The Impact of Spending and Tuition on College Enrollment

Joe Patten

1 Introduction

A college degree has been seen as a way of opening new doors. Along with the ever increasing economic return of a college degree (David et al., 2014), college graduates are happier and have better health outcomes Wagstaff (1993). But, if college is such a great investment, why aren't students paying for it out of pocket?

College costs have been seen as a major barrier to potential college students (Deming and Dynarski, 2010). Between 2006 and 2016, sticker-price in-state tuition and fees at public four-year institutions increased at an average rate of 3.5% per year beyond inflation (Ma et al. (2016)). Tuition has grown from 14,724 in 2000 to 22,424 in 2015 (in 2015 dollars). In 2011, a Pew survey found that only 22% of respondents agreed that most people can afford to pay for college, a considerable drop from 1985 when 39% agreed with that statement (Taylor et al., 2011).

In recent years, many high-quality studies have investigated natural experiments to explore the casual link between spending and educational outcomes at the K-12 level (Jackson et al., 2015; Lafortune et al., 2018). Although many studies have been done to evaluate this causal link at the K-12 level, very few have explored this link at the postsecondary level. Deming and Walters (2017) were the first to appropriately evaluate the effects of tuition and spending one enrollment at postsecondary institutions. The original thought experiment was as follows: suppose an institution were to receive an extra $1000 per student. The institution could either spend that extra money on students in the form of tuition cuts, or spend the extra $1000 on things like smaller classes or better resources. Deming and Walters (2017) found that a 10% increase in institutional spending, while keeping tuition constant, increases current enrollment by 3%; whereas impacts of changes of tuition, while keeping spending constant, are statistically insignificant. Deming and Walters (2017) also tried to evaluate the spillover effect that public institutions had on private institutions. According to their analysis, they estimated that only 15% of the increase in enrollment could be explained by crowd-out of private school enrollment in the same county. However, many student choose usually choose between a variety of universities and colleges when making education decisions. Oftentimes, these institutions are not in the same county. Thus, this spillover effect might be bigger than this estimate.

I hope to contribute to the literature by further evaluating the effect of spending on postsecondary enrollment at the state level. I will use data from the Integrated Postsecondary Education Data System (IPEDS) matched with data from Census and the American Community Survey (ACS) to evaluate the impact of change in spending and tuition at U.S. public postsecondary institutions on college enrollment and degree attainment for individuals in a state. As I wish to evaluate the effect of tuition and spending on enrollment, I will set up an instrumental variable approach to capture causal effects. Budget cuts and tuition caps are two instruments that affect an institution's spending and tuition, but should not directly affect demand for college education. I will exploit the variation in budget cuts across states as well as the reliance of institutions in a state on state appropriations. Additionally, I will use the variation in tuition caps accross states. The combination of these two instruments (as well as a derivation of a third instrument described in the subsequent section) will help estimate causal effects, if any, of spending and tuition on enrollment. My hypothesis is that if there is an effect, this effect will be less than what Deming and Walters (2017) found due to crowd-out of private institutions, as well as transfers[1] within the public schools.

[1] I define transfers as either current students that transfer to another school, or new students that would have gone to one school, but instead are induced go to another

2 Data

Higher education data is taken from the Delta Cost Project (DCP) at American Institutes for Research. The DCP has compiled data from the Integrated Postsecondary Education Data System (IPEDS). IPEDS conducts annual surveys of higher education institutions (such as colleges, universities, and technical and vocational institutions). Institutions that administer federal student financial aid are required to participate in IPEDS. IPEDS collects institution-level data that include: student enrollment, degree completion, revenue, expenditures, state appropriations, and institutional characteristics. All financial variables are in 2015 dollars (using the HECA index). For our analysis, IPEDS data is aggregated to the state level. Table 1 shows a summary of the IPEDS data for 1990 and 2013.

	1990		2013	
	Four year	Two year	Four year	Two year
Institution count	580	997	602	920
Enrollment	10997	4791	14432	7177
State appropriations	12286	2618	7342	1975
Tuition and fees	3263	1948	7503	3703
Total spending	25293	5835	29484	7289

Table 1: Descriptive Statistics for U.S. public institutions. Enrollment is the mean institutional enrollment. State appropriations, and total spending divided by enrollment. Financial variables are in 2015 dollars (using the HECA index). Tuition and fees is the mean sticker price for in-state tuition.

