ANNENBERG
BROWN UNIVERSITY

EdWorkingPaper No. 21-387

Making College Affordable? The Impacts of Tuition Freezes and Caps

Lois Miller
University of Wisconsin, Madison

Minseon Park
University of Wisconsin, Madison

Many state governments impose tuition regulations on universities in pursuit of college affordability. How effective are these regulations? We study how universities' ``sticker price'' and institutional financial aid change during and after tuition caps and freezes by leveraging temporal and geographic variation in the United States from 1990 to 2013. We find that listed tuition is lower than it would have been in the absence of the regulation by 6.3 (9.3) percentage points at four-year (two-year) colleges during the regulation. Meanwhile, the negative impact on institutional aid at four-year colleges during a tuition cap/freeze is nearly double (-11.3 percentage points) the impact on listed tuition, implying that universities adjust institutional aid in order to recoup some of their losses from the tuition cap/freeze. Effects are long-lasting at four-year institutions; two years after the regulation is lifted, tuition is 7.3 percentage points lower and institutional aid is 19.5 percentage points lower than it would have been without the regulation. Meanwhile at two-year colleges, tuition ``catches up'' so that by three years after the end of the regulation tuition is not statistically different from what it would have been in the absence of the regulation. Universities that are not research-intensive and universities that have a greater dependency on tuition revenue exhibit larger negative impacts on institutional aid with smaller impacts on ``sticker price''. Our estimates suggest that tuition caps and freezes do not simply lower the prices that students pay for college and that the benefit of tuition regulations is unequally spread across types of universities and students.

VERSION: April 2021

Suggested citation: Miller, Lois, and Minseon Park. (2021). Making College Affordable? The Impacts of Tuition Freezes and Caps. (EdWorkingPaper: 21-387). Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/f9ny-7284

Making College Affordable? The Impacts of Tuition Freezes and Caps*

Lois Miller and Minseon Park†

April 19, 2021

Abstract

Many state governments impose tuition regulations on universities in pursuit of college affordability. How effective are these regulations? We study how universities' "sticker price" and institutional financial aid change during and after tuition caps and freezes by leveraging temporal and geographic variation in the United States from 1990 to 2013. We find that listed tuition is lower than it would have been in the absence of the regulation by 6.3 (9.3) percentage points at four-year (two-year) colleges during the regulation. Meanwhile, the negative impact on institutional aid at four-year colleges during a tuition cap/freeze is nearly double (-11.3 percentage points) the impact on listed tuition, implying that universities adjust institutional aid in order to recoup some of their losses from the tuition cap/freeze. Effects are long-lasting at four-year institutions; two years after the regulation is lifted, tuition is 7.3 percentage points lower and institutional aid is 19.5 percentage points lower than it would have been without the regulation. Meanwhile at two-year colleges, tuition "catches up" so that by three years after the end of the regulation tuition is not statistically different from what it would have been in the absence of the regulation. Universities that are not research-intensive and universities that have a greater dependency on tuition revenue exhibit larger negative impacts on institutional aid with smaller impacts on "sticker price". Our estimates suggest that tuition caps and freezes do not simply lower the prices that students pay for college and that the benefit of tuition regulations is unequally spread across types of universities and students.

Keywords: Cost of Higher Education, Tuition Freezes/Caps, Institutional Financial Aid.

JEL codes: H75, I21, I25.

*We are grateful to Chris Taber for invaluable guidance. We thank Drew Anderson, Emily Cook, Chao Fu, Nick Hillman, John Kennan, Sarah Pingel, Jeff Smith, Andria Smythe, and seminar participants at the University of Wisconsin-Madison, E-con of Ed Graduate Student Workshop, and the Association for Education Finance and Policy (AEFP) for helpful comments and suggestions.

†Department of Economics, University of Wisconsin, Madison.

1 Introduction

In the face of concerns about college affordability, tuition freezes and caps are becoming an increasingly popular policy tool for state governments to regulate public universities. They are a rare set of policies that often receive bipartisan support. Both parties frame freezes and caps as beneficial for state residents, who will be enabled to affordably obtain a college education.

A tuition freeze or cap occurs when a state government sets limits on the amount that universities are allowed to raise tuition from year to year. Typically, a "freeze" occurs when universities are banned from raising nominal tuition at all. However, states will frequently impose limits on the percent that universities are allowed to increase tuition (e.g. 3%/year), rather than fully freezing tuition. From 1990 to 2013, seventeen states implemented a tuition freeze or cap at least once, affecting 2-3% of institutions and 7-8% of students each year (Deming and Walters, 2017). These tuition regulations typically only affect the in-state undergraduate tuition level.

From a politician's point of view, tuition regulations are a more attractive policy than many other tools targeting college affordability. The government does not have to fund the policy explicitly, in contrast to a state-run scholarship program such as the Georgia HOPE scholarship. However, public universities' interests might not be perfectly aligned with those of the state government (Groen and White, 2004), yielding different results from what the state government intended by imposing the tuition regulation. Facing financial constraints, universities may respond by adjusting margins that they can still control, such as institutional financial aid, student fees, or room and board charges. Institutions may also rapidly increase tuition after a cap or freeze is lifted, potentially shifting the financial burden from one cohort to another. The amount to which they are able to make these adjustments depends on how limited they are by other government regulations and their market power in the in-state and out-of-state student markets. Yet, we have reason to believe institutions will respond in some ways, as previous studies find that universities adjust various margins in response to financial shocks (Dinerstein et al., 2014; Delaney and Kearney, 2015, 2016; Bound et al., 2016; Clelan and Kofoed, 2017; Deming and Walters, 2017; Webber, 2017). Further, even if these regulations lower tuition on average, there may be differences in how the benefits are distributed across students if universities make adjustments that can be student-specific, such as changes in financial aid.

Despite the prevalence of these policies and the *a priori* ambiguity in their effectiveness, there has been little empirical evidence about the effects of these tuition regulations and how they change tuition dynamics over time. These effects are of direct interest to policy-makers considering these regulations, as well as to students and their families who may be subject to them.

In this paper, we investigate the effects of tuition freezes and caps on the dynamics of tuition during regulations, as well as after they have been lifted. Our estimates from an event study design show that while a tuition regulation is present, listed tuition is 6.3 percentage points lower at four-year colleges than it would be in the absence of the regulation, and 9.3 percentage points lower at two-year colleges. We find that two-year colleges increase tuition in the years following the regulation such that within three years after the end of a tuition cap or freeze, there is no statistically significant gap between colleges' actual tuition level and the level their tuition would have been without the regulation.

At four-year universities, we identify institutional financial aid as a key margin along which universities adjust when facing a tuition cap or freeze. Because it is common for many students to have a discrepancy between the "sticker price" and net price that they face, a university could effectively increase the net price by decreasing institutional aid. At four-year universities under a regulation, institutional aid is 11.3 percentage points lower than it would be without the regulation - nearly double the relative decrease in listed tuition. In the years following a regulation lifted, institutional aid continues to lag behind where it would have been without the cap/freeze so that it is 19.5 percentage points behind two years after the end of the cap/freeze. This implies that since tuition caps and freezes only affect listed "sticker price" (and not aid), universities cut institutional aid to still have some control over the net price that students actually pay. The gap between institutions' posted price and net price, and the importance of considering this gap in analyzing the universities' response is also documented in previous studies (Hoxby and Turner, 2015; Webber, 2017).

Our results show heterogeneity in responses by university characteristics. We find that research

universities[1] do not increase tuition rapidly following the end of a cap/freeze, nor do they ever greatly decrease institutional aid from where it would have been without the regulation. We also find a much larger response from universities that are more dependent on tuition for revenue.[2]

Although we explore several other charges as well as non-price margins that universities may adjust in response to a regulation, we do not find any of them to be as important as adjustments in institutional aid. We do find suggestive evidence that instruction-related expenditures per student are 3.3 percentage points lower under tuition regulations. The lack of effects on most other outcomes may be due to universities being limited by other government regulations or market forces. For instance, universities do not substitute away from in-state students to out-of-state students facing tuition regulations. Both lack of market power in the out-of-state student market and some state regulations on the number or percent of out-of-state students at public universities are possible explanations for this result.

Finally, we use our estimates to simulate the difference in net tuition paid from students' points of view. We consider students who vary in terms of 1) whether they receive institutional aid, 2) which type of institution they enroll in, and 3) when they first enroll with respect to the timing of the regulation. Our results imply that states that implement a uniform regulation on all universities within the state may be creating inequalities in the way the regulation is felt by various students. Depending on the type of student we consider, our estimates range from a student receiving a 5.9 percent discount to having to pay 3.8 percent more over four years of college due to the regulation.

Our paper fits into a literature investigating how universities respond to financial shocks. Many studies have shown that universities adjust prices through changes to tuition and institutional aid. Webber (2017) finds that decreases in state funding are partially passed to students through increases in tuition. He finds that on average between 1987 and 2014, students bear 25.7 percent of the financial burden from state funding changes. This proportion rises over time, with larger responses from institutions with solid PhD programs. In a similar vein, Clelan and Kofoed (2017) show that universities lower institutional aid as a response to the negative shock. Delaney and Kearney (2015, 2016) study impacts of the Illinois 2004 "Truth in Tuition" law, which requires flat tuition rates for 4 years for each cohort of students. They find that universities increase tuition before cohorts enter in anticipation of not being able to increase it later. Dinerstein et al. (2014) study universities' response to a positive financial shock, the federal stimulus funds during the Great Recession. One source of this federal funding increase came in the form of expanded Pell Grants; their findings show that public universities raise tuition to fully capture this increase in Pell Grant. We also investigate whether universities adjust non-price margins such as student composition or per-student expenditures. Although less studied, there is some evidence of this behavior in the literature. For instance, Bound et al. (2016) find that in response to decreasing government appropriations, public universities enroll more wealthy international students.

Our paper is also closely related to Deming and Walters (2017), who exploit tuition freezes and caps in their analysis of whether increasing expenditures or lowering tuition is more effective in increasing enrollment and graduation at public universities. They find a strong "first stage" effect of tuition caps/freezes on listed tuition; our results support this while adding the finding that the decrease in listed tuition is accompanied by decreases in institutional aid. This may be key to explaining the Deming and Walters (2017) finding that lower tuition (instrumented with tuition freezes) does not have a strong effect on total enrollment or graduation rates.

We add to this literature by examining the dynamic effects of tuition regulations and exploring a variety of universities' responses, most importantly institutional financial aid. We also add evidence of heterogeneity in the type of regulation (i.e., cap or freeze and length of regulation) and university characteristics.

The rest of the paper proceeds as follows: section 2 describes the institutional background and the data sets for our analyses, section 3 describes our empirical strategy and identification, section 4 presents results, section 5 gives context to our results by interpreting them as their impact on a representative student, and section 6 concludes.

[1]Research universities are defined as doctoral universities a Carnegie classification of with high or very high research activity.

[2]A university is *More Dependent* if its fraction of total revenue from tuition and fees is greater than the median among public universities.

2 Institutional Background and Data

The setting for our study is higher education institutions in the United States. Our primary analysis will be from 1990 to 2013, although we will show some specifications with more recent years (through 2019).[3] We are interested in legislative tuition regulations. Thus, we do not consider tuition freezes/caps initiated by universities themselves, without government regulations, e.g. Purdue University (2020). These tuition regulations almost exclusively affect only in-state undergraduate tuition; universities are not regulated on how to set graduate tuition or out-of-state undergraduate tuition. Students fees are often regulated together with tuition, but financial aid is rarely regulated.[4]

These regulations are often politically motivated, put forth by politicians in an aim to make college more affordable for state residents. They are typically enacted as a part of the state higher education budget. This budget goes through multiple rounds of revisions. In addition to the general uncertainty of whether budget requests will be fully funded (which depends in part on tax revenues), there is uncertainty whether the tuition regulation will be enacted at the end of the budget process. There have been cases where either the upper house or the lower house of a state legislature proposes a bill for a tuition regulation but it does not pass the other house or the governor (e.g. Georgia 2016-17 HR 1326, Georgia 2018-19 SR 215, Tennessee 2014–16 HB 2179/SB 1683, Texas 2017-19 SB 19, Virginia 2018-19 HB 351).

In this study, we will combine data sets from various sources. The main data is the Integrated Postsecondary Education Data System (IPEDS). IPEDS is a survey of colleges, universities and vocational institutions conducted annually by the U.S. Department of Education. All universities that receive Title IV federal funding are required to report their data to IPEDS, so it is a universe of public colleges in the United States and a near universe of private colleges (aside from some for-profit institutions). IPEDS collects information on tuition and enrollment by student residency (i.e. in-state/out-of-state) status. IPEDS also collects detailed information on institutional finances and student financial aid, including revenues and expenditures by source.[5]

Our second data set is tuition regulations by state, detailing in which states and years tuition regulations were imposed. This data set, which we take from Deming and Walters (2017), distinguishes between tuition freezes and caps, and records the specific limits for tuition caps. In secondary analysis, we augment this data set by hand-collecting tuition regulations from 2014 to 2019 from state legislation. We collect this legislation through a combination of Lexis-Nexis searches of legislation and news articles, communication with state boards of education and legislatures, and verification using legislative records from state websites. We also double-check the data set from Deming and Walters (2017), making a few adjustments where we find discrepancies between their data and legislative records.

For our primary time period of focus, 1990-2013, 17 states imposed formal price regulations on public institutions at least once.[6] For these 17 states between 1993 and 2013, 26.7 percent (109 out of 408) of state by year observations were under tuition regulations. In around half of these cases, universities were under tuition freezes. The rest were tuition caps, with the exception of one case where institutions were mandated to cut tuition (Virginia, 2000). The caps ranged from three percent to 10 percent limits on increases in tuition, as shown in Table 1. Sometimes these regulations lasted for only one year, but they were often extended for multiple continuous years. Table 2 shows the distribution of the length of regulations in our data. Finally, while some states imposed uniform price regulations on all public universities, others differentiated by sector (see Table 3). Table 4 presents summary statistics of variables of interest by institution type (private/public, 4-year/2-year), with the first two columns showing statistics of universities under tuition freezes or caps.

[3] We explain our reasoning for focusing on years before 2013 in section 3.

[4] We found only one instance of tuition regulation packaged with institutional aid regulation (Rhode Island 2013-14 HB 7133, 2014-15 HB 5900).

[5] We supplement our data with IPEDS finance data constructed and published by the Urban Institute (Blom et al., 2020). While the Delta Cost Project is well known to aggregate multiple institutions within some public university systems into a single administrative unit (Jaquette and Parra, 2016), the Urban Institute data leave that decision to the data user by reporting raw finance data and parent-child relationship among institutions (i.e., branches of a university system). In our analysis of state appropriations (presented in appendix Table A5), we do not aggregate parent-child observations.

[6] Full List: AL, CT, FL, ID, MD, ME, MO, MT, NC, NH, NJ, NY, OH, OK, OR, VA, WI

Our final two data sources consist of state level economic and political variables. First, we proxy for states' economic environments with unemployment rates from annual county level labor force data (U.S. Bureau of Labor Statistics, 2021). Second, we construct a variable indicating the majority party of each state's lower and upper legislative houses based on election data collected by Klarner (2018). This data covers each individual candidate who ran for state legislative office, with general election returns between 1990 and 2015, which we aggregate to the state by year level.

3 Empirical Strategy

In order to estimate the effects of tuition regulations on the dynamics of institutions' prices and other outcomes, we use an event study framework with some modifications to the typical set-up found in the literature. For our benchmark specification, we estimate

$$y_{it} = \sum_{k=-3, k\neq -1}^{3} 1(TuitReg_{t-k})_{it}\beta_k + \beta_4 \sum_{k=4}^{\infty} 1(TuitReg_{t-k})_{it} + \beta_{-4} \sum_{k=4}^{\infty} 1(TuitReg_{t+k})_{it} + \gamma_t + \phi_i + t\rho_{c(i)} + \beta_X X_{s(i)t} + u_{its} \quad (1)$$

where $1(TuitReg_{t-k})_{it}$ is an indicator equal to 1 if institution i is under a tuition cap or freeze in year $t-k$, γ_t is a calendar time fixed effect, ϕ_i is an institution fixed effect, $t\rho_c$ is a public/private-specific linear time trend, and X_{st} is a vector of time-varying controls. The control vector includes the state unemployment rate (along with its lead and lag) and the majority political party in each state's legislative lower and upper houses. Standard errors are clustered at the state level. We estimate Equation 1 separately for 2-year and 4-year institutions.

