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Migration Behaviors and Educational Attainment of Metro and Non-Metro Youth☆

Xiao Li
Department of Sociology
Washington State University – Vancouver

Abstract While research has consistently demonstrated a positive relationship between migration from rural areas and educational attainment, it is unclear whether migration is the driver of educational attainment or merely a mediator. The "rural brain drain" perspective suggests that young people leave rural areas if they have greater academic potential than their peers. A "migration gain" perspective implies that people, regardless of prior achievements, may move to invest in human capital, thereby gaining more education than those who do not move. This article uses data from the National Longitudinal Study of Youth 97 to test these competing predictions with multilevel/mixed-effects models. Consistent with previous research, the study found that youth attained the least education if they stayed in non-metro areas. By contrast, they gained more education if they moved not just from but also to non-metro areas, consistent with the "migration gain" hypothesis. Academic performance alone did not explain the association between education and migration, contradicting the "rural brain drain" theory. However, academic performance and college enrollment, which are also influenced by available educational opportunities, together explain the association between migration and education significantly, suggesting that the educational outcomes of migrants are influenced by a combination of individual and institutional characteristics.

Introduction

Scholars have long been concerned with the "rural brain drain" phenomenon, i.e., the out-migration of academically talented rural youth. The talented youth are more likely to move to non-rural places to attend colleges than other youth (Brown and Schafft 2011; Carr and Kefalas 2009; Corbett 2007, 2009; Sherman and Sage 2011). They then tend to report better educational outcomes than people who stay in rural areas. Therefore, the "rural brain drain" perspective suggests that the greater educational attainment of migrants to non-rural areas may be because rural youth with high levels of academic achievement are

☆ The author is grateful to Dr. Alair MacLean and the reviewers for their helpful suggestions. Address correspondence to Xiao Li, Department of Sociology, Washington State University – Vancouver, 14204 NE Salmon Creek Ave, Multimedia Classroom Building (VMMC) 207, Vancouver, WA 98686, USA. Email: xiao.li2@wsu.edu

more likely to move to non-rural places. In other words, academic ability causes migration, which is then associated with better educational outcomes.

In investigating the phenomenon, scholars have produced mixed findings. Some studies have confirmed the "brain drain" theory. For instance, Domina (2006) found that college-educated rural youth are more likely to move to urban areas than their peers without a college degree. However, other research found that high school students with high and low grades are equally likely to aspire to leave rural areas (Petrin, Schafft, and Meece 2014). If people who aspire to move, in fact, move, this finding suggests that students may be equally likely to move to non-rural areas regardless of their academic ability. If so, the greater educational attainment of migrants suggests that migration causes education, not the reverse.

It is essential to understand whether migration directly affects education, or mediates the effects of academic ability on educational outcomes, given the chronic "rural brain drain," the long-lasting geographic inequality in education, and rural community sustainability (Brown and Schafft 2011; Corbett 2007; Guo 2009; Hillman and Weichman 2016; Hirschl and Smith 2020; Johnson and Lichter 2019; Rosenboom and Blagg 2018; Sherman and Sage 2011). Although rural or non-metropolitan areas experienced short-term population increases due to the in-migration of middle-aged and older adults, for youth, the overall migration trend has consistently been from rural to non-rural settings (Brown and Schafft 2011; Guo 2009; Johnson and Fuguitt 2000; Johnson and Lichter 2019). From 1950 to 2010, rural depopulating counties on average lost 43 percent of the young adults aged from 20 to 24 in each decade (Johnson and Lichter 2019).

Examining the relationship between migration and education is essential to understand how students navigate their status attainment process across places and to what degree communities are losing their talented young people. Although rural places have seen more college-educated people, the education gap between rural and non-rural places has grown in the 21st century (Marré 2017). Rural students were more likely than non-rural students to attend two-year colleges, but they were less likely to attend selective colleges and complete four-year college education than non-rural students (Brown and Schafft 2011; Byun, Irvin, and Meece 2015; Byun, Meece, and Irvin 2012; Demi et al. 2010; Pittman, McGinty, and Johnson-Busbin 2014). Given the unequally distributed educational opportunities across places, they have to move to pursue higher education (Hillman and Weichman 2016; Hirschl and Smith 2020; Hughes, Kimball, and Koricich 2019; Koricich, Chen, and

Hughes 2018; Rosenboom and Blagg 2018). Many of them did not return due to the limited job opportunities in rural areas (Artz and Yu 2011; Brown and Schafft 2011; Estes et al. 2016). The chronic out-migration of talented youth has challenged the community sustainability by influencing community social, economic, and cultural resources, especially if people who leave tend to be more talented than those who stay (Brown and Schafft 2011; Corbett 2007; Johnson and Lichter 2019; Sherman and Sage 2011).

Few studies have tested how migration affects educational attainment. Among the few, prior studies either reported the correlation between education and migration (Snyder, McLaughlin, and Coleman-Jensen 2009) or treated education as one predictor or control variable of migration (Guo 2009; Jordan et al. 2011; Mykerezi et al. 2014). These studies have either failed to clarify the potentially reciprocal nature of migration and education, or simplified migration as a process that only starts after youth complete their education. They have overlooked that some people move to attend college, as their educational attainment is a process that occurs across locations.

It is unclear whether and to what degree migrants achieve better educational outcomes because of their prior academic talents, or only because they move to opportunities. In addition, it is unclear whether the relationship between migration and education is specific to rural youth. Studies have not clarified whether and how, for urban youth, moving to rural places may be associated with educational attainment. Although rural areas have fewer postsecondary institutions than non-rural places (U.S. Department of Education 2018), rural colleges may also attract urban-born youth. Some rural colleges are the states' flagship universities (such as the University of Idaho and University of Mississippi) and land-grant colleges that offer agriculture and mechanic arts-related programs (including University of Arizona and Washington State University) (7 U.S.C. 1925). They may better fit non-rural students who prefer agriculture-related programs, relatively low living costs, convenient access to nature and outdoor activities, a close-knit, highly spirited rural campus culture, and a slow-paced lifestyle (Patel 2021). There are also highly selective private institutions in rural areas that have distinctive missions and histories to attract urban-born youth, such as Dartmouth College, Colby College, and College of the Ozarks.

The following study examines whether, and to what extent, the relationship between migration and educational attainment is reciprocal for both rural and urban youth. The paper presents two perspectives regarding the relationship between migration across rural/non-rural boundaries and education. First, according to human capital theory,

youth attain better educational outcomes if they move across boundaries. They move to invest in human capital due to the unequally distributed educational resources. Migration may also improve student-college match, i.e., the degree to which college selectivity matches with students' academic credentials, resulting in better educational outcomes than if students do not move and attend colleges that do not match with their capacity. Second, based on the "rural brain drain" perspective, youth are more likely to move to non-rural areas to pursue higher education if they have better pre-migration academic ability than if they do not. Hence, migration may mediate the effects of academic performance on future educational outcomes.

With data from the National Longitudinal Study of Youth 97, the study examines the effects of migration behaviors on education and whether the effects are influenced by youth prior achievement ability using mixed-effects longitudinal models. The study also examines how family and community factors may impact the relationship between migration and education by controlling for family background and community characteristics in the models. The study mainly reports results based on the metropolitan/non-metropolitan definition of rurality. Results using different measures of rurality are available upon request.

Theory and Hypotheses

Migration and Education

Migration generally refers to changes in people's residential addresses. Empirical studies adopt different terms to represent different types of residential moves (Rossi 1980). Among them, immigration refers to the farthest residential moves, moves across country boundaries. Migration, or internal migration, refers to changes in residential addresses across relatively distant localities. It is often measured by moves across county boundaries but within a country (Rossi 1980). In addition, residential mobility represents moves within one locality, often measured by intra-county or intra-metropolitan area moves (Rossi 1980).

Recent studies on migration mainly focus on the effects of international migration/immigration. Relatively few have explored the impact of internal migration (Ellis 2012). Among the few, studies on migration and education mainly focus on the migration experiences of rural youth and their educational attainment, reflecting a concern about the "rural brain drain" (e.g., Brown and Schafft 2011; Carr and Kefalas 2009; Corbett 2007, 2009; Domina 2006; Petrin et al. 2014; Sherman and Sage 2011). For rural youth, moving to non-rural areas is associated with better educational outcomes. However, it is unclear whether this

association is because higher achieving youth—who would likely have higher educational attainment than their peers regardless of migration status—tend to move, or because migration directly contributes to better educational outcomes.

