

Brain Drain in Maryland: Exploring Student Movement
from High School to Postsecondary Education and the Workforce

Amber Bloomfield¹

Bess A. Rose²

Alison M. Preston²

Angela K. Henneberger²

¹University of Maryland, College Park; College Park, MD 20742

²University of Maryland, Baltimore; 620 W. Lexington St., Baltimore, MD 21201

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Abstract

Brain drain, the movement of high school and college graduates out of state for employment, is a concern for state policymakers. This study focuses on brain drain for students who graduate high school in Maryland. Using data from the Maryland Longitudinal Data System and applying propensity score matching to control for differences between the groups, we evaluated the degree to which brain drain exists in Maryland, and which students are susceptible to brain drain. Findings indicate that brain drain does exist: students who graduated from a Maryland high school and attended college out-of-state were less likely to return to Maryland to join the workforce compared to students who remained in-state for college. Additionally, higher achieving students were more likely to be lost to brain drain.

Keywords: Brain drain, propensity score matching, student migration

Introduction

States invest significant funds in public school systems in an effort to support students and prepare them for success. One of the direct returns on the investment in public education would take the form of in-state workforce participation (Winters, 2015). The loss of in-state high school and college graduates to other states has been termed “brain drain” by researchers and is a concern for state policymakers (Kelchan & Webber, 2018; Zhang & Ness, 2010). Recently, many states have invested in state-wide merit scholarship programs designed to retain students who have strong potential to graduate from a state higher education institution and ultimately bolster the state’s educated workforce (Zhang & Ness, 2010).

Brain drain can occur at two transition points – in-state high school students can be lost to out-of-state colleges or in-state college students can be lost to the out-of-state workforce. To understand the full picture of the brain drain phenomenon, it is important to consider student migration (that is, movement of students out of their original state of residence) at both transition points. To do so, it is necessary to follow students from high school, through college, and into the workforce. However, prior research taking this approach is limited.

In this study, we used data from the Maryland Longitudinal Data System (MLDS) to examine the movement of Maryland public high school graduates to college and then to the Maryland workforce. First, we examined the student characteristics that were associated with selection into a Maryland college compared to an out-of-state college. Second, we used propensity score matching to examine the role of out-of-state college attendance on the likelihood to return to Maryland for the workforce. Third, we examined the student characteristics of out-of-state college graduates who did return to Maryland for the workforce to identify the type of student who is most likely to be lost to brain drain.

Conceptual Framework

A clear understanding of the migration patterns of students and the motivations behind student migration is important for researchers, policymakers, and other stakeholders who are working to develop and implement programs designed to encourage student retention and eventual workforce participation. Students who attend college can decide to stay in their state of residence or attend college in another state, and their decision may rest on a variety of factors such as cost, institutional characteristics, and future employment prospects (Zhang & Ness, 2010). It is generally expected that students examine the options and make selections according to rational choice theory, which contends that people arrive at a decision by examining all the options then selecting the option which best allows goal attainment according to a set of criteria (Finn & Darmody, 2017). An understanding of student mobility patterns can help researchers determine the criteria commonly associated with students' college attendance decisions, and policymakers can use that information to implement programs or policies designed to increase the ability for in-state institutions to meet those criteria.

Human capital theory also asserts that people make conscientious life decisions, such as the decision of whether to attend college and where to go, by examining the options and selecting the one best suited for obtaining the goal in mind. In this case, the goal is always the increase of the individual's human capital, or abilities, education and training; to improve the outcome in the labor market (Heller & Rasmussen, 2002). Students will choose to educate themselves where they can find the best balance of cost and credentialing in order to build their human capital to enter the workforce in a position with the highest benefit, regardless of geography. From this human capital perspective, state policymakers are also interested in how

individuals improve themselves for the job market through education. It follows logically that if a state spends public funds to support an education or training program for a student, the state wants that student to enter that particular workforce and generate income that returns to the state at the highest rate possible. Students who are educated using public funds and then leave the state for college or employment can be viewed as losses in state resources.

Related Literature and Hypotheses

Brain Drain from High School to College

The first major transition point for a college-bound student involves the decision of where to attend college. There are many considerations involved and choosing to go out-of-state for college is a function of the available institutional opportunities and geographic characteristics of both the original state and the destination state (Cooke & Boyle, 2011). States with the highest rates of brain drain between high school and college are small, densely populated states, such as Maryland, or larger populous states like Illinois (Cooke & Boyle, 2011). Less densely populated states, such as Pennsylvania and Indiana, tend to attract students at higher rates, potentially due to their proximity to high density states (Cooke & Boyle, 2011). The variation in states in terms of geographic size, population, and number and quality of higher education institutions means that considering migration of students state-by-state provides a more accurate picture of the brain drain phenomenon than a nationwide estimate alone. Eleven states reported a net loss of first-time degree/certificate seeking students at four year degree-granting public institutions in 2014 (U.S. Department of Education, 2015).

Brain Drain from College to the Workforce

Following college, students seeking employment can either join the workforce in the same state as their college or move to a different state for work. Kodrzycki (2001) reported that approximately 30 percent of college graduates in the National Longitudinal Survey of Youth relocate to a different state within five years of graduation. A more recent analysis using LinkedIn alumni profiles found that 58 percent of 4-year college attendees had relocated to a different metropolitan area than that of their college (Rothwell, 2015). States that tend to have larger student loss rates either have large rural areas, such as Iowa, or border large cities in other states, as is the case with Delaware's proximity to Philadelphia (Kelchan & Webber, 2018). Overall, states in the South and West are more likely to see gains from student migration while states in the Northeast and Midwest are more likely to see losses (Kelchan & Webber, 2018).

