State Appropriations and Employment at Higher Education Institutions

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Abstract: This paper studies the impacts of state appropriations on staffing and salaries at public higher education institutions in the United States using employment and revenue data from the Integrated Postsecondary Education Data System, along with an instrumental variables strategy borrowed from Deming and Walters (2018) and Chakrabarti et al. (2020). The instrument sidesteps the potential endogeneity of state appropriations for a given institution in a given year by interacting an institution's historical reliance on state appropriations with total state appropriations for all higher education institutions in a given year. The results suggest that higher state appropriations are associated with an increase in tenure-track assistant professors at four-year institutions. They are also associated with an increase in part-time instructional staff at both four-year and two-year institutions. However, they are not associated with a change in the number of tenured faculty. Appropriations are also positively related to salaries for a variety of employee groups, although notably not for instructional staff who are instructors, lecturers, or without an academic rank. Overall, the results show that public higher education institutions use state appropriations in a variety of ways, but I do not find evidence that they replace contingent faculty with tenured or tenure-track faculty when appropriations rise.

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1 Introduction

Higher education can confer large pecuniary and nonpecuniary benefits on individuals, as well as the economy as a whole (Goldin and Katz, 2008; Moretti, 2004; Oreopoulos and Petronijevic, 2013; Oreopoulos and Salvanes, 2011). In spite of this, public funding for higher education has fallen over time and is quite volatile (Barr and Turner, 2013; Hinrichs, 2017). It is likely that the Covid-19 pandemic and associated economic disruption will result in further challenges for financing higher education.

Meanwhile, other important changes are occurring in the labor market for higher education faculty and staff. For example, the percentage of faculty who are full-time employees is declining (Hinrichs, 2016). Furthermore, faculty hiring varies with the business cycle, with universities sometimes implementing hiring freezes during economic downturns (Turner, 2014).

To what extent are the staffing changes at higher education institutions related to declining public financial support? Are they direct responses to declining state appropriations, or are they merely a secular trend that happens to be coterminous with the decline in state appropriations? In other words, would the changes still be occurring even if appropriations were not declining, as higher education institutions try to lower their costs for a given level of state revenue? The answer matters for whether the trends in higher education staffing are likely to reverse if state appropriations rebound.

This paper studies the impacts of state appropriations on staffing and salaries at public higher education institutions in the United States using employment and revenue data from the Integrated Postsecondary Education Data System, along with an instrumental variables strategy borrowed from Deming and Walters (2018) and Chakrabarti et al. (2020). The instrument sidesteps the potential endogeneity of state appropriations for a given institution in a given year by interacting an institution's historical reliance on state appropriations with total state appropriations for all higher education institutions in a given year. The results suggest that higher state appropriations are associated with an increase in tenure-track assistant professors at four-year institutions. They are also associated with an increase in part-time instructional staff at both four-year and two-year institutions. However, they are not associated with a change in the number of tenured faculty. Appropriations are also positively related to salaries for a variety of employee groups, although notably not for instructional staff who are instructors, lecturers, or without an academic rank. Overall, the results show that public higher education institutions use state appropriations in a variety of ways, but I do not find evidence that they replace contingent faculty with tenured or tenure-track faculty when appropriations rise.

This paper is related to at least three different larger topics. First, and most generally, it is

related to the objectives and the behavior of higher education institutions. A classic article by Winston (1999) argues that colleges are part church and part car dealer, meaning that they have a public service mission but are also trying to sell a product. The fact that the objectives of higher education institutions are not theoretically clear *ex ante* makes them an interesting subject for empirical study. Such work is relatively sparse, although there are notable counterexamples, such as work on college amenities by Jacob et al. (2018) and work on college pricing by Stange (2015), Hemelt and Stange (2016), Kim and Stange (2016), Andrews and Stange (2019), and Miller and Park (2022). More closely related to the present paper due to its focus on academic labor markets, Goolsbee and Syverson (2019) find that universities have monopsony power over tenure-track faculty but not over non-tenure-track faculty. The present paper helps fill in the picture by directly studying higher education staffing decisions and how these decisions respond to changes in revenue.

Second, and more specifically, this paper is related to higher education budget shocks. Prior work finds that lower state appropriations are associated with lower spending by higher education institutions, leading to lower enrollment and degree completion (Deming and Walters, 2018); more debt for students at four-year colleges, as well as less ownership of automobiles and homes (Chakrabarti et al., 2020); higher tuition (Webber, 2017; Cook and Turner, 2022); lower enrollment at public institutions, higher enrollment at for-profit institutions, and increased student loan borrowing (Goodman and Volz, 2020); higher enrollment of foreign students (Bound et al., 2020); and lower instructional expenditures, higher tuition revenue, fewer degrees awarded, and lower faculty salaries at four-year institutions (Bound et al., 2019).[1]

Methodologically, this paper is similar to Deming and Walters (2018) and Chakrabarti et al. (2020) because it uses the same instrumental variables strategy. Topically, it is similar to Bound et al. (2019) and Bound et al. (2020) because it goes inside the black box to study how higher education change their actions in response to changes in state appropriations. However, the paper adds to previous research by examining staffing and salary outcomes that have not been the focus of prior work.[2] Additionally, it studies two-year institutions in addition to four-year institutions. The paper also differs from Bound et al. (2019) and Bound et al. (2020) by studying a different time period and conceptualizing the instrument differently.[3]

[1] In addition to work on the consequences of declining state appropriations, Kane et al. (2005) and Webber (2018) study determinants of state appropriations, finding that higher Medicaid spending leads to lower state appropriations for higher education. There is also a small amount of work on sources of higher education revenue other than state appropriations, such as Bulman (2022) on endowment shocks and Dinerstein et al. (2014) on federal stimulus money.

[2] Bound et al. (2019) show results for faculty salaries at four-year institutions and briefly discuss staffing at these institutions but do not show results, instead noting, "We find suggestive evidence that falls in appropriations adversely affect both the number of faculty and postdoctoral scholars at research universities."