For urban youth, scholars have mainly explored the effects of residential mobility on students' education outcomes. These studies tend to show negative effects of residential mobility on student educational outcomes, such as academic achievement, school attendance, and dropout rates (Haelermans and De Witte 2015; Voight, Giraldo-García, and Shinn 2020). After considering unobserved factors, the negative effects of mobility on child development turn to be small or even positive (Garboden, Leventhal, and Newman 2017). These studies show that children who report frequent residential moves are more likely to come from socioeconomically disadvantaged family backgrounds (Murphey, Bandy, and Moore 2012). Their socioeconomic background disadvantages explain most of the negative effects of mobility (Murphey et al. 2012). However, these urban studies mainly examine the educational outcomes of young children. Few have investigated the effects of youth residential moves on higher education. Moreover, no research has explored the relationships between migration across rural/non-rural boundaries and the educational attainment of urban youth.

This study explores the relationships between migration across boundaries and educational attainment for both rural and non-rural youth. Migration decisions and education attainment are often intertwined processes (Dustmann and Glitz 2011; Schapiro 2009). On the one hand, individuals may decide to attend college when they already expected to move or not return in the future (see Figure 1a). Their decision to move may influence the decision to attend college (Dustmann and Glitz 2011). Migration may affect educational attainment by offering better educational or job market opportunities. Thereby, migration may directly affect education.

On the other hand, migration may serve as a mechanism when people move for or because of education. In this case, people with specific characteristics, such as better academic performance, move to pursue higher education. Migration, therefore, may mediate the effects of pre-migration characteristics on people's educational outcomes (see Figure 1b).

Human Capital Theory, Educational Resources Distribution, and Student-College Match

Scholars have followed an economic perspective to explain how migration may affect youth education and labor market outcomes. According

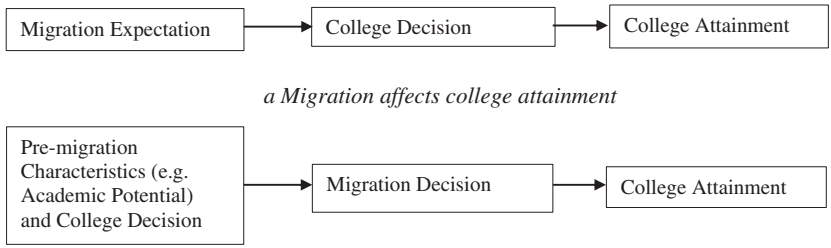

Figure 1. Relationships between Migration and College Attainment. (a) Migration affects college attainment. (b) Migration mediates the effects of pre-migration characteristics on college attainment.

to human capital theory, rural-to-urban migration can be treated as an investment in human capital through which rural youth are able to overcome the resource gap between rural and non-rural areas to achieve better education and labor market outcomes (Guo 2009; Mykerezi et al. 2014). Rural youth rationally choose to move in order to invest in human capital.

They do so partly due to the unequally distributed educational resources across places. Most higher education institutions are located in metropolitan areas. According to data from the Integrated Postsecondary Education Data System (IPEDS), from 2018 to 2019, 85 percent of higher educational institutions[1] were located in metropolitan places, while only 15 percent of colleges were in non-metropolitan areas. Prior studies also show that most education deserts, defined as communities with no postsecondary institutions or only one public community college within 25 miles, are located in rural places (Hillman and Weichman 2016). Not only physical but also digital educational resources are lacking in rural America (Hillman and Weichman 2016; Hirschl and Smith 2020; Rosenboom and Blagg 2018). Accounting for online education, rural areas are still home to 82 percent of people living in education deserts (Rosenboom and Blagg 2018). Therefore, rural youth may be attracted to urban places by the abundant educational resources. Migration directly contributes to the education advantages of migrants from rural areas.

[1]The higher educational institutions refer to "institutions that participate in or are applicants for participation in any federal student financial aid program (such as Pell grants and federal student loans) authorized by Title IV of the Higher Education Act of 1965, as amended (20 USC 1094, Section 487(a)(17) and 34 CFR 668.14(b)(19))", for who it is mandatory to complete IPEDS surveys (U.S. Department of Education 2018).

Given the unequally distributed higher educational resources, boundary-crossing migration may improve student-college match, thereby resulting in better educational outcomes for migrants. Prior studies found that rural students are more likely to undermatch, i.e., to attend less selective colleges than their academic credentials permit (Light and Strayer 2000; Smith, Pender, and Howell 2013). Because rural areas have fewer postsecondary educational institutions and these institutions tend to be less selective (Dillon and Smith 2017; Hillman and Weichman 2016; Hughes et al. 2019; Prins and Kassab 2017), rural students are more likely to undermatch if they stay and attend nearby colleges (Freeman 2017; Ovink et al. 2018). Moreover, undermatching negatively impacts youth college completion and early career outcomes (Kang and García Torres 2021; Light and Strayer 2000; Ovink et al. 2018). Therefore, youth may obtain better educational outcomes if they move than if they stay in non-metro areas, partially because migration may result in better student-college matching.

At the same time, rural postsecondary institutions, such as the University of Idaho, University of Mississippi, Ohio University, Washington State University, etc., may also attract some urban youth to move to rural places for educational purposes. Given the more abundant college choices in non-rural areas, non-rural youth may attend rural institutions only when these institutions have more advantages than the available colleges in their hometowns. These rural colleges, chosen by urban youth, may be of better quality than other rural colleges. They may better fit urban youth who prefer relatively lower living costs, rural campus environments, and other school benefits (Patel 2021). They may also academically match migrants from urban areas better. If so, migrants from non-rural areas will also obtain better educational outcomes than people who do not move.

Given the unequally distributed postsecondary educational resources, youth may move for education to invest in human capital. The migration may also improve student-college matching, resulting in better educational outcomes. Therefore, the study examines the *Migration Gain Hypothesis*: people are more likely to obtain better educational outcomes if they move across rural/non-rural boundaries than if they do not.

"Rural Brain Drain"

Scholars have long been concerned that talented youth tend to leave rural areas, causing a "rural brain drain." They have examined the phenomenon using different measures of talent, including college degrees and academic ability. They have explored whether these measures

predict youth migration aspirations and behaviors. The findings from these studies are mixed.

To examine the existence and degree of "rural brain drain," some scholars have defined "brain drain" as the out-migration of college-educated people. They have shown that college-educated people are more likely to move to non-rural places mainly due to the economic incentives and the perceived lack of job opportunities in rural places (Artz 2003; Brown and Schafft 2011; Domina 2006). For instance, Artz (2003) found that from 1970 to 2000, most non-metropolitan and rural counties experienced a decreased share of college-educated workers. Using data from 1989 to 2004, Domina (2006) also found that college-educated youth led the out-migration from non-metro areas. These studies contribute to clarifying the trend of "brain drain."

Another approach focused on college-educated youth is to study the return of college graduates. Based on alumni data from specific land grant universities, prior studies found that fewer than half of rural youth who left to pursue higher education returned to rural areas after graduation (Artz and Yu 2011; Estes et al. 2016). These studies shed light on the mechanisms of "brain drain" by showing that the decision of leaving or returning is affected by rural labor market job structure, students' major, and nonpecuniary goals and values, such as building a family business from zero for children to inherit (Artz and Yu 2011; Estes et al. 2016). However, their findings focus on college graduates from specific land grant universities located in metropolitan places. It is still unclear how rural youth chose their majors and colleges after high school graduation. It is also unclear whether these "brain drain" patterns hold for students at other universities, especially colleges located in non-metro areas. Overall, by focusing on migration behaviors of college graduates, the above studies treated education as a predictor of migration. They ignored that migration may occur before college completion and predict future educational attainment.

Other studies have defined "rural brain drains" as the leaving of rural youth who perform better in high schools. Some studies have examined the effects of academic achievement on youth migration aspirations. They often assumed that talented youth are more likely to move to non-rural places due to a college expectations. For example, Corbett (2007) suggested that rural high schools may hurt community sustainability by encouraging youth to expect a college education and to leave rural communities to attend college, thereby spurring a "rural brain drain." According to these studies, academically talented rural students may be more likely than other students to expect a college education. They then tend to move to non-rural places to attend college. Hence,

academic ability predicts migration, which then leads to better education. Migration may mediate the effect of academic ability on future education.

Nevertheless, other scholars have questioned these findings. According to Petrin et al. (2014), high school students with high and low grades are roughly equally likely to aspire to leave rural areas (Petrin et al. 2014). Although migration aspiration may not always lead to a move, prior studies show that aspiration is one "proximate determinant" for migration behavior (De Jong 2000; De Jong et al. 1985; Rossi 1980). People who aspire to move are more likely to move. If people who aspire to move, in fact, move, the finding of Petrin et al. (2014) suggests that rural youth are equally likely to move to urban places regardless of prior academic ability. If so, the academic ability does not impact the association between migration and education. To clarify the "rural brain drain," the study evaluates whether migration mediates the effects of academic ability on future education. It tests the *"Rural Brain Drain" Hypothesis*: Rural youth who have higher grades are more likely to move to non-rural places and thereby obtain better educational outcomes than those who do not.