Relocation decisions are influenced by personal characteristics as well as state economies, population and amenities, and a history of moving across state lines as a child (Kodrzycki, 2001). Recent nationally representative findings indicated that students who were more likely to leave the state of college attendance had attended highly selective institutions, had applied to multiple institutions, or were grant recipients (Ishitani, 2010). Students who were more likely to stay in the same state after college attendance were more often Hispanic or attended college in states with a higher gross domestic product (Ishitani, 2010).

Brain Drain from High School to College and the Workforce

Studying brain drain from high school to college to workforce has been approached using multiple datasets at corresponding points in time (such as Groen, 2004), or by using one longitudinal dataset that follows a sample of students across both transition points (such as Perry, 2001). These studies consistently found that students who attend college in their home state are more likely to work in their home state when compared to those who attend an out-of-state

college. Groen (2004) investigated brain drain using two separate longitudinal datasets, both including students who initially enrolled in a 4-year college in the 1970s (the Mellon Foundation's College and Beyond dataset [C & B; 1976 cohort] and the National Longitudinal Study of the High School Class of 1972 [NLS-72]). Controlling for gender and SAT score, Groen (2004) found that 48 percent of students in the C & B sample who attended college in-state lived in their original state of residence versus 39 percent of students who attended college out-of-state; comparable percentages in the NLS-72 sample were 62 percent versus 52 percent.

Perry (2001), investigating brain drain using data from the NCES Baccalaureate and Beyond Longitudinal Study, found that 83 percent of in-state graduates lived in their original state of residence, compared to only 52 percent of out-of-state graduates. Perry also found that the majority of college graduates in her sample had graduated from a college in their original state of residence (i.e., most college graduates were in-state students). In addition, students who attended college in-state were more likely to live in the state of the college from which they had graduated than were students who attended college out-of-state (Perry, 2001).

It is important to note that both Groen (2004) and Perry (2001) examined students' state of residence, not employment status within the state. For the purpose of studying brain drain, state policymakers would be interested in students' eventual contribution to the workforce and ability to support the economy of the state, not just their residency. Much of the research that does address employment outcomes centers on the results of state-sponsored scholarship programs intended to encourage students to stay in-state for college (e.g., Harrington et al., 2016; Hawley and Rork, 2013; Hickman, 2009, Sjoquist and Winters, 2013), rather than providing the general overview of student migration necessary to fully understand the trends. The current literature generally focuses on either the high school to college transition, or the college to

workforce transition, possibly due to the difficulty of obtaining linked longitudinal data over time. While some research has been able to longitudinally investigate the full path of brain drain, these studies are limited in only considering college graduates (Perry, 2001), or examining employment location after a considerable time gap (Groen, 2004). A further limitation of prior research has been the lack of sufficiently rigorous approaches to control for pre-existing differences between students who enrolled in-state and those who enrolled out-of-state (e.g. SAT scores, marital status). Those studies that were able to track students from high school through college and into the workforce had limited information about these students and so could not control for potential differences between those who chose an out-of-state institution and those who chose an in-state institution. Groen (2004) investigated the role of SAT scores in brain drain patterns, but did not investigate other likely relevant characteristics like race or socio-economic status (SES); Perry (2001) did not take into account student characteristics when examining brain drain patterns. This gap is of concern because the same factors that may lead a student to select an in-state institution may also affect their likelihood of attaining work in their home state. We address these limitations by investigating the relationship between location of the higher education institution (out-of-state versus in-state) and the likelihood that students return to their home state's workforce, taking into account differences in demographic, academic achievement, and high school characteristics.

The Current Study

In Maryland, there is evidence of notable student migration between high school and college as well as between college and the workforce. In 2014, Maryland reported a net loss of 8,881 students between high school and college, the fifth largest net loss in the country (U.S.

Department of Education, 2015). For the second transition point, from college to the workforce, data from the Integrated Public Use Microdata Series (IPUMS-USA) indicated that Maryland had a net migration rate for college graduates under age 40 of approximately one percent from 2000-2015 (Bui, 2016). This means that there was an approximately one percent positive difference in the number of college graduates under 40 who moved to Maryland compared to the number who left. While this particular study indicated a positive net migration rate, there is still a considerable amount of flow in and out of Maryland in the timeframe included.

Our study aims to address the limitations of prior research by applying a propensity score matching analysis approach to a unique longitudinal high school-college-workforce extant dataset to analyze brain drain at both transition points in Maryland. Data from the Maryland Longitudinal Data System (MLDS) link high school, college, and workforce records across multiple years for Maryland public high school attendees. Thus, this study can examine the same group of students at both transition points. This study answers the following research questions: (1) do Maryland public high school graduates who enroll in out-of-state colleges differ from those who enroll in in-state colleges with regard to achievement or demographic variables; (2) does location of college enrollment change the likelihood of working in Maryland (i.e., is there brain drain in Maryland); and (3) do students who enroll in out-of-state colleges and go on to work in Maryland differ from students who enroll in out-of-state colleges and do not go on to work in Maryland (i.e., who is lost to brain drain in Maryland)?