[3] Webber (2017), Cook and Turner (2022), Bound et al. (2019), and Bound et al. (2020) also use instrumental variables strategies, but they differ from the instrument in Deming and Walters (2018) and Chakrabarti et al. (2020).

Third, this paper is related to the topic of contingent faculty. Most of the research on contingent faculty is empirical work studying impacts on student outcomes.[4] This research studies a variety of higher education settings and a variety of outcomes, and the exact definition of "contingent faculty" or "adjunct" varies from one study to another. The results are likewise mixed. Among the findings are that contingent faculty are associated with lower graduation rates at four-year colleges (Ehrenberg and Zhang, 2005); little effect on a variety of student outcomes (Hoffmann and Oreopoulos, 2009); a small, positive effect on enrollment in a field (Bettinger and Long, 2010); more learning in first-term courses (Figlio et al., 2015); positive impacts on grades in the current course but negative impacts in future courses (Ran and Xu, 2019); higher grades and a change in future course enrollment patterns (Chen et al., 2021); and worse student outcomes (Zhu, 2021). Although this research has not reached a consensus, there are two additional points worth making. First, a null effect of contingent faculty on student outcomes, as in Hoffmann and Oreopoulos (2009), is likely an argument in favor of contingent faculty, since they are generally less expensive to hire than tenured or tenure-track faculty. Second, Zhu (2021) finds that the penalty to students for being taught by an adjunct instructor decreases when the adjunct instructor becomes a full-time instructor, suggesting that lower effectiveness is not a fixed property of the instructors who hold positions as adjuncts; rather, the employment arrangement itself matters.

This paper differs from earlier research on contingent faculty by studying causes, rather than consequences, of contingent faculty. Studying this topic may give some revealed preference information on how much higher education institutions value tenured faculty, even though the direct empirical evidence on the relative effectiveness of contingent faculty is unsettled. Furthermore, there are over 1.5 million higher education faculty in the United States, and the relationship between state appropriations and higher education staffing is relevant to their labor market.[5] Faculty composition is also important as a potential cost driver in higher education because track-track faculty are more expensive to hire than contingent faculty (Hemelt et al., 2021). Lastly, the odds

Webber (2017), Cook and Turner (2022), and Bound et al. (2019) instrument state appropriations at a given institution with state appropriations to all higher education institutions in the state, while Bound et al. (2020) instrument state appropriations at a given institution with state appropriations to other higher education institutions in the state. The appendix to Bound et al. (2020) shows results using the Deming and Walters (2018) and Chakrabarti et al. (2020) instrument, as well as using an instrument that uses state revenue after subtracting off entitlements.

[4] Remler and Pema (2009) give theoretical insight into higher education staffing decisions by examining arguments for why higher education institutions reward research even though the primary product they sell is education. Although they do not focus specifically on contingent faculty, the arguments are still highly relevant because contingent faculty are less likely to have research expectations than tenured or tenure-track faculty are. The authors do not ultimately take a position on the true reason that higher education institutions reward research, but among the arguments they consider are that research ability and teaching ability are complements, that research quality is a proxy for teaching quality that avoids problems inherent in student evaluations of teaching, that students enjoy interacting with "celebrity" researchers, and that research enhances institutional prestige.

[5] This figure comes from Table 315.10 of de Brey et al. (2021).

of obtaining a tenure-track position may affect incentives to obtain a Ph.D., which may in turn affect research activity and knowledge production in the economy.

The next section of this paper discusses the IPEDS data in more detail, Section 3 discusses the research design, Section 4 discusses the empirical results, and Section 5 concludes the paper with a brief summary.

2 Data

The primary data source is the Integrated Postsecondary Education Data System (IPEDS). The IPEDS survey is conducted annually by the National Center for Education Statistics in the US Department of Education. It is a near census of higher education institutions in the United States, since such institutions must complete the survey in order to participate in federal financial aid programs. IPEDS includes information on a variety of topics, including enrollment, completions, finances, and employment.

I use IPEDS data for two-year and four-year public higher education institutions in the 50 states and the District of Columbia from 2011 through 2019.[6] The analytic sample runs from 2012 through 2019. The 2011 data are used only to construct the instrument, which I discuss in more detail in the next section of the paper. I focus on revenue data and employment data. The revenue data include information on total revenue as well as revenue by source, including state appropriations. The employment outcomes I use are head counts of full-time instructional staff by tenure status and by rank, head counts of full-time non-instructional staff by occupational category, head counts of part-time instructional staff and part-time non-instructional staff, head counts of full-time new hires by tenure status for instructional staff and by occupational category for non-instructional staff, average salaries for full-time non-medical school instructional staff by rank, and average salaries for full-time non-medical school non-instructional staff by occupational category.[7] The staffing data are head counts and are not weighted by the number of courses or credit hours taught, although the head counts of instructional staff and non-instructional staff are reported separately for full-time and part-time employees. IPEDS does not include information on tenure decisions, retirements (or other separations), or the distribution of faculty by department or academic field.[8]

[6] Throughout the paper, I refer to an academic year with the first calendar year of that academic year. For example, "2012" refers to the 2012–2013 academic year.

[7] IPEDS does not report new hires by faculty rank or salaries by tenure status. Part-time employees are not included in the new hires data, and neither part-time employees nor medical school employees are included in the salary data.

[8] Evidence from elsewhere suggests that the share of faculty who are neither tenured nor on the tenure track varies by field. Hemelt et al. (2021) find that the share is relatively low in economics and engineering disciplines, while it

Throughout the paper, I report dollar values in 2019 dollars using the Consumer Price Index retroactive series using current methods (R-CPI-U-RS). In regression models I include state-level controls for the unemployment rate (from the Bureau of Labor Statistics), size of the population aged 18–21 (from Census Bureau estimates), and median income (also from the Census Bureau). In practice, the results depend very little on the inclusion or exclusion of these controls.