Other Factors Influencing Youth Migration and Educational Attainment

In addition to individual academic ability and the institutional context of available postsecondary educational resources, prior studies have also explored other factors that influence both youth migration and educational attainment. First, family socioeconomic status (SES), referring to individuals' economic and social positions in society, may influence both youth education attainment and their capacity to move across boundaries. Studies have long found that family SES is significantly and positively associated with youth educational attainment, using both SES indices and separate measures of family income and parental education (Byun et al. 2012, 2015; Koricich et al. 2018; Li 2019; McDonough 1997; Roscigno and Crowle 2009; Roscigno, Tomaskovic-Devey, and Crowley 2006; Sewell et al. 1969; Sirin 2005). Rural students were more disadvantaged in educational attainment because they had lower family SES than non-rural students (Ardoin 2018; Byun et al. 2015; Koricich et al. 2018; Li 2019; McDonough 1997; Roscigno and Crowle 2009). At the same time, family SES may also influence youth capacity to move across rural/non-rural boundaries. For rural youth from low-SES families, moving for education may be a "cruel fiction" if they have no economic means to move (Corbett 2007). Therefore, to examine the association between migration and education, the current study controls family SES measures.

Second, social capital and relationships within families and communities affect both migration and educational attainment. Social capital refers

to support from social relationships and networks (Coleman 1988). The close social relationships in rural communities may, on the one hand, support youth educational attainment, while on the other hand, they may limit their migration tendencies. On the one hand, closer social relationships may result in stronger social capital and support students to pursue higher education by serving as information channels, providing general support, and shaping a pro-college climate (Byun et al. 2012; Nelson 2016; Petrin et al. 2014), thereby encouraging rural youth to move for education.

On the other hand, studies found that close social relationships may limit migration tendencies (Rossi 1980). Closer social relationships in rural communities suggest stronger community attachment and satisfaction, factors that may limit rural students' college aspirations and migration intentions (Howley 2006; Ulrich-Schad et al. 2013; Wolfe, Black, and Welser 2020). Rural parents also consider the proximity of college location a critical factor in their children's college decisions (Tieken 2020). By limiting migration aspirations, the strong community attachment also limits youth educational attainment. Hence, the study controls social capital-related variables to clarify the relationship between migration and education.

Third, youth may move to non-rural areas to pursue higher education due to the limited job opportunities in rural labor markets (Johnson 2012). They move to attend colleges in order to find better and more stable jobs. Rural places offer fewer economic opportunities and lower returns than four-year college education (Mykerezi et al. 2014; Smith and Glauber 2013; Smith and Tickamyer 2011). According to Statistics of U.S. Businesses (SUSB), most establishments/businesses were located in metropolitan areas. In 2016, 86 percent of establishments were in metro areas. Hence, rural youth may move to attend college due to the limited job opportunities in rural labor markets. Moreover, the perception of a lack of economic opportunities may influence both migration and educational attainment. Rural youth were more likely to aspire to move to non-rural places when they perceived a lack of economic opportunities in rural labor markets (Petrin et al. 2014). Together, local labor market environments and people's perception of labor market environments may influence youth migration and educational attainment.

In addition, other community socioeconomic environments may also influence youth migration and educational attainment. Rural communities have experienced increased racial diversity (Lichter, Parisi, and Taquino 2016). The in-migration of racial minorities has raised concerns about increased community conflicts and decreased social cohesion

and community commitment levels (Lichter and Brown 2011). The in-migration of the urban middle class has enhanced rural inequality, while persistent poverty remains a challenge for rural low-income people (Brown and Schafft 2011; Koricich et al. 2018; Sherman 2018). These community characteristics may disadvantage rural youth in their educational attainment while making them more likely to move. At the same time, though still lagging behind urban places, rural communities have experienced an increased share of college-educated adults (Marré 2017), which may positively contribute to youth education attainment. These socioeconomic environments may influence migration and educational attainment in different ways. Hence, the study also controls the community labor market and socioeconomic environments.

Data

This study used data from the National Longitudinal Survey of Youth 1997 (NLSY 97). The NLSY 97 survey is sponsored and directed by the U.S. Bureau of Labor Statistics and managed by the Center for Human Resource Research (CHRR) at The Ohio State University. Interviews are conducted by the National Opinion Research Center (NORC) at the University of Chicago (Bureau of Labor Statistics 2019). The NLSY 97 consists of a nationally representative sample of 8,984 youth who were 12 to 16 years old in December of 1996. Respondents were interviewed annually from 1997 to 2011 and interviewed biannually from 2013 to 2017. The dataset provides abundant information on youth location, migration records, family background, educational trajectories, and attainment, as well as other demographic characteristics. To better observe youth education and migration and compare them at similar stages in the life course, I rearranged the data to observe respondents at particular ages.

The study also used restricted geocoded data. These data include more measures of rurality than the publicly available data. They also contain the labor market characteristics, including industry structure and unemployment rate, and the population characteristics, including racial composition, poverty rate, and the percent of college-educated adults. In addition, they include detailed information about the colleges that respondents attended.

Variables

Rural/Urban

The NLSY 97 provides both the Census-defined rural/urban definition and the metropolitan (MSA)/non-metropolitan (non-MSA)

defined by the Office of Management and Budget (OMB). The Census Bureau defines urban as any population, housing, or territory with a population of more than 2,500, and rural as any non-urban place. According to the OMB, an MSA is a region comprised of an urbanized area of at least 50,000 residents and its less-populated surrounding areas that are highly integrated with the urbanized area with respect to industry, infrastructure, housing, and through a high rate of commuting. All other areas outside of metropolitan areas are defined as non-metropolitan areas.

This study mainly reports results based on metropolitan/non-metropolitan standards. The metro/non-metro standards take into account the adjacency to a metropolitan center. According to the standards, a metropolitan area will include the "adjacent outlying counties" that have "a high degree of social and economic integration with the central county or counties as measured through commuting" (Office of Management and Budget 2021). Therefore, they can better capture the social and economic opportunities people have. The Census-defined rural/urban standards, however, are mainly based on the population density and overlook the geographic closeness and economic connections among places.

The NLSY97 provided MSA status of residence from the 1997 to 2004 waves. However, the data stopped reporting MSA status and switched to a CBSA[2] status of residence from the 2006 wave. Therefore, I used the 2003 rural–urban continuum codes[3] to get consistent metro/non-metro residences for all the waves.

Educational Attainment

For the descriptive analyses, I analyzed the education variable at age 25 in four categories: high school dropout, GED and high school diploma,[4] associate degree, bachelor's degree, or higher. Age 25 was chosen because youth are expected to have completed a bachelor's degree by

[2]The Core-Based Statistical Areas (CBSA) contain metropolitan areas and micropolitan areas. The latter is defined as places around an urbanized area (urban cluster) with a population size of 10,000 to 49,999.

[3]The rural-urban continuum codes, or the Beale Codes, divide metropolitan areas (MSA) and non-metropolitan areas (Non-MSA) into nine subgroups based on Census-defined rural/urban standards, population size, and adjacency to metropolitan areas (USDA ERS, 2013). Metropolitan counties are divided into three categories, and non-metropolitan counties are divided into six categories.

[4]The comparison patterns remain similar if classifying people with GED as high school dropouts.

25. For the mixed-effects models, the dependent variable is whether the youth earned a bachelor's degree by age 25 or not.

Migration Status

The primary independent variable is boundary-crossing migration status. The study defines migrants as those who moved across metro-non-metro boundaries. Hence, stayers (i.e., people who did not move across boundaries) also include those who reported moves to places with the same metro/non-metro status (such as one who moved from New York City, NY to Seattle, WA).

At the same time, prior studies on migration and education mainly measured youth migration status by comparing their residences between different waves of the surveys or different ages (Jordan et al. 2011; Mykerezi et al. 2014; Snyder et al. 2009). These studies often fail to specify whether people moved before college or after they completed education.[5]

This study tests whether migration may directly affect education. Therefore, I measured youth migration at age 18 or 19 by observing their residence at age 17 and comparing that to their residence and college location at age 18 and 19. Since most youth are not expected to have completed a four-year college education by the age of 19, migration at age 18 or 19 would happen before youth obtain a college degree. In addition, not only residential moves but also moves for or because of college were measured. In some cases, respondents did not report that they changed their residence even though they attended college in a different county. Therefore, I also compared the respondents' college addresses to their residential addresses. The results show that 55.8 percent of non-metro youth and 54.6 percent of metro youth reported no residential changes but attended colleges in counties with a different metropolitan status.

Youth were defined as *non-metro stayers* if they stayed in non-metro places at ages 17, 18, and 19. They were defined as *non-metro migrants* if they lived in non-metro areas at age 17 but moved to or attended college in metro areas at age 18 or 19. Youth were defined as *metro stayers* if they stayed in metro areas from age 17 to 19. They were defined as *metro migrants* if they lived in metro areas at age 17 but then moved to or attended colleges in non-metro areas.

