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Dramatic Declines in Higher Education Appropriations: State Conditions for Budget Punctuations

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Abstract Public colleges and universities depend heavily on state appropriations and legislatures must decide how much to fund higher education. This study applies punctuated equilibrium theory to characterize the distribution of annual changes in higher education appropriations and defines the threshold for a dramatic budget cut. Using data for the 50 states from years 1980 to 2009, this study investigates the relationship between such unique policy events and state characteristics using a Cox proportional hazards model. Results show that economic and political conditions are most predicative of dramatic budget cuts. High unemployment rates increase the probability of cuts while rapid increases in tax revenue and wider income inequality are protective against cuts. Unified Republican and unified Democratic governments are both more likely to cut spending compared to a divided government. Sensitivity analyses of state characteristics associated with small budget cuts demonstrates that large cuts are indeed unique events catalyzed by different conditions.

Keywords Higher education finance · State appropriations · Public budgeting · Punctuated equilibrium theory · Event history analysis

Introduction

State funding for public higher education has captured the attention of scholars, practitioners, and policymakers looking to reshape the financing of the system on a national scale. Declines in state support occurred most dramatically during and after the Great

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Recession, when real state dollars per full time equivalent (FTE) student fell 23 % from FY 2007 to FY 2012 and net tuition revenue per FTE rose by 19 % (State Higher Education Executive Officers 2013). Appropriations per FTE fell during this period in 48 of the 50 states (Doyle and Zumeta 2014). At the same time, fiscal constraint and external accountability were emphasized, and public colleges are increasingly expected to demonstrate prudent and effective use of taxpayer funds. Higher education accountability has been a prominent theme over the last two decades (Zumeta 1998, 2012). Colleges are confronted with mounting pressures to increase transparency and institutional efficiency, while simultaneously experiencing fluctuating endowments and unstable state support (Powell et al. 2012).

Colleges struggle to fund their operational expenses and improve student completion and retention while also attempting to minimize tuition increases to appease the public. Balancing the needs of multiple stakeholders (e.g. student, campus employees, state, taxpayer) is undoubtedly both complex and trying for policymakers and campus leaders alike (McGuinness and Novak 2011).

Motivated by prior literature, this study seeks to model the policy decision to cut higher education appropriations, and the economic and political conditions specifically associated with dramatic declines. This study differs from previous studies that operationalize funding as a continuous variable, in which much effort has gone into measuring (Tandberg and Griffith 2013). Scholars have also attributed political, economic, and structural conditions to the reasons behind annual spending levels (Archibald and Feldman 2006; Delaney and Doyle 2011; McLendon et al. 2009; Tandberg 2010, 2009). My research question is related yet fundamentally different—it concerns the policy phenomenon of severe cuts to higher education funding. I measure funding as a discrete variable—in a given year, whether a state experiences a severe cut or not. Thus, I am more interested in using explanatory variables to predict this event, which I propose is a unique policy decision, and less so to predict fluctuating annual spending in all observed years.

This study poses three research questions. First, how can the policy event of a severe funding cut to higher education appropriations be defined? Second and relatedly, at what point is a funding cut deemed severe, as opposed to more common and expected annual adjustments? Next, what are the state-level characteristics that predict the probability of this policy event? Specifically, are there economic, political, demographic, and higher education conditions that contribute to the likelihood of a severe cut to appropriations?

Measuring higher education funding as a discrete variable has several advantages and potential new contributions to the literature. The aftermath of a funding decline draws more attention from higher education officials and the media, certainly more so than gradual ebbs and flows. Scholars and policymakers alike have documented the detrimental implications of substantial funding cuts, especially that of the last recession, and policymakers are very much aware of the tension between colleges and states (Longanecker 2006; Newfield 2010). Scholars characterize tightened state budgets as higher education's "new normal" (Doyle 2013), explain varying responses to declines (Doyle and Zumeta 2014), describe the institutional search for alternative resources (Cheslock and Gianneschi 2008), and predict long term impacts of funding cuts (DePillis and DePillis 2001). Ultimately, the policy decision to defund state appropriations is more consequential and hence more amply studied than instances of flush budgets and generous allocations. Yet existing studies continue to analyze annual spending as a whole without differentiating between growth and decline periods, and between smaller and larger declines.

Literature Review

When state governments are pressured to defund public needs, higher education is particularly vulnerable to cuts (Delaney and Doyle 2011; Hovey 1999). Higher education is more resilient because colleges can generate revenue through tuition hikes.[1] There are no empirical tests to define large versus small cuts, though one certain institutional response is to raise tuition and fees (Cheslock and Hughes 2011; Titus 2009). Legislators are aware that in addition to raising tuition, colleges may also look to endowments, philanthropic donations, auxiliary revenue generation, and research funding. Moreover, colleges can decrease expenditures through strategies such as hiring more part-time faculty and increasing faculty teaching loads (Li and Zumeta 2015). Colleges also seek more higher paying, out-of-state students in times of austerity. Declines in state appropriations for BA-granting colleges are associated with increases in nonresident freshman enrollment, a relationship that is stronger for research universities (Jaquette and Curs 2015). Colleges do in fact monetize students; they seek out added revenue from out-of-state tuition payers. Cuts to appropriations can catalyze a shift in a university's mission more heavily towards privatization and prioritization of paying customers (Priest and St. John 2006).

Dramatic budget cuts result in an unfortunate reality: college becomes less affordable to students and their families, which has detrimental consequences for access and attainment. Colleges may encounter difficult decisions such as closing programs and services, delays in necessary infrastructure maintenance and renovations, and layoffs or furloughs to employees. The quality of higher education is at risk of suffering "product degradation" (Brinkman and Morgan 1995, p. 17). "As services and programs are cut from the institutional agenda due to a lack of funding, a simultaneous reduction in quality also occurs" (Carter 2011, p. 42). In short, cuts to higher education is a policy issue of vital concern with potential detrimental consequences.

Punctuated Equilibrium Theory

This study raises the question of why it is important to consider large budget cuts versus any level decline in appropriations. I apply punctuated equilibrium theory (PET) to conceptualize higher education budget outcomes. The theory has been used to describe political attention paid to policy issues, policy adoption, and the policy process whereby governments allocate scarce resources (Jones et al. 2009). Researchers have employed punctuated equilibrium theory to characterize budget changes at the national level (Baumgartner et al. 2009), the state level (Breunig and Koski 2006), and subcategory levels such as education or health spending (Breunig and Koski 2012). PET concepts can frame the idea of severity and frequency of funding cuts in order to shed light on a plausible threshold for the "dramatic cuts" described in the present study.

The classic incremental model of public budgeting posits that each year's budget is based heavily on the previous year's allocation and budgets change gradually rather than abruptly Jones and Baumgartner (2005). Political actors have limited resources to evaluate merits of alternative budgeting choices so they depend on previous spending decisions

[1] The State Higher Education Executive Officers (SHEEO) State Higher Education Finance (SHEF) report in 2013 shows that tuition increases in these circumstances rarely offset entirely the effects of state funding cuts.

(Breunig and Koski 2006). Incrementalism implies that if annual changes for any particular budget were plotted as a histogram, it would follow a normal distribution.

On the contrary, punctuated equilibrium theory depicts government spending as following a pattern of long periods of stability interrupted by bursts of rapid change (True et al. 2007). Spending decisions change when there is a strong external signal or when these signals amass over time. Components of a state's environment represent external signals, which can initiate higher education cuts. In conjunction, "policymaking systems remain stable until the signals from outside exceed a threshold, and then they lurch forward—that is, a policy punctuation occurs; afterward, they resume equilibrium" (Jones and Baumgartner 2012, p. 8). If higher education is consistent with this theory, annual appropriations would be dominated by small incremental changes, with some medium-level changes, and more instances of large changes than expected from an incrementalist-supported normal distribution.

PET is particularly relevant to higher education budgeting—a legislative process where policymakers have much control over allocations from a larger budget. Among 60 programmatic subfunctions in the US budget from years 1947 to 2006, higher education exhibited the third highest degree of punctuation (extreme changes), after Medicare and occupational health (Breunig et al. 2010). "Discretionary" budget categories such as higher education are "flattened in times of plenty and trimmed—on occasion butchered—in times of budgetary penury" (Breunig and Koski 2012, p. 61). Higher education is the balance wheel for state budgets (Hovey 1999), meaning that when state budgets are flush, appropriations rise disproportionally compared to other spending categories and when budgets are weak, appropriations get cut more deeply. Using data from 1991 to 1999, Delaney and Doyle (2011) find that higher education does operate as a balance wheel, but that K-12, corrections, and health do not. Similarly, using data from 1985 to 2004, Delaney and Doyle (2011) confirm the balance wheel hypothesis. Thus, we would expect large annual changes to higher education appropriations, which encourages the application of punctuated equilibrium theory.

Hovey (1999) suggested that "often state officials are slow to recognize the onset of recession", and once external signals point to a fiscal crisis, "budgets are grossly out of balance" (p. 17). Framed using punctuated equilibrium theory, state conditions are external signals because they ensue and/or coincide with shocks to higher education budgets. Given monetary shortfalls, at least a 5 % or higher magnitude of corrections is necessary to return to a balanced budget, which requires a combination of spending cuts and tax increases that often must be continued for several years (Hovey 1999). This implies there is some threshold of cuts to higher education that when reached, signify a policy decision beyond the confines of normal budget shifts. Additionally, "there exist trigger points in the process of [U.S.] budget cuts, such that significant reduction in budget deficits may take place only when the ratio of deficit to output reaches a certain threshold. This may reflect the existence of political constraints blocking deficit cuts, which are relaxed only when the budget deficit reaches a sufficiently high level, deemed to be unsustainable." (Arestis et al. 2004, p. 216). This suggests that political and economic realities in a state reflect decisions to cut higher education as a strategy to ease overall deficits. Ultimately, punctuated equilibrium theory provides a way to characterize the severity of funding cuts. Episodes of dramatic spending cuts signal a policy response to circumstances that may indeed differ from the circumstances that prompt more incremental adjustments.

Modeling the Outcome Variable

My first step to characterize the pattern of higher education funding cuts is to examine the year to year percent change in appropriations per student.[2] My dataset consists of 50 states from years 1980 to 2009 for a total of 1500 state-years and 1450 observations of percent changes. Data on higher education appropriations was collected from SHEEO and represent state support for public and independent higher education, CPI-adjusted to 2013 dollars. Figure 1 displays a histogram of annual percent changes in state appropriations per student, with the normal curve plotted. If higher education followed the traditional incremental model of public budgeting, annual percent changes would form a normal distribution.