Table 1 shows summary statistics. The average four-year institution in the sample employs 240.6 tenured faculty, 96.5 tenure-track faculty, and 169.4 instructional staff who are neither tenured nor on the tenure track. When looking by rank rather than tenure status, the average four-year institution employs 143.2 full professors, 125.4 associate professors, 133.8 assistant professors, and 104.2 instructors, lecturers, or instructional staff with no academic rank.[9] The divergence between these two sets of numbers reflects the fact that, although there is a connection between rank and tenure status, that connection is not perfect. For example, although many associate professors are tenured, some institutions employ untenured associate professors. Two-year institutions employ fewer faculty on average than four-year institutions, and these faculty are skewed toward instructors, lecturers, and instructional staff with no academic rank who are not on the tenure track. Notably, the standard deviation is large relative to the mean for all of the faculty size variables at both four-year and two-year institutions, and all of these variables are bounded from below by 0. These two facts suggest that these variables are skewed to the right, meaning that there are some institutions whose faculty sizes are large relative to the mean.

The next part of the table shows employment levels for full-time non-instructional staff by occupational category. These staff are distributed across a number of occupational categories, including student and academic affairs, management, business and financial operations, and office and administrative support. The largest such category at both two-year and four-year institutions is office and administrative support, and four-year institutions employ more people in each category than two-year institutions do.

is relatively high in English and mathematics. And in a special tabulation from the Survey of Earned Doctorates, I find that, among new holders of research doctorates who obtain a faculty position, the percentage who are not on the tenure track is high is humanities and arts, as well as physical and earth sciences. The percentage is low in mathematics and computer sciences, as well as engineering.

[9] In the original data, lecturers, instructors, and faculty with no academic rank are reported separately, and institutions are instructed to report faculty counts based on job titles. This raises the possibility that a given job title might have a different meaning across institutions. Looking at the data shows that it is relatively rare for two-year institutions to report that they employ lecturers, while the large majority report employing instructors. However, there are some two-year institutions that report employing lecturers but not instructors. Because of this, I aggregate lecturers, instructors, and faculty with no academic rank. Full professors, associate professors, and assistant professors are likely to have more consistent definitions across institutions. Furthermore, IPEDS salary data suggest that lecturers ($63,801), instructors ($68,593), and instructional staff without an academic rank ($64,761) have similar average salaries to each other but lower than assistant professors ($77,069), associate professors ($89,541), and full professors ($122,476). Note that these figures differ from what is shown on the tables because they combine four-year and two-year institutions and also weight by size.

The summary statistics for full-time new hires are mostly in line with the summary statistics at the top of the table for the stock of employees. One noticeable difference, though, is that the number of new hires who are tenured is very low relative to the stock of faculty with tenure, suggesting that the large majority of tenured faculty are tenured internally rather than hired with tenure.

Salaries are higher at four-year institutions than two-year institutions for most groups of instructional staff, although the pattern is reversed for instructors, lecturers, and instructional staff without an academic rank. Salaries for non-instructional staff are similar across two-year and four-year institutions in most categories, although salaries in the management category are notably higher at four-year institutions. Salaries in that category are higher than for any group of instructional staff at four-year institutions, as well as at two-year institutions. The sample size for salaries changes across variables because some institutions do not employ people in certain categories. This is especially true for professors, associate professors, and assistant professors at two-year institutions.

The average four-year institution in the sample receives $78.2 million in state appropriations in a year, whereas the average two-year institution receives $15.1 million. The remainder of the table gives information about the instrument, which I discuss in more detail in the next section, as well as the covariates that I include in the regressions.

3 Research Design

I estimate equations of the form

$$Y_{ist} = \alpha Approp_{ist} + X_{ist} + \theta_i + \delta_t + \epsilon_{ist} \tag{1}$$

separately for two-year and four-year institutions. Here Y_{ist} is an employment outcome for institution i in state s in year t, $Approp_{ist}$ is the amount of state appropriations (in millions of dollars) for this institution, X_{ist} refers to the covariates, θ_i denotes a full set of institution fixed effects, δ_t denotes a full set of year fixed effects, and ϵ_{ist} is the error term. The parameter of interest is α. I begin by estimating the models by ordinary least squares (OLS), clustering the standard errors at the state level. The inclusion of the institution and year fixed effects should eliminate bias and inconsistency resulting from omitted variables that are time invariant or institution invariant, and the inclusion of additional covariates may further reduce bias. However, there is still a possibility that bias and inconsistency may result if state appropriations are reallocated over time toward (or away from) particular institutions that happen to be changing employment levels or salaries for