Method

Sample Selection

The data used for these analyses are from the Maryland Longitudinal Data System (MLDS), which contains linked longitudinal data from multiple sources.¹ The Maryland State Department of Education (MSDE) provides data for public Pre K-12 students and schools. The Maryland Higher Education Commission (MHEC) provides data for Maryland public and private colleges and students. Out-of-state college enrollment and degree information is obtained through the National Student Clearinghouse (NSC). The Department of Labor Licensing and Regulation (DLLR) provides data for Maryland employees who work for employers who are subject to Maryland's Unemployment Tax law. The workforce data do not include information for federal employees, military employees, individuals who are self-employed, or private contractors. The latest workforce data available at the time of these analyses were for FY 2016.²

All Maryland public high school students who graduated in academic year 2008-2009³ were identified. We focused on graduates whose first year of college enrollment occurred in 2010, excluding those who enrolled in college in 2011 or later, to allow six years for the completion of undergraduate education within the time span of the available data (through 2017). This six-year graduation window is considered adequate for reporting and is a widely-used metric for reporting undergraduate graduation rates (Engelmyer, 2019). We further focused on those students whose initial enrollment was in a 4-year institution (public or private). Finally, to focus on the role of in-state versus out-of-state college undergraduate enrollment in the likelihood of joining the Maryland workforce after undergraduate education, we excluded the data of students who were still enrolled as undergraduates in 2016.

Ultimately, we retained data from 29 percent of the 2009 Maryland high school graduates for these analyses. The group of students included differs in several ways from other 2009 Maryland high school graduates. For instance, the students retained for analyses tended to have

stronger academic indicators than students whose data were excluded for one or more reasons. In addition, students retained for analyses were less likely to belong to minority race or ethnic groups. Table 1 shows the demographic and achievement variables for the retained and excluded students.

	Data not included (<i>N</i> = 41,461)	Data included (<i>N</i> = 16,935)
HS Program Completion -Met requirements for		
Approved Career and Technology program	13%	2%
Approved USM and occupational program	10%	9%
Approved USM	46%	78%
Non Completer	2%	< 1%
Other high school completions	28%	11%
Missing	< 1%	< 1%
Gender		
Male	50%	44%
Female	50%	56%
Race		

White	57%	59%
Black	37%	31%
Asian	4%	9%
Native Hawaiian or Other Pacific Islander	< 1%	< 1%
American Indian or Alaska Native	< 1%	< 1%
Two or More Races	1%	< 1%
Ethnicity		
Hispanic or Latino	8%	3%
Not Hispanic or Latino	92%	97%
Highest AP Test Score	$M = 2.7; SD = 1.4$	$M = 3.4; SD = 1.4$
Highest IB Diploma Test Score	$M = 26.0; SD = 6.4$	$M = 28.4; SD = 6.4$
Highest IB Grade Test Score	$M = 12.3; SD = 13.7$	$M = 17.30; SD = 14.8$
Highest IB Diploma Proficiency	$M = 3.34; SD = 0.9$	$M = 3.55; SD = 0.9$
Highest IB Grade Proficiency	$M = 4.85; SD = 1.3$	$M = 5.20; SD = 1.2$
PSAT Verbal	$M = 41.01; SD = 11.0$	$M = 50.94; SD = 10.9$
PSAT Writing	$M = 40.54; SD = 10.8$	$M = 50.58; SD = 11.1$
PSAT Math	$M = 41.86; SD = 11.4$	$M = 52.48; SD = 11.8$
Took the ACT/SAT	50%	94%
Took at least one IB exam	1%	4%
Took the PSAT	60%	80%
Took at least one AP exam	20%	70%
SAT/ACT Math	$M = 458.3; SD = 118.4$	$M = 547.2; SD = 117.4$

SAT/ACT Verbal	$M = 455.5; SD = 111.0$	$M = 537.8; SD = 109.4$
SAT/ACT Writing	$M = 450.6; SD = 108.3$	$M = 536.6; SD = 109.8$
Met Rigorous HS Program Requirements for:		
Foreign Language	33%	72%
Math	24%	61%
Science	12%	39%
Advanced Technology Education	7%	8%
Completed HS with a cumulative GPA ≥ 3.0	26%	70%

Notes: Students whose data were included in analyses graduated from a Maryland public HS in 2009, enrolled at a 4-year college in 2010, and were not enrolled in any undergraduate program in 2016.

USM= University System of Maryland, AP= Advanced Placement, IB= International Baccalaureate, HS=high school, GPA= Grade Point Average

Where available, ACT Reading and ACT English scores are summed, then converted into SAT Verbal scores.

Table 1. Demographic and achievement variable values for students whose data were included in the analyses and those whose data were not included

Measures

In-state and out-of-state college enrollment was measured by examining the first record of college enrollment at a 4-year public or private institution. Covariates included demographic variables (e.g., race and gender), academic achievement indicators (SAT scores, HS GPA), and characteristics of the high schools from which the students graduated (e.g., the percentage of students in the school eligible for free and reduced price meals [FARMS]). Due to the small number of students in some race categories, groups were collapsed into underrepresented minorities (URM; Black, Native Hawaiian or Other Pacific Islander, American Indian or Alaskan Native, Two or More Races) and not underrepresented minorities (White, Asian). These categories are consistent with the National Institutes of Health (NIH) definition of URM in Sciences (<https://researchtraining.nih.gov/resources/faq>). Workforce participation in Maryland was coded if the student had at least one workforce record that occurred in the 4th fiscal quarter of the same calendar year as their last year of undergraduate college enrollment, or any quarter of a later year. This excluded the summer quarter following the last college enrollment record, which might indicate temporary summer employment prior to enrolling in graduate school or seeking more permanent employment. Graduate students who did not have any concurrent employment were classified as students who did not seek employment in Maryland following graduation from an undergraduate program.