Our setup differs from a canonical event study set-up in two ways. First, the event of a tuition freeze or cap can occur more than once at a given institution over the time period studied. This stands in contrast to the simplest case where events happen once for each unit (e.g. a policy change that goes into effect and remains in effect until the end of the time period studied). To deal with universities that are treated multiple times, we follow a strategy proposed in Sandler and Sandler (2014). Each university that is treated more than once will have multiple sets of dummy variables representing the event time. Because we are collapsing all time periods 4 or more years before (after) the tuition regulation, this leads to some of the "dummies" taking a value of more than 1.[7]

Our set-up also departs from the typical event study because a tuition cap or freeze can last for several years before being lifted. Whenever a tuition regulation lasts for more than one year, we collapse the duration of the freeze into one "year" period in the regression. In this case, we can interpret the first lead as the year before the tuition regulation starts, and the first lag as the first year after the tuition regulation ends.

We include a public/private-specific linear time trend rather than a state-specific trend in our main specification for two reasons. First, we see a positive pre-trend in the state trend specification, while inclusion of the public/private-specific trend helps us meet the parallel trend assumption. Moreover, there could be spillover effects on private universities located in the same state; private universities could set their tuition or aid taking those of their competitors into account. For instance, Epple et al. (2006) study how universities set listed prices and institutional aid in an equilibrium setting. We will show some evidence of spillover effects in subsection 4.4. We also present the

[7] For example, if a university experiences a tuition freeze in 2000 and another tuition freeze in 2005, the $\sum_{k=4}^{\infty} 1(TuitReg_{1995+k}))_{it}$ "dummy", which represents the year 1995, will be set to 2. Therefore, β_{-4} is identified not only by the difference between treated and untreated units 4 and more periods ahead of the tuition regulation but also by the linearity assumption on $\sum_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$. In other words, the baseline specification assumes that the difference between never-treated and once-treated unit 4 or more periods before is same as the difference between the once-treated and a twice-treated unit before 4+ periods. The same argument is applied to β_4. To investigate if this linearity assumption matters, we run a variation of equation 1 where we replace $\sum_{k=4}^{\infty} 1(TuitReg_{1995+k})_{it}$ with a set of dummy variables $\sum_{k=4}^{\infty} 1(TuitReg_{1995+k}) = N)$. Our coefficients of interest β_ks, $k = -3, -2, 0, 1, 2, 3$, are very robust with the modification.

sensitivity analysis results where we include a sector-specific quadratic time trend or state-specific linear time trend in appendix table A4.

The coefficients of interest are β_ks with $k = -3, -2, 0, 1, 2, 3$.[8] With our normalization which omits $1(TuitReg_{t-1})$ in equation 1, β_k captures the additional difference in y_{it} between treated and untreated units k periods after[9] the tuition cap or freeze is imposed, beyond the difference in the -1 period (which has been normalized to zero). In equation form,

$$\beta_k = E(y_{it-k}|R=1,\tilde{X}) - E(y_{it-k}|R=0,\tilde{X}) - \big(E(y_{it-k-1}|R=1,\tilde{X}) - E(y_{it-k-1}|R=0,\tilde{X})\big) \quad (2)$$

where $R = 1$ is a university with a tuition regulation k periods before (i.e. $1(TuitReg_{t-k})_{it} = 1$) and $R = 0$ is a university without a tuition regulation. In addition, $\tilde{X}$ represents the collection of $\gamma_t, \phi_i, t\rho_c$ and X_{st} from equation 1. Notably, because we have collapsed tuition regulations that last more than one year into one period, β_0 can be interpreted as the average effect across all years that the tuition regulation was in place.

We can interpret β_k, $k \geqslant 0$ as a causal effect of a tuition cap or freeze only when the mean change in unobserved part of treated observations over time is equal to that of untreated observations. In equation form,

$$E(u_{it}|R=1,\tilde{X}) - E(u_{it'}|R=1,\tilde{X}) = E(u_{it}|R=0,\tilde{X}) - E(u_{it'}|R=0,\tilde{X}) \quad (3)$$

where t' is time before the treatment and t is time after the treatment; R and $\tilde{X}$ are defined as before. In other words, after conditioning on $\tilde{X}$, the time trend of an outcome variable of the treated units would be parallel to that of the untreated units in the absence of treatment.

To bolster the case for a causal interpretation, we do three things. First, we investigate coefficients β_k, $k < 0$, in the years prior to the tuition regulation. It's possible that the state government could use the regulation as a punishment for universities that have been increasing tuition rapidly. On the contrary, they could take advantage of universities that are already slowing down tuition increases by advertising the tuition regulation to voters without having any meaningful impact on tuition setting. However, in these cases, we should see this behavior in the years leading up to the tuition regulation. This would show up as values of β_k that are statistically significantly different from zero when $k < 0$, which we find no evidence of in our results.

Second, we control for several key variables in equation 1. Institution fixed effects capture any non-time-varying differences between treated and untreated units. Our public/private-specific linear time trend captures a linear approximation of time-varying differences between private and public schools. The calendar time fixed effect captures the national-level time trend. Finally, our inclusion of state-level unemployment rates,[10] their leads and lags, and indicators for the majority political party capture state-varying differences in macroeconomic or political factors that may affect both tuition prices and the probability of a state imposing a freeze/cap.

Third, we implement robustness checks with different comparison groups. First, we have a specification that only includes universities that have been under a tuition cap or freeze at least once during the time frame studied. In this analysis, we leverage only variation in the timing of cap/freeze, exploiting the fact that different states imposed tuition regulations at different times (Bailey and Goodman-Bacon, 2015). Second, we implement a matching procedure where we match treated institutions to untreated institutions with similar tuition levels and trends in the years prior to the regulation.

Conceptually, we are thinking of the results we see as universities' response to a tuition cap or freeze being imposed on them. However, there are cases where we want to be cautious with this

[8] The interpretation of β_k when $k = -4, 4$ is unclear due to the aggregation of periods and differing amounts of observations at the tail ends of the time period studied, so we do not focus on them.

[9] In the case where $k < 0$, this can be interpreted as $-k$ units before the treatment. For example, $k = -2$ implies it is two years before the treatment.

[10] We use labor force data by county from Local Area Unemployment Statistics (LAUS) announced annually by Bureau of Labor Statistics (BLS). We control for the average unemployment rate by state, aggregated from counties within each state weighted by the size of labor force population.

interpretation. First, we might be picking up other policies imposed on universities that happen at the same time as the tuition regulation. Specifically, states imposing tuition caps/freezes often simultaneously give more generous funding to universities as compensation. Our analysis show that institutions have 6 percentage points higher state appropriations during a tuition regulation (this effect is not statistically significant for four-year institutions but significant at a 5 percent level for two-year institutions. For more detail, see appendix figure A1). In this case, our coefficient would capture the combined effect of the cap/freeze and the state funding. Thus we implement a sensitivity check where we control for state funding, and our findings of the effect of tuition regulations on tuition and aid are robust (see appendix table A5).[11]

Moreover, state governments may be aware of changes in the unobservable u_{it} and use it to make a decision of whether to impose a tuition regulation. Previous work has shown that state governments adjust appropriations based on temporary financial shocks to universities (Dinerstein et al., 2014; Fu et al., 2019). It is also possible that the state government and universities could be jointly deciding whether to have a tuition regulation. In this case, our estimates would simply show what happens during and after a tuition regulation. Notably, our interpretation of effects on students (and how effects vary with student characteristics) remain the same.

In addition to the benchmark specification in equation 1, we run two other specifications. First, we explore heterogeneity in whether schools experience a freeze or a cap (and in the size of the cap). Specifically, we estimate

$$y_{it} = \sum_{k=-3,k\neq-1}^{3} 1(TuitReg_{t-k})_{it}\beta_k + \sum_{k=0}^{3}(TuitCap_{t-k})_{it}\alpha_k + \beta_4 \sum_{k=4}^{\infty} 1(TuitReg_{t-k})_{it} + \beta_{-4} \sum_{k=4}^{\infty} 1(TuitReg_{t+k})_{it} + \phi_i + \gamma_t + t\rho_c + X_{st} + u_{its} \quad (4)$$

which is the same as our benchmark specification except in the second term. $(TuitCap_{t-k})$ represents the size of the cap and is coded from 0 to 1; for a 3 percent cap, $(TuitCap_{t-k}) = .03$. When tuition is frozen, $(TuitCap_{t-k})$ takes a value of 0. With this specification, β_k represents the effect of tuition being completely frozen. The effect of tuition cap is $\beta_k + \alpha_k \times (TuitCap_{t-k})$.

We also run regression models that consider the variation in the length of tuition regulations.

$$y_{it} = \sum_{k=-3,k\neq-1}^{3} 1(TuitReg_{t-k})_{it}\beta_k + 1(FirstYrofTuitReg_t)_{it}\alpha_F + 1(LastYrofTuitReg_t)_{it}\alpha_L + \beta_4 \sum_{k=4}^{\infty} 1(TuitReg_{t-k})_{it} + \beta_{-4} \sum_{k=4}^{\infty} 1(TuitReg_{t+k})_{it} + \phi_i + \gamma_t + t\rho_c + X_{st} + u_{its} \quad (5)$$

$$y_{it} = \sum_{k=-3,k\neq-1}^{3} 1(TuitReg_{t-k})_{it}\beta_k + (T_{it} - 1)\alpha_A + \beta_4 \sum_{k=4}^{\infty} 1(TuitReg_{t-k})_{it} + \beta_{-4} \sum_{k=4}^{\infty} 1(TuitReg_{t+k})_{it} + \phi_i + \gamma_t + t\rho_c + X_{st} + u_{its} \quad (6)$$

Equation 5 additionally includes indicators for the first and last year of the cap/freeze. $1(FirstYrofTuitReg_t)_{it} = 1$ if the institution is under the first year of tuition cap/freeze. $1(LastYrofTuitReg_t)_{it}$ is defined

[11] We do not control for state funding in our main specification because state appropriations could be determined as an outcome of the negotiation between colleges and the state after a tuition cap/freeze is imposed. In this case, universities with different unobservable characteristics such as their bargaining power could select into different levels of increases in state funding. (This is a "bad control" discussed in Angrist and Pischke (2008) in detail. Webber (2017) also uses a sparse set of time-varying control for the same reason in a similar context to ours.). However, results from our robustness check show that this might not be a concerning issue in our context.

similarly. In this specification, β_0 gives the average effect for all years other than the first and last year in which the regulation is in place. The value of the outcome variable in the first/last year of tuition regulation is equal to $\beta_0 + \alpha_F, \beta_0 + \alpha_L$, respectively.[12]

Equation 6 allows each additional year of a tuition regulation to have a linear effect on tuition and fees. T_{it} represents the number of consecutive tuition regulations up to year t. Thus, the β_0 represents the effect of having a tuition regulation in place for exactly one year. The effect of having a tuition regulation for 5 years continuously is given by $\beta_0 + \alpha_A \times (5 - 1)$.

4 Results

4.1 Dynamics of Tuition

Figure 1 shows results from our benchmark specification (equation 1) for two outcomes: log of in-state undergraduate tuition and fees[13], and log of institutional financial aid for first-time undergraduate students. The solid lines represent coefficient estimates and the dotted lines represent 95 percent confidence intervals. Focusing first on four-year colleges in panel (a), we see that neither in-state tuition nor institutional aid statistically differs from zero in most years prior to the tuition regulation. This satisfies our parallel trends assumption, which requires that there are no significant effects of having a tuition regulation in the future, because at this point, neither group has experienced treatment yet. If anything, both tuition and aid are slightly increasing in years prior to tuition regulation so adjusting for this trend would make decreases in the years following tuition regulation larger.

Next, we are interested in the coefficient at period 0, which gives the effect of a tuition regulation on tuition and fees while the regulation is in place. As expected, we see a statistically significant negative effect (-6.3 percentage points).[14] One year after the regulation has been lifted, we still see a negative effect on tuition of 8.5 percentage points, which is slightly larger than the effect during the cap/freeze. This is due to the fact that the period 0 effect captures the average deviation from the trend, not the deviation from the trend in the final year of the regulation.

To further understand the dynamics of tuition regulations that last for more than one year, Figure 2 illustrates the results from equation 5. In this plot, "First Year" gives the effect of the tuition regulation on in-state tuition and fees in the first year that the regulation is in place, "Last Year" gives this same effect in the final year the regulation is in place, and "Middle Years" give the average effect for all years other than the first and last year in which the regulation is in place. The figure shows that as tuition regulations last longer, their cumulative impact on the amount that tuition and fees deviates from its trend becomes larger, with a -2.2 percentage point estimate in the first year and a -11.6 percentage point estimate in the final year for four-year colleges. The easiest way to think about this is in the context of a three-year regulation, where tuition steady falls further from the trend in each of the years. If, instead, it was a four-year regulation, the "Middle Years" would represent the average of the second and third year, and so on with longer regulations. In a similar vein, columns 2 and 4 in appendix table A2 present results from equation 6. Having a tuition regulation in place for exactly one year is -2.3 percentage points. Having another consecutive year of regulation lowers tuition by an additional 9.9 percentage points. These results support the conclusion that the cumulative effect of tuition regulations increases as the regulation lasts longer.

Continuing to focus on the years after the regulation is lifted, both figures 1 and 2 show that

[12] If a tuition cap/freeze lasts only one year, both the first and last year dummy variables are switched on. If it lasts for two years, the first year is switched on for the first year and the last year for the second year.

[13] Results using tuition levels rather than the log of tuition are similar and can be found in Table 7. We use the sum of tuition and fees because this variable is available for the entire time period we study whereas tuition alone is not available until 2000.

[14] This interpretation comes from the following calculation. Note that we use log of tuition. $\beta_0 = -0.06$ means $E(log\frac{P_t}{P_{t-1}}|1(TuitReg_t)_{it} = 1) - E(log\frac{P_t}{P_{t-1}}|1(TuitReg_t)_{it} = 0) = 0.06$. Using the approximation that $log(1 + x) \approx x$ when x is small, we have $E(\frac{\Delta P_t}{P_{t-1}}|1(TuitReg_t)_{it} = 1) - E(\frac{\Delta P_t}{P_{t-1}}|1(TuitReg_t)_{it} = 0) = -0.06$, where $\Delta P_t = P_t - P_{t-1}$.

tuition remains lower than it would have been in the absence of the regulation for three years after the end of the cap/freeze, with some evidence of small increases as institutions "catch up" to where they would have been without the regulation. We expected to see a somewhat faster catch-up, but suspect the absence of this effect may be related to state variation in the degree of autonomy that institutions have to set tuition rates, as noted by Webber (2017). All of the coefficient and standard error estimates for figures 1a and 2a can be found in tables 5 and A2, respectively.[15]

Panel (b) of figures 1 and 2 show these patterns for two-year colleges. The patterns in both figures are similar to those of four-year institutions, although the magnitudes are bigger: the effect on tuition is -8.2 percentage points on average during the regulation and -18.7 percentage points in the last year of the regulation. Despite the larger negative effects of the tuition regulation on tuition during the cap/freeze, we see a much stronger "catch up" effect for two-year institutions. By the third year after the freeze/cap ends, there is no statistically significant different between actual tuition and counterfactual tuition in a world where the college did not experience any cap or freeze. We suspect that two year colleges exhibit a stronger "catch-up" effect than four-year colleges because two-year colleges cannot adjust along the institutional aid margin, given that initial levels of institutional aid at two-year colleges are very low as presented in table Table 4. All of the coefficient and standard error estimates for figures 1b and 2b can be found in appendix tables A1 and A2, respectively.

Next, we take a brief interlude to explain why our main analysis excludes the most recent years. Table 11 shows effects on tuition for two time periods: 2010 and earlier, and 2011 and later. First, we see that tuition regulations were not effective in lowering tuition in recent years. Furthermore, because of the large heterogeneity across different time periods, the effects of tuition regulations are less precisely estimated, resulting in large standard errors on coefficients for the pooled sample in column (1). Table 12 illuminates one of the driving forces behind this result by comparing the average annual increase in tuition between treated and untreated institutions over the two time periods. In 2010 and earlier, institutions under tuition regulations raised tuition by 3.1 percent each year on average while institutions not under tuition regulations raised tuition by 7.2 percent. Since 2011, treated institutions have behaved similarly as before, raising tuition by 3.3 percent each year. However, institutions that were not regulated only raised tuition by 4.2 percent, less than one percentage point above the treated group. Because institutions that were not forced to keep tuition levels down were not raising tuition much, the tuition freezes and (even more so) caps did not have bite.[16]

Notably, our primary interest is on the downstream effects of these regulations. That is, how universities change tuition in the years following the regulation, and how they adjust along other margins, such as institutional aid, out-of-state tuition, and other student fees. When the tuition regulation is not so effective, universities do not have to seek for different margins to make up for the loss from the regulation. Therefore, we do not dive further into the effect of tuition regulation on other outcomes in the recent years.

