerably larger portion of overall migration than migration of those who are enrolled.[8] However, the relative importance of college students in overall migration varies considerably across counties.

Empirical Results

The migration equations are first estimated for the entire population. These results are presented in Table 2. The first column presents the results for the in-migration rate, the second column presents the results for the out-migration rate, and the third column presents the results for the net migration rate. As expected, the share of adults in the county with a college degree has a strong positive correlation with the in-migration rate. In other words, more people are moving to highly educated places than less educated places. The coefficient estimate of 0.571 suggests that increasing the college share by 0.1 increases the in-migration rate by .057. This is a considerable effect. According to the results in the second column, the local human capital level is positively correlated with the out-migration rate as well with a coefficient of 0.436. On net though, the local human capital level brings in more people than it pushes out, and the college-educated share has a strong positive correlation with the net migration rate with a coefficient estimate of 0.123. This result is consistent with findings from previous literature that a more educated populace causes an area's population to grow.

(Table 2 about here)

As discussed above, there may be problems with misreporting of previous residence in the data, especially for persons who were attending college five years prior to the census. If so, the effects of the college share on out-migration may be understated and the effects of the college share on net migration may be overstated. We partially address this concern by briefly looking at the effect of the share of adults with a college degree on actual population growth (results not shown). When we regress county population growth between 1990 and 2000 on the explanatory variables, we get a coefficient of 0.300 that is statistically significant at the 1 percent level. Cutting the effect in half to account for the longer time period gives a coefficient of 0.150, which is a little more than the coefficient for net migration between 1995 and 2000. The difference might be partially attributable to international in-migration, differences in fertility and mortality, and asymmetry between the first and second halves of the decade. Given all of these considerations, the results for population growth are quite similar to the results for net migration and reduce concerns that measurement error causes major problems for the net migration regressions.

The results in Table 2 also suggest that many of the other variables have important effects on migration as well. However, we will later see that these variables often have differing effects on student and non-student migrants. Because the effects of these variables are a secondary interest of this paper, we will hold off on discussing the results for these variables until the next subsection when we estimate separate migration equations for persons enrolled in higher education and person not enrolled.

Migration by Enrollment in Higher Education

The results in Table 2 tell us that the share of adults in an area who are college educated is positively correlated with future population growth. However, Table 2 does not tell us much about the role of student migration in the relationship between the local level of human capital and population growth. More specifically, this paper is interested in the extent to which the positive relationship between human capital and non-metropolitan population growth is attributable to students moving to an area for higher education and then staying in the area after their education is complete. To investigate this, the migration equations are next estimated separately for persons enrolled in higher education and persons not enrolled in higher education. For these equations, the migration rates include only persons age 16 and over, but the results are unaffected by including persons under age 16. The results are presented in Table 3.

(Table 3 about here)

Looking first at the in-migration equations, the positive relationship between the share of adults with a college degree and in-migration rates appears to be entirely due to persons enrolled in higher education. The coefficient for those enrolled is 0.574 and highly statistically significant. The coefficient for those not enrolled, however, is virtually zero (0.001). These results suggest that students moving for higher education account for virtually all of the greater in-migration to highly educated non-metropolitan counties. Persons not enrolled in higher education are not moving to these areas in large numbers.

The results in Table 2 also suggested that out-migration rates are positively correlated with the local human capital level. If the relationship between in-migration and human capital is due to student in-migrants, then the positive relationship between human capital and out-migration rates is likely due in part to persons leaving after completing their education. The separate out-migration equations by enrollment in Table 3 shed light on this as well. The human capital stock is positively correlated with the out-migration of both those enrolled in higher education and those not enrolled. The majority of the effect, however, is due to persons not enrolled. This is consistent with the hypothesis that individuals move to high human capital areas for higher education, but often leave after completing their education.

Turning to the net migration results, the share of adults with a college degree is positively and significantly correlated with the net migration rate for those enrolled with a coefficient estimate of 0.488. For those not enrolled in higher education, the human capital stock is negatively and significantly correlated with net migration with a coefficient estimate of -0.334. Thus, highly educated areas are on net gaining people enrolled in higher education and losing people not enrolled in higher education. This is again consistent with the hypothesis that people move to highly educated areas for education but often leave once their formal education is done. Importantly though, the net migration coefficient for those enrolled is larger in absolute value than the net migration coefficient for those not enrolled. This suggests that some of the people who move for higher education end up staying in the area after their educations are complete. This causes highly educated areas to experience faster population growth than their less educated counterparts.