[5]Knapp and White (2016) included whether youth exit from school when classifying youth migration statuses. However, they ignored the situation that youth may move before or for college education.

Control Variables

All mixed-effects models controlled whether youth moved out of their residential state. Based on the boundary-crossing migration measure, stayers included those who moved out of the original residential state but to a place with the same metro/non-metro status. To account for the possible effects of between-state residential moves, the models controlled a dichotomous variable of whether youth moved out of state at age 18 or 19, based on a comparison of youth residence at age 17 and their residence or location of college at age 18 and 19.[6]

At the same time, both individual-level and aggregate-level factors were used as control variables. Family characteristics include parental education (whether parents were college-educated or not), the quarters of household net worth, whether respondents reported missing household net worth, and family structure at age 17 (two-parent family, or single-parent family). The study used household net worth to represent family economic situations because the data do not contain other economic measures, such as parental income or occupation. Parental education and household net worth were both measured in 1997, the only year in which they were measured.

Three variables were used to examine how students' attitudes and behaviors influence migration and educational attainment. The first variable is the number of days absent from school, which influences youth participation in school activities and represents youth's behavioral outcomes/reflection of school engagement (Perry 2008). The second one is to what degree respondents agree or disagree that they feel safe in schools, with one as strongly disagree and four as strongly agree. The third variable is an index measuring students' perceptions of teachers, which takes the average of respondents' answers to three questions asking to what degree youth agree or disagree that (1) teachers are good; (2) teachers are interested in the students; (3) students are graded fairly. For each question, one refers to strongly disagree, and four refers to strongly agree. All these variables were only available in the 1997 wave when respondents were at age 13 to 17.

Other individual-level variables include the quartiles of Armed Services Vocational Aptitude Battery (ASVAB) scores measured in 1999, whether the ASVAB score is missing, as well as college enrollment status at age 19. NLSY97 provides the weighted percentiles of the ASVAB scores for respondents based on their Mathematical Knowledge

[6]Models results show that whether moving out of state does not have a significant interaction effect with migration status across boundaries.

(MK), Arithmetic Reasoning (AR), Word Knowledge (WK), and Paragraph Comprehension (PC) test results. The study constructed the quartiles of ASVAB scores and whether the ASVAB score is missing (a categorical variable) based on this weighted percentile ASVAB score variable (the original continuous variable provided by NLSY97). College enrollment by age 19 was also controlled because the variable may influence the association between migration and education. People need to enroll in college first in order to obtain a bachelor's degree. They may move for college education when there are unequal chances of college enrollment across places. Hence, controlling college enrollment by age 19 helps clarify the mechanism through which migration at age 18 or 19 influences youth bachelor's degree attainment by age 25.

The analyses also included the gender, race, and ethnicity of respondents. For race and ethnicity, the survey provided a four-category racial and ethnic variable, including (1) Blacks; (2) Hispanics; (3) Mixed Race, and; (4) Other. The Other category includes all non-Black and non-Hispanic people.

The analyses also included two sets of county-level variables measured when youth were 17. The first set of measures includes the percent of workers employed in: (1) agriculture, (2) manufacturing, (3) wholesale/retail, (4) financial and real estate, (5) health service, and (6) public administration. It also includes the unemployment rate. The second includes the percentage of county residents who are (1) racial/ethnic minorities, (2) college graduates, and (3) poor.

In addition, not included in the descriptive analyses and main models but to further clarify the relationship between migration and education, I constructed a measure of college selectivity at age 19 or 20 by merging the NLSY97 data with the IPEDS data. The college selectivity variable was based on the reversed institution admission rates and further recoded as a categorical variable, with five categories: (1) not enrolled in colleges, (2) no IPEDS information, (3) no selectivity (100% admission) or highest two quarters of admission rates, (4) the second quarter of selectivity (third quarter of admission rates), and (5) the top quarter of selectivity (lowest quarter of admission rate).

Methods

The study examined the association between migration and education based on multiple-imputed (MI) dataset. The NLSY97 data from the 1997 to 2010 waves were used for the descriptive analysis and regression models. Respondents' locale information and educational status at ages 17, 18, 19, and 25 were used to build the independent and dependent

variables. 1,126 subjects were classified as missing data based on migration status because they failed to participate in the interviews at these ages. An additional 1,112 respondents contain missing information for variables used in the analysis. To address missing data, I estimated models using the multiply imputed (MI) dataset with the number of imputations as 10. The multiple imputations included all the above individual-level variables (except for college selectivity),[7] but did not include county-level variables.[8] Overall, the final sample contains 8,517 respondents based on a metropolitan/non-metropolitan standard of rurality.

Based on the MI dataset, first, a descriptive analysis of education at 25 by migration status at age 18 or 19 was conducted using cross-tabulation and mean tests. The NLSY provided customized weights based on respondents available for different waves. These weights were used in all the descriptive analyses.

Second, multilevel/mixed-effects logistic regressions were estimated to model the dichotomous dependent variable, whether youth had obtained a bachelor's degree or higher by age 25. They adjusted the variation, or the random effects, across different counties. The models had two levels, with individual observations nested within counties.

The models controlled individual-level and aggregate-level factors step by step to examine how these factors may influence youth migration's effects on their future educational outcomes. The individual-level factors include demographics, family background, school-related behaviors and attitudes, academic ability, and college enrollment. The aggregate-level characteristics include regions, county labor market characteristics, and county social environments. The results may support the *"Rural Brain Drain" Hypothesis* if controlling academic ability influences the coefficients of migration status. The results may support the *Migration Gain Hypothesis* that migration has direct effects on education if migration shows significant effects on education net of all the individual-level and

[7]Variables in imputation models included gender, race/ethnicity, whether youth moved out of state; their family background factors, including household net worth, family structure, and parental education; their school behaviors and attitudes, including days absent from schools, students' perception of teachers, the degree of feeling safe in schools; ASVAB scores; and college enrollment. These variables contributed to explaining whether data are missing or not. College selectivity was not included because there was a big size of missing data (13%) after merging IPEDS data and the NLSY97 and because the variable was not a focus of the main analyses.

[8]Due to attrition, 467 respondents reported missing values on all county-level variables. These variables are not included in multiple imputations because it can be problematic to only use individual-level variables to predict county characteristics.

aggregate-level factors. However, the effects may also be due to unobserved factors.

The study examined the intraclass correlation (ICC) for the null model. Clogg tests were used to examine whether the changes in coefficients are statistically significant. Weights were not used in these models.[9] The study presents results based on a metropolitan/non-metropolitan definition of rurality. I also examined the relationship between migration and education based on the Census-defined rural/urban definition. Different from findings based on the metro/non-metro definition, results using the rural/urban standard show that youth who moved from urban to rural areas were not more likely to earn a BA degree than people who had other migration statuses. But the results demonstrate a greater advantage in educational outcomes of youth who moved to urban areas than all other youth. These alternate results are available upon request.

In addition, to help explain how migration influences education, particularly for youth who moved from the metro to non-metro areas, the study compared the selectivity levels of colleges attended by youth with different migration statuses, based on the non-imputed original data. The results were discussed below, and the tables were presented in Appendices A–C.

Descriptive Analysis

The descriptive findings show that people who moved across boundaries at age 18 or 19 reported significantly higher ASVAB scores and better educational outcomes at age 25 than those who did not move. Migrants across boundaries tend to have grown up in more advantaged families than stayers, while people who stayed in non-metro places reported the lowest educational outcomes. These results may support the *"Rural Brain Drain" Hypothesis*. In addition, metro youth grew up in counties with more advantages than non-metro youth.

After weighting, 73 percent of non-metro youth stayed in non-metro places while the rest 27 percent migrated to metro areas. Conversely,

[9]Weights were not included in the models mainly due to the difficulty of applying sampling weights to the mixed-effects/multilevel logistic regression models using the MI data. At the same time, county-level weights were not available. Prior studies suggest using sampling weights in multilevel models to overcome potential model misspecification and biases due to informative sampling (West et al. 2015). However, weights at all levels should be incorporated to get unbiased estimates. Some studies found only slight differences between unweighted and weighted models (Carle 2009) and between unweighted and weighted models with level-one weights (Laukaityte and Wiberg 2018). Hence, weights were not used in the models for this study.

among metro youth, 95 percent stayed in metro places whereas 5 percent migrated to a non-metro place.

