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John V. Winters
Oklahoma State University

Department of Economics
Oklahoma State
University
Stillwater, Oklahoma

339 BUS, Stillwater, OK 74078, Ph 405-744-5110, Fax 405-744-5180

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John V. Winters
Oklahoma State University and IZA
jvwinte@okstate.edu

Abstract

College graduates are considerably more mobile than non-graduates, and previous literature suggests that the difference is at least partially attributable to college graduates being more responsive to employment opportunities in other areas. However, there exist considerable differences in migration rates by college major that have gone largely unexplained. This paper uses microdata from the American Community Survey to examine how the migration decisions of young college graduates are affected by earnings in their college major. Results indicate that higher major-specific earnings in an individual's state of birth reduce out-migration suggesting that college graduates are attracted toward areas that especially reward the specific type of human capital that they possess.

Keywords: graduate migration; college major; college graduates; human capital
JEL: J24, J61, R23

Address mail correspondence to: Oklahoma State University, 331 Business Building, Stillwater, OK 74078-4011.

1. Introduction

College graduates are critical inputs for regional economies, and many policymakers are interested in how they can attract and retain college graduates in their areas.[1] College graduates earn higher average incomes than their less educated counterparts and are often thought to externally benefit other workers in the same area.[2] However, building the stock of college graduates in an area is no simple task. Researchers have documented that post-secondary education is associated with higher rates of geographic mobility (Malamud and Wozniak 2012). This higher mobility appears to be at least partially attributable to greater responsiveness to job opportunities in other areas and greater demand for location-specific amenities (Adamson, Clark, and Partridge 2004; Chen and Rosenthal 2008; Whisler et al. 2008; Wozniak 2010; Brown and Scott 2012; Arntz, Gregory, and Lehmer 2014; Zheng 2015).

Recent research also shows that college graduate income differences across areas differ somewhat by college major (Cunningham, Patton, and Reed 2013; Winters and Xu 2014; Abel and Deitz 2015). Consequently, one might also expect differential location decisions by college major. However, differences in migration by college major have gone largely undocumented and unexplained. This paper seeks to help fill this critical gap in the research literature by examining how migration decisions of college graduates relate to earnings differences across college majors. The data come from the American Community Survey (ACS), which in 2009 began asking persons holding a bachelor's degree or higher to report the field of study in which they earned their bachelor's.

[1] This paper follows most of the previous literature and uses the term "college graduates" to refer to persons whose highest completed education is a bachelor's degree or higher.

[2] For example, Moretti (2004) suggests that the share of the local population with a college degree creates positive human capital externalities by increasing wages for both college graduates and non-graduates in the same area. Similarly, Winters (2013) finds that a more educated local population increases labor force participation and employment probabilities for both college graduates and non-graduates.

The descriptive analysis shows that there are indeed differences in average geographic mobility across college majors. Furthermore, the regression analysis indicates that higher major-specific earnings in an individual's state of birth reduce out-migration and therefore increase birth-state retention of college graduates. Thus, college graduates are attracted toward areas that especially reward the specific type of human capital that they possess. These results have important implications for policymakers interested in reducing brain drain from their states. Economic opportunities play an important role in college graduate migration decisions, and the opportunities available to a given college graduate depend on their college major.

2. Conceptual Framework and Previous Literature

Young adults typically make a number of personal, educational, locational, and employment decisions that often have long-lasting consequences. Given the importance of both present and future costs and benefits, these decisions are often analyzed through variants of the human capital framework (Becker 1962; Sjaastad 1962). In this framework, decisions with multi-period consequences are treated as investments, and costs and benefits experienced in the future are discounted relative to the present.[3] Individuals are also assumed to be expected utility maximizers and therefore make choices that offer the highest expected utility. For example, in choosing the number of years of schooling, a young person will assess the net present value (NPV) of marginal costs and benefits of incremental schooling and choose the level of schooling offering the highest expected utility. Similarly in making location decisions, a young person will

[3] This framework often makes several simplifying assumptions. For example, the discussion herein largely ignores complexities related to informational uncertainty, risk aversion, dual-earner households, financing constraints, etc.

assess the NPV of the income stream and other benefits and costs of residing in various locations and choose the location offering the highest expected utility.[4]

The interaction between education and migration decisions has also received considerable attention from scholars, with much of this interest related to the causes and consequences of migration decisions of college graduates.[5] Education increases the quantity of knowledge and skills in general, but higher education is unique in that it usually involves the acquisition of relatively specialized knowledge and skills that can differ substantially depending on an individual's major field of study. Researchers have shown that investments in different skills by college major can have substantial impacts on the future earnings of college graduates (Arcidiacono 2004). For example, engineering and economics majors typically earn much higher incomes than those in education and performing arts (Winters and Xu 2014). However, earnings differences across majors are not independent of location; some areas offer relatively high earnings for a given major while other areas offer much lower earnings for the same major (Cunningham, Patton, and Reed 2013). Furthermore, the earnings gaps across majors differ across areas (Winters and Xu 2014). Local labor markets differ in their relative demands for various types of labor and market forces will cause higher relative earnings for those majors that are in greater demand.

The increased skill specialization by college graduates combined with geographic differences in earnings returns to specialized skills will cause college graduates to be especially geographically mobile compared to persons with less education and more homogeneous skills.

[4] Studies empirically examining the effects of expected earnings differentials on migration decisions include Treyz et al. (1993) and Kennan and Walker (2011).

[5] For example, recent studies include Faggian, McCann, and Sheppard (2006, 2007); Waldorf (2009); Busch and Weigert (2010); Corcoran, Faggian, and McCann (2010); Dahl and Sorenson (2010); Scott (2010); Brown and Scott (2012); Haapanen and Tervo (2012); Winters (2012); Böckerman and Haapanen (2013); Di Cintio and Grassi (2013); Faggian, Corcoran, and McCann (2013); Marinelli (2013); Knapp, White, and Wolaver (2013); Carree and Kronenberg (2014); Liu and Shen (2014); Nifo and Vecchion (2014); Tano (2014); Winters (2014); Abreu, Faggian, and McCann (2015); Betz, Partridge, and Fallah (2015); and Leguizamon and Hammond (2015).

