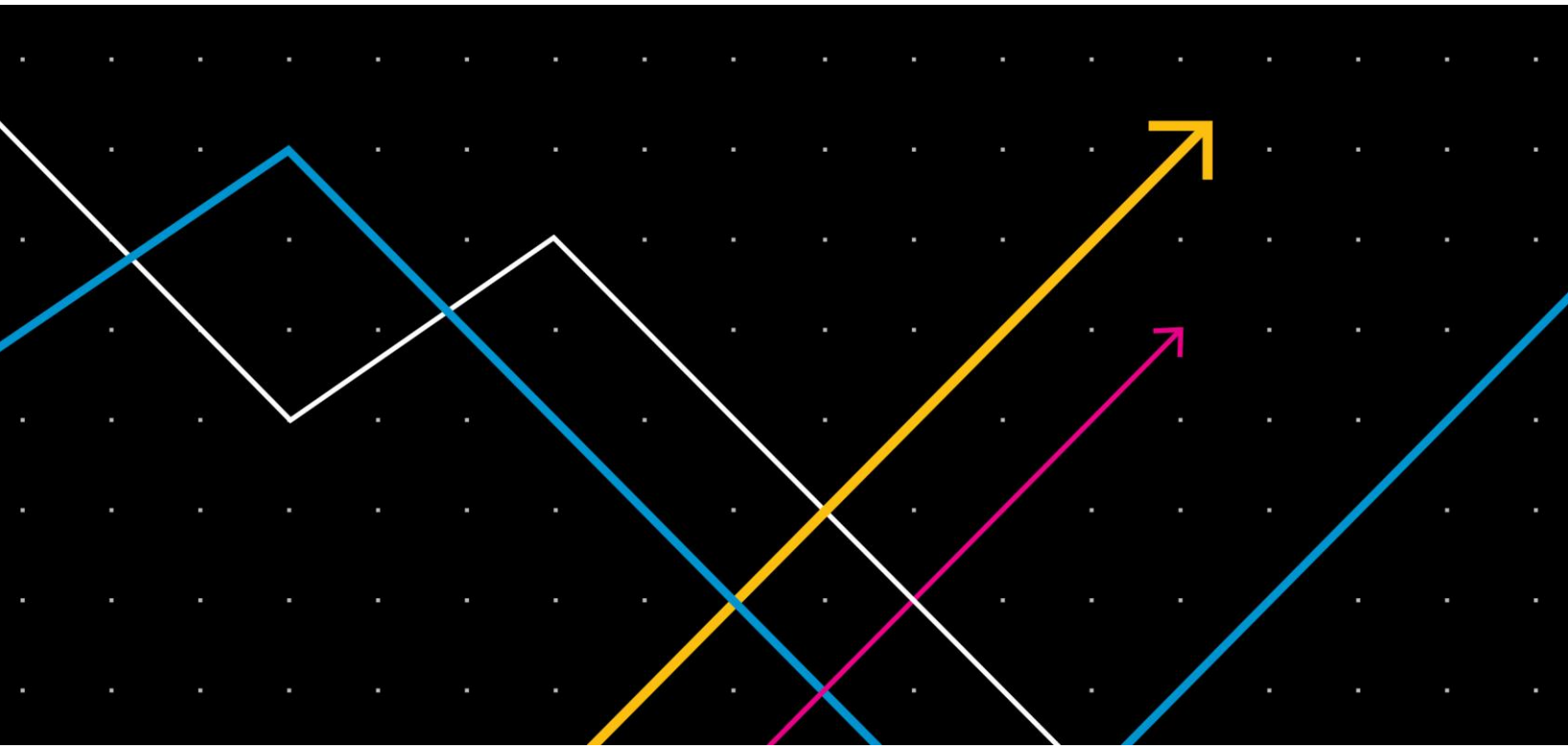

RESEARCH REPORT

Comparing Colleges' Graduation Rates

The Importance of Adjusting for Student Characteristics

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Executive Summary

Policymakers are increasingly using data to understand how well their colleges and universities serve students by examining such outcomes as graduation rates and earnings in the labor market. States and the federal government have relied on advances in administrative data systems to publish institution- and program-level data on student outcomes, but these measures reflect both the characteristics of students as well as the quality of the institutions they attend.

In this report, we harness longitudinal data systems in Connecticut and Virginia to demonstrate how student-level data can be used to measure graduation rates that compare each institution's students with demographically similar students around the state.

We find that student demographics and academic preparation explain a considerable amount of the differences in six-year graduation rates between institutions. At four-year colleges, the adjustments substantially reduce the distribution of graduation rates by as much as 20 percentage points and alter how institutions rank. Differences in academic preparation, rather than demographics, account for most of these adjustments.

At two-year colleges, we find that the overall adjustments are smaller and that race or ethnicity and family income play a larger role than academic preparation. This likely reflects the fact that community colleges primarily enroll students from the surrounding area, whereas four-year colleges vary in their selectivity as they admit students from around the state.

These results mean state policymakers should look beyond commonly used unadjusted metrics when they want to assess institutional quality. This is especially true when outcomes vary significantly across subgroups or when student characteristics vary significantly across colleges.

Finally, we show that these adjustments cannot be approximated by using only publicly available institution-level data. State policymakers should consider developing and maintaining student-level data systems so these more robust measures can be calculated, allowing them to assess which institutions are best serving their students rather than simply enrolling students who are likely to graduate from any institution.

Adjusted Graduation Rates

Data availability on student outcomes in higher education has significantly increased in recent years. At the national level, the US Department of Education now reports graduation rates for part-time and transfer students after decades of only tracking completion for first-time, full-time students. But graduation rates can conflate institutional quality with student characteristics. For example, selective colleges that admit only students with strong academic preparation are likely to have better outcomes than open-access colleges, regardless of the quality of instruction they provide. As a result, a focus on such seemingly straightforward measures as graduation rates is likely to give misleading impressions to policymakers and others concerned with improving higher education outcomes.

An alternative to raw performance measures is to develop "value-added" or "adjusted" measures that provide a more nuanced view of an institution's performance by taking into account student characteristics (e.g., demographics and academic preparation). These adjusted measures can be useful to state policymakers as they attempt to determine the relative efficacy of their state's higher education institutions. If adjusted measures alter the rankings, relative to raw measures, that could affect conclusions about how certain institutions or programs are performing or how to allocate resources across institutions.

Researchers have long recognized value-added measures as a way to compare institutional performance in a way that takes student characteristics into account (Bowen, Chingos, and McPherson 2009; Totty 2019). But these measures are most useful if they are based on student-level data that track individual students. Such databases have become available in a growing number of states over the past decade,[1] increasing the possibility that such measures can be more widely used.

But for value-added measures to be useful, state policymakers must be able to understand how they work (their advantages and disadvantages). Using detailed individual-level data from Virginia and Connecticut on graduation rates, this brief demonstrates how adjusted graduation rates can be calculated and whether and how much they matter. Below, we show how graduation rates and time-to-degree measures are affected by adjustments for both four-year institutions and two-year institutions. In appendix A, we explain why these adjusted measures cannot be calculated with the same degree of accuracy using institution-level data.

Developing Adjusted Measures

In discussions with policymakers regarding institutional performance metrics, a common refrain is that "we have the students we have." In other words, comparing a highly selective institution such as the University of Virginia with a less selective one such as Virginia State University is misleading at best and unfair at worst. As such, we have developed measures that attempt to show how well Institution X is performing, given the students it has. Our adjustment corrects for observed differences in student characteristics between institutions caused by sorting (on the part of students) or selection (on the part of institutions). We cannot fully account for all sorting and selection, as much of this is caused by unmeasured factors (e.g., motivation) and factors that are observable to admissions officers but generally not captured in data available to researchers (e.g., teacher recommendations and admissions essays).[2]

Value-added measures of college quality are not new. Hoxby (2015) uses quasi randomization by admissions staff and students to address selection based on academic background and geography or family background. At community colleges, Horn, Horner, and Lee (2019) argue that value-added measures are important to consider alongside raw performance metrics, providing a more nuanced interpretation of what might otherwise appear to be lackluster performance. Value-added measures may also predict student outcomes more accurately than conventional rankings or provide a point of comparison for community colleges or nonselective institutions that have been omitted from previous rankings altogether (Rothwell and Kulkarni 2015).