Data from the Census and American Community Survey (ACS) from 1990, and 2000 to 2013 is aggregated by year of birth, year of survey, and state. Each observation in this aggregated data can be thought of as a cohort of individuals that are the same age, from the same state, and are interviewed in the same year. Covariates, such as log median income, log population, percent black, percent hispanic, percent male, and percent below the poverty line have been included as time variant controls. As enrollment is the primary focus of this paper, share of current individuals enrolled is also included.

3 Methods

One might be tempted in using a naive approach to estimate the effects of tuition and spending on enrollment by using a model similar to the one below:

$$Y_{i,j,t} = s_i + \psi_t + \delta_l X_{i,j,t-l} + u_{i,j,t} \tag{1}$$

where $Y_{i,j,t}$ is the log enrollment for state i in year t of cohort j, s_i and ψ_t are state and year fixed effects, respectively, $X_{i,j,t}$ is log spending or log tuition, and δ_l is the relationship between enrollment in year t and tuition or spending l years later or earlier. A problem with this model, is that there may be concerns (and rightfully so) of reverse causality. For example, if there were an increase in demand for education, enrollment might affect tuition prices. Likewise, with this influx of revenue from demand, spending might increase. Deming and Walters (2017) show that there are indeed lag and lead relationships between spending and enrollment as well as between tuition and enrollment. Thus, it is essential to adopt a model that deals with this endogeneity.

3.1 Instrumental Variables Approach

As previously discussed, when faced with a budget cut an institution can choose to either reduce spending or increase tuition. This budget shock should have a greater impact on institutions that rely more heavily on state appropriations as a source of revenue. State legislative budget decisions are usually made across the board, thus when one institution experiences a budget cut, most institutions in that state also experience a budget cut. An ideal instrument would take into account both a state's reliance on state appropriations, as well as the magnitude of state appropriations received in a given year. $Z_{i,t}$, or budget shock, addresses these two points:

$$Z_{i,t} = \frac{Approps_{i,90}}{Rev_{i,90}} \times \frac{Approps_{i,t}}{Pop_{i,t}}$$

where $Approps_{i,90}$ is the revenue from state appropriations for state i in 1990, $Approps_{i,t}$ is the revenue from state appropriations for state i in time t, $Rev_{i,90}$ is state i's total revenue in 1990, and $Pop_{i,t}$ is the college aged population (aged 18 to 24). That first term in $Z_{i,t}$ gives state i's reliance on state appropriations (as a source of revenue) in 1990. The second term is state appropriations per college-age student in state i, which gives a magnitude of state appropriations. One would expect that an increase in budget shock Z would lead to an increase in spending if tuition is kept constant. Likewise, an increase in budget shock Z should lead to a decrease in tuition if spending is kept constant.

The state legislature can also impose tuition caps. Tuition cap can be broken down further into two variables: $TuitCap_{i,t}$ and $TuitMax_{i,t}$. $TuitCap_{i,t}$ is binary variable measuring if a state legislature has put a cap or freeze on tuition prices. $TuitMax_{i,t}$ is the maximum percentage a college can raise their tuition in year t. If there is a freeze, then this value is equal to 0. One would expect $TuitCap$ would have a negative effect on tuition, and a negative effect on spending; whereas an increase in $TuitMax$ would have a positive effect on tuition, and a positive effect on spending.

Using these three instruments: $TuitCap$, $TuitMax$, and Z, we can appropriately identify if there are causal effects of spending or tuition on enrollment. Two-stage least squares will be used. In each stage, I will employ a first difference[2] approach. Thus, the first stage is:

$$\Delta X_{i,t} = \phi_{s(i)} + \omega_t + \Delta W'_{i,t}\lambda + \pi_1 \Delta Z_{i,t} + \pi_2 \Delta TuitCap_{i,t} + \pi_3 \Delta TuitMax_{i,t} + u_{i,t}$$

where $\Delta F_{i,t} = F_{i,t} - F_{i,t-1}$ for $F \in \{X, Z, W', TuitCap, TuitMax\}$, $X_{i,t}$ is log spending or log tuition, $W_{i,t}$ is a control matrix that contains time invariant coavariates of state i, such as unemployment, share of male individuals, share of black individuals, etc. ω_t and $\phi_{s(i)}$ are year and state fixed effects.

[2]Recall that using a first difference approach will yield the same results as using a fixed effects approach when there are two time periods. However, the two approaches are different when there are more than two time periods. First difference will be used in this analysis as it requires less restrictive assumptions for causal estimation.