Moving back to Figure 1 (and the earlier time period), the line with triangle marks shows the effect on institutional financial aid during and after the tuition regulation. Institutional aid includes all grants given by the university to students, and does not include loans or any financial aid that the student receives from the government or any other source outside the institution. Universities are decreasing institutional aid by a greater proportion than tuition, which leads us to interpret this effect as universities using institutional financial aid as a way to recoup some of the tuition losses from the tuition regulation. The pattern of institutional aid in the years after the regulation follows a similar path to that of tuition, although always of lower magnitude.[17] Because institutional aid is unlikely to be a large factor at two-year colleges, we do not include estimates for institutional aid

[15] In Table A2, the effect of the first year of the tuition regulation is $1(TuitReg_t) + 1(FirstYRofTuitReg_t)$, while the effect of the last year is $1(TuitReg_t) + 1(LastYRofTuitReg_t)$.

[16] These results are not sensitive to the specific year we choose to cut the data within the years between 2009 and 2014. We decide to use 2013 as a cutoff for our main results since this is where we switch from using Deming and Walters (2017) data to our own hand-collected data, and although we tried to follow their methods there may be some differences in sample collection procedures.

[17] GMM results show that coefficients on tuition and institutional aid are statistically significantly different from each other at the 5 percent level in every year after the regulation has been lifted (1, 2, and 3 years after the regulation p-values are 0.028, 0.006, and 0.020, respectively) and marginally insignificant at the 5 percent level during the regulation (p-value 0.055).

in panel (b).[18]

There are two other possible explanations worth mentioning for the negative effect on institutional aid. First, students are spending relatively less on tuition, so they should need a smaller amount of aid to cover their costs. Relatedly, it could be that institutional aid decreases mechanically following the decrease in tuition if the amount of the aid is tied with the amount of tuition (e.g. aid is X percent of tuition). However, we see that the magnitude of the effect on institutional aid is not only bigger during the tuition cap/freeze, it falls further after the regulation is lifted.

Second, tuition regulation could change the composition of students that institutions enroll. This could make the new student body different in terms of income or academic preparedness, which could explain a change the amount of aid. However, Figure 3 shows that federal Pell grants and state grants to students were not affected by tuition caps/freezes. Given that Pell grants are need-based, this suggests regulations didn't lead to a big change in the student composition by income. Like institutional aid, state aid is awarded by both need and merit. We do not see a clear effect of tuition regulations on state aid either. Further, appendix table A10 shows there is no effect of tuition regulations on first-time students' SAT score, giving more direct evidence that colleges' student composition by academic preparedness did not change. These results support our interpretation that the negative effect on institutional aid is at least in part an effort by institutions to make up for lost tuition revenues.

Table 6 illustrates the dynamics of tuition revenue in response to tuition regulations. During a regulation, gross tuition revenue is 4.7 million dollars lower (significant at 10%) than it would have been in the absence of a regulation. Meanwhile, we do not see a significant decrease in net tuition revenue during the tuition regulation, and the magnitude of the net tuition coefficient is over 2 million dollars higher (i.e. less negative) than gross tuition. This adds to our evidence that universities decrease institutional aid to make up for tuition losses. After the regulation is lifted, the effects on both gross and net tuition revenue are no longer significant (although still sizeable).[19]

To give a sense of the impacts of tuition regulations in dollar terms, we present results an outcome variables of level of tuition and fees (as opposed to logs) in Table 7. Column (1) shows that a tuition regulation has a -268 dollar effect on in-state tuition and fees each year during the regulation. Column (3) shows that universities are almost completely compensating for this loss with institutional aid: the effect on aid is -212 dollars each year. Institutional aid continues to lag behind where it would have been in the absence of a cap/freeze in the years after the cap/freeze has ended, even more that tuition in some years.

In addition to representing the information conveyed in the figures described above, columns 2 and 4 of tables 5 and A1 present estimates from equation 4 where we differentiate tuition caps and freezes. Focusing first on four-year colleges in Table 5, we see that the effect of a 5 percent tuition cap is -9.4 + 0.05(96.7) = -4.6 percentage points. When tuition is frozen, ($TuitCap_{t-k}$) takes a value of 0, so the coefficient of -0.094 indicates that the effect of tuition being completely frozen on in-state tuition and fees is -9.4 percentage points for each year that is it frozen. This specification shows the intuitive result that institutions under caps experience smaller negative effects on tuition than institutions under freezes during and after the regulation. Three years after the end of the regulation, the tuition at universities that had a freeze are still 9.4 percentage points behind where they would have been without the freeze. Meanwhile, those with a 5 percent cap are only 5 percentage points behind. The patterns for institutional aid at four-year colleges, as well as tuition at two-year colleges shown in appendix table A1, are similar.

4.2 Heterogeneity

Next, we investigate heterogeneity in universities' responses to tuition freezes. First, we look into whether universities' dependency on tuition affects how they respond to tuition regulations. Following a strategy of measuring state appropriations dependency from Deming and Walters (2017),

[18] However, estimates can be found in appendix table A1.

[19] Given that revenue is tuition times the number of students, we check if there is an effect of tuition regulations on the total number of enrolled students but find no evidence of this. The coefficient of $1(TuitReg_t)_i t$ is -23 with robust standard error 165.55 when we regress a measure of full time equivalent students on dummies of tuition regulations and control variables.

we categorize institutions into more or less dependent on tuition based on the fraction of their total revenue that is sourced from tuition and fees in the initial year of our data, i.e. 1991. If this fraction is greater than the median fraction for all public universities, the institution is classified as *More Dependent* whereas institutions with a fraction less than the median are classified as *Less Dependent*.

Figure 4 shows the results. Focusing first in-state tuition (grey lines with circle markers), we see that institutions that are more dependent on tuition seem to increase tuition faster in the years following the end of the regulation, presumably because they do not have as many other sources of revenue to pull from when they take a loss from the tuition regulation. Similarly, institutions that are more dependent on tuition decrease their institutional aid more during and following the tuition regulation. These results support our interpretation of the decrease in institutional aid in our main results as being due to universities adjusting to make up for tuition revenue losses.

Next, we break down universities into three broad categories from the Carnegie classification system, using a modification of the classification from Bound et al. (2019). *Research* universities are doctoral-granting universities with high or very high research activity. The *Non-Research* group includes masters-granting universities and doctoral-granting universities with low research activity. All other 4+ year degree granting institutions fall into the *Other* category. These three categories proxy for a university's stature, selectivity, and available resources.

Figure 5 reveals that although the coefficients on tuition during the time of the regulation were of a similar size, there are differences in the tuition-setting behavior of universities in the years following the cap or freeze. The *Non-Research* and *Other* groups seem to "catch up" a little more quickly while the *Research* universities' tuition remains well below where it would have been in the absence of the regulation. This may be because *Research* universities have more resources and do not need to raise tuition as rapidly to make up for the losses incurred by the regulation.

More strikingly, there is a discrepancy among the way these groups of universities adjust their institutional aid. *Research* universities seem to reduce institutional aid in proportion to the reduction in tuition during the regulation and in the first year following, but then increase it slightly in the next two years. *Non-Research* universities do not adjust much during the regulation but reduce institutional aid in a proportion greater than tuition in the years following the cap or freeze. Finally, *Other* universities have a sharp decline in institutional aid offered during the regulation that remains below the reductions in tuition for several years after the end of the regulation. Of course, all of these results should be taken with caution due to the large standard errors associated with the coefficients on institutional aid.

4.3 Robustness

In this section, we perform four analyses to ensure the robustness of out results. First, we implement a matching procedure to ensure that treated and comparison units are balanced on their tuition levels and trends before the regulation is put into place. Matching results can be found in the first two columns of Table 8. We implement 1-1 matching of institutions by year based on the Mahalanobis distance of the level of in-state undergraduate tuition and the annual rate of increase in in-state undergraduate tuition for the years one, two, and three years before the tuition cap/freeze.[20] The main conclusions from our baseline analysis remain.

Second, we include a specification that only includes institutions in states that were treated at some point during the time period we study. This is motivated by a potential concern that there may be some unobserved differences between the time trends of states that are subject to tuition regulations and states that never experience a tuition regulation. This version leverages only variation in the timing of the tuition regulations, rather than timing and existence of tuition regulations. Columns 3 and 4 of Table 8 restricts the sample to "ever treated" institutions. Although estimates are nosier than our main results, the signs and magnitudes of estimates are very similar.

Third, we limit the sample to only observations where we observe both tuition and aid, which changes the sample dramatically since institutional aid data does not become available until 2001. This helps us ensure that the relative magnitude of "sticker price" and institutional aid is not driven by differences in estimating samples. The final column of Table 8 shows results for in-state tuition when only including observations that are in our estimating sample for institutional aid. Our

[20] We use the user-written Stata command *kmatch* (Jann, 2017).

results are robust and if anything indicate a greater gap between the change in in-state tuition and institutional aid.

Finally, there may be some concern that our estimates are picking up not only the effects of tuition regulations, but the combined effect of tuition regulations and changes in state and local funding. To address this, we investigate the relationship between state and local funding and tuition caps/freezes. Although we find that during a tuition regulation, institutions receive 6 percentage points more in state appropriations (not statistically significant for four-year colleges), if we control for state and local funding in our main specification, the coefficients of interest do not change. Appendix figure A1 shows the estimated effect of a tuition regulation on state funding. Appendix figure A5 shows estimates of the effects of tuition regulations on tuition and institutional aid after controlling for state and local funding. Columns 1 and 2 give effects for four-year institutions, while column 3 shows results for two-year institutions.

4.4 Other Outcomes

Student Fees, Room and Board Charges If tuition regulations do not include limits on additional student fees, we may expect to see an increase in fees during and after the regulation. However, appendix table A8 shows that fees are not affected very much, aside from some suggestive evidence that two-year colleges increase fees in the first and second year after a regulation ends. It could be that effects are dampened by some states that also limit student fees in their tuition regulations (e.g. North Carolina, Ohio, Virginia). Appendix table A8 also shows the effect of tuition regulations on room and board, another potential margin that universities could adjust to make up for lost tuition revenue. However, we do not find any evidence of this behavior.

Out-of-state Student Tuition and Enrollment Appendix table A9 illustrates the effect of tuition caps and freezes on out-of-state tuition and the composition of enrolled students by state residency. We restrict our sample to 4-year institutions given that 2-year institutions enroll few out-of-students. We do not see a clear pattern of effects of tuition regulations on these outcome variables. Notably, universities do not hike up out-of-state tuition to compensate for losses from freezing in-state tuition. Our lack of significant changes in out-of-state tuition may be related to universities not having market power in the out-of-state student market, making them essentially price-takers. Rizzo and Ehrenberg (2004) also find that public institutions use out-of-state students to increase institutional quality, not to increase revenue.

Expenditure If universities are facing financial losses from tuition caps and freezes, they may adjust their expenditures. Here we focus on instructional expenditures since these are the most likely to affect the quality of students' education. Table 10 presents the effects of a caps and freezes on per-student instructional expenditures. We see a negative effect of 3.3 percentage points during a cap/freeze, with large heterogeneity by institution characteristics. This aligns with results from Bound and Turner (2007) which show that universities decrease expenditures per student when the size of a cohort is large.

Completion Rate We may expect the decrease in the expenditure per student and aid to impact completion rates (Dynarski, 2003; Bound and Turner, 2007; Dynarski and Scott-Clayton, 2013; Bettinger et al., 2019; Anderson, 2020). However, we do not find any strong evidence that tuition regulations impact completion rates. It could be because we can not separately identify completion rates of low-income students, who are known to benefit the most from generous financial aid (Anderson, 2020).[21] Column (1) in appendix table A10 presents result.

Spillover Effects on Private Schools We also investigate if tuition regulations have spillover effects on private universities located within the same state. Tuition regulations do not apply to private universities, but they may respond to tuition regulations since they are competing

[21] IPEDS provides separate graduation rates for Pell grants recipients, but only beginning in 2016. We do have access to completion rates by race and gender for a longer period of time, but we do not find any meaningful patterns of tuition regulation effects on these completion rate, either.

for students with the regulated public institutions.[22] In Table 9, we compare private universities whose competing public universities are under tuition caps/freezes to private universities whose competitors are not regulated. Thus, $1(TuitReg_t)_{it}$ is equal to one if a public university in the same state is under a tuition cap or freeze at time t.

Our results suggest a spillover effect of tuition regulations on private universities' tuition and aid. Private universities do not adjust the level of tuition during a tuition cap/freeze, but there are some negative effects in the post-tuition-regulation period. Meanwhile, they decrease institutional aid by 5 percentage points during tuition regulations, with a lingering effect after the regulation is lifted in a similar pattern to our main analysis. Notably, the magnitude of the coefficients are around one-third to half of the magnitude of the effects on public institutions shown in Table 5. Columns (3)-(8) of Table 9 present spillover effects by Carnegie classification. Negative effects on tuition and aid are largely driven by *Other* universities rather than *Research* or *Non-Research* universities. This aligns with our main heterogeneity analysis in subsection 4.2 showing the strongest responses from public *Other* universities and is intuitive given that private universities are likely to compete with public universities of similar characteristics such as selectivity or resource availability.

5 Representative Student's Change in Tuition Paid

So far, we have shown that tuition regulations have meaningful impacts on in-state tuition and institutional financial aid and that these impacts vary over time and across different types of universities. However, it is difficult to see a clear picture of the overall impact that one of these regulations might have on a student moving through their education around the time of one of these regulations. In this section, we summarize the effects that tuition regulations have on several "representative" students that differ in the types of university they are attending as well as whether they receive institutional financial aid. We also incorporate differences in the dynamics of tuition and financial aid during and after a cap or freeze by presenting estimates for two types of students who start their education at different times. First, we consider a student who begins their four-year education in the first year of a tuition regulation. For simplicity, we assume that the tuition regulation lasts 3 years, which is the median length of tuition regulations in our data. Next, we consider a student who begins their four-year education in the first year after a tuition regulation has ended.

We use our estimates from appendix table A2 to calculate the effect on each representative student's tuition in each year of their four-year education. This specification captures the dynamics of negative impacts on tuition increasing as the regulation lasts longer.[23] We use the average percent of tuition covered by institutional aid at four-year public universities as a baseline for the portion of tuition that is affected by changes in institutional aid. This average is unconditional on receipt of institutional aid, so our results can be interpreted as the average effect across students who do and do not receive institutional aid. For each subgroup, we compute this average within institutions of that subgroup.[24] To make the tuition and aid estimates comparable, we restrict the sample to observations that have non-missing values for both tuition and institutional aid.

Figure 6 presents our results. The top panel represents students starting their education in the first year of a regulation and the bottom panel represents students starting in the first year after a

[22] Few papers have studied how universities set tuition and aid in an equilibrium framework (Epple et al., 2006; Fu, 2014). Epple et al. (2006) consider a setting where private universities set financial aid strategically, predicting that a student would get the same aid offer from all private universities when her academic preparedness is common knowledge among universities. Although our paper is about private universities responses to decisions of public universities while their papers focus on competition among private universities, our results are in line with their prediction.

[23] For the student who starts their education in the first year the regulation is imposed, we use $1(TuitReg_t)_{it} + (FirstYrofTuitReg_t)_{it}$ for their first year, $1(TuitReg_t)_{it}$ for their second year, $1(TuitReg_t)_{it}+1(LastYrofTuitReg_t)_{it}$ for their third year, and $1(TuitReg_{t-1})_{it}$ for their fourth and final year. For the student starting right after the regulation has been lifted, we use $1(TuitReg_{t-k})_{it}$ for their kth year.

[24] The average percent of tuition covered by aid is 23.5 percent overall, 20.6 percent for universities more dependent on tuition, 27.5 percent for universities less dependent on tuition, 32.0 percent for research universities, 21.2 percent for non-research universities, and 17.5 percent for other universities.

regulation has ended. The first column shows average effects; the second and third columns show heterogeneity in effects across types of universities outlined in subsection 4.2. Tuition estimates gives the percentage point change in tuition paid by the representative student, aid estimates the percentage point change in tuition paid due to changes in institutional aid received, and total estimates combine these two effects. Note that positive values for the aid column do not imply that aid is increasing, they show that the decrease in aid leads to students paying more tuition.

Focusing on the upper left panel, the top line shows that the representative student starting their education in the first year of the regulation gets a 4.3 percent discount on their tuition over the four years they are enrolled. However, the second line shows that students must pay 2.9 percent more in tuition due to their decrease in institutional aid. The bottom line shows the combination of these two effects, which reveals that they get a 1.4 percent discount overall. These separate estimates emphasize the importance of considering financial aid when thinking about how beneficial tuition regulations are to students, since without considering changes in institutional aid we would have concluded that the average discount was around triple the true discount. Students who do not receive any institutional financial aid experience the full tuition discount shown in the top row, highlighting the differences in benefits from the tuition regulation between students depending on their institutional aid receipt.