The results in Table 2 suggested that many of the other variables have important effects on migration. The results in Table 3 suggest that these variables often have differing effects on the migration of those enrolled in higher education and those not enrolled. Focusing on the net migrations equations for brevity, the results suggest that the local population increases the net migration of students but decreases the net migration of non-students. Per capita income has the opposite effect - it decreases the net migration of students but increases the net migration of non-students. The manufacturing share has a positive but insignificant coefficient for the net migration of those enrolled but a negative and significant effect on the net migration of those not enrolled. January temperature and January sun have positive and significant effects on the net migration of those not enrolled, but for the net migration rate of those enrolled January temperature has an insignificant effect and January sun has a significantly negative effect. July temperature significantly reduces the net migration of those not enrolled, but significantly increases the net migration of those enrolled. July humidity is insignificant for both. Topography and the percent of the area covered by water have significantly positive effects on the net migration of those not enrolled, but negative coefficients for the net migration of those enrolled, though the effect for topography is not significant. These results suggest that persons not enrolled in higher education are drawn to areas with nice natural amenities, but persons pursuing higher education are generally not. The distance to the nearest metro area has a negative and significant effect on the net migration of both those enrolled and those not enrolled, supporting the findings of Partridge et al. (2008a, b, c). The distance to the nearest metro with a population of at least 1.5 million also has a significantly negative effect on the net migration of persons enrolled in higher education. This suggests that proximity to a large metropolitan area is more important for student migrants than non-student migrants. The West region dummy is significantly positive for the net migration of persons not enrolled, the South dummy is significantly positive for both, and the Midwest dummy is significantly positive for those enrolled. Finally, the spatial error coefficient is significant in all of the equations confirming that standard errors are spatially correlated. Consequently, methods that do not account for spatial error correlation such as OLS are likely to produce inconsistent standard errors and potentially incorrect inferences. The magnitude and significance of the spatial error term also suggest that there are important unobserved regional factors that affect nearby counties in similar ways. Thus, policymakers for non-metropolitan counties might often be well served by working with other nearby counties to make their entire regions more desirable to potential migrants.

Migration by Age Group

Evidence in the previous section suggests that the relationship between the local human capital level and population growth is primarily due to persons pursuing higher education. If this is true, we also might expect the age distribution of persons moving to high human capital areas to be skewed towards persons in their primary college-going years. Similarly, we might expect the age distribution of persons leaving high human capital areas to be skewed towards age groups who are likely to have recently completed higher education or dropped out of school. This paper, therefore, next examines the effect of human capital on migration by five year age groups. 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 rates between 1995 and 2000. Though the results are not reported, the regressions in Table 4 also include the additional explanatory variables included previously. The full results are available upon request. The coefficients in Table 4 are also illustrated graphically in Figure 1.

(Table 4 about here)

(Figure 1 about here)

As seen in Table 4 and Figure 1, the largest effect of the local human capital level on in-migration is for persons in their peak college-going years. The effect is largest for the 20-24 age group with a significant coefficient of 0.391, followed by the 15-19 and 24-29 age groups with significant coefficients of 0.162 and 0.055, respectively. For all other age groups, the effect of human capital on in-migration is much smaller and even significantly negative for some age groups. The out-migration results by age are also as expected. The effect of human capital on out-migration is largest for the 25-29 age group followed by the 30-34 and 20-24 age groups.

The net migration results in the third column of Table 4 suggest that on net high human capital areas are gaining workers in their peak college-going years (15-19 and 20-24) and losing workers in age groups who are likely to have recently finished their education (25-29 and 30-34), which is also nicely illustrated in Figure 1. Importantly though, the effect of human capital on the net inflow of the younger cohorts exceeds the effect of human capital on the net outflow of the older cohorts. Examining migration by five year age groups, therefore, provides further support for the hypothesis that high human capital areas are growing faster than low human capital areas because many of the persons who move to an area for higher education remain in the area after their schooling is complete.