Table 1: Summary Statistics

	Four-Year			Two-Year		
	Mean	SD	N	Mean	SD	N
Full-Time Instructional Staff by Tenure Status						
Tenured Faculty	240.6	299.3	5,749	45.6	64.6	7,173
Tenure-Track Faculty	96.5	116.5	5,749	15.6	27.3	7,173
Other Full-Time Instructional Staff	169.4	310.6	5,749	57.0	98.2	7,173
Full-Time Instructional Staff by Rank						
Professor	143.2	217.5	5,749	16.6	39.1	7,173
Associate Professor	125.4	159.5	5,749	11.7	25.7	7,173
Assistant Professor	133.8	193.6	5,749	12.7	33.5	7,173
Instructor, Lecturer, or No Academic Rank	104.2	155.6	5,749	77.2	88.6	7,173
Full-Time Non-Instructional Staff						
Library and Student/Academic Affairs	86.9	148.3	5,863	25.4	35.0	7,377
Management	148.1	263.9	5,863	31.7	35.2	7,377
Business and Financial Operations	150.6	324.6	5,863	15.5	27.5	7,377
Office and Administrative Support	234.2	361.8	5,863	50.9	57.8	7,377
Part-Time Staff						
Part-Time Instructional Staff	269.6	316.1	5,863	231.3	289.4	7,377
Part-Time Non-Instructional Staff	177.5	370.4	5,863	89.3	159.8	7,377
Graduate Assistants	393.2	873.0	5,863	0.0	0.3	7,377
New Hires						
Tenured Faculty	2.4	15.1	5,775	0.3	5.9	6,430
Tenure-Track Faculty	14.0	17.9	5,775	2.6	6.1	6,430
Other Full-Time Instructional Staff	17.2	35.6	5,775	4.1	7.3	6,430
Library and Student/Academic Affairs	7.5	15.6	5,775	2.1	3.7	6,430
Management	8.1	15.8	5,775	2.3	3.7	6,430
Business and Financial Operations	11.8	29.8	5,775	1.3	3.5	6,430
Office and Administrative Support	18.8	37.7	5,775	3.6	5.6	6,430
Average Salaries of Instructional Staff						
Professor	108,974	31,474	5,205	78,479	17,505	3,015
Associate Professor	84,701	19,581	5,205	67,246	13,143	2,883
Assistant Professor	73,062	16,495	5,197	60,083	10,580	2,868
Instructor, Lecturer, or No Academic Rank	59,182	15,712	5,542	61,937	16,614	6,884
Average Salaries of Non-Instructional Staff						
Library and Student/Academic Affairs	54,367	15,241	5,810	51,213	12,796	7,177
Management	110,606	31,462	6,033	95,330	25,100	7,332
Business and Financial Operations	59,357	12,912	5,962	56,112	13,432	7,089
Office and Administrative Support	41,479	8,876	6,031	41,737	10,474	7,326
Treatment Variable, Instrument, and Covariates						
State Appropriations (millions of 2019 dollars)	78.2	106.1	5,720	15.1	18.8	8,024
Instrument	552.9	718.8	5,290	221.4	371.6	7,885
State Population Aged 18-21 (millions)	1.1	1.0	6,205	1.2	1.2	8,199
State Unemployment Rate	5.3	1.5	6,205	5.4	1.6	8,199
Median State Income (2019 dollars)	61,625	9,905	6,205	60,890	9,766	8,199

other reasons.[10]

To reduce the magnitude of this inconsistency, I turn to an instrumental variables strategy that has been used previously by Deming and Walters (2018) and Chakrabarti et al. (2020). This instrument interacts an institution's reliance on state appropriations in a base period with overall state appropriations for higher education. In particular the instrument is

$$\frac{Approp_{is,2011}}{Revenue_{is,2011}} \times StApprop_{st}, \tag{2}$$

where $Approp_{is,2011}$ is state appropriations going to institution i in state s in the base year (2011), $Revenue_{is,2011}$ is total revenue from all sources for this institution in the base year, and $StApprop_{st}$ is state appropriations going to all institutions in state s in year t.[11] The instrument thus multiplies the share of revenue coming from state appropriations in the base year by total state appropriations in year t. The instrument relies on the idea that a given change in appropriations at the state level should tend to have more of an impact at institutions that are more reliant on state appropriations, but it avoids endogeneity problems that could result from a state legislature deciding to disproportionally allocate funding toward (or away from) a particular insitution in a particular year. The instrument may also be helpful in purging variation resulting from current state appropriations being related to current enrollment.

Table 2 shows results from the first stage regressions, which regress state appropriations on the instrument, institution fixed effects, state fixed effects, and other covariates. Although the estimating equation is the same across rows, the samples are slightly different due to missing staffing and salary data. For the most part, the sample sizes and first stage coefficient estimates do not change appreciably across samples. The coefficient estimates at four-year institutions range from 0.055 to 0.069, all of which are highly statistically significant. With a few exceptions, the coefficient estimates at two-year institutions range from 0.017 to 0.021 and are again all highly statistically significant. The exceptions are salaries for professors (0.036), associate professors (0.044), and assistant professors (0.041). The sample sizes are lower in these three cases because many two-year institutions do not employ faculty with these ranks, but the results are still statistically significant at the 1% level, the 10% level, and the 5% level, respectively.

Recent work by Borusyak et al. (2022) and Goldsmith-Pinkham et al. (2020) clarifies identification issues associated with shift-share instruments. Taking this work into account, Chakrabarti

[10] Deming and Walters (2018), citing Parmley et al. (2009), note that budgets are generally set in advance. This may mitigate the endogeneity problem somewhat, but instrumental variables can still help with the issue of reallocation between institutions over time.

[11] In the regressions for two-year institutions, I use use total state revenue for all two-year institutions in the state. In the regressions for four-year institutions, I use total state revenue for all four-year institutions in the state.

et al. (2020) find that the instrument withstands a number of threats to validity, including that the instrument is correlated with local economic activity, that the instrument itself is serially correlated, and that the instrument is correlated with the demographic or socioeconomic composition of students at higher education institutions.

4 Results

Table 3 shows results for the stock of full-time instructional staff by tenure status. The bivariate regression results in the first column suggest that a $1 million increase in revenue is associated with an increase in 2.366 tenured faculty, 0.733 faculty who are untenured but on the tenure track, and 1.755 instructional staff who are neither tenured nor on the tenure track. All of these results are statistically significant at the 1% level. However, the raw correlations likely suffer from omitted variable bias, and each of the estimates drops in magnitude in column 2, which includes year fixed effects, institution fixed effects, and additional covariates. As discussed earlier, however, the OLS estimates may be inconsistent if state appropriations are reallocated toward (or away from) particular institutions that happen to be shifting their faculty mix for other reasons. The IV estimates in the third column sidestep this issue. These IV results are statistically significant only for tenure-track faculty. The coefficient for tenure-track faculty is also the largest in magnitude and suggests that a $1 million increase in state appropriations is associated with 0.599 additional tenure-track faculty.[12]

