Power in Numbers? Effects of Faculty Labor Unions on Compensation and Productivity

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February 6, 2017

Abstract

I study the impacts of faculty unionization within US higher education, focusing on bargaining units covering part-time non-tenure track faculty (adjuncts), full-time non-tenure track faculty (instructors), and full-time tenure track faculty (assistant, associate, and full professors). By exploiting variation in the timing of collective bargaining agreement ratification, I estimate effects on university spending for wages and benefits and teaching and research production. My estimates indicate that unions do not impact compensation. I also find that neither student retention rates nor student ratings of teaching quality respond to faculty unionization, which suggests that teaching productivity is unaffected. Estimates for student earnings and research output are less precise but also suggest no significant impacts.

*I am grateful to Heidi Williams, David Autor, and Joshua Angrist for their comments, encouragement, and guidance. I have benefitted from discussions with Pierre Azoulay and the MIT Labor Lunch participants. I thank Toy Vano at MTV/RateMyProfessors.com for providing student ratings data, Kathleen Kelly at Central Michigan University and Catherine Burns at Michigan Technological University for fulfilling Freedom of Information Act requests for faculty records, and Pierre Azoulay and Bruce Weinberg for their guidance and access to the Web of Science data. I gratefully acknowledge the financial support of the National Institutes of Health (under Grant No. P01-AG039347) as well as the National Science Foundation Graduate Research Fellowship program (under Grant No. 1122374). Any opinion, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Institutes of Health, the National Science Foundation, MTV/RateMyProfessors.com, or any of the institutions mentioned in this article.
1 Introduction

Collective bargaining agreements are an important feature of the higher education landscape, covering more than 25% of part-time faculty and 20% of full-time faculty at public and private non-profit institutions (Figure 1). Despite the prevalence of faculty labor unions and the controversy surrounding granting collective bargaining rights to college faculty, there is little rigorous evidence on their effects. This paper assesses the impacts of faculty unions on the teaching and research production process.

Arguments against faculty labor unions are predicated on the assumption that they deliver significant union premia. If faculty labor unions raise wages, this could either drain state resources, in the case of public-sector unions, or impose sizeable costs on private employers. Budgetary pressures have motivated state legislatures in Wisconsin, Tennessee, Idaho, and Ohio to pass legislation limiting the collective bargaining abilities of public-sector unions (Greenhouse 2014). However, it is not obvious that faculty labor unions capture rents, especially at public institutions. Most organized faculty at public institutions lack the right to strike. Furthermore, state legislatures usually control tuition revenue and state appropriations, the major funding sources that finance faculty salaries, so trustees at individual institutions may not be able to raise salaries even when facing union pressure (Enhrenberg et al. 2004).

Whether faculty labor unions lead to wages above competitive levels is important not only for understanding the financial implications for colleges and universities but also for understanding potential impacts on institutional productivity. If unions increase labor costs, institutions may increase tuition prices to cover the increased costs, resulting in increased prices for students. Alternatively, institutions may divert resources from other educational inputs to faculty compensation, potentially resulting in adverse effects for students. Regardless of how institutions absorb the cost increases, labor productivity as measured by teaching output per dollar spent may decrease. Faculty labor unions may also have a more direct effect on productivity by changing faculty effort (Ehrenberg et al. 2004). For example, unions may increase job security, especially for faculty outside the tenure system, so that
faculty can decrease teaching or research efforts without risk of job loss.

However, proponents of faculty unionization argue that unions will actually improve productivity, not decrease it (Ehrenberg et al. 2004). For example, unions may give faculty the power to push back against ever increasing spending on administration, prioritizing spending on research efforts or instructional programs. Moreover, faculty who are “in the trenches” may use their insights to inform institutional policies that will benefit their students. In this way, faculty unions may increase institutional productivity by giving faculty a greater voice in university governance (Hedrick et al. 2011).

This paper provides new evidence on how faculty labor unions affect faculty compensation and the productivity of public and private non-profit colleges and universities. Because union status is not randomly assigned, cross-sectional estimates comparing outcomes across institutions with unionized and non-unionized faculty may deliver biased estimates of the impact of unionization. Instead, I exploit variation in the timing of collective bargaining agreements, controlling for unobserved institution level factors impacting unionization. An event-study analysis allows me to test whether unionized and non-unionized institutions were on similar trends prior to unionization. For a wide variety of outcomes, I find that non-unionized and unionized institutions in the same state and institution type category (public or private non-profit) are on similar trends prior to unionization, providing support the parallel trends assumption underlying my differences-in-differences approach.

In the first part of my analysis, I revisit the question of whether faculty labor unions generate union premia, focusing on implications for college and university budgets, student tuition costs, and educational production. The few existing studies in the context of higher education have found either no significant impacts or relatively modest union premia for full-time faculty. Hosio and Siow (2004) estimate that Canadian faculty labor unions deliver a 2.4% wage premia at undergraduate universities and no significant premia at comprehensive institutions. Hedrick et al. (2011) conclude that after adjusting for cost of living differences, there is no union premium for full-time faculty members at US colleges and universities. Henson et al. (2012) limit their scope to two-year institutions, finding that there is a 3-5%
wage premium at these US colleges.

However, both US studies used random effects rather than fixed effects models. Since it is implausible that institution-specific factors influencing wages are uncorrelated with union adoption, random effects estimates are likely biased. Second, the studies do not examine impacts on benefits, which make up more than 20% of the total compensation paid to full-time college and university faculty in the US. It may be that a union premia takes the form of better benefits. Third, they neglect part-time, non-tenure track faculty for reasons of data availability. However, impacts for part-time instructors at US colleges and universities who are the largest and fastest growing segment of the postsecondary workforce may be quite different (Coalition on the Academic Workforce 2012). Part-time instructors, or “adjuncts” as they are commonly known, have wages so low that 1 in 3 lives below the federal poverty line and 1 in 4 collects some of government aid (Jacobs et al. 2015). Given that wages in the absence of unionization are quite low, there may be more scope for collective bargaining to lead to substantial wage gains. Adjunct unions are also the only relevant faculty group for private non-profit labor unions since the 1980 Supreme Court ruling in National Labor Relations Board v. Yeshiva University has made it nearly impossible for tenure-track faculty at private institutions to organize.

This paper addresses all three of these limitations, providing new evidence on the effects of faculty unions on compensation. Since I have longer and more comprehensive panel data that include both salary and benefits information at the institution-level, I estimate fixed effects models. Ultimately, though, I find very similar wage premia results to those in the existing literature. Unions covering full-time tenured/tenure-track faculty deliver no significant increases in wages or benefits, and my estimates rule out increases larger than 3%.