Again, using a first difference method for the second stage yields:

$$\Delta Y_{i,t} = \Phi_i + \Omega_t + \Delta W'_{i,t}\Lambda + \beta_1 \Delta \log \widehat{spending}_{i,t} + \beta_2 \Delta \log \widehat{tuition}_{i,t} + \varepsilon_{i,t} \qquad (2)$$

where $\Delta F_{i,t} = F_{i,t} - F_{i,t-1}$ for $F \in \{Y, W', \log \widehat{spending}, \log \widehat{tuition}\}$, $Y_{i,t}$ is log enrollment, and Ω_t and Φ_i are year and state fixed effects.

4 Results

4.1 Public Institution Enrollment

Using the two-stage least squares approach outlined above, I will analyze public institution (PI) enrollment at the state level. Table 2 shows the impact of state log PI spending and state log PI tuition on state log PI enrollment. As shown in column 1 (the first stage regression of the instruments on spending), the effect of a budget shock on spending is statistically significant at the 0.01 level. Since the coefficient for budget shock is 0.161, it can be implied that a $1,000 increase in the budget shock increases spending by about 16.1 percent. Tuition cap and tuition max are not statistically significant.

In column 2 (the first stage regression of the instruments on tuition), the coefficient for tuition cap on tuition is statistically significant at the 0.01 level. Thus, this implies that tuition caps lower tuition by about 2.8 percent. Tuition max is not statistically significant, and budget shock is only weakly related to tuition as it is statistically significant at the 0.10 level.

In the second stage, one would expect the coefficients for log tuition and log total spending to be negative and positive, respectively. Both coefficients are not statistically significant at the 0.05 level. This does not mean that spending or tuition does not have an effect on PI enrollment. Spending and tuition changes this year could affect enrollment in subsequent years. Notice that

	First stage		Second stage
	Log Spending	Log Tuition	Log Enrollment
	(1)	(2)	(3)
Z	0.161***	-0.033*	
	(0.06)	(0.02)	
TuitCap	-0.001	-0.028***	
	(0.01)	(0.01)	
TuitMax	-0.002	0.151	
	(0.09)	(0.11)	
Log Spending			-0.137
			(0.12)
Log Tuition			-0.237
			(0.39)

Table 2: 2SLS - Evaluating the impact of log spending and log tuition on log PI enrollment. Standard errors are clustered by state. ${}^{*}p < 0.10;^{**}p < 0.05;^{***}p < 0.01$

equation 2 can be altered to evaluate the effect of lagged spending and tuition on enrollment:

$$Y_{i,t+s} - Y_{i,t-1} = \Phi_i + \Omega_t + \Delta W'_{i,t}\Lambda + \beta_1 \Delta \log \widehat{spending}_{i,t} + \beta_2 \Delta \log \widehat{tuition}_{i,t} + \varepsilon_{i,t} \tag{3}$$

where $\Delta F_{i,t} = F_{i,t} - F_{i,t-1}$ for $F \in \{W', \log \widehat{spending}, \log \widehat{tuition}\}$, and $s \in \{1, 2, 3\}$. $Y_{i,t+s} - Y_{i,t-1}$ is the $s + 1$ year change in enrollment. Table 3 shows the impact of lagged log spending and log tuition on log public enrollment. Note that the coefficient for log spending in year T on log enroll

	Current year	T+1	T+2	T+3
Log Spending	-0.137	0.012	0.154**	0.157*
	(0.13)	(0.05)	(0.08)	(0.09)
Log Tuition	-0.237	-0.125	-0.146	-0.200
	(0.16)	(0.11)	(0.13)	(0.17)

Table 3: 2SLS - Evaluating the impact of lagged log spending and log tuition on log public enrollment. Standard errors are clustered by state. ${}^{*}p < 0.10;^{**}p < 0.05;^{***}p < 0.01$

in year T+2 is statistically significant at the 0.05 level, and that the coefficient for log spending in year T on log enroll in year T+3 is statistically significant at the .10 level. This suggests that a 10% increase in PI spending in the year T increases PI enrollment by around 1.5% in years T+2 and T+3. This estimate is considerably lower than the estimate reported by Deming and Walters

(2017), who found that a 10% increase in PI spending in year T increased PI enrollment by around 8 to 8.5 % in years T+2 and T+3 (of course done at the institution level)[3]. This finding suggests that the effect is diminished at the state level, meaning that some of the students affected by an institution's spending might have gone to another institution instead. In other words, it suggests that spending might not induce new students to enroll, or even current students to stay in college as much as was estimated by Deming and Walters (2017). The above analysis only assesses the impact of spending and tuition on those enrolled in public universities. As the purpose of this paper is to assess the impact of PI spending and tuition on state level enrollment, I will use state level enrollment data from the Census and ACS instead of PI enrollment.

