

Higher Education Structure and Education Outcomes: Evidence from the United States

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This paper documents substantial differences across states in their higher education (HE) structures, and highlights several empirical relationships between these structures and individuals' higher-education outcomes. Not surprisingly, individuals who are exposed to more-fractionalized HE structures are more likely to attend small, public universities, and less likely to attend large, public universities. Exposure to more-fractionalized structures is also associated with increased degree attainment, and increased exits from the in-state public university system (to private and out-of-state public universities). These findings highlight potentially important tradeoffs related to state policy on HE structure.

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I. Introduction

In 1990, the state of Iowa had a population of approximately 2.8 million and funded three public four-year universities. Oregon, which also had a statewide population of approximately 2.8 million in 1990, funded eight public four-year universities. All three public universities in Iowa had enrollments above 12,000 students while in Oregon, almost one in four students who attended a public university attended a university with an enrollment below 6,000 students.¹ This is just one example of the large differences across states in higher education (HE) structure. I refer to this aspect of HE structure, where some states fund more, small universities and others fund fewer, large universities, as fractionalization.

The public higher education market in the United States is highly localized to the state level because students receive substantial tuition subsidies if they attend in-state public universities (see, for example, Johnson, 1984, or Kane, 1995). This suggests that individuals will be affected by their home states' HE structures. For example, mechanically, individuals from states with more-fractionalized HE structures will be more likely to attend smaller public universities. HE structure may also increase or decrease university attendance, and shift individuals toward or away from private universities.

This paper empirically investigates the relationships between HE fractionalization and individuals' higher education outcomes. I highlight three key findings: (1) mechanically, more-fractionalized HE structures are associated with a dramatic increase (decrease) in the likelihood that individuals obtain degrees from small (large) public universities, (2) increased fractionalization is associated with an increase in degree attainment at four-year universities, and there is suggestive evidence that fractionalization is also positively related to university

¹ These calculations are based on data from the National Science Foundation (NSF) population of institutions in the Integrated Postsecondary Education Data System (IPEDS) enrollment survey. The university count in Oregon includes one health-sciences university with an enrollment of approximately 1,300 students in 1990.

attendance, and (3) increased fractionalization corresponds to an increase in exits from the in-state public university system, either to private or out-of-state public universities.² Overall, fractionalization is associated with some positive outcomes, like degree attainment; and some negative outcomes, like higher system exits. That system exits rise with fractionalization is telling because it suggests that some individuals forego substantial in-state tuition subsidies to avoid attending a university in a more-fractionalized HE system.

A limitation of the empirical analysis is that there are few observed HE structures – this study is based on the 50 state-level systems in the United States. Compounding this problem is that HE structure is also highly inertial within states over time, which means that there is limited variability in the data more generally. This renders useless some of the more-sophisticated empirical techniques that might otherwise be employed in the evaluation, and makes it unlikely that it will be possible to obtain experimental or quasi-experimental evidence on the effects of HE structure. However, despite the data limitations, policymakers must still make decisions about HE structure that will affect many individuals, and involve considerable public expenditures.³ This study offers what is perhaps the best alternative to experimental or quasi-experimental evidence on the effects of HE structure - a careful observational analysis that makes use of exceptional micro-level data, and performs a series of robustness checks to confirm that the findings are not biased by any obvious source.

² Earlier versions of this work also attempted to link HE structure to wage and employment outcomes later in life. There is a negative relationship in the data between exposure to a more-fractionalized HE structure and wages, but ultimately, the challenges with the data on HE structure are substantial enough (see Section II) that this portion of the analysis was unconvincing (even given the exceptional quality of the micro data, see Section IV). Also note that fractionalization is negatively correlated with Zhang's (2009) measure of state-level value added in higher education.

³ From 1980 to 2000 the share of the US population 25 and older who had completed at least a bachelor's degree increased by half - moving from 16.2 to 24.4 percent (US Census). Because the public sector plays such a large role in the provision of HE (approximately three-fourths of all four-year university attendees attend public universities - see Snyder, Dillow and Hoffman, 2008), state expenditures on higher education have increased correspondingly. Rising over 160 percent during these same two decades (Snyder, Dillow and Hoffman, 2008).

II. The Across-State Variability and Within-State Persistence of HE Structure

There is substantial variation in HE structure across states. Figures 1 and 2 illustrate the across-state variability in HE structure in 1990, the year for which states' structures are most relevant for the empirical analysis that follows. First, Figure 1 plots the number of publicly funded state universities against statewide populations for each of the 50 states. Among the 13 states with populations in the 3-5 million range in 1990, for example, the number of publicly funded universities ranged from as low as three to as high as sixteen.

Figure 2 provides additional documentation of the cross-sectional variability in HE structure – it shows the statewide shares of public university enrollments at universities with over 10,000 students, again using data from 1990 (the 10,000-student threshold is just one of many possible thresholds that can be used to separate “large” and “small” universities). In some states, like Arizona and Iowa, all public universities had enrollments in excess of 10,000 students. But most states have some smaller colleges, and in more than half of the states, enrollment in public universities with more than 10,000 students accounted for less than 70 percent of total enrollment.

Although HE structure differs substantially *across* states, it is highly inertial *within* states over time. Even during the latter half of the 20th century, as the labor market underwent dramatic changes (see Katz and Murphy, 1992; Buchinsky, 1994), states' HE structures were highly persistent. Table 1 illustrates the within-state persistence of HE structure by showing correlations between state-level university counts and measures of universities-per-capita over the second half of the 20th century.⁴ The correlations are large and indicate that states' HE structures were virtually unchanged over this time period.

⁴ The data for the public four-year university counts from 1970 on are from the National Science Foundation (NSF) population of universities in the Integrated Postsecondary Education Data System (IPEDS). The university counts from 1950 are from the 1950-52 Biennial Survey of Education produced by the U.S. Office of Education. I use the 1950-52 Biennial Survey of Education for the 1950 university counts because the NSF data are not available prior to 1967. Within each state, I count all public universities, liberal arts colleges, teachers' colleges and technical colleges (non-community colleges) as designated by the Office of Education in 1950.