Although not a focus of our work here, value-added measures are also relevant in understanding what *institutional* characteristics, rather than student characteristics, are conducive to student success. Using earnings data from the College Scorecard to rank colleges, Rothwell (2019) finds that graduates of colleges with certain qualities—including curricula oriented around well-paid fields, higher completion rates, and higher faculty salaries—enjoy higher earnings. Other research suggests institutions with cultures of equity and mentorship are particularly effective.[3] Smith and Stange (2015) use value-added models to demonstrate the role of high-performing peers and low transfer barriers in community college student achievement.

Model

Our value-added models are based on individual-level data. As we argue in appendix A, this is a superior approach to one using institution-level data. We use separate models for each state (Connecticut and

Virginia) and level of institution (two-year versus four-year), but they all take the following generic form:

$$Y_{ij} = a_j + X_{ij}B + e_{ij}$$

where Y_{ij} represents graduation for individual i at institution j. We estimate this model using ordinary least squares.

X_{ij} represents (some subset of) the following student characteristics: academic preparedness (e.g., high school GPA, SAT scores, standardized test scores), demographics (e.g., race or ethnicity, gender, age, Pell grant receipt, income variables), and intensity of study (e.g., full time versus part time) measured at entry,[4] with the exact set of covariates depending on the state and the level of institution (described below). Students missing any of these data (with the exception of income) are excluded from the model. B is a vector of coefficients.

The a_j are the institution "value-add" measures, which tell us the difference in the probability of graduating from any two given schools. We convert these into "adjusted" outcome measures by adding back in $X_{ij}B$ calculated for a "typical" student in the state. Thus, the adjusted outcome reflects the expected graduation rate for a student with average characteristics among all students in the model. By construction, the adjusted measures have the same mean as the raw measures. Below are the precise variables included in each model.

- **Four-year model, Virginia.** The model we use includes indicators for gender, race or ethnicity, Pell grant receipt, measures of income (log of family income, an indicator for missing income, a quadratic in family size, out-of-state status, and dependency status), whether the student graduated from high school in the past 12 months, a quadratic in SAT scores, and a quadratic in high school GPA (these last four are "academic factors"). We omit full-time versus part-time status, as most students are full time at the four-year colleges in our sample. We also omit variables that are available only in high school records, such as standardized test scores or high school attendance rates, because several four-year colleges in Virginia admit substantial numbers of out-of-state students who do not have high school records in our data.
- **Four-year model, Connecticut.** We use the same model as Virginia but omit income variables, whether the student graduated from high school in the past 12 months, and high school GPA, as these variables are unavailable in the Connecticut data.
- **Two-year model, Virginia.** We include gender, race or ethnicity, Pell grant receipt, family income, full-time versus part-time status, dependency status, high school attendance, and

quadratics in reading, writing, and geometry high school standardized test scores. The models are limited to students who attended high school in Virginia and include only associate's degrees or higher.

- **Two-year model, Connecticut.** We use the same model as Virginia but omit the income measures (as these variables are unavailable) and instead include free and reduced-price lunch status. The models are limited to students who attended high school in Connecticut.

Data

We use data from state longitudinal data systems that track students from the K–12 system, through college, and into the labor force. These data allow us to understand student pathways and success and help us develop nuanced institutional metrics. In particular, they allow us to link individual student outcomes with demographic characteristics and high school preparation.

In Virginia, we have data for all public and private nonprofit four-year colleges and for all public two-year colleges. In Connecticut, we have data for all public two- and four-year colleges and two private nonprofit four-year colleges. In our analyses, we use cohorts entering college in fall 2010, 2011, and 2012 for Connecticut two-year colleges; fall 2009, 2010, 2011, and 2012 for Connecticut four-year colleges; and fall 2009, 2010, 2011, and 2012 for Virginia two- and four-year colleges.

Four-Year Colleges

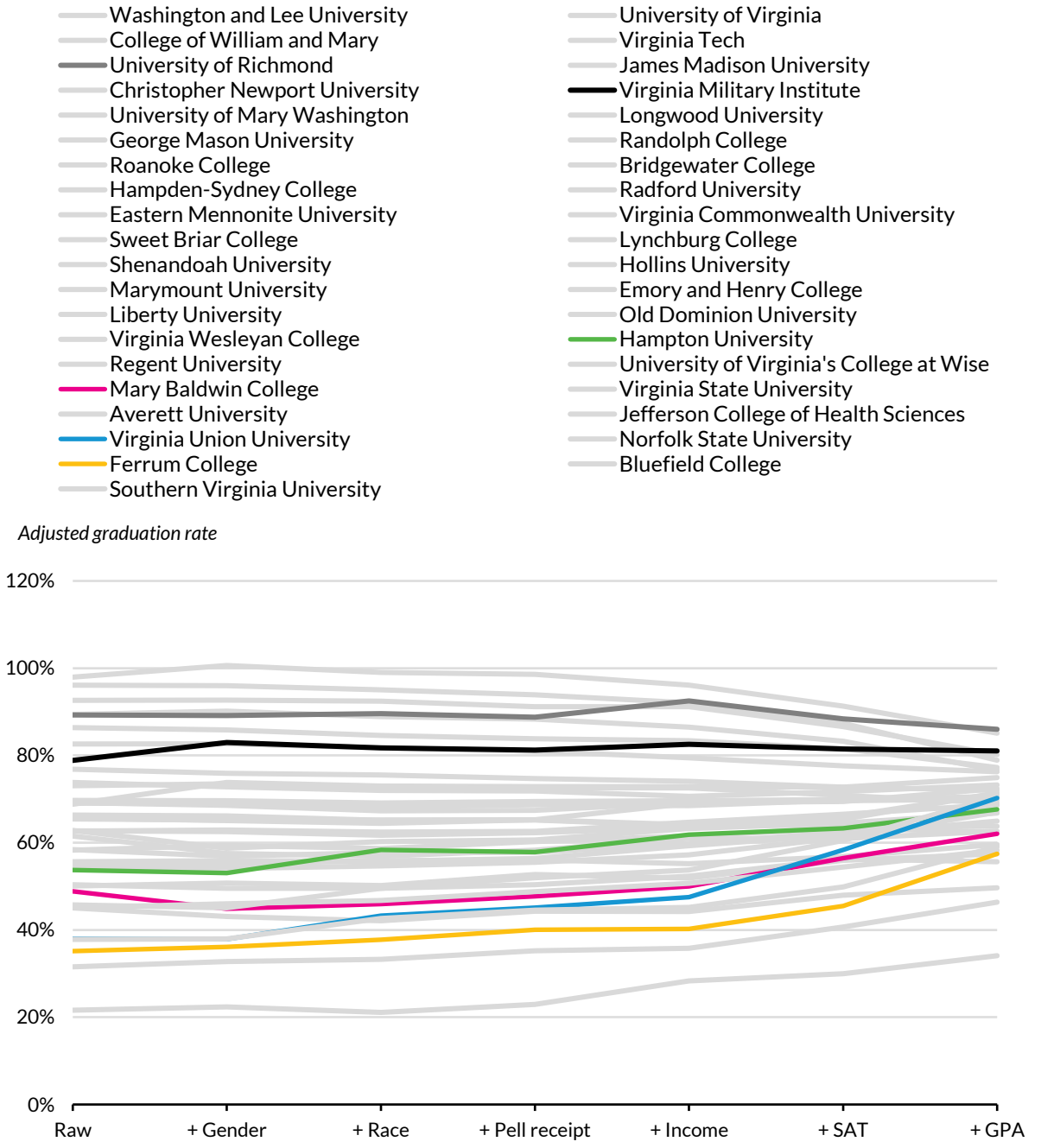
We begin our exploration of adjusted outcome measures using four-year college graduation rates in Virginia. Virginia has 39 public and private nonprofit colleges and universities with raw graduation rates ranging from just over 20 percent to nearly 100 percent. Using the model described above to adjust for gender, race or ethnicity, Pell grant receipt, income, and academic factors, we see this raw difference of over 70 percentage points shrink to about 50 percentage points.