Analyses

Missing data. Data, particularly achievement indicators like SAT subtest scores, were missing for several of the students in our sample. We applied multiple imputation to use the patterns among existing data in the dataset to extrapolate missing data values (Sinharay, Stern, & Russell, 2001), creating 20 complete datasets. In conducting imputation, we assumed that high

school information, such as the proportion of students eligible for free and reduced price meals (FARMS) at a given high school, was missing at random, conditional on known variables, and that this information could be reasonably imputed. However, other information, such as SAT scores, could be missing data or might indicate that the student did not take the SAT. To handle this type of missingness, we first generated variables indicating whether a student had taken the PSAT or SAT/ACT. Subtest scores were then imputed only if the indicator variable for that test was positive; if the person did not have a score on any SAT or ACT subtest, no scores were imputed (approximately 6 percent of the sample).⁴ A similar process was followed for scores on the PSAT subtests (approximately 18 percent of students were missing all PSAT subtest scores). No scores were imputed for Advanced Placement or International Baccalaureate tests, as taking one of these tests does not indicate that a person has taken others.

Analytic approach. In order to estimate the effect of location of college on likelihood of joining the Maryland workforce after college, we applied a propensity score matching approach (Austin 2011; Rosenbaum & Rubin, 1983).⁵ Propensity score matching is used to impose a quasi-experimental design onto non-experimental datasets (Holmes, 2013). In an experiment, random assignment of participants to conditions helps to control for the possibility of differences in extraneous variables, such as the participants' academic achievements, leading to group differences in the outcome of interest. In real extant data, such relationships are likely to exist: a high school student with a higher GPA may be more likely to attend an out-of-state university because the student is more likely to receive merit-based financial aid to offset out-of-state tuition. We used propensity score matching to correct for pre-existing differences between students who enrolled at a Maryland college and those who enrolled at an out-of-state college on covariates that could potentially affect the outcome. The propensity score model included all

high school, demographic, and achievement covariates (see Table 2).⁶ We selected 1-to-1 matching between students in the “treatment condition” (out-of-state college enrollment) and students in the “control condition” (Maryland college enrollment) and used a greedy matching algorithm with a caliper of 0.20 and no replacement. The matching procedure was repeated for each of the imputed datasets; due to differences in the imputed values between the datasets, the number of students in the treatment condition that could successfully be matched to students in the control condition varied slightly, yielding slightly different sizes for the resulting matched datasets (14,518 - 14,556).

Figure 1 shows the distribution of propensity scores between the two groups prior to matching and Figure 2 shows the distribution after matching. A comparison of figure 1 and figure 2 shows sufficient overlap of propensity scores for the students who attended college in Maryland and outside of Maryland, with overlap improving in the matched sample. Figure 3 shows the standardized mean differences for the variables included in the propensity score model in the unmatched and matched datasets. The standardized mean difference (SMD) between the treatment and the control groups was below 0.1 for all covariates in all of the 20 matched datasets, indicating that differences between the groups were negligible (Austin, 2011; Normand et al., 2001). The SMD improved in the matched datasets when compared to the unmatched dataset.