III. Sources of Variation in HE Structure

Where did the observed variation across states in HE structure come from? An obvious starting point in addressing this question is to look at the characteristics of states when their HE systems were forming. Unfortunately, this is not straightforward because states' systems evolved slowly, generally over the span of 50-100 years (typically between the mid-1800s and the early-to-mid 20th century).⁵

Given that states' HE systems developed slowly, it is difficult to pinpoint precise factors at specific points in time that may have determined their structures. Instead, I use inertial state-level characteristics measured near the turn of the 20th century, a time when most systems were in the process of forming, to predict states' HE structures in 1990. The use of inertial characteristics is important because I cannot pinpoint the exact dates when the systems were formed, and using inertial characteristics allows for a greater margin for error in terms of when the predictive variables are measured. I focus on six state-level characteristics from the turn of the 20th century. These characteristics are geographic size (time invariant), the number of acres in the state involved in agricultural production, the share of acreage in the state involved in agricultural production, population density, total population, and the share of the white population that was illiterate in 1900.⁶ These choices are not motivated by a strong theoretical framework for how states' HE structures were formed because no such framework exists. However, if HE structure does indeed depend on state-specific characteristics, these are likely candidates. Stories could be told for how each characteristic might be important. For example, geographically larger states may have tended toward more-fractionalized systems so that a larger share of the population would be closer to a university. Less-dense states may have preferred more- or less-fractionalized systems. A more-fractionalized system would perhaps put universities closer to more individuals, but less-dense states may also have had fewer population

⁵ I determined the time spans over which states' HE systems were developed using the founding dates of the individual universities in each system (based on initial founding, even if under a different name than the one used today). Just over half of all of the universities in current state systems were founded prior to 1800. One of the few common themes in university creation across states is the Morrill Land-Grant Act of 1862.

⁶ These variables were taken from the US Census and the US Census of Agriculture.

centers with the political power to push for a university (i.e., cities). States that differed in terms of agricultural interests and literacy rates may have had different priorities when it came to the development of their HE systems.

I individually regress states' HE fractionalization measures in 1990 on each of these state characteristics to evaluate their predictive power. A limitation of the regressions is that the entire sample includes just the 50 states, and only 45 states have data for one of the characteristics, so the sample sizes are small. However, even so, none of the state characteristics are meaningfully correlated with HE fractionalization – the unadjusted R-squared from the simple regressions never exceeds 0.02. It would be difficult to argue that any of these characteristics, or any characteristic that is highly correlated with any of these characteristics, is the driving force behind the substantial variation in states' HE structures that we observe today.⁷

These findings do not rule out the possibility that state-specific idiosyncratic factors and happenstance occurrences are largely responsible for the modern-day variation in states' HE structures. However, while the data do not suggest a clear link between HE structure and any specific state attribute, the data are also not sufficient to rigorously defend a “random variation” story (i.e., the sample size is too small).⁸ Furthermore, even if much of the variation in HE structure is the result of a series of chance circumstances in states, it could be that some of these circumstances also influenced states in other ways that may predict higher-education outcomes today – that is, the “random variation” condition is not sufficient to argue that HE structure is exogenous to individuals' higher-education outcomes. The empirical models that I estimate below take this concern very seriously, and condition on a variety of controls that measure state-specific conditions that one might worry are correlated with HE structure and influence individuals' higher-education outcomes (e.g., state-specific economic conditions).

⁷ I omit the regression results for brevity but they are available upon request.

⁸ Informally, the histories behind many of the state systems are also consistent with a “random variation” story.

IV. Data

I use two primary data sources in the analysis. Data for individuals are from the restricted-use version of the National Educational Longitudinal Survey, base-year 1988 (NELS:88), compiled by the National Center for Education Statistics (NCES). The NELS:88 began with a nationally representative sample of grade-8 students in 1988 and followed them through high-school, college if applicable, and into the workforce. Follow-up surveys were administered in 1990, 1992, 1994 and 2000. I use the data file from the fourth follow-up survey in 2000, and report descriptive statistics in Table 2. I also use the Integrated Postsecondary Education Data System (IPEDS), provided by the National Science Foundation (NSF), to construct the HE fractionalization measures. These two data sources are supplemented with data from the United States Census and the NCES.

Three features make the NELS:88 data particularly useful for investigating the associations between HE structure and individual outcomes. First, the base year of the survey occurred when individuals were in the eighth grade, long before they made any higher-education decisions related to HE structure. The base-year survey collected information on parental income, parental education, test score performance and grade point average, along with race, gender, number of siblings (which may affect the share of family resources that can be devoted to privately funding HE), and whether English is the individual's first language. These variables are strong predictors of individual outcomes and serve as important controls in the models (see appendix). Second, the follow-up survey in 1992 indicates the state in which each individual attended the twelfth grade. I use these state indicators to link each individual to a state-level HE structure. Finally, the fourth follow-up survey in 2000 provides information about higher-education outcomes.⁹

I construct the state-level HE fractionalization measures using enrollment data from the NSF population of public, four-year universities in IPEDS. The enrollment data are from 1990,

⁹ The data are weighted using the sample weights provided by the NCES throughout the analysis. I require individuals to have completed the base-year survey to be included in the models.

two years before the micro-sample's high-school graduation year. The primary fractionalization measures are constructed as state-level enrollment shares at universities with enrollments below certain thresholds, which are used to distinguish "large" and "small" universities. Because the definitions of "large" and "small" are subjective, I use multiple enrollment thresholds – at 8,000, 10,000, 12,000 and 15,000 students. The fractionalization measures divide the number of students enrolled in "small" public universities by total statewide enrollment at public universities. The larger the value, the more fractionalized is the state's structure.¹⁰

The enrollment-threshold approach to measuring fractionalization may initially seem unorthodox. One alternative is to use Herfindahl Indices; however, there is a rough upper limit on university size across states, meaning that Herfindahl Indices would make it appear as though university systems in large states are more fractionalized than those in small states even in cases where the average university size is constant. For example, from Figure 2, most public-university students in Ohio and Utah attend large schools, but because students are dispersed across more universities in Ohio, the states' Herfindahl Indices would be quite different. Another alternative is to use the ratio of public universities to total population to measure fractionalization (as seen in Figure 1), but this measure is rather coarse. Although the enrollment-threshold approach is limited by the subjectivity in determining the thresholds, this weakness can be overcome by considering multiple thresholds, making it preferable to the available alternatives.

I also consider a related measure that emphasizes the divide between large- and small-university attendance within states. Specifically, I measure fractionalization using the ratio of the student-share in universities with less than 10,000 students to the student-share in universities with more than 15,000 students. If one believes that the real impacts of fractionalization will come from the tails of the university-size distribution, then this metric is more appropriate. However, it may not be the case that the share of students attending mid-sized universities is less

¹⁰ I base the fractionalization measures on total enrollments and do not distinguish by enrollment type (i.e., undergraduate, graduate, etc.). I exclude enrollments in military schools and include enrollments in medical schools in my calculations, but these enrollments make up such a small share of total enrollments that the results are entirely insensitive to these decisions.

important. In practice, my findings are qualitatively similar regardless of which fractionalization measure is used.