However, the distribution exhibits a strong slender peak that extends past the normal distribution's peak. It also has extended tails at the far left and right sides–instances of more extreme annual changes beyond what is expected in a normal distribution. Both features indicate what is called leptokurtosis, which can be captured in a statistic called the L-kurtosis (L-K) (Jones and Baumgartner 2005). The normal distribution has an L-kurtosis score of about 0.12 on a 0 to 1 scale with higher scores representing greater punctuation (Breunig and Koski 2012). I calculate the L-K score for annual percent change in appropriations per student, which is 0.22, indicting that higher education budgets do follow a punctuated equilibrium pattern.

Variation exists among states in the degree of budget punctuation (Breunig and Koski 2006), and Fig. 2 compares L-K scores for higher education spending in each state. The extent of punctuation varies, though the majority of states exhibit L-K scores above 0.12 and offer support to the applicability of punctuated equilibrium theory. In other words, most states show few moderate changes relative to small and extreme changes, yet extreme changes are still rare compared to small changes. Punctuated changes are unique, supporting this study's argument that the policy decision to make dramatic cuts to higher education is distinctive from incremental cuts.

Granted, there exists no definitive cutoff point for a "small" change that has been empirically demonstrated by prior studies. Researchers postulate that changes within $\pm$ 10 % are generally considered small and changes beyond $\pm$10 % are large (Anderson and Halbridge 2010; Leloup and Moreland 1978). Differentiating between large and small cuts requires the continuous variable appropriations per student to be transformed into a discrete variable. To identify large cuts, I incorporate Robinson et al.'s (2007) budget categorizations of changes in K-12 instructional spending per pupil in Texas. The authors are one of the few from the public budgeting and higher education finance literature who apply Jones and Baumgartner (2012) punctuated equilibrium theory to decide on an absolute cutoff. Robinson et al. (2007) states:

> A large change is a change in the tails of the distribution where the observed frequencies exceed the frequencies predicted by the normal distribution. A medium change is a change in the region where the observed frequencies are lower than those predicted by the normal distribution. A small change is a change near the mode of the distribution where the observed frequency exceeds the frequency predicted by the normal distribution (p. 144).

[2] Appropriations are per fall enrollment, not per FTE. I conduct diagnostics on the alternative outcome of total appropriations. It shows comparable descriptive patterns. I retain the per-student measure, which is widely accepted Tandberg and Griffith (2013).

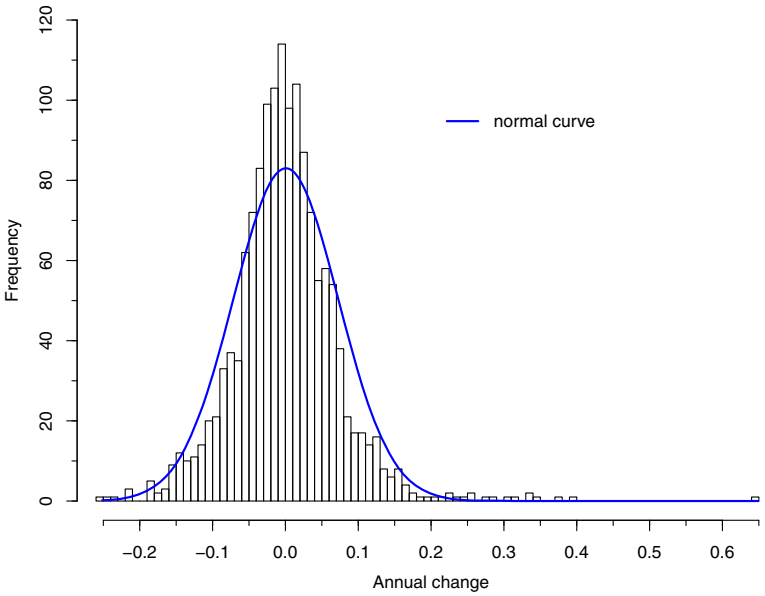

Fig. 1 Annual percent changes in higher education appropriations per student

Figure 3 shows the same histogram of all 1450 % changes in state appropriations along with the normal curve. I calculate points where the actual data and the normal curve intersect, represented by lines at −0.14 and −0.06 on the *x*-axis. State-level cuts that are more severe than 14 % are defined as large, cuts of less than 6 % are defined as small, and cuts within the 6 to 14 % range are medium. The outcome variable now lends itself well to event history analysis methods.[3] In summary, I take the previously outlined steps to arrive at the conclusion that a 14 % decrease in higher education appropriations is a reasonable definition of a substantial, punctuated funding cut. Public budgeting theory combined with explorations of the data inform my operationalization of dramatic budget cuts to higher education spending.

Determinants of State Spending for Higher Education

The definition of dramatic cuts to higher education spending is critical for this study, as is the consideration of factors leading to dramatic cuts. Scholars have examined the relationship between state characteristics and higher education spending. Spending has been measured in several ways, including the natural log of all appropriations (Toutkoushian and Hollis 1998), funding per capita (Kane et al. 2003), as a percent of total state spending (Tandberg 2010), and funding per FTE student (Tandberg and Griffith 2013). Again, what these studies have in common is the continuous nature of the outcome variable. Next, I survey the literature and describe the predictor variables in this study.

[3] State-years of large cuts are coded "1", otherwise they are coded "0".

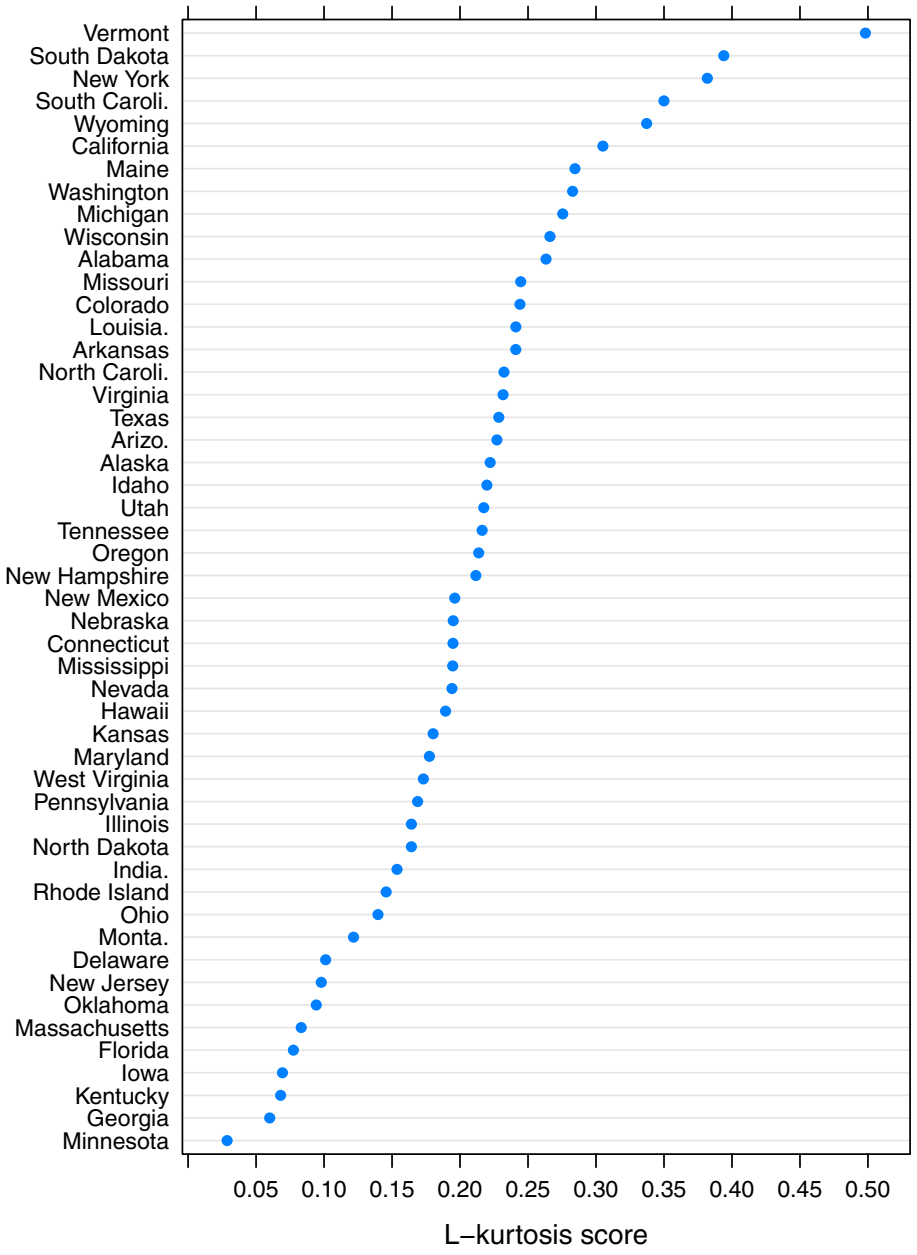

Fig. 2 L-Kurtosis scores for percent change in higher education appropriations per student

Region

First, states within a region may be similar to one another in unmeasured ways, and more similar in their exposure to and responses to fiscal crises. Moreover, the effect of omitted variables may be picked up by regional controls and therefore, I include regional controls