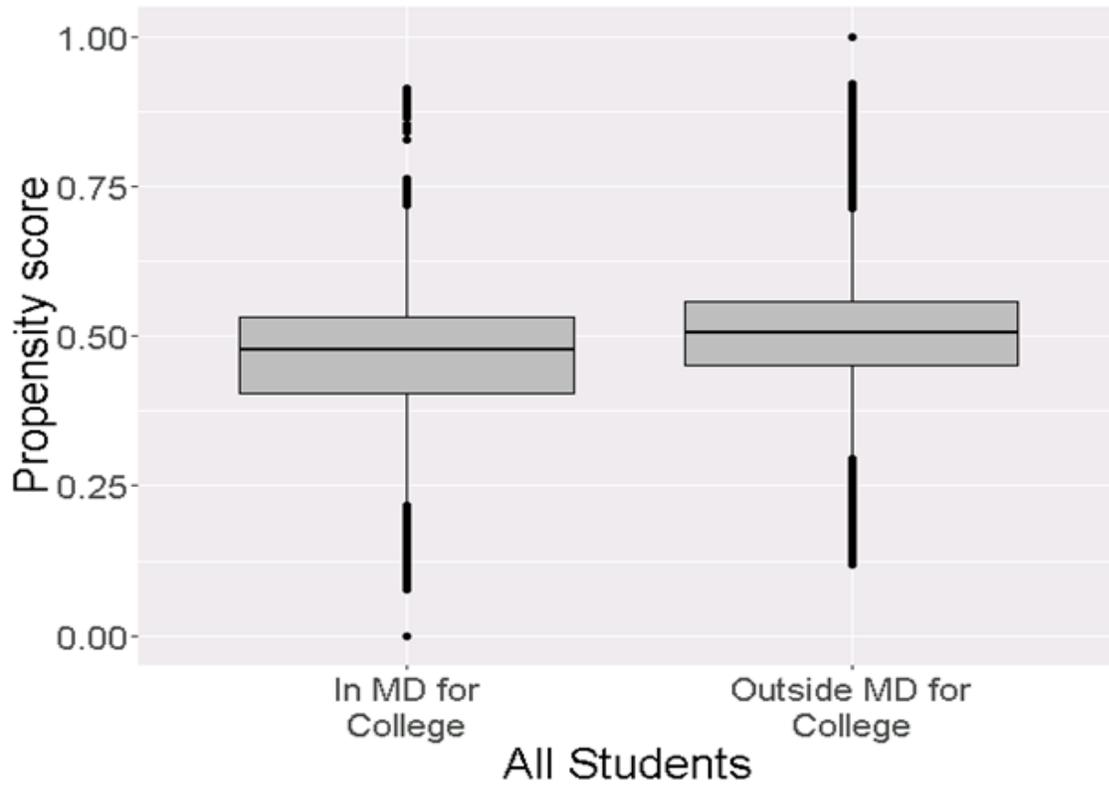


Fig 1 Distribution of propensity scores in the in-state and out-of-state groups before matching

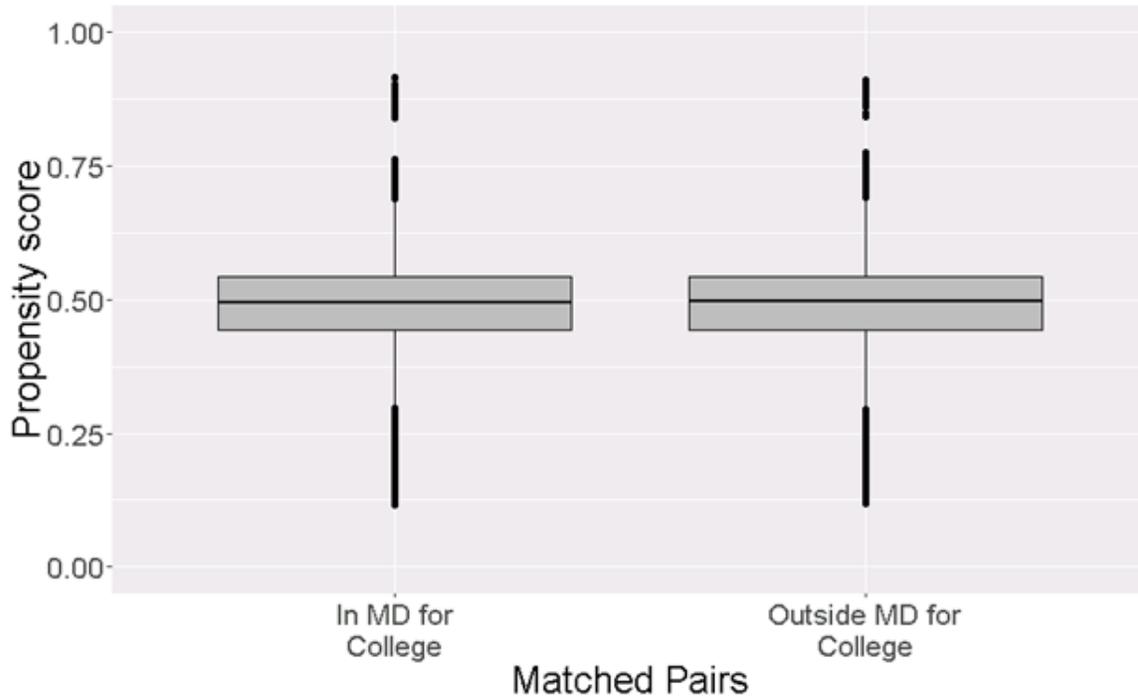


Fig 2 Distribution of propensity scores in the in-state and out-of-state groups after matching

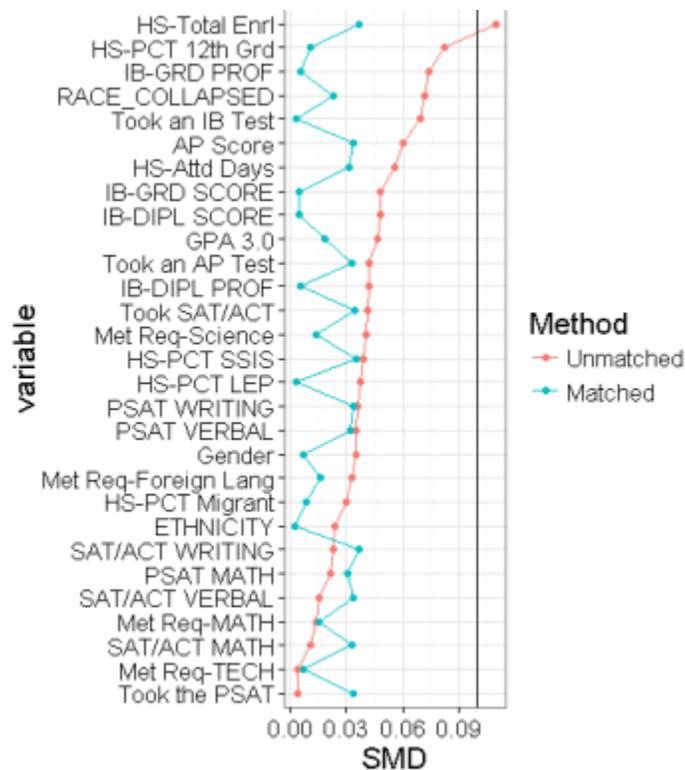


Fig 3 Standardized mean difference (SMD) on variables in the matched and unmatched samples

Logistic regression analyses were conducted with the matched datasets to explore whether enrolling at a college outside of Maryland affected the likelihood of a Maryland high school graduates joining the Maryland workforce after college after the groups were matched on all available covariates. Coefficients and variances from these analyses were statistically combined using Rubin’s (1987) pooling methodology to generate a single set of results. Follow-up descriptive analyses examined the student characteristics of students who attended college out-of-state and returned to Maryland for the workforce in comparison to out-of-state college students who did not return to Maryland for the workforce.