Finally, in addition to the individual-level controls and the fractionalization measures, I also include state-level controls in the models. I discuss these controls in more detail in Sections VI and VII.

V. Private Universities

The focus of this study is on publicly-funded four-year universities, for which the in-state structures are determined by public policy. However, the private sector in higher education also merits attention. Unlike in the public sector, the private sector does not generally offer explicit cost savings for in-state attendance. Correspondingly, in the data, while over 87 percent of public-university graduates attended an in-state university (based on their state of residence in grade 12), only 52 percent of private-university graduates remained in-state.

Although the private-university market is clearly less-localized than the public-university market, even the 52-percent figure implies some home-state bias (a likely explanation is the distance mechanism). Therefore, in some models, I control for the degree of fractionalization of states' *private universities* in addition to their public universities (the fractionalization measures across the public and private sectors are weakly positively correlated within states – the correlation ranges from 0.10 to 0.20 depending on which fractionalization measure is used). Including private-university fractionalization does not meaningfully affect the results for public-university fractionalization in any of the models considered below. For brevity, I only report estimates from models that include private-university fractionalization measured by the 10,000-student enrollment threshold.

VI. Educational Outcomes

I document the relationships between public HE structure and individuals' higher-education outcomes. The outcomes that I consider are (1) university attendance, (2) degree attainment from any four-year university, (3) degree attainment from a private four-year

university (or out-of-state university) and (4) degree attainment from a public four-year university, by university size.

How should we expect HE structure to affect these outcomes? First, for attendance, basic economic theory suggests that it will increase in response to fractionalization. The reason is that a more-fractionalized system will reduce commuting costs to the nearest university for individuals, inducing marginal attendees to attend (for more on the importance of university distance see, for example, Card 1995, 1999; Frenette, 2009; McMillen, Singell and Waddell, 2007). For degree attainment, there should be a positive effect of fractionalization associated with the increased attendance, and the reduced commuting costs should also encourage increased continuation in school, increasing graduation rates. But the effect also depends on whether universities in more- and less-fractionalized systems differ in terms of their effectiveness in seeing students through to graduation, independent of any commuting-cost effects. For example, even though less-fractionalized systems will be associated with higher commuting costs for students, if the universities in those systems are otherwise better at retaining students, less-fractionalized systems could produce more graduates. *Ex ante*, it is not clear whether more or less fractionalization is better for producing the most graduates.

With regard to the relationship between HE structure and out-of-system degree attainment, the effect will hinge on how individuals on the margin between attending an in-system versus out-of-system university respond to fractionalization. Importantly, the individuals on this margin are likely to be very different from the individuals on the attendance or graduation margins.¹¹ It seems likely that these individuals will be more responsive to their perceptions of the quality of their in-state public university options. If more-fractionalized systems have higher-quality universities as perceived by this group then fractionalization should be associated with a decrease in out-of-system degrees, and conversely, if this group perceives their university choices in a more-fractionalized system to be of lower quality, they should exit at a higher rate.

¹¹ In the data, individuals who ultimately attend out-of-system universities are, on average, better students prior to college enrollment, and they have higher wages later in life.

Finally, whether individuals attend large or small universities will mechanically depend on HE fractionalization. The university-size outcomes are likely to be particularly important for individuals who are “trapped” in their in-state systems. For these individuals, even when the quality of the public system declines, the expected net benefit of moving to the private sector remains negative, while the expected net benefit of public-university attendance over non-attendance remains positive (the wedge is driven by the tuition subsidies that come with attending an in-state university). The result is that these individuals shift within their in-state systems to fill the available slots at public universities.

The purpose of documenting the relationship between fractionalization and degree attainment by university size is not to show a surprising result, but rather to formally document the relationship. Currently I am not aware of any research that rigorously compares the efficacy of large and small universities holding student quality constant – given the stakes involved in higher education, and the large-scope nature of public policy on HE structure, this is a potentially important oversight in the literature.

I estimate a separate probit model for each educational outcome and report marginal effects taken at the sample averages of the control variables. The probit models take the following form:

$$y_{ij} = \beta_0 + X_i\beta_1 + S_j\beta_2 + F_j\lambda + \varepsilon_{ij} \quad (1)$$

In (1), y_{ij} is an educational outcome for individual i who resided in state j in the year that she graduated from high school, X_i is a vector of individual-level controls described above, S_j is a vector of the state-level control variables that are constructed based on data from 1990, and F_j is a fractionalization measure. All standard errors are clustered at the state level. The HE-structure estimates are based on the structures to which individuals were initially exposed upon high-school graduation. This allows for the possibility that subsequent state moves are endogenous.

I estimate the models separately using each fractionalization measure described in Section IV. Table 3 reports summary statistics for the fractionalization measures across the 50

states. Note that nine states did not have any universities with enrollment in excess of 15,000 students in 1990 – these states are omitted from the models where I define fractionalization by the ratio of the student-share at universities with fewer than 10,000 students to the student-share at universities with more than 15,000 students.¹²

Discretion is required in selecting the state-level control variables that are included in the models because the underlying variation comes from just the 50 states, and unfortunately, the analysis in Section III provides little guidance for forming *ex ante* expectations about what types of state-level control variables might be most useful to include. To begin, in the initial models I simply select four state-level controls that are likely to capture important differences across states. The first two state-level controls – median household income and the statewide unemployment rate – capture basic economic conditions in each state. Next, I include the share of state income devoted to higher education to ensure that the fractionalization coefficients are not confounded by states’ expenditures on, or, more generally, their commitments to higher education (based on calculations from Trostel and Ronca, 2009). Finally, despite lacking an obvious theoretical motivation, I include the share of each state’s population that is white as a basic demographic control.

Is this the best set of state-level control variables to include in the models? This question is difficult to answer, especially without strong priors about how states’ HE structures were formed. However, it also appears to be of little practical consequence for the analysis – in a robustness exercise in the next section, I show that the choice of which state-level control variables to include in the models generally does not affect my findings. Specifically, I show that the fractionalization estimates from the initial models are qualitatively insensitive to adding additional controls for economic climate, K-12 education funding and performance, and regional differences across states. Perhaps more telling is that the fractionalization estimates are also qualitatively similar even if I exclude *all state-level control variables* (this finding is consistent

¹² In unreported results, I also top-coded the ratio for each state without any enrollment at a university with more than 15,000 students at the observed maximum, allowing for the inclusion of these states in the models that use this definition of fractionalization. The results from this exercise are qualitatively similar to the results shown in the text.

with the analysis in Section III). Even if there are some qualms about which set of state-level control variables is best, it seems unlikely that a significant biasing variable exists that is not correlated with any of the fundamental state-level characteristics that I consider in the initial and sensitivity models.