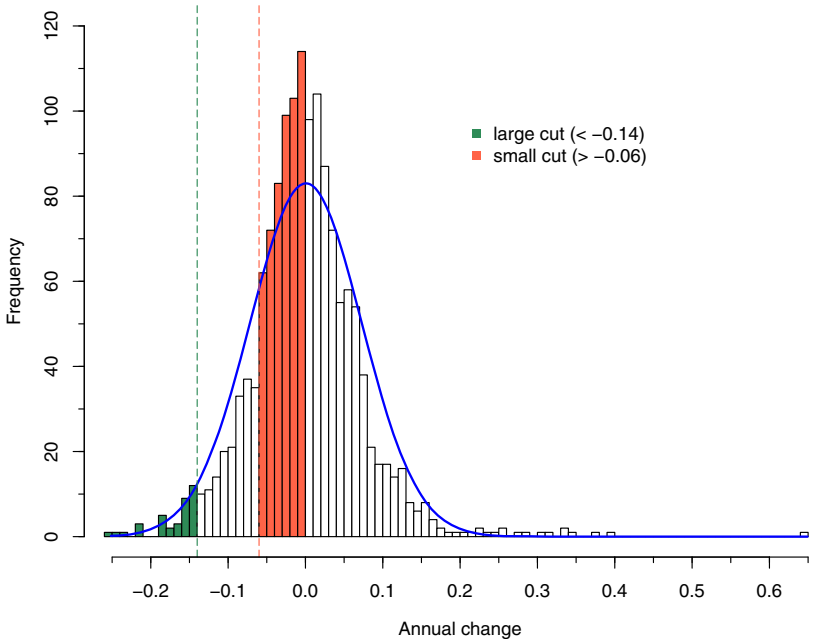

Fig. 3 Small, medium, and large cuts to higher education appropriations per student

to capture time-invariant, unmeasured characteristics common to states in the same region that may impact the outcome variable. I define regions using higher education compacts, which serve as vehicles for interstate policy discussion, collaboration, and innovation (Cohen-Vogel et al. 2007; Layzell 2007). The four compacts are the New England Board of Higher Education (NEBHE), the Southern Regional Education Board (SREB), the Midwestern Higher Education Compact (MHEC), and the Western Interstate Commission for Higher Education (WICHE). These compacts include all states except New York, New Jersey, and Pennsylvania, and due to geographic proximity, I include these three states in the New England region.[4] There is considerable variation by region in terms of dependence on public colleges to educate the population as well as state support of public colleges (Li and Zumeta 2015). Traditionally, states in the New England area have more affluent populations that can potentially shoulder the tuition increases that follow budget cuts. The prominence of New England's private colleges may also place its public colleges at a disadvantage when it comes to state support. In contrast, states in the Midwestern compact include the "Big Ten" and these distinguished public universities are widely appreciated in their states. Therefore, I hypothesize that policymakers in Midwestern states might be more inclined to protect state appropriations to higher education.

Economic Conditions

The wealth and financial health of a state affects its public revenue streams and higher education spending decisions (Levy and Zumeta 2011; Titus 2009). Higher state wealth

[4] I run analyses with NY, NJ, and PA in a separate region. I choose to keep these three states in the New England compact, as Doyle (2006) does, and because substantive findings do not change.

and lower unemployment rates tend to be associated with greater spending on higher education (Heck et al. 2014; Toutkoushian and Hollis 1998). Drawing from existing literature, I include economic variables found to predict higher education support. Unemployment rate is an indicator of state economic health (Delaney 2011), and the effect of higher unemployment on appropriations is generally found to be negative (McLendon et al. 2009; Tandberg 2010; Weerts and Ronca 2012). Second, personal income per capita represents the supply side of state budgets, or "ability to pay". Levels of income per capita as well as year to year changes are potentially tied to higher education. In addition, states with greater income inequality, denoted by the gini coefficient, allocate more to higher education, perhaps as a strategy to promote educational opportunities among poorer residents (Tandberg 2009). The gini coefficient ranges from 0 to 1 where 0 expresses perfect equality and 1 expresses maximum inequality. The last economic variable I include is total tax revenues, a useful indicator of a state's affluence and "willingness to tax" its citizens.[5] I hypothesize that in general, state prosperity and financial stability will decrease the likelihood of punctuated budget cuts. All financial variables in the dataset are CPI-adjusted.

If the annual levels of economic variables influence budget cuts, annual changes in these variables may also matter. For instance, states experiencing more rapid unemployment growth or more rapid tax revenue decreases are more likely to address resulting budget deficits by squeezing from higher education. The rate of short-term changes in economic indicators has been hypothesized to affect policy decisions (McLendon et al. 2006). Thus in separate models, I replace the following level variables with annual percent changes: personal income per capita, unemployment rate, tax revenue, and the gini coefficient.

Political Environment

Political ideology is defined as "a coherent and consistent set of orientations or attitudes toward politics" (McLendon et al. 2009, p. 691). A liberal government is traditionally more supportive of direct funding to public services and greater intervention (Alt and Lowry 2000). Previous studies find that Democratic governors are more generous towards higher education and a greater share of Democrats in the legislature more amply funds higher education (Archibald and Feldman 2006; McLendon et al. 2009; Tandberg 2009, 2010). I include variables representing party affiliation of the governor and Republican strength in the legislature, measured as the proportion of legislators who are Republican. In a separation-of-powers system, a government divided between the parties poses more roadblocks to the passage of legislation (Alt and Lowry 2000), and "the bargaining costs that political actors must pay to reach agreement on policy tend to be higher" (McLendon et al. 2007, p. 653). Divided governments face the most conflicts, since differing parties have divergent preferences that limit the ability to authorize innovative legislation (Huber et al. 2001). Therefore I alternatively measure state political conditions using unified governments—the case where a single party controls the House, the Senate, and the governor's seat.[6]

To further represent the political setting, I utilize two continuous variables that measure ideological preferences of a state's voters and its elected officials. Citizen ideology was

[5] Total tax revenues is comprised of both the tax base and the tax rate. Base captures underlying wealth and rate captures willingness to tax. Total tax revenues measures a combination of the two concepts.

[6] I include Nebraska by coding a unified government as one where the governor and the unicameral legislatures have the same party affiliation.

developed as a measure for the position of a state's active electorate on a liberal-conservative continuum, with 0 being the most conservative and 100 the most liberal (Berry et al. 1998). The government ideology measure represents the views of elected officials on this same continuum (Berry et al. 2010). Both variables aim to capture a state's "policy mood" (Berry et al. 2007, p. 162). Previous research finds that more liberal citizenry increases higher education funding (Tandberg 2009), though others assert that neither ideology measure is related (Morgan et al. 2001), providing an opportunity test these previous findings on dramatic budget cuts in particular.

Legislative professionalism describes the amount of staff resources provided to legislators. As salaries increase, legislators have more incentive to serve, more time to gather information to make informed decisions, and increased ability to focus on their job duties (Squire 2007). More professionalized legislatures allocate more public funding in general (Barrilleaux and Berkman 2003), which extends to higher education (McLendon et al. 2009; Tandberg 2010). In the present study, legislative professionalism is represented by legislators' average salaries in a state.[7] Relatedly, term limits impose a time frame on elected offices, reducing the benefits gained from added years of experience (Squire 2007). The existence of term limits is associated with greater spending on higher education, which McLendon et al. (2009) speculates is because less experienced legislators are more persuaded by higher education interest groups. A larger number of registered higher education interest groups in a state is positively associated with appropriations, so colleges' lobbying efforts appear to be influential and beneficial (Tandberg 2009). Interest group density equals a state's total number of interest groups minus the number of higher education interest groups (Tandberg 2010). I alternatively use the annual percent change in this variable as a proxy to explore whether rapid surges in lobbying activity relate to the likelihood of cuts.

Other political dynamics affect public funding and one cannot ignore the influence of the governor. A governor's institutional authority encompasses line-item veto powers, revenue revisions, level of responsibility for the budget, and appointment powers (Barrilleaux and Berkman 2003). In some states for instance, the governor appoints the state officials tasked with overseeing higher education. The state higher education executive officer and his/her board members could all be appointed by the governor, which extends the governor's preferences to higher education (McLendon 2003). Previous research is mixed on whether governor budgetary authority predicts higher education funding, but the inclusion of this variable is an important way to assess if a governor tends to invest in higher education, a possible example of supporting state-wide (versus local) interests (Barrilleaux and Berkman 2003; Weerts and Ronca 2012). In my analyses I include the governor budget powers index on a scale of 0 to 5, where higher scores indicate greater power.

Demographics

Furthermore, the composition of a state's population may impact higher education spending. A greater proportion of college age residents would intuitively prompt policymakers to prioritize investment in higher education, although some researchers find this relationship to be negative (McLendon et al. 2009; Tandberg 2009). By contrast, a larger

[7] This variable is used because it is highly correlated with an alternative composite measure that captures added factors such as time demands and staff resources–the Squire index–and has more years of available data.

elderly population (age 65+) signifies more demand for programs such as Medicare and state officials may cater to this particular constituency, placing higher education at greater risk for substantial cuts. As with the economic variables, I also use the annual percent change in the two demographic variables. Steady growth in 18 to 24 year olds, or slower growth among the elderly, could shift attention around decisions to fund higher education.

Higher Education Systems

In addition to economic, political, and demographic conditions, higher education systems in the state may also impact higher education spending. A state's higher education governance structure defines how its public colleges and universities are formally organized, operated, overseen, and to a greater or lesser extent, controlled. On one hand, consolidated governing boards have line authority over college fiscal matters (e.g. managing and disbursing state merit aid programs), leadership (e.g. hiring and firing university presidents), and academic affairs (e.g. approving a new degree program) (McGuinness 2003). On the other side are the planning boards and statewide coordinating boards that have more limited jurisdiction, and who might simply conduct policy research and inform strategic planning. Centralized governing boards are theoretically thought to represent institutional rather than state interests, pursue innovative policies, and make swifter financial and strategic decisions. Some studies find that governance does not affect support for higher education (Delaney and Doyle 2011; McLendon et al. 2006, 2009), yet others find that states with more centralized governance structures tend to spend less on higher education (Tandberg 2009). I include governance structure as a covariate, with a dummy variable representing governing board (versus coordinating or planning board) (Education Commission of the States 2016). Relating back to the discussion on governor's powers, greater power magnifies the effect of governance structures on appropriations, if a direct effect exists (Tandberg 2013). Therefore I construct an interaction variable between higher education governance structure and governor budget powers.

With respect to additional state higher education characteristics, the proportion of students enrolled in private colleges and universities is negatively related to state support (Curs et al. 2011; Delaney and Doyle 2011; Tandberg 2010). This variable represents the relative impact of a budget cut to higher education constituencies, public colleges, and students. In states with more developed private colleges and higher enrollments at private colleges, such as in many New England states (Li and Zumeta 2015), a decrease in support for public higher education directly affects a smaller proportion of the population so perhaps the legislature is more inclined to cut funding.

Studies also suggest that tuition increases at 4-year public institutions are inversely linked to per-student appropriations. As noted earlier, public colleges respond to decreased state funding by raising tuition and fees (Cheslock and Hughes 2011; Titus 2009). I anticipate states with high tuition prices or rapid growth in prices to be less likely to cut higher education funding, especially since dramatic cuts will cause further tuition rises. Soaring tuition prices may be unacceptable to the public and attract negative attention to policymakers, who may be less willing to pass costs on to students. In my analyses, I lag the tuition variable by one year because previous year prices are more likely to affect current year appropriations. I also create the annual percent change in tuition and apply a one-year lag.