Individual-Level Factors

Table 1 shows individual-level factors, including educational outcomes at age 25, family background, school-related attitudes and behavior by migration status at age 18 or 19. According to the table, people who

Table 1. Individual-Level Characteristics by Migration Status, MI Dataset

Migration Status	Nonmetro Stayers	Nonmetro Migrants	Metro Stayers	Metro Migrants
Education by 25 (%)				
HS dropout	11.8	8.7	12.2	10.7
GED and HS Diploma	66.3	51.5***	59.3***a	41.7***abbb
Associate Degree	6.5	7.6	5.8	6.4
Bachelor's Degree & Higher	15.4	32.2***	22.7***a	41.1***bbb
Family SES				
Parental College (%)	47.2	57.3**	55.8*	65.1***bb
Two Parent Family (%)	67.7	66.8	64.1	67.2
Household Net Worth (%)				
Missing	20.8	18.6	25.8a	25.2
Lowest Q	10.5	11.9	15.8***	11.0b
Second Q	21.8	13.2***	16.5**	17.5
Third Q	24.9	25.5	18.6**a	19.7
Highest Q	22.0	30.9**	23.2	26.5
School Factors				
Days Absent (*Mean*)	4.4	3.6*	4.9*aaa	5.1a
Perception of teacher (*Mean*)	3.1	3.0	3.1	3.0
Feel Safe at Schools (*Mean*)	3.2	3.2	3.2	3.2
Other Variables				
College Enrollment at 19 (%)	32.2	58.5***	42.4***aaa	60.0***bbb
ASVAB Quarters (%)				
Missing	15.5	14.4	19.0	15.4
Lowest Q	17.2	9.4**	15.8aaa	8.4**bbb
Second Q	22.2	17.0*	18.7*	16.1*
Third Q	24.6	23.9	21.8	24.2
Highest Q	20.5	35.4***	24.7*aaa	35.9***bb
Female (%)	45.4	57.7***	48.3*aa	56.1**b
Race (%)				
Black	10.4	8.5	17.4**aaa	11.8bb
Hispanic	5.2	4.0	15.6***aaa	2.7*bbb
Mixed race (non-Hispanic)	0.7	1.3	1.4	1.1
Others	83.7	86.1	65.7***aaa	84.4bbb
Moving out of state (%)	17.2	43.3***	21.8aaa	47.3***bbb
Average *N*/Percentage (%)	1,333/16	489/6	6,345/74	350/4

Note: Compared with nonmetro stayers ***$p<.001$ **$p<.01$ *$p<.05$; Compared with nonmetro migrants aaa $p<.001$ aa $p<.01$ a $p<.05$; Compared with metro stayers bbb $p<.001$ bb $p<.01$ b $p<.05$.

moved across boundaries had the highest education at age 25. Those who stayed in non-metro areas had the lowest educational level.

People had the best educational outcomes if they moved from metro to non-metro places. The migrants from metro areas were most likely to have graduated from colleges, with 41.1 percent of them reporting a BA or higher education by age 25. Sixty percent of them enrolled in college at age 19, a proportion significantly higher than those of stayers in metro and non-metro areas (42.4% and 32.2%, respectively). They also had the highest ASVAB test scores, with 35.9 percent of metro migrants having the highest quarter of ASVAB scores. Regarding family background, migrants from metro areas were less likely than metro stayers to have grown up in families with the lowest quarter of household net worth. They were more likely to have college-educated parents than both metro and non-metro stayers. In addition, they were more likely to be female, non-Hispanics, and move out of the original residential state than the metro and non-metro stayers.

People who moved to metro places also reported better educational outcomes than those who stayed in metro or non-metro areas. Thirty-two point two percent of migrants from non-metro areas earned a bachelor's degree or higher, a proportion significantly higher than those of non-metro (15.4%) and metro stayers (22.7%). They were more likely to enroll in colleges at age 19 (58.5%) than the metro and non-metro stayers (respectively, 42.4% and 32.2%). They also had higher ASVAB scores than stayers. Thirty-five point four percent of non-metro migrants had the highest quarter of ASVAB scores versus 24.7 percent of metro stayers and 20.5 percent of non-metro stayers did so. Migrants from non-metro areas were the least likely to miss school. They were more likely to have grown up in households with the highest quarter of net worth values than non-metro stayers. They were also more likely to be female and move out of the original residential state than either metro or non-metro stayers.

Metro stayers were more likely than non-metro stayers to earn a bachelor's degree (22.7% vs. 15.4%) but less likely to do so than migrants from both metro and non-metro origins. They tend to have grown up in households with the lowest level of net worth. They were more likely to be female than non-metro stayers but less likely to be female than migrants. They were the most likely to be Black or Hispanic and the least likely to be White or other races/ethnicities.

Youth reported the lowest educational outcomes if they grew up and stayed in non-metro areas. Non-metro stayers were least likely to have earned a BA or higher degree by 25 (15.4%) and to be enrolled in college at age 19 (32.2%). Instead, they were the most likely to be high school graduates by age 25 (66.3%). They also reported the lowest ASVAB scores. Regarding family background, they were the least likely to

have college-educated parents. They were also more likely to have grown up in households with the second-lowest quarter of net worth than those who moved to or stayed in metro areas.

Aggregate-Level Characteristics

Regarding aggregate-level factors, Table 2 shows that metro youth grew up in communities with more socioeconomic advantages and diversity than non-metro youth. They grew up in counties with higher percentages of college-educated adults and racial minorities, but lower poverty rates and unemployment rates. They grew up in counties with higher percentages of workers employed in the financial and real estate industry and lower percentages of workers in the agriculture industry than non-metro youth.

Among non-metro youth, community characteristics are relatively homogeneous across migration statuses. However, youth reported the highest proportion of workers employed in the manufacturing industry if they moved to metro areas (22.5%), significantly higher than if they stayed in non-metro areas (20.4%).

Among metro youth, those who stayed grew up in more diverse communities than did migrants. Compared with migrants, metro stayers lived in counties with higher percentages of workers in the financial and real estate industry (6.9% vs. 6.3%) and health industry (8.4% vs. 8.1%),

Table 2. Aggregate-Level Factors by Migration Status, MI Dataset

Migration Status	Nonmetro Stayers	Nonmetro Migrants	Metro Stayers	Metro Migrants
County-level variables at age 17 (%)				
Percent of college-educated adults	14.2	13.8	21.2***aaa	20.9***aaa
Percent of racial minorities	12.6	12.4	23.3***aaa	20.1**aabb
Percent of people in poverty	12.2	12.0	9.5***aa	9.1***aaa
Percent in agriculture related	6.1	6.0	2.1***aaa	2.3***aaa
Percent in manufacturing	20.4	22.5**	17.2a	18.4b
Percent in wholesale	20.9	20.5	21.7	21.9
Percent in financial and real estate	4.2	4.2	6.9***aaa	6.3***aaabbb
Percent in health	8.3	8.1	8.4	8.1b
Percent in public administration	4.7	4.1	5.0a	5.0
Unemployment rate	7.5	7.5	6.7*aa	6.3***aaab
Region (%)				
Northeast	19.0	14.4	18.5	20.4
North Central	36.6	41.6	22.9*a	28.7
South	32.6	31.5	34.5	38.6
West	11.8	12.5	24.2***aaa	12.3bbb

Note: Compared with nonmetro stayers ***$p<.001$ **$p<.01$ *$p<.05$; Compared with nonmetro migrants aaa $p<.001$ aa $p<.01$ a $p<.05$; Compared with metro stayers bbb $p<.001$ bb $p<.01$ b $p<.05$.

a higher percentage of racial minorities (23.3% vs. 20.1%), a lower percentage of workers employed in manufacturing industry (17.2% vs. 18.4%). But they also reported a higher unemployment rate (6.7%) than did those who moved to non-metro places (6.3%).

Model Results

Consistent with the descriptive analysis, model results from Tables 3 and 4 show that people were less likely to have a bachelor's degree or higher at age 25 if they stayed in non-metro areas than if they moved. The associations are reduced by including family background, school behaviors and attitudes, academic achievement, and college enrollment. They are also reduced by county characteristics. However, net of these factors, people who stayed in non-metro areas still reported less education than those who moved across metro and non-metro boundaries. The results are consistent with the *Migration Gain Hypothesis*. The findings are not consistent with a pure *"Rural Brain Drain" Hypothesis* since

Table 3. Mixed-Effects Logistic Regression of Bachelor's Degree Completion by age 25 on Migration Behaviors, Controlling Individual-Level Factors, MI Dataset (Coefficients)

	Control Variables in the Model	Non-metro Migrants	Metro Stayers	Metro Migrants
Model 0	Moving out of state	1.079*** [0.154]	0.503*** [0.141]	1.416*** [0.186]
Model 1	Moving out of state, gender, race/ethnicity, and family background factors[a]	0.916*** [0.162]	0.502*** [0.126]	1.282*** [0.196]
Model 2	Moving out of state, gender, race/ethnicity, family background factors, school behaviors and attitudes[b]	0.930*** [0.165]	0.529*** [0.125]	1.369*** [0.196]
Model 3	Moving out of state, gender, race/ethnicity, family background factors, school behaviors and attitudes, ASVAB scores	0.755*** [0.171]	0.419** [0.126]	1.178*** [0.199]
Model 4	Moving out of state, gender, race/ethnicity, family background factors, school behaviors and attitudes, ASVAB scores, college enrollment	0.351 [0.181]	0.310* [0.135]	0.879*** [0.220]

Note: Numbers in parentheses are standard errors. The reference group for migration status is non-metro stayers. The models are not weighted. Coefficients of control variables are available upon request. *$p<.05$ **$p<.01$ ***$p<.001$.