The higher rates of geographic mobility for the college educated have been long recognized and documented by empirical researchers (Ladinsky 1967; Greenwood 1975; Schwartz 1976). Malamud and Wozniak (2012) establish a causal link for this relationship.

Geographic differences in earnings across college majors are also likely to have additional effects on migration decisions that have gone largely unexplored. In particular, college graduates will differ across college majors in the utility that they receive from residing in a given location. Areas with high relative demand and paying relatively high salaries for a given major should be especially attractive to persons from that major while being less attractive to persons from majors with lower local demand; these differences should affect migration decisions as people choose locations offering them the highest expected utility. Despite the intuition and importance of this hypothesis, it has received little attention from empirical researchers, largely because of data limitations. Reliable data on geographic differences in earnings by college major have been sparse until recently. This paper contributes to the literature by examining the effects of geographic differences in relative earnings across college majors on migration decisions. Specifically, I examine the effects of major-specific earnings in one's birth-state on the likelihood of remaining in that state after completing college.

3. Data

The data for this study come from the pooled 2009-2013 American Community Survey (ACS) microdata samples and are obtained from IPUMS (Ruggles et al. 2010). During this time, the ACS asked all college graduates to report the field in which they earned their bachelor's degree. Survey respondents provide printed answers, which the U.S. Census Bureau then converts to one of 176 detailed college major categories, which are also grouped into 38 broad

major categories. The ACS also includes information on individual sex, age, race, Hispanic origin, highest degree completed, annual earnings, hours worked, and weeks worked. Importantly, the ACS microdata (and the decennial census microdata that preceded it) also include information on an individual's state of birth and state of current residence, which can jointly be used to measure lifetime migration as done by several researchers (Hickman 2009; Malamud and Wozniak 2012; Sjoquist and Winters 2014).[6]

The current paper defines an individual to have out-migrated from their birth state if at the time of the ACS they live in a state other than their birth state. Figure 1 shows how this migration measure differs by age and education for persons ages 22-59. Rates are reported for four education categories: 1) any education level, 2) no college, 3) some college (but less than a bachelor's degree), and 4) a bachelor's degree or higher. Averaged over all education levels, the birth-state out-migration rate is 26.8% for age 22. However, the rate for those already earning a bachelor's degree is 33.1% and only 23.5% for those with no college and 27.4% for some college. As age increases, so do lifetime out-migration rates, especially for college graduates, whose birth-state out-migration rates exceed 50% after age 50; of course, education levels might also increase with age, especially for young people during their 20s. Out-migration rates for those with no college reach a max of 31.8% at age 59, which is below the rate for college graduates of any age. Thus birth-state out-migration is strongly increasing with both age and education.

The high mobility rates of college graduates have generated considerable interest, especially among researchers and policymakers hoping to better understand their location decisions. However, there is some understanding that not all areas are created equally when it

[6] The ACS also asked individuals to report their location one year prior to the survey, which can be used to measure one-year migration. However, one-year migration is moderately noisy for many purposes and may be driven by short-run migration decisions. Lifetime migration should depend on long run factors.

comes to college graduate migration. Specifically, some areas are very successful at attracting and retaining graduates while others struggle. Table 1 illustrates this by reporting birth-state out-migration rates for college graduates ages 22-30 and 31-59 by birth state. Of particular note, California and Texas have the lowest out-migration rates for ages 22-30 at 28.7% and 29.1%, respectively, while Alaska and Wyoming have the highest out-migration rates for ages 22-30 at 73.0% and 71.6%, respectively. Of course some people leave their birth state prior to finishing college.

Interestingly, out-migration rate rankings are very consistent between the two ages ranges considered in Table 1. California and Texas also have the lowest out-migration rates for ages 31-59, although Texas is now the lowest at 30.3%, and Alaska and Wyoming again have the two highest out-migration rates. The simple correlation between out-migration rates for the two age ranges is 0.929 and the Spearman rank correlation is 0.896. It appears that the factors that affect college graduate birth-state out-migration do so at a relatively early age and are quite persistent, increasing the importance of better understanding the location decisions of young recent college graduates. Obviously, California and Texas both have large populations with relatively warm winters, while Alaska and Wyoming are sparsely populated with cold winters, and these out-migration rates could reflect broader long-term trends in migration towards areas with better amenities (Rappaport 2007; Partridge 2010; Rickman and Rickman 2011). However, the determinants of birth-state out-migration rates are still less than fully understood. Furthermore, if Alaska and Wyoming were universally agreed to be bad places for college graduates, why would some graduates stay. And why does cold-winter Minnesota have lower out-migration rates than many comparably sized states in warmer areas? The current paper hopes to provide some new insights on these issues, but there is still much to learn from future research.

The current paper suggests that migration decisions of college graduates might depend in part on the type of higher education obtained, specifically, on the college major in which they earn their degree. Table 2 reports birth-state out-migration rates for college graduates ages 22-30 by broad college major. A couple of caveats are worth noting. First, a few of these categories (e.g. military technologies and precision production and industrial arts) have very few college graduates and may not produce very reliable estimates. The number of individual observations per category is also reported in the table. Second, the broad categories often include several detailed categories, which may have quite different out-migration rates among them. The regression analysis below will utilize the 176 detailed college major categories in the ACS, but the out-migration rates for the 38 broad categories illustrated in Table 2 are likely easier to digest initially.