Findings

Comparing Maryland College Students to Out-of-State College Students

Of the cohort of Maryland high school graduates included in analyses, 48 percent initially enrolled in a college outside of Maryland. Table 2 presents the results comparing the demographic and achievement characteristics of Maryland public high school graduates who enrolled in college in-state and out-of-state. Students enrolled outside of Maryland were less likely to have completed course requirements for both the University System of Maryland (USM) and a career and technology program, and were less likely to be Black or Asian and more likely to be White. In terms of academic variables, such as SAT score and taking an AP exam, the differences between the two groups are very slight.

	Outside Maryland (<i>N</i> = 8,145)	Inside Maryland (<i>N</i> = 8,790)
HS Program Completion - Met requirements for:		

Approved Career and Technology program	2%	2%
Approved USM and occupational program	8%	11%
Approved USM	78%	77%
Non Completer	< 1%	< 1%
Other high school completions	11%	10%
Missing	< 1%	< 1%
Gender		
Male	43%	45%
Female	57%	55%
Race		
White	63%	55%
Black	30%	33%
Asian	6%	12%
Native Hawaiian or Other Pacific Islander	< 1%	< 1%
American Indian or Alaska Native	< 1%	< 1%
Two or More Races	< 1%	< 1%
Hispanic or Latino	3%	4%
Highest AP Test Score	$M = 3.5; SD = 1.4$	$M = 3.4; SD = 1.4$
Highest IB Diploma Test Score	$M = 29.7; SD = 6.2$	$M = 26.9; SD = 6.3$
Highest IB Grade Test Score	$M = 17.1; SD = 15.5$	$M = 17.6; SD = 13.8$

Highest IB Diploma Proficiency	$M = 3.6; SD = 0.9$	$M = 3.4; SD = 0.9$
Highest IB Grade Proficiency	$M = 5.3; SD = 1.2$	$M = 5.1; SD = 1.2$
PSAT Verbal	$M = 51.4; SD = 11.3$	$M = 50.5; SD = 10.5$
PSAT Writing	$M = 51.0; SD = 11.6$	$M = 50.2; SD = 10.5$
PSAT Math	$M = 52.7; SD = 12.1$	$M = 52.2; SD = 11.5$
Took the ACT/SAT	94%	95%
Took at least one IB exam	4%	3%
Took the PSAT	82%	82%
Took at least one AP exam	70%	68%
SAT/ACT Math	$M = 552.0; SD = 118.1$	$M = 542.7; SD = 116.5$
SAT/ACT Verbal	$M = 542.8; SD = 113.7$	$M = 533.3; SD = 105.1$
SAT/ACT Writing	$M = 542.3; SD = 114.6$	$M = 531.2; SD = 105.0$
Met the Rigorous HS Program Requirements for:		
Foreign Language	71%	73%
Math	61%	62%
Science	38%	39%
Advanced Technology Education	8%	8%
Completed HS with a cumulative GPA ≥ 3.0	69%	71%

Notes: USM= University System of Maryland, AP= Advanced Placement, IB= International Baccalaureate, HS = high school, GPA= Grade Point Average. Where available, ACT Reading and ACT English scores are summed, then converted into SAT Verbal scores.

Table 2. Demographic and achievement characteristics for Maryland public high school graduates who enrolled in 4-year colleges outside and inside of Maryland

Does Brain Drain Exist in Maryland?

The descriptive statistics in Table 2 indicate that the high school graduates in the sample who enroll out-of-state for college differ from those who enroll in Maryland for college. Using propensity score matching, in-state and out-of-state enrollees were matched on these variables. It was then possible to examine whether there is a difference between the two matched groups in their likelihood of appearing in the Maryland employment records after college. Table 3 presents the results of the logistic regression analyses using out-of-state 4-year college enrollment to predict workforce participation in Maryland using the full sample and the matched sample. In the sample matched on all available demographic, academic achievement, and high school characteristics, enrollment at a college outside of Maryland had a negative relationship with joining the Maryland workforce following college. We can transform the log-odds (indicated by the beta weight in Table 3) into odds to understand how likely a student in the matched dataset who went to an out-of-state institution was to have participated in the Maryland workforce compared to one who went to a Maryland institution: $e^{-1.13} = 0.323$, or roughly 1/3 as likely. Across the matched datasets, 80 percent of students who enrolled at Maryland colleges had post-college workforce records, compared to 57 percent of students who enrolled outside Maryland. The coefficient size for the treatment was larger in the unmatched than the matched, indicating

that propensity score matching eliminated some of the between-group differences that influenced the likelihood of joining the Maryland workforce. Even after propensity score matching, however, the relationship between location of initial college enrollment and likelihood of joining the Maryland workforce remains sizable.