Additionally I explore the existence of a broad based merit aid program. In the 1990's and early 2000s, the concept of state merit-based aid gained popularity—the provision of financial aid on the basis of student academic merit illustrated by high school grade point

averages, SAT/ACT scores, or performance on state tests (Heller 2004). Many states, particularly in the South, adopted merit aid programs and this pool of funding grew faster than need-based aid (NASSGAP 2012). Merit aid programs operate as individual financial entitlements for students who meet the criteria, and altering these programs after inception is challenging. Consequently, states that have committed to broad based merit aid programs may encounter more political roadblocks to cutting appropriations. I use a dummy variable that assigns a "1" for all years after a state begins operating a broad based merit program (Doyle 2006, 2010; Zhang and Ness 2010). Table 1 displays summary statistics for all variables, for a total of 1500 observations (state-years). Variable descriptions and sources are listed in the Appendix.

Table 1 Summary statistics

Variable	Mean	SD
Higher education appropriations per student	4989.05	1600.63
New England compact (+ NY, NJ, PA)	0.18	
Southern	0.32	
Midwestern	0.24	
Western	0.26	
Income per capita ($1,000's)	35.38	7.11
Unemployment rate	5.92	2.07
Tax revenue (log)	15.79	1.03
Gini coefficient (*100)	40.09	3.10
Unified Republican (3 chamber government)	0.17	
Unified democratic	0.27	
Republican governor	0.47	
Percent Republicans in legislature	44.10	16.98
Government ideology	49.54	24.26
Citizen ideology	48.80	15.34
Legislative professionalism (10,000's)	2.99	2.63
Governor budget powers	3.59	0.53
Term limits	0.11	
Interest group density (1000's)	0.69	0.58
Percent 18 to 24 year olds	10.59	1.97
Percent 65+ year olds	12.01	2.11
Tuition (log)	8.41	0.70
Governing board	0.46	
Broad based merit aid program	0.11	
Percent private college enrollment	28.15	15.55
Annual Percent Change (*100)		
Income	1.47	2.35
Unemployment	3.49	21.82
Tax revenue	2.86	8.24
Gini coefficient	0.29	8.39
Interest group density	5.48	22.20
Percent 18 to 24 year olds	0.89	14.05
Percent 65+ year olds	4.75	40.94
Tuition	7.95	14.74

N = 1500 state-years

Financial variables in 2013 CPI-adjusted dollars.

For dummy variables, the proportion of state-years is displayed as the mean

Data

Policy Event

A clear definition of the event of interest is essential to modeling event history data. As noted in the section "Modeling the Outcome Variable", my dataset consists of the 50 states from years 1980 to 2009. There are 1450 instances of year to year percent changes in higher education funding per student.[8] This standardized measure is the CPI-adjusted dollar amount of all higher education appropriations divided by enrollment for state *i* in year *t*. The first year that the possibility of a cut occurs is 1981. In any given year in the dataset, a state is capable of experiencing a substantial, punctuated funding cut, defined as a 14 % or greater decline. The number of states in the risk set is identical across all years. In each year, all 50 states are "at risk" of experiencing this policy event, which occurs 37 times (2.6 % of state-years). Figure 4 displays the years in which each state experiences the event, excluding states that never make annual cuts reaching or exceeding 14 %. Notice that some states experience more than one funding cut, the statistical treatment of which is covered in the Methods section.[9]

The state characteristics introduced in the literature review are analyzed in varying sets and specifications during the modeling process. Operational definitions of political variables require Nebraska to be excluded in certain analyses and this is noted in the results.

Method

Drawing on existing literature, I utilize event history analysis to assess the relationship between a state's decision to substantially cut higher education funding and a series of predictor variables. Event history analysis, also called survival analysis, is built on regression concepts and models the length of time to events, providing estimates for the "instantaneous risk" (probability or hazard rate) of the event occurring at any observed time interval in the study (Box-Steffensmeier and Jones 2004). Originating from biostatistics, event history analysis is often used to study political event processes (Baybeck et al. 2011). In the higher education literature, the method has been employed to study the dynamics surrounding state adoption of merit aid programs (Doyle 2006), eminent scholar programs (Hearn et al. 2013), performance accountability policies (McLendon et al. 2006), and higher education finance innovations (Lacy and Tandberg 2014). Event history analysis examines the time it takes for events to occur, cases of non-events versus events, and models the relationship between the event and one or more predictors (i.e. covariates, controls, or independent variables).

A specific technique in event history analysis is the Cox proportional hazards model. The Cox method is a semi-parametric model that leaves the baseline hazard unspecified. It is flexible in the sense that it does not assume a shape for the underlying risk of an event occurring, if the hazard is increasing or decreasing with time, exponentially or otherwise. In other words, the likelihood of a substantial funding cut is not systematically expected to differ between one year versus another, hence the term proportional-hazard. While "time

[8] Larger enrollments logically require greater financial support so a per-student variable assesses the adequacy of funding.

[9] A relatively large number of funding cuts occurred in 2009. I conduct analyses excluding data from 2009, which resulted in conclusions substantively the same as those discussed in the results section.

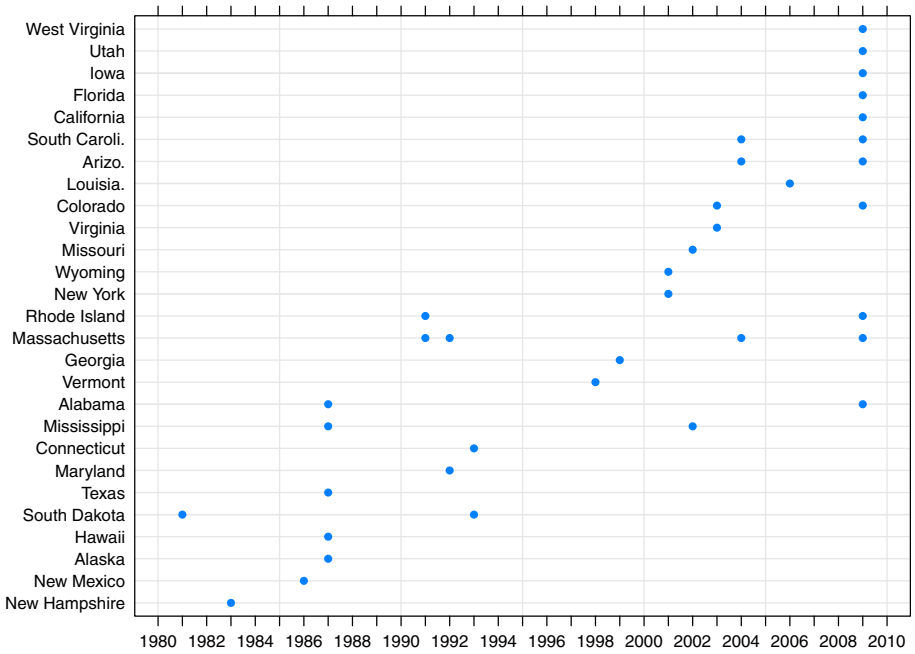

Fig. 4 Dramatic funding cuts by state and year

to event" is parameterized using a set of covariates, the distributional form of these times is not parameterized. The Cox model is appropriate for research questions where the focus is on the relationship between an outcome and covariates of theoretical interest, as opposed to time-dependency itself (Box-Steffensmeier and Jones 2004; Fox 2002).

The Cox model specifies the hazard rate at time t for the ith unit as:

$$h_i(t) = h_0(t)exp(\mathbf{X}_i\beta) \tag{1}$$

where $h_0(t)$ is the baseline hazard function at time t, $\mathbf{X}_i$ is a vector of covariate values corresponding to the ith unit, and β is a vector of coefficients to be estimated (Mason 2005; Thomas and Reyes 2014). Again, the Cox model does not have an intercept term because the baseline hazard is presumed unknown. It is "semi-parametric because while the baseline hazard can take any form, covariates enter the model linearly" (Fox 2002, p. 3). For example, a $1000 increase in per capita income affects the likelihood of a funding cut similarly in the 1980s decade as it does in all other decades. I test this assumption by first generating results that assume proportional hazards and then examining the residuals in a later section titled "Model Diagnostics".

I estimate the relationship between covariates and a substantial decline in state appropriations for higher education in a model equivalent to Eq. 1:

$$h_i(t) = h_0(t)exp(\beta_1 x_{i1} + \beta_2 x_{i2}(t) + \cdots + \beta_k x_{ik}) \tag{2}$$

where $h_i(t)$ is the hazard of drastically cutting spending in state i, year t, $h_0(t)$ is the unspecified baseline hazard, x_{i1} is a static covariate for state i, $x_{i2}(t)$ is a time-varying covariate for state i in year t, and β is a k x 1 vector of coefficients, where k is the number of covariates (Andersen and Gill 1982; Fox 2002). Efron's method is used to handle tied

events (Box-Steffensmeier and Jones 2004).[10] I conduct all analyses in `R` using the `survival` package and its dependencies.

Repeating Events

Some states in the dataset experience dramatic funding cuts multiple times and this must be addressed methodologically. Earlier in Fig. 4, we saw that the policy event occurs more than once in a number of states. Within this subset of states, events most often occur twice and Massachusetts actually experiences four instances of the event.[11] Repeated funding cuts within a state are not independent of one another; there is intra-subject correlation. Robust standard errors clustered around the 50 states are estimated in attempts to account for this correlation (Box-Steffensmeier and De Boef 2006; Darmofal 2009; Willett and Singer 1995).

Repeating events in the dataset are set up as ordered failure events using the Andersen-Gill counting process (Andersen and Gill 1982). A state cannot experience a second funding cut unless it experiences the first since there is a natural, even if not conceptually distinctive, order of events. The sequence of events is important and it is possible that circumstances surrounding a cut are affected by earlier instances of such cuts. An ordered event specification (as opposed to unordered) is more consistent with policy learning, in which observing previous experiences leads to added knowledge about the political support for the current policy decision, its success, and repercussions (Shipan and Volden 2008). In short, the models analyzed recognize that the second cut follows the first and captures the effect of time to the first cut and between multiple cuts in a state.

Model Diagnostics

The proportional hazards assumption is a strong assumption of the Cox model. It is advisable to test whether a fitted Cox regression model adequately describes the data and if the effect of covariates on the hazard rate stays constant.[12] Using graphical diagnostics, I plot scaled Schoenfeld residuals against transformed time for each covariate in a full model (all covariates included) and add a smoothing-spline fit, with 2-standard error bands around the fit (Fox 2002). Departures from the horizontal line indicate non-proportional hazards. The next step is to run a statistical test to confirm a single covariate's violation of the proportionality assumption and test for global non-proportionality. As recommended, I create interactions between worrisome covariates and time, which extends the Cox model to allow non-proportional effects of covariates on the underlying hazard (Allison 1995, 2010).