Previous studies have neglected part-time faculty for reasons of data availability. Rather than using mean wages reported at the rank level which are unavailable for adjuncts in any nationally representative dataset, I estimate whether there are any significant impacts on total spending on wages for instruction. I estimate that there is no statistically significant
change in spending on wages for instruction with the introduction of a collective bargaining agreement covering adjuncts. However, this effect is estimated imprecisely, and the 95% confidence interval cannot rule out effects as large as a 10% increase. There is no heterogeneity in the estimated effect by the adjunct-intensity of an institution which provides further support the conclusion that adjunct unions do not significantly impact wages for instruction. I also find that institutions do not substitute away from adjuncts towards other forms of teaching labor in response to unionization, and tuition rates do not significantly respond.

The second part of the paper provides evidence on how unions influence teaching and research productivity. Of the relatively little existing work looking at effects of labor unions on higher education productivity, the evidence is mixed. Cassell and Halaseh (2014) find that unions make public four-year institutions more efficient as measured by expenses per degree awarded. On the other hand, other studies find that research output declines after faculty unionize (Meador and Walters 1994; Hosio and Siow 2004).

I begin by looking at measures of teaching productivity. Specifically, I test whether faculty unions impact student retention rates or students’ post-graduation earnings using a national panel of US institutions. Then, for a small subset of recently unionized public institutions in Michigan, I analyze instructor ratings from RateMyProfessors.com. My results indicate that faculty unions have no consistently significant impacts on cohort-level student outcomes, and students posting ratings to RateMyProfessors.com do not report being more or less satisfied with instructors after they are covered by a collective bargaining agreement.

The research output results are less precise but tell a similar story. Using academic publications from a Web of Science/PubMed extract that corresponds to publications in the life sciences, I show that there is no statistically significant change in the number of publications after departments unionize. However, the estimates for total number of publications cannot rule out fairly large changes in research output in response to unionization of tenured/tenure-track faculty. Taken as a whole, the results are broadly suggestive that unions do not influence teaching quality or research output of the faculty they represent.

Section 2 that follows discusses the data sources. Section 3 presents results for the effects
of unions on faculty compensation, institutional input choices, and student tuition charges. Section 4 presents results for teaching quality, and Section 5 presents results for research output. Section 6 concludes.

2 Data

My main empirical analysis uses a directory of collective bargaining agreements and institution-level outcomes from a national panel of US colleges and universities. I also employ aggregated student earnings data and publication counts reported at the institution level to assess teaching and research productivity.

2.1 Data Description

I obtain my measure of unionization from the National Center for the Study of Collective Bargaining in Higher Education and the Professions 2012 Directory of Contracts and Bargaining Agents in Institutions of Higher Education (NCSCBHEP). This directory is a list of collective bargaining units at US institutions of higher education compiled by the NCSCBHEP, an impartial, nonprofit educational institution operating on the Brookdale Campus of Hunter College, City University of New York. The data provide a snapshot at one unit in time, although survey questions ask about when bargaining units were first formed and when the first bargaining agreement was approved. I use the first year a collective bargaining agreement went into effect as my measure of the first year for which a faculty group was unionized. The directory is up to date as of 2008, and I manually update unionization information for contracts that were set to expire up to 2009.

Most of my institution-level outcomes come from the National Center for Education Statistics Integrated Postsecondary Data System (IPEDS). The Integrated Postsecondary Education Data System (IPEDS) consists of nine interrelated survey components that are collected over three collection periods (Fall, Winter, Spring) each year. The data cover all institutions that participate in federal student aid programs since these institutions are required by the
Higher Education Act of 1965 to report data on enrollments, program completions, faculty and staff, finances, institutional prices, and student financial aid. The data are public-use and consist of aggregate data at the institution level. I combine the yearly surveys into a panel from 1999-2009.\(^1\) I restrict my sample to two and four-year US institutions, dropping any institutions that only grant certificates.

To supplement student outcome measures available in the IPEDS, I collect institution-cohort-level earnings data for students enrolling between 1993 and 2001 from the College Scorecard project. The College Scorecard Project is an effort from the U.S. Department of Education to provide more transparency in comparisons of college quality. Their cohort-level earnings measures come from U.S. Treasury linked de-identified tax records of federally aided students aggregated up to the institutional level.

My institution-level measure of research output consists of yearly counts of publications and citations from a PubMed/Web of Science extract that spans 1973-2009. The extract consists of all publications that have at least one US address and appear in the PubMed database. PubMed is a search engine used to access data maintained by the National Center for Biotechnology Information (NCBI) at the National Library of Medicine (NLM). It collects articles published in the biomedical literature from MEDLINE (a biomedical database created by the NLM), life science journals, and online books. Because PubMed does not contain citation information, the Web of Science, a citation database covering arts, humanities, science, and social sciences, is used to obtain citation counts for the articles in the PubMed extract. By using articles in PubMed, I limit my focus to the life sciences. I do this for several reasons of data availability and the fact that publication counts may be a poor measure of research output in non-science fields like humanities. Moreover, life sciences have relatively short lag times between when a researcher submits an article for review and when it is published: 9.5 months in biomedicine versus 17.7 months in business/economics (Bjork and Soloman 2013). The short lag makes it more likely that effects of increased research effort would be observable shortly after unionization.

\(^1\)Less than 10% of institutions report staff and salary information in pre-1999 surveys, so data from these years are unlikely to be representative of the industry as a whole.
2.2 Prevalence of Faculty Unions

Figure 1 shows the extent of unionization in terms of number of collective bargaining units and shares of faculty covered by an agreement. The top plot shows that the number of bargaining units has increased dramatically since the 1960s. As of 2009, there were collective bargaining agreements (CBAs) at 510 institutions covering full-time tenured or tenure track faculty, 378 covering adjuncts, and 313 covering full-time non-tenured. There were 3,538 two and four-year institutions operating in 2009, so this represents 14%, 11%, and 9% of operating institutions. The bottom plot puts these numbers in terms of shares of total faculty. Since IPEDS only collected reliable data on full-time faculty starting in 1990 and part-time non-tenure track faculty in 2002, the plot only corresponds to the more recent period. It is clear from the bottom plot that institutions with unionized faculty tend to be larger institutions since shares of faculty covered exceed shares of institutions for all three faculty rank categories.

Even though the most union growth occurred in the 1970s, there are still enough new unions between 1999 and 2009, the period of most of my outcomes data, to estimate effects of unionization with institution fixed effects specifications. Figure 2 shows the extent of my identifying variation. Over the 1999 to 2009 period, there were 71 new collective bargaining agreements for faculty units covering full-time tenured or tenure track faculty, 71 covering full-time non-tenured faculty, and 96 covering adjunct faculty.