The estimates in Table 2 provide some interesting results. Criminal justice and fire protection, education administration and teaching, and agriculture have the lowest out-migration rates. Out-migration rates are especially high for both some humanities fields (e.g. philosophy, religion, theology, linguistics, and fine arts) and some sciences (e.g. engineering, physical sciences, biology, and math). The higher out-migration rates among those in certain humanities fields may be partially attributable to unobserved preferences for self-exploration that are best achieved through experiencing new places. The out-migration rates for some majors, however, may partially result from earnings opportunities in different states. The final column of Table 2 reports mean earnings (converted to 2013 real dollars using the Consumer Price Index) for college graduates ages 22-59 by broad college major; the mean is computed for the larger age range than migration since young migrants will care about both current earnings and expected future earnings. Figure 2 plots the relationship between the out-migration rates and mean

earnings from Table 2. As might be expected, there is a positive relationship between the two; the correlation coefficient is 0.398 and a simple linear regression suggests that a $10,000 increase in mean earnings increases the out-migration rate by 2.04 percentage points. Of course, this is purely a descriptive relationship and should be interpreted with caution. Furthermore, there are a few majors such as business and engineering technologies that have relatively high earnings and relatively low out-migration rates.

4. Regression Analysis

4.1 Regression Framework

The paper next uses the 2009-2013 ACS microdata to more rigorously examine the effects of earnings on birth-state out-migration differences by college major. Specifically, I examine the effects of differences in major-specific mean earnings by birth state on out-migration of person i from birth state s and educated in college major m by estimating a linear probability model (LPM) of the following equation:

$$OutMigrate_{ism} = \theta MeanLogEarnings_{sm} + \rho MajorShare_{sm} + \beta X_{ism} + \delta_s + \gamma_m + \varepsilon_{ism} \quad (1)$$

The dependent variable is a dummy equal to one if an individual lives outside their birth state and zero if they live in their birth state, X_{ism} is a vector of individual characteristics and year dummies included as control variables, δ_s is a set of birth-state fixed effects, γ_m is a set of detailed college-major fixed effects, and ε_{ism} is a mean zero error term. The LPM is used instead of probit or logit because of the need to include the large number of fixed effects which often prevent probit/logit from being estimable and asymptotically unbiased. LPM estimation also facilitates easier interpretation since coefficients can be directly interpreted as marginal effects. Standard errors reported below are clustered by birth state.

The X vector includes dummy variables for being female, Black, Hispanic, Asian, and Other non-white; attainment of a master's, professional or doctoral degree; single year of age; and interactions between the female dummy and the other individual characteristics. The birth state fixed effects will account for aggregate differences in out-migration propensities across states that affect all college graduates similarly.[7] The college major fixed effects account for aggregate differences in out-migration propensities across college majors. The inclusion of both birth-state and college-major fixed effects means that the identifying variation comes from across majors within birth states. The primary regression sample is restricted to college graduates ages 22-30 born in the 50 U.S. states and also excludes persons enrolled in higher education at the time of the survey in order to focus on the location decisions of individuals recently finishing college and entering the labor force. Persons currently enrolled in higher education are less likely to make location decisions based on local earnings and are likely to face a more important migration decision after finishing their formal schooling. Older persons likely entered the labor market much earlier and their current location decisions may be moreso affected by past earnings, e.g., the earnings during their early post-college years for which data by major and state are unavailable. I do, however, consider the effects of observed earnings on the out-migration of older graduates in additional results discussed below.

The $MeanLogEarnings_{sm}$ variable is computed as a regression-adjusted mean of log earnings by birth state and college major for a sample of college graduates ages 22-59. Specifically, $MeanLogEarnings_{sm}$ is computed by first using the individual data to estimate:

$$LogEarnings_{ism} = \alpha X_{ism} + \pi Hours_{ism} + \mu_{ism} \quad (2)$$

[7] In particular, birth-state fixed effects in equation (1) control for statewide differences in aggregative earnings, cost-of-living and amenities. Of course, there are likely some differences in these across areas within states but the implicit assumption is that cost of living and amenities are conditionally uncorrelated with major-specific earnings.

, where $LogEarnings_{ism}$ is the natural log of annual earned income reported in the ACS, X_{ism} includes the same controls as above with additional age dummies for older workers, and $Hours_{ism}$ is a vector of controls for hours worked that includes a continuous variable for the usual number of hours worked per week and a set of interval categorical dummies for the number of weeks worked in the previous year. Residuals are computed from equation (2) and then mean residuals are computed for each intersection of state and college-major combinations, which yields $MeanLogEarnings_{sm}$.[8] These estimates are available from the author by request. For the primary sample, this variable has a weighted mean and standard deviation of -0.006 and 0.189, respectively.

One important concern is that location-specific earnings in various majors may affect college major decisions with young people being attracted to higher earning majors. There is prior literature finding that young people respond to temporal variation in major-specific earnings by altering their major choice (e.g. Long et al. 2015), but little evidence on the extent to which spatial variations in earnings would matter. If young people make decisions based solely on national-level earnings across majors, possible sorting effects would be captured by the college major fixed effects. However, young people may also care about local earnings in various majors to the extent that they desire to be in a particular location after college. To account for this, equation (1) also includes $MajorShare_{sm}$, a control variable for the (age group-specific) share of graduates from birth-state s completing a degree in major m. This variable

[8] The mean residuals are computed by state of residence for workers in each state and college major and then merged to individuals based on their birth state. This measures the earnings of workers currently residing in one's birth state and not the mean earnings of workers born in one's birth state. It measures the earnings differential one might expect if they resided in their birth state. Notice also that birth-state fixed effects in equation (1) remove statewide differences across birth-states in cost-of-living and amenities. Of course, there may be differences in these across areas within states

will help account for selection into various majors that might be correlated with $MeanLogEarnings_{sm}$.

The empirical approach is subject to some other concerns as well. For one, many people move from their native states before college or to attend college. Of course, many of those who moved away for college may move back to their home state after finishing college and the relative wages they could earn likely are an important factor in that decision. Empirically, the issue is primarily addressed by including birth-state fixed effects in the regressions to account for average differences in out-migration across birth states. The other control variables help account for this as well. Unobserved factors affecting pre-graduate out-migration are included in the error term. The empirical approach assumes that after conditioning on the fixed effects and other control variables in equation (1), mean log earnings by major and birth state are not correlated with the error term. If so, coefficient estimates for $MeanLogEarnings_{sm}$ will be unbiased and allow accurate inferences. I believe this is a credible assumption, but it is not testable, so some caution is required. Furthermore, the estimated effect of θ is capturing effects of earnings on the location decisions of marginal graduates, most of whom are still in their state of birth at young ages as indicated in Figure 1.