[10] In this case, a "tied event" is when more than one state makes a funding cut in the same year. The Efron method computes an approximation of the exact marginal calculation. A strict exact marginal calculation assumes continuous times, which make it mathematically impossible for events to occur at the same time. Efron's is a balance between the slightly less precise Breslow method and the conservative and computationally intensive Exact method.

[11] These types of data are known as a multiple risk set or multiple failure-time data.

[12] I consider the advice of Allison (2010), who states that a violation of the proportional hazards assumption for a variable simply means that the coefficient estimated on this variable represents an average effect over the period of observation.

Model Building

Motivated by the conceptual framework surrounding regional differences, I run a full model with region and state-level variables. The gini coefficient variable requires an interaction with time to correct non-proportionality. These adjustments also contribute to improved model fits, informed by the Akaike information criterion (AIC).[13] With regards to tuition, prior year prices may theoretically and practically affect current year budget decisions more so than current year prices. The tuition variable (same-year and one-year lag) does not reach significance in any model, so I retain only its lagged value for parsimony's sake. I also estimate models to inform the question of which set of theoretically analogous political variables better describes government ideology in relation to punctuated funding cuts, which turns out to be the unified three-chamber variables.

To summarize my modeling approach, I:

1. Run a full model that includes all state-level and region variables.
2. Examine violations of the proportional hazards assumption and test for the significance of time interactions.
3. Explore the two different measures of variables (level versus change). Change variables are selected according to sensible conceptual connection with the outcome and if these changes reflect time-variance in the raw variable (i.e. are not static from year to year or only show tiny changes, which would result in many zeros in the data).
4. Replace same year financial variables with lagged variables.
5. Interchange the political party affiliation variables with each set of specifications (unified three-chamber government; governor and legislative party strength; composite government ideology measure).
6. Add groups of conceptually similar variables sequentially (e.g. economic, political, demographic, higher education) to create a model with higher variance explained and assess if variable effects are consistent across models.
7. Compare the AIC and R^2 values to arrive at preferred models that balance model fit, variance explained, and parsimony while still addressing the research question of what state characteristics predict funding cuts.

Subsequently, I conduct an additional analysis to explore whether different state characteristics contribute to large versus small cuts, that is, if the policy event of a punctuated budget cut is fundamentally distinct from the occurrence of more gradual funding cuts.

Results

Interpretation

Results of my analysis are reported as coefficients, which are equivalent to hazard ratios. The hazard ratio is the exponentiated coefficient, so all hazard ratios are positive. A variable with a hazard ratio greater than 1 is associated with an increased probability of the event, whereas a ratio less than 1 corresponds to a decrease (Tabachnick and Fidell 2013). Coefficients assume independence among variables and all other factors held constant. To

[13] Comparisons between survival analysis models can be made using the AIC. The AIC penalizes models for the number of covariates included. Lower AIC values indicate a better fit with the data. Note that the AIC is not intended to compare nested models (Allison 2010).

Table 2 Coefficients on dramatic higher education funding cuts

	Economic	Economic & political	Preferred	Region
Income per capita (*1,000)	0.05	0.07	0.06	0.04
	(0.03)	(0.04)	(0.05)	(0.05)
Unemployment rate	0.29**	0.35***	0.31**	0.30*
	(0.11)	(0.11)	(0.12)	(0.12)
Tax revenue (log)	-0.27	−0.36	−0.50	−0.50
	(0.14)	(0.28)	(0.29)	(0.33)
Gini coefficient (*100)	−0.05	−0.26**	−0.27*	−0.28*
	(0.06)	(0.10)	(0.12)	(0.12)
Gini:time interaction		0.01	0.01	0.01
		(0.01)	(0.01)	(0.01)
Unified Republican (reference: divided)		1.06*	1.06**	1.11**
		(0.46)	(0.40)	(0.40)
Unified Democratic		0.89*	0.99**	0.87*
		(0.38)	(0.38)	(0.41)
Citizen ideology (*10)		0.14	0.13	0.09
		(0.13)	(0.14)	(0.13)
Legislative professionalism (*10,000)		−0.03	−0.03	0.00
		(0.08)	(0.08)	(0.08)
Governor budget powers		−0.39	−0.40	−0.31
		(0.34)	(0.42)	(0.40)
Term limits		0.66	0.63	0.71
		(0.49)	(0.45)	(0.46)
Interest group density (*1000)		0.27	0.25	0.22
		(0.35)	(0.33)	(0.33)
Percent 18 to 24 year olds			0.13	0.11
			(0.09)	(0.08)
Percent 65+ year olds			−0.02	−0.03
			(0.07)	(0.07)
Tuition (log, 1-year lag)			0.73	0.64
			(0.69)	(0.87)
Governing board			−0.42	−0.46
			(0.39)	(0.39)
Merit aid program			0.82	0.76
			(0.46)	(0.48)
Percent private college enrollment			0.00	0.00
			(0.01)	(0.01)
Southern compact (reference: New England)				−0.27
				(0.63)
Midwestern compact				−0.91
				(0.81)
Western compact				−0.32
				(0.72)
AIC	285.78	287.88	293.49	297.77

Table 2 continued

	Economic	Economic & political	Preferred	Region
R^2	0.01	0.01	0.02	0.02
Max. R^2	0.17	0.17	0.18	0.18
Num. events	37	37	37	37
Num. obs.	1500	1500	1450	1450
Missings (due to lags)	0	0	50	50
Global proportional hazards test	0.42	0.86	0.64	0.71

Robust standard errors in parentheses

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

interpret a continuous variable's effect, a 1-unit increase in the hazard ratio changes the probability or instantaneous risk of an event by $[exp(\beta) - 1] * 100$ percent. For a dummy or discrete variable, the interpretation is the same, only in relation to the reference category. Table 2 displays results of models analyzing the levels of variables, and Table 3 displays results of models analyzing changes in variables. Units of some variables are adjusted for easier interpretation of coefficients, as noted.

Covariate Effects

In Table 2, column 4, estimates show that none of the regional higher education compacts are significantly different from one another in the likelihood of their states making dramatic cuts to appropriations. This is true when regional controls are used in isolation as well as within more specified models containing economic, demographic, political, and higher education variables. I evaluate regional differences by omitting each compact as the reference category. The probability of a funding cut, whether or not further state characteristics are controlled for, is similar among states belonging to the Southern, Midwestern, Western, or New England (plus NY, NJ, and PA) compacts. These findings imply that if regional differences do exist, they are not masked by other variables such as merit aid programs (more prevalent in Southern states) and private sector enrollment (a greater proportion of students attend private colleges in New England). However, when percent changes in various financial and demographic variables are substituted for levels, states in the Midwestern compact appear to be 78 % less likely ($exp(-1.50) - 1 = -0.78$) than New England states to reduce higher education funding by 14 % or more in a single year (Table 3, column 4). This result is aligned with previously noted theoretical ideas about region but is sensitive to the choice of other variables in the model. As a whole, the region variables exhibit limited marginal effects and changes in remaining covariate effects are nominal whether or not region is included. Consequently, my preferred models exclude the regional compact dummies.

Looking across all columns in Table 2 and Table 3, we see that much of the heterogeneity across states is explained by economic and political characteristics. The direction of significant covariate effects is consistent across models, ensuring greater confidence in results from the preferred models. On the other hand, one cannot extrapolate information from a reduced model about all variables concerned, which is a primary research question in this study.

I arrive at two preferred models displayed in column 3 of Tables 2 and 3, after comparing the AIC and R^2 values to balance model fit and variance explained while still

Table 3 Coefficients on dramatic higher education funding cuts: percent change variables

	Economic	Economic & political	Preferred	Region
Income change	(0.09) 0.13	(0.09) 0.13	(0.12) 0.11	(0.12) 0.09
Unemployment change	0.03***	0.03**	0.04***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Tax revenue change	−0.05**	−0.06**	−0.07**	−0.06**
	(0.02)	(0.02)	(0.03)	(0.02)
Gini coefficient change	−0.11*	−0.11**	0.00	0.01
	(0.05)	(0.04)	(0.03)	(0.03)
Gini coefficient change:time interaction	0.01*	0.01*		
	(0.00)	(0.00)		
Unified Republican (reference: divided)		0.90*	0.95*	0.95*
		(0.42)	(0.45)	(0.44)
Unified Democratic		0.83*	0.79*	0.76
		(0.36)	(0.38)	(0.42)
Citizen ideology (*10)		0.20	0.33	0.22
		(0.16)	(0.17)	(0.16)
Legislative professionalism (*10,000)		−0.01	−0.05	−0.02
		(0.06)	(0.06)	(0.05)
Governor budget powers		−0.37	−0.45	−0.41
		(0.34)	(0.29)	(0.28)
Term limits		0.68	0.75	0.83*
		(0.44)	(0.42)	(0.42)
Interest group density change		−0.02	−0.02*	−0.02*
		(0.01)	(0.01)	(0.01)
Percent 18 to 24 year old change			−0.01	−0.01
			(0.01)	(0.01)
Percent 65+ year old change			−0.01	−0.01
			(0.01)	(0.01)
Tuition change (1-year lag)			0.02	0.02
			(0.02)	(0.02)
Governing board			−0.39	−0.41
			(0.38)	(0.36)
Merit aid program			0.88*	0.98**
			(0.34)	(0.36)
Percent private college enrollment			0.01	0.01
			(0.01)	(0.01)
Southern compact (reference: New England)				−0.64
				(0.39)
Midwestern compact				−1.50*
				(0.65)
Western compact				−0.43
				(0.47)

Table 3 continued

	Economic	Economic & political	Preferred	Region
AIC	277.85	278.82	278.38	279.39
R^2	0.01	0.02	0.02	0.03
Max. R^2	0.18	0.18	0.18	0.18
Num. events	37	37	36	36
Num. obs.	1450	1450	1400	1400
Missings (due to lags)	50	50	100	100
Global proportional hazards test	0.51	0.97	0.96	0.98

Robust standard errors in parentheses

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

analyzing state characteristics of interest that may predict funding cuts. These models exclude region controls, incorporate all state-level variables introduced in the literature review, a one-year tuition lag, the gini variable interaction when deemed statistically necessary, and the set of three-chamber government variables.[14] I focus primarily on reporting these results and extrapolate from coefficient estimates of a covariate's value and from its yearly rate of change.