Controlling for "College Towns"

To provide additional evidence, we next estimate the effect of the share of adults with college degrees on migration separately for "college town" and non-college town counties. This paper defines college towns using a definition similar to that suggested by Plane and Heins (2003). A county is defined as a college town if the age profile of its in-migration flows is skewed towards persons age 15-24.[9] More specifically, a county is defined as a college town if its share of in-migrants age 15-24 is more than one standard deviation above the mean share across all non-metropolitan counties. This definition identifies 205 non-metropolitan counties as college towns.

Table 5 reports the results from re-estimating the equations in Table 2 separately for college town and non-college town counties. The regressions also include the additional explanatory variables in Table 2 and a spatially lagged error term, but for brevity only the results for the college share variable are presented. Panel A reports the results that only include college town counties. The percent of adults with a college degree has a statistically significant effect on in, out, and net migration with coefficients of 0.770, 0.512, and 0.260, respectively. Not surprisingly, the effects for college town counties are even larger than the effects for all non-metropolitan counties in Table 2. In particular, the net migration effect more than doubles.

(Table 5 about here)

When the sample is restricted to non-college town counties in Panel B, the percent of adults with a college degree continues to have a positive and statistically significant effect on both in-migration and out-migration rates, with coefficients of 0.138 and 0.134. These effects, however, are considerably smaller than the corresponding estimates for college town counties and for the full sample. Even more important, the effects on in- and out-migration for non-college towns are of roughly equal magnitude and the effect on net migration is virtually nil (-0.003) and not statistically significant. In other words, the human capital level appears to have no effect on net migration for non-college town counties. The relationship between net migration and the share of adults with college degrees found in Table 2 is entirely due to net migration to highly educated college town counties.

An additional way to examine the importance of college towns is to re-estimate the full sample regressions adding the share of the population ages 15-24 as an additional explanatory variable. This additional variable is expected to be highly correlated with the extent to which the county is a college town and including it should greatly reduce the coefficient on the share of college graduates in the migration equations. Panel C of Table 5 reports the results of adding the share of the population ages 15-24 to the full sample regressions in Table 2. The share of the population ages 15-24 is significant in all three regressions with coefficients of 0.604, 0.256, and

0.340, respectively, suggesting that this variable is an important predictor of migration flows for non-metropolitan counties. As expected, controlling for the share ages 15-24 reduces the effect of the college graduate share on both in- and out-migration to 0.229 and 0.265, respectively. More importantly, the coefficient on the share of college graduates for net migration is small (-0.038) and statistically insignificant. Thus, when we include this additional measure of the extent to which a county is a college town, the college graduate share is unrelated to net migration.

Additional Results

Table 6 presents some additional results. In Panel A we consider the robustness of the results in Table 3 to using 1993 metropolitan area definitions. As seen in Panel A, the coefficient estimates and significance levels are nearly identical to the corresponding estimates in Table 3. In Panel B we examine the robustness of replacing regional fixed effects with state fixed effects. Again the results are virtually identical to the baseline results in Table 3 and are therefore quite robust to including state fixed effects.

(Table 6 about here)

In Panel C of Table 6, we examine the effect of adding to the regressions a term for the interaction between the share of college graduates and the distance to the nearest metro area. The regressions already included separate measures for these variables, but we might be interested in whether the effect of the share of college graduates depends on proximity to metropolitan areas. The results in Panel C suggest that there is indeed some interaction effect. The interaction term has a negative effect on in-migration and net migration of college students with coefficients of -1.542 and -1.298, respectively. These negative interaction effects suggest that the effects of human capital on student in-migration decline with the distance to the nearest metro area. Thus there is a positive effect of being near a metro area on student in-migration. However, the interaction effect for persons not enrolled in higher education goes in the opposite direction. While the interaction term does not significantly affect the in-migration of non-students, it does significantly affect out-migration and net migration of persons not in college with coefficients of -1.253 and 2.385, respectively. This suggests that the proximity to a metro area actually increases the outflow of recent graduates from non-metropolitan college towns.

6. Conclusion

This paper examines the well-established positive relationship between human capital and population growth for non-metropolitan counties in the U.S. Following Winters (2010), this paper suggests that because high human capital areas are often centers of higher education, persons moving to college towns to pursue higher education may play an important role in the positive relationship between human capital and population growth in non-metropolitan areas. Consistent with this hypothesis, this paper finds that the positive relationship between human capital and in-migration is almost entirely due to persons enrolled in higher education. For persons not enrolled in higher education, there is virtually no relationship between in-migration and the local level of human capital.