Another concern is that $MeanLogEarnings_{sm}$ could be measured with some degree of error from sampling, which would attenuate estimates of θ toward zero. However, the individual-level regression structure gives larger state-major combinations more weight and these should also have $MeanLogEarnings_{sm}$ be more precisely estimated, so the attenuation bias should not be too substantial. I try to address this below using lags as instrumental variables. Additionally, the available data are for 2009-2013, a period of time in which the U.S. economy was slowly recovering from the Great Recession that began in December 2007. There

is some concern that this might have reduced mobility and responsiveness to geographic differences in earnings (Partridge et al. 2012). I address this further below.

For various reasons there could be heterogeneous effects by age, sex, race, and ethnicity. The primary analysis focuses on ages 22-30 since young college graduates are likely the most mobile and responsive to earning differences. However, effects for ages 31-40, 41-50, and 51-59 are also examined. Results are first estimated for both sexes combined and then separately for males and females. Sex differences in responsiveness to major-specific earnings across states may exist, but the direction is not clear *a priori*. Previous literature suggests that migration rates may differ by sex with some evidence that women are more mobile than men in the UK (Faggian et al. 2007). Alternatively, if women are more likely than men to be tied stayers or tied movers, one might expect their migration decisions to be less responsive to their major-specific earnings (Cook et al. 2009; Docquier et al. 2012). Differences by race and ethnicity are similarly unclear *a priori* but certainly of interest (Faggian et al. 2006).

4.2 Regression Results

Regression results from estimating equation (1) for graduates ages 22-30 are reported in Table 3.[9] Columns 1-3 report estimates for both sexes combined, males, and females, respectively. The results are quite consistent. For all three columns, higher major-specific log earnings in an individual's birth state significantly reduce the probability that the individual has out-migrated from their birth state. The coefficients of -0.071, -0.074, and -0.073 are fairly consistent in magnitude suggesting minimal differences in responsiveness to state-major-specific earnings between men and women. The magnitudes of the coefficients can be interpreted as

[9] Result for the demographic characteristics are reported in Appendix Table A. Results for birth-state, year, and college-major fixed effects are not reported to conserve space but are available from the author by request.

suggesting that a 10 percent increase in state-major-specific earnings (an approximately 0.1 increase in the explanatory variable) would decrease the probability of birth-state out-migration by roughly 0.7 percentage points (i.e., 0.007). Similarly, a one standard deviation increase in the earnings variable would decrease birth-state out-migration by roughly 1.3 percentage points.

The estimated magnitudes in Table 3 are not very large but are certainly not trivial. As a source of comparison, Malamud and Wozniak (2012) find using an earlier time period that completing an additional year of higher education increases birth-state out-migration by roughly three to four percentage points. The magnitudes estimated in the current study are of sufficient economic importance to warrant policy attention, especially given the importance of college graduates to states and regions. However, the specific implications should consider the relatively modest magnitudes. For example, providing income subsidies to college graduates to stay and work in-state would have a relatively small impact relative to the costs required.[10] Furthermore, incomes do affect college graduate migration decisions, but the modest magnitudes suggests that other factors are likely important as well. These other factors may include local amenities, social networks, and location-specific investments that make moving costly.

I conducted some sensitivity analysis to consider some of the above concerns. First, I attempted to create a more nuanced measure of major-specific earnings in potential destinations outside the birth state. College major dummies account for national level earnings differences across majors, but there may be subnational forces at work. Specifically, I computed the flows from birth state to state of current residence for each detailed major and then computed a weighted average of major-specific mean log earnings outside of one's birth state using these flows as weights combined with major-specific mean earnings in destination states. Results

[10] Such a policy would also be costly because of a general inability to distinguish graduates making marginal location decisions from those who are infra-marginal. Thus, only a small percentage of subsidy recipients would alter their location decisions because of the subsidy.

reported in Appendix Table B show that the out-migration coefficients for major-specific earnings in one's birth state are very minimally affected. The positive coefficient on earnings in destination states on birth-state out-migration is the direction one would be expect; higher earnings in alternative labor markets likely pull people away from their birth state. The coefficients for both sexes and males of 0.137 and 0.165 are significant at the five percent level, but the female coefficient of 0.103 is not statistically significant at conventional levels. Interestingly, the magnitudes appear to suggest that pull factors from earnings outside the state are stronger than push factors from earnings in the state. However, the imprecision of the estimates for destination state earnings prevents strong inferences and the differences are not statistically significant at conventional levels. Furthermore, there is certainly some concern that the construction of the destination earnings variable could be subject to some degree of endogeneity, since it is based in part on migrants. Future research may be able to better address major-specific pull factors in a more comprehensive and convincing way. Still, it is useful to know that including this measure of destination earnings does not affect the results for major-specific earnings in one's birth state.

I next re-estimated the results limiting the sample to the 2013 ACS since this time period allows the most time for recovery after the Great Recession and most closely approximates a "normal" economy. Results for 2013 were qualitatively similar to those for the full time period with a both sexes combined sample coefficient estimate of -0.069 and a standard error of 0.036, which is significant at the ten percent level. I also attempted to address measurement error in the earnings variable. To do so, I separately estimated $MeanLogEarnings_{sm}$ by year and then used the one-year lag as an instrument. If the measurement error is purely from sampling and is independent across years, this instrumental variables (IV) approach will give consistent

estimates, but generally be less efficient than OLS. The instrument was significant in the first stage, but the second-stage was much less precisely estimated than OLS. For the both sexes sample, the coefficient was -0.134 with a standard error of 0.142, which is neither statistically different from zero nor the OLS estimate.[11] The IV estimates suggest that the OLS estimates might be attenuated somewhat, but the imprecision in the IV estimates limit their usefulness; thus they are not reported in the table.[12]

Table 4 reports results for ages 31-40, 41-50, and 51-59. Results are qualitatively similar to those for ages 22-30 but coefficients are generally slightly smaller in magnitude in Table 4 for ages 41-50 and 51-59. This is to be expected since recent college graduates are the most mobile and arguably the most responsive to differences in economic conditions across areas. However, the coefficient estimates for the older age ranges in Table 4 are not statistically significantly different from those for ages 22-30 in Table 3. The results in Table 4 also weakly suggest that women may be even more responsive to earnings differentials than men, but the sex differences are not statistically significant at the 10 percent level.