4.2 Share of Individuals Currently Enrolled in College

I will now use the share of individuals currently enrolled in college as the dependent variable. Using the share of individuals currently enrolled in college in cohort j in survey year t as $Y_{i,j,t}$, equation 3 becomes:

$$Y_{i,j,t+s} - Y_{i,j,t-1} = \Phi_i + \Omega_t + \Delta W'_{j,i,t}\Lambda + \beta_1 \Delta \log \widehat{spending}_{i,j,t} + \beta_2 \Delta \log \widehat{tuition}_{i,j,t} + \varepsilon_{i,j,t} \tag{4}$$

Table 4 shows the impact of lagged log PI spending and log PI tuition on the share of individuals currently enrolled in college restricting the sample to only college aged cohorts (aged 18 to 24). Table 4 suggests that at the state level, the effects of spending on enrollment disappear. This could be explained by crowd-out of private school enrollment, as well as transfers of students between public schools.

[3] Table 6 in the Appendix reports my replication of (Deming and Walters, 2017). I find that a 10% increase in PI spending in year T increases PI enrollment by around 3 to 6.5 % in years T+2 and T+3 at the institution level.

	Current year	T+1	T+2	T+3
Log Spending	0.032	0.032	0.014	0.016
	(0.02)	(0.02)	(0.02)	(0.02)
Log Tuition	0.069	0.091	-0.027	0.054
	(0.10)	(0.09)	(0.10)	(0.09)

Table 4: 2SLS - Evaluating the impact of lagged log PI spending and log PI tuition on the share of individuals currently enrolled in college. Standard errors are clustered by state. Cohort size is used as analytical weights. $^{*}p < 0.10;^{**}p < 0.05;^{***}p < 0.01$

5 Discussion

This study has explored the impacts of PI tuition and spending on college enrollment at the state level. The variation in state legislative budget cuts and tuition caps, as well as the variation in a state's institutions make for a valuable natural experiment. I was able to estimate and evaluate the impacts spending and tuition through using the aforementioned instruments. My results show that although there is evidence of (lagged) PI spending having a positive effect on PI enrollment, this effect is diminished when evaluating PI enrollment at the state level, and seems to disappear when considering state-wide enrollment. Although Deming and Walters (2017) addressed this concern with evaluating the spillover effect of PI spending and PI tuition on enrollment of private institutions that are in the same county as public institutions, their analysis does not take into account that students oftentimes consider a variety of universities or colleges that are not in the same county as one another.

The issue of the transferability[4] of students should be a focus of future research. This issue does not frequently show up in K-12 studies as K-12 students usually do not have much of a choice of where to attend. This study also sacrifices within state variation in order to assess aggregate results.

Finally, although my results suggests little to no impact of tuition and spending on college enrollment, spending can still have a positive impact on other outcomes, such as degree completion or increased wages. These possible benefits of changes in spending will need to be further explored.

[4]Either current students that transfer to another school, or new students that would have gone to one school, but instead are induced go to another

References

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6 Appendix

6.1 Institution Level Analysis

	First stage		Second stage
	Log Spending	Log Tuition	Log Enrollment
	(1)	(2)	(3)
Z	0.065***	-0.085***	
	(0.01)	(0.01)	
TuitCap	0.006**	-0.035***	
	(0.00)	(0.00)	
TuitMax	-0.078***	0.340***	
	(0.03)	(0.06)	
Log Spending			0.151
			(0.15)
Log Tuition			-0.087
			(0.08)

Table 5: 2SLS - Evaluating the impact of log spending and log tuition on log public enrollment at the institution level. Standard errors are clustered by institution. $^{*}p < 0.10;^{**} p < 0.05;^{***} p < 0.01$

Table 6: 2SLS on Institution-Level Data

	Current year	T+1	T+2	T+3
Total Spending	0.151	0.454***	0.666***	0.324*
	(0.15)	(0.15)	(0.18)	(0.19)
Log Tuition	-0.087	0.007	-0.019	-0.256**
	(0.08)	(0.08)	(0.10)	(0.12)

Table 7: Evaluating the impact of lagged log PI spending and log PI tuition on log public enrollment at the institution level. Standard errors are clustered by institution. $^{*}p < 0.10;^{**} p < 0.05;^{***} p < 0.01$