After completing their education many of those who recently moved to an area for higher education move back to a previous area or on to a new location. However, many recent student in-migrants develop location-specific human capital such as relationships with local employers and friends and a taste for local amenities, and these local attachments often make their current location the best place to start their careers and families. As a result, many recent student in-migrants remain in an area after completing their schooling causing centers of higher education to grow in population and increase their local level of human capital. Importantly though, this paper finds that the stock of human capital only increases net migration to non-metropolitan areas that are college towns. Non-metropolitan areas without access to higher education institutions have much greater difficulty attracting educated workers and thus are less able to build their human capital stock and grow their population.

The question then becomes what, if anything, can policymakers do to help stem the brain drain from non-metropolitan areas and prevent the hollowing out of Middle America (Artz, 2003; Carr and Kefalas, 2009)? Some might suggest that small, isolated, rural areas are a lost cause and the best thing we can do for their residents is to encourage them to relocate to areas with better employment prospects. Many others, however, believe that America needs its small towns and we can and should do something to help them survive and even thrive. A number of policies have been advanced to make non-metropolitan areas more desirable places, but there seems to be no consensus on the best approach. Examples include efforts to build up local recreational amenities, student loan forgiveness programs, better K-12 education, improving infrastructure and access to high-speed internet, and economic development strategies that directly try to bring in industries. This paper suggests that access to higher education may play a special role. Unfortunately, it is simply not possible to have a world class university in every small town in America. However, there may be large social benefits from increasing the density of university satellite campuses and community colleges in parts of states that are relatively underserved.

Online learning may present an especially promising strategy for increasing access to higher education in non-metropolitan areas, provided that the quality of the education is not diminished. While a number of higher education institutions, both public and private, have been involved in online learning for some time now, we may only be scratching the surface of the benefits that online learning could provide to small, remote areas. Online learning increases access to higher education but does not force residents to leave home to acquire that education. However, one of the major obstacles to online learning is that most potential students have very little experience with it and are generally unsure about it. One way to increase experience with online learning is to offer more online courses to high school students. Ideally, this could also be accomplished with Advanced Placement (AP) or dual enrollment courses that potentially allow students to earn high school and college credits simultaneously. There might also be considerable benefits from increased efforts to market online programs, especially to non-traditional students who live in remote areas. There is, of course, an important role here for university officials, but there also could be an important role for local officials. Local officials and educators could set up programs in local schools and libraries that help students navigate online higher education programs, either as individuals or in small groups. Increased information and local support for online programs would likely increase the number of non-metropolitan residents who participate. Online learning, therefore, is a potentially important way to increase access to higher education to persons in remote areas, and there are many things that local leaders could do to make online learning more accessible.

Notes

1. Alternatively, Florida, Mellander and Stolarick (2008) suggest that local human capital stocks should be measured by the relative presence of a "creative class" of artists and workers employed in creative occupations.

2. For reviews of the literature on human capital externalities, see Henderson (2007), Lange and Topel (2006), and Moretti (2004b).

3. This explanation is not necessarily incompatible with the first two explanations.

4. Franklin (2003) provides an insightful analysis of the migration of the young, single, and college educated. Additional analyses of college graduate migration are provided by Corcoran, Faggian, and McCann (2010); Faggian and McCann (2009); Faggian, McCann, and Sheppard (2007a, b); and Gibbs (1995, 2000).

5. Drucker and Goldstein (2007) survey the literature on the regional impacts of universities including student migration. See also Goldstein and Drucker (2006) and Lendel (2010).

6. We define as non-metropolitan all counties not part of a metropolitan area according to year 2003 Census definitions.

7. OLS coefficients would be consistently estimated but OLS standard errors would not be.

8. Note also that the migration rates for the enrolled and non-enrolled do not add up to the migration rates for the total population because the enrolled and non-enrolled rates only include the population 16 and over, while the total population migration rates are for the population 5 and over.

9. It might be preferable to use a narrower age group definition such as persons age 18-24. However, data by age groups are only reported in five year bands.