[a]Family background factors include household net worth, family structure, parental education.

[b]School behaviors and attitudes include days absent from schools, students' perception of teachers, the degree of feeling safe in schools.

Table 4. Mixed-Effects Logistic Regression of Bachelor's Degree Completion by age 25 on Migration Behaviors, Controlling County-Level and Individual-Level Factors, MI Dataset (Coefficients)

	Control Variables in the Model	Non-metro Migrants	Metro Stayers	Metro Migrants
Model 1	Moving out of state, region	1.078*** [0.154]	0.502*** [0.139]	1.419*** [0.186]
Model 2	Moving out of state, region, and labor market characteristics[a]	1.068*** [0.156]	0.294 [0.157]	1.223*** [0.199]
Model 3	Moving out of state, region, labor market characteristics, and county socioeconomic characteristics[b]	1.067*** [0.156]	0.267 [0.155]	1.196*** [0.198]
Model 4	Moving out of state, region, labor market characteristics, county socioeconomic characteristics, and individual-level variables[c]	0.372* [0.182]	0.209 [0.156]	0.810** [0.233]

Note: Numbers in parentheses are standard errors. The reference group for migration status is non-metro stayers. The models are not weighted. Coefficients of control variables are available upon request. *p<.05 **p<.01 ***p<.001.

[a]Labor market characteristics include unemployment rate, percent of workers employed in (1) agriculture, (2) manufacturing, (3) wholesale/retail, (4) financial and real estate, (5) health service, and (6) public administration.

[b]County socioeconomic characteristics variables include the percentage of county residents who are (1) racial/ethnic minorities, (2) college graduates, and (3) poor.

[c]Individual-level factors include parental education, household net worth, family structure at age 17, days absent from schools, students' perception of teachers, the degree of feeling safe in schools, ASVAB scores, college enrollment, gender, race, and ethnicity.

changes in the coefficients of migration statuses are not significant when controlling test scores.

For the mixed-effects logistic regression models, the intraclass correlation coefficient (ICC) of the null model is 0.145, and the variance at the county level is 0.560. These results suggest that controlling county-level variance leads to more accurate model results.

Individual-Level Models

Table 3 presents the model results of education on migration, controlling for individual-level factors. The basic model, model 0, controls whether people moved out of the original state. The results show that people were least likely to have earned a bachelor's degree or higher by age 25 if they stayed in non-metro places. Those who moved to, stayed in, or moved away from metro places were respectively 25 percent ($= \frac{e^{1.079}}{1+e^{1.079}} - 0.5$), 12 percent, and 30 percent more likely to earn this credential than those who stayed in non-metro areas.

Model 1 controls household net worth, parental educational level, family structure, race, ethnicity, and gender. After controlling these factors, the educational differences between non-metro stayers and migrants from non-metro and metro areas decrease to 21 percent and 28 percent respectively but remain significant. The decreases are not significant, according to the Clogg tests,[10] suggesting that family factors do not significantly explain the association between migration and education. The educational gap between stayers in metro and non-metro areas remains similar.

Model 2 includes the degree to which students feel safe at schools, their attitudes toward teachers, and days absent from school. After controlling these variables, the educational gaps between non-metro stayers and people who moved to, stayed in, and moved from metro areas all increased slightly (from 21% to 22%, 12% to 13%, and 28% to 30%, respectively). The changes are non-significant, according to the Clogg tests. Hence, these school-related factors do not explain the effects of migration on education significantly.

Model 3 controls the ASVAB score quarters and shows that the educational differences across migration statuses all decline but remain significant. People who stayed in non-metro areas were respectively 18 percent, 10 percent, and 26 percent less likely to earn a BA or higher than those who moved to, stayed in, or moved away from metro places. According to the Clogg test, changes in the coefficients are not significant. Hence, the results are inconsistent with the *"Rural Brain Drain" Hypothesis* since academic aptitude alone does not significantly explain the association between migration and education.

Model 4 controls youth college enrollment at 19. Educational differences across migration statuses are largely reduced. People who stayed in non-metro areas were 8 percent and 21 percent less likely to have a BA or higher than those who stayed in and moved away from metro areas. The educational gap between non-metro stayers and migrants to metro areas is not significant anymore. According to the Clogg test, the decline in the coefficient of moving to metro places has a p-value of 0.052, suggesting that college enrollment has a weak effect on the relationship between education and migration among non-metro youth. The chance to get enrolled in a college explains the educational advantage of migrants to metro areas over non-metro stayers.

In addition, compared with model 2, the Clogg test results show that controlling ASVAB scores and college enrollment together causes

[10]Here and below, the Clogg test statistics were not included in the tables, but they are available upon request.

significant declines in the educational gaps between non-metro stayers and migrants across boundaries. The educational difference between youth who moved to and stayed in non-metro areas reduces from 30 percent to 21 percent. The gap between youth who left and stayed in non-metro areas reduces from 22 percent to 9 percent. The results suggest that although test scores and college enrollment rate alone do not impact the association between education and migration significantly, together they contribute to the better educational outcomes of migrants than non-metro stayers. Hence, instead of a pure "rural brain drain," individual academic performance and college enrollment chances, which are also influenced by available educational opportunities, together influence the association between education and migration.

County-Level Models

Table 4 presents how county-level factors influence the relationship between migration and education. Model 1 controls geographical regions and whether youth moved out of the original state. The educational differences among people with different migration statuses remain similar to the basic model (model 0 of Table 3).

Model 2 shows that after controlling the labor market characteristics of counties at age 17, people were still more likely to have a BA or higher if they moved than if they stayed in non-metro places. However, controlling these variables reduces the educational gap between non-metro and metro stayers to non-significant. But the decline in the coefficient is not significant at the level of $\alpha = 0.05$, according to the Clogg test. The results suggest that county labor market environments do not significantly affect the association between migration and education.

Model 3 controls the percentage of college-educated adults, the rate of racial minorities, and the poverty rate of youth residential counties at age 17. After controlling these factors, the educational differences slightly decline between non-metro stayers and those who moved. The coefficient of metro stayers is still not significant. According to the Clogg tests, all the changes in coefficients of migration statuses are not significant.

Finally, model 4 of Table 4 shows that after controlling all these variables, the migrants who moved across boundaries were respectively 9 percent and 19 percent more likely to earn a BA or higher than people who stayed in non-metro areas. The finding is consistent with the *Migration Gain Hypothesis* by showing significant effects of migration on the education net of all individual-level and aggregate-level factors. Compared with model 4 in Table 3, adding aggregate-level variables leads to a significant educational gap (9%) between those who stayed in and

those who moved away from non-metro areas. The result suggests that community characteristics may, to some degree, disadvantage migrants in their educational attainment so that controlling these factors leads to significantly better educational outcomes of migrants than stayers in non-metro areas. At the same time, youth were still equally likely to earn a BA or higher if they stayed in metro and non-metro areas, net of individual and aggregate-level variables.

Overall, model results show that non-metro stayers were most disadvantaged in educational attainment than people with other migration statuses. Consistent with the *Migration Gain Hypothesis*, youth who moved across boundaries obtained the highest educational outcomes, even after controlling all the individual-level and aggregate-level factors. Inconsistent with a pure *"Rural Brain Drain" Hypothesis*, academic aptitude alone does not significantly explain the association between migration and education. Family factors, school attitudes and behaviors, county labor market characteristics, and county socioeconomic environments together explained part of the associations between migration and education, although these factors alone do not significantly explain the association.

Discussion and Conclusion

This study provides evidence consistent with the *Migration Gain Hypothesis*. According to the descriptive analysis and the mixed-effects logistic models, youth obtained the lowest educational outcomes if they stayed in non-metro areas. They were significantly more likely to graduate from college if they moved across boundaries than if they stayed in non-metro areas, net of all the individual-level and aggregate-level factors. These findings suggest that migration may directly affect education.

The descriptive results show that migrants have higher test scores than people who stayed in non-metro or metro areas, preliminary evidence for a "brain drain." However, the multilevel/mixed-effects model results are not consistent with the pure *"Rural Brain Drain" Hypothesis* because controlling test scores does not significantly decrease the educational gaps among youth with different migration statuses. Instead, test scores and college enrollment rates together significantly influence the association between migration and education.