I find little effect of state appropriations on the number of full-time instructional staff at two-year institutions. Although the results from the bivariate OLS regressions show a large and statistically significant correlation between state appropriations and full-time instructional staff, the magnitudes fall and the results mostly lose statistical significance when including fixed effects and additional controls. Upon estimating the model by instrumental variables, two estimates become negative in sign, one of which even becomes marginally significant in this unexpected direction. The contrast between the results for two-year institutions and four-year institutions suggests an important difference in behavior between the two types of institutions. At two-year institutions, staffing of full-time instructional staff is relatively invariant to funding, perhaps because additional funding is used to raise salaries for existing faculty, hire part-time instructional staff, or achieve other goals. At four-year institutions, however, hiring additional faculty to teach classes, conduct research, advise students, and perform service activities may be a benefit that follows from increases

[12] In results that are not shown here, I study effects on the share of instructional staff who are neither tenured nor on the tenure track; the share of instructional staff who are instructors, lecturers, or without an academic rank; and the student-to-faculty ratio. I do not find significant effects on any of these variables.

Table 2: First Stage

	Four-Year			Two-Year		
	Coeff.	SE	N	Coeff.	SE	N
Full-Time Instructional Staff by Tenure Status						
Tenured Faculty	0.060***	(0.018)	4953	0.019***	(0.004)	6992
Tenure-Track Faculty	0.060***	(0.018)	4953	0.019***	(0.004)	6992
Other Full-Time Instructional Staff	0.060***	(0.018)	4953	0.019***	(0.004)	6992
Full-Time Instructional Staff by Rank						
Professor	0.060***	(0.018)	4953	0.019***	(0.004)	6992
Associate Professor	0.060***	(0.018)	4953	0.019***	(0.004)	6992
Assistant Professor	0.060***	(0.018)	4953	0.019***	(0.004)	6992
Instructor, Lecturer, or No Academic Rank	0.060***	(0.018)	4953	0.019***	(0.004)	6992
Full-Time Non-Instructional Staff						
Library and Student/Academic Affairs	0.055***	(0.015)	5042	0.017***	(0.004)	7086
Management	0.055***	(0.015)	5042	0.017***	(0.004)	7086
Business and Financial Operations	0.055***	(0.015)	5042	0.017***	(0.004)	7086
Office and Administrative Support	0.055***	(0.015)	5042	0.017***	(0.004)	7086
Part-Time Staff						
Part-Time Instructional Staff	0.055***	(0.015)	5042	0.017***	(0.004)	7086
Part-Time Non-Instructional Staff	0.055***	(0.015)	5042	0.017***	(0.004)	7086
Graduate Assistants	0.055***	(0.015)	5042	0.017***	(0.004)	7086
New Hires						
Tenured Faculty	0.055***	(0.016)	4973	0.018***	(0.004)	6270
Tenure-Track Faculty	0.055***	(0.016)	4973	0.018***	(0.004)	6270
Other Full-Time Instructional Staff	0.055***	(0.016)	4973	0.018***	(0.004)	6270
Library and Student/Academic Affairs	0.055***	(0.016)	4973	0.018***	(0.004)	6270
Management	0.055***	(0.016)	4973	0.018***	(0.004)	6270
Business and Financial Operations	0.055***	(0.016)	4973	0.018***	(0.004)	6270
Office and Administrative Support	0.055***	(0.016)	4973	0.018***	(0.004)	6270
Average Salaries of Instructional Staff						
Professor	0.069***	(0.014)	4678	0.036***	(0.011)	2942
Associate Professor	0.069***	(0.014)	4674	0.044*	(0.023)	2807
Assistant Professor	0.069***	(0.014)	4664	0.041**	(0.017)	2800
Instructor, Lecturer, or No Academic Rank	0.059***	(0.018)	4773	0.019***	(0.004)	6704
Average Salaries of Non-Instructional Staff						
Library and Student/Academic Affairs	0.063***	(0.019)	5018	0.021***	(0.004)	7009
Management	0.056***	(0.015)	5216	0.017***	(0.004)	7142
Business and Financial Operations	0.056***	(0.015)	5163	0.017***	(0.004)	6905
Office and Administrative Support	0.056***	(0.015)	5216	0.017***	(0.004)	7136

Notes: The table shows regression results, standard errors that are robust to clustering at the state level (in parentheses), and sample sizes. A single asterisk denotes significance at the 10% level, a double asterisk denotes significance at the 5% level, and a triple asterisk denotes statistical significance at the 1% level.

Table 3: Full-Time Instructional Staff by Tenure Status

	Four-Year			Two-Year		
	OLS	OLS	IV	OLS	OLS	IV
Tenured Faculty	2.366***	0.417*	0.049	1.632***	0.147*	0.098
	(0.155)	(0.208)	(0.171)	(0.556)	(0.079)	(0.102)
	5399	5399	4947	7095	7095	6980
Tenure-Track Faculty	0.733***	0.299***	0.599***	0.601***	0.184	-0.486*
	(0.065)	(0.078)	(0.167)	(0.177)	(0.131)	(0.273)
	5399	5399	4947	7095	7095	6980
Other Full-Time Instructional Staff	1.755***	0.426	-0.274	2.572**	0.147	-0.067
	(0.182)	(0.376)	(0.618)	(1.125)	(0.238)	(0.192)
	5399	5399	4947	7095	7095	6980
Year FE	No	Yes	Yes	No	Yes	Yes
Institution FE	No	Yes	Yes	No	Yes	Yes
Additional Controls	No	Yes	Yes	No	Yes	Yes

Notes: The table shows regression results, standard errors that are robust to clustering at the state level (in parentheses), and sample sizes. A single asterisk denotes significance at the 10% level, a double asterisk denotes significance at the 5% level, and a triple asterisk denotes statistical significance at the 1% level.

in funding.