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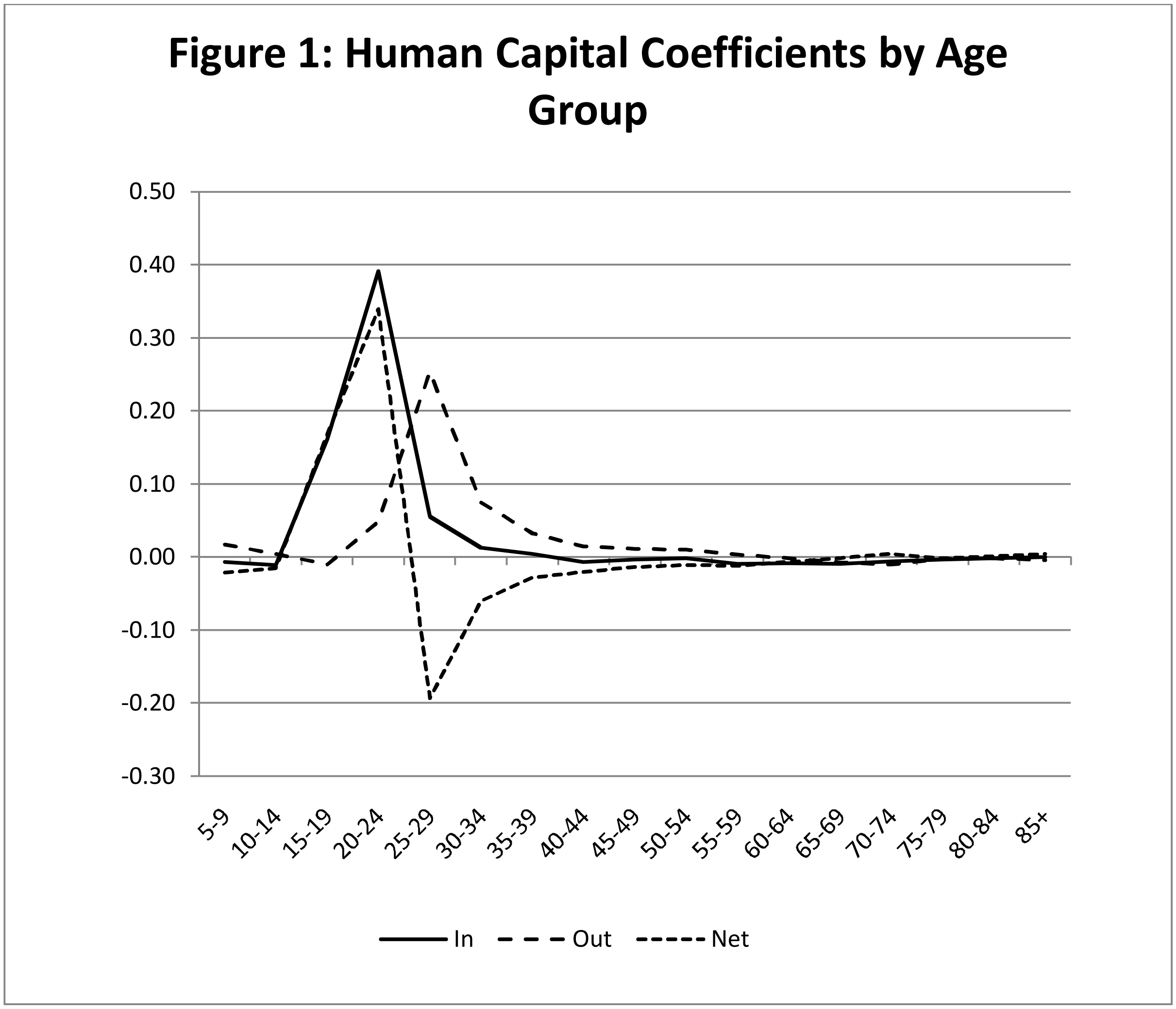
Figure 1: Human Capital Coefficients by Age Group
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84
85+
In
Out
Net