The findings from the initial models are reported in Tables 4, 5 and 6. The tables report “effect sizes” that correspond to the fractionalization coefficients. The effect sizes are calculated by multiplying the fractionalization coefficients by the across-state standard deviation in the relevant measure of HE fractionalization (from Table 3). For brevity, the coefficients for the control variables in the models are suppressed in each table, but again, these controls are important predictors of outcomes and strengthen inference from the models. Selected estimates for the control-variable coefficients are reported in the appendix.

Table 4 shows results for the first two outcomes together: *university attendance* and *degree completion*, both at any four-year university. The table shows that degree completion is positively correlated with fractionalization, and there is suggestive evidence of a positive relationship between HE structure and university attendance. The results using the 10,000-student enrollment threshold indicate that a one-standard deviation increase in HE fractionalization is associated with a 1.8 percentage-point increase in degree attainment. If the attendance effect is taken at face value, fractionalization corresponds to a 1.1 percentage-point increase in university attendance.¹³ The fact that the degree-attainment estimates are bigger than the attendance estimates suggests that fractionalization affects graduation rates for some individuals who are not on the attendance margin. It may be that the reduced commuting costs associated with fractionalization affect college continuance, or that smaller universities are better at seeing students through to graduation.

¹³ While Table 4 is suggestive of an association between private-university fractionalization and attendance, it is unclear how to interpret this result. Unlike public universities, private universities can “shop” across states. Larger and more prestigious private universities may endogenously locate in states where more individuals are inclined to attend a private university – this would imply less private fractionalization in these states (by the definition used here), and these states may also have populations with stronger preferences for university attendance in general. Recall that private and public fractionalization are not highly correlated within states, suggesting that the two sectors are fairly unresponsive to each other along the dimension of structure.

Next I consider *degree attainment from a private university* and *degree attainment from an out-of-state public university*. I also treat these outcomes as synonymous, which may be most relevant because in both cases individuals exit their in-state public systems. Table 5 shows that fractionalization is associated with increased system exits. The results using the 10,000-student enrollment threshold indicate that a one-standard deviation increase in HE fractionalization is associated with a 1.3 percentage-point increase in degree attainment from outside universities. One explanation for this finding is that individuals on the margin between attending an in-system or out-of-system university perceive public universities in more-fractionalized systems to be of lower quality.¹⁴

Overall, roughly a quarter of the individuals in the data who graduated from an in-state public university lived in a different state by the time of the year-2000 NELS:88 survey.¹⁵ However, among individuals who obtained degrees from out-of-system schools (either private or out-of-state public), nearly twice as many lived in a different state by the year 2000. Further restricting the sample to individuals who obtained degrees exclusively from out-of-state universities, either public or private, over 60 percent changed states. Consistent with Table 5, when mover-status is formally modeled, fractionalization is associated with an increase in state-level out-migration, with individuals who graduated from out-of-system universities being the most likely to have moved. Because these individuals tend to be high wage earners, this association in the data may have important implications for labor-force quality within states.

Finally, in Table 6 I consider the mechanical relationship between HE structure and *degree attainment from small and large public universities*. As expected, a more-fractionalized HE structure is associated with increased degree attainment at small public universities and decreased degree attainment at large public universities. Using the fractionalization measure

¹⁴ This result moves counter to what would be expected from the distance mechanism alone. The distance mechanism should be less important for individuals on the public-private margin if the benefits to university quality are sufficiently large such that the returns to a proper university match outweigh any cost savings associated with university distance.

¹⁵ This mover share seems reasonable in relation to mobility estimates from the larger population (Pew Research Center, 2008).

based on the 10,000-student enrollment threshold, a one-standard deviation increase in fractionalization corresponds to a 2.2 percentage-point increase in degree attainment at small public universities, and a 3.1 percentage-point decrease in degree attainment at large public universities. Movement along the university-size margin may be important because the human-capital production process differs across large and small universities. Significant differences across states in their enrollment shares at large and small universities could have implications for statewide human capital accumulations, but more research is needed to determine the importance of this implication of HE structure.

In summary, Tables 4, 5 and 6 show that more-fractionalized HE structures are associated with increased degree attainment (and likely increased attendance as well), increased out-of-system university attendance, and a shift from attendance at large public universities to attendance at small public universities.

VII. Robustness

In this section I consider some of the more likely sources of bias in the above-reported findings. First, one concern is that individuals (or their parents) may make state-of-residence decisions based on HE structure, in which case the HE structures to which they are exposed will be endogenous. I test for this possibility by dividing individuals into bins based on their conditional probabilities of college graduation, and then estimating the variance of HE fractionalization within bins (using the 10,000-student enrollment threshold to measure fractionalization). I estimate individuals' graduation probabilities using a probit where the dependent variable is degree attainment from any four-year university and the independent variables include the individual-level controls from the base-year NELS:88 data. If the variance of HE fractionalization is not roughly constant across the bins, this would suggest endogenous sorting. For example, if individuals with the highest graduation probabilities gravitate toward states with certain HE structures, the variance of HE structure should be smaller in the highest bin relative to the other bins. I divide the sample into five bins based on the fitted values from the

probit. The variance of HE structure by bin is virtually constant, providing no evidence of endogenous sorting.¹⁶

A second concern, returning to the findings from Section II, involves the persistence of HE structure within states. Specifically, because HE structure does not change over time, the estimates in Section VI may be confounded with other time-invariant state policies and/or economic conditions. One way to indirectly gauge the extent to which HE structure is correlated with state-level unobservables is to evaluate its heterogeneity across *regions* of the United States. If state-level confounding variables are correlated with HE structure, and these variables are themselves correlated within regions, we might expect the between-region variance in HE structure to be large. As a specific example, if unobserved regional attributes of southern states correlate with a certain type of HE structure, we would find similar HE structures in southern states that are different from the structures found outside of the south. I use the four regional divisions of the United States as defined by the US Census to decompose the variance of HE fractionalization into its within- and between-region components. The within-region variance of HE structure accounts for approximately 90 percent of the total across-state variance, suggesting that the majority of the variation in HE structure is unrelated to states' region-specific attributes (also see Figure 2).

Although the regional variance decomposition is suggestive, the most straightforward way to evaluate the extent to which confounding variables are biasing the results is to perform a series of robustness checks that incorporate some of the most likely sources of bias. Table 7 reports robustness results for each educational-outcome model. For brevity, the table shows estimates only from models where fractionalization is measured using the 10,000- and 15,000-student enrollment thresholds.

