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What is a School Finance Reform? Uncovering the ubiquity and diversity of school finance reforms using a Bayesian changepoint estimator

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Abstract

School finance reforms are not well defined and are likely more prevalent than the current literature has documented. Using a Bayesian changepoint estimator, we quantitatively identify the years when state education revenues abruptly increased for each state between 1960 and 2008 and then document the state-specific events that gave rise to these changes. We find 108 instances of abrupt increases in state education revenues across 43 states; about one-quarter of these changes had been undocumented. Half of the abrupt increases that occurred post-1990 were preceded by litigation-prompted legislative activity, and Democrat-party control of a state increases the probability of a changepoint occurring by 8 percentage points.

Keywords: school finance, school finance reforms

What is a School Finance Reform? Uncovering the ubiquity and diversity of school finance reforms using a Bayesian changepoint estimator

State revenues are central to policy discussions about funding public schools. Although total funding for elementary and secondary education is the sum of state, local, and federal revenues, state funding has become increasingly prominent. Aside from the Great Recession period, state revenues, on average, have been the largest share of total elementary and secondary funding since 1980 (NCES, 2020). These state investments in education are important for numerous reasons, but perhaps most notably, state revenues can help equalize total revenues among school districts (Chingos and Blagg, 2018; Shores et al., in press).

Increased state investment in education spans a decades-long time horizon. Since the 1960s, there has been a steady, positive trend in state-level per pupil investments in elementary-secondary education—about $1,000 in every decade between 1960 and 2010 (see Figure 1)—accompanied by periodic and state-specific large and abrupt increases in state revenues. We refer to these changes as "positive changepoints." For example, in states like Mississippi, state revenues per pupil generally mirror that of the national secular trend, whereas in other states, such as New Hampshire and Nebraska, state educational contributions increased abruptly, exhibiting sharp departures from the state's own secular trend.

[FIGURE 1 ABOUT HERE]

The trends depicted in Figure 1 can generate at least two lines of research questions. One might look to assess whether increasing economic growth, rising personnel costs, or declining pupil-teacher ratios are explanations for the long-term secular growth in educational spending (e.g., Hanushek and Rivkin, 1996). Alternatively, one might want to quantify and document the events that give rise to these apparent positive changepoints. In this paper, we are concerned with

the latter, as these abrupt increases in state investment are more likely to reflect political actions taken by the courts, voters, and legislators to change the state's role in school funding. Knowledge of these political actions are of interest because they reflect choices stakeholders make about the importance of educational spending in the state and can inform others about the types of steps that need to be taken to reshape educational spending.

When we consider plausible causes of these positive changepoints in state spending, the most likely source is a political event in the form of a legislative statute that increases (or changes) revenue collection to increase state investments. Giving prominence to the legislature in school finance reform is necessary since state-level tax regulation, budgeting, and revenue apportionment are all conducted through the legislature.

Unfortunately, contemporary lists of SFRs are often entirely or overwhelmingly comprised of state supreme court rulings and only occasionally include a handful of well-known legislative statutes.[1] This focus on the courts has likely occurred for two reasons. First, researchers interested in identifying causal effects have argued that the court orders were exogenous, or at least more exogenous relative to the passage of new legislation. Second, it is easier to identify court orders, as these are well-defined events, whereas educational legislation (e.g., in the form of budgets or spending) are passed nearly every year in nearly all states, making it difficult to parse which of these myriad bills would constitute an abrupt change in the state's role of funding schools. Nevertheless, the courts cannot collect revenues or make budgets, and so the first best political actor to follow is the legislature.

In addition to court cases failing to properly characterize the political economy of school finance reform, these lists of SFRs based primarily on court rulings are also both incomplete and surfeit. They are incomplete because there are states (e.g., Figure 1 and Shores et al., in press)

where large and abrupt changes to state-level spending occurred without a documented SFR or court ruling of any kind. They are surfeit because many of the court orders contained in these catalogues of SFRs did not result in any change in state-level spending or new legislation, and of those that did result in change, it is most likely that the change occurred after the court ruling (sometimes long after), as the legislature must convene before issuing new laws. Thus, a focus on the legislature provides a more accurate and complete understanding of state-level educational finance.