These adjustments not only substantially compress the distribution of graduation rates, but, for several institutions, the rankings change considerably. Although the rankings of many schools at the top and bottom remain unchanged, nearly all the others change. The University of Richmond (the dark gray line in figure 1) rises from fifth to first, while Ferrum College (gold) rises from third lowest to sixth lowest. Some of the swings are more dramatic: Virginia State University rises from 32nd to 16th with a 24 percentage-point increase in its graduation rate, and Virginia Union University (blue) moves from 35th to 17th with a 32 percentage-point increase.

What drives these results? Figure 1 shows the cumulative impact of each factor as it enters the model, with the final adjusted graduation rates on the right. We first include only gender in the model, and then we add other characteristics until we arrive at our final adjusted measure, which includes all factors. Although graduation rate differences between institutions tend to shrink, not all factors adjust graduation rates in the same direction. Below, we discuss how and why these factors have the effects they do.

FIGURE 1

Six-Year Graduation Rates at Four-Year Colleges in Virginia



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Source: Analysis of Virginia Longitudinal Data System data.

Notes: GPA = grade point average. "Income" includes the logarithm of family income, an indicator for missing income, a quadratic in family size, dependency status, and an out-of-state flag. SAT scores include a flag for whether the student graduated from high school in the previous 12 months.

First, note that a graduation rate can be rewritten as a weighted average of graduation rates across different subgroups. For example, a college's graduation rate can be calculated as the female graduation rate times the share of students who are female, plus the male graduation rate times the share of students who are male. The adjusted graduation rate essentially reweights the graduation rates for each group by the average weights across the state to reflect the expected graduation rate for a "typical" student. If an institution has a large subgroup whose statewide average graduation rate is lower than for other subgroups, the adjusted graduation rate will tend to move upward (and vice versa). In other words, two things matter: the size of each subgroup at each institution and the statewide graduation rates for those subgroups. Table 1 describes the average characteristics of each college's students.

The role of race, ethnicity, and gender in the model is most obvious at colleges with demographics dramatically different from the average. For example, the black line in figure 1 above is the Virginia Military Institute, which is 90 percent male. Moreover, the statewide male graduation rate (66 percent) is substantially lower than the female rate (74 percent) (appendix table B.1). As a result, the Virginia Military Institute graduation rate is adjusted upward. We see a similar adjustment at Hampden-Sydney College, a men's college. Conversely, Mary Baldwin College (magenta) and Hollins University, both women's colleges, are adjusted downward.

This plays out similarly in colleges and universities that tend to serve mainly one racial or ethnic group. For example, Hampton University (green) and Virginia Union University, both historically black colleges or universities (HBCUs), are adjusted upward when race or ethnicity is included (appendix table B.2). To see why, observe that the statewide white graduation rate (75 percent) is higher than the statewide black graduation rate (53 percent). Hampton University is 97 percent black. The high share of black students combined with a statewide black college graduation rate that is lower than the white graduation rate results in an upward adjustment to Hampton University's graduation rate.

Pell grant receipt and the income variables do not dramatically adjust graduation rates, but this is partly because they are correlated with race. Nevertheless, this adjustment does affect some institutions. Hampton University is adjusted upward when income is included, as the average family income ($77,836) is below the state average of $99,680, and students from less wealthy families tend to graduate at lower rates than students from wealthier families.[5]

TABLE 1

Demographics and Academic Preparation by College

Four-year colleges, Virginia

	Graduation rate (%)	Female (%)	White (%)	Black (%)	Hispanic (%)	Asian (%)	Pell receipt (%)	Income ($)	Family size (people)	Out of state (%)	Graduated from high school last year (%)	SAT score	GPA	*N*
Averett College	45	40	59	33	4	1	54	66,336	3.7	44	100	941	3.2	421
Bluefield College	32	42	59	22	3	0	49	67,023	3.8	30	88	924	3.1	450
Bridgewater College	69	57	78	10	3	1	29	94,924	4.0	23	99	1027	3.4	2,022
Christopher Newport University	83	55	79	6	4	3	14	126,150	4.1	7	99	1155	3.6	3,728
College of William and Mary	93	55	58	8	9	8	10	150,935	4.1	30	95	1342	4.1	4,732
Eastern Mennonite University	66	61	74	9	8	2	34	58,023	4.1	47	92	1070	3.5	826
Emory and Henry College	58	44	79	11	2	1	42	81,091	3.8	42	99	1027	3.5	1,048
Ferrum College	35	44	47	40	5	0	58	62,702	3.7	19	97	892	2.8	1,667
George Mason University	73	51	55	8	8	16	23	102,009	4.1	24	90	1149	3.6	9,270
Hampden-Sydney University	69	0	81	9	2	1	20	125,956	4.0	26	100	1110	3.3	1,132
Hampton University	54	63	1	97	1	0	40	77,836	3.5	79	96	966	3.1	3,694
Hollins University	62	100	74	11	5	2	42	76,852	3.9	54	100	1097	3.5	678
James Madison University	86	61	80	4	4	5	13	131,405	4.1	24	100	1148	3.8	13,711
Jefferson College of Health Sciences	45	78	83	10	2	1	50	60,999	3.7	5	94	942	3.3	244

	Graduation rate (%)	Female (%)	White (%)	Black (%)	Hispanic (%)	Asian (%)	Pell receipt (%)	Income ($)	Family size (people)	Out of state (%)	Graduated from high school last year (%)	SAT score	GPA	*N*
Liberty University	56	53	64	8	4	2	31	104,235	4.3	65	87	1018	3.3	9,245
Longwood University	74	67	77	6	4	1	21	89,732	4.0	0	99	1030	3.4	3,745
Lynchburg College	63	58	79	10	4	1	30	94,871	4.0	38	100	1012	3.2	2,184
Mary Baldwin College	49	99	45	34	7	7	55	62,661	2.6	29	46	845	3.1	823
Marymount University	58	72	41	20	16	9	31	90,833	4.1	50	93	994	3.1	1,517
Norfolk State University	38	55	2	77	2	1	65	49,438	3.5	24	93	877	2.8	3,507
Old Dominion University	55	51	52	29	5	5	32	82,309	3.8	11	65	1025	3.3	10,059
Radford University	66	57	82	7	4	2	24	100,686	3.9	7	97	1003	3.2	7,058
Randolph College	70	55	74	13	4	3	28	107,999	3.7	31	98	1071	3.5	1,686
Regent University	50	59	65	15	8	1	36	72,484	4.2	41	0	1040	3.5	282
Roanoke College	69	60	86	4	4	1	24	115,159	4.0	54	100	1078	3.4	1,536
Shenandoah University	63	53	72	13	4	3	26	108,652	1.8	41	97	1012	3.3	1,570
Southern Virginia University	22	48	85	4	3	2	44	83,088	5.2	86	95	1048	3.3	754
Sweet Briar College	63	100	24	2	1	1	32	99,289	2.6	53	86	1052	3.4	642
University of Mary Washington	77	66	63	6	5	5	15	111,875	4.1	16	99	1143	3.6	358
University of Richmond	89	57	45	7	5	6	16	119,319	4.1	77	100	1275	3.8	2,188