Table 4 examines impacts on instructional staff in a different, but complementary, way by studying academic rank. As noted earlier, rank and tenure status are related, albeit imperfectly. In addition, a benefit of studying impacts on faculty count by rank is that it allows for differential effects between full professors and associate professors. Nonetheless, the results in Table 4 are in line with what might be expected based on Table 3. In particular, the IV results suggest that the number of assistant professors rises at four-year institutions when state appropriations rise, but I find no effect for other ranks at four-year institutions or for any rank at two-year institutions. In general, the results from Tables 3 and 4 suggest that four-year institutions respond to increases in appropriations by hiring more tenure-track assistant professors, but they do not appreciably adjust staffing levels of other full-time faculty.

Table 5 shows results for non-instructional staff by job category. At four-year institutions, the OLS results suggest that higher state appropriations are associated with more management employees, as well as more business and financial operations employees. However, the IV estimate for management employees is smaller in magnitude than the OLS estimate, the IV estimate for business and financial operations employees changes sign, and both estimates are statistically insignificant at conventional levels. At two-year institutions, the OLS results suggest that state appropriations are not associated with employment in any of the categories shown, while the IV results suggest a marginally significant increase in employees in the business and financial operations category

Table 4: Full-Time Instructional Staff by Rank

	Four-Year			Two-Year		
	OLS	OLS	IV	OLS	OLS	IV
Professor	1.686***	0.259*	-0.070	0.682**	-0.014	0.069
	(0.146)	(0.142)	(0.234)	(0.290)	(0.045)	(0.139)
	5399	5399	4947	7095	7095	6980
Associate Professor	1.176***	0.160	-0.145	0.654**	0.085*	0.032
	(0.096)	(0.116)	(0.165)	(0.270)	(0.043)	(0.046)
	5399	5399	4947	7095	7095	6980
Assistant Professor	1.252***	0.439**	0.381**	0.916**	0.106*	-0.053
	(0.125)	(0.179)	(0.159)	(0.434)	(0.055)	(0.103)
	5399	5399	4947	7095	7095	6980
Instructor, Lecturer, or No Academic Rank	0.740***	0.284*	0.208	2.552***	0.301*	-0.502
	(0.096)	(0.156)	(0.166)	(0.522)	(0.156)	(0.334)
	5399	5399	4947	7095	7095	6980
Year FE	No	Yes	Yes	No	Yes	Yes
Institution FE	No	Yes	Yes	No	Yes	Yes
Additional Controls	No	Yes	Yes	No	Yes	Yes

Notes: The table shows regression results, standard errors that are robust to clustering at the state level (in parentheses), and sample sizes. A single asterisk denotes significance at the 10% level, a double asterisk denotes significance at the 5% level, and a triple asterisk denotes statistical significance at the 1% level.

and an unexpected highly significant decrease in library and student/academic affairs employees. But overall, considering the results for both four-year institutions and two-year institutions, the results do not give overwhelming evidence that higher education institutions adjust the level of noninstructional staff in response to changes in state appropriations.

Table 6 shows results for part-time employees. There is a strong association between state appropriations and employment of part-time instructional staff, especially at two-year institutions. The IV results suggest that a $1 million increase in state appropriations is associated with an increase of 0.487 part-time instructional staff at four-year institutions and 4.325 part-time instructional staff at two-year institutions. Thus, higher education institutions do not merely replace less expensive contingent faculty with more expensive tenure-track faculty when state appropriations rise. Rather, they employ more of each. However, according to the IV estimates, they do not appear to be hiring more non-instructional staff, including part-time staff.

Although IPEDS does not include information on promotions, transfers, or departures, it does include information on new hires by job category. These data allow for at least a partial examination of job flows, particularly whether higher education institutions hire more outside employees when state appropriations rise.[13]

[13] As an example to see why it is not possible to do a complete examination of job flows using the available data, suppose that a university employed 100 tenured faculty one year, 120 the next year, and hired 30 new tenured faculty

Table 5: Full-Time Non-Instructional Staff

	Four-Year			Two-Year		
	OLS	OLS	IV	OLS	OLS	IV
Library and Student/Academic Affairs	0.889***	0.076	-0.326	0.695**	0.089	-0.781***
	(0.112)	(0.191)	(0.657)	(0.267)	(0.056)	(0.171)
	5504	5504	5040	7287	7287	7074
Management	1.470***	0.376**	0.175	1.172***	0.107	-0.166
	(0.245)	(0.185)	(0.213)	(0.339)	(0.089)	(0.130)
	5504	5504	5040	7287	7287	7074
Business and Financial Operations	2.201***	0.437**	-0.481	0.807***	0.073	0.144*
	(0.306)	(0.189)	(0.461)	(0.226)	(0.069)	(0.080)
	5504	5504	5040	7287	7287	7074
Office and Administrative Support	2.630***	0.389	-0.225	2.256***	0.152	-0.285
	(0.220)	(0.334)	(0.510)	(0.318)	(0.112)	(0.213)
	5504	5504	5040	7287	7287	7074
Year FE	No	Yes	Yes	No	Yes	Yes
Institution FE	No	Yes	Yes	No	Yes	Yes
Additional Controls	No	Yes	Yes	No	Yes	Yes

Notes: The table shows regression results, standard errors that are robust to clustering at the state level (in parentheses), and sample sizes. A single asterisk denotes significance at the 10% level, a double asterisk denotes significance at the 5% level, and a triple asterisk denotes statistical significance at the 1% level.