Implications

The study contributes to prior studies by examining the reciprocal nature of migration and education. Prior studies have not clarified the relationship between migration and education. Research on "rural brain drain" focuses either on the out-migration of college-educated youth

(Artz 2003; Artz and Yu 2011; Brown and Schafft 2011; Domina 2006; Estes et al. 2016) or on academically talented high school students and their migration aspirations (Corbett 2007, 2009; Petrin et al. 2014). It was unclear whether the association between migration and education is because most talented youth tend to move, or because migration directly contributes to better education, net of prior academic ability. Clarifying the association contributes to a better understanding of the reasons and extent to which rural communities lose their talented youth. The finding also has important implications for future policies and research.

First, the current study found that the association between migration and education is not significantly affected by prior academic ability. Instead, migration results in higher educational levels, net of individual academic aptitude, family, and community characteristics. The results suggest that the main problem of "rural brain drain" may not be ***who*** chooses to leave, but that those who leave obtain better educational outcomes.

Consistent with prior studies (Hughes et al. 2019), the direct effect of migration on education suggests a strong structural challenge in rural youth's status attainment process, due to the geographically unequal distribution of educational resources. As Hughes et al. (2019) claimed, college-going is a complex "dual commodification" process that involves actions and factors of both individuals and institutions. The institutional context of available postsecondary educational resources plays a non-negligible role in shaping youth migration and educational attainment. Rural students were more likely to live in education deserts and have less access to postsecondary institutions (Hillman and Weichman 2016; Hirschl and Smith 2020; Rosenboom and Blagg 2018). The available institutions to them are also less selective (Hillman and Weichman 2016; Hughes et al. 2019; Prins and Kassab 2017). Hence, they have to move to pursue better educational opportunities. For them, migration is a tool and strategy to overcome the structural challenge of unequally distributed educational resources.

Migration may also contribute to better education outcomes by improving student-college matching. Controlling for college enrollment and other individual-level, aggregate-level factors, migrants to metro places obtained better educational outcomes than stayers in non-metro areas. The finding may be due to the high quality of urban educational resources and the potentially high level of student-college matching for migrants. Given the limited and less selective postsecondary institutions in rural areas, migration may help rural youth attend more selective colleges that match their academic abilities more closely. In contrast, those who stayed in rural areas may experience an undermatching that

negatively influences college completion, consistent with prior studies (Smith et al. 2013). Hence, instead of attending colleges nearby, moving to metro areas may positively contribute to the educational attainment of rural youth by making students attend more selective institutions and improve student-college matching.

Second, the study contributes to prior studies on "rural brain drain" by examining how controlling academic ability may influence the association between migration and education. The model results failed to support a pure *"Rural Brain Drain" Hypothesis* that migrants have higher educational levels because of their higher academic ability. Given that ASVAB scores alone do not significantly impact the association between education and migration, migration may benefit the youth of different levels of academic aptitudes equally. Hence, the "rural brain drain" problem is not that more talented youth are more likely to leave, but that leaving results in better educational outcomes for everyone. In other words, the limited postsecondary educational resources have limited educational attainment of all rural youth regardless of their academic talents, making migration a successful strategy to overcome the structural challenge.

Consistently, individual academic performance and the chance to enroll in a college together affect the association between education and migration significantly, though neither of them alone is enough to shape the better educational outcomes of migrants compared to those of stayers. Instead of a pure "rural brain drain," the educational outcomes of youth across migration status may be influenced by a combination of individual academic performance and available educational opportunities that allow college enrollment.

The results, again, are consistent with the "dual commodification" theory by Hughes et al. (2019) that individual students and institutions together shape the college-going process. The results contribute to prior studies by confirming that individual college choices based on academic ability must be understood in the context of available postsecondary educational resources. Rural students, high achieving or not, may have to move to urban areas if they expect to attend college, under the context of limited educational resources in rural places. Since those who move for education are more likely to be high-achieving youth, together, individual academic ability and the uneven geographical distribution of colleges join to shape a better educational outcome for rural migrants than rural stayers. At the same time, due to the more convenient transportation and lower costs of information, rural youth may be more likely than before to move to urban areas and attend the selective colleges there (Goetz et al. 2010; Hoxby 2009; Lichter and Brown 2011). Therefore,

studies on "rural brain drain" should focus more on the effects of the changing rural communities (Lichter and Brown 2011) and the persistent lack of educational resources in rural areas.

In addition, consistent with prior studies, the study shows that equal mobility cannot be rightly assumed when understanding the phenomenon of "rural brain drain" (Corbett 2007). The descriptive results show that rural migrants tend to come from more advantaged family backgrounds and counties with more manufacturing industry workers than stayers. Although these family and community factors alone fail to explain the association between migration and education significantly, together they contribute to explaining the association.

Third, the findings of this study extend previous research by showing that youth who grew up in metro areas also enjoy a migration gain in education. Moving to non-metro areas is associated with higher educational outcomes than staying in metro or non-metro areas. The education advantage of migrants to non-metro areas holds even after controlling individual-level and aggregate-level factors.

One explanation could be that migrants to non-metro areas tend to attend colleges or universities that academically match and socially fit them better. To clarify the possible mechanism, the study also examined youth college selectivity (measured by the inversed admission rates) at age 19 or 20 by their migration statuses (see Appendix A for the cross-table). The results suggest that youth were the most likely to attend highly selective colleges or universities if they moved to non-metro areas. Migrants from metro to non-metro areas were significantly more likely to attend colleges with the second quarter of selectivity (27.6%) than those who stayed in either metro (12.6%) or non-metro areas (9.5%). They (19.8%) were also more likely than metro stayers (14.3%) to attend colleges with the highest level of selectivity, although the difference is only significant at the level of $\alpha = 0.1$.

The results suggest that although non-metro areas, in general, have fewer postsecondary institutions than metro places, some rural colleges/universities are highly selective and fit with metro-born youth who have high academic capacities. For instance, Appendices B and C listed the colleges/universities with the top two-quarters of selectivity, attended by metro migrants. Among them, there are highly selective private institutions, such as Dartmouth College and Colby College, and four-year public institutions, including Alcorn State University, University of North Carolina, and the State University of New York College at Cortland (SUNY Cortland) (see Appendix B). These colleges/universities may fit with metro youth who have high levels of academic performance to attract them to move to non-metro areas for educational purposes. Some

rural public universities with the second quarter of selectivity (such as the University of Arizona, University of Idaho, and Washington State University) are also land-grant universities that may attract metro youth who prefer agriculture and mechanic arts-related programs.

At the same time, compared with attending equally selective colleges in urban areas, rural colleges may also fit better socially with metro youth who prefer relatively lower living costs, convenient access to nature and outdoor activities, a close-knit, highly spirited campus culture, and peaceful, slow-paced lifestyle (Patel 2021). The better student-college matching may also contribute to the higher educational outcomes of youth who moved to non-metro areas, compared with people who stayed in non-metro areas.

Another explanation of this finding could be that migrants from metro areas are more motivated to earn a bachelor's degree than those who did not move because they expect to return to and work in metro areas. Also, given that youth who stayed in metro areas are of a greater number and more diverse than those who moved to non-metro areas, there may be other unobserved individual and aggregate-level characteristics that contribute to better educational outcomes of those who moved away from those why stayed in metro areas. Future research should also clarify the horizontal differences in educational attainment across migration statuses.

Finally, in terms of policy implication, the current study suggests that policies aiming to stanch the "rural brain drain" should not only focus on college-educated rural youth since the migration or the "brain drain" process starts earlier than college completion. In addition to attracting college-educated youth back, policies must focus more on strengthening rural postsecondary educational resources that affect all youth in rural areas.

For example, enhancing the quality of rural postsecondary education and providing merit-based scholarships may be the efficient solution to the "brain drain." Studies on "state brain drain," i.e., the leaving of academically talented youth from their original state, found that public funding for higher education and state merit-based aid programs may contribute to "stanch the brain drain" and attract the talented students from other states (Ionescu and Polgreen 2009; Zhang and Ness 2010). Rural areas not only have fewer postsecondary educational institutions, but the rural public colleges are more underfunded than other public colleges (McClure et al. 2021). Given these institutional challenges, more investment in the rural postsecondary education system is necessary to limit the out-migration of rural youth and support educational attainment for everyone.

At the same time, given the overall effects of family and community environments on the relationship between migration statuses and

educational outcomes, it would be beneficial to have more holistic community development plans that focus not only on education but also on poverty, unemployment, job market opportunities (Koricich et al. 2018). As Ionescu and Polgreen (2009) suggest, if the economic returns to higher education do not increase, these talented students will still leave the place after graduation. Hence, holistic policies would be more efficient in coping with the "brain drain."

Limitations

To understand the relationship between migration and education accurately, readers must recognize the limitations of the current study. Due to the limited data and concerns about the complexity of models, there are unobserved and uncontrolled factors. These factors may influence the impact of migration on education. For example, youth with different migration statuses may also have different college expectations, career expectations, college majors, and may attend different types of educational institutions. These factors may further explain the effects of migration status on education.