	Graduation rate (%)	Female (%)	White (%)	Black (%)	Hispanic (%)	Asian (%)	Pell receipt (%)	Income ($)	Family size (people)	Out of state (%)	Graduated from high school last year (%)	SAT score	GPA	*N*
University of Virginia	96	56	61	7	5	17	12	123,514	4.1	0	98	1330	4.2	8,428
University of Virginia College at Wise	50	48	77	14	2	1	54	59,418	3.8	6	100	943	3.3	1,458
Virginia Commonwealth University	65	58	50	19	6	15	30	90,879	3.9	10	93	1082	3.5	13,096
Virginia Military Institute	79	10	84	6	4	5	15	121,015	4.2	44	100	1143	3.5	1,737
Virginia State University	46	63	1	68	2	0	69	45,204	3.5	38	45	857	2.8	4,828
Virginia Tech	89	47	73	4	5	11	16	116,699	4.1	0	98	1216	3.9	13,955
Virginia Union University	38	57	0	98	1	0	67	47,850	3.4	53	37	768	2.6	880
Virginia Wesleyan College	55	60	57	24	5	2	38	87,528	1.2	29	0	994	3.1	1,284
Washington and Lee University	98	35	94	4	0	2	12	178,165	4.5	0	100	1364	4.0	49
State average	70	55	60	17	5	7	27	99,680	3.9	24	90	1094	3.5	139,715

Source: Analysis of Virginia Longitudinal Data System data.

The largest factor by far, however, is academic preparation. This is consistent with a vast literature (Chingos 2018). In general, colleges with high raw graduation rates are adjusted downward by our academic preparation measures, while colleges with low raw graduation rates tend to be adjusted upward. This is because colleges vary in selectivity. The College of William and Mary, for example, tends to admit students from the top of the distribution of academic preparedness. These are students who are likely to graduate from any college, so the value-add is less than raw graduation rates might initially make it appear. At the same time, students in the middle quintile at William and Mary tend to graduate at a rate that is about 10 percentage points higher than the state average (appendix table B.3), suggesting either that these students have unmeasured characteristics that give them a high likelihood of graduating or that William and Mary truly is adding value for these students. Conversely, the lowest-performing college, Southern Virginia University, is adjusted upward (these students do better than we might expect, given their academic preparation).

In Connecticut (figure 2), we see a similar pattern, and we also see that academic factors are the greatest contributors to the adjustment. At the same time, the adjustments are more muted than in Virginia, and colleges' rankings do not change. Several factors are responsible.

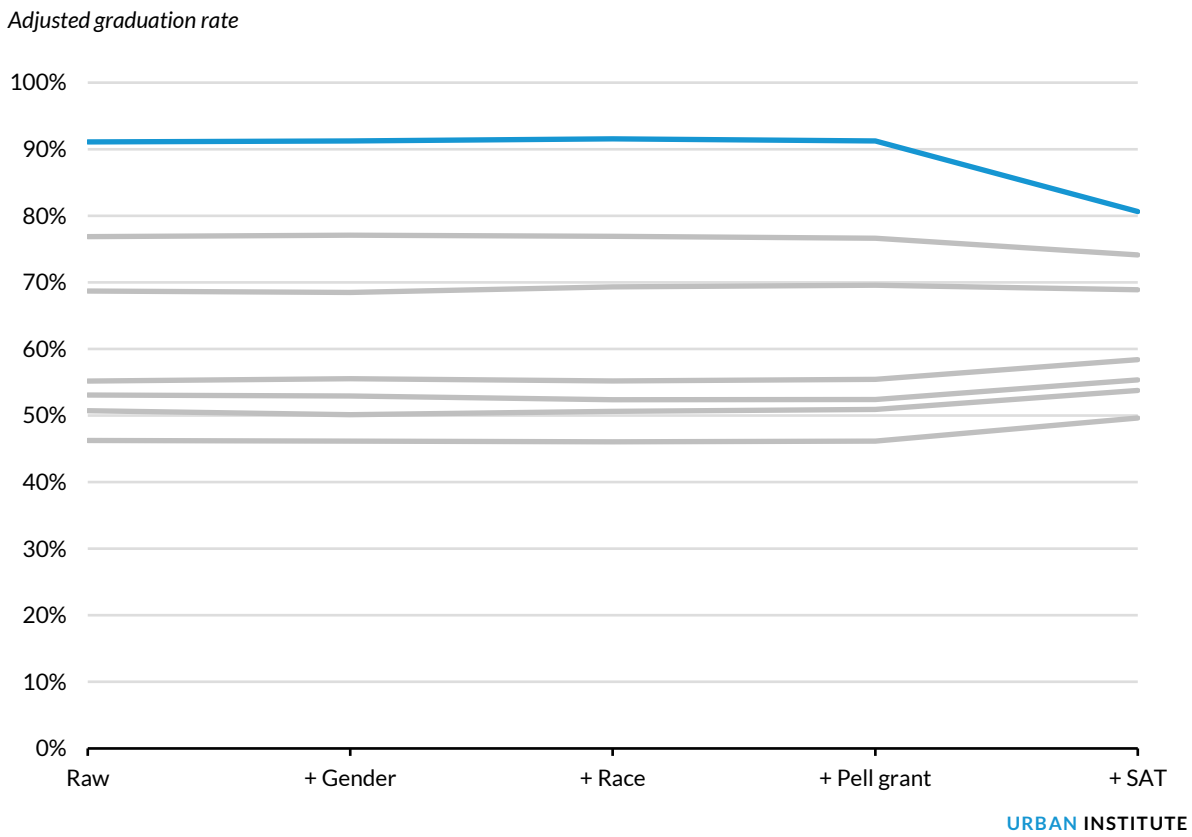
We argued above that two factors matter for the adjustments: the sizes of those subgroups at each institution and the statewide graduation rates for those subgroups. Given this, we would expect either that student characteristics are more similar across colleges in Connecticut than in Virginia or that graduation rates vary less between subgroups. Here, both play a role. Student characteristics vary less across colleges than in Virginia (e.g., there are no HBCUs in our Connecticut data). The share of black students across the seven colleges in our sample varies only between 6 and 14 percentage points (table 2). Similarly, the range of SAT scores is, with the exception of one of the private colleges, relatively narrow. The second factor, statewide graduation rates by group, also plays a role. For example, as we show in a companion brief, the graduation rate gaps by race or ethnicity are smaller in Connecticut than in Virginia. Combining these two elements results in less adjustment in Connecticut than in Virginia.

In addition, the adjustment is affected by the omission of two sets of variables we included in the Virginia analysis: family income and high school GPA. In Virginia, we saw that adding GPA led to greater adjustments than SAT scores alone. There is no reason to believe we would not see a similar pattern in Connecticut, given similar data. To determine how much this matters, we adjusted the Virginia data using the same covariates as are available in Connecticut (e.g., gender, race or ethnicity, Pell grant receipt, and SAT scores). Graduation rates were adjusted substantially less than they were using the full model. In particular, our full model for Virginia results in an average adjustment of 9 percentage points, in absolute-value terms. Our Connecticut-equivalent model adjusted graduation rates by only 4

percentage points, on average. For states wishing to create adjusted graduation rates similar to those shown here, the implications for other states are clear: the richer the data, the better the resulting adjustment.

FIGURE 2

Four-Year Graduation Rates, Connecticut



Source: Analysis of Connecticut Preschool through Twenty and Workforce Information Network data.
Note: We were requested to keep the Connecticut schools anonymous, which is why the data lines are not labeled.