Table 6: Part-Time Staff

	Four-Year			Two-Year		
	OLS	OLS	IV	OLS	OLS	IV
Part-Time Instructional Staff	1.342***	0.484*	0.487**	10.649***	0.243	4.325**
	(0.197)	(0.256)	(0.197)	(2.114)	(0.661)	(1.771)
	5504	5504	5040	7287	7287	7074
Part-Time Non-Instructional Staff	1.867***	0.192	-0.014	4.002**	0.108	0.316
	(0.254)	(0.190)	(0.742)	(1.625)	(0.244)	(0.613)
	5504	5504	5040	7287	7287	7074
Graduate Assistants	6.440***	0.484	-0.206	-0.000	-0.000	-0.000
	(0.492)	(0.314)	(1.230)	(0.000)	(0.000)	(0.001)
	5504	5504	5040	7287	7287	7074
Year FE	No	Yes	Yes	No	Yes	Yes
Institution FE	No	Yes	Yes	No	Yes	Yes
Additional Controls	No	Yes	Yes	No	Yes	Yes

Notes: The table shows regression results, standard errors that are robust to clustering at the state level (in parentheses), and sample sizes. A single asterisk denotes significance at the 10% level, a double asterisk denotes significance at the 5% level, and a triple asterisk denotes statistical significance at the 1% level.

The results for new hires in Table 7 are broadly consistent with the results from Table 3 on the stock of faculty. Table 3 shows that the number of tenure-track faculty rises as state appropriations rise, and Table 7 shows that a fair share of that comes from newly hired tenure-track faculty. However, the magnitude of the new hires do not completely explain the magnitude of the stock, suggesting that higher education institutions may also have a higher retention rate for existing employees when state appropriations rise. At two-year institutions, the results in Table 7 show an increase in new hires of tenure-track faculty even though the results in Table 3 show a decrease in the stock. These are several possible ways to reconcile the results for new hires with the results for the stocks of employees. One is simply that there may be measurement error. A second possibility is that there may be churn at two-year institutions when appropriations rise and that new hires replace departing employees. A third possibility is that there may be a dynamic adjustment process. In other words, state appropriations may be correlated across years, and the regression coefficients may be picking up effects across multiple years. For example, if an institution receives a permanent increase in annual state appropriations and hires new faculty in a staggered manner, then the estimated impact on the stock of faculty could be higher than the estimated effect on new hires in a particular year.

Consistent with the results on Table 5 showing little change in the stock of non-instructional faculty at four-year institutions when appropriations rise, the IV results in Table 7 show little change in new hires. However, the Table 7 results for non-instructional new hires at two-year institutions are in notable contrast to the Table 5 results for the stock of non-instructional employees at two-year institutions, as well as the Table 7 results for new hires of non-instructional staff at four-year institutions. In particular, the Table 7 results suggest that there are more non-instructional new hires in several categories at two-year institutions when appropriations rise, whereas Table 5 shows an increase in the stock only for business and financial operations. This suggests that two-year institutions may be hiring new employees to replace departing ones.

The results up to this point have focused on counts of employees, but another way that state appropriations may have an impact is through salaries. The results in Table 8 suggest that, at four-year institutions, salaries rise for professors, associate professors, and assistant professors when appropriations increase.[14] In particular, the IV results suggest that a $1 million increase in state appropriations is associated with an extra $100.13 in salary for full professors, $116.06 for associate

in between. Suppose it has 50 tenure-track faculty in the first year, 60 in the next year, and hired 15 new tenure-track faculty in between. One possibility that is consistent with the data is that 10 tenured faculty departed, 5 tenure-track faculty departed, and 0 tenure-track faculty received tenure. Among a number of other possibilities is that 10 tenured faculty departed, 0 tenure-track faculty departed, and 5 tenure-track faculty received tenure. Essentially, there are three unknowns (promotions, departures of tenured faculty, and departures of tenure-track faculty) but only two equations (one for tenured faculty and one for tenure-track faculty).

[14] As noted earlier, IPEDS includes information on salary by rank but not by tenure status.

Table 7: New Hires

	Four-Year			Two-Year		
	OLS	OLS	IV	OLS	OLS	IV
Tenured Faculty	0.025***	0.042*	0.147	0.023**	0.003	-0.013
	(0.003)	(0.023)	(0.109)	(0.011)	(0.029)	(0.080)
	5435	5435	4972	6362	6362	6257
Tenure-Track Faculty	0.103***	0.066***	0.128**	0.083**	0.050	0.357***
	(0.009)	(0.022)	(0.051)	(0.031)	(0.046)	(0.109)
	5435	5435	4972	6362	6362	6257
Other Full-Time Instructional Staff	0.173***	0.072	-0.078	0.128**	0.018	0.091
	(0.021)	(0.053)	(0.118)	(0.062)	(0.021)	(0.062)
	5435	5435	4972	6362	6362	6257
Library and Student/Academic Affairs	0.071***	0.044	-0.028	0.037**	0.028**	0.122*
	(0.009)	(0.031)	(0.098)	(0.018)	(0.011)	(0.070)
	5435	5435	4972	6362	6362	6257
Management	0.063***	0.064***	0.048	0.065***	0.025***	0.080
	(0.012)	(0.017)	(0.032)	(0.018)	(0.009)	(0.075)
	5435	5435	4972	6362	6362	6257
Business and Financial Operations	0.157***	0.121**	-0.100	0.056***	0.034***	0.159***
	(0.024)	(0.052)	(0.261)	(0.018)	(0.011)	(0.046)
	5435	5435	4972	6362	6362	6257
Office and Administrative Support	0.209***	0.120**	-0.038	0.125***	0.077***	0.260***
	(0.021)	(0.055)	(0.200)	(0.025)	(0.021)	(0.084)
	5435	5435	4972	6362	6362	6257
Year FE	No	Yes	Yes	No	Yes	Yes
Institution FE	No	Yes	Yes	No	Yes	Yes
Additional Controls	No	Yes	Yes	No	Yes	Yes

Notes: The table shows regression results, standard errors that are robust to clustering at the state level (in parentheses), and sample sizes. A single asterisk denotes significance at the 10% level, a double asterisk denotes significance at the 5% level, and a triple asterisk denotes statistical significance at the 1% level.

professors, and $74.68 for assistant professors. However, salaries do not appear to rise for instructors, lecturers, and instructional faculty without an academic rank. In fact, the OLS estimate with fixed effects and the IV estimate are both negative, albeit insignificant at conventional levels. These results suggest that tenured and tenure-track faculty may have the power to capture some of the increase in appropriations to a given institution in the form of higher salaries, but contingent faculty may be forced to accept market wages as part of a competitive labor market.