Table 5 reports separate results by race and ethnicity. The five groups examined are whites, blacks, Hispanics, Asians, and one group for all other.[13] The both sexes and male estimates for whites are slightly lower than the full sample results in Table 3, but the differences are not statistically significant at conventional levels. The white male coefficient also has a p-value of only 0.111 and is thus not significant at the ten percent level. The white female coefficient is very similar to the overall female coefficient in Table 3. The coefficients for black,

[11] The IV coefficient was -0.086 for men and -0.205 for women, possibly suggesting a greater responsiveness for women, but the imprecision of the estimates prevents making inferences.
[12] Another approach considered to address measurement error was to use the broad major categories in order to increase sample sizes for which earnings are measured. Doing so yielded moderately larger OLS coefficients and similar IV coefficients as the results using detailed majors, consistent with expectations. However, the heterogeneity in majors within many broad categories makes this approach less desirable than using detailed majors.
[13] Groups are defined to be mutually exclusive based on primary race and excluding Hispanics from other groups. Also, recall that the sample includes only persons born in the U.S.

Hispanic, and Asian females differ somewhat but are not statistically significantly different from white females and may simply result from variance due to smaller samples. However, the coefficients for Black, Hispanic, and Asian males of -0.297, -0.274, and -0.309, respectively, are much larger than for whites and the differences relative to white males are significant at the ten percent level or higher. Expectations about differences by race were unclear *a priori*, but it is certainly interesting that non-white males are the most responsive to major-specific earning differences. Better understanding and explaining these differences is likely a useful area for future research.

There are certainly some limitations with the analysis in this paper that could be further addressed in future research. Linking major-specific earnings to in-migration to specific areas could be a useful direction for future research, but does require some assumptions about how to specify migration flows.[14] Additionally, the focus on birth-state out-migration in the current study conveniently limits the sample to persons born in the U.S. More generally, there are a host of issues related to the destination decisions of foreign-born college graduates, and these are quite likely to differ by college major in important ways. Furthermore, future research could use other migration measures based on one-year migration in the ACS[15], e.g., to look at differences in migration flows across MSAs. Finally, researchers examining migration as a joint decision

[14] This is especially problematic for small majors, which often have zero observations for various flows and even among the "origin" population of some majors in given states. Having large numbers of zeros complicates analyses that take logarithmic transformations of migration flows. Having missing and/or noisy origin populations complicates analysis based on in-migration and net migration rates. Given the difficulties with examining in-migration, the current study maintains a focus on birth-state out-migration for simplicity.

[15] In results not shown, I also explored using one-year state out-migration as a binary dependent variable. Regressing a dummy for leaving the state of residence one year prior on major-specific regression-adjusted mean log earnings in the state one-year prior yields a small negative coefficient that is not statistically significant at conventional levels. Unfortunately, one-year migration is a noisy measure for the current analysis because relatively few people move across states in a given year. Furthermore, individual locations in the prior year are likely not independent of recent earnings in the state. For example, recent graduates may have already left areas paying especially low salaries to persons with their major.

made by a couple could likely gain additional insights by examining the importance of college majors.

5. Conclusion

College graduates are widely believed to be important ingredients for regional prosperity in developed economies, and researchers and policymakers are interested in what factors affect college graduates' location decisions. Employment opportunities in an area are likely an important factor, but these are likely to differ depending on the college major in which a graduate earned their degree. This paper uses American Community Survey microdata on income and migration to examine the effects of major-specific earnings in a college graduate's state of birth on the probability of out-migrating from that state. Results suggest that higher major-specific earnings in one's birth state reduce the likelihood of birth-state out-migration. OLS suggests that a 10 percent increase in major-specific earnings decreases birth-state out-migration by 0.7 percentage points or average. Measurement error may make this a conservative estimate, but even accounting for measurement error bias, the average effect is likely only moderately large. Interestingly, however, the effect magnitudes for black, Hispanic and Asian males are roughly four times that of the average effect, but it is unclear why they are so much more responsive.

The analysis in this paper has important implications. College graduates are geographically mobile in ways consistent with economic theory. In general, these results suggest that the stock of college graduates in an area depends at least in part on the demand for college graduates in the area and the incomes that graduates can earn. The policy implications require careful interpretation. For example, state and regional policies that try to alter graduate location

decisions via short-term income subsidies would likely have limited impact relative to their cost and are likely unjustified. Furthermore, the modest effects of earnings suggest that other factors are also likely important such as locational amenities and attachments to family, friends, and places. More generally, the stock of college graduates in an area is likely affected by both supply and demand-side forces.

However, this study also offers some more specific insights that have received minimal attention by previous researchers. College graduates have heterogeneous skills, and their earnings differ with these skills. Furthermore, various local labor markets reward various skills differently. College graduates are attracted to areas that offer high relative earnings for their specific set of skills. To some extent, young people likely have incomplete information about local earnings prospects for various majors in their state or region when they are making decisions about what major to pursue. Policymakers seeking to build the stock of college graduates in their area may be well served by facilitating the dissemination of better information about local earnings in various majors. This may help young people who want to locate in their home state after college make more informed decisions about their college major, which can increase their earnings and their propensity to stay after college.