¹⁶ The results from this analysis are available upon request. I also considered linking each individual to a HE structure based on state-of-residence in grade-8 instead of grade-12. This does not affect my findings - less than five percent of the sample moved across state lines between grade-8 and grade-12, and correspondingly, the correlation in individuals' assigned HE structures between grade-8 and grade-12 exceeds 0.95 using all definitions.

The first row in each panel of Table 7 shows the estimates from the baseline model in the previous section for comparison. The remaining rows report estimates from alternative specifications. First, I add additional information about economic climate and population to the models. I control for total population, population density, median house prices, and occupation shares.¹⁷ The population, population-density and median-house-price data are from the US Census. The occupation-share data are from the Bureau of Labor Statistics (BLS). While the estimates in several of the models get smaller when I add these additional controls, all of the estimates are qualitatively consistent with those from the baseline specification.

The next row in each panel examines the extent to which state-level conditions in K-12 education might confound the results. I include controls for state-level spending per pupil on K-12 education and the secondary-school graduation rate, both obtained from the NCES. There is no evidence that the omission of these controls in the baseline models introduces any bias.

Next I add a control for state-level research and development (R&D) expenditures at public universities, also obtained from the NCES. Perhaps not surprisingly, R&D expenditures are negatively correlated with fractionalization, but they are not driving the results.

I then consider the extent to which regional differences across the United States might explain the findings, despite the limited across-region variability in HE structure. I take two different approaches. First, I add regional indicators for the four regional divisions of the United States to the baseline specification. The inclusion of these variables means that the across-region variation in HE fractionalization is no longer used to identify the fractionalization effects. Second, I return to the baseline model and omit observations from the Northeast region. States in the northeast differ to some extent from those in the rest of the country with regard to the formation of their HE systems (among other things, there is a much larger and more-mature private sector in this region— see Goldin and Katz (1999) for more information). Despite the additional strain put on the data by further reducing the identifying variation in both of these

¹⁷ In unreported results I also considered using birth-cohort size in place of the state population control as in Bound and Turner (2007). This did not qualitatively affect the findings.

models, the estimates are still generally consistent with the findings from the other models (with the exception of the model for university attendance, where the estimates change sign but are small relative to their standard errors).

Finally, the last row in each panel shows estimates from a model that excludes all state-level control variables. The findings are qualitatively similar to the models with the various state-level controls in most cases. Even if there is some disagreement about which set of state-level controls is best, it stands to reason that if state-level factors were biasing the findings, some of the controls that I consider in Table 7 would affect the estimates in a meaningful way. Of particular interest is the similarity of the results in the out-of-system-degree model – there, the state-level controls are important predictors of outcomes even conditional on the individual-level controls (see appendix), but when they are omitted there is no suggestion of bias in the estimates.

Overall, the findings from the previous section are generally robust to the more-detailed models in Table 7, and equally importantly, to the model that excludes all state-level controls. The key findings from this analysis do not appear to be driven by bias from any obvious source.

VIII. Conclusion

This paper documents substantial variation in HE structure across states and highlights several empirical associations between HE structure and individuals' higher-education outcomes. More-fractionalized HE structures are associated with increased degree attainment (there is also suggestive evidence of a positive relationship with university attendance), a shift from in-system to out-of-system university attendance, and mechanically, an increase in degree attainment at small public universities and a decrease in degree attainment at large public universities. This information should be of interest to state policymakers in the United States and other developed nations, and also to policymakers in regions of the world where higher-education systems are in the process of being formed. Finally, given the large scope of state policy in this regard, work that identifies the potential consequences of the relationships identified here should continue to be pursued. One question that immediately comes from this work is whether small or large universities are more effective at producing human capital.

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Figure 1. University counts plotted against statewide populations (in millions), 1990.

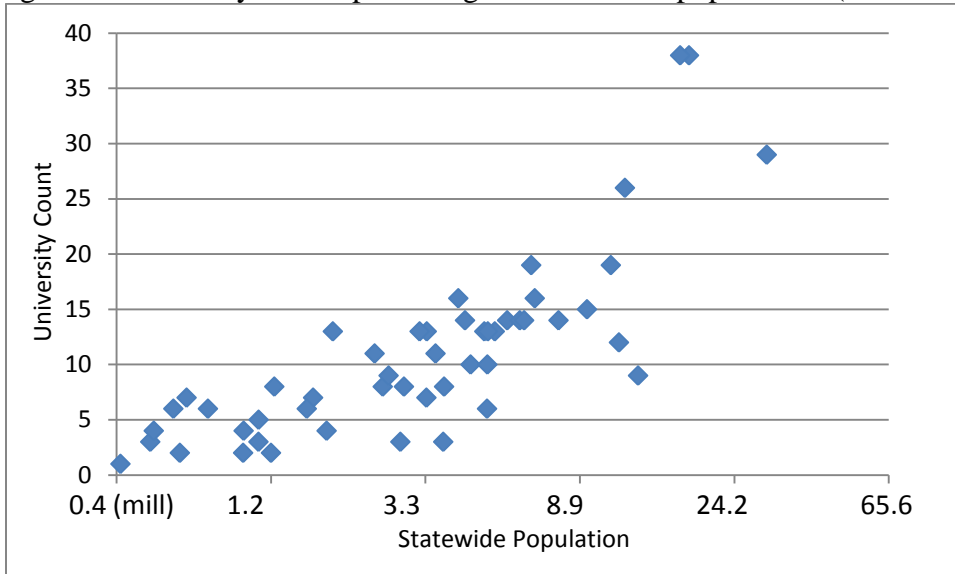


Figure 2. Shares of statewide public-university attendees enrolled at universities with 10,000 or more students, based on enrollment data from 1990. States ordered by total population in 1990.