3 Faculty Compensation

To assess impacts of faculty unionization, I adopt a differences-in-differences approach where other institutions in the same state with the same institutional control (public or private non-profit) are used as the counterfactual for what would have happened to labor conditions and institutional productivity. Models for faculty outcomes (i.e. wages and employment) take the general form:
\[ y_{isct} = \beta U_{it} + \alpha_i + \gamma_{sc} + \varepsilon_{isct} \]  

where \( y_{isct} \) is the outcome for a particular faculty rank group at institution \( i \) operating in state \( s \) with control type \( c \) (public or private non-profit) in year \( t \). \( U_{it} \) equals 1 if the faculty rank group at institution \( i \) was covered by a collective bargaining agreement in year \( t \). I include institution fixed effects (\( \alpha_i \)) to control for level differences across institutions as well as year by state by institution control type fixed effects. The identifying assumption is that outcomes for unionized institutions would have evolved similarly to those for non-unionized institutions in the same state and institution control type in the absence of unionization. To provide support for the plausibility of this assumption, I estimate event study specifications where I replace \( U_{it} \) with leads and lags relative to the first unionization year \( T_i \):

\[ y_{isct} = \sum_{j=-5}^{10} \beta_j \{ t - T_i = j - 1 \}_{it} + \alpha_i + \gamma_{sc} + \varepsilon_{isct} \]

In these models, the omitted category is the year prior to the first collective bargaining agreement.\(^2\)

I estimate effects separately by faculty rank (i.e. estimate a separate regression for each faculty rank group) because unions may benefit only some types of faculty and not others. Joel Waldfogel in his 2016 NBER working paper documents that higher-paid faculty, more productive faculty, and faculty in more politically conservative fields were more likely to sign open letters of union opposition. Faculty that oppose unionization may be those least likely to benefit from collective bargaining. Moreover, bargaining units may have different objective functions depending on what type of faculty they represent. While part-time instructors may be most concerned with compensation, tenure track faculty may be relatively more concerned with tipping teaching vs. research loads.\(^3\)

\(^2\)I estimate equations (1) and (2) limiting to the sample where time to CBA is less than or equal to 5 years and time since CBA is less than or equal to 10 years. This makes the results from the pre/post specifications and the event studies directly comparable.

\(^3\)Union contracts covering adjuncts tend to focus on compensation and job security. For example, the collective bargaining agreement recently negotiated by faculty at Lesley University enacts a 29% pay increase between 2015 and 2018, makes adjuncts eligible for health insurance benefits, and stipulates that the adjuncts must receive a 15% course cancellation payment if a course is cancelled within three weeks of the start date. If an employee teaches at least three courses per year over four years, s/he
The IPEDS Human Resources survey component collects data on mean wages by rank for all full-time faculty. This allows me to directly test whether average wages increase after collective bargaining agreements go into effect for these faculty. The dependent variable is the natural log of mean wages for the faculty rank (i.e. instructors, assistant professors, associate professors, or full professors). I cluster standard errors at the institution level.

Table 1 shows there is no evidence of a union wage premia for any rank of full-time faculty. The wage premia for instructors is small and statistically insignificant; the 95% confidence interval rules out increases larger than 1.7%. The estimated wage premia for the tenured/tenure track faculty ranks is -1.3% for assistant professors, -1.1% for associate professors, and -2.1% for full professors in the preferred specifications with year by state by institution type fixed effects, none of which are significantly different from zero. The 95% confidence intervals corresponding to these estimates rule out increases larger than 2.9%, 3.4%, and 3.1%. Event studies, shown in appendix Figures A.2 and A.1, show that full-time non-tenure track and tenured/tenure track professors were on similar wage trends to non-unionized institutions in their state and type category both before and after unionization.

Wages make up 78% of total compensation for full-time faculty in my sample. Benefits such as retirement contributions and health insurance make up the remainder. IPEDS does not collect data on benefits by rank but does collect data on average benefits across all full-time employees. Though prior work has found either no wage premia or very modest wage premia for full-time faculty, these studies have only used data on salaries. It may be that most of the increase in total compensation takes the form of better benefits. To test whether unions successfully negotiate for higher benefits, I estimate the following model with the natural log of mean monthly benefits as the dependent variable:

\[
y_{isct} = \beta_1 NTT_{isct} + \beta_2 TT_{isct} + \alpha_i + \gamma_{sct} + \varepsilon_{ict}
\]

(3)

must automatically receive a two-year appointment (Lesley University 2015). While contracts for full-time faculty also deal with compensation, salary increases tend to be more modest, and much attention is paid to teaching loads. A recent bargaining agreement covering full-time faculty within the University of Alaska System, for instance, specifies a 2% yearly increase in salaries relative to the previous contract. The agreement formalizes the tenure process and sets a limit on the number of credits a faculty member can be assigned to teach (University of Alaska 2014).
I code up union treatment variables separately for each of two important categories of faculty ranks: tenured or tenure-track full-time \((TT_{act})\) and non-tenure track full-time \((NTT_{act})\).

The estimates in Table 2 indicate that unionization does not significantly raise benefits for faculty. The point estimates for both types of unions are close to zero and statistically insignificant. However, the estimation is imprecise; the 95% confidence intervals cannot rule out effects as large as a 10% increase for non-tenure track full-time faculty and an 11% increase for tenured/tenure-track faculty in the specification with the most flexible year effects (column 3). The event studies in Appendix Figure A.3 show that there is also no pre-trend in benefits in the five years prior to unionization.

More unions have formed for part-time non-tenure track faculty than any other faculty group in the past decade, yet these faculty have been neglected in the faculty labor unions literature due to lack of data availability. IPEDS does not collect data on mean wages for part-time instructors. However, each institution does report total spending on wages for instruction of which a large component is likely spending on part-time instructional faculty (i.e. adjuncts). In order to shed light on compensation effects for adjuncts, I test whether total spending in this category increases after a collective bargaining agreement covering adjuncts goes into effect. I limit the sample to institutions that report employing at least 1 adjunct in 2002, the first year for which adjunct employment information is available. Then I regress the natural log of spending on wages for instruction on an indicator for the institution having a collective bargaining agreement covering adjuncts, institution fixed effects, and year by state by type fixed effects.

Table 3 shows that institutions do not spend significantly more on labor expenses for instruction after adjunct unionization. The estimate from column 2 implies that spending on wages for instruction increases by 4%, but this effect is not statistically significant.\(^4\) The specification in column 3 adds controls for each full-time faculty union (non-tenure or tenure/tenure-track). The point estimate barely changes, consistent with no significant union premia for full-time faculty.

\(^4\)The top plot of Appendix Figure A.4 shows the analogous event study.
If there is a positive effect on wages for instruction driven by adjunct unionization, we would expect institutions that employ greater numbers of adjuncts to drive the effect. I test this in the last three columns. I estimate a specification where I interact adjunct unionization with high adjunct utilization or low adjunct utilization. I define a college or university as having high or low adjunct utilization based on whether an institution employs more than the median number of adjuncts per full-time equivalent student in 2002, the first year for which this variable is reported in IPEDS. The point estimates suggest that the estimated effects are nearly identical for the two groups of institutions. Thus, the results are most consistent with the conclusion that adjunct unions do not significantly increase institutional spending on wages for instruction.