The middle panel splits these effects into universities that are more or less dependent on tuition revenue. Finally, the right panel shows responses by broad Carnegie classification. Benefits to students vary greatly across types of institutions and their timing of entering college. We estimate that a student who starts their education in the first year of the regulation at an institution that is *Less Dependent* on tuition will receive an overall 3.9 percent discount, but a student who starts after the regulation at a *More Dependent* on tuition institution will end up paying 2.5 percent more than they would have in the absence of the regulation. Appendxi figure A2 shows the corresponding figure where changes in tuition and institutional aid are measured in dollars rather than percent. Results are qualitatively similar for average and tuition dependency panels, but change for the Carnegie classification panel due to differences in tuition levels between subgroups.

To illustrate how the effects of the tuition regulation vary with the timing of student entry, we further break down the yearly effects. We focus on the subgroup of colleges that are *More Dependent* on tuition, since this is where the timing of student entry leads to the most dramatic differences in total tuition paid. As shown in Figure 6, students who enter in the first year of the regulation receive a 0.5 percent discount, while those who enter after the regulation ends have to pay 2.5 percent more. Figure 7 shows that this is driven by the deep discount in the final year of the tuition regulation, which occurs in students' junior (third) year if they started with the regulation. Meanwhile, students who start after the regulation have to pay more in the last three years of their education than they would have in the absence of the regulation. This aligns with our results presented in Figure 2, which show that more tuition-dependent colleges begin to raise tuition while keeping institutional aid low in the years after the regulation.

The only margins that we consider in this analysis are changes in in-state tuition and institutional aid, abstracting away from other things that may be affected. First, we do not capture any changes in application or enrollment behavior induced by the tuition regulation. Second, we assume all students complete their university education in four years, which excludes any student who drops out or takes more than four years. In addition, we don't consider any changes in educational quality resulting from the regulations. We suspect that change in institutional quality would decrease the benefits students receive from tuition caps and regulations due to the decreases in per-student instructional expenditure discussed in subsection 4.4 and shown in Table 10. We do not consider these changes in benefit calculations for simplicity, but without considering them, our results may be overstating the benefits of tuition regulations for students.

6 Conclusion

This paper has explored the effects of a popular policy tool for targeting college affordability - tuition caps and freezes. We find that although tuition falls during a cap or freeze relative to where it would have been without regulations, the effects on tuition alone do not accurately reflect actual discounts for students. This is because universities decrease their institutional financial aid when facing a tuition cap or freeze by a proportion that is almost double the decrease in tuition. Even in the years

following the lifting of the regulation, institutional aid lags behind where it would have been without a regulation.

Effects of tuition regulations are not felt equally across all students. In particular, students who do not receive institutional financial aid will see much greater benefits from tuition caps and freezes than students who rely on aid. Unfortunately our institution level data does not allow us to investigate which students see decreases in their institutional aid around the time of a tuition cap/freeze. However, we can get a sense of who is likely to be most hurt from looking at the characteristics of students who receive institutional financial aid in another data source, the National Postsecondary Student Aid Study (NPSAS). Students attending four-year public colleges are more likely to receive institutional aid if they are low-income. 27 percent of students from the bottom quartile get institutional aid, as opposed to 16 percent from the top income quartile. 34 percent of students receiving Pell grants also get institutional aid, whereas only 18 percent of non-Pell-eligible students get institutional aid. This suggests that the benefit of tuition regulations may be smallest for those most in need. Further, heterogeneity analysis reveals that research institutions and universities that do not rely heavily on tuition revenue are largely shielded from these effects, creating more inequality in how the regulations are felt by students who attend different types of universities. These are important responses for policy-makers to understand when they consider implementing a tuition regulation.

References

Drew M Anderson. When financial aid is scarce: The challenge of allocating college aid where it is needed most. Journal of Public Economics, 190:104253, 2020.

Joshua D Angrist and Jörn-Steffen Pischke. Mostly harmless econometrics: An empiricist's companion. Princeton university press, 2008.

Martha J Bailey and Andrew Goodman-Bacon. The war on poverty's experiment in public medicine: Community health centers and the mortality of older americans. American Economic Review, 105(3):1067–1104, 2015.

Eric Bettinger, Oded Gurantz, Laura Kawano, Bruce Sacerdote, and Michael Stevens. The long-run impacts of financial aid: Evidence from california's cal grant. American Economic Journal: Economic Policy, 11(1):64–94, 2019.

Erica Blom, Kelia Washington, Macy Rainer, Carina Chien, and Robert Kelchen. Ipeds finance user guide. 2020.

John Bound and Sarah Turner. Cohort crowding: How resources affect collegiate attainment. Journal of public Economics, 91(5-6):877–899, 2007.

John Bound, Breno Braga, Gaurav Khanna, and Sarah Turner. A Passage to America: University Funding and International Students. 2016.

John Bound, Breno Braga, Gaurav Khanna, and Sarah Turner. Public universities: The supply side of building a skilled workforce. RSF: The Russell Sage Foundation Journal of the Social Sciences, 5(5):43–66, 2019.

Elizabeth B Clelan and Michael S Kofoed. The Effect of the Business Cycle on Freshman Financial Aid. Contemporary Economic Policy, 35(2):253–268, 2017. doi: 10.1111/coep.12192.

Jennifer A. Delaney and Tyler D. Kearney. The impact of guaranteed tuition policies on postsecondary tuition levels: A difference-in-difference approach. Economics of Education Review, 47: 80–99, 2015. doi: 10.1016/j.econedurev.2015.04.003.

Jennifer A. Delaney and Tyler D. Kearney. Alternative student-based revenue streams for higher education institutions: A difference-in-difference analysis using guaranteed tuition policies. Journal of Higher Education, 87:731–769, 2016. doi: 10.1353/jhe.2016.0028.

David Deming and Chris Walters. The impacts of price and spending subsidies on us postsecondary attainment. NBER Working Paper, 23736, 2017.

Michael F Dinerstein, Caroline M Hoxby, Jonathan Meer, and Pablo Villanueva. Did the Fiscal Stimulus Work for Universities? In Jeffrey R. Brow and Caroline M. Hoxby, editors, How the Financial Crisis and Great Recession Affected Higher Education, pages 263–320. University of Chicago Press, 2014. ISBN 9780226201832. URL http://www.nber.org/chapters/c12864.

Susan Dynarski and Judith Scott-Clayton. Financial aid policy: Lessons from research. The Future of children, 23(1):67–91, 2013.

Susan M Dynarski. Does aid matter? measuring the effect of student aid on college attendance and completion. American Economic Review, 93(1):279–288, 2003.

Dennis Epple, Richard Romano, and Holger Sieg. Admission, tuition, and financial aid policies in the market for higher education. Econometrica, 74(4):885–928, 2006.

Chao Fu. Equilibrium tuition, applications, admissions, and enrollment in the college market. Journal of Political Economy, 122(2):225–281, 2014.

Chao Fu, Shoya Ishimaru, and John Kennan. Government expenditure on the public education system. Technical report, National Bureau of Economic Research, 2019.

Jeffrey A Groen and Michelle J White. In-state versus out-of-state students: the divergence of interest between public universities and state governments B. Journal of Public Economics, 88: 1793–1814, 2004. doi: 10.1016/j.jpubeco.2003.07.005.

Caroline M Hoxby and Sarah Turner. What high-achieving low-income students know about college. American Economic Review, 105(5):514–17, 2015.

Ben Jann. Kmatch: Stata module for multivariate-distance and propensity-score matching. 2017.

Ozan Jaquette and Edna Parra. The problem with the delta cost project database. Research in Higher Education, 57(5):630–651, 2016.

Carl Klarner. State legislative election returns, 1967-2016. https://doi.org/10.7910/DVN/3WZFK9, Harvard Dataverse, V3, UNF:6:pV4h1CP/B8pHthjjQThTTw==, 2018.

Purdue University. Purdue announces 9th consecutive tuition freeze, 2020. URL https://www.purdue.edu/newsroom/releases/2020/Q1/purdue-announces-9th-consecutive-tuition-freeze.html.

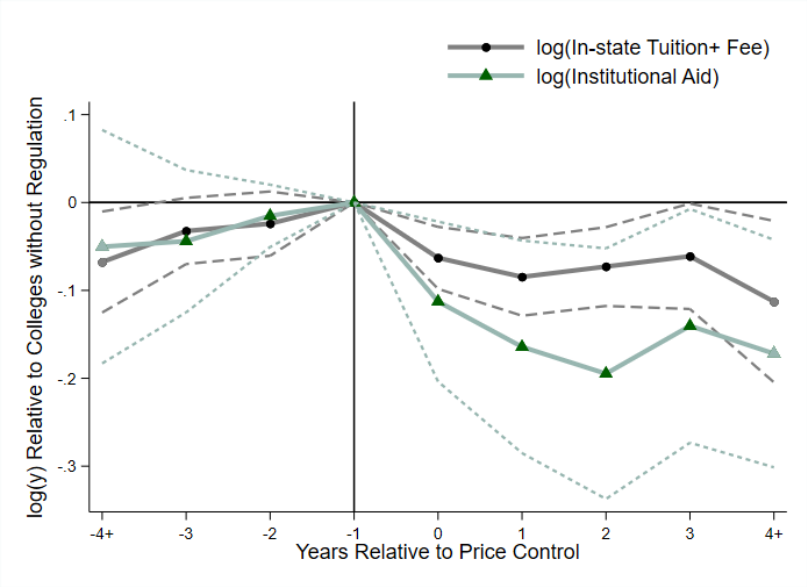
Michael J. Rizzo and Ronald G Ehrenberg. Resident and Nonresident Tuition and Enrollment at Flagship State Universities. In College Choices: The Economics of Where to Go, When to Go, and How to Pay For It, pages 303–354. University of Chicago Press, 2004. ISBN 0226355357. doi: 10.7208/chicago/9780226355375.003.0008.

Danielle H. Sandler and Ryan Sandler. Multiple event studies in public finance and labor economics: A simulation study with applications. Journal of Economic and Social Measurement, 39(1-2):31–57, 2014. ISSN 07479662. doi: 10.3233/JEM-140383.

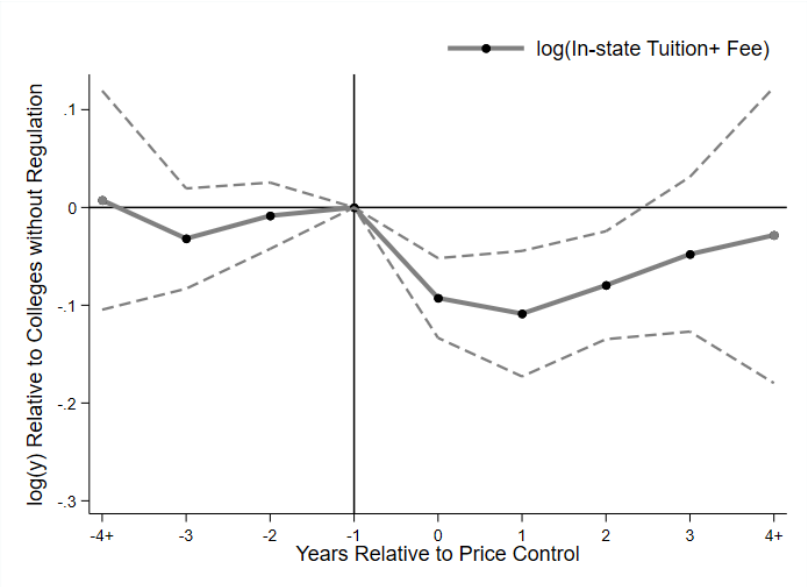
U.S. Bureau of Labor Statistics. Local area unemployment statistics, 2021. URL https://www.bls.gov/lau/.

Douglas A. Webber. State divestment and tuition at public institutions. Economics of Education Review, 60:1–4, 2017. doi: 10.1016/j.econedurev.2017.07.007.

Figure 1: Effect of Tuition Regulation on Tuition and Aid



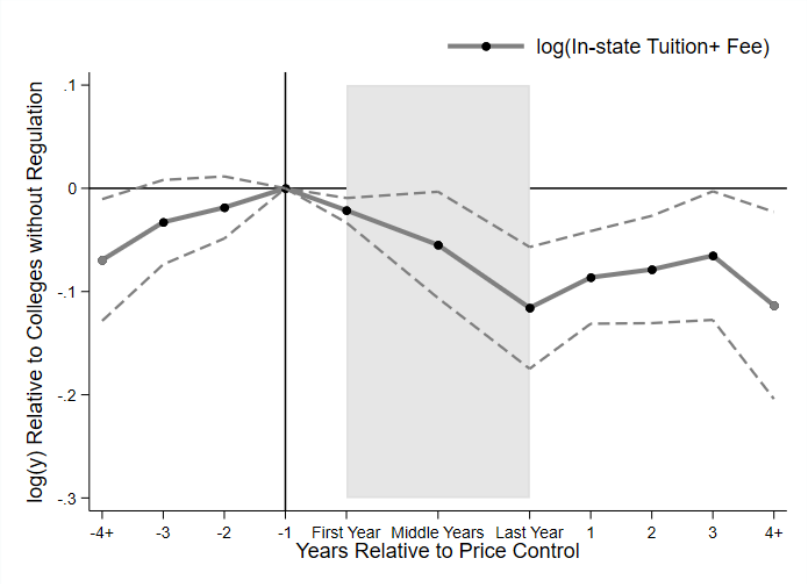
(a) 4-yr Institution



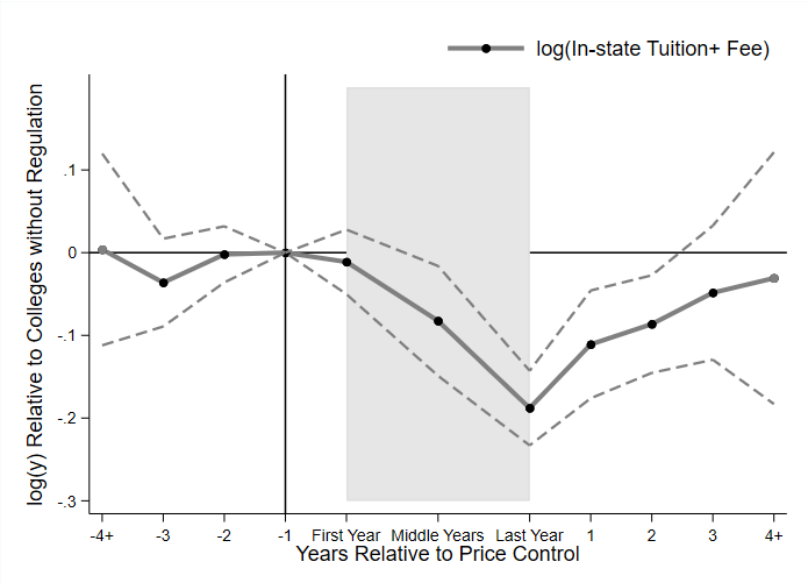
(b) 2-yr Institution

Notes: -4+ means 4 or more years before the tuition regulation is introduced, and 4+ is 4 or more years after the tuition regulation is lifted. The value of coefficients in the top panel are presented in Table 5; the bottom panel in Table A1. Confidence interval at 95% level.