The economic variables explored in this study are associated with the hazard of a state making substantial, punctuated budget cuts to higher education appropriations—defined as a 14 % decrease in a single year. In any given year, higher unemployment rates are associated with greater risk of such a cut. In the first preferred model (Table 2, column 3), a one percentage point rise in the unemployment rate (e.g. from 5 to 6 %) increases the probability of a funding cut by 36 % ($exp(0.31) - 1 = 0.36$). To better contextualize, unemployment rates in the dataset range from 2.2 to 18; the first and third quartiles are 4.5 and 6.9. In relative terms a one percentage point increase is considerable and logically has a notable effect. Observing year to year changes in the unemployment rate also leads to a parallel conclusion (Table 3, column 3). Rapid increases in unemployment also contribute to higher risk of funding cuts. Specifically, a one percentage point rise in the *rate* of unemployment *growth* from the prior year increases the hazard rate by 4 % ($exp(0.04) - 1 = 0.04$). For example, Washington state's unemployment rate was 5 % in 2006, 4.5 % in 2007, and 5.4 % in 2008. The annual *rate of change* was −10 % from 2006 to 2007, and +20 % from 2007 to 2008. The first difference of the *rate of change* is 30 *percentage points*. The hazard ratio is $exp(0.04) = 1.04$. We know the Cox model has a multiplicative structure, so $1.04^{30} = 3.24$. Therefore, Washington state is more than three times as likely to cut higher education funding given unemployment conditions in year 2008 compared to 2007.

The tax revenue variable approaches but does not reach significance in the models reported in Table 2. However, the change models in Table 3 affirm the intuitive notion that when a state experiences rapid annual growth in total tax revenue, policymakers may face less pressure to slash higher education spending. Personal income per capita and its rate of change both have no relationship with the policy event.

[14] Applying one-year lags of economic, demographic and higher education variables decrease explanatory power and worsen model fit. Applied, prior year financial indicators are not associated with current year funding cuts. Similar non-findings occur when the percent changes are lagged by one year. That is, the rate of change in economic conditions from 2000 to 2001 do not relate to funding cuts in 2002. From here on, results for same year variables are reported.

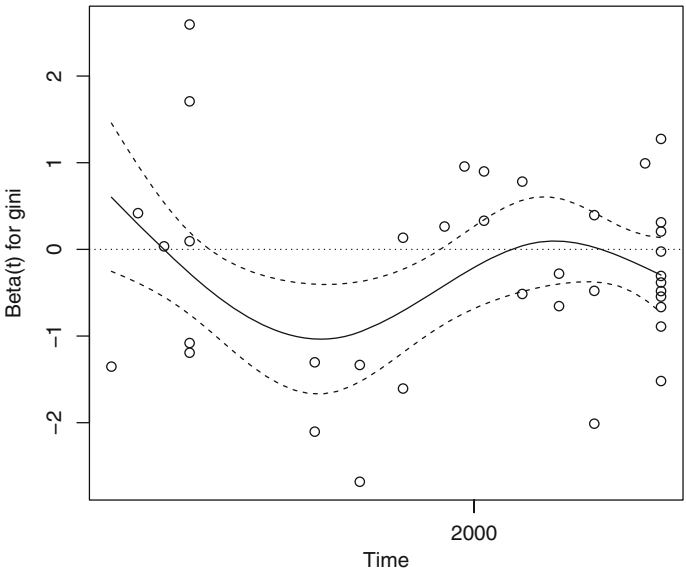

Fig. 5 Transformed time Gini coefficient Schoenfeld residuals

Greater income inequality tends to diminish the likelihood of a funding cut. We see from the preferred model in Table 2 that a 0.01 increase in the gini coefficient on its raw scale is associated with an average 24 % decrease in the risk of a funding cut ($exp(-0.27) - 1 = -0.24$), all other variables held constant. Values in the data range from 0.32 to 0.49, on a scale of 0 to 1 where 0 indicates perfect income equality and 1 is maximum inequality. Moreover, the positive coefficient on the gini *interaction* term suggests that on average, the direction of this effect moves positively with time (in this case, the negative effect of gini becomes smaller). The average effect of the gini variable is negative (previous noted β of -0.27) though the effect moves in a positive direction at a rate of 0.01 per year (see β of linear interaction term). The Schoenfeld residuals reveal a more nuanced relationship (Fig. 5): the gini coefficient initially has a positive effect on the hazard rate (although confidence bands cross 0), which quickly dips and maintains a negative effect, until its effect becomes negligible (essentially null) in the 2000's decade (Fox 2002). Additionally, the effect of the *rate of change* in the gini coefficient also varies across time, but this only appears in the partial models (Table 3, columns 1 and 2). These particular estimates suggest that on average, states with rapidly widening wage inequalities are probably less likely to cut appropriations.

Moving onwards, political dynamics and party affiliation within a state do have a direct connection with decisions to severely cut higher education appropriations. To reiterate, the three-chamber government variables consistently have the best predicative power. Evidently, a large and significant difference is present during a year when a state's House, Senate, and governor are controlled by one party, versus a divided government.[15] In all

[15] Efforts are made to include Nebraska in the analysis. Budget cuts exceeding 14 % do not occur in Nebraska, though these non-event years still contribute statistically to the hazard function. Nebraska is coded as unified ("1") when the governor and the unicameral legislature are of the same party. In a separate analysis, I code Nebraska as "0.66" during these years to represent the slightly reduced version of a unified

models, both unified Republican and unified Democratic governments are twice as likely to cut higher education budgets—divided government is treated as the reference category here. Party affiliation itself is unrelated to sizable cuts—here I omit one of the unified variables. Governor's party affiliation combined with Republican strength in the legislature does not influence the hazard rate (not reported). Similarly, government ideology on a liberal-conservative continuum is also unrelated to the hazard rate (not reported).

Other political characteristics examined: the citizen ideology measure, legislative professionalism, governor institutional powers, term limits, and higher education interest group density do not consistently help predict the probability of a major funding cut. The number of non-higher education interest groups in a year is not associated with the outcome. To some degree, however, when this variable increases sharply from the previous year, a current year funding cut is more likely to occur. The negative coefficient on the *rate of change* variable suggests that a flood of new interest groups is potentially advantageous for public colleges. A sudden abundance of non-higher education groups may dilute each one's relative influence, which gives higher education interest groups more traction. However, there is a possibility that changes in the number of interests groups may simply indicate that state reporting laws for lobbyists have become more or less stringent. Lastly, no association with punctuated budget cuts is found when governor powers is interacted with higher education governing board (not reported).[16]

The variables representing a state's broad demographic composition and annual changes are not related to the policy decision to make large cuts to higher education appropriations per student. A larger proportion of 18 to 24 year old residents does not increase or decrease funding cuts, nor does a larger proportion of residents over age 65. I also analyzed the ratio of 18 to 24 year olds to 65+ year olds, which points to no relationship (not reported).

Lastly, results in Table 3 suggest a connection between one higher education control variable and punctuated budget cuts. The existence of a broad based merit aid program more than doubles the likelihood of a major budget cut. The remaining higher education variables: proportion of student enrollment at private colleges, tuition prices and rate of change, and centralized governing board versus coordinating/planning board are not associated with the policy event.

Comparison to Incremental Funding Cuts

This study relies on punctuated equilibrium theory to inform the methodological choice to analyze the outcome of higher education funding as a discrete event. Yet another question emerges: does it make sense to distinguish between large and small cuts in an either/or fashion, even if higher education budget changes do follow a punctuated equilibrium pattern? I conduct a sensitivity analysis to challenge the argument that a larger cut to state funding per student differs from a smaller cut (defined earlier as 6 % or less). Are these two events catalyzed by a different set of state conditions?

Consider the results presented in Table 4, columns 2 and 3, and Table 5, columns 2 and 3, where preferred models are applied to predicting smaller budget cuts. Notice that smaller cuts are affected by personal income per capita as well as changes in income. A $1000

Footnote 15 continued
government with two power centers versus three. I also listwise delete Nebraska. Substantive results do not change.

[16] It is possible for an interaction term to reveal a significant relationship with an outcome even if main effects are absent.

increase in income per capita results in a 3 % lower likelihood of incremental cuts. Unemployment, income inequality, and rate of change in tax revenue, all of which predicted large cuts, are no longer relevant. In contrast, a merit aid program affects both large and small cuts. The effect of merit aid is smaller and in the opposite direction of large cuts. Commitment to a merit-based aid program decreases the overall likelihood of incremental budget cuts yet contributes to a higher likelihood of punctuated cuts. Select variables have opposite effects on large cuts versus small cuts, while other variables are only relevant to one type of cut, suggesting that forces driving cuts differ depending on the severity of the cut.

The political variables paint a mixed story for incremental versus punctuated budget cuts. A unified Democratic government lowers the risk of small cuts (Table 5, column 2), an effect opposite of that for large cuts. Additionally the legislature composition variable matters for small cuts, using both the level and change variable models. We observe a 1 % increase $(exp(0.01) - 1 = 0.01)$ in chances of a small cut when the proportion of Republican legislators increases by 1 %. Recall that Republican share of the legislature did not predict large budget cuts. These findings appear to show party ideology differences in which a Democratic presence in the legislature protects higher education funding when only a small cut is necessary to balance state budgets, compared to a stronger Republican presence. However when state budgets are drastically out of balance, Democrats and Republicans both are willing to substantially cut higher education budgets. Speculatively, in this situation Democrats may attempt to sustain funding to other subfunctions (e.g. healthcare, social services) that benefit a larger and more needy population—policymakers may reroute higher education funds to other categories. Consistent with more conservative ideology, Republicans are resistant to tax increases as a way to address any degree of budget shortfalls and might choose to cut spending across the board when faced with deficits large or small. The main assurance from this sensitivity check is that the state factors estimated to predict punctuated budget cuts are different from factors that predict incremental cuts. Larger cuts occur in unique economic and political contexts that we can only tease apart when we differentiate cuts by severity.