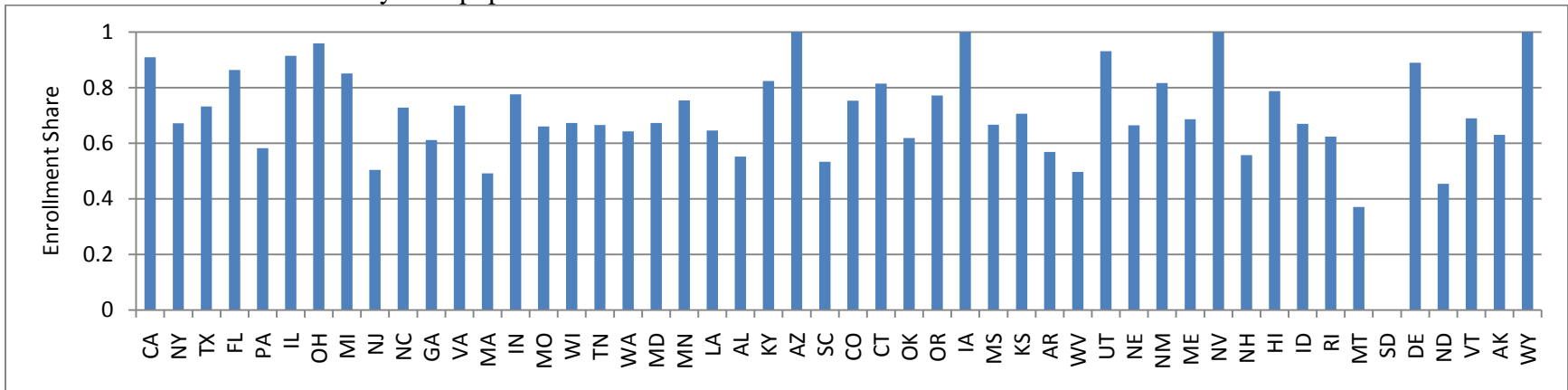


Table 1. Correlations of HE structures within states over time

University Counts				
	1950	1970	1980	1990
1950	1.0			
1970	0.87	1.0		
1980	0.88	0.98	1.0	
1990	0.88	0.98	1.0	1.0

Universities Per Capita				
	1950	1970	1980	1990
1950	1.0			
1970	0.80	1.0		
1980	0.71	0.95	1.0	
1990	0.66	0.87	0.96	1.0

Table 2. Summary Statistics for Final Data Sample and Original NELS:88 Baseline Survey.

	Sample Means Final Micro Sample	Sample Means Grade-8 Survey
<u>Basic Demographics</u>		
Asian	0.04	0.03
Black	0.11	0.13
Hispanic	0.10	0.10
White	0.71	0.68
Female	0.51	0.50
<u>Family Income (base-year survey)</u>		
< 10,000	0.09	0.11
10,001 – 20,000	0.15	0.15
20,001 – 35,000	0.26	0.26
35,001 – 50,000	0.20	0.18
50,001 – 75,000	0.14	0.13
75,001 – 100,000	0.03	0.03
100,001 – 200,000	0.03	0.02
> 200,000	0.01	0.01
Unknown	0.08	0.11
<u>Four-Year University Outcomes</u>		
Attendance	0.54	
Bachelor's attained	0.32	
Bachelor's from private	0.12	
Bachelor's from public out-of-state	0.04	
Bachelor's from public in-state	0.16	
Bachelor's from small public in-state (<10,000)	0.04	
Bachelor's from large public in-state (>10,000)	0.12	
N	10920	24599

Table 3. Descriptive statistics across states for the fractionalization measures.

	<u>Public</u>				10/15 Ratio	<u>Private</u>
	Share 8,000 or less	Share 10,000 or less	Share 12,000 or less	Share 15,000 or less		Share 10,000 or less
Mean	0.22	0.30	0.39	0.51	0.57	0.89
St Dev	0.14	0.18	0.24	0.29	0.49	0.18
Min	0	0	0	0	0	0.07
Max	0.50	1	1	1	2.15	1
N	50	50	50	50	41	50

Table 4. Dependent Variables: Four-Year University Attendance (top); Any Bachelor’s Degree Attainment (bottom)

	<i>Fractionalization Measures (Enrollment Thresholds)</i>					Include private fractionalization:
	8,000	10,000	12,000	15,000	10/15 Ratio	10,000
<u>Four-Year University Attendance</u>						
Fractionalization (public)	0.022 (0.096)	0.064 (0.083)	0.081 (0.058)	0.069 (0.043)	0.013 (0.023)	0.086 (0.069)
Fractionalization (private)						-0.204 (0.074)**
Implied Effect size	0.003	0.011	0.019	0.020	0.006	
<u>Any Bachelor’s Degree Attainment</u>						
Fractionalization (public)	0.048 (0.083)	0.102 (0.070)	0.099 (0.051)†	0.072 (0.035)*	0.034 (0.018)†	0.106 (0.067)
Fractionalization (private)						-0.035 (0.082)
Implied effect size	0.007	0.018	0.024	0.021	0.017	
N	10920	10920	10920	10920	10388	10920

** Denotes statistical significance at the 1 percent level

* Denotes Statistical significance at the 5 percent level

† Denotes Statistical significance at the 10 percent level

Notes: Standard errors are clustered at the state level. Recall from the text that the “implied effect size” multiplies the fractionalization point estimate by the standard deviation of the fractionalization measure across states. See appendix for list of control variables used in each model.

Table 5. Dependent Variables: Private-University Degree Attainment (top); Out-of-State Public University Degree Attainment (middle); Combined Exits from In-State Public System (bottom)

	<i>Fractionalization Measures (Enrollment Thresholds)</i>					Include private fractionalization:
	8,000	10,000	12,000	15,000	10/15 Ratio	10,000
<u>Private-University Degree Attainment</u>						
Fractionalization (public)	-0.010 (0.036)	0.040 (0.030)	0.032 (0.023)	0.034 (0.015)*	0.007 (0.008)	0.079 (0.042)†
Fractionalization (private)						-0.054 (0.041)
Implied Effect size	-0.001	0.007	0.008	0.010	0.003	
<u>Out-of-State Public Degree Attainment^a</u>						
Fractionalization (public)	0.020 (0.015)	0.014 (0.013)	0.013 (0.010)	0.020 (0.006)**	0.005 (0.003)	0.015 (0.013)
Fractionalization (private)						-0.006 (0.010)
Implied effect size	0.003	0.002	0.003	0.006	0.002	
<u>Combined Exits from In-State System</u>						
Fractionalization (public)	0.030 (0.050)	0.072 (0.046)	0.061 (0.032)†	0.076 (0.019)**	0.018 (0.011)†	0.044 (0.027)
Fractionalization (private)						-0.040 (0.028)
Implied effect size	0.004	0.013	0.015	0.022	0.009	
N	10920	10920	10920	10920	10388	10920

** Denotes statistical significance at the 1 percent level

* Denotes Statistical significance at the 5 percent level

† Denotes Statistical significance at the 10 percent level

^a One variable perfectly predicts failure in this model (indicator for unknown siblings). Consequently, observations where this variable is equal to one are dropped. The sample size is reduced from 10920 to 10864.

Notes: Standard errors are clustered at the state level. Recall from the text that the “implied effect size” multiplies the fractionalization point estimate by the standard deviation of the fractionalization measure across states. In the third horizontal panel, private-university degree attainment and out-of-state public university degree attainment outcomes are treated to be the same (i.e., exits from the in-state public system). See appendix for list of control variables used in each model.