Table 1: Summary Statistics

Variable	Mean	S.D.	Min	Max
In-migration rate (Total)	0.179	0.066	0.039	0.630
Out-migration rate (Total)	0.183	0.051	0.086	0.507
Net migration rate (Total)	-0.003	0.062	-0.307	0.427
In-migration rate (Enrolled)	0.014	0.028	0.000	0.336
Out-migration rate (Enrolled)	0.025	0.012	0.000	0.151
Net migration rate (Enrolled)	-0.011	0.028	-0.146	0.249
In-migration rate (Not Enrolled)	0.132	0.051	0.028	0.532
Out-migration rate (Not Enrolled)	0.128	0.037	0.058	0.400
Net migration rate (Not Enrolled)	0.004	0.050	-0.223	0.404
Share with bachelor's degree	0.117	0.047	0.037	0.534
Population in millions	0.022	0.020	0.000	0.174
Per capita income in $1000s	10.182	1.825	3.417	26.755
Manufacturing Share	0.144	0.114	0.000	0.615
January temperature /100	0.315	0.123	0.011	0.634
January sun /100	1.530	0.335	0.480	2.600
July temperature /100	0.756	0.056	0.555	0.879
July humidity /100	0.543	0.148	0.140	0.800
Topography /100	0.091	0.066	0.010	0.210
% Water Area /100	0.035	0.097	0.000	0.750
Population of nearest metro in millions	0.277	0.405	0.040	4.123
Distance to nearest metro /1000	0.060	0.037	0.010	0.253
Dist. to metro w/ pop>250K /1000	0.107	0.087	0.020	0.579
Dist. to metro w/ pop>500K /1000	0.132	0.092	0.020	0.629
Dist. to metro w/ pop>1500K /1000	0.194	0.103	0.030	0.629
West	0.140	0.347	0.000	1.000
South	0.430	0.495	0.000	1.000
Midwest	0.384	0.486	0.000	1.000

Notes: Sample includes 2004 non-metropolitan counties. All migration rates are for internal migration between 1995 and 2000 and are computed with the total population in 1995 as the base. Migration rates for those enrolled and not enrolled in higher education are for the population age 16 and over. Time-varying explanatory variables are measured as of 1990.

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

	In	Out	Net
Share with bachelor's degree	0.571**	0.436**	0.123**
	(0.036)	(0.024)	(0.038)
Population in millions	-0.448**	-0.441**	0.000
	(0.073)	(0.048)	(0.077)
Per capita income in $1000s	-0.002*	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Manufacturing Share	-0.110**	-0.052**	-0.050**
	(0.015)	(0.010)	(0.016)
January temperature /100	0.103**	0.060**	0.052
	(0.034)	(0.019)	(0.031)
January sun /100	0.018*	0.010*	0.009
	(0.007)	(0.004)	(0.007)
July temperature /100	-0.182**	-0.080**	-0.121**
	(0.042)	(0.024)	(0.034)
July humidity /100	-0.083**	-0.076**	0.005
	(0.022)	(0.012)	(0.020)
Topography /100	0.074*	-0.036*	0.109**
	(0.029)	(0.018)	(0.029)
% Water Area /100	0.022	-0.008	0.034*
	(0.016)	(0.010)	(0.017)
Population of nearest metro in millions	0.006*	0.000	0.006
	(0.003)	(0.002)	(0.003)
Distance to nearest metro /1000	-0.293**	0.018	-0.279**
	(0.066)	(0.040)	(0.065)
Dist. to metro w/ pop>250K /1000	-0.048	0.044	-0.091
	(0.059)	(0.035)	(0.056)
Dist. to metro w/ pop>500K /1000	0.000	0.028	-0.024
	(0.055)	(0.032)	(0.052)
Dist. to metro w/ pop>1500K /1000	-0.136**	-0.035	-0.100**
	(0.035)	(0.020)	(0.032)
West	0.034*	0.011	0.029*
	(0.016)	(0.009)	(0.014)
South	0.037**	-0.003	0.041**
	(0.014)	(0.008)	(0.013)
Midwest	0.033*	0.005	0.031**
	(0.013)	(0.007)	(0.012)
Constant	0.292**	0.223**	0.065**
	(0.034)	(0.018)	(0.023)
Spatial error (λ)	0.614**	0.487**	0.496**
	(0.004)	(0.010)	(0.008)
Adjusted R^2	0.426	0.562	0.261

Notes: Sample includes 2004 non-metropolitan counties. Standard errors are in parentheses. * Significant at 5%; ** Significant at 1%.