Discussion

I now summarize the results of this study and concentrate on implications for scholarship, policy, and practice. I note limitations of this study, particularly methodological, and suggest avenues for future research. A general limitation of this study is the issue of omitted variable bias. In event history analysis, as with any regression analysis, the omission of variables that actually have an effect on the outcome can lead to bias. This is especially true if the omitted variable is strongly correlated with included variables (Allison 2010). For example, this study does not analyze other, non-higher education spending categories.[17] More categories could be included in a statistical model analyzing higher education support and the empirical literature identifying these categories could be expanded. Other state or national dynamics not accounted for could affect the likelihood of

[17] Researchers have questioned the relationship between higher education and subcategories. For example, Kane et al. (2003) demonstrated that higher education spending must fall if Medicaid spending rises because of federal mandates or incentives. However, as Archibald and Feldman (2006) proposed, if the budget itself is endogenous, different expenditure categories may instead be complements. If total revenues fall, higher education and Medicaid spending may both increase (or decrease).

Table 4 Sensitivity checks on large cuts compared to small cuts

	Cuts meet or exceed percent threshold		
	14	<6	<6
Income per capita (*1,000)	0.06	−0.03*	−0.03*
	(0.05)	(0.01)	(0.01)
Unemployment rate	0.31**	0.04	0.06
	(0.12)	(0.03)	(0.04)
Tax revenue (log)	−0.50	−0.21*	−0.15
	(0.29)	(0.09)	(0.10)
Gini coefficient (*100)	−0.27*	0.01	0.01
	(0.12)	(0.02)	(0.01)
Gini:time interaction	0.01*		
	(0.01)		
Unified Republican (reference: divided)	1.06**	−0.06	
	(0.40)	(0.11)	
Unified Democratic	0.99**	−0.18	
	(0.38)	(0.11)	
Republican governor			−0.06
			(0.10)
Percent Republicans in legislature			0.01**
			(0.00)
Citizen ideology (*10)	0.13	−0.02	0.03
	(0.14)	(0.04)	(0.04)
Legislative professionalism (*10,000)	−0.03	0.05	0.05
	(0.08)	(0.04)	(0.04)
Governor budget powers	−0.40	−0.09	−0.17
	(0.42)	(0.11)	(0.10)
Term limits	0.63	0.08	0.11
	(0.45)	(0.16)	(0.15)
Interest group density (*1000)	0.25	0.04	−0.06
	(0.33)	(0.13)	(0.14)
Percent 18 to 24 year olds	0.13	−0.00	0.00
	(0.09)	(0.02)	(0.02)
Percent 65+ year olds	−0.02	0.02	0.02
	(0.07)	(0.03)	(0.03)
Tuition (log, 1-year lag)	0.73	0.18	0.14
	(0.69)	(0.13)	(0.12)
Governing board	−0.42	−0.12	−0.16
	(0.39)	(0.13)	(0.13)
Merit aid program	0.82	−0.50*	−0.53*
	(0.46)	(0.21)	(0.22)
Percent private college enrollment	0.00	−0.00	−0.00
	(0.01)	(0.00)	(0.00)
AIC	293.49	3923.00	3812.29
Num. events	37	533	522

Table 4 continued

	Cuts meet or exceed percent threshold		
	14	<6	<6
Num. obs.	1450	1450	1421
Missings (due to lags and Nebraska)	50	50	79
Global proportional hazards test	0.64	0.97	0.86

Robust standard errors in parentheses

*** $p < 0.004$; ** $p < 0.01$; * $p < 0.05$

policy events, which presents an opportunity for future studies to expand and refine the literature base.

Within Compacts: A Regional Matter?

The finding that Midwestern compact states are less likely than New England states to cut funding, albeit a fragile one, is consistent with notions of "Big 10" schools being well supported, while private colleges dominate in the northeast. Again, this effect is not consistent across models and does not confirm my earlier hypothesis about regional differences. Generally, states within regions are no more likely than states across regions to experience substantial declines in appropriations per student. Several researchers have suggested that "legislatures in different regions of the country may react differently to the changing economic and demographic climates in their states" (Toutkoushian and Hollis 1998, p. 3), and that including regional controls is important when analyzing appropriation levels (Okunade 2004). However, my results contradict these ideas and the idea that fixed regions matter (Berry and Berry 2007). Either regional effects do not exist when the specific outcome of punctuated budget cuts (and incremental cuts) is isolated from all changes, or the importance of state conditions surpass any regional ones. Methodologically speaking, there may not be enough regional variation between state-years coded as "events" versus "non-events" in a dataset where events occur 2.6 % of the time. In a practical sense, even though higher education compacts are an avenue for interstate policy discussion and legislators probably reflect on circumstances in neighboring states, they may be restricted in their ability to avoid funding cuts. In any case, state-level factors better capture the likelihood of such events.

Higher Education's Reliance on State Fiscal Health

Economic conditions are the best predictors of punctuated budget cuts, regardless of whether political and higher education factors are controlled for. Not surprisingly, high unemployment rates and rapid surges in unemployment contribute to greater likelihood of major declines. This finding is consistent with earlier findings that unemployment has a negative effect on funding levels (McLendon et al. 2009; Tandberg 2010; Titus 2009; Weerts and Ronca 2012). The relationship between unemployment and appropriations, measured as a continuous variable, holds true for punctuated declines, measured discretely. Several implications are worth noting, the first being that more unemployed persons generally leads to college enrollment increases (Crookston and Hooks 2012). It also means smaller tax revenues from the state's citizens, and we know higher education is especially

Table 5 Sensitivity checks on large cuts compared to small cuts: percent change variables

	Cuts meet or exceed percent threshold		
	14	<6	<6
Income change	0.11	−0.04*	−0.04*
	(0.12)	(0.02)	(0.02)
Unemployment change	0.04***	0.00	0.00
	(0.01)	(0.00)	(0.00)
Tax revenue change	−0.07**	−0.01	−0.01
	(0.03)	(0.01)	(0.01)
Gini coefficient change	0.00	0.01	0.01
	(0.03)	(0.00)	(0.00)
Unified Republican (reference: divided)	0.95*	−0.03	
	(0.45)	(0.11)	
Unified Democratic	0.79*	−0.26*	
	(0.38)	(0.12)	
Republican governor			−0.03
			(0.11)
Percent Republicans in legislature			0.01**
			(0.00)
Citizen ideology (*10)	0.33	−0.02	0.01
	(0.17)	(0.05)	(0.05)
Legislative professionalism (*10,000)	−0.05	−0.01	−0.01
	(0.06)	(0.03)	(0.03)
Governor budget powers	−0.45	−0.09	−0.13
	(0.29)	(0.13)	(0.13)
Term limits	0.75	0.15	0.18
	(0.42)	(0.17)	(0.16)
Interest group density change	−0.02*	0.00	0.00
	(0.01)	(0.00)	(0.00)
Percent 18 to 24 year old change	−0.01	−0.00	−0.00
	(0.01)	(0.00)	(0.00)
Percent 65+ year old change	−0.01	−0.00	−0.00
	(0.01)	(0.00)	(0.00)
Tuition change (1-year lag)	0.02	−0.00	−0.00
	(0.02)	(0.00)	(0.00)
Governing board	−0.39	−0.06	−0.12
	(0.38)	(0.13)	(0.13)
Merit aid program	0.88*	−0.45*	−0.47*
	(0.34)	(0.20)	(0.20)
Percent private college enrollment	0.01	−0.00	−0.00
	(0.01)	(0.00)	(0.00)
AIC	278.38	3724.53	3624.12
Num. events	36	504	494
Num. obs.	1400	1400	1372

Table 5 continued

	Cuts meet or exceed percent threshold		
	14	<6	<6
Missings (due to lags and Nebraska)	100	100	128
Global proportional hazards test	0.96	0.90	0.80

Robust standard errors in parentheses

*** $p < 0.004$; ** $p < 0.01$; * $p < 0.05$

vulnerable in the face of budget shortfalls. More serious declines in appropriations per student tend to occur during these times, which conceivably affects the quality of education that public colleges can provide given the new influx of students.

Second, higher unemployment increases the risk of funding cuts even after tax revenues are controlled for. Colleges are simply at greater risk of losing funding during economic downturns (Hovey 1999). Third, the measurement of the outcome variable could be inflating the effect of unemployment (a one percentage point rise increases the probability of a punctuated cut by 36 %). I use higher education appropriations per student, not total appropriations, so if enrollments expand in one year and total appropriations stay constant, a funding cut is more easily captured by the data. A jump in unemployment most likely creates an immediate strain on colleges' ability to sustain resources per student. Total appropriations might catch up to enrollments in subsequent years. Unemployment certainly increases the probability of a same-year funding cut, though I suspect that public colleges find short-term ways to adapt to enrollment growth if total operational budgets are stable (by increasing class sizes, for example). From a practical standpoint, colleges can anticipate a shortfall in their budget if the job market appears shaky or takes a downward spiral. When economic conditions worsen, colleges may benefit from more intensive lobbying efforts to preserve existing funding levels and soften adverse budget shocks.

Findings regarding the gini coefficient show a complex relationship between a state's income inequality and the risk of dramatic higher education cuts. As inequity rises, the likelihood of cuts falls and this effect is strongest during the late 1980's and throughout the 1990's, and becomes weak in the late 2000's. On average, widening income inequality and sharp rises in inequality reduce the chances of a spending cut. This finding is consistent with the idea that investing in higher education helps equalize opportunities for poorer residents (Tandberg 2009). Improving access for traditionally disadvantaged populations can help reduce the gap between the rich and the poor, and foster educational attainment. A policy implication is that legislators may deliberately take into account income inequalites among citizens in their state when making budget decisions. While the rate of change in income inequality would be difficult to practically evaluate, policymakers are probably in tune with the general conditions of their state. Perhaps policymakers see investment in higher education as a redistributive mechanism, a characterization that has been discussed in the literature (McLendon et al. 2014, 2005). Future research may wish to consider whether policymakers do hold this view and if higher education spending truly has redistributive properties, and if lower income residents see long-term benefits in cases where dramatic funding cuts are less frequent.

Personal income per capita reflects a different facet of the business cycle and is not associated with funding cuts as defined in this study. Neither is total tax revenue, yet fluctuations in the form of sudden inflows of revenue appear to decrease risk. The finding for income is perplexing and also raises the question of whether it should continue to be a

standard financial variable that gets included. The topic of family incomes (and financial aid) not keeping pace with tuition attracts media coverage and should stimulate empirical research to substantiate relationships between these variables. These results might be different if the outcome were derived from alternative measures of support such as the natural log of appropriations or appropriations per $1000 of personal income (Tandberg and Griffith 2013).

Nevertheless, the present study echoes earlier findings of higher education's dependence on various aspects of the business cycle (Kane et al. 2003). In addition, "States that increase the educational attainment of their citizens will eventually reap the rewards of stronger economics and increased tax revenues—not to mention other benefits such as reduced income inequality and spending on social support programs—but the benefits of these investments will not be immediately realized." (Baum et al. 2012, p. 4). A long-term policymaking strategy that promotes "return on higher education investment" is worth implementing given the strong connections between state economics, affluence, and higher education.