The point estimates for salaries of professors, associate professors, and assistant professors are higher at two-year institutions than four-year institutions. However, there are several caveats. First, as noted earlier, the sample size is low for two-year institutions for professors, associate professors, and assistant professors because many institutions only employ instructional staff who are instructors, lecturers, or who have no academic rank. And two-year institutions that do employ such faculty often employ only a small number, which may make the data on average salaries quite variable. Second, although the IV estimate for assistant professors at two-year institutions is statistically significant at the 5% level, the estimates for professors and associate professors are not significantly different from 0 at conventional levels due to the relatively high standard errors. Third, state appropriations are generally higher for four-year institutions than two-year institutions. Thus, an increase in state appropriations of the same percentage at four-year and two-year institutions would likely be a larger increase in the level at two-year institutions, possibly resulting in a larger increase in salaries at two-year institutions. Fourth, four-year institutions employ more instructional staff than two-year institutions, and so the impact of a given increase in state appropriations on the final wage bill may be larger at four-year institutions despite a smaller impact on the average salary.

Table 9 shows results for salaries of non-instructional staff. The results suggest that salaries rise across a variety of employment categories. The magnitudes at four-year institutions are generally smaller than the magnitudes shown in Table 8 for instructional staff. However, salary levels also differ, and thus the impacts on salaries would thus look more similar when put in percentage terms. It is also notable that the estimates in Table 9 differ between two-year and four-year institutions.

5 Conclusion

The results of this paper suggest that higher state appropriations are associated with an increase in tenure-track assistant professors at four-year institutions. They are also associated with an increase in part-time instructional staff at both four-year and two-year institutions. However, they are not associated with a change in the number of tenured faculty. Appropriations are also positively related to salaries for a variety of employee groups, although notably not for instructional staff who

Table 8: Average Salaries of Instructional Staff

	Four-Year			Two-Year		
	OLS	OLS	IV	OLS	OLS	IV
Professor	164.59***	54.34***	100.13**	157.26	139.68*	396.78
	(13.55)	(14.62)	(48.03)	(100.48)	(70.16)	(247.47)
	4875	4875	4673	2982	2982	2924
Associate Professor	85.71***	37.41***	116.06***	94.63	97.88	324.87
	(8.18)	(8.21)	(23.21)	(70.85)	(66.49)	(201.92)
	4870	4870	4671	2847	2847	2793
Assistant Professor	75.98***	27.50**	74.68***	81.87	36.29	255.27**
	(7.11)	(11.46)	(24.49)	(62.19)	(56.16)	(99.60)
	4863	4863	4661	2835	2835	2786
Instructor, Lecturer, or No Academic Rank	40.15***	-1.33	-29.47	213.74**	48.83	-120.11
	(5.51)	(11.78)	(19.36)	(102.92)	(46.09)	(79.72)
	5204	5204	4767	6807	6807	6686
Year FE	No	Yes	Yes	No	Yes	Yes
Institution FE	No	Yes	Yes	No	Yes	Yes
Additional Controls	No	Yes	Yes	No	Yes	Yes

Notes: The table shows regression results, standard errors that are robust to clustering at the state level (in parentheses), and sample sizes. A single asterisk denotes significance at the 10% level, a double asterisk denotes significance at the 5% level, and a triple asterisk denotes statistical significance at the 1% level.

Table 9: Average Salaries of Non-Instructional Staff

	Four-Year			Two-Year		
	OLS	OLS	IV	OLS	OLS	IV
Library and Student/Academic Affairs	27.85***	15.41	27.20	168.04***	24.60	27.77
	(5.84)	(10.48)	(38.42)	(42.86)	(28.18)	(76.39)
	5474	5474	5015	7110	7110	6999
Management	93.06***	41.23**	60.33	300.64***	70.26**	625.04***
	(15.92)	(15.77)	(39.43)	(79.77)	(34.93)	(201.62)
	5680	5680	5214	7253	7253	7132
Business and Financial Operations	30.84***	12.97***	66.01***	195.24***	44.12	-52.09
	(6.93)	(3.85)	(16.18)	(47.49)	(32.50)	(83.30)
	5621	5621	5157	7012	7012	6891
Office and Administrative Support	14.64***	11.51***	39.95***	146.96***	29.42	-112.36**
	(3.37)	(2.97)	(9.39)	(48.76)	(17.97)	(55.31)
	5680	5680	5214	7246	7246	7127
Year FE	No	Yes	Yes	No	Yes	Yes
Institution FE	No	Yes	Yes	No	Yes	Yes
Additional Controls	No	Yes	Yes	No	Yes	Yes

Notes: The table shows regression results, standard errors that are robust to clustering at the state level (in parentheses), and sample sizes. A single asterisk denotes significance at the 10% level, a double asterisk denotes significance at the 5% level, and a triple asterisk denotes statistical significance at the 1% level.

are instructors, lecturers, or without an academic rank. Overall, the results show that public higher education institutions use state appropriations in a variety of ways, but I do not find evidence that they replace contingent faculty with tenured or tenure-track faculty when appropriations rise.

The estimates shown in this paper are reduced form effects that can help understand policy impacts on higher education staffing and salaries when a state legislature decides to adjust higher education appropriations. However, colleges may make adjustments along other margins, such as tuition, financial aid, degree offerings, or fundraising efforts, when state appropriations change, and these changes may mediate the changes in staffing levels and salaries. Some of these outcomes have been the focus of prior work. For example, Bound et al. (2019) and Webber (2017) both find that lower public funding for higher education institutions leads to higher revenue from tuition, and Bound et al. (2019) also find that lower public funding leads to higher private gifts at research universities. Understanding the impacts on other outcomes could be an important avenue for future work.

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