Table 3: Non-Metropolitan Migration by Enrollment in Higher Education, 1995-2000

	Enrolled in Higher Education			Not Enrolled in Higher Education		
	In	Out	Net	In	Out	Net
Share with bachelor's degree	0.574**	0.081**	0.488**	0.001	0.337**	-0.334**
	(0.014)	(0.006)	(0.015)	(0.028)	(0.019)	(0.031)
Population in millions	0.148**	-0.053**	0.202**	-0.488**	-0.356**	-0.130*
	(0.029)	(0.013)	(0.030)	(0.057)	(0.038)	(0.063)
Per capita income in \$1000s	-0.009**	0.000	-0.009**	0.005**	-0.001	0.006**
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Manufacturing Share	0.005	-0.007**	0.011	-0.097**	-0.038**	-0.053**
	(0.006)	(0.002)	(0.006)	(0.012)	(0.008)	(0.013)
January temperature /100	-0.016	-0.022**	0.007	0.120**	0.066**	0.055*
	(0.011)	(0.004)	(0.011)	(0.026)	(0.015)	(0.026)
January sun /100	-0.005*	0.002	-0.007**	0.020**	0.005	0.016**
	(0.003)	(0.001)	(0.003)	(0.006)	(0.003)	(0.006)
July temperature /100	0.042**	0.010*	0.032**	-0.210**	-0.088**	-0.137**
	(0.012)	(0.005)	(0.012)	(0.030)	(0.018)	(0.027)
July humidity /100	0.012	0.000	0.011	-0.061**	-0.057**	0.004
	(0.007)	(0.005)	(0.007)	(0.017)	(0.010)	(0.016)
Topography /100	-0.024*	-0.020**	-0.004	0.088**	-0.011	0.095**
	(0.011)	(0.004)	(0.011)	(0.023)	(0.014)	(0.024)
% Water Area /100	-0.018**	-0.005*	-0.014*	0.038**	-0.003	0.045**
	(0.006)	(0.003)	(0.006)	(0.013)	(0.008)	(0.014)
Population of nearest metro in millions	0.002	0.000	0.003	0.003	0.000	0.003
	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)	(0.003)
Distance to nearest metro /1000	-0.085**	0.021*	-0.104**	-0.152**	0.000	-0.137**
	(0.023)	(0.010)	(0.024)	(0.051)	(0.032)	(0.053)
Dist. to metro w/ pop>250K/1000	0.013	0.017*	-0.006	-0.052	0.029	-0.079
	(0.020)	(0.008)	(0.020)	(0.046)	(0.027)	(0.045)
Dist. to metro w/ pop>500K/1000	-0.002	-0.004	0.003	0.010	0.021	-0.009
	(0.019)	(0.007)	(0.019)	(0.042)	(0.025)	(0.042)
Dist. to metro w/ pop>1500K/1000	-0.051**	0.008	-0.058**	-0.080**	-0.044**	-0.037
	(0.011)	(0.004)	(0.011)	(0.027)	(0.016)	(0.026)
West	0.009	0.004	0.006	0.022	0.003	0.024*
	(0.005)	(0.002)	(0.005)	(0.012)	(0.007)	(0.011)
South	0.008	-0.001	0.009*	0.022*	-0.002	0.025*
	(0.004)	(0.002)	(0.004)	(0.011)	(0.006)	(0.010)
Midwest	0.010*	0.002	0.009*	0.018	0.000	0.018
	(0.004)	(0.002)	(0.004)	(0.010)	(0.006)	(0.010)
Constant	0.014	0.009**	0.004	0.224**	0.182**	0.042*
	(0.008)	(0.003)	(0.008)	(0.023)	(0.013)	(0.018)
Spatial error (λ)	0.446**	0.332**	0.416**	0.601**	0.494**	0.495**
	(0.014)	(0.016)	(0.014)	(0.006)	(0.010)	(0.009)
Adjusted R^2	0.477	0.462	0.426	0.403	0.500	0.251

Notes: Sample includes 2004 non-metropolitan counties. Standard errors are in parentheses. * Significant at 5%; ** Significant at 1%.