Also of interest is the impact of unions on the choice of labor inputs. Much attention has been paid to the “adjunctification” of the academy (Bettinger and Long 2010; USCHCEW 2014; Jacobs et al. 2015). It is possible that adjunct unions could encourage institutions to switch to more tenure track faculty if the work requirements imposed by CBAs covering adjuncts made employing adjuncts less attractive. As shown in Table 4, I find no statistically significant change in the use of adjunct labor after an adjunct union goes into effect. However, the point estimate from column 5 says that adjunct unionization decreases adjunct employment by about 7% (a decrease of 5.9 adjuncts per 1000 FTE off a mean of 88.2 adjuncts per 1000 FTE). I also find no statistically significant substitution towards graduate teaching assistants (TAs) at institutions which employ TAs. TAs are likely close substitutes for adjuncts, especially in introductory courses, so we might expect institutions to shift from employing many adjuncts to employing many TAs. Similarly, unions covering full-time faculty have no statistically significant impacts on employment of faculty in full-time ranks. The fact that I find no evidence of changes in labor inputs is perhaps unsurprising given that I found that unions do not affect spending on faculty wages.

5The bottom plot of Appendix Figure A.4 shows the analogous event study.
4 Teaching Quality

There are several channels through which unions can affect teaching quality. First, the teaching and research allocations negotiated in collective bargaining agreements may induce faculty to spend less or more time preparing course materials and interacting with students. Second, for part-time or non-tenured full-time faculty, unions may increase job security. Greater job security may reduce the risks of being fired, inducing less effort from teaching faculty. Alternatively, greater job security may increase the benefit to making long term investments in a particular institution, inducing more effort. Finally, unions may give faculty a voice in university governance, allowing them to raise or address problems affecting undergraduates at their institutions (Ehrenberg et al. 2004).

In this section, I investigate whether unions impact teaching quality as measured by shorter-term outcomes (student persistence and students’ satisfaction with their instruction) and longer term outcomes (earnings after graduation). Prior work at the primary and secondary school level has shown even when shorter-term outcomes such as high school dropout rates do not respond to teacher unions (Lovenheim 2009), adverse effects can appear for longer term outcomes such as earnings and labor force participation (Lovenheim and Willén 2015). Thus, examining both types of outcomes can provide a more complete picture of union effects.

4.1 Cohort-Level Outcomes: Retention and Earnings

My two college retention rate measures come from the IPEDS. Retention rates are measured as the percent of first-time degree/certificate seeking students enrolled in the fall who reenroll the following school year. A cohort is union treated if the cohort attended institution \(i\) in year \(t\) when faculty were unionized. I code up union treatment variables separately for each of three important categories of faculty ranks: tenured or tenure-track full-time (\(TT_{isct}\)), non-tenure track full-time (\(NTT_{isct}\)), and non-tenure track part-time, also known

\[\text{Retention rate} = \frac{\text{Number of students reenrolling}}{\text{Number of students enrolled in fall}}\]

\[\text{Retention rate} = 100 \times \frac{\text{Number of students reenrolling}}{\text{Number of students enrolled in fall}}\]

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6 The retention rate excludes any students who left the institution for one of the following reasons: died or were totally and permanently disabled; served in the armed forces (including those called to active duty); served with a foreign aid service of the Federal Government (e.g., Peace Corps); or served on official church missions.
as adjuncts, \((AU_{isct})\) and include all three as regressors:

\[
y_{isct} = \beta_1 AU_{isct} + \beta_2 NTT_{isct} + \beta_3 TT_{isct} + \alpha_i + \gamma_{sct} + \epsilon_{ict}
\]  

(4)

This specification flexibly allows for each type of union to have a separate impact on student outcomes \(y_{icst}\) and includes institution fixed effects and year by state by type fixed effects. I display the results in Table 5.

The first column of Table 5 shows that there are no statistically significant impacts on full-time retention rates from full-time tenure/tenure track (FT-TTT) unions or full-time non-tenure track unions (FT-NTT). The point estimates are very small, close to zero, and precisely estimated. The 95% confidence interval for the estimated impact of a FT-TTT union on the full-time retention rate is \([-3.9,+1.9]\) percentage points, and the 95% confidence interval for a FT-NTT union is \([-3.8,+2.1]\) percentage points. There is, however, a statistically significant positive effect of an adjunct union. The point estimate indicates that adjunct unions increase full-time retention rates by 1.7 percentage points. For part-time students (column 2), I have much less statistical power because there is greater year to year variation in retention rates. None of the effects are statistically significant, and the confidence intervals fail to exclude increases in retention rates up to 6.9 percentage points for FT-NTT unions and 6.2 percentage points for an adjunct union.

To complement the shorter-term retention results, I also estimate impacts on earnings measured 6 years after college entry. These data come from College Scorecard. Estimating impacts on the post-graduation outcomes is not as straightforward as for retention rates because cohorts are partially treated if they attended an institution in some years where faculty were unionized and other years where they were not. For models with these outcomes, I code up treatment variables so that the union indicators equal one if the cohort was ever exposed to a faculty group that was unionized at any of their first four years for students at four-year institutions and for any of the first two years for students at two-year institutions.\(^7\)

\(^7\)I have also estimated models where I consider a cohort “treated” only if the faculty group was unionized during all of their first four years or first two years. The results are very similar.
The evidence for the impact of a FT-TTT faculty union indicates that these unions had, if anything, a negative impact on earnings. All the point estimates are negative, though only the effect for the 10th percentile of the earnings distribution (column 4) is statistically significant at conventional levels. This coefficient implies that a tenured/tenure-track faculty union reduces wages for the cohort of students exposed to the union at the 10th percentile by 6%. There is no clear pattern on the sign of impacts of non-tenure track or adjunct unions, and all of these effects are estimated to be small and statistically insignificant at conventional levels.

4.2 Student Satisfaction: Evidence from RateMyProfessors.com

The fact that student outcomes I examine above are reported at the cohort-institution level may make it difficult to detect effects. Since students take many courses over the course of their college experience, some taught by tenured faculty, some non-tenured faculty, and others adjuncts, the estimated impacts are partial treatment effects. I present results for one additional outcome reported at the instructor-year level: student satisfaction as revealed in RateMyProfessors.com (RMP) ratings.

There are several advantages to having an outcome at the instructor-year rather than cohort-institution-year level. First, the outcome corresponds to a faculty member was fully treated or not treated. Second, because institutions have variation in treated and non-treated faculty members due to bargaining units covering some ranks but not others, I am able to estimate triple-differences specifications. These specifications which include institution by year fixed effects, more flexibly control for institution-year shocks impacting all students at the institution in a particular year.