Understanding the actual processes by which states intervene in elementary-secondary education spending also allows us to answer more policy relevant questions. For example, do states that dramatically increase educational investments always follow court orders? If so, is there a typical length of time that it takes for investments to increase following rulings? When laws are passed to increase educational spending, are they always funded, so that budgets can be enacted quickly, or are there lags? And if there are lags, how long do they typically last? Moreover, what types of governing bodies and political arrangements are more likely to increase state investment? The recent SFR literature has not attempted to answer questions like these because it has largely presupposed that the courts are generative of change.

Lastly, there is an econometric implication from this changed focus onto the legislature and changepoints that warrant attention. As noted, this list of court orders is necessarily incomplete, meaning that a binary treatment variable indicating the presence of an SFR is measured with error. Mismeasurement of a binary treatment variable results in a well-known form of attenuation bias (Aigner, 1973; Card, 1996; Pishke, 2007), meaning that exclusively relying on court rulings is likely to lead to an underestimate of the true effect of SFRs on elementary and secondary spending.

Taking stock, the literature lacks a comprehensive investigation of the events that precede and catalyze increases in state education revenues, with implications for both policy and research methodology. We address this gap using a newly digitized, state-year panel of per pupil state education revenues spanning fiscal years 1960 to 2008 (before the Great Recession) and a Bayesian time series decomposition algorithm to identify which states-years positive changepoints in state education revenues have occurred. Next, focusing on the so-called adequacy era (i.e., post-1990) in school finance, we conducted a search using multiple sources of information to identify the state-level political events (i.e., legislative statutes, court rulings, constitutional amendments, and resource shocks) that preceded or coincided with our list of positive changepoints.

Previewing our results, spanning fiscal years 1960–2008, we find 108 positive changepoints occurring in 43 different states, with more changepoints occurring in the equity era (1960–1989) than the adequacy era (1990–2008)—65 and 43, respectively, though about 2 changepoints per year for both eras. Comparatively, the SFR literature has identified 112 SFR events across 39 states, with 37 and 75 occurring in the equity and adequacy eras, respectively. Despite the frequent occurrence of SFRs, the timing of changepoints and SFRs do not tend to overlap, and states with SFRs often do not have changepoints (and vice-versa). In the equity and adequacy eras, respectively, changepoints on average occur 7.5 and 3.6 years apart from their most proximal SFR, and about 40 percent of states in each era either had an SFR but no changepoint or had a changepoint but not an SFR. These results show that commonly used lists of SFRs are incomplete, often excessive, and unaligned with the timing of positive changepoints.

Further, these changepoints are predicted by state political factors, whereas SFRs are not. Notably, a changepoint is more likely to occur when there are party supermajorities at the state level, and the likelihood of a changepoint occurring is greater when there are Democratic supermajorities specifically. Then, leveraging changepoints as binary treatment indicators, we show that these changepoints predict larger increases in state educational spending relative to extant SFR lists, indicating that changepoints are less subject to attenuation bias relative to extant SFR indicators.

Perhaps most importantly, we comprehensively document the myriad ways states have dramatically transformed their educational finance systems, often in the pursuit of equity. Based on our review of the literature and an admittedly non-systematic understanding of public opinion, we suspect states' efforts are not fully understood and valued. One concern is that states will walk back these efforts if the scholarly community and public opinion broadly fail to recognize and encourage the important state-level education finance policies that have taken place, especially in the last three decades. At a minimum, this paper serves as a quantitative record of the deliberate policies states have undertaken to increase education funding.

The remainder of the paper is organized as follows: (i) conceptual framework, (ii) data, (iii) methods, (iv) results, and (v) conclusion.

Conceptual Framework

In this section, we first provide an overview of state involvement in education finance and then discuss the causes of changepoints that produce shifts in state investment in education. While the details discussed in the first part are established in the finance literature, we summarize them to contextualize our results.

Part I: The Role of States in Education Finance

State Constitutions

State constitutions set the foundation or ground rules for public elementary-secondary education in each state (Hanushek & Lindseth, 2009; Howell & Miller, 1997; Ladd & Hansen, 1999, p. 26; Odden & Picus, 2020, pp. 11–12). Every state constitution includes an education clause that defines the rights of citizens (and children), the duties of the state, and the characteristics of the education system that will be provided (Dallman & Nath, 2020; Parker, 2016; Shaw, 2022). However, there is cross-state variation in the specific wording used in constitutions to describe public school systems, which has consequences for how schools are funded in each state (Jenkins-Robinson, 2012, pp. 307-322; Shaw, 2022). Some state constitutions only require the establishment of a "free" or "common system" of education, while others include more detailed wording in their education provisions, such as "uniform", "efficient", "equal rights", and "high-quality education" (Dallman & Nath, 2020).