Coefficients	Full sample ($N = 16,935$)			Matched Sample ($N \geq 14,518$)*		
	Estimate	Std. Error	p	Estimate	Std. Error	p
(Intercept)	1.46	0.03	<0.001	1.39	0.03	<0.001
Outside Maryland for College	-1.22	0.04	<0.001	-1.13	0.04	<0.001

* Sample size shown is the minimum of the range across the sets of matched data

Table 3. Logistic regression with 4-year college enrollment outside of Maryland predicting workforce participation in Maryland

Who is Lost to Brain Drain from Maryland?

Table 4 displays the descriptive statistics for students who enrolled at a 4-year college outside of Maryland and returned to Maryland for work compared to students who enrolled at a 4-year college outside of Maryland and do not have Maryland employment records after college. Individuals who enrolled in college out-of-state and joined the Maryland workforce tended to have less positive high school academic indicators than individuals who did not join the Maryland workforce after enrolling in college out-of-state (e.g., lower SAT/ACT subtest scores). There was no difference between the two groups in the rate of enrolling in a graduate program.

	Did not join the Maryland workforce ($N \geq 3,145$)*	Did join the Maryland workforce ($N \geq 4,109$)*
Count of college enrollment terms	$M = 9.9; SD = 3.0$	$M = 9.5; SD = 3.7$
Enrolled in a graduate program	20%	21%
Received a certificate	0 %	1%

Received an associate degree	1%	3%
Received a bachelor's degree	75%	69%
Received a master's degree	<1%	3%
Female	54%	57%
Underrepresented minority	27%	35%
Hispanic or Latino	4%	3%
Highest AP Test Score	$M = 3.7; SD = 1.4$	$M = 3.2; SD = 1.4$
Highest IB Diploma Test Score	$M = 19.8; SD = 15.9$	$M = 17.2; SD = 14.0$
Highest IB Grade Test Score	$M = 19.8; SD = 14.9$	$M = 17.2; SD = 14.0$
Highest IB Diploma Proficiency	$M = 2.4; SD = 1.9$	$M = 2.2; SD = 1.9$
Highest IB Grade Proficiency	$M = 5.4; SD = 1.1$	$M = 4.9; SD = 1.3$
PSAT Verbal	$M = 53.6; SD = 11.2$	$M = 48.9; SD = 10.8$
PSAT Writing	$M = 53.2; SD = 11.4$	$M = 48.5; SD = 11.0$
PSAT Math	$M = 55.7; SD = 12.2$	$M = 50.3; SD = 11.4$
Took the ACT/SAT	96%	92%
Took at least one IB exam	4%	3%
Took the PSAT	84%	80%
Took at least one AP exam	78%	63%
SAT/ACT Math	$M = 577.6; SD = 117.3$	$M = 526.2; SD = 112.3$
SAT/ACT Verbal	$M = 566.1; SD = 112.1$	$M = 517.5; SD = 106.4$
SAT/ACT Writing	$M = 561.8; SD = 112.6$	$M = 516.1; SD = 107.5$
Met the Rigorous HS Program Requirements for Foreign Language	77%	69%

Met the Rigorous HS Program Requirements for Math	68%	57%
Met the Rigorous HS Program Requirements for Science	44%	34%
Met the Rigorous HS Program Requirements for Advanced Technology Education	10%	8%
Completed high school with a cumulative GPA of 3.0 or higher	78%	64%
<p><i>Notes:</i> These analyses include all individuals in the matched datasets who were in the treatment group (i.e., initially enrolled out-of-state); sample sizes shown are the minimum of the range across sets of matched data. AP = Advanced Placement, IB = International Baccalaureate, HS = high school, GPA= Grade Point Average.</p> <p>Where available, ACT Reading and ACT English scores are summed, then converted into SAT Verbal scores.</p> <p>* The samples sizes shown are the minimum of the range across sets of matched data.</p>		

Table 4. Demographic, achievement, college attendance, and degree characteristics of Maryland public high school graduates who enrolled in a 4-year out-of-state college by whether the person worked in Maryland after college

Discussion

This study examined the brain drain phenomenon in Maryland; specifically, we examined the characteristics of Maryland high school students who enrolled in college in-state in

comparison to those who enrolled in college out-of-state, whether those students who remained in-state for college continue to remain in-state for employment following graduation, and what differences exist between the two groups. The findings indicate that there is some degree of brain drain when Maryland public high school students enroll in colleges outside of Maryland. Students who enrolled in 4-year out-of-state colleges were less likely to join the Maryland workforce following college when compared to Maryland public high school students who enrolled in Maryland colleges (80 percent of students who enrolled at Maryland colleges had post-college workforce records, compared to 57 percent of students who enrolled outside Maryland). Further, the individuals who return to the Maryland workforce after enrolling in out-of-state colleges tend to be lower achieving students (with regard to high school achievement measures) than students who do not return to the Maryland workforce. This suggests that individuals with stronger academic indicators may be more likely to go on to employment outside of Maryland following enrollment in a college outside of Maryland than are individuals with less positive academic indicators.