Figure 2: Effect of Tuition Regulation on Tuition, First and Last Year of Regulation



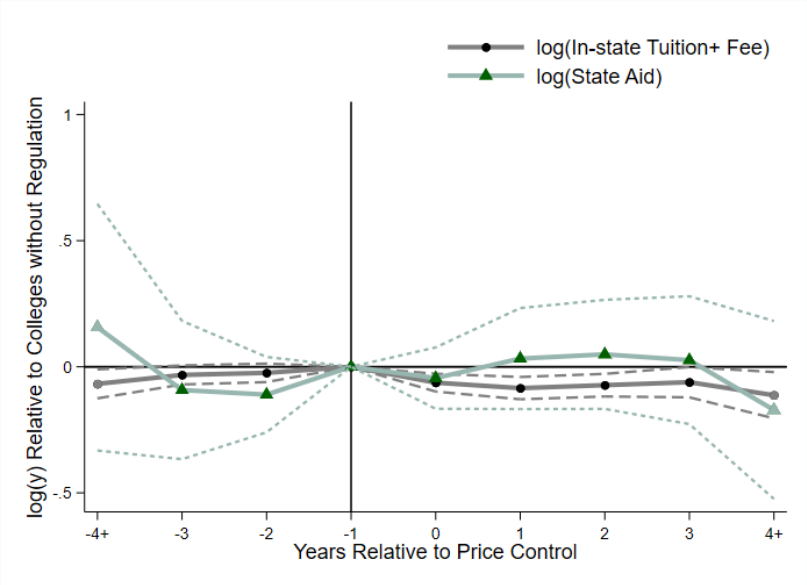
(a) 4-yr Colleges



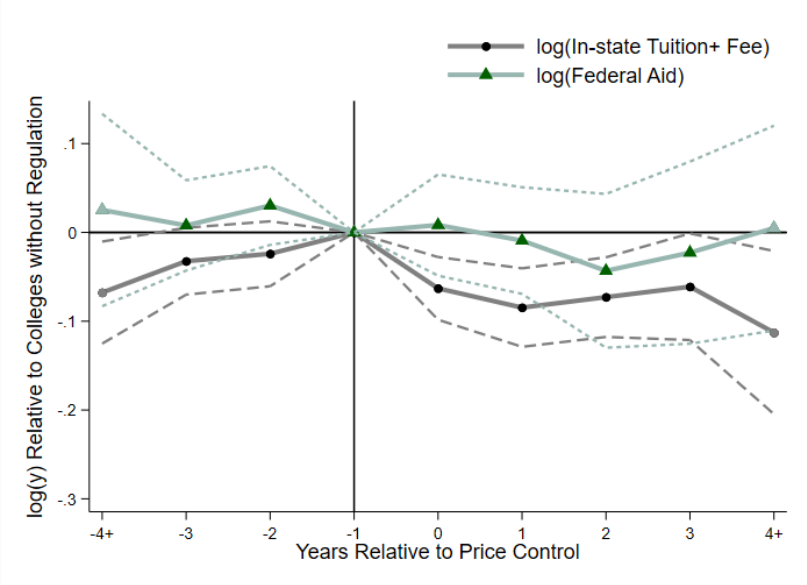
(b) 2-yr Colleges

Notes: -4+ means 4 or more years before the tuition regulation is introduced, and 4+ is 4 or more years after the tuition regulation is lifted. The value of coefficients are presented in Table A2. Confidence interval at 95% level.

Figure 3: Effect of Tuition Regulation on Other Sources of Aid



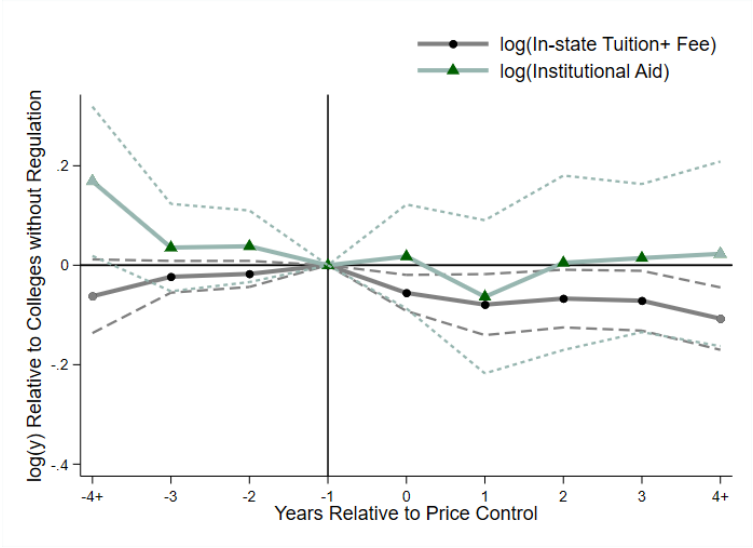
(a) State Aid



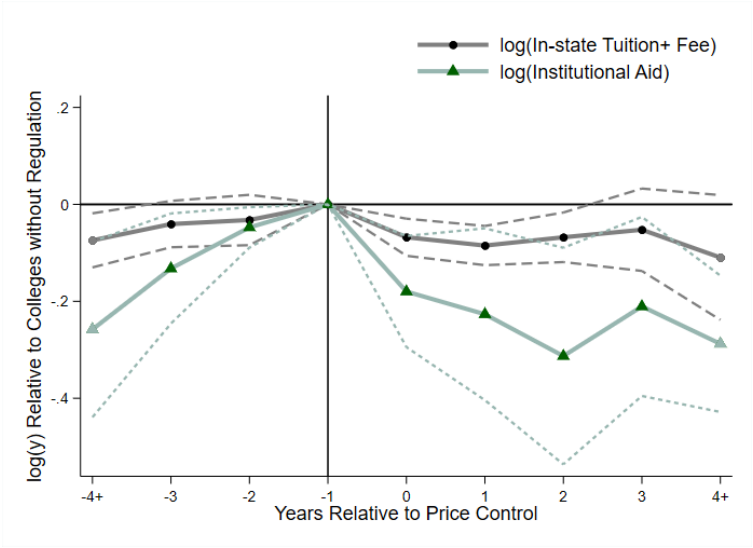
(b) Pell Grant

Notes: Sample of 4+ year degree granting universities. -4+ means 4 or more years before the tuition regulation is introduced, and 4+ is 4 or more years after the tuition regulation is lifted. The value of coefficients are presented in Table A3. Confidence interval at 95% level.

Figure 4: Effect of Tuition Regulation on Tuition and Aid: by Tuition Revenue Dependency



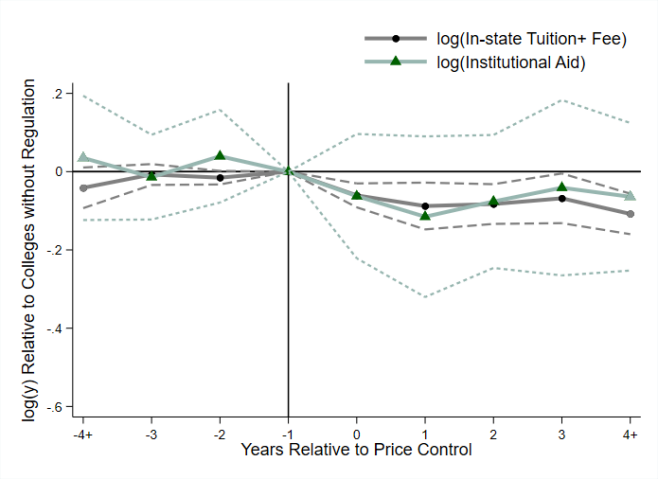
(a) *Less Dependent*



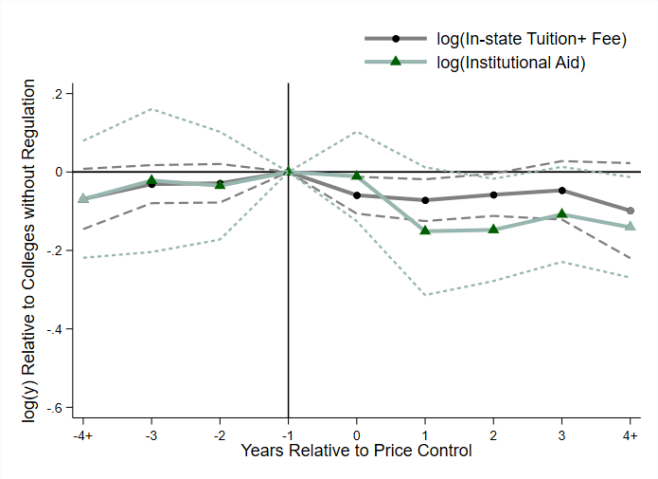
(b) *More Dependent*

Notes: Sample of 4+ year degree granting universities. -4+ means 4 or more years before the tuition regulation is introduced, and 4+ is 4 or more years after the tuition regulation is lifted. The value of coefficients are presented in Table A6. We classify an institution into *More Dependent* if the ratio of gross tuition revenue to total revenue is above the median of the institutions in the same sector (pubic and private separately) in 1991; *Less Dependent* if below the median. Confidence interval at 95% level.

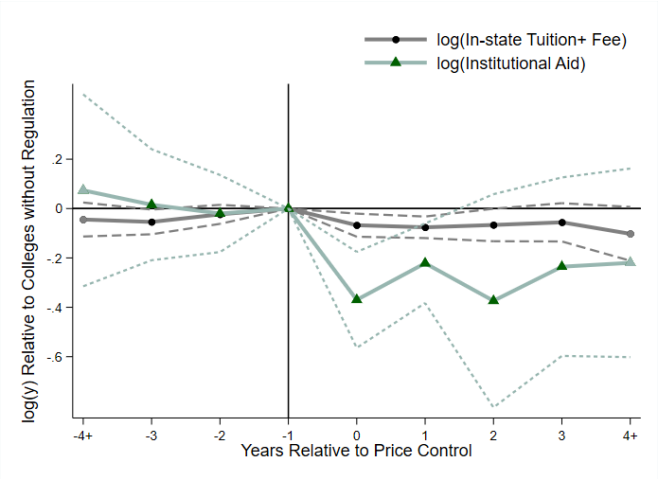
Figure 5: Effect of Tuition Regulation on Tuition and Aid: by Carnegie Classification



(a) *Research*



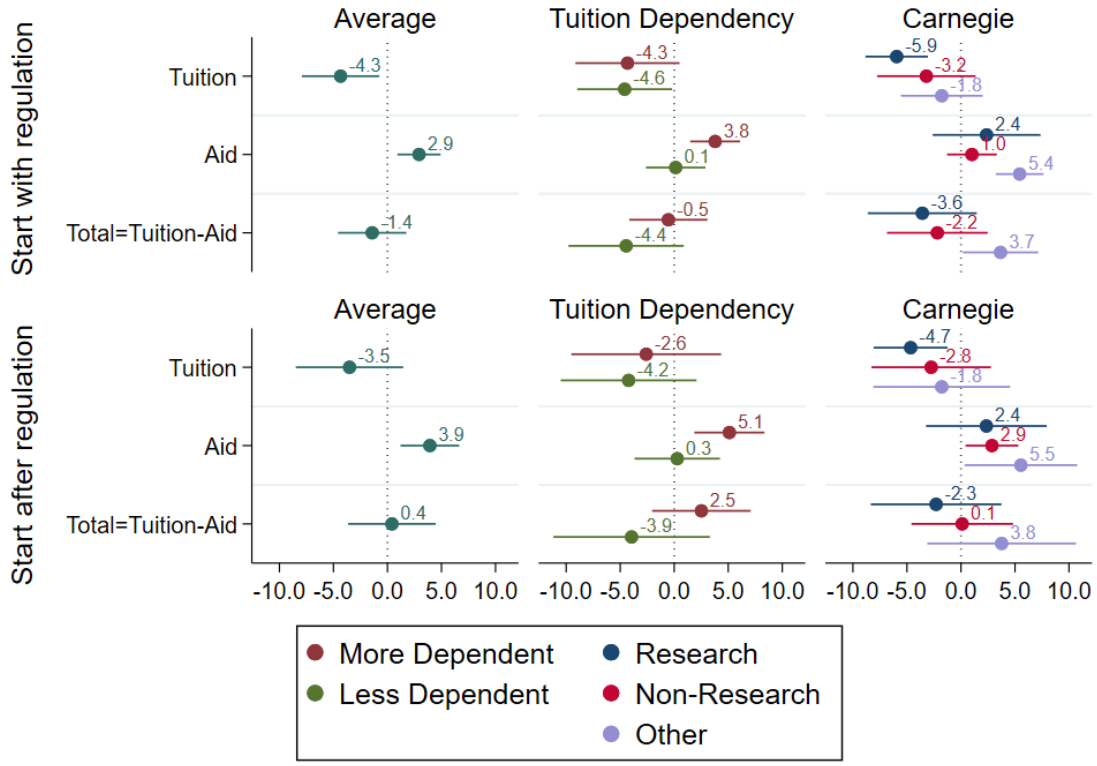
(b) *Non-research*



(c) *Others*

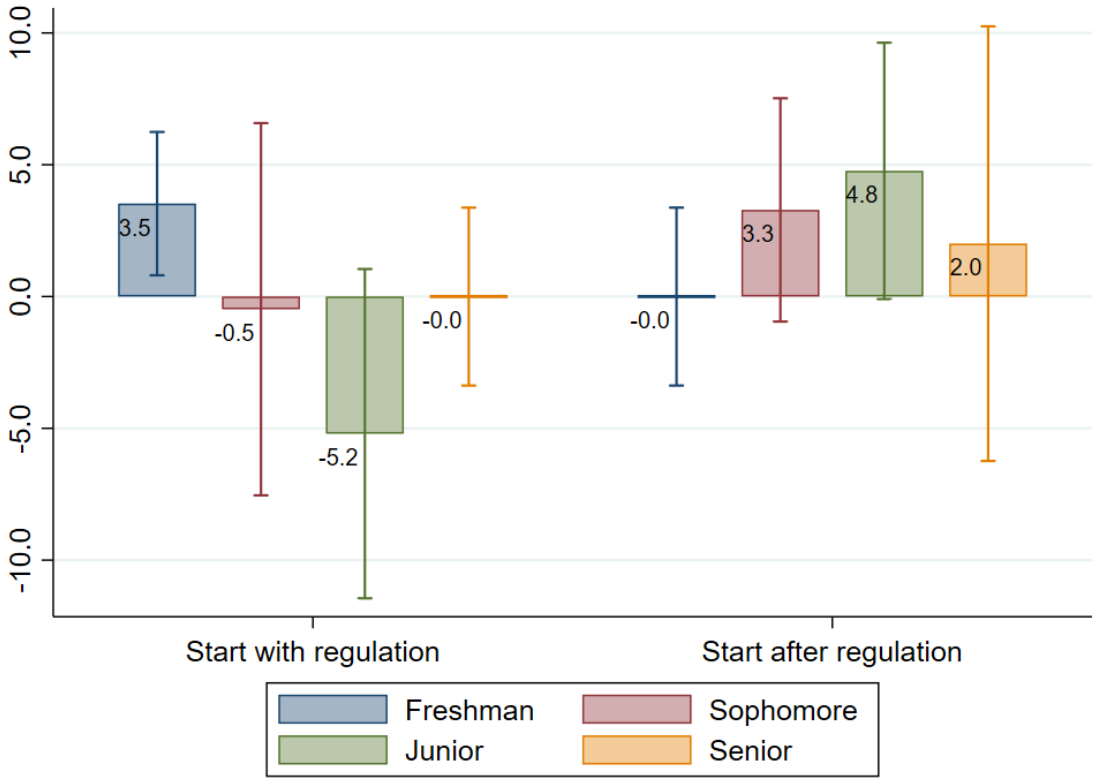
Notes: Sample of 4+ year degree granting universities. -4+ means 4 or more years before the tuition regulation is introduced, and 4+ is 4 or more years after the tuition regulation is lifted. The value of coefficients are presented in Table A7. *Research* sample is of doctoral universities with high or very high research activity (Carnegie classification). *Non-Research* is sample of master's universities or Doctoral universities with low research activity. *Others* include all other 4+ year degree granting universities. Confidence interval at 95% level.

Figure 6: Percent Change in Tuition Paid for Representative Students



Notes: Sample of 4+ year degree granting universities. Tuition gives the percentage point change in tuition paid for an average student at each type of university based on out estimates of change in listed tuition only. Aid gives the percentage point change in tuition paid due to changes in institutional aid. It is constructed by multiplying our estimates of the percent change in institutional aid with the (unconditional) percent of tuition covered by aid in each subgroup before any tuition regulations are imposed. Total combines these two effects to give the overall percentage point change in tuition paid by a student who receives the average institutional aid, including those who receive no institutional aid. All calculations assume that the tuition regulation lasts 3 years and students attend college for 4 years. The top row gives the effect on a student whose first year of education is the first year of the regulation; bottom row gives the effect on a student whose first year of education is the first year after the end of the regulation. Subgroups are defined as in the text. Confidence intervals at the 95% level.

Figure 7: Percent Change in Tuition Paid for Representative Students by at *More Dependent* Colleges, by Cohort



Notes: Sample of 4+ year degree granting universities. We classify an institution into *More Dependent* if the ratio of gross tuition revenue to total revenue is above the median of the institutions in the same sector (pubic and private separately) in 1991. Each year plots the total percentage point change paid in tuition incorporating changes in listed tuition and institutional aid. All calculations assume that the tuition regulation lasts 3 years and students attend college for 4 years. Left side shows results for a student whose first year of education is the first year of the regulation; right side gives results for a student whose first year of education is the first year after the end of the regulation. Confidence intervals at the 95% level.

Table 1: Distribution of Tuition Regulations

Cap	Freq.	Percent	Notes
-0.2 (mandated cut)	1	0.92	Virginia, 2000
0 (tuition freeze)	55	50.46	
0.03	8	7.34	
0.035	6	5.5	
0.04	7	6.42	
0.055	2	1.83	
0.06	12	11.01	
0.065	1	0.92	
0.07	2	1.83	
0.08	4	3.67	
0.09	1	0.92	
0.1	10	9.17	
Total	109	100	

Table 2: Distribution of Length of of Tuition Regulation

Duration (Years)	Freq.	Percent
1	15	41.67
2	9	25.00
4	2	5.56
5	3	8.33
6	1	2.78
7	2	5.56
8	3	8.33
9	1	2.78
Total	36	100.00

Table 3: Type of Affected Institutions

	By State		By Year	
Scope	Freq.	Percent	Freq.	Percent
All public institutions	6	35.29	44	40.36
4-year public institutions	7	41.18	35	32.11
2-year public institutions	3	17.65	16	14.68
CUNY (except 2003) and Cornell	1	5.88	14	12.84
Total	17	100	109	100

Notes: Oklahoma imposed a tuition regulation on all public institutions except for Oklahoma Technology Centers. For simplicity, it is counted as in the category "All public institutions".