The language used in education clauses can be changed via constitutional amendments, which in turn, can alter how public elementary-secondary education is provided by states (Dinan, 2007). Amendments can be proposed by the legislature or, in some states, directly by citizens.[2] Between 1990 and 2018, a total of 312 amendments related to the education clause were proposed across the country. Of those 312 amendments, 193 were passed, 153 sought to add or amend language regarding education funding and expenditures, and 200 amendments specifically related to education funding passed (Dallman & Nath, 2020).

State Legislatures

State legislatures commit to and uphold the education clauses of their state constitutions by enacting laws that provide and fund elementary-secondary education (Eastman, 1998, 2006). State legislatures enact laws that establish school funding formulas, which determine the total

cost of educating students and stipulate the state's share of those costs (Chingos & Blagg, 2017; Skinner, 2019). Across the states, a common funding formula component is a foundation plan (Shores et al., in press; Verstegen & Knoeppel, 2012; Wood et al., 2019), which finances a minimum per pupil revenue level through both state and local effort. Local jurisdictions must finance their contribution—the local effort requirement—based on a required local minimum property tax; the state funds the remaining amount. In addition, state legislatures must also enact laws that establishing funding streams for education—typical state sources include income taxes, retail sales taxes, excise taxes such as those on alcohol and tobacco products, and revenues from state lotteries (Howell & Miller, 1997; Skinner, 2019).

Ultimately, state legislatures determine the magnitude of the state's contribution to K-12 education and how those contributions will be funded via taxes. Thus, changes to state legislative policy are the most likely cause of abrupt changes in state education spending or changepoints. Nevertheless, there are external forces that constrain (or enable) state education spending that are independent of legislative policy action. Here, we highlight four factors that constrain (or enable) state education funding, paying particular attention to those factors that can vary across states and over time.

Fiscal solvency. All states except Vermont have a balanced budget requirement, though the stringency of this requirement varies among states (Walczak & Cammenga, 2020). Thus, even when holding state education policies constant, the availability of revenues will determine how much funding there is for K-12 education (Orland & Cohen, 1995). Tax revenues vary over time and across states, thereby affecting the level of state education spending. State education funding has been shown to decline, for example, when economic recessions reduce state income and sales tax revenues (Biolsi et al., 2021; Evans et al., 2019; Jackson et al., 2021; Shores &

Steinberg, 2019; Sørensen & Yosha, 2001) and increase when the supply of taxable resources (e.g., shale oil) increases (Marchand & Weber, 2020).

Non-education obligations. States have obligations to other spending categories, and because of fiscal solvency, states must balance their commitments to both education and non-education goods. In particular, state commitments to higher education, public welfare and healthcare, highways and roads, and criminal justice limit how much revenues can be allocated to K-12 education (Baicker & Gordon, 2006; Murray et al., 2007; Shaw, 2022). Though elementary-secondary education is the second largest category of total state funding, on average, comprising 19 percent of total state expenditures (National Association of State Budget Officers, 2020), changes in demographics and other factors can cause states to change their commitments from education to other expenditure categories (e.g., Harris, et al., 2001; Murray, et al., 2007; Poterba, 1998), just as education spending can crowd out other expenditure categories (Baicker & Gordon, 2006; Liscow, 2018).

Sustaining taxpayer support for education. Fiscal solvency also means that state budgets must maintain a stable and reliable tax base. Taxpayers typically deride the property tax more than other taxes (e.g., the sales tax) because it has higher visibility: there is an annual tax bill that clearly articulates the property valuation, tax rate, and amount due (Chetty et al., 2009; Cabral & Hoxby, 2012). Thus, local property tax relief may be a goal of state legislatures, especially in states that require local effort to fund education (Picus et al., 2015). Holding total K-12 revenues constant, such policies require alternative funding streams (Baker, 2018; O'Sullivan, et al., pp. 5-7), which can materialize as an increase in state fiscal centralization and therefore state revenues contributions (e.g., Courant and Loeb, 1997). A prominent example of such a policy is New York's School Tax Relief (STAR) program, which provided property tax

relief in either the form of a check or through an exemption that reduced the school tax bill, with foregone property tax revenues reimbursed by the state (Baker, 2018, Eom & Rubenstein, 2006; Eom et al., 2014; Rockoff, 2010).