TABLE 2

Demographics and Academic Preparation by College

Four-year colleges, Connecticut

	Graduation rate (%)	Female (%)	White (%)	Black (%)	Hispanic (%)	Asian (%)	Pell receipt (%)	SAT score	*N*
Private 4-year	91	51	52	6	10	9	17	1,417	2,538
Private 4-year	67	56	38	6	3	1	29	1,132	5,587
Public 4-year	53	47	72	9	10	3	30	1,003	6,872
Public 4-year	52	55	72	7	7	2	23	1,009	5,264
Public 4-year	50	62	63	14	10	2	33	976	7,095
Public 4-year	76	49	61	7	9	9	18	1,162	17,227
Public 4-year	44	54	70	8	12	3	26	989	5,023
State average	63	53	62	8	9	5	24	1,089	49,606

Source: Analysis of Connecticut Preschool through Twenty and Workforce Information Network data.
Notes: Some racial or ethnic groups, including "unknown," are not displayed. We were requested to keep the Connecticut schools anonymous, which is why we have used descriptions in the first column.

Two-Year Colleges

Our models for two-year colleges differ from those for four-year colleges. First, we focus on colleges with high school data to include measures of academic preparation, which are not captured in the college data. This limits us to traditional-age students who attended high school in Virginia or Connecticut. Second, we consider graduation from any institution as an outcome so we can account for students who begin their postsecondary studies at a two-year college and then transfer to a four-year college.

In general, the adjustments are substantially smaller than for four-year colleges, particularly in Virginia. Raw graduation rates range from 23 percent to 39 percent, a 16 percentage-point range. After adjustments, this range is compressed to 11 percentage points. In addition, because community colleges are not, in general, selective institutions, our measures of academic preparation vary less between colleges than they do for four-year institutions. As a result, graduation rates are adjusted far less than among the four-year colleges.[6] Figures 3 and 4 plot two-year graduation rates for Virginia and Connecticut, respectively.

In general, the two-year model is noisier than the four-year model. In the four-year model, each additional input tends to shift the adjustment in the same direction (although not always). This is not the case for two-year institutions. Nonetheless, notable patterns emerge.

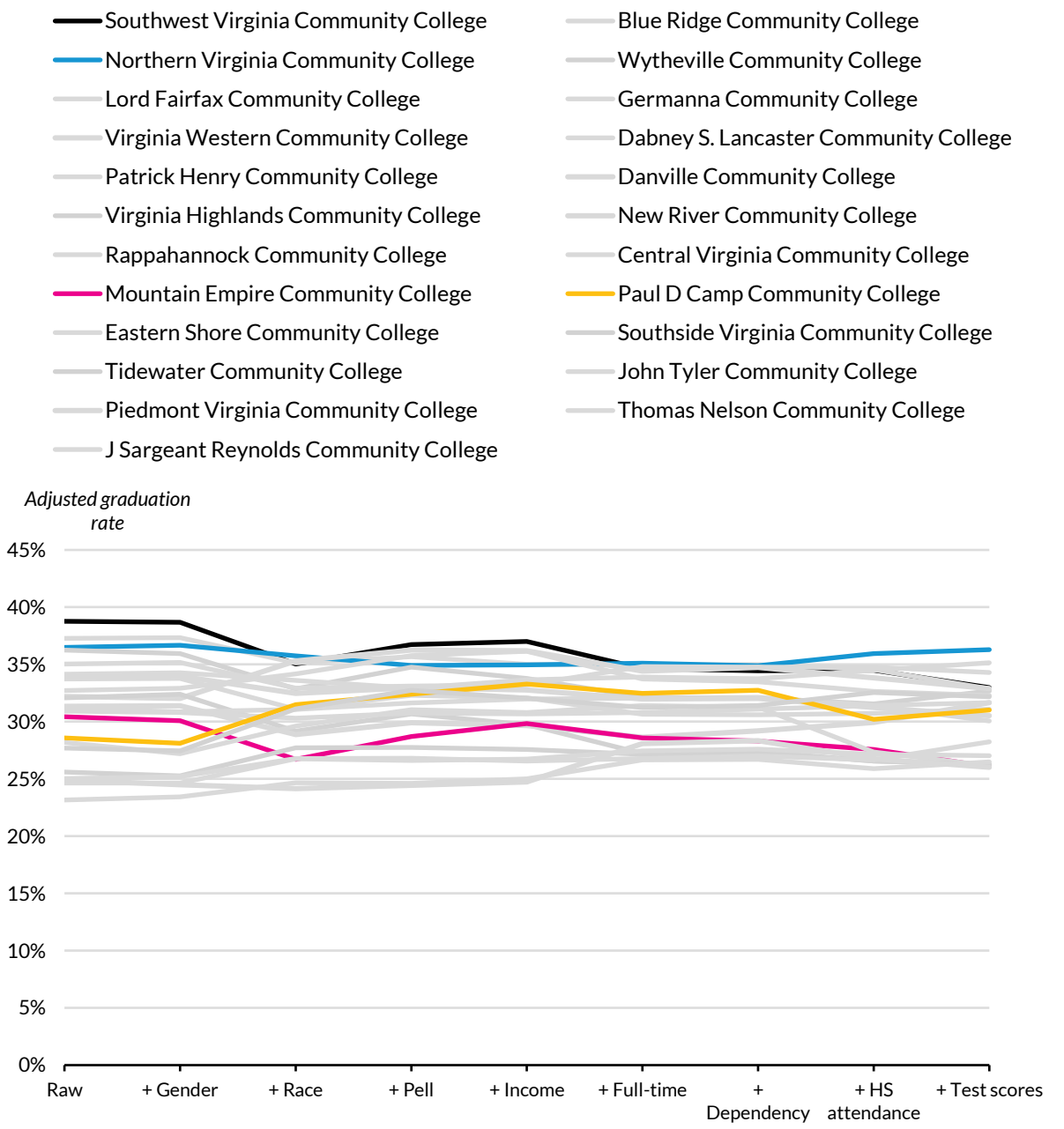
Unlike in four-year colleges, race or ethnicity is far more important than academic measures. (We do not include SAT scores, as most community college students do not take the SAT. Instead, we measure academic preparation using state standardized test scores collected roughly in 10th grade.[7]) For example, Mountain Empire Community College (magenta), an overwhelmingly white institute, has its graduation rate adjusted downward when race is included, whereas Paul D. Camp (gold), which is 42 percent black, is adjusted upward.

We also find that Pell grant receipt and family income play important roles, in contrast with four-year colleges. The black line in figure 3 represents Southwest Virginia Community College (SWCC). Its graduation rate is adjusted up when Pell grant receipt is included and is adjusted up slightly more when income is included. Accounting for the fact that SWCC serves less-wealthy students (table 3), who are less likely to graduate on average, adjusts the graduation rate upward. Conversely, Northern Virginia Community College's (NVCC's) graduation rate (blue) is adjusted slightly downward with Pell grant receipt and income, as their students' family incomes are slightly above the state average. In fact, NVCC is the only community college whose graduation rate is adjusted downward more than half a percentage point by Pell receipt and family income. In the four-year model, we did not include full-time status, as most four-year students in our sample were enrolled full time (defined as enrolled in 12 or more credits in the fall semester of their freshman year). But many community colleges students attend part time. Students who study full time are more likely to graduate that those who do not.[8] This is borne out in our adjustments. For example, SWCC's graduation rate is adjusted downward because the share of full-time students at SWCC in our sample is high, and we would expect these students to have a higher likelihood of graduating from any college.

FIGURE 3

Two-Year Graduation Rates, Virginia

Associate's degree or higher



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Source: Analysis of Virginia Longitudinal Data System data.
Note: HS = high school.