Unfortunately, RateMyProfessors records only the name of each instructor, not her official title or rank. For five public institutions in Michigan (University of Michigan-Ann Arbor, University of Michigan-Flint, University of Michigan-Dearborn, Central Michigan University, and Eastern Michigan University), I obtained administrative faculty records to determine whether a particular instructor had a rank covered by a collective bargaining
I linked the faculty records with RateMyProfessors ratings by performing a fuzzy match using instructor name, requiring an exact match on institution and year, and checked all the proposed matches by hand. Of all the RateMyProfessors ratings for the five institutions, I match 72% to faculty in my faculty records. Not all faculty are rated by students posting on RateMyProfessors.com; 47% have at least one rating and 32% have at least five ratings.

Because I am only able to carry out the analysis for these five institutions in Michigan, results from this analysis may not generalize to private institutions or institutions in other states. In addition, none of the five have variation in whether tenured/tenured track faculty are unionized over the time period for which I have data, so I am unable to estimate effects of tenured/tenure track unions. Nevertheless, the results shed light on how adjunct and full-time instructor unions affect student perceptions of teaching.

Because there is little work establishing a link between real learning outcomes and instructor ratings, I think of the RMP ratings like a customer satisfaction measure, rather than a direct measure of instructional quality. However, administrators at many schools do use traditional student teaching evaluations in hiring, promotion, and compensation decisions. Coladarci and Kornfield (2007) document that the correlation between the RMP overall quality measure and formal in-class student evaluations of teaching are 0.68 at the University of Maine which suggests that RMP ratings have some of the same information content as traditional in class evaluations. I was unable to obtain traditional in-class evaluations for any institutions in Michigan, so I am unable to test this correlation in my sample.

My preferred specification is a triple differences model of the following form:

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8 These were the only public institutions with variation in whether adjuncts or non-tenure track faculty are unionized during the period of the RateMyProfessors ratings data (1999-2015), were willing to provide faculty records, and that had sufficient job title/rank detail in the faculty records to identify adjunct vs. non-tenured full-time vs. tenured/tenure track full-time positions.

9 The RateMyProfessors data span 1999-2015, but my faculty records span 2001-2013 for the University of Michigan schools, 2007-2015 for Eastern Michigan University, and 2001-2013 for Central Michigan University. Therefore, I am not able to use all years of the RMP data for these institutions. As an additional analysis, I performed a less conservative match where I generated a list of faculty that did not change their rank over the time period of the institution's faculty records. Then I matched ratings to faculty in this list, including ratings from years for which I did not have faculty records, assuming that the rank would be the same in these years as well. The results are robust to this less conservative matching approach. I find no significant impact of either union type.

10 The match rate is less than 100% for several reasons. It is common for RateMyProfessors.com to have a nickname listed for the instructor rather than the formal name as appears in administrative faculty records. I allow matches for very common nicknames (i.e. “Bill” for “William”) but err on the side of being conservative for non-common nicknames. Moreover, I have faculty records for fewer years than the RMP ratings, so there are some faculty who work at these institutions in years preceding or following record availability and not in the years for which I have records.
\[ R_{eit} = \beta_1 AU_{eit} + \beta_2 NTT_{eit} + \delta_e + \gamma_{it} + \varepsilon_{eit} \] (5)

The rating outcome \( R_{eit} \) is for “helpfulness” or “clarity”; these ratings range from 1 and 5.\(^{11}\) \( AU_{eit} \) and \( NTT_{eit} \) equal 1 if employee \( e \) was an adjunct or full-time instructor at institution \( i \) in year \( t \) in a post-union year. I include institution by year fixed effects (\( \gamma_{it} \)) to control for any institution-level shocks impacting students’ perception of teaching quality and employee fixed effects (\( \delta_e \)) to control for time-invariant characteristics of instructors. Tenure-track faculty help identify the institution-year shocks. In an event study specification, I replace the post-union indicators with leads and lags for 5 years before and 5 years after unionization.

The triple-differences event study plots that include employee fixed effects in Figure 3 provide evidence that teaching faculty and tenure track faculty at the same universities were on similar ratings trends prior to teaching faculty unionization. In the five years following unionization, there is no significant change in average ratings for unionized teaching instructors relative to the tenured or tenure track faculty not covered by the collective bargaining agreements. However, if I do not include employee fixed effects (Appendix Figure A.6), I find that adjuncts and full-time instructors have significantly higher ratings than the full-time tenured/tenure track faculty both prior to unionization and after. These event studies inform my choice of the preferred specification with employee fixed effects. Conceptually, employee fixed effects specifications compare student satisfaction with the same adjunct/instructor before and after unionization, so this approach allows for a cleaner identification of how teaching effort is potentially changing when a faculty member switches from non-unionized to unionized.

In the pre-post specification presented in Table 6, the point estimates from the preferred specification with employee fixed effects (columns 2 and 4) are small and statistically insignificant for both adjuncts and full-time instructors. The 95% confident interval for the impact of the adjunct union on students’ perceptions of helpfulness of adjuncts is \([-0.09,0.16]\). The analogous confidence interval for instructors is \([-0.12,0.08]\). The results for clarity are

\(^{11}\) Appendix Figure A.5 shows the distribution of RMP ratings for my sample.
nearly identical: [-0.14,0.10] for adjuncts and [-0.13,0.07] for instructors. The confidence intervals rule out effect sizes larger than about 1/10 of a standard deviation in either direction where the standard deviation is measured across instructors.\footnote{The standard deviation in both mean instructor helpfulness and clarity is 1 point on the 5 point rating scale.} This evidence suggests that students are no more or less satisfied with the instruction they receive once their teaching faculty unionize.

5 Research Output

Teaching is not the only outcome of interest for colleges and universities. Research is just as important, especially for tenured or tenure track faculty at research-focused departments. In 2014, the US spent $67 billion on research and development within colleges and universities; nearly $38 billion came directly from the federal government and another $16 billion came from institutions themselves (NSF 2015). Unions may impact the research productivity of institutions by limiting teaching responsibilities so that faculty have more time to devote to research. It is also possible that giving faculty a greater say in university governance shifts university budgets in a way that favors research output.

To examine how unions impact the extensive margin of research output, I use counts of life sciences publications at the institution-year level from the Web of Science/PubMed extract to estimate the following linear probability model:\footnote{The middle plot in Appendix Figure A.7 shows that the median institution in the sample has 0 publications up until the late 1990s, which is why I start by looking at this extensive margin.}

$$A_{it} = \beta U_{it} + \alpha_i + \gamma_t + \varepsilon_{it}$$ (6)

The outcome of interest, $A_{it}$, is an indicator for institution $i$ having any life sciences publications in year $t$, and the regressor of interest, $U_{it}$, is an indicator for whether the the tenured/tenure track faculty are unionized in year $t$ at institution $i$. The specification includes institution fixed effects ($\alpha_i$) and year fixed effects to control for a time trend in the field of life sciences ($\gamma_t$). I cluster the standard errors at the department level. I also estimate
an analogous event study specification where I replace $U_{it}$ with lead and lag indicators.