Another limitation is the lack of direct measures of social capital. This study adopted family structure, school-related behaviors and attitudes, and county socioeconomic characteristics to indirectly represent social capital in families, schools, and communities. For example, according to Coleman (1988), family structure is an indicator of family social capital that influences parent-child relationships. Days absent from school may influence students' school engagement levels (Perry 2008). Students' perceptions of teachers and the degree of feeling safe at school may represent their social connections with teachers and the sense of school belonging. At the same time, the percentage of racial minorities may indirectly represent community attachment (Lichter and Brown 2011). However, all these variables do not directly measure students' social connections and networks within family, school, and communities. They only represent social capital indirectly.

In addition, the race/ethnicity measure provided by NLSY 97 is not optimum because the measure groups Whites, Asians, and Native Americans all in the non-Black, non-Hispanics Others category. The classification does not separate racial minorities from the majority of White people,[11] which may limit the understanding of the effects of race and ethnicity.

[11]It is possible to separate the majority of White people from racial minorities using other NLSY97 measures of race. The study did not do so because race/ethnicity is not the focus of the study.

Directions for Future Research

Based on the above findings and limitations, the study has some implications for future research directions. First, since migration predicts education, future studies on "rural brain drain" should focus more on earlier stages of the "brain drain," such as the transition from high school to colleges, to better understand how rural youth navigate their status attainment given the structural limits of available educational resources.

Second, future studies should continue to examine the horizontal differences in college attendance to explore further how migration affects education. For instance, future studies should further examine whether the migrants and stayers differ in areas such as college major, student-college match, more measures of selectivity other than admission rates, and future career plans, to better understand the educational advantage of migrants to non-metro areas over people who grew up and stayed there.

Direct social capital measures should be used to further clarify the effects of social capital on the association between migration and education. In addition, different measures of boundary-crossing migrations should also be utilized to examine the topic. This study adopts the dichotomous migration/non-migration measure to examine the general relationship between migration and education. Future studies should utilize the non-binary measures of migration to further explore the diversity and complexity of migration behaviors. For example, distance should be considered in the migration measures since it may influence people's educational experience and outcomes, based on the matching theory (Freeman 2017; Ovink et al. 2018).

Finally, to fully understand "rural brain drain," more studies should examine the reasons for and effects of return migration on both individuals and communities. Rural communities may lose their college-educated young people if youth who had better academic performances, enrolled in college, and obtained better educational outcomes do not return.

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APPENDIX A
College Selectivity at Age 19 or 20 by Migration Status, Non-Imputed Data

College Selectivity at Age 19/20[a] (%)	Nonmetro Stayers	Nonmetro Migrants	Metro Stayers	Metro Migrants
Not Enrolled in College	65.7	35.9***	53.6***aaa	31.0***bbb
No IPEDS info	0.7	0.6	0.8	0.4
Lowest/No Selectivity	17.7	24.3	18.7	21.2
2nd quarter of selectivity	9.5	26.4***	12.6aaa	27.6***bbb
Highest quarter of selectivity	6.4	12.8*	14.3***	19.8***
N/Weighted Percentage[b]	1,091/16	354/5	6,068/75	265/4

Note: Compared with nonmetro stayers ***$p<.001$ **$p<.01$ *$p<.05$; Compared with nonmetro migrants aaa $p<.001$ aa $p<.01$ a $p<.05$; Compared with metro stayers bbb $p<.001$ bb $p<.01$ b $p<.05$.

[a]College Selectivity is measured by inversed college admission rate, from the IPEDS data 2001–2006.

[b]The cross-table is based on non-imputed original data. For information at age 19 or 20, 1,206 cases had missing data for migration status, college enrollment status at age 19 or 20, and/or university/college ID information (UNITID). After deleting missing information, the total sample size is 7,778. The weighted percentages of youth with different migration statuses are similar to those based on imputed data.

APPENDIX B
Non-Metro Postsecondary Institutions with Highest Quarter of Selectivity, Attended by Metro Migrants at Age 19/20

UNITID	Institution Names	Admission Rates	Public/ Private[a]
178697	College of the Ozarks	0.13	2
182670	Dartmouth College	0.19	2
161086	Colby College	0.35	2
175342	Alcorn State University	0.38	1
217873	Claflin University	0.38	2
199184	University of North Carolina School of the Arts	0.43	1
203535	Kenyon College	0.45	2
196149	SUNY Cortland	0.49	1
196185	SUNY Oneonta	0.50	1
106467	Arkansas Tech University	0.51	1
157058	Kentucky State University	0.52	1
237057	Whitman College	0.52	2
160621	Southern University and A & M College	0.53	1
234085	Virginia Military Institute	0.53	1
228778	The University of Texas at Austin	0.54	1
196158	SUNY at Fredonia	0.56	1

UNITID	Institution Names	Admission Rates	Public/ Private[a]
198303	Chowan University	0.56	2
213020	Indiana University of Pennsylvania-Main Campus	0.57	1
196246	SUNY College at Plattsburgh	0.57	1
196088	University at Buffalo	0.59	1
139861	Georgia College & State University	0.59	1
139250	College of Coastal Georgia	0.62	1
196024	SUNY College of Technology at Delhi	0.62	1
198561	Gardner-Webb University	0.62	2
164216	Washington College	0.63	2
129215	Eastern Connecticut State University	0.64	1
107044	Harding University	0.65	2
163912	St. Mary's College of Maryland	0.65	1
176080	Mississippi State University	0.65	1
196006	SUNY College of Technology at Alfred	0.65	1
197869	Appalachian State University	0.66	1
218733	South Carolina State University	0.66	1
229814	West Texas A & M University	0.68	1
195003	Rochester Institute of Technology	0.69	2
144892	Eastern Illinois University	0.69	1
141361	Young Harris College	0.69	2
211158	Bloomsburg University of Pennsylvania	0.69	1
229115	Texas Tech University	0.70	1

Note: Data come from the IPEDS data 2001–2006 and the NLSY97 geocode data

[a]One refers to public institution; two refers to private. Non-profit institutions.

APPENDIX C

Non-Metro Postsecondary Institutions with 2nd Quarter of Selectivity, Attended by Metro Migrants at Age 19/20

UNITID	Institution Names	Admission Rate	Public/ Private[a]
104179	University of Arizona	0.85	1
107558	University of the Ozarks	0.82	2
126614	University of Colorado Boulder	0.83	1
127185	Fort Lewis College	0.77	1
128391	Western State Colorado University	0.79	1
139621	East Georgia State College	0.76	1
142285	University of Idaho	0.82	1
149222	Southern Illinois University-Carbondale	0.75	1
151801	Indiana Wesleyan University-Marion	0.76	2
152530	Taylor University	0.84	2
155025	Emporia State University	0.77	1
155681	Pittsburg State University	0.77	1
166629	University of Massachusetts-Amherst	0.74	1
168591	Alma College	0.80	2
169248	Central Michigan University	0.75	1
172699	Western Michigan University	0.84	1

UNITID	Institution Names	Admission Rate	Public/ Private[a]
173647	Gustavus Adolphus College	0.78	2
174066	University of Minnesota-Twin Cities	0.71	1
174844	St Olaf College	0.72	2
175272	Winona State University	0.79	1
175810	Holmes Community College	0.81	1
178615	Truman State University	0.82	1
179557	Southeast Missouri State University	0.73	1
188641	Alfred University	0.74	2
190044	Clarkson University	0.83	2
198136	Campbell University	0.72	2
199102	North Carolina A & T State University	0.81	1
200004	Western Carolina University	0.76	1
201104	Ashland University	0.82	2
201885	University of Cincinnati-Main Campus	0.82	1
204857	Ohio University-Main Campus	0.82	1
207388	Oklahoma State University-Main Campus	0.83	1
208646	Eastern Oregon University	0.76	1
210669	Allegheny College	0.74	2
211158	Bloomsburg University of Pennsylvania	0.69	1
211644	Clarion University of Pennsylvania	0.76	1
213613	Lock Haven University	0.80	1
219046	Black Hills State University	0.82	1
221731	Tennessee Wesleyan University	0.75	2
224527	East Texas Baptist University	0.77	2
227881	Sam Houston State University	0.75	1
228431	Stephen F Austin State University	0.73	1
228529	Tarleton State University	0.76	1
231174	University of Vermont	0.75	1
233897	The University of Virginia's College at Wise	0.78	1
234827	Central Washington University	0.82	1
236939	Washington State University	0.77	1
237330	Concord University	0.73	1
240268	University of Wisconsin-Eau Claire	0.72	1
240365	University of Wisconsin-Oshkosh	0.83	1

Note: Data come from the IPEDS data 2001–2006 and the NLSY97 geocode data.

[a]One refers to public institution; two refers to private. Non-profit institutions.