Table 6. Dependent Variables: Small-Public-University Degree Attainment (top); Large-Public-University Degree Attainment (bottom)

	<i>Fractionalization Measures (Enrollment Thresholds)</i>					Include private fractionalization: 10,000
	8,000	10,000	12,000	15,000	10/15 Ratio	
<u>Small Public Univ Degree Attainment^a</u>						
Fractionalization (public)	0.109 (0.015)**	0.123 (0.019)**	0.122 (0.019)**	0.088 (0.018)**	0.026 (0.008)**	0.117 (0.020)**
Fractionalization (private)						0.036 (0.021)†
Implied effect size	0.015	0.022	0.029	0.026	0.013	
<u>Large Public Univ Degree Attainment</u>						
Fractionalization (public)	-0.172 (0.033)**	-0.170 (0.030)**	-0.157 (0.024)**	-0.146 (0.021)**	-0.048 (0.011)**	-0.170 (0.029)**
Fractionalization (private)						-0.003 (0.036)
Implied effect size	0.025	0.031	0.038	0.043	0.024	
N	10920	10920	10920	10920	10388	10920

** Denotes statistical significance at the 1 percent level

* Denotes Statistical significance at the 5 percent level

† Denotes Statistical significance at the 10 percent level

^a Two indicator variables perfectly predict failure in this model (father's education is unknown, race is unknown). Consequently, observations where either of these variables is equal to one are dropped. The sample size is reduced from 10920 to 10738.

Notes: The "small-university" and "large-university" definitions for the dependent variables in each model correspond to the fractionalization enrollment thresholds where possible. For example, in column (1), a degree is designated as being from a "small university" if it is from a university with an enrollment below 8,000 students in 1990, and similarly for column (2) with the 10,000 cutoff, and so on. For the models that use the 10/15 enrollment ratio to measure fractionalization, the enrollment threshold used to distinguish university size is 10,000 students. All standard errors are clustered at the state level. Recall from the text that the "implied effect size" multiplies the fractionalization point estimate by the standard deviation of the fractionalization measure across states. See appendix for list of control variables used in each model.

Table 7. Robustness results.

	<u>Any</u> <u>Attendance</u>	<u>Any Degree</u>	<u>Out-of-System</u> <u>Degree</u>	<u>Small-Public</u> <u>Degree^a</u>	<u>Large-Public</u> <u>Degree</u>
<i>Robustness results using 10,000-student enrollment threshold</i>					
Baseline Model (from previous section)	0.064 (0.083)	0.102 (0.070)	0.072 (0.046)	0.123 (0.019)**	-0.170 (0.030)**
Add Density, Total Pop, House Prices and Occ. Shares	0.024 (0.093)	0.048 (0.064)	0.053 (0.053)	0.135 (0.019)**	-0.174 (0.029)**
Add K-12 Education Controls	0.035 (0.091)	0.084 (0.074)	0.064 (0.050)	0.129 (0.017)**	-0.177 (0.028)**
Add (Public) Academic R&D Expenditures	0.062 (0.084)	0.095 (0.070)	0.063 (0.044)	0.125 (0.018)**	-0.170 (0.030)**
Include Census Division Indicators (Primary Model)	-0.036 (0.109)	0.079 (0.070)	0.024 (0.048)	0.128 (0.021)**	-0.134 (0.044)**
Exclude Northeast Region of the United States ^b	-0.033 (0.121)	0.043 (0.079)	0.012 (0.050)	0.139 (0.020)**	-0.162 (0.048)
Exclude all State Controls	0.131 (0.080)†	0.118 (0.062)†	0.082 (0.043)†	0.126 (0.021)**	-0.147 (0.033)**
<i>Robustness results using 15,000-student enrollment threshold</i>					
Baseline Model (from previous section)	0.069 (0.043)	0.072 (0.035)*	0.076 (0.019)**	0.088 (0.018)**	-0.146 (0.021)**
Add Density, Total Pop, House Prices and Occ. Shares	0.071 (0.050)	0.054 (0.032)	0.072 (0.025)**	0.096 (0.017)**	-0.152 (0.015)**
Add K-12 Education Controls	0.051 (0.046)	0.060 (0.035)†	0.072 (0.019)**	0.093 (0.018)**	-0.146 (0.025)**
Add (Public) Academic R&D Expenditures	0.068 (0.044)	0.059 (0.038)	0.061 (0.018)**	0.101 (0.016)**	-0.148 (0.023)**
Include Census Division Indicators (Primary Model)	-0.019 (0.051)	0.060 (0.040)	0.060 (0.025)*	0.094 (0.019)**	-0.147 (0.026)**
Exclude Northeast Region of the United States ^b	-0.002 (0.052)	0.043 (0.044)	0.057 (0.024)*	0.108 (0.020)**	-0.172 (0.031)**
Exclude all State Controls	0.106 (0.047)*	0.105 (0.034)*	0.063 (0.025)**	0.092 (0.017)**	-0.144 (0.021)**
N	10920	10920	10920	10738	10920

** Denotes statistical significance at the 1 percent level * Denotes Statistical significance at the 5 percent level † Denotes Statistical significance at the 10 percent level

^a Two variables perfectly predict failure in this model (father's education is unknown, race is unknown). Consequently, observations where either of these variables is equal to one are dropped.

^b The sample size is smaller in these models. For columns 1,2,3 and 5, the sample size is 8832; for column 4 the sample size is 8690.

Notes: All standard errors are clustered at the state level. The northeast region is defined by the first regional division in the US Census, and includes ME, NH, VT, MA, RI, CT. The sample size applies to all robustness checks except for the "Omit Northeast Region" models, where the sample size is 10,460. See appendix for list of control variables used in each model in addition to those noted in column (1).

Appendix

This appendix reports coefficients for the control variables used in the models described in the text. Marginal effects are reported at the average of the controls variables. Estimates are reported from models using the fractionalization measure based on the 10,000-student enrollment threshold. The control-variable marginal effects are similar across the models that use the different fractionalization measures.

Appendix Table A.1. Marginal effects for the control variables in each model (using fractionalization measure based on the 10,000-student enrollment threshold).

	Any Attendance	Any Degree	Out-of-System Degree	Small-Public- University Degree ^a	Large-Public- University Degree
Share of public enrollment at universities with 10,000 students or less	0.064 (0.083)	0.102 (0.070)	0.072 (0.046)†	0.123 (0.019)**	-0.170 (0.030)**
<u>State Controls</u>					
Percent white	-0.001 (0.186)	0.016 (0.101)	-0.019 (0.077)	0.046 (0.027)†	-0.043 (0.054)
HE spending share ^b	-0.634 (0.281)*	-0.374 (0.198)†	-0.345 (0.143)*	0.022 (0.050)	0.020 (0.091)
Median household income (log)	-0.149 (0.099)	0.067 (0.052)	0.181 (0.029)**	-0.027 (0.020)	-0.131 (0.029)**
Unemployment Rate	-0.003 (0.010)	-0.002 (0.007)	0.001 (0.006)	0.002 (0.003)	-0.007 (0.003)**
<u>Individual Controls</u>					
English as second language	0.112 (0.045)*	0.062 (0.028)*	0.076 (0.011)**	0.006 (0.010)	0.024 (0.017)
One sibling	-0.124 (0.072)†	-0.007 (0.033)	0.001 (0.021)	0.004 (0.006)	-0.012 (0.015)
Two siblings	-0.159 (0.082)†	-0.012 (0.034)	0.002 (0.021)	0.007 (0.010)	-0.017 (0.015)
Three or more siblings	-0.232 (0.080)**	-0.097 (0.034)**	-0.023 (0.018)	-0.005 (0.007)	-0.038 (0.015)*
Siblings unknown	-0.216 (0.163)	-0.089 (0.054)†	-0.021 (0.040)	-0.018 (0.006)	-0.026 (0.028)
Father educ: high school	0.025 (0.048)	0.067 (0.024)**	0.028 (0.014)*	0.009 (0.012)	0.038 (0.014)**
Father's educ: some college	0.125 (0.056)*	0.162 (0.026)**	0.092 (0.020)**	0.014 (0.012)	0.060 (0.015)**
Father's educ: college	0.228 (0.043)**	0.199 (0.037)**	0.114 (0.022)**	0.016 (0.010)	0.064 (0.024)**
Father's educ: grad school	0.253 (0.044)**	0.287 (0.039)**	0.151 (0.031)**	0.003 (0.011)	0.085 (0.031)**
Father's educ: unknown	0.087 (0.058)	0.094 (0.031)**	0.048 (0.028)†	0.025 (0.013)*	0.033 (0.018)†
Father's educ: empty	0.010 (0.072)	-0.002 (0.078)	0.008 (0.054)	--	0.075 (0.051)
Mother's educ: high school	0.068 (0.042)	0.082 (0.024)**	0.036 (0.018)*	0.017 (0.010)†	0.025 (0.014)†
Mother's educ: some college	0.112 (0.037)**	0.113 (0.027)**	0.071 (0.023)**	0.016 (0.010)	0.026 (0.013)†
Mother's educ: college	0.135 (0.035)**	0.161 (0.025)**	0.111 (0.026)**	0.021 (0.015)	0.010 (0.018)

Mother's educ: grad school	0.180 (0.042)**	0.146 (0.033)**	0.089 (0.026)**	0.015 (0.012)	0.026 (0.023)
Mother's educ: unknown	0.066 (0.048)	0.150 (0.035)**	0.088 (0.023)**	-0.002 (0.007)	0.055 (0.022)*
Mother's educ: empty	0.108 (0.087)	0.401 (0.135)**	0.099 (0.075)	0.173 (0.123)	0.165 (0.113)
Family Income: < 10K	-0.388 (0.067)**	-0.218 (0.023)**	-0.086 (0.007)**	0.008 (0.014)	-0.054 (0.011)**
Family Income: 10K – 20K	-0.265 (0.087)**	-0.159 (0.035)**	-0.081 (0.010)**	0.058 (0.031)†	-0.026 (0.023)
Family Income: 20K – 35K	-0.281 (0.074)**	-0.184 (0.037)**	-0.078 (0.013)**	0.032 (0.016)*	-0.035 (0.018)†
Family Income: 35K – 50K	-0.258 (0.080)**	-0.128 (0.041)**	-0.064 (0.015)**	0.048 (0.021)*	-0.009 (0.022)
Family Income: 50K – 75K	-0.088 (0.086)	-0.072 (0.045)	-0.040 (0.013)**	0.038 (0.018)*	0.002 (0.021)
Family Income: 75K – 100K	0.052 (0.090)	-0.050 (0.054)	-0.030 (0.019)	0.016 (0.018)	0.007 (0.026)
Family Income: > 200K	0.225 (0.089)**	0.221 (0.085)**	0.010 (0.036)	0.068 (0.045)	0.014 (0.031)
Family Income: Unknown	-0.229 (0.083)**	-0.113 (0.035)**	-0.041 (0.014)**	0.068 (0.030)*	-0.039 (0.017)*
Composite standardized test score	0.015 (0.001)**	0.008 (0.001)**	0.003 (0.001)**	0.000 (0.000)	0.002 (0.000)**
GPA	0.198 (0.016)**	0.220 (0.016)**	0.075 (0.008)**	0.018 (0.005)**	0.076 (0.005)**
Indicator for missing test score	-0.558 (0.021)**	-0.210 (0.014)**	-0.072 (0.009)**	-0.009 (0.016)	-0.050 (0.012)**
Asian	0.081 (0.046)†	0.031 (0.031)	-0.013 (0.015)	-0.008 (0.007)	0.038 (0.016)*
Hispanic	0.000 (0.037)	-0.037 (0.022)	0.003 (0.018)	-0.016 (0.006)*	-0.011 (0.009)
black	0.162 (0.037)**	0.018 (0.026)	0.019 (0.019)	0.002 (0.009)	-0.014 (0.015)
American Indian	-0.027 (0.067)	-0.084 (0.044)†	-0.040 (0.023)†	0.018 (0.025)	-0.066 (0.011)**
Race unknown	0.040 (0.090)	-0.091 (0.038)*	-0.020 (0.029)	--	-0.013 (0.037)
Female	-0.008 (0.014)	0.051 (0.017)**	0.011 (0.009)	0.008 (0.004)*	0.013 (0.007)†
Pseudo R-squared	0.29	0.32	0.27	0.12	0.16
Observations	10920	10920	10920	10738	10920

** Denotes statistical significance at the 1 percent level or better

* Denotes Statistical significance at the 5 percent level

† Denotes Statistical significance at the 10 percent level

^a Two indicator variables perfectly predict failure in this model (father's education is unknown, race is unknown). Consequently, observations where either of these variables is equal to one are dropped.

^bThis measure is taken from Trostel and Ronca (2009).

Notes: Standard errors are clustered at the state level. Omitted controls are: English is first language, Mother and Father education < HS, Family Income between 100K and 200K, race is white, gender is male, individual is an only child.