Table 4: Summary Statistics by Type of Institution

Sample	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Treated		Public 4-year		Private 4-year		Public 2-year		Private 2-year	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
In-state Tuition										
$, 2016 referenced	5,166.55	3,361.55	5,531.35	2,690.30	18,850.56	9,482.26	2,765.61	1,756.91	9,343.28	5,675.13
% annual growth	0.001	0.068	0.044	0.078	0.033	0.096	0.041	0.157	0.028	0.14
Out-of-state Tuition										
$, 2016 referenced	11,815.97	6,094.78	13,563.50	5,599.00	18,866.66	9,469.98	6,265.22	3,155.81	9,490.43	5,737.69
% annual growth	0.006	0.094	0.036	0.109	0.032	0.096	0.027	0.193	0.027	0.146
Average Institutional aid										
$, 2016 referenced	935.239	1,283.43	1,279.78	1,213.97	7,814.53	5,616.63	256.167	410.341	1,313.53	2,443.63
% annual growth	0.111	0.985	0.09	0.689	0.073	0.635	0.082	1.043	0.091	1.139
% Revenue Souced with Tuition	0.336	0.188	0.287	0.144	0.639	1.29	0.223	0.132	0.669	3.123
Carnegie Classification										
Others	0.32	0.466	0.247	0.431	0.603	0.489	-	-	-	-
Non-research	0.333	0.471	0.452	0.498	0.339	0.473	-	-	-	-
Research	0.347	0.476	0.301	0.459	0.058	0.234	-	-	-	-
N of Obs	2,636		13,856		29,025		23,908		4,683	
N of Aid Obs	2,012		8,761		17,903		14,440		1,842	

Notes: 1. The unit of observation is Year × Institution. 2. Variables in dollar amount are adjusted using Consumer Price Index (CPI). Deflator of 2016 is normalized to be 100. 3. Tuition is the sum of undergraduate tuition and fee. 4. *Research* sample is of doctoral universities with high or very high research activity (Carnegie classification). *Non-Research* is sample of master's universities or Doctoral universities with low research activity. *Others* include all other 4+ year degree granting universities. 5. % Revenue soured with tuition is the fraction of gross tuition revenue out of total revenue.

Table 5: Effect of Tuition Regulation on Tuition and Aid: 4-year Institution

Dep. Variable	(1) log(In-state Tuition)	(2) log(In-state Tuition)	(3) log(Institutional Aid)	(4) log(Institutional Aid)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-0.068**	-0.063**	-0.050	-0.044
	(0.029)	(0.028)	(0.066)	(0.061)
$1(TuitReg_{t+3})_{it}$	-0.032*	-0.032	-0.044	-0.034
	(0.019)	(0.019)	(0.040)	(0.041)
$1(TuitReg_{t+2})_{it}$	-0.024	-0.023	-0.015	-0.016
	(0.018)	(0.018)	(0.018)	(0.020)
$1(TuitReg_{t})_{it}$	-0.063***	-0.094***	-0.113**	-0.101**
	(0.018)	(0.020)	(0.045)	(0.046)
$1(TuitReg_{t-1})_{it}$	-0.085***	-0.115***	-0.164***	-0.201***
	(0.022)	(0.031)	(0.060)	(0.070)
$1(TuitReg_{t-2})_{it}$	-0.073***	-0.100***	-0.195***	-0.280***
	(0.022)	(0.028)	(0.071)	(0.091)
$1(TuitReg_{t-3})_{it}$	-0.061**	-0.094***	-0.140**	-0.186**
	(0.030)	(0.031)	(0.066)	(0.088)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.113**	-0.110**	-0.172**	-0.162***
	(0.046)	(0.044)	(0.064)	(0.060)
$TuitCap_{it}$		0.967***		-0.199
		(0.322)		(0.373)
$TuitCap_{it-1}$		1.024*		1.397
		(0.528)		(1.064)
$TuitCap_{it-2}$		0.831*		2.837*
		(0.478)		(1.606)
$TuitCap_{it-3}$		0.871**		1.434
		(0.337)		(1.848)
Observations	41,410	41,410	26,239	26,239
R-squared	0.856	0.857	0.293	0.293
Two-way FEs	yes	yes	yes	yes
Sector specific trend	yes	yes	yes	yes
State level control	yes	yes	yes	yes

Notes: 1. The outcome variables are the log of in-state undergraduate tuition and fee combined in columns (1)-(2), and the log of average institutional aid for first-time undergraduate in column (3)-(4). 2. Two-way fixed effects include institution fixed effects and year fixed effects. 3. A private/public specific time trend is included. 4. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 5. Standard errors clustered at state-level are in parenthesis. 6. $***p < 0.01, **p < 0.05, *p < 0.1$

Table 6: Effect of Tuition Regulation on Tuition Revenue

Dep. Variable	(1) Gross Revenue	(2) Net Revenue	(3) log(Gross Revenue)	(4) log(Net Revenue)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-6.928	-5.126	0.048	0.015
	(8.920)	(6.716)	(0.045)	(0.059)
$1(TuitReg_{t+3})_{it}$	-2.367	-1.099	0.046*	0.075*
	(3.035)	(2.156)	(0.024)	(0.038)
$1(TuitReg_{t+2})_{it}$	-2.630*	-1.262	0.024	0.060*
	(1.525)	(1.009)	(0.015)	(0.032)
$1(TuitReg_{t})_{it}$	-4.720*	-2.675	-0.035	-0.023
	(2.615)	(2.027)	(0.028)	(0.049)
$1(TuitReg_{t-1})_{it}$	-3.287	-3.461	-0.013	-0.012
	(4.854)	(2.897)	(0.030)	(0.054)
$1(TuitReg_{t-2})_{it}$	-3.721	-3.828	0.009	0.033
	(4.973)	(3.039)	(0.030)	(0.047)
$1(TuitReg_{t-3})_{it}$	-2.955	-3.727	0.019	0.031
	(5.603)	(3.371)	(0.029)	(0.046)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-3.220	-3.511	-0.021	-0.019
	(7.740)	(4.555)	(0.033)	(0.051)
Observations	31,944	32,050	31,943	32,048
R-squared	0.248	0.229	0.604	0.430
Two-way FEs	yes	yes	yes	yes
State level control	yes	yes	yes	yes

Notes: 1. Sample of 4+ year degree granting universities. 2. The outcome variables are gross tuition revenue (in millions) in column (1), net tuition revenue (in million) in column (2), and the log of gross/net tuition revenue in column (3) and (4), respectively. 3. Two-way fixed effects include institution fixed effects and year fixed effects. 4. A private/public specific time trend is included. 5. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 6. Standard errors clustered at state-level are in parenthesis. 7. $***p < 0.01, **p < 0.05, *p < 0.1$

Table 7: Effect of Tuition Regulation on Tuition and Aid: Dollar Amount

Dep. Variable	(1) In-state Tuition($)	(2) In-state Tuition($)	(3) Institutional Aid($)	(4) Institutional Aid($)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-465.3*	-417.6*	-380.7**	-367.0***
	(252.8)	(234.6)	(145.5)	(133.7)
$1(TuitReg_{t+3})_{it}$	-83.4	-56.3	-153.7**	-119.2
	(121.5)	(126.0)	(75.7)	(71.7)
$1(TuitReg_{t+2})_{it}$	-118.4	-125.0	-64.3	-47.6
	(88.6)	(99.6)	(58.1)	(55.9)
$1(TuitReg_{t})_{it}$	-268.3**	-326.0***	-212.2***	-243.4***
	(121.8)	(98.3)	(63.3)	(52.5)
$1(TuitReg_{t-1})_{it}$	-243.7*	-520.1***	-292.0***	-341.6***
	(137.8)	(126.9)	(108.8)	(102.4)
$1(TuitReg_{t-2})_{it}$	-162.2	-510.6***	-278.4*	-439.8***
	(162.8)	(184.9)	(139.5)	(91.5)
$1(TuitReg_{t-3})_{it}$	-129.0	-488.9**	-221.1	-412.6***
	(175.6)	(193.6)	(142.1)	(93.5)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-558.6**	-518.7**	-436.4***	-419.8***
	(218.8)	(198.7)	(99.0)	(100.9)
$TuitCap_{it}$		2,217.4		1,158.0
		(2,976.6)		(797.8)
$TuitCap_{it-1}$		10,135.8**		1,509.2
		(4,982.4)		(1,290.7)
$TuitCap_{it-2}$		11,970.1***		5,071.7***
		(4,392.0)		(1,763.8)
$TuitCap_{it-3}$		11,059.2***		5,610.4***
		(3,642.0)		(1,906.6)
Observations	41,539	41,539	26,446	26,446
R-squared	0.819	0.819	0.612	0.612
Two-way FEs	yes	yes	yes	yes
Sector specific trend	yes	yes	yes	yes
State level control	yes	yes	yes	yes

Notes: 1. Sample of 4+ year degree granting universities. 2. The outcome variables are in-state tuition and fee combined in columns (1)-(2), and the mean institutional aid in column (3)-(4). 3. Two-way fixed effects include institution fixed effects and year fixed effects. 4. A private/public specific time trend is included. 5. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 6. Standard errors clustered at state-level are in parenthesis. 7. $***p < 0.01, **p < 0.05, *p < 0.1$

Table 8: Effect of Tuition Regulation on Tuition and Aid: Robustness Checks

	(1)	(2)	(3)	(4)	(5)
Sample	Matching		Ever Treated		Aid Sample
Dep. Variable	log(In-state Tuition)	log(Institutional Aid)	log(In-state Tuition)	log(Institutional Aid)	log(In-state Tuition)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-0.072***	-0.103	-0.096***	-0.172	-0.011
	(0.025)	(0.079)	(0.026)	(0.103)	(0.028)
$1(TuitReg_{t+3})_{it}$	-0.026	-0.099**	-0.037**	-0.090*	0.003
	(0.016)	(0.046)	(0.013)	(0.047)	(0.014)
$1(TuitReg_{t+2})_{it}$	-0.024	-0.020	-0.031*	-0.061	-0.010
	(0.016)	(0.033)	(0.015)	(0.035)	(0.009)
$1(TuitReg_{t})_{it}$	-0.046***	-0.110**	-0.041**	-0.091**	-0.044**
	(0.013)	(0.043)	(0.015)	(0.043)	(0.019)
$1(TuitReg_{t-1})_{it}$	-0.069***	-0.173**	-0.054**	-0.157**	-0.047***
	(0.017)	(0.067)	(0.020)	(0.067)	(0.017)
$1(TuitReg_{t-2})_{it}$	-0.064***	-0.192**	-0.051**	-0.172**	-0.032
	(0.019)	(0.075)	(0.021)	(0.078)	(0.023)
$1(TuitReg_{t-3})_{it}$	-0.063**	-0.135**	-0.054*	-0.105	-0.008
	(0.028)	(0.067)	(0.029)	(0.077)	(0.026)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.109**	-0.200***	-0.090*	-0.123	-0.045
	(0.046)	(0.060)	(0.048)	(0.084)	(0.038)
Observations	5,947	3,851	4,138	2,785	25,517
R-squared	0.928	0.311	0.936	0.297	0.860
Two-way FEs	yes	yes	yes	yes	yes
Sector specific trend	yes	yes	yes	yes	yes
State level control	yes	yes	yes	yes	yes

Notes: 1. Sample of 4+ year degree granting universities. Treated and comparison observations are 1-1 matched in column (1) and (2) based on the Mahalanobis distance in the annual tuition increase rate and the level of tuition from one to three years before regulation. Column (3) and (4) only include ever treated observations. Column (5) includes observations with non-missing institutional aid. 3. The outcome variables are log of in-state undergraduate tuition and fee combined in columns (1), (3), (5), and log of average institutional aid for first-time undergraduate in column (2)-(4). 4. Two-way fixed effects include institution fixed effects and year fixed effects. 5. A private/public specific time trend is included. 6. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 7. Standard errors clustered at state-level are in parenthesis. 8. $***p < 0.01, **p < 0.05, *p < 0.1$

Table 9: Spillover Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
					Carnegie Classification			
Sample	All		Other		Non-research		Research	
Dep. Variable	log(Tuition)	log(Aid)	log(Tuition)	log(Aid)	log(Tuition)	log(Aid)	log(Tuition)	log(Aid)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-0.016	-0.051	-0.027	0.013	-0.004	-0.102**	0.001	0.104
	(0.013)	(0.032)	(0.022)	(0.044)	(0.011)	(0.042)	(0.013)	(0.072)
$1(TuitReg_{t+3})_{it}$	-0.012	-0.070*	-0.018	-0.050	-0.010	-0.062	0.002	-0.045
	(0.010)	(0.040)	(0.014)	(0.062)	(0.011)	(0.044)	(0.006)	(0.095)
$1(TuitReg_{t+2})_{it}$	-0.003	-0.021	-0.011	-0.010	0.002	-0.008	0.003	0.052
	(0.004)	(0.025)	(0.007)	(0.041)	(0.003)	(0.033)	(0.004)	(0.054)
$1(TuitReg_{t})_{it}$	-0.004	-0.059***	-0.002	-0.065**	-0.001	0.001	-0.008	-0.068
	(0.005)	(0.021)	(0.006)	(0.028)	(0.005)	(0.028)	(0.005)	(0.070)
$1(TuitReg_{t-1})_{it}$	-0.008	-0.088***	-0.012	-0.086*	-0.000	-0.029	-0.014	-0.007
	(0.008)	(0.032)	(0.008)	(0.047)	(0.010)	(0.042)	(0.009)	(0.036)
$1(TuitReg_{t-2})_{it}$	-0.018*	-0.099***	-0.018**	-0.107***	-0.010	-0.023	-0.011	-0.011
	(0.009)	(0.031)	(0.009)	(0.037)	(0.012)	(0.047)	(0.009)	(0.032)
$1(TuitReg_{t-3})_{it}$	-0.023**	-0.107***	-0.032**	-0.108*	-0.012	-0.020	-0.011	-0.023
	(0.010)	(0.031)	(0.013)	(0.054)	(0.013)	(0.048)	(0.009)	(0.075)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.027**	-0.107***	-0.054***	-0.116*	0.004	-0.036	-0.008	0.062
	(0.012)	(0.038)	(0.020)	(0.066)	(0.012)	(0.053)	(0.012)	(0.044)
Observations	30,798	18,160	14,054	8,735	10,409	6,650	1,742	1,141
R-squared	0.820	0.278	0.787	0.253	0.928	0.369	0.970	0.482
Two-way FEs	yes	yes	yes	yes	yes	yes	yes	yes
State level control	yes	yes	yes	yes	yes	yes		

Notes: 1. Sample of 4+ year degree granting private universities. $1(TuitReg_{t-k})_{it}$ equals to one if public universities of the same state as i are under tuition regulation in $t-k$. 2. The outcome variables are the log of in-state tuition and fee combined in odd-numbered columns, and log of average institutional aid for first-time undergraduate in even-numbered columns. 3. Two-way fixed effects include institution fixed effects and year fixed effects. 4. State level controls include lag, lead and the current year of state-level unemployment rate. 5. Standard errors clustered at state-level are in parenthesis. 6. $***p < 0.01, **p < 0.05, *p < 0.1$

Table 10: Effect of Tuition Regulation on Per-Student Instruction-Related Expenditure