TABLE 3

Demographics and Academic Preparation by College

Two-year colleges, Virginia

	Graduate rate (%)	Female (%)	White (%)	Black (%)	Hispanic (%)	Asian (%)	Pell receipt (%)	Income ($)	Family size (people)	Full time (%)	Independent (%)	Graduated from high school last year (%)	HS attendance (%)	Std. test score	*N*
Blue Ridge	37	49	82	6	7	1	44	50,103	3.8	75	8	87	94	1444	1,674
Central Virginia	31	52	74	49	2	1	45	42,482	3.3	72	6	82	93	1433	1,692
Dabney S. Lancaster	34	50	89	5	1	0	54	39,920	3.7	82	8	88	93	1421	430
Danville	32	54	53	42	2	1	63	37,425	3.4	81	10	81	94	1405	767
Eastern Shore	28	67	56	35	6	0	72	32,544	3.5	69	6	85	97	1403	344
Germanna	34	49	67	15	8	2	26	55,571	3.7	68	9	88	93	1408	2,114
J. Sargeant Reynolds	23	46	58	30	4	4	41	45,854	3.5	62	12	84	95	1397	2,945
John Tyler	25	47	56	29	7	2	43	49,407	3.7	70	10	83	94	1380	2,677
Lord Fairfax	35	48	83	6	6	1	37	49,936	3.7	64	8	87	94	1428	2,101
Mountain Empire	30	56	96	2	1	0	68	27,781	3.4	82	10	88	94	1442	976
New River	31	49	88	6	1	1	52	42,989	3.5	81	11	81	92	1397	1,200
Northern Virginia	63	48	37	15	25	15	31	57,162	4.0	69	5	90	93	1400	17,327
Patrick Henry	33	47	66	29	3	0	71	29,330	3.4	86	9	88	94	1404	813
Paul D. Camp	29	58	53	42	2	0	63	30,815	3.3	75	12	81	96	1379	245
Piedmont Virginia	25	57	68	19	4	2	44	44,037	3.5	54	12	81	95	1418	1,385
Rappahannock	31	56	70	22	4	0	49	35,758	3.6	72	8	85	94	1406	959
Southside Virginia	28	55	51	44	2	1	77	35,254	3.5	77	9	83	92	1388	863
Southwest Virginia	39	52	98	1	0	0	61	34,899	3.5	89	9	90	93	1456	730
Thomas Nelson	25	50	52	33	5	3	41	46,661	3.5	67	11	84	94	1400	2,837
Tidewater	26	56	46	37	6	5	47	47,208	3.5	73	12	85	95	1396	9,882

	Graduate rate (%)	Female (%)	White (%)	Black (%)	Hispanic (%)	Asian (%)	Pell receipt (%)	Income ($)	Family size (people)	Full time (%)	Independent (%)	Graduated from high school last year (%)	HS attendance (%)	Std. test score	*N*
Virginia Highlands	32	45	95	3	1	0	57	45,313	3.4	91	7	86	94	1437	876
Virginia Western	34	49	79	13	3	2	45	47,051	3.5	78	8	86	94	1430	2,337
Wytheville	63	56	93	3	3	0	67	41,399	3.5	86	7	88	94	1407	982
State average	31	51	56	21	11	6	42	47,643	3.6	71	9	86	94	1406	56,156

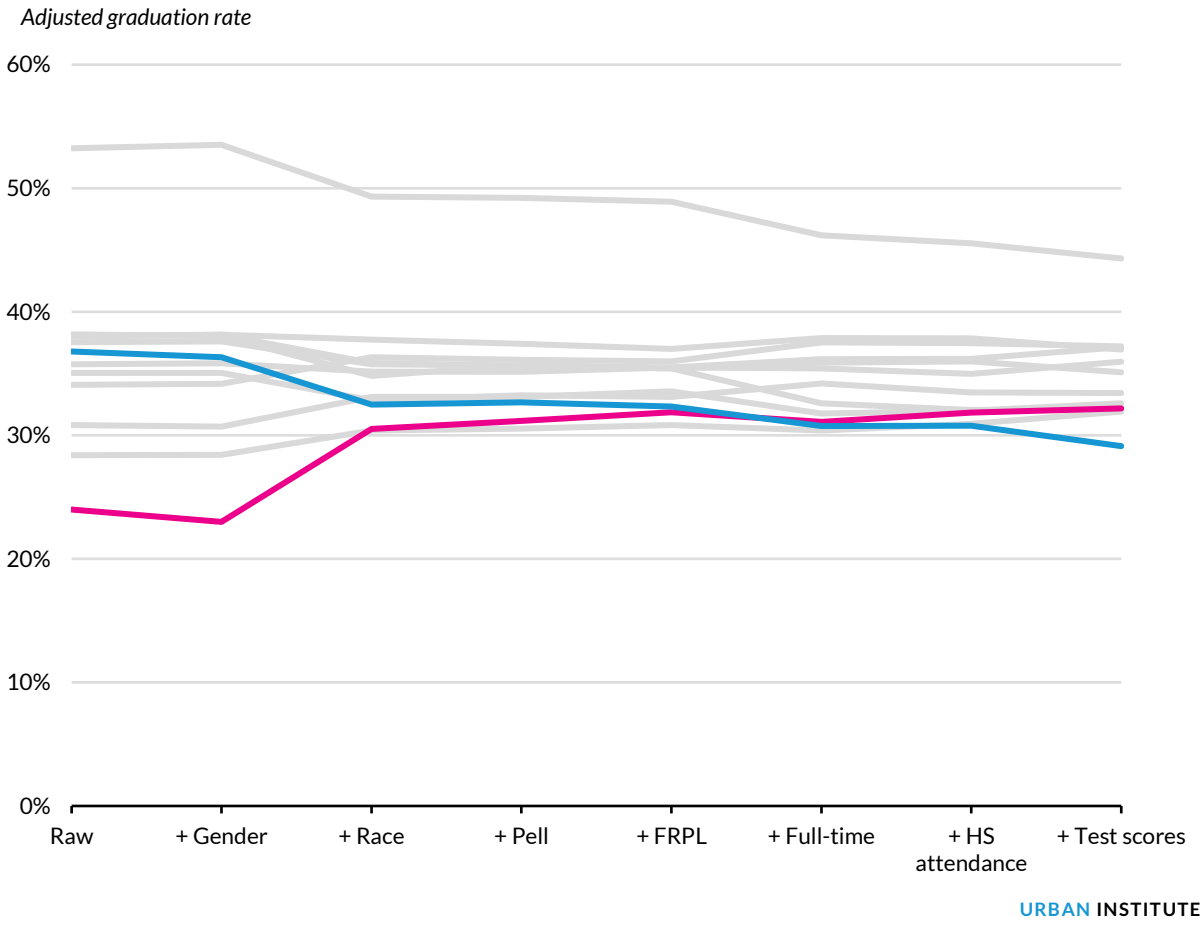
Source: Analysis of Virginia Longitudinal Data System data.

Note: HS = high school.

In Connecticut, we also see the dramatic effect of race or ethnicity. For example, the graduation rate for community college 8 (blue) is adjusted downward when we include race or ethnicity because 83 percent of its students are white (table 4), and white students tend to have higher graduation rates than most other races or ethnicities. Conversely, the graduation rate for community college 2 (magenta), which is 24 percent white, is adjusted upward.[9]

FIGURE 4

Two-Year Graduation Rates, Connecticut



Source: Analysis of Connecticut Preschool through Twenty and Workforce Information Network data.
Note: FRPL = free and reduced-price lunch; HS = high school. We were requested to keep the Connecticut schools anonymous, which is why the data lines are not labeled.

TABLE 4

Demographics and Academic Preparation by College

Two-year colleges, Connecticut

	Graduate rate (%)	Female (%)	White (%)	Black (%)	Hispanic (%)	Asian (%)	Pell receipt (%)	FRPL (%)	Full time (%)	Attendance (%)	Std. test score	*N*
1	26	52	78	8	7	3	32	27	31	94	167	2,397
2	17	68	24	34	27	3	55	79	15	91	99	5,050
3	17	57	45	24	19	3	44	54	20	92	149	9,233
4	15	60	38	28	24	3	46	57	24	92	148	6,885
5	21	52	59	15	15	4	38	35	21	93	236	9,203
6	17	57	64	9	17	3	35	33	28	94	172	3,936
7	21	55	59	10	21	2	38	43	21	93	196	8,420
8	17	65	83	2	8	1	31	25	20	93	149	2,072
9	18	57	42	17	27	4	34	48	17	93	165	7,407
10	19	62	77	2	12	2	47	37	21	93	164	2,694
11	18	56	68	8	14	3	43	36	18	93	183	5,914
12	16	56	69	8	14	3	34	32	21	93	205	5,755
State average	18	57	55	16	19	3	40	43	21	93	174	68,966

Source: Analysis of Connecticut Preschool through Twenty and Workforce Information Network data.