Converging Political Party Preferences

Prior literature asserts that a more conservative government is less likely to fund higher education. This view embodies Republican ideology that the students who directly benefit should be responsible for paying. Additionally, a unified Republican government would achieve more success in pushing this agenda forward. My results partially support this argument and I find that a Republican government unified across the three chambers is more than twice as likely to make significant cuts to appropriations per student compared to a divided government. What is unexpected is the finding that a unified Democratic government is also twice as likely. In fact, both Republicans and Democrats appear to be equally willing to balance state budgets at the expense of higher education while a divided government is less prone to such behavior. If punctuated budget cuts are unrelated to party ideology, why does a divided government hinder this policy event? If we assume that elected officials from the Republican and Democratic parties all respond to external financial shocks by defunding higher education, why does this response not carry over to divided governments, as it should given agreement across party lines?

A possible explanation emerges from an earlier finding that faced with fiscal shocks, unified governments can more quickly shift state spending priorities (Alt and Lowry 2000). In the annual budget process, if the House and Senate belong to the same party as the governor, each branch can readily pass the governor's proposed budget. "Otherwise, divided government introduces bargaining and compromise since neither party has unilateral control" (Alt and Lowry 2000, p. 1039). Even though higher education is more susceptible to cuts during years of unified party control, there may be more contention within divided governments regarding *how much* to cut spending in all subcategories, lowering the possibility of higher education cuts exceeding the 14 % threshold. Legislature composition and governor party affiliation are unrelated to the outcome. Unlike previous findings that Democratic governors and a larger share of Democrat legislators are more sympathetic towards higher education (Archibald and Feldman 2006; McLendon et al. 2009; Tandberg 2009, 2010), and conflicting findings that Republican-controlled legislatures are more sympathetic (Weerts and Ronca 2012), my results suggest no effect of party affiliation. Rather, I speculate that unified governments are the vehicle for budgeting decisions where both parties can smoothly implement their rather congruent preferences. Another explanation is that liberalism and conservatism with respect to higher education

has evolved and a static categorization of such concepts is not appropriate for multiple decade data. Moreover, conservative in one state probably means something different in another state. Shifting party ideologies at the national level could also muddle the empirical clarity of political preferences.

The remaining political variables analyzed largely have a weak association with the outcome. Non-findings for citizen ideology, state official ideology, legislative professionalism, governor budget powers, and term limits support this conclusion.[18] Economic conditions in a state generate certain external shocks that when encountered by different types of political institutions, induce similar responses. However, when there is rapid single-year growth in the number of active non-higher education interests groups, higher education funding is actually less likely to be cut. The direction of this association appears counterintuitive at first glance. Although, if more interest groups means that power becomes less concentrated in the hands of the few who used to dominate the field, this could lead to a less coherent voice, allowing higher education lobbyists to advance their agendas even as total interest groups expand. Strategic activity and lobbying efforts do matter for budget outcomes and this topic could be more intricately researched (Tandberg 2010). Practically speaking, colleges might want to engage in lobbying efforts to block a major cut to appropriations, regardless of which political party is in control.

The Utility of Age Group Demographics

Surprisingly, I find no relationship between shares of the college age population nor the elderly population and punctuated budget cuts. A larger proportion of 18 to 24 year olds in a state, even if this age group is growing quickly, does not lower instances of sharp budget cuts. Likewise, more elderly residents and faster growth in elderly residents do not seem to affect funding cuts. When policymakers are confronted with difficult fiscal decisions, they should consider relative demand for public services, yet this conceptual logic does not materialize in the results. One explanation is that the traditional college-going age does not accurately reflect demand for higher education. Today's college students are diverse and there are many returning adult students. Future researchers might investigate alternative measures that more adequately capture need, such as growth in jobs that require post-secondary training. This may resolve curious findings of a negative relationship (McLendon et al. 2009; Tandberg 2009), or no relationship (Delaney and Doyle 2011) between higher education spending and the proportion of 18 to 24 year olds. Overall, my findings question the relevance of age group demographics in predicting higher education support. Either these variables do not matter for substantial cuts or do not adequately capture demand relative to other public priorities, or legislators are under-informed about or impervious to the needs of these particular age groups.

Higher Education Systems...Overshadowed

Tuition levels, tuition growth, private college enrollment, and governance structure are all unrelated to large budget cuts. Lack of an association for the tuition variables is puzzling

[18] I also examine the relationship between higher education funding and whether a state has tax and expenditure limits (TELs) (Archibald and Feldman 2006; New 2010). I use data from New (2010) to create a TEL dummy variable indicating whether a state had a TEL during each year. I run models including and excluding TELs, which indicate that they do not predict large funding cuts, nor do they change results of existing covariates.

because following a year of large tuition increases, a persuasive argument can be made (by colleges and policymakers) for avoiding a large cut and passing along greater cost burdens to students. Strong governing board oversight does not seem to impact cuts when compared to a planning or coordinating board arrangement. This finding is unexpected because governing boards arguably have more power to advance the interests of higher education and can more effectively preserve funding. Granted, previous findings on this topic are mixed and several studies do conclude that governance structure matters little for higher education support (Delaney and Doyle 2011; McLendon et al. 2006, 2009).

Interestingly, state commitment to merit-based student financial aid increases the risk of punctuated budget cuts. A state's commitment to funding a broad based merit program may influence the perceived criticality of higher education appropriations. Perhaps policymakers believe merit aid softens any undesirable impacts to students that can emerge when direct support to colleges is reduced.[19] Given the large amount of research on financial aid, affordability, and equity implications of merit aid programs but less so on the connection to trends in appropriations, the relationship between aid (merit and need based) and higher education appropriations could be a worthy avenue for further scholarly exploration. One question is whether the dominance of merit aid versus need aid affects budgeting decisions regarding higher education. Student awareness of different types of aid could shape policymaker choices regarding which areas to defund.

Conclusion

This study presents a novel approach to the study of higher education funding by characterizing the severity of budget cuts, which is particularly relevant given that higher education increasingly operates in environments of budget constraint. Motivated by the public budgeting literature on punctuated equilibrium theory and guided by systematic observations of the underlying data, this study models the specific outcome of substantial cuts to higher education appropriations per student. Results indicate that external fiscal shocks drive what I term punctuated budget cuts, and the economic health of a state contributes to the likelihood of such cuts. Unified governments are more likely to make budget cuts, although party preferences diverge once smaller budget cuts are considered. This study finds that state characteristics associated with budget cuts are overwhelmingly economic and political, as opposed to regional and what researchers would classify as demographic or higher education-related. Therefore, a state-level political economy approach to studying higher education funding deserves continued scholarly attention. Lastly, recognizing the distinctions between environments leading to large cuts versus smaller cuts can help colleges anticipate, prepare for, and hopefully mitigate future shocks to their budgets. This study expands the literature on dynamics surrounding higher education spending, a topic that will continue to stay relevant for colleges and policymakers at the state and national level.

Appendix

See Table 6.

[19] It is worth noting though, some states have separate funding mechanisms for their merit aid programs such as through a lottery.

Table 6 Variable descriptions and sources

Variable	Description	Source
Policy event	Punctuated budget cut coded 1 if higher education appropriations per student experience annual 14 % decline or more	State higher education executive officers (SHEEO), state higher education finance (SHEF) database; fall enrollment from integrated postsecondary education data system (IPEDS) via WebCASPAR
CPI	Consumer price index to adjust all financial variables to 2013 dollars	Bureau of Labor Statistics
Regional compact	Higher education compact membership dummy variables: New England + NY, NJ, PA (reference); South; Midwest; West)	Regional compact websites NEBHE, SREB, WICHE, MHEC
Income	Personal income per state capita	Bureau of Economic Analysis
Unemployment	Unemployment rate of state population	Bureau of Labor Statistics
Tax revenue	Total state tax revenue	Census bureau, annual survey of state Government tax collections
Gini coefficient	Income inequality measure: 0 to 1 where 0 is perfect equality and 1 is maximum inequality	Bureau of economic analysis
Unified Republican	Coded 1 if Republicans control all 3 chambers: House, Senate, and governor's seat. Divided government is reference. Nebraska coded unified if Republican governor and Republican majority in unicameral legislature	National Governor's Association statistical abstracts; Ballotpedia.org; Council of State Governments
Unified Democratic	Coded 1 if Democrats control all 3 chambers	National Governor's association statistical abstracts; ballotpedia.org; Council of state Governments
Republican governor	Coded 1 if Republican governor	Council of State Governments
Percent Republicans	Percent of Republican legislators in House and Senate combined, Nebraska excluded	Council of State Governments
Government ideology	Composite measure of elected officials on conservative-liberal continuum (0 to 100 where 0 is most conservative), developed by Berry et al.	Inter-University Consortium for Political & Social Research (ICPSR)
Citizen ideology	Composite measure of state electorate on a conservative-liberal continuum (0 to 100 where 0 is most conservative), developed by Berry et al.	ICPSR
Legislative professionalism	Legislative salary	Council of State Governments, Book of the States
Governor budget powers	Governor authority index (0 to 5 where 5 indicates greatest power), considers line-item veto powers, level of responsibility for budget, appointment powers, developed by Barrilleuax and Berkman [2003]	David Tandberg, personal communication

Table 6 continued

Variable	Description	Source
Term limits	Coded 1 if state has term limits	National Conference of State Legislatures
Interest group density	Total number of interest groups minus registered public higher education interest groups, developed by Tandberg [2010] based on Gray and Lowery [1996]	David Tandberg, personal communication
Percent 18 to 24 year olds	Percent of state population ages 18 to 24	Census Bureau
Percent 65+ year olds	Percent of state population ages 65 and older	Census Bureau
Tuition	Average undergraduate resident tuition at public colleges	IPEDS via WebCASPAR
Governing board	Higher education governance structure coded 1 if consolidated governing board, 0 if planning or coordinating board	Education Commission of the States
Merit state	Coded 1 if state has broad based merit aid program	Doyle (2006), Zhang and Ness (2010)
Private enrollment	Percent of all higher education enrollment in private colleges	IPEDS via WebCASPAR
Change variables	Annual percent change in variables: income, unemployment, tax revenue, gini coefficient, interest group density, percent 18 to 24 year olds, percent 65+ year olds, tuition	Author calculations

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