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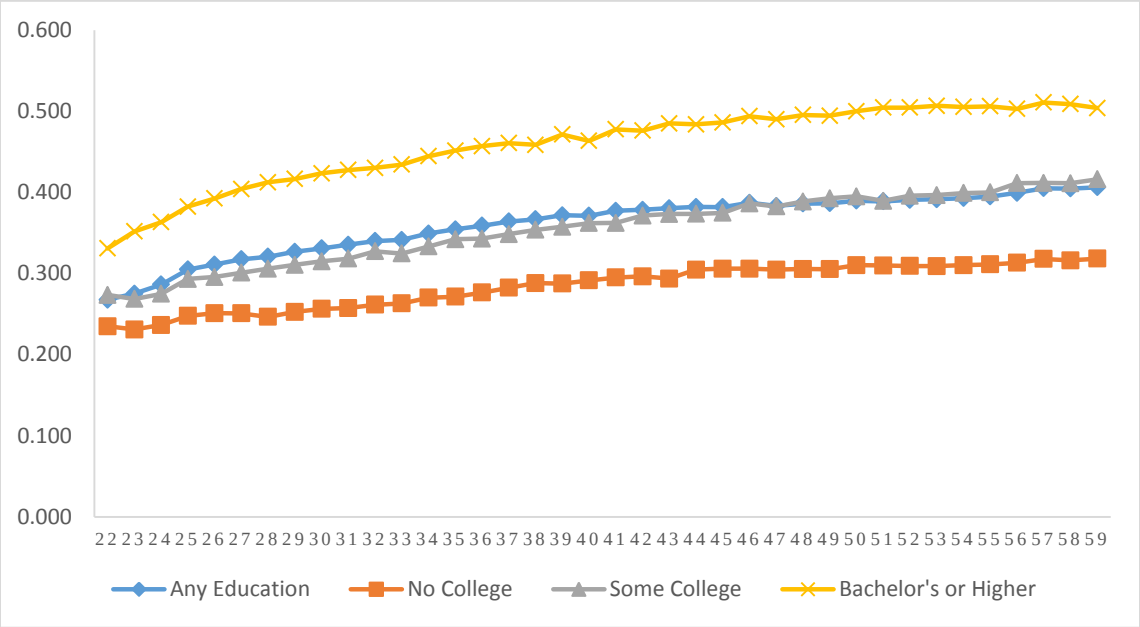
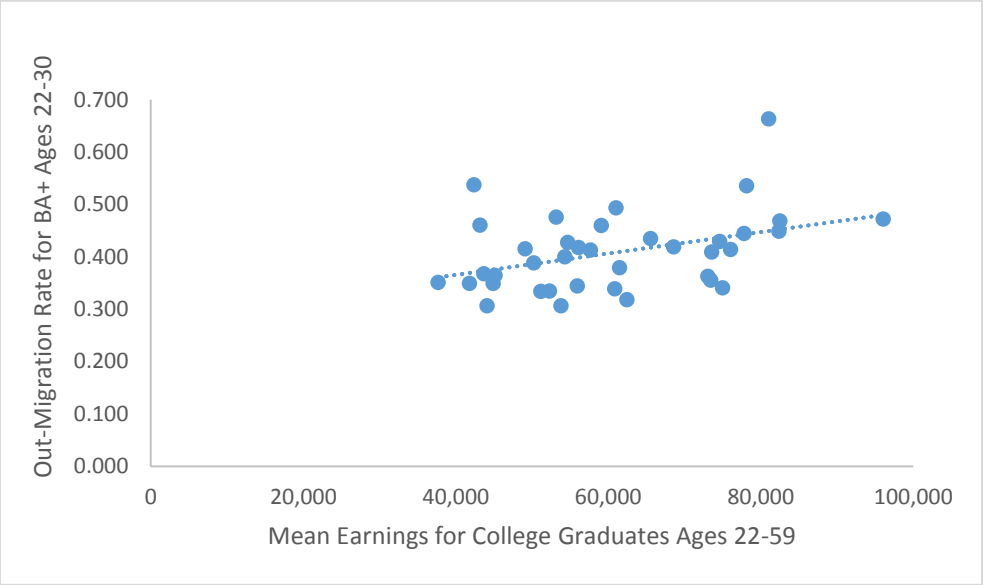
Figure 1: Birth-State Out-Migration by Age and Education



Source: Based on author's calculations from the pooled 2009-2013 American Community Survey.

Figure 2: Out-Migration Rates and Mean Earnings by Broad Major



Source: Based on author's calculations from the pooled 2009-2013 American Community Survey.

Table 1: Birth-State Out-Migration Rate for Colleges Graduates by Birth State and Age Range

State	Out-Migration Rate		State	Out-Migration Rate	
	Ages 22-30	Ages 31-59		Ages 22-30	Ages 31-59
Alabama	0.366	0.456	Montana	0.561	0.620
Alaska	0.730	0.794	Nebraska	0.444	0.564
Arizona	0.453	0.520	Nevada	0.566	0.638
Arkansas	0.396	0.503	New Hampshire	0.589	0.607
California	0.287	0.365	New Jersey	0.444	0.541
Colorado	0.468	0.528	New Mexico	0.579	0.610
Connecticut	0.497	0.540	New York	0.363	0.537
Delaware	0.579	0.657	North Carolina	0.346	0.388
Florida	0.395	0.487	North Dakota	0.571	0.650
Georgia	0.376	0.410	Ohio	0.394	0.491
Hawaii	0.569	0.544	Oklahoma	0.446	0.510
Idaho	0.568	0.622	Oregon	0.456	0.502
Illinois	0.360	0.489	Pennsylvania	0.373	0.486
Indiana	0.430	0.524	Rhode Island	0.514	0.595
Iowa	0.482	0.599	South Carolina	0.402	0.469
Kansas	0.461	0.572	South Dakota	0.562	0.639
Kentucky	0.392	0.461	Tennessee	0.384	0.445
Louisiana	0.412	0.489	Texas	0.291	0.303
Maine	0.512	0.537	Utah	0.419	0.437
Maryland	0.447	0.543	Vermont	0.622	0.621
Massachusetts	0.382	0.469	Virginia	0.452	0.530
Michigan	0.413	0.461	Washington	0.404	0.446
Minnesota	0.351	0.411	West Virginia	0.524	0.617
Mississippi	0.424	0.525	Wisconsin	0.407	0.458
Missouri	0.407	0.502	Wyoming	0.716	0.746

Source: Based on author's calculations from the pooled 2009-2013 American Community Survey.