The top event study in Figure 4 shows that unionization does not change the probability that an institution has at least one publication in a given year. There is no pre-trend in the five years prior to unionization, and the 95% confidence interval for the effect of unionization in the pre-post specification (column 1 of Table 7) is $[-1.8, +5.8]$ percentage points.

Faculty unionization may have very little impact on the extensive margin because institutions on the margin of having 0 or 1 publications are teaching intensive institutions. To estimate the effects of unions on the intensive research margin, I first limit the sample to institutions with at least five publications in the first five years of my publication counts sample (1973-1977).\(^{14}\) Then, I estimate a Poisson model of total publications (as well as total citations) in each year using data from 1978 and later to model the count nature of the data. The conditional mean function for institution $i$ in year $t$ is as follows:

$$E[y_{it}|x_{it}] = \exp\{\alpha_i + \gamma_{qt} + \beta U_{it}\}$$

This specification includes institution fixed effects ($\alpha_i$) as well as year by pre-1977 research intensity quintile fixed effects ($\gamma_{qt}$). I prefer this specification with a flexible set of time fixed effects because models with only year effects reveal a pre-trend (Appendix Figure A.8). However, I still report estimates from the year fixed effects model in Table 7. I estimate the model using quasi-maximum likelihood estimation (Wooldridge 1997; Gouriéroux et al. 1984) and cluster the standard errors at the department level. I also plot results from the analogous event study specification where I replace $U_{it}$ with lead and lag indicators.

The middle event study in Figure 4 shows that there is no statistically significant impact of faculty unionization on the number of publications. The bottom event study shows that the impact on total citations is, if anything, negative, but only two of the five post-unionization event study indicators are statistically significant at the 5% level. Table 7 shows the preferred pre/post model as well as the pre-post model with only year fixed effects. There is no

\(^{14}\)The bottom plot in Appendix Figure A.7 shows the median number of publications in each year of the sample for this group of institutions.
statistically significant impact of faculty unionization on the total number of publications or total citations. However, the confidence intervals are extremely wide and cannot rule out meaningfully large effects in either direction. The 95% confidence interval for publications is [-25%,14%] (column 4), and the 95% confidence interval for citations is [-43%,10%] (column 6). Ultimately, the empirical approach lacks power to estimate effects of faculty unionization on the intensive margin of research output.

6 Conclusion

This paper provides new evidence on the impact of faculty labor unions in US higher education. Using data from a national panel of public and private non-profit colleges and universities, I document that there is no significant change in compensation for full-time faculty after unionization. The estimates are precise and allow me to rule out wage increases larger than 3% for all full-time faculty ranks. The impact on benefits is estimated less precisely, but I similarly find no statistically significant evidence that unions impact benefits for full-time faculty. Lacking rank-level data on wages for part-time faculty, I instead test whether total spending on wages for instruction changes with adjunct unionization. I find that adjunct unions do not have a statistically significant effect on on instructional wages, and institutions do not appear to substitute towards other forms of instructional faculty in response to the adjunct unionization. All in all, the evidence indicates that faculty unions do not impose additional costs on colleges and universities.

The second part of the paper investigates how unions influence teaching and research production. I find little robust evidence that faculty unions impact students as measured by retention rates or students’ post-graduation earnings. Moreover, an analysis of ratings from RateMyProfessors.com for non-tenured faculty at five public institutions in Michigan that recently unionized reveals that students are no more or less satisfied with the instruction they receive after unionization. The research output results are less precise but tell a similar story. Focusing attention on articles published in life sciences fields, I document that there is no
statistically significant change in the number of publications after tenure/tenure-track faculty unionize. However, the estimates for total publications and total citations are too imprecise to rule out large increases or decreases in research output in response to unionization.
References


Web of Science. Thomas Reuter’s. https://www.webofknowledge.com/

Figure 1: Unionization Over Time

Number of Collective Bargaining Units

Share of Faculty


Notes: The sample of institutions for both plots is the set of Title IV participating public and private non-profit institutions offering two-year or four-year degrees. The top panel shows the number of bargaining units with active collective bargaining agreements in each year broken out by the type of faculty covered. The bottom panel shows the share of faculty covered by a collective bargaining agreement. The adjunct plot starts in 2002 because this is the first year for which IPEDS reports data on the number of part-time non-tenure track instructional faculty.
Figure 2: New Collective Bargaining Agreements 1999-2009

Histogram: Year of First Collective Bargaining Agreement


Notes: The figure plots the number of Title IV participating public and private non-profit institutions offering two-year or four-year degrees for which the first year collective bargaining agreement took effect between 1999 and 2009.
Figure 3: Impact of Unionization on RateMyProfessor Instructor Ratings

Institutions: University of Michigan- Ann Arbor, University of Michigan- Flint, University of Michigan- Dearborn, Central Michigan University, Eastern Michigan University

Source: Data provided by RateMyProfessors.com
Notes: The two plots show different coefficients from the same regression where there are two sets of leads and lags: one for adjunct unions and another set for full-time instructor unions. The specification includes year by institution fixed effects and instructor fixed effects. The omitted category is one year prior to when the first collective bargaining agreement took effect. Standard errors are clustered at the instructor level.
Figure 4: Impact of Tenure-Track Faculty Union on Life Sciences Publications

- **Any Publications**
  - Union Type: Full Time Tenure Track Faculty Union
  - Coeff 95% CI

- **Number of Publications**
  - Union Type: Full Time Tenure Track Faculty Union
  - Coeff 95% CI

- **Total Citations**
  - Union Type: Full Time Tenure Track Faculty Union
  - Coeff 95% CI

Source: Web of Science/PubMed publications matched by author to institutions based on researcher address information

Notes: The sample used to construct publication counts consists of publications from the Web of Science that have at least one US address and appear in the PubMed database. Any institution with at least one publication between 1973 and 2009 is included in the institution sample. Any institution with at least five publications between 1973 and 1977 is included in the sample for the middle and bottom plot. All specifications include institution fixed effects and year fixed effects. The omitted category is one year prior to when the first collective bargaining agreement took effect. To increase statistical power, I include event study indicators for each two year period rather than each year. Standard errors are clustered at the institution level.
<table>
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<th>(4)</th>
<th>(5)</th>
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<td>(0.019)</td>
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<td>(0.019)</td>
<td>(0.021)</td>
<td>(0.018)</td>
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Source: National Center for Education Statistics Integrated Postsecondary Data System Instructional Staff and Salary Files
Notes: Each column is a separate regression. All specifications include institution fixed effects. Sample sizes differ across columns since not all institutions employ all six types of full-time faculty. Standard errors are clustered at the institution level.
*: p<0.10, **: p<0.05, ***: p<0.01
Table 2: Union Benefit Premia for Full-Time Instructional Faculty

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<td></td>
<td>(0.039)</td>
<td>(0.036)</td>
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<td>Tenured/Tenure Track Unionized</td>
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Source: National Center for Education Statistics Integrated Postsecondary Data System Instructional Staff and Salary Files

Notes: Each column is a separate regression. All specifications include institution fixed effects. Standard errors are clustered at the institution level.