Notes: FRPL = free and reduced-price lunch. Std. test score refers to the sum of Connecticut Academic Performance Test mathematics, reading, and writing test scores. We were requested to keep the Connecticut schools anonymous, which is why we have used numbers in the first column.

These analyses relied on individual-level state longitudinal data. Similar analyses could be done—and have been done—using institution-level data. But institution-level analyses conflate institutional quality with student characteristics, a problem that individual-level analyses can somewhat mitigate. For example, in an institution-level model, the coefficient on, for example, black students, captures both systemic biases against black students and the fact that black students tend to attend worse colleges. An individual-level model can separate these out.

In appendix A, we illustrate how analyses based on the same underlying data, but using different models, can diverge in significant ways. We provide some insight about these differences using Virginia four-year colleges as a case study. In particular, we show that the questions policymakers are interested in—the value that colleges add, conditional on the students they serve—are best answered using the approach we use here.

Conclusion

Individual-level data can add nuance to typical college and university performance metrics. As state longitudinal data systems mature and become a commonplace resource for state higher education decisionmakers, we urge policymakers to incorporate value-added analyses into conversations around institutional quality. No model is perfect—the choice (and availability) of conditioning variables matters, as others have pointed out (Cunha and Miller 2014)—but including variables that capture student preparation and family background can change our perceptions of college rankings. The differences in adjustments between Connecticut and Virginia, which had richer conditioning variables and more institutions included in their system, further show the value of such variables as high school GPA and family income.

At the same time, the analyses we undertook here are preliminary. Sensitivity to which variables are included, for example, leads us to echo others' recommendations (Melguizo et al. 2017) that adjusted measures not be used in isolation but as part of a broader set of performance metrics. Furthermore, policymakers will have to settle trade-offs that are necessary when not all data are available. For example, some colleges did not report high school GPAs for all students, so we excluded these students.[10] Similarly, for analyses where we linked high school data, we excluded out-of-state and older students. As time goes on, this latter problem will become less of an issue. Furthermore, as efforts to link data across states take shape, the former problem may also disappear.

Similar analyses could also be performed for other outcome measures—earnings, in particular. Institution- and program-level earnings data are increasingly available but face the same problem as graduation rates: to what extent do these data reflect student characteristics rather than institutional value-add? We hope to address this question in future work.

Appendix A. What Are the Gains from Individual-Level Data?

College value-added measures, including our own in previous work, often rely on institution-level data.[11] While often this is the best that can be done with available data, it can lead to different results, even when the aggregate data reflect the same underlying individual-level data. In this appendix, we compare value-added estimates based on individual-level data, as done here, with value-added estimates based on aggregate data and argue that the former has several benefits.

The two models can be generally described by the following two equations:

$$(1)\quad Y_{ij} = a_j + X_{ij}B + e_{ij}$$
$$(2)\quad Y_j = X_jD + u_j$$

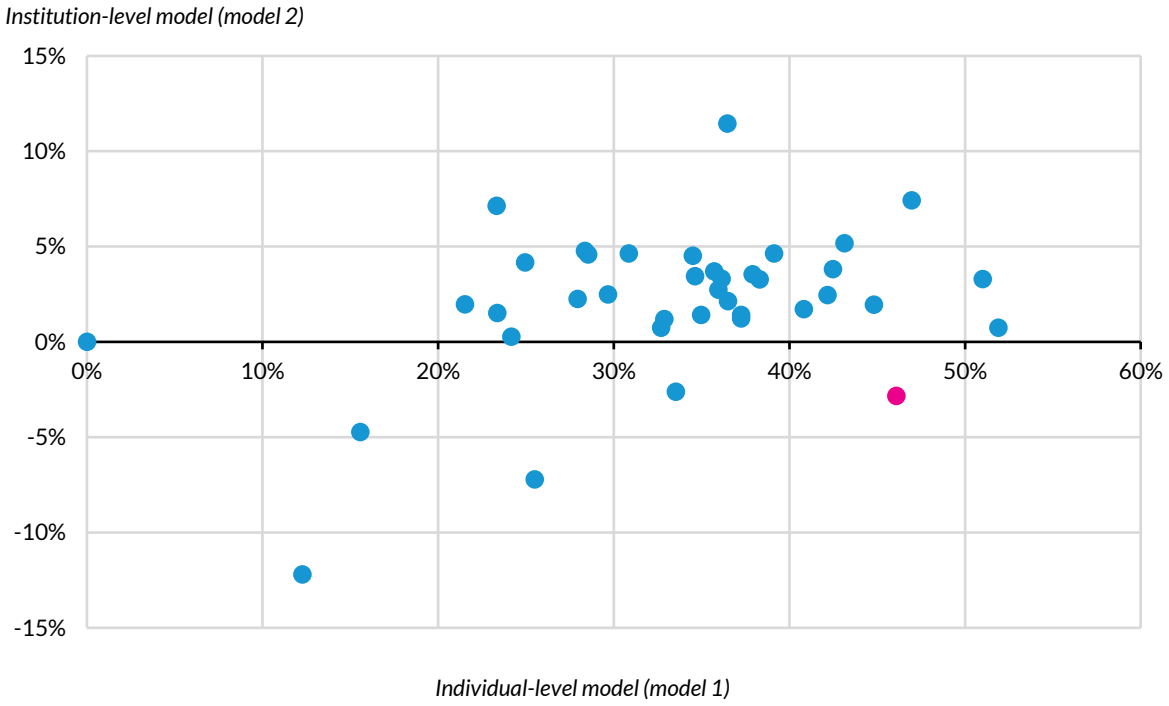
where model 1 is an individual-level model and model 2 is an institution-level model. In model 1, Y_{ij} is the outcome (graduation) for individual i at institution j, a_j is the institution fixed effect, X_{ij} are the individual characteristics, and e_{ij} are individual residuals. In model 2, Y_j is the average outcome (graduation rate) at institution j, X_j are the average demographics and student characteristics at institution j, and u_j are institution residuals.

Model 1 mimics what we used in the Developing Adjusted Measures section above. The institution fixed effects are the value-add. This kind of model is also used, for example, in calculating teacher value-add and is known in that context as a one-step model (Totty 2017). Model 2, a typical institution-level model, treats the residuals—the unexplained variation in outcomes—as the value-add. We use the data for six-year graduation rates at four-year colleges in Virginia as a test case. The implied value-added measures from each model are plotted in figure A.1. (Rather than presenting adjusted graduation rates, we present value-added measures, which differ from the adjusted graduation rates only by a constant, with the lowest value-add normalized to 0 in the individual-level model. The numbers shown here are therefore not directly comparable with those in figure 1. The value-added measures for the institution-level model are centered on 0.)

FIGURE A.1

Value-Added Measures Based on Institution-Level versus Individual-Level Data

Four-year colleges, Virginia



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Source: Analysis of Virginia Longitudinal Data System data.

Although these models are related, they capture substantially different things (correlation = 0.38). For example, the College of William and Mary (magenta dot) has a value-add in our individual-level model of 0.46, one of the highest, whereas it has a below-average value-add of -0.028 in the aggregate model. Using group-level analyses to make inferences for individuals is a problem known as the ecological fallacy (Piantadosi, Byer, and Green 1988). Economists refer to this as the difference between "within" and "between" estimators, and it is especially problematic in this case.