	(1)	(2)	(3)	(4)	(5)	(6)
		Tuition Dependency		Carnegie Classification		
Sample	All	Less Dep.	More Dep.	Other	Non-research	Research
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-0.028	-0.068**	-0.005	-0.070*	-0.032	0.010
	(0.029)	(0.030)	(0.027)	(0.039)	(0.031)	(0.018)
$1(TuitReg_{t+3})_{it}$	-0.021	-0.035*	-0.018	-0.047	-0.023**	0.004
	(0.017)	(0.020)	(0.011)	(0.034)	(0.011)	(0.011)
$1(TuitReg_{t+2})_{it}$	0.000	-0.013	0.001	-0.027	-0.004	0.006
	(0.014)	(0.019)	(0.011)	(0.028)	(0.012)	(0.007)
$1(TuitReg_{t})_{it}$	-0.033*	-0.021	-0.050***	-0.054*	-0.033	-0.008
	(0.017)	(0.019)	(0.018)	(0.028)	(0.021)	(0.009)
$1(TuitReg_{t-1})_{it}$	-0.022	-0.040**	-0.027	-0.074**	-0.010	-0.019
	(0.017)	(0.018)	(0.024)	(0.031)	(0.020)	(0.015)
$1(TuitReg_{t-2})_{it}$	-0.027	-0.042**	-0.029	-0.087***	-0.013	-0.008
	(0.019)	(0.016)	(0.029)	(0.031)	(0.023)	(0.017)
$1(TuitReg_{t-3})_{it}$	-0.024	-0.046**	-0.025	-0.080***	-0.010	-0.014
	(0.024)	(0.020)	(0.027)	(0.029)	(0.024)	(0.014)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.020	-0.044*	-0.022	-0.055*	-0.018	-0.023*
	(0.026)	(0.026)	(0.018)	(0.030)	(0.021)	(0.014)
Observations	44,694	20,347	20,485	19,392	15,443	5,463
R-squared	0.492	0.535	0.679	0.450	0.743	0.627
Two-way FEs	yes	yes	yes	yes	yes	yes
Sector specific trend	yes	yes	yes	yes	yes	yes
State level control	yes	yes	yes	yes	yes	yes

Notes: 1. Sample of 4+ year degree granting universities. We classify an institution into *More Dependent* if the ratio of gross tuition revenue to total revenue is above the median of the institutions in the same sector (pubic and private separately) in 1991; *Less Dependent* if below the median. Research sample is of doctoral universities with high or very high research activity (Carnegie classification). Non-Research is sample of master's universities or Doctoral universities with low research activity. Others include all other 4+ year degree granting universities. 2. The outcome variable is log of per-student Instruction-related Expenditure in all columns. 3. Two-way fixed effects include institution fixed effects and year fixed effects. 4. A private/public specific time trend is included. 5. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 6. Standard errors clustered at state-level are in parenthesis. 7. $***p < 0.01, **p < 0.05, *p < 0.1$

Table 11: Effect of Tuition Regulation on Tuition: Time Periods Before 2010 and After 2011

Sample	(1) 1990-2019	(2) 1990-2010	(3) 2011-2019
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	0.020	-0.077**	0.038
	(0.033)	(0.032)	(0.023)
$1(TuitReg_{t+3})_{it}$	0.010	-0.036*	-0.008
	(0.027)	(0.019)	(0.015)
$1(TuitReg_{t+2})_{it}$	0.014	-0.029	-0.001
	(0.026)	(0.020)	(0.012)
$1(TuitReg_{t})_{it}$	-0.025	-0.064***	0.005
	(0.029)	(0.015)	(0.017)
$1(TuitReg_{t-1})_{it}$	-0.010	-0.094***	0.021
	(0.034)	(0.022)	(0.024)
$1(TuitReg_{t-2})_{it}$	-0.004	-0.072**	0.003
	(0.030)	(0.031)	(0.026)
$1(TuitReg_{t-3})_{it}$	0.002	-0.064	-0.006
	(0.032)	(0.043)	(0.031)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.034	-0.118**	0.007
	(0.034)	(0.058)	(0.030)
Observations	51,136	35,516	15,620
R-squared	0.880	0.829	0.565
Two-way FEs	yes	yes	yes
Sector specific trend	yes	yes	yes
State level control	yes	yes	yes

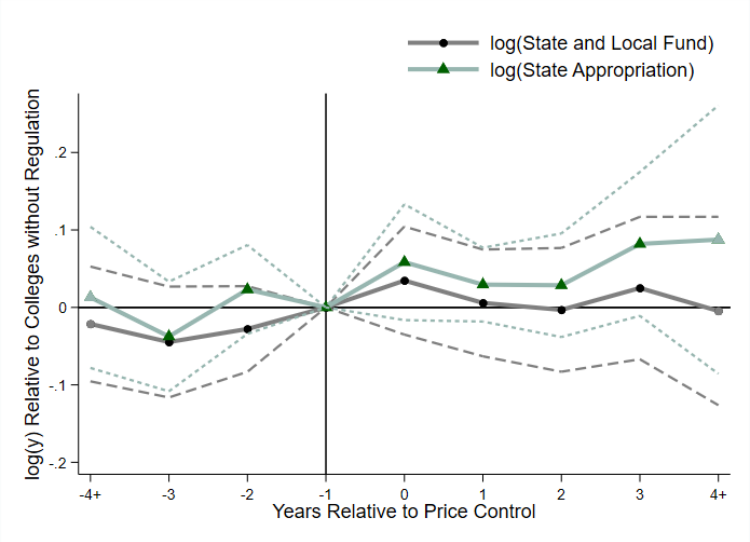
Notes: 1. Sample of 4+ year degree granting universities. 2. The outcome variables are the log of in-state undergraduate tuition and fee combined in all columns (1)-(2). 3. Two-way fixed effects include institution fixed effects and year fixed effects. 4. A private/public specific time trend is included. 5. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 6. Standard errors clustered at state-level are in parenthesis. 7. $***p < 0.01, **p < 0.05, *p < 0.1$

Table 12: Annual Increases in Tuition Before and After 2010

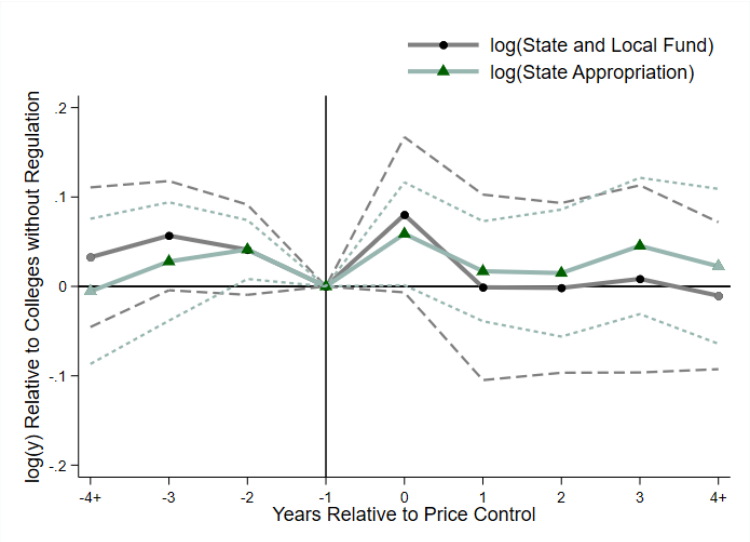
	Under tuition reg			Not under tuition reg		
	N	mean	sd	N	mean	sd
Average % tuition increase						
Before 2010	1,081	0.031	0.069	10,943	0.072	0.086
After 2011	1,267	0.033	0.036	4,724	0.042	0.071

A Supplementary Tables and Figures

Figure A1: State Funding Before and After Tuition Regulation



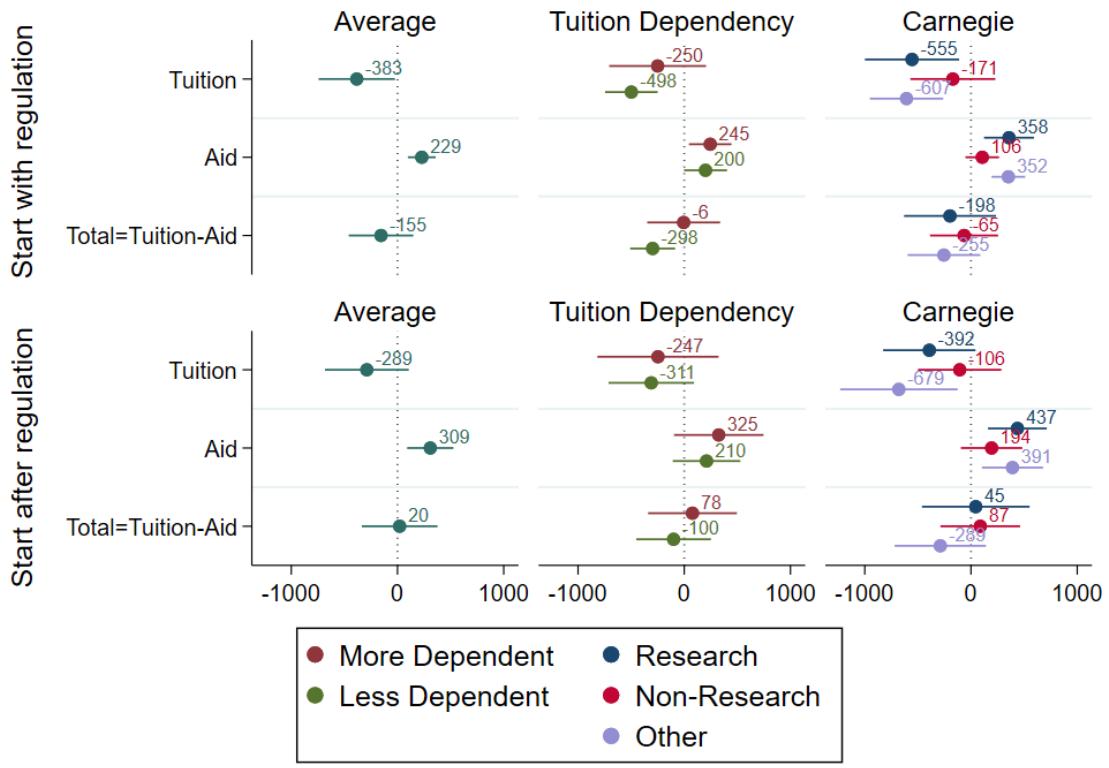
(a) 4-year Institution



(b) 2-year Institution

Notes: -4+ means 4 or more years before the tuition regulation is introduced, and 4+ is 4 or more years after the tuition regulation is lifted. log(State and Local Fund) is a total sum of appropriation and grants from either State or local government. log(State Appropriation) only captures the appropriation from State. Confidence interval at 95% level.

Figure A2: Dollar Change in Tuition Paid by Representative Students



Notes: Sample of 4+ year degree granting universities. Tuition gives the dollar amount change in tuition paid for an average student at each type of university based on out estimates of change in listed tuition only. Aid gives the dollar amount change in tuition paid due to changes in institutional aid. Total combines these two effects to give the overall dollar amount change in tuition paid by a student who receives the average institutional aid, including those who receive no institutional aid. All calculations assume that the tuition regulation lasts 3 years and students attend college for 4 years. The top row gives the effect on a student whose first year of education is the first year of the regulation; bottom row gives the effect on a student whose first year of education is the first year after the end of the regulation. Subgroups are defined as in the text. Confidence intervals at the 95% level.

Table A1: Effect of Tuition Regulation on Tuition and Aid: 2-year Institutions

Dep. Variable	(1) log(In-state Tuition)	(2) log(In-state Tuition)	(3) log(Institutional Aid)	(4) log(Institutional Aid)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	0.007	0.004	-0.054	-0.057
	(0.056)	(0.056)	(0.084)	(0.089)
$1(TuitReg_{t+3})_{it}$	-0.032	-0.039**	-0.094	-0.100
	(0.026)	(0.018)	(0.108)	(0.106)
$1(TuitReg_{t+2})_{it}$	-0.008	-0.008	-0.138	-0.154
	(0.017)	(0.016)	(0.132)	(0.140)
$1(TuitReg_{t})_{it}$	-0.093***	-0.104***	0.033	0.036
	(0.020)	(0.024)	(0.096)	(0.096)
$1(TuitReg_{t-1})_{it}$	-0.109***	-0.130***	0.087	-0.014
	(0.032)	(0.043)	(0.112)	(0.153)
$1(TuitReg_{t-2})_{it}$	-0.080***	-0.086**	0.089	-0.020
	(0.027)	(0.035)	(0.128)	(0.158)
$1(TuitReg_{t-3})_{it}$	-0.048	-0.056	0.233*	0.176
	(0.039)	(0.036)	(0.118)	(0.133)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.028	-0.035	0.159	0.175
	(0.075)	(0.081)	(0.178)	(0.165)
$TuitCap_{it}$		0.749		2.069**
		(0.671)		(0.774)
$TuitCap_{it-1}$		1.235		5.900**
		(1.455)		(2.359)
$TuitCap_{it-2}$		0.288		5.964*
		(1.358)		(3.420)
$TuitCap_{it-3}$		0.382		3.530
		(1.347)		(2.789)
Observations	29,486	29,486	15,045	15,045
R-squared	0.715	0.715	0.173	0.174
Two-way FEs	yes	yes	yes	yes
Sector specific trend	yes	yes	yes	yes
State level control	yes	yes	yes	yes

Notes: 1. The outcome variables are the log of in-state undergraduate tuition and fee combined in columns (1)-(2), and the log of average institutional aid for first-time undergraduate in column (3)-(4). 2. Two-way fixed effects include institution fixed effects and year fixed effects. 3. A private/public specific time trend is included. 4. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 5. Standard errors clustered at state-level are in parenthesis. 6. $***p < 0.01, **p < 0.05, *p < 0.1$

Table A2: Effect of Tuition Regulation on Tuition: Dynamics During Regulation

	(1)	(2)	(3)	(4)
	4-year Institution		2-year Institution	
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-0.069**	-0.062**	0.004	0.020
	(0.029)	(0.030)	(0.058)	(0.059)
$1(TuitReg_{t+3})_{it}$	-0.033	-0.028	-0.036	-0.026
	(0.020)	(0.018)	(0.026)	(0.026)
$1(TuitReg_{t+2})_{it}$	-0.019	-0.022	-0.002	-0.007
	(0.015)	(0.016)	(0.017)	(0.016)
$1(FirstYrofTuitReg_t)_{it}$	0.033		0.071***	
	(0.025)		(0.025)	
$1(TuitReg_t)_{it}$	-0.055**	-0.023**	-0.082**	-0.029
	(0.026)	(0.009)	(0.033)	(0.029)
$NofConsecutiveYears - 1_{it}$		-0.019**		-0.029***
		(0.007)		(0.008)
$1(LastYrofTuitReg_t)_{it}$	-0.061***		-0.105***	
	(0.012)		(0.033)	
$1(TuitReg_{t-1})_{it}$	-0.086***	-0.085***	-0.111***	-0.108***
	(0.022)	(0.023)	(0.032)	(0.033)
$1(TuitReg_{t-2})_{it}$	-0.079***	-0.079***	-0.086***	-0.086***
	(0.026)	(0.025)	(0.029)	(0.028)
$1(TuitReg_{t-3})_{it}$	-0.065**	-0.066*	-0.048	-0.049
	(0.031)	(0.033)	(0.040)	(0.040)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.113**	-0.108**	-0.031	-0.026
	(0.045)	(0.045)	(0.076)	(0.074)
Observations	41,410	41,410	29,486	29,486
R-squared	0.857	0.857	0.715	0.716
Two-way FEs	yes	yes	yes	yes
Sector specific trend	yes	yes	yes	yes
State level control	yes	yes	yes	yes

Notes: 1. Sample of 4+ year degree granting universities in columns (1)-(2), and 2+ but less than 4 year degree granting universities in columns (3)-(4). 2. The outcome variable is the log of in-state undergraduate tuition and fee combined in columns (1)-(4). 3. Two-way fixed effects include institution fixed effects and year fixed effects. 4. A private/public specific time trend is included. 5. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 6. Standard errors clustered at state-level are in parenthesis. 7. $***p < 0.01, **p < 0.05, *p < 0.1$

Table A3: Effect of Tuition Regulation on Aid from Other Sources

	(1) log(State Aid)	(2) log(Federal Aid)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-0.155	0.025
	(0.245)	(0.054)
$1(TuitReg_{t+3})_{it}$	-0.177	0.008
	(0.142)	(0.025)
$1(TuitReg_{t+2})_{it}$	-0.190**	0.030
	(0.074)	(0.022)
$1(TuitReg_{t})_{it}$	0.022	0.008
	(0.061)	(0.028)
$1(TuitReg_{t-1})_{it}$	0.114	-0.009
	(0.115)	(0.030)
$1(TuitReg_{t-2})_{it}$	0.188	-0.043
	(0.129)	(0.043)
$1(TuitReg_{t-3})_{it}$	0.208	-0.023
	(0.141)	(0.051)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	0.033	0.005
	(0.187)	(0.057)
Observations	24,999	26,644
R-squared	0.036	0.320
Two-way FEs	yes	yes
Sector specific trend	yes	yes
State level control	yes	yes

Notes: 1. Sample of 4+ year degree granting universities. 2. The outcome variables are the log of mean state aid in column (1) and the log of mean federal aid in column (2). 3. Two-way fixed effects include institution fixed effects and year fixed effects. 4. A private/public specific time trend is included. 5. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 6. Standard errors clustered at state-level are in parenthesis. 7. $***p < 0.01, **p < 0.05, *p < 0.1$