*: p<0.10, **: p<0.05, ***: p<0.01
Table 3: Effects of Adjunct Unions on Ln Wages for Instruction

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<td>Adjuncts Unionized</td>
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<td>0.043</td>
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<td>(0.023)</td>
<td>(0.030)</td>
<td>(0.031)</td>
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**Panel A: Basic Specification**

| Adjuncts Unionized x High Adjunct Utilization | 15.748 | 0.020  | 0.043  | 0.043  |
|                                              |        | (0.037)| (0.044)| (0.045)|

**Panel B: Heterogeneity in Adjunct Union Effect**

| Adjuncts Unionized x Low Adjunct Utilization | 16.232 | 0.022  | 0.039  | 0.043  |
|                                              |        | (0.029)| (0.032)| (0.032)|
| Controls for FT Faculty Union                 | No     | No     | Yes    | No     | No     | Yes    |
| Year by State FE                              | Yes    | No     | No     | Yes    | No     | No     |
| Year by State by Type FE                      | No     | Yes    | Yes    | No     | Yes    | Yes    |
| Institution-Year Observations                 | 20,122 | 20,122 | 20,122 | 20,122 | 20,122 | 20,122 |

Source: National Center for Education Statistics Integrated Postsecondary Data System Delta Cost File

Notes: Each column in each panel is a separate regression. The sample includes institutions that report employing at least 1 adjunct in 2002, the first year for which adjunct employment data is available. An institution is defined to have high adjunct utilization if it employs above the median number of adjuncts per full-time equivalent (FTE) student in 2002 (i.e. above 0.0487 adjuncts per FTE student). An institution is defined to have low adjunct utilization if it employs below the median number of adjuncts per full-time equivalent student in 2002. Standard errors are clustered at the institution level.

*: p<0.10, **: p<0.05, ***: p<0.01
Table 4: Effect of Faculty Unions on Employment

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<tr>
<td>Full Professors per 1000 FTE</td>
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<td>Assistant Professors per 1000 FTE</td>
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<td>Full-time Instructors per 1000 FTE</td>
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<tr>
<td>Adjuncts per 1000 FTE</td>
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<tr>
<td>Teaching Assistants per 1000 FTE</td>
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<td>(5.77)</td>
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Source: National Center for Education Statistics Integrated Postsecondary Data System Instructional Staff and Salary Files and Employees by Assigned Position Files

Notes: Each column is a separate regression. All specifications include institution fixed effects and state by year by type fixed effects. Standard errors are clustered at the institution level.

*: p<0.10, **:p<0.05, ***:p<0.01
Table 5: Effect of Unions on Student Outcomes

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<td>Retention Rate for Full-Time Students</td>
<td>Retention Rate for Part-Time Students</td>
<td>Fraction Working</td>
<td>10th Percentile of Earnings</td>
<td>50th Percentile of Earnings</td>
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Source: National Center for Education Statistics Integrated Postsecondary Education Data System Fall Enrollment Files (columns 1-2); U.S. Department of Education College Scorecard Data (columns 3-6)

Notes: Each column is a separate regression. All specifications include institution fixed effects and state by type by year fixed effects. Standard errors are clustered at the institution level.

*: p<0.10, **: p<0.05, ***: p<0.01
Table 6: Triple Differences Estimate of Impact of Unionization on Student Satisfaction with Teaching

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<td></td>
<td>(0.058)</td>
<td>(0.064)</td>
<td>(0.057)</td>
<td>(0.059)</td>
</tr>
<tr>
<td>Full-Time Instructors Unionized</td>
<td>0.276***</td>
<td>-0.024</td>
<td>0.300***</td>
<td>-0.028</td>
</tr>
<tr>
<td></td>
<td>(0.069)</td>
<td>(0.053)</td>
<td>(0.068)</td>
<td>(0.050)</td>
</tr>
<tr>
<td>Employee FE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Year by Institution FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Ratings</td>
<td>98,417</td>
<td>98,417</td>
<td>98,417</td>
<td>98,417</td>
</tr>
<tr>
<td>Institutions</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Source: Data provided by RateMyProfessors.com
Notes: Each column is a separate regression. Standard errors are clustered at the instructor level.
*: p<0.10, **:p<0.05, ***:p<0.01
### Table 7: Effect of Unionization on Life Sciences Publication Counts

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Any Publications</td>
<td>Total Publications</td>
<td>Total Citations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenure/Tenure Track</td>
<td>0.020</td>
<td>0.044</td>
<td>0.095</td>
<td>-0.054</td>
<td>0.015</td>
<td>-0.169</td>
</tr>
<tr>
<td>Faculty Unionized</td>
<td>(0.020)</td>
<td>(0.031)</td>
<td>(0.101)</td>
<td>(0.101)</td>
<td>(0.134)</td>
<td>(0.137)</td>
</tr>
<tr>
<td>Number of Institutions</td>
<td>35,797</td>
<td>12,275</td>
<td>10,365</td>
<td>10,365</td>
<td>10,365</td>
<td>10,365</td>
</tr>
<tr>
<td>Total Publications</td>
<td>1124</td>
<td>399</td>
<td>399</td>
<td>399</td>
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<td>399</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Year by Research Intensity Bin FE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Source: Web of Science/PubMed  
Notes: Columns 1-2 show the results of an OLS regression. Columns 3-6 show the results from Poisson regressions. Columns 3-6 limit the sample to institutions who have at least five publications in the first five years of the sample (1973-1977) and then estimate effects using publications in years 1978-2009. All specifications include institution fixed effects. Standard errors are clustered at the institution level.  
*: p<0.10, **:p<0.05, ***:p<0.01
Appendix Figures

Figure A.1: Event Studies for Effect of a Non-Tenure Track Union on Faculty Salaries

Notes: All specifications include year by institution type by state fixed effects and institution fixed effects. The omitted category is one year prior to when the first collective bargaining agreement took effect. Standard errors are clustered at the institution level.
Figure A.2: Event Studies for the Effect of a Tenure/Tenure Track Union on Faculty Salaries

Notes: All specifications include year by institution type by state fixed effects and institution fixed effects. The omitted category is one year prior to when the first collective bargaining agreement took effect. Standard errors are clustered at the institution level.
Figure A.3: Event Studies for the Effect of a Tenure/Tenure Track Union on Benefits for Full-Time Faculty