Table 2: Birth-State Out-Migration Rates for Ages 22-30 and Mean Earnings for Ages 22-59 by Broad Major

ACS Broad Major Code	ACS Description for Broad Major	Out-Migration Rate for College Graduates Ages 22-30	Observations for College Graduates Ages 22-30	Mean Earnings for College Graduates Ages 22-59 ($2013)
11	Agriculture	0.318	4,908	62,457
13	Environment and Natural Resources	0.413	3,071	57,675
14	Architecture	0.435	2,757	65,579
15	Area, Ethnic, and Civilization Studies	0.460	1,848	59,119
19	Communications	0.400	24,446	54,322
20	Communication Technologies	0.415	1,013	49,098
21	Computer and Information Sciences	0.414	10,201	76,058
22	Cosmetology Services and Culinary Arts	0.368	482	43,714
23	Education Administration and Teaching	0.307	39,823	44,126
24	Engineering	0.472	21,363	96,107
25	Engineering Technologies	0.363	1,992	73,094
26	Linguistics and Foreign Languages	0.476	4,208	53,193
29	Family and Consumer Sciences	0.351	4,118	37,699
32	Law	0.344	785	55,978
33	English Language, Literature, and Comp.	0.427	13,479	54,684
34	Liberal Arts and Humanities	0.334	5,450	52,302
35	Library Science	0.349	64	41,810
36	Biology and Life Sciences	0.449	23,538	82,385
37	Mathematics and Statistics	0.444	4,480	77,840
38	Military Technologies	0.663	14	81,054
40	Interdisciplinary and Multi-Disc. Studies	0.418	5,029	56,141
41	Physical Fitness, Parks, Rec., and Leisure	0.365	7,585	45,184
48	Philosophy and Religious Studies	0.493	3,523	61,017
49	Theology and Religious Vocations	0.537	2,378	42,384
50	Physical Sciences	0.468	8,900	82,518
51	Nuclear, Industrial Radiology, and Bio. Tech.	0.379	138	61,519
52	Psychology	0.388	25,503	50,254
53	Criminal Justice and Fire Protection	0.306	9,419	53,819
54	Public Affairs, Policy, and Social Work	0.349	5,046	44,898
55	Social Sciences	0.429	33,184	74,655
56	Construction Services	0.340	1,117	74,996
57	Electrical and Mechanic Repairs and Tech.	0.334	118	51,190
58	Precision Production and Industrial Arts	0.409	13	73,596
59	Transportation Sciences and Technologies	0.536	1,035	78,180
60	Fine Arts	0.460	22,844	43,192
61	Medical and Health Sciences and Services	0.339	25,385	60,859
62	Business	0.355	75,681	73,451
64	History	0.419	9,652	68,592

Source: Based on author's calculations from the pooled 2009-2013 American Community Survey.

Table 3: Effects of Major-Specific Earnings in Birth State on Birth-State Out-migration, Ages 22-30

	(1) Both Sexes	(2) Males	(3) Females
Major-Specific Log Earnings in Birth State	-0.071	-0.074	-0.073
	(0.025)***	(0.033)**	(0.026)***
Individual Observations	305,501	129,120	176,381

Notes: The sample includes college graduates ages 22-30 born in the 50 U.S. states. The dependent variable is a binary indicator equal to one if the individual no longer resides in their birth state at the time of the ACS. The explanatory variable is the regression-adjusted average log earnings by college major and birth state, which is computed as the mean residuals by college major and birth state from regressing individual log earnings for college graduates ages 22-59 on individual controls for sex, race/ethnicity, age, education, year, weeks worked and hours worked. The out-migration regression also includes individual controls for sex, race/ethnicity, age, education, year and fixed effects for birth state and detailed college major and a control variable for the share of graduates from the birth-state completing a degree in a given major. Standard errors are clustered by birth state.

**Significant at the 5% level based on clustered standard errors; ***Significant at the 1% level

Table 4: Effects of Major-Specific Earnings in Birth State on Birth-State Out-migration for Other Ages

	(1) Both Sexes	(2) Males	(3) Females
A. Ages 31-40			
Major-Specific Log Earnings in Birth State	-0.069	-0.057	-0.083
	(0.026)**	(0.033)*	(0.028)***
Individual Observations	451,107	200,112	250,995
B. Ages 41-50			
Major-Specific Log Earnings in Birth State	-0.048	-0.033	-0.061
	(0.019)**	(0.022)	(0.024)**
Individual Observations	498,487	234,362	264,125
C. Ages 51-59			
Major-Specific Log Earnings in Birth State	-0.057	-0.049	-0.071
	(0.016)***	(0.019)**	(0.025)***
Individual Observations	482,139	233,652	248,487

Notes: The sample includes college graduates born in the 50 U.S. states. The dependent variable is a binary indicator equal to one if the individual no longer resides in their birth state at the time of the ACS. The explanatory variable is the regression-adjusted average log earnings by college major and birth state, which is computed as the mean residuals by college major and birth state from regressing individual log earnings for college graduates ages 22-59 on individual controls for sex, race/ethnicity, age, education, year, weeks worked and hours worked. The out-migration regression also includes individual controls for sex, race/ethnicity, age, education, year and fixed effects for birth state and detailed college major and a control variable for the share of graduates from the birth-state completing a degree in a given major. Standard errors are clustered by birth state.
*Significant at the 10% level based on clustered standard errors; **Significant at the 5% level; ***Significant at the 1% level.