The findings from this study are generally consistent with prior research reporting brain drain from high school through college to the workforce (Groen, 2004; Perry, 2001). The majority of the Maryland public high school students in the sample initially enrolled at a Maryland institution, consistent with Hawley and Rork (2013) and Perry (2001). Also consistent with Perry (and with Groen, 2004), there was a negative relationship between enrollment in an out-of-state college and likelihood of returning to the original state of residence for employment. However, previous examinations of college graduate migration (Bui, 2016) reported that Maryland has a net gain with regard to the number of college graduates under 40 – more graduates come into Maryland than leave. Unfortunately, it is not possible with the current data

to see this positive difference, which would require access to the data of all college graduates across the United States, rather than just those who first graduated from a Maryland public high school or who attended Maryland post-secondary institutions. In other words, the results reported here indicate that brain drain occurs, but do not speak to the sum total of post-college individuals who join the Maryland workforce.

This study is limited in several ways. The available workforce data did not include self-employment, military service, federal employment, or independent contractors. A person who does not have workforce records following college enrollment could be unemployed, employed outside of Maryland, or employed in one of these domains. To draw conclusions from differences in the number of in-state college enrollees and out-of-state enrollees who have workforce records, it is assumed that the likelihood of being employed in these types of jobs is the same for both groups. Further, the propensity scores used to match the treatment and non-treatment groups in this study were calculated based on the variables available, and it is possible that there were unmeasured confounders, or other variables related to Maryland employment that were not included. For instance, information about students' specific socioeconomic status (SES), their parent's education level, or the students' behavior during high school, such as suspensions or referrals, may have improved the matching process and potentially influenced the results of the outcome analysis. Finally, this study retained only 29 percent of the 2009 Maryland high school graduates, and the students retained differed from those that were excluded on several indicators, including demographic characteristics and academic performance indicators. Therefore, the generalizability of this study is limited to students who matched the profile of included students.

Policy Implications

Many states, such as Missouri, Texas, Georgia, and Florida, have adopted legislation designed to reward high performing students with merit- or need-based assistance. These programs have differed in their impact on brain drain (Harrington et al., 2016; Hickman, 2009; Sjoquist & Winters, 2013; Zhang & Ness, 2010). The current study investigated the question of brain drain as it occurs at the intervention point of these kinds of programs: if a Maryland high school graduate is motivated to enroll at a Maryland college rather than an out-of-state college, is that person more likely to stay in Maryland to work? The results suggest that a program that increases the likelihood of a high school graduate attending an in-state college is likely to increase the number of high school graduates who stay in the state's workforce. Further, other research suggests that out-of-state high school graduates who enroll at a state's colleges will not be as likely to stay in the state post-college as are high school graduates who stay in-state for college (Perry, 2001). This implies that retaining high school graduates in-state for college is more likely to benefit a state's workforce than is attracting out-of-state students to its colleges. However, neither the current study nor Perry's investigation explored the types of employment held by different groups. It is possible that workers who originally live in other states tend to work at different jobs, or that students who go out-of-state for college and return to the original state's workforce work different jobs than those who stay in-state for college and join the workforce. Further, previous research suggests that programs designed to encourage in-state college enrollment may accomplish this goal but still fail to increase the number of individuals who join the state's workforce after college (Sjoquist & Winters, 2013). A solution may involve programs that encourage in-state enrollment for specific subgroups of high school graduates for

whom in-state enrollment has the strongest relationship to likelihood of joining the original state's workforce.

Future Directions

To help states more completely understand the brain drain phenomena and how to best mitigate its impact, future research should explore differences in rates of enrollment in public and private institutions for students who enroll at in-state versus out-of-state colleges. The approach taken to mitigate brain drain may depend on whether it is primarily students attending out-of-state private institutions who do not return to the state's workforce or primarily students attending out-of-state public institutions who do not return. A similar motivation exists for examining the location of the out-of-state institution (e.g., within 250 miles versus further than 250 miles away, or colleges in specific states) and its effect on likelihood of returning to the original state's workforce after college. Future research on brain drain could also usefully investigate the types of employment held by former in-state versus out-of-state college students. It is possible that certain types of jobs tend to be held by people who went out-of-state for college.

CONCLUSION

This study used linked longitudinal data from the MLDS to investigate the full brain drain process from high school to college and to the workforce. The findings indicate that brain drain does exist in Maryland: Maryland public high school students who go out-of-state for college are less likely to be found in the Maryland workforce than Maryland public high school students who stayed in-state for college. The findings of this study contribute to the literature on

brain drain in that they provide a direct examination of how enrollment in an out-of-state college affects the rate of joining the state's workforce while using propensity score matching to control for the differences that exist between these two groups at the outset. The demographic variables, academic indicators, and high school information available in the MLDS enabled the application of advanced statistical methods for this analysis in order to be more confident that similar groups of students, who differed only in the location of their initial college enrollment, were compared regarding their workforce outcome.

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Notes

¹For more information, visit <https://mldscenter.maryland.gov/>

² For more information, visit <http://www.studentclearinghouse.org/>

³ In future references to enrollment and graduation years, we indicate the academic year. For instance, 2009 corresponds to the academic year 2009, which began in Fall 2008.

⁴ACT subtest scores were converted to SAT subtest scores where present, rather than imputing the missing SAT scores. The conversion table was taken from <https://www.ets.org/Media/Research/pdf/RR-99-02-Dorans.pdf>.

⁵ We used the *Matching* package (Sekhon, 2011) in the *R* statistical environment (R Core Team, 2015).

⁶ The propensity model included the interaction between the SAT/ACT and PSAT indicator variables and the subtest scores rather than the main effect of the subtest scores. This allowed us to retain all students in analyses while still estimating the relationship between subtest score and belonging to the treatment group.