State Courts

The state-level judicial branch also plays an important, albeit indirect role, in education finance. The judicial system's primary function is "supervisory," meaning it is responsible for determining whether states legislatures are fulfilling their constitutional obligations to maintain and provide systems of public education (Obhof, 2019) but cannot enact laws, even if it finds specific state contributions to be constitutionally required.

State citizens have taken advantage of this supervisory function and asked the courts to force state legislatures to change how schools are funded. Since the early 1970's, 45 of the 50 state court systems have considered one or more court cases in which citizens have argued that the state has failed to provide equitable or adequate levels of funding necessary to comply with the educational provisions of their state constitutions.[3] Well-known court cases include *Serrano v. Priest* (1971) in California and *Rose v. Coucil for Better Education* (1989) in Kentucky. In total, between 1973 and the present, the court systems in 26 states have ruled that students have a legally enforceable right to "equity" or "adequacy" in school funding under their state's constitutions.[4]

Part II: Causes of Changepoints

We now have the tools to understand how changepoints in state educational investment can take place. In nearly all cases, a changepoint will require a state legislative body to pass a law that encodes a level of funding and a means by which to fund it. Thus, nearly all

changepoints must be precipitated by a statute, though statutes can also be precipitated by other events.

The only instance in which a changepoint can occur without a statute would be a shock to the state budget. Such budgetary shocks could increase state spending holding the law constant. Prominent examples of budgetary shocks have occurred when states either expanded natural resource extraction (e.g., shale oil in Pennsylvania and Texas) or when the price of a natural resource fluctuated due to macroeconomic factors (e.g., Newell and Raimi, 2015; Marchand and Weber, 2020). For these events to be exclusively resource shocks, the state would need to have already been taxing resource extraction and what changed is the price or supply of the extracted resource.

In all other cases, state budgets can only abruptly change when statutes are passed that change how much the state contributes to K-12 education. These statutes can be induced by other means, most notably by constitutional amendments or court rulings. Examples of increased state education investments following state constitutional amendments can be found in Michigan and Florida. In March 1994, Michigan's state legislature referred and state citizens approved of a constitutional amendment, Proposal A, which amended the tax system (specified in Title IX of the Michigan constitution) that raised revenues for schools. Specifically, Proposal A increased sales and use taxes, as well as a mix of other state taxes (e.g., real estate taxes, taxes on alcohol and cigarettes), which were then earmarked for the state School Aid Fund. Similarly, in 2002, state citizens approved an amendment to the Florida Constitution that set class size limits in public elementary-secondary schools. In turn, the Florida Legislature was legally obligated (under Article IX, section 1 of the Florida Constitution) to provide funds to reduce the average number of students in each classroom, with an estimated cost of about about $20 billion over the

first eight years, with continuing operating costs of about $4 billion per year in subsequent years (Chingos, 2012).

Finally, as has been well documented (e.g., Baker, 2018; Hanushek & Lindseth, 2009), the courts can also initiate changes to state educational spending by ruling that the current system violates the state constitution. The most well-known cases of the courts acting in this way are Serrano (1971) and Kentucky Rose (1989), but the courts have ruled many more times in many states across the U.S. And while there is ample evidence that these court orders did ultimately increase educational spending (Candelaria & Shores, 2019; Corcoran & Evans, 2015; Jackson, Johnson, Persico, 2016; Shores et al., in press), it is necessarily the case that the sequence of events included legislative activity either coinciding with or following court order to induce a changepoint.

Data

Identification of changepoints in state education funding, on which our search for policy changes and events relies, requires a time series of state funding data. We leverage an annual, state-level panel of state education revenues and student enrollment data from fiscal years [Fys] 1959-1960 to 2007-08. We only use data up to the 2007-08 school year to limit our detection of positive changepoints to years before the Great Recession occurred. For FYs 1986-87 to 2007