Table 5: Effects of Major-Specific Earnings on Out-migration by Race/Ethnicity, Ages 22-30

	(1) Both Sexes	(2) Males	(3) Females
A. Whites			
Major-Specific Log Earnings in Birth State	-0.062	-0.052	-0.075
	(0.024)**	(0.032)	(0.026)***
Individual Observations	250,491	106,958	143,533
B. Blacks			
Major-Specific Log Earnings in Birth State	-0.158	-0.297	-0.156
	(0.089)*	(0.120)**	(0.108)
Individual Observations	16,690	6,232	10,458
C. Hispanics			
Major-Specific Log Earnings in Birth State	-0.145	-0.274	-0.074
	(0.081)*	(0.112)**	(0.084)
Individual Observations	12,080	5,610	6,470
D. Asians			
Major-Specific Log Earnings in Birth State	-0.171	-0.309	-0.081
	(0.104)	(0.093)***	(0.165)
Individual Observations	18,971	7,316	11,655
E. Other			
Major-Specific Log Earnings in Birth State	-0.152	-0.232	-0.116
	(0.092)	(0.145)	(0.118)
Individual Observations	7,269	3,004	4,265

Notes: The sample includes college graduates ages 22-30 born in the 50 U.S. states. The dependent variable is a binary indicator equal to one if the individual no longer resides in their birth state at the time of the ACS. The explanatory variable is the regression-adjusted average log earnings by college major and birth state, which is computed as the mean residuals by college major and birthstate from regressing individual log earnings for college graduates ages 22-59 on individual controls for sex, race/ethnicity, age, education, year, weeks worked and hours worked. The out-migration regression also includes individual controls for sex, race/ethnicity, age, education, year and fixed effects for birth state and detailed college major and a control variable for the share of graduates from the birth-state completing a degree in a given major. Standard errors are clustered by birth state.
*Significant at the 10% level based on clustered standard errors; **Significant at the 5% level; ***Significant at the 1% level.

Table A: Additional Results for Primary Analysis, Ages 22-30

	(1) Both Sexes	(2) Males	(3) Females
Female	0.007		
	(0.005)		
Highest Education Is Master's Degree	0.073	0.074	0.029
	(0.013)***	(0.013)***	(0.012)**
Highest Education Is Master's Degree*Female	-0.043		
	(0.006)***		
Highest Education Is Professional Degree	0.097	0.099	0.085
	(0.013)***	(0.013)***	(0.011)***
Highest Education Is Professional Degree*Female	-0.009		
	(0.012)		
Highest Education Is Doctorate Degree	0.169	0.171	0.097
	(0.020)***	(0.019)***	(0.011)***
Highest Education Is Doctorate Degree*Female	-0.067		
	(0.026)**		
Black	0.004	-0.001	-0.037
	(0.014)	(0.014)	(0.014)**
Black*Female	-0.043		
	(0.009)***		
Asian	-0.021	-0.018	-0.009
	(0.061)	(0.058)	(0.063)
Asian*Female	0.016		
	(0.009)*		
Hispanic	-0.062	-0.060	-0.064
	(0.020)***	(0.019)***	(0.022)***
Hispanic*Female	-0.001		
	(0.008)		
Other Non-white Race	0.013	0.013	0.018
	(0.031)	(0.030)	(0.024)
Other Non-white Race*Female	0.005		
	(0.016)		
Age 23	0.022	0.021	0.007
	(0.011)*	(0.011)*	(0.010)
Age 24	0.015	0.015	0.023
	(0.010)	(0.010)	(0.012)*
Age 25	0.033	0.033	0.040
	(0.009)***	(0.009)***	(0.010)***
Age 26	0.032	0.031	0.046
	(0.011)***	(0.010)***	(0.010)***
Age 27	0.048	0.048	0.053
	(0.012)***	(0.012)***	(0.010)***
Age 28	0.066	0.066	0.049
	(0.015)***	(0.015)***	(0.012)***
Age 29	0.059	0.059	0.058
	(0.014)***	(0.014)***	(0.011)***
Age 30	0.070	0.069	0.062
	(0.014)***	(0.014)***	(0.012)***
Share of graduates from birth-state in major	-5.280	-5.416	-5.276
	(0.462)***	(0.532)***	(0.524)***
Individual Observations	305,501	129,120	176,381

Notes: The sample includes college graduates ages 22-30 born in the 50 U.S. states. The dependent variable is a binary indicator equal to one if the individual no longer resides in their birth state at the time of the ACS. The explanatory variable is the regression-adjusted average log earnings by college major and birth state, which is computed as the mean residuals by college major and birthstate from regressing individual log earnings for college graduates ages 22-59 on individual controls for sex, race/ethnicity, age, education, year, weeks worked and hours worked. The out-migration regression also includes individual controls for sex, race/ethnicity, age, education, year and fixed effects for birth state and detailed college major and a control variable for the share of graduates from the birth-state completing a degree in a given major. Standard errors are clustered by birth state. *Significant at the 10% level; **Significant at the 5% level; ***Significant at the 1% level.

Table B: Robustness to Controlling for Earnings in Destination States, Ages 22-30

	(1) Both Sexes	(2) Males	(3) Females
Major-Specific Log Earnings in Birth State	-0.071	-0.075	-0.073
	(0.026)***	(0.033)**	(0.026)***
Major-Specific Mean Log Earnings in Destination States	0.137	0.165	0.103
	(0.061)**	(0.082)**	(0.090)
Individual Observations	305,501	129,120	176,381

Notes: The sample includes college graduates ages 22-30 born in the 50 U.S. states. The dependent variable is a binary indicator equal to one if the individual no longer resides in their birth state at the time of the ACS. The explanatory variable is the regression-adjusted average log earnings by college major and birth state, which is computed as the mean residuals by college major and birthstate from regressing individual log earnings for college graduates ages 22-59 on individual controls for sex, race/ethnicity, age, education, year, weeks worked and hours worked. The out-migration regression also includes individual controls for sex, race/ethnicity, age, education, year and fixed effects for birth state and detailed college major and a control variable for the share of graduates from the birth-state completing a degree in a given major. Standard errors are clustered by birth state.

*Significant at the 10% level based on clustered standard errors; ***Significant at the 1% level.