Table 4: Non-Metropolitan Migration by Age Group, 1995-2000

	In	Out	Net
Share with bachelor's degree 1990			
Age 5-9	-0.007*	0.017*	-0.021**
	(0.003)	(0.004)	(0.004)
Age 10-14	-0.011**	0.004	-0.015**
	(0.003)	(0.003)	(0.004)
Age 15-19	0.162**	-0.011**	0.169**
	(0.006)	(0.004)	(0.007)
Age 20-24	0.391**	0.048**	0.339**
	(0.010)	(0.007)	(0.012)
Age 25-29	0.055**	0.253**	-0.193**
	(0.005)	(0.007)	(0.007)
Age 30-34	0.013**	0.075**	-0.061**
	(0.005)	(0.004)	(0.005)
Age 35-39	0.004	0.032**	-0.028**
	(0.005)	(0.003)	(0.005)
Age 40-44	-0.007	0.014**	-0.021**
	(0.004)	(0.003)	(0.005)
Age 45-49	-0.004	0.011**	-0.014**
	(0.003)	(0.003)	(0.004)
Age 50-54	-0.002	0.010**	-0.011**
	(0.003)	(0.002)	(0.003)
Age 55-59	-0.010**	0.003	-0.012**
	(0.003)	(0.002)	(0.003)
Age 60-64	-0.009**	-0.002	-0.007*
	(0.003)	(0.002)	(0.003)
Age 65-69	-0.010**	-0.008**	-0.002
	(0.003)	(0.002)	(0.003)
Age 70-74	-0.006**	-0.010**	0.004
	(0.002)	(0.002)	(0.003)
Age 75-79	-0.003**	-0.003	-0.002
	(0.001)	(0.002)	(0.002)
Age 80-84	-0.002	-0.002	0.001
	(0.001)	(0.002)	(0.002)
Age 85+	0.000	-0.004	0.004
	(0.002)	(0.003)	(0.003)

Notes: Sample includes 2004 non-metropolitan counties. Regressions also include the additional explanatory variables included in Tables 2 and 3. Standard errors are in parentheses. * Significant at 5%; ** Significant at 1%.

Table 5: Controlling for "College Town" Counties, 1995-2000

	In	Out	Net
A. Only Including College Town Counties (N=205)			
Share with bachelor's degree	0.770**	0.512**	0.260**
	(0.072)	(0.056)	(0.071)
Adjusted R^2	0.496	0.527	0.201
B. Excluding College Town Counties (N=1799)			
Share with bachelor's degree	0.138**	0.134**	-0.003
	(0.043)	(0.027)	(0.048)
Adjusted R^2	0.405	0.561	0.283
C. Controlling for the Share of the Population Ages 15-24 (N=2004)			
Share with bachelor's degree	0.229**	0.265**	-0.038
	(0.040)	(0.026)	(0.043)
Share of population ages 15-24	0.604**	0.256**	0.340**
	(0.043)	(0.029)	(0.047)
Adjusted R^2	0.477	0.575	0.296

Notes: Regressions also include the additional explanatory variables included in Tables 2 and 3. Standard errors are in parentheses. ** Significant at 1%.

Table 6: Additional Results

	Enrolled in Higher Education			Not Enrolled in Higher Education		
	In	Out	Net	In	Out	Net
A. Using 1993 Metro Definitions						
Share with bachelor's degree	0.587**	0.082**	0.502**	0.019	0.353**	-0.330**
	(0.015)	(0.006)	(0.015)	(0.029)	(0.019)	(0.032)
Adjusted R^2	0.488	0.456	0.437	0.393	0.501	0.242
B. Including State Fixed Effects						
Share with bachelor's degree	0.602**	0.081**	0.518**	0.006	0.357**	-0.352**
	(0.014)	(0.006)	(0.015)	(0.029)	(0.019)	(0.032)
Adjusted R^2	0.499	0.470	0.454	0.405	0.506	0.265
C. Including an Interaction Term for Metro Proximity						
Share with bachelor's degree	0.664**	0.095**	0.564**	-0.062	0.410**	-0.473**
	(0.024)	(0.010)	(0.025)	(0.048)	(0.032)	(0.052)
Distance to nearest metro /1000	0.113*	0.052*	0.063	-0.289**	0.161*	-0.444**
	(0.049)	(0.021)	(0.051)	(0.097)	(0.064)	(0.106)
Share w/ bachelor's*Distance to metro /1000	-1.542**	-0.242	-1.298**	1.064	-1.253**	2.385**
	(0.332)	(0.143)	(0.346)	(0.651)	(0.436)	(0.722)
Adjusted R^2	0.483	0.462	0.430	0.404	0.502	0.254

Notes: Regressions also include the additional explanatory variables included in Tables 2 and 3. Standard errors are in parentheses. * Significant at 5%; ** Significant at 1%.