Table A4: Effect of Tuition Regulation on Tuition and Aid: Different Time Trend

Dep. Variable	(1)	(2)	(3)	(4)	(5)	(6)
	log(In-state Tuition)			log(Institutional Aid)		
	Quadratic	State	State, Sector	Quadratic	State	State, Sector
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-0.072**	-0.100***	-0.056**	-0.050	-0.120*	-0.037
	(0.029)	(0.025)	(0.027)	(0.065)	(0.064)	(0.069)
$1(TuitReg_{t+3})_{it}$	-0.030	-0.038**	-0.025	-0.044	-0.071*	-0.041
	(0.019)	(0.016)	(0.017)	(0.040)	(0.041)	(0.044)
$1(TuitReg_{t+2})_{it}$	-0.025	-0.030*	-0.024	-0.015	-0.029	-0.017
	(0.019)	(0.018)	(0.018)	(0.018)	(0.017)	(0.018)
$1(TuitReg_{t})_{it}$	-0.062***	-0.040**	-0.059***	-0.113**	-0.060	-0.101**
	(0.015)	(0.016)	(0.014)	(0.044)	(0.043)	(0.047)
$1(TuitReg_{t-1})_{it}$	-0.084***	-0.059***	-0.081***	-0.164***	-0.106*	-0.156**
	(0.020)	(0.017)	(0.019)	(0.060)	(0.055)	(0.063)
$1(TuitReg_{t-2})_{it}$	-0.075***	-0.047**	-0.069***	-0.195***	-0.129*	-0.185**
	(0.022)	(0.020)	(0.019)	(0.071)	(0.068)	(0.077)
$1(TuitReg_{t-3})_{it}$	-0.064**	-0.024	-0.048*	-0.140**	-0.075	-0.137*
	(0.030)	(0.027)	(0.025)	(0.067)	(0.066)	(0.075)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.125***	-0.049	-0.082**	-0.172***	-0.073	-0.158**
	(0.044)	(0.044)	(0.039)	(0.064)	(0.062)	(0.077)
Observations	41,410	41,410	41,410	26,239	26,239	26,239
R-squared	0.857	0.863	0.866	0.293	0.300	0.302
Two-way FEs	yes	yes	yes	yes	yes	yes
State level control	yes	yes	yes	yes	yes	yes

Notes: 1. Sample of 4+ year degree granting universities. 2. The outcome variables are the log of in-state undergraduate tuition and fee combined in columns (1)-(3) and the log of average institutional aid for first-time undergraduate in columns (4)-(6). 3. Two-way fixed effects include institution fixed effects and year fixed effects. 4. Column (1),(4) controls for quadratic sector-specific time trend, column (2),(5) state-specific linear time trend, and (3),(6) both sector- and state-specific linear time trend. 5. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 6. Standard errors clustered at state-level are in parenthesis. 7. $***p < 0.01, **p < 0.05, *p < 0.1$

Table A5: Effect of Tuition Regulation on Tuition and Aid: Control for State Funding

Dep. Variable	(1) log(In-state Tuition)	(2) log(Institutional Aid)	(3) log(In-state Tuition)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-0.071**	-0.052	-0.035
	(0.031)	(0.073)	(0.054)
$1(TuitReg_{t+3})_{it}$	-0.032	-0.041	-0.039
	(0.019)	(0.041)	(0.026)
$1(TuitReg_{t+2})_{it}$	-0.025	-0.005	-0.025
	(0.019)	(0.021)	(0.015)
$1(TuitReg_{t})_{it}$	-0.064***	-0.114**	-0.089***
	(0.016)	(0.046)	(0.020)
$1(TuitReg_{t-1})_{it}$	-0.081***	-0.153**	-0.095***
	(0.022)	(0.062)	(0.035)
$1(TuitReg_{t-2})_{it}$	-0.068***	-0.171**	-0.053**
	(0.024)	(0.080)	(0.022)
$1(TuitReg_{t-3})_{it}$	-0.073**	-0.154**	-0.074
	(0.030)	(0.068)	(0.047)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.123**	-0.177***	-0.090
	(0.050)	(0.063)	(0.070)
$log(StateLocalFund)_{t}$	-0.001	-0.003	-0.009*
	(0.002)	(0.008)	(0.005)
$log(StateLocalFund)_{t-1}$	0.000	0.008	-0.015**
	(0.002)	(0.010)	(0.007)
$log(StateLocalFund)_{t+1}$	0.002	0.013	0.004
	(0.002)	(0.011)	(0.011)
Observations	24,938	15,787	20,215
R-squared	0.894	0.295	0.750
Two-way FEs	yes	yes	yes
Sector specific trend	yes	yes	yes
State level control	yes	yes	yes

Notes: 1. Sample of 4+ year degree granting universities in columns (1)-(2), and 2+ but less than 4 year degree granting universities in columns (3). 2. The outcome variable is the log of in-state undergraduate tuition and fee combined in columns (1), (3) and the log of average institutional aid for first-time undergraduate in column (2). 3. log(State Local Fund) is a total sum of appropriation and grants from either State or local government. 4. Two-way fixed effects include institution fixed effects and year fixed effects. 5. A private/public specific time trend is included. 6. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 7. Standard errors clustered at state-level are in parenthesis. 8. $***p < 0.01, **p < 0.05, *p < 0.1$

Table A6: Effect of Tuition Regulation on Tuition and Aid: by Tuition Revenue Dependency

Dep. Variable	log(In-state Tuition)		log(Institutional Aid)	
Sample	*Less Dep.*	*More Dep.*	*Less Dep.*	*More Dep.*
	(1)	(2)	(3)	(4)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-0.062*	-0.074**	0.169**	-0.258***
	(0.037)	(0.028)	(0.075)	(0.090)
$1(TuitReg_{t+3})_{it}$	-0.023	-0.041*	0.036	-0.132**
	(0.016)	(0.024)	(0.044)	(0.056)
$1(TuitReg_{t+2})_{it}$	-0.017	-0.032	0.038	-0.047**
	(0.013)	(0.026)	(0.036)	(0.021)
$1(TuitReg_{t})_{it}$	-0.056***	-0.068***	0.018	-0.180***
	(0.018)	(0.019)	(0.052)	(0.057)
$1(TuitReg_{t-1})_{it}$	-0.079**	-0.085***	-0.063	-0.227**
	(0.031)	(0.020)	(0.077)	(0.088)
$1(TuitReg_{t-2})_{it}$	-0.067**	-0.068**	0.005	-0.313***
	(0.029)	(0.025)	(0.087)	(0.111)
$1(TuitReg_{t-3})_{it}$	-0.071**	-0.052	0.014	-0.210**
	(0.030)	(0.042)	(0.074)	(0.092)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.107***	-0.110*	0.023	-0.288***
	(0.031)	(0.064)	(0.092)	(0.070)
Observations	17,476	19,513	11,268	12,921
R-squared	0.844	0.920	0.296	0.333
Two-way FEs	yes	yes	yes	yes
State level control	yes	yes	yes	yes

Notes: 1. Sample of 4+ year degree granting universities. We classify an institution into *More Dependent* if the ratio of gross tuition revenue to total revenue is above the median of the institutions in the same sector (pubic and private separately) in 1991; *Less Dependent* if below the median. 2. The outcome variables are the log of in-state undergraduate tuition and fee combined in columns (1)-(2) and the log of average institutional aid for first-time undergraduate in columns (3)-(4). 4. Two-way fixed effects include institution fixed effects and year fixed effects. 4. Column (1),(4) controls for quadratic sector-specific time trend, column (2),(5) state-specific linear time trend, and (3),(6) both sector- and state-specific linear time trend. 5. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 6. Standard errors clustered at state-level are in parenthesis. 7. $***p < 0.01, **p < 0.05, *p < 0.1$

Table A7: Effect of Tuition Regulation on Tuition and Aid: by Carnegie Classification

	(1)	(2)	(3)	(4)	(5)	(6)
	log(In-state Tuition)			log(Institutional Aid)		
	Other	*Non-research*	*Research*	*Other*	*Non-research*	*Research*
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-0.044	-0.069*	-0.041	0.074	-0.069	0.035
	(0.034)	(0.038)	(0.026)	(0.193)	(0.074)	(0.079)
$1(TuitReg_{t+3})_{it}$	-0.054**	-0.031	-0.007	0.015	-0.022	-0.014
	(0.025)	(0.024)	(0.013)	(0.112)	(0.091)	(0.054)
$1(TuitReg_{t+2})_{it}$	-0.023	-0.029	-0.015*	-0.020	-0.035	0.039
	(0.019)	(0.024)	(0.009)	(0.078)	(0.068)	(0.059)
$1(TuitReg_{t})_{it}$	-0.067***	-0.059**	-0.061***	-0.370***	-0.011	-0.063
	(0.023)	(0.023)	(0.015)	(0.097)	(0.057)	(0.079)
$1(TuitReg_{t-1})_{it}$	-0.076***	-0.072***	-0.088***	-0.222***	-0.151*	-0.115
	(0.022)	(0.026)	(0.030)	(0.080)	(0.081)	(0.102)
$1(TuitReg_{t-2})_{it}$	-0.067**	-0.058**	-0.083***	-0.374*	-0.148**	-0.076
	(0.033)	(0.027)	(0.025)	(0.215)	(0.065)	(0.085)
$1(TuitReg_{t-3})_{it}$	-0.056	-0.047	-0.068**	-0.235	-0.108*	-0.041
	(0.039)	(0.037)	(0.032)	(0.180)	(0.060)	(0.111)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.102*	-0.098	-0.108***	-0.220	-0.141**	-0.064
	(0.054)	(0.060)	(0.026)	(0.190)	(0.064)	(0.094)
Observations	16,988	15,434	5,444	10,688	10,272	3,716
R-squared	0.806	0.928	0.939	0.254	0.330	0.448
Two-way FEs	yes	yes	yes	yes	yes	yes
Sector specific trend	yes	yes	yes	yes	yes	yes
State level control	yes	yes	yes	yes	yes	yes

Notes: 1. Sample of 4+ year degree granting universities. *Research* sample is of doctoral universities with high or very high research activity (Carnegie classification). *Non-Research* is sample of master's universities or Doctoral universities with low research activity. *Others* include all other 4+ year degree granting universities. 2. The outcome variables are the log of in-state undergraduate tuition and fee combined in columns (1)-(3) and the log of average institutional aid for first-time undergraduate in columns (4)-(6). 4. Two-way fixed effects include institution fixed effects and year fixed effects. 4. Column (1),(4) controls for quadratic sector-specific time trend, column (2),(5) state-specific linear time trend, and (3),(6) both sector- and state-specific linear time trend. 5. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 6. Standard errors clustered at state-level are in parenthesis. 7. $***p < 0.01, **p < 0.05, *p < 0.1$

Table A8: Effect of Tuition Regulation on Other Charges

	(1)	(2)	(3)	(4)
	4-year Institution		2-year Institution	
Dep. Variable	Fee	log(room and board)	Fee	log(room and board)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-9.928	0.002	-32.521	-0.028*
	(107.154)	(0.010)	(33.505)	(0.016)
$1(TuitReg_{t+3})_{it}$	2.817	0.000	-26.917	-0.063
	(46.923)	(0.005)	(19.901)	(0.062)
$1(TuitReg_{t+2})_{it}$	8.987	0.002	12.988	-0.037
	(31.422)	(0.003)	(10.185)	(0.031)
$1(TuitReg_{t})_{it}$	-32.644	-0.016**	41.516	-0.008
	(69.297)	(0.007)	(41.036)	(0.014)
$1(TuitReg_{t-1})_{it}$	77.262	-0.012	52.511*	0.028
	(102.909)	(0.011)	(27.217)	(0.018)
$1(TuitReg_{t-2})_{it}$	77.306	-0.005	56.821*	0.009
	(118.445)	(0.008)	(32.155)	(0.016)
$1(TuitReg_{t-3})_{it}$	92.980	-0.010	51.676	0.039
	(111.926)	(0.012)	(34.774)	(0.034)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	84.222	-0.008	-39.367	0.113***
	(112.792)	(0.013)	(34.892)	(0.026)
Observations	26,548	33,937	17,031	5,039
R-squared	0.173	0.863	0.158	0.709
Two-way FEs	yes	yes	yes	yes
Sector specific trend	yes	yes	yes	yes
State level control	yes	yes	yes	yes

Notes: 1. The outcome variables are the undergrad in-state Fee in columns (1), (3) and log of room and board charged in columns (2), (4). 2. Two-way fixed effects include institution fixed effects and year fixed effects. 3. A private/public specific time trend is included. 4. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 5. Standard errors clustered at state-level are in parenthesis. 6. $***p < 0.01, **p < 0.05, *p < 0.1$

Table A9: Effect of Tuition Regulation on Out-of-state Students

Dep. Variable	(1) log(Out-of-state Tuition)	(2) % In-state Freshmen	(3) N In-state Freshmen
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	-0.065**	0.017**	50.978
	(0.031)	(0.006)	(32.781)
$1(TuitReg_{t+3})_{it}$	-0.026	0.010*	19.226
	(0.018)	(0.006)	(22.256)
$1(TuitReg_{t+2})_{it}$	-0.011	0.010*	11.905
	(0.014)	(0.006)	(20.087)
$1(TuitReg_{t})_{it}$	-0.045**	0.009	6.238
	(0.020)	(0.006)	(23.378)
$1(TuitReg_{t-1})_{it}$	0.010	0.014*	32.203
	(0.027)	(0.007)	(28.278)
$1(TuitReg_{t-2})_{it}$	0.015	0.013	50.068
	(0.033)	(0.009)	(40.397)
$1(TuitReg_{t-3})_{it}$	0.004	0.009	62.738
	(0.030)	(0.009)	(47.208)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	-0.078**	0.006	18.413
	(0.031)	(0.008)	(46.116)
Observations	41,410	8,147	8,147
R-squared	0.838	0.008	0.104
Two-way FEs	yes	yes	yes
Sector specific trend	yes	yes	yes
State level control	yes	yes	yes

Notes: 1. The outcome variables are the log of undergrad out-of-state tuition and fee combined in column (1), percentage/the number of students in fall cohort who paying in-state tuition rates in column (2) and (3), respectively. 2. Two-way fixed effects include institution fixed effects and year fixed effects. 3. A private/public specific time trend is included. 4. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 5. Standard errors clustered at state-level are in parenthesis. 6. $***p < 0.01, **p < 0.05, *p < 0.1$

Table A10: Effect of Tuition Regulation on Graduation Rate and SAT Score

Dep. Variable	(1) 150% time grad. rate	(2) SAT 75	(3) SAT 25	(4) % submitting SAT scores
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t+k})_{it}$	0.006	-0.601	0.657	0.297
	(0.005)	(3.108)	(3.468)	(1.307)
$1(TuitReg_{t+3})_{it}$	0.003	-1.293	2.626	0.432
	(0.003)	(2.025)	(2.856)	(0.711)
$1(TuitReg_{t+2})_{it}$	0.002	-0.974	-0.064	0.778
	(0.002)	(1.715)	(2.330)	(0.680)
$1(TuitReg_{t})_{it}$	-0.002	0.591	-1.337	0.339
	(0.003)	(1.870)	(2.400)	(0.680)
$1(TuitReg_{t-1})_{it}$	0.003	0.553	-1.194	-4.278
	(0.005)	(2.091)	(3.099)	(2.795)
$1(TuitReg_{t-2})_{it}$	0.003	0.812	-0.041	-0.810
	(0.006)	(2.747)	(4.184)	(1.086)
$1(TuitReg_{t-3})_{it}$	0.008	2.703	0.602	-1.460
	(0.005)	(3.501)	(4.840)	(1.209)
$\Sigma_{k=4}^{\infty} 1(TuitReg_{t-k})_{it}$	0.013**	3.972	3.485	-2.988**
	(0.006)	(3.929)	(5.414)	(1.334)
Observations	36,666	15,438	15,441	17,047
R-squared	0.065	0.020	0.015	0.081
Two-way FEs	yes	yes	yes	yes
Sector specific trend	yes	yes	yes	yes
State level control	yes	yes	yes	yes

Notes: 1. Sample of 4+ year degree granting universities. 2. The outcome variables are 150% time graduation rate (=6 years) of cohort started with tuition regulation, 75 percentile of admitted students' SAT score, 25 percentile of admitted students' SAT score, and the percent of applicants submitted SAT score. 3. A private/public specific time trend is included. 4. Two-way fixed effects include institution fixed effects and year fixed effects. 5. State level controls include lag, lead and the current year of state-level unemployment rate. Two dummy variables - one if the majority of both Upper and Lower house are taken by Republicans and the other if by Democrats - are also included. 6. Standard errors clustered at state-level are in parenthesis. 7. $***p < 0.01, **p < 0.05, *p < 0.1$