Notes: The two plots show different coefficients from the same regression where there are two sets of leads and lags: one for full-time tenure track unions and another set for full-time non tenure-track unions. The specification includes year by state by institution type fixed effects and instructor fixed effects. The omitted category is one year prior to when the first collective bargaining agreement took effect. Standard errors are clustered at the institution level.
Figure A.4: Event Studies for the Effect of an Adjunct Union on Instructional Spending on Wages

Notes: The event study specifications include year by state by institution type fixed effects and institution fixed effects. The omitted category is one year prior to when the first collective bargaining agreement took effect. Standard errors are clustered at the institution level.
Figure A.5: Distribution of Rate My Professor Ratings for Select Michigan Institutions

Institutions: University of Michigan- Ann Arbor, University of Michigan- Flint, University of Michigan- Dearborn, Central Michigan University, Eastern Michigan University

Source: Data provided by RateMyProfessors.com
Notes: The overall rating is the average of the the clarity and helpfulness rating.
Figure A.6: Impact of Unionization on RateMyProfessor Instructor Ratings

Institutions: University of Michigan- Ann Arbor, University of Michigan- Flint, University of Michigan- Dearborn, Central Michigan University, Eastern Michigan University

Source: Data provided by RateMyProfessors.com
Notes: The two plots show different coefficients from the same regression where there are two sets of leads and lags: one for adjunct unions and another set for full-time instructor unions. The specification includes year by institution fixed effects only. The omitted category is one year prior to when the first collective bargaining agreement took effect. Standard errors are clustered at the instructor level.
Figure A.7: Publications Over Time

Source: Web of Science/PubMed publications matched by author to institutions based on researcher address information
Notes: The sample consists of publications from the Web of Science that have at least one US address and appear in the PubMed database.
Figure A.8: Research Output Event Studies with Year Fixed Effects

Source: Web of Science/PubMed publications matched by author to institutions based on researcher address information.

Notes: The sample used to construct publication counts consists of publications from the Web of Science that have at least one US address and appear in the PubMed database. Any institution with at least one publication between 1973 and 2009 is included in the sample for the top plot. Any institution with at least five publications between 1973 and 1977 is included in the sample for the middle and bottom plot. All specifications include institution fixed effects and year fixed effects. The omitted category is one year prior to when the first collective bargaining agreement took effect. To increase statistical power, I include event study indicators for each two year period rather than each year. Standard errors are clustered at the institution level.
Data Appendix

Identifying Types of Faculty Covered by Collective Bargaining Agreements

I used both the 2006 and 2012 NCSCBHEP directories to identify which institutions had collective bargaining agreements and to identify which faculty types were covered under these agreements. The 2012 directory classifies a bargaining agreement as covering one of more of the following: full-time tenure track/tenured faculty, full-time non-tenure track faculty, part-time tenure track faculty, part-time non-tenure track faculty, and non-instructional faculty. The 2006 directory classifies a bargaining agreement as covering one or more of the following: full time, part-time, adjuncts, and librarians. When available, I use the 2012 classification. If a 2012 classification is not available, either because the bargaining agreement was in effect only during the 2006 directory data collection period or because the type of faculty covered was missing in the 2012 directory, I use the 2006 classifications to impute the union types covered as follows: adjuncts are treated as PT-NTT faculty, part-time faculty are treated as PT-TTT, and full time faculty are marked as covering both FT-TTT and FT-NTT faculty.

Bargaining Agent Decertifications

To account for bargaining units that were in effect for some of the sample period but then decertified, I use the tables of decertifications listed in the 2006 and 2012 directories. The 2006 directory lists decertifications back to the 1970s so this covers decertifications far enough back to cover the research output analysis period of 1973-2009. To determine which faculty types were covered by these decertified bargaining agents, I use the following method:

1. If the bargaining unit appears in the 2006 directory, I use the 2006 classifications to impute faculty types covered.
2. If the bargaining unit does not appear in the 2006 directory, I use information from the 1998 directory. In particular, if the unit is listed under adjunct faculty bargaining units, I code the CBA as covering PT-NTT faculty. If the unit is listed under faculty bargaining units but does not have any additional details about who is covered, I code it as covering FT-TTT, FT-NTT, and PT-TTT. If there is a separate line for part-time faculty, I code that line as covering PT-TTT. If there is a separate adjunct line, I code that line as covering PT-NTT. If the line has “ft,” I code it only as covering FT-TTT and FT-NTT.

Matching Unionization Data to Institution-Level Data

The IPEDS data has numeric identifiers, six digit UNITIDs, while the NCSCBHEP data has only institution names. Therefore, it is necessary to match UNITIDs to institution names and bargaining agreements. In the excel file version of the bargaining agreement directory, the institution names are given but not individual campuses for university systems. Because the UNITIDs correspond to individual campuses in public university systems, I created a crosswalk between bargaining unit entries in the excel file and UNITIDs corresponding to these bargaining units with the help of details in the excel file as well as campuses listed in the pdf version of the directory. In many cases, a single bargaining unit entry corresponds to several UNITIDs. For example, there are three four-year institutions part of the University of Alaska system (University of Alaska-Anchorage, University of Alaska-Fairbanks, and University of Alaska-Southeast.) There are two bargaining agreements covering these three institutions- one for full time faculty and another for part time faculty. I duplicate the bargaining unit entry information 3 times, assigning each of the UNITIDs to each agreement. The final desired format of the data has unitid as the unit of observation.

Constructing the IPEDS Panel Dataset

I construct the IPEDS panel by combining complete cross-sectional IPEDS files from 1987 to 2009, when available. Some outcome variables such as the counts of employed graduate student assistants and part-time instructional faculty are available only starting in 2002, so in these cases, I combine files from 2002 to 2009. Finance variables come from the 1987 to 2009 Delta Cost Project since this longitudinal database maintained
by the National Center for Education Statistics has already standardized the finance variables across public and private institutions over my time period of interest.

Assigning PubMed/Web of Science Publications Data to Institutions

Starting with a set of publications from the Web of Science between 1973 and 2009 that have at least one US address and appear in the PubMed database (N=8,070,610), I use information in the author address fields to assign publications to US colleges and universities. To limit my scope to publications from faculty at US institutions of higher education, I eliminate any publications that do not have “UNIVERSITY” or “COLLEGE” or a common US institution name such as “MIT,” “CALTECH,” “RENNSELAER POLYTECHNIC INSTITUTE,” or “VIRGINIA TECH”\textsuperscript{15} in the author organization name. For the set of remaining organization names, I created a crosswalk from author organization name and author city to IPEDS UNITID by hand. I specifically exclude any organization names that correspond to university-affiliated hospitals, medical centers, or medical schools to focus on publications from faculty in sciences departments. A total of N=2,772,831 publications are matched to a (non-medical school) US college or university.

\textsuperscript{15}I identified these other strings associated with US colleges and universities by looking through commonly dropped publication author organization names by hand.