By construction, the second model forces the value-added measure to be uncorrelated with the other variables. In particular, the value-added measure is uncorrelated with factors such as academic preparation, as seen for the College of William and Mary. With the individual-level model, the inclusion of the value-added measure as a fixed effect allows it to be correlated with the other factors in the model. This is the chief problem with the second model and why we advise against it.

A second issue is that the first model allows us to include many more variables. We have many more degrees of freedom because of a larger sample size. In small states (or states with few institutions), the

number of institutions would limit the number of variables that can be included. For example, the second model could not even be run for the seven four-year colleges in our Connecticut data (and would be ill-advised for the two-year colleges).

Finally, the individual-level model also implicitly weights institutions correctly, since larger institutions will have more observations. Unless the second model is weighted, the coefficients on the independent variables will be biased, thus affecting the residuals (the value-added estimates).

As such, we urge state policymakers to make use of the rich data many of them already collect, enabling richer analyses of not only graduation rates but other outcomes as well.

Appendix B. Graduation Rate Tables

TABLE B.1

Graduation Rates by Gender

Four-year colleges, Virginia

	Male (%)	Female (%)
Averett College	35	59
Bluefield College	22	45
Bridgewater College	65	72
Christopher Newport University	78	87
College of William and Mary	90	95
Eastern Mennonite University	60	69
Emory and Henry College	50	69
Ferrum College	30	42
George Mason University	67	79
Hampden-Sydney University	69	
Hampton University	48	57
Hollins University		62
James Madison University	82	89
Jefferson College of Health Sciences	54	43
Liberty University	50	61
Longwood University	66	78
Lynchburg College	56	68
Mary Baldwin College		49
Marymount University	53	61
Norfolk State University	32	43
Old Dominion University	50	60
Radford University	60	71
Randolph College	66	73
Regent University	49	51
Roanoke College	61	75
Shenandoah University	54	71
Southern Virginia University	12	33
Sweet Briar College		63
University of Mary Washington	70	80
University of Richmond	88	90
University of Virginia	94	97
University of Virginia College at Wise	45	55
Virginia Commonwealth University	60	69
Virginia Military Institute	79	78
Virginia State University	40	49
Virginia Tech	86	94
Virginia Union University	33	41
Virginia Wesleyan College	49	58
Washington and Lee University	97	
State average	66	74

Source: Analysis of Virginia Longitudinal Data System data.

TABLE B.2

Graduation Rates by Race or Ethnicity

Four-year colleges, Virginia

	White (%)	Black (%)	Hispanic (%)	Asian (%)	Other (%)
Averett College	50	37			
Bluefield College	38	14			33
Bridgewater College	72	56	67		63
Christopher Newport University	84	69	84	86	79
College of William and Mary	94	89	92	88	91
Eastern Mennonite University	72	37	56		46
Emory and Henry College	61	51			44
Ferrum College	41	29	38		31
George Mason University	73	72	67	77	70
Hampden-Sydney University	71	54			65
Hampton University	43	54	55		74
Hollins University	62	63	43		65
James Madison University	87	73	84	88	84
Jefferson College of Health Sciences	50				
Liberty University	59	37	47	57	54
Longwood University	74	72	73	78	71
Lynchburg College	64	57	52	69	60
Mary Baldwin College	53	44	54	48	41
Marymount University	63	44	57	65	60
Norfolk State University	44	38	35		36
Old Dominion University	57	52	56	57	50
Radford University	67	63	58	63	64
Randolph College	71	63	66	77	70
Regent University	55	33			45
Roanoke College	70	69	59		69
Shenandoah University	66	51	64	71	53
Southern Virginia University	23	12			18
Sweet Briar College	68				62
University of Mary Washington	78	68	73	82	75
University of Richmond	90	89	81	93	89
University of Virginia	97	93	94	96	96
University of Virginia College at Wise	51	45			51
Virginia Commonwealth University	66	63	63	70	63
Virginia Military Institute	80	63	72	86	
Virginia State University	37	48	42		42
Virginia Tech	90	79	90	91	87
Virginia Union University		38			
Virginia Wesleyan College	57	50	53		56
Washington and Lee University	98				
State average	75	53	70	80	66

Source: Analysis of Virginia Longitudinal Data System data.

TABLE B.3

Graduation Rates by Index of Academic Performance

Four-year colleges, Virginia

	Quintile of Academic Performance				
	Lowest (%)	Second (%)	Middle (%)	Fourth (%)	Highest (%)
Averett College	37	50	53		
Bluefield College	22	38	46	48	
Bridgewater College	51	62	77	85	94
Christopher Newport University	53	77	81	85	89
College of William and Mary		83	83	92	93
Eastern Mennonite University	40	52	72	81	92
Emory and Henry College	40	55	64	70	81
Ferrum College	28	50	62	61	
George Mason University	53	65	72	76	80
Hampden-Sydney University	53	63	70	83	85
Hampton University	47	54	64	70	79
Hollins University	43	53	59	69	84
James Madison University	56	76	84	88	92
Jefferson College of Health Sciences	21	53	71		
Liberty University	36	54	66	76	93
Longwood University	60	72	78	86	91
Lynchburg College	49	65	73	81	82
Mary Baldwin College	46	50	63	50	
Marymount University	48	61	72	74	78
Norfolk State University	33	48	60	84	
Old Dominion University	47	52	60	69	76
Radford University	58	69	74	76	85
Randolph College	55	62	73	77	92
Regent University	30	47	50	65	74
Roanoke College	57	61	72	79	90
Shenandoah University	44	61	69	86	90
Southern Virginia University	12	16	27	29	39
Sweet Briar College	43	60	70	73	77
University of Mary Washington	48	71	74	81	89
University of Richmond	88	80	84	89	91
University of Virginia	63	87	93	96	96
University of Virginia College at Wise	37	50	65	75	74
Virginia Commonwealth University	51	59	67	73	82
Virginia Military Institute	50	70	83	85	85
Virginia State University	43	58	68	74	
Virginia Tech	59	75	86	90	91
Virginia Union University	37	52			
Virginia Wesleyan College	42	56	68	72	85
Washington and Lee University					98
State average	43	61	73	83	91

Source: Analysis of Virginia Longitudinal Data System data.

Note: "Academic index" consists of equally weighted components of high school grade point average, SAT math scores, and SAT verbal scores.

Notes

[1] The Data Quality Campaign tracks progress in each state. See the campaign's website at https://dataqualitycampaign.org/.

[2] Dale and Krueger (2002) are among the first to attempt to control for not only observed differences in student characteristics but unobserved characteristics.

[3] Gabriel W. Mast, "Institutional Effects on Community College Completion Rates: An Analysis of Washington State's Community and Technical College System" (PhD diss., University of Washington, 2017).

[4] Full time is defined as enrolled in 12 or more credits in the fall semester of freshman year.

[5] These income averages may seem high, but consider that these are not averages across all households in the state but among households with students attending four-year colleges. These households tend to earn above-average incomes.

[6] Most community college students attend college close to home. See, for example, Blagg and Chingos (2016).

[7] In Connecticut, this is the Connecticut Academic Performance Test. We include measures of reading, writing, and math. In Virginia, these are end-of-course Standards of Learning assessments in reading, writing, and geometry.

[8] See, for example, Colleen Campbell and Marcella Bombardieri, "New Data Highlight How Higher Education Is Failing Part-Time Students," Center for American Progress, October 18, 2017, https://www.americanprogress.org/issues/education-postsecondary/news/2017/10/18/440997/new-data-highlight-higher-education-failing-part-time-students/.

[9] At the request of institutional leaders, we have suppressed institution names in Connecticut.

[10] In principle, high school GPA could be calculated from detailed high school transcript data. But this was beyond the scope of this project and furthermore would not address out-of-state or older students.

[11] David Leonhardt and Sahil Chinoy, "The College Dropout Crisis," *New York Times*, May 23, 2019, https://www.nytimes.com/interactive/2019/05/23/opinion/sunday/college-graduation-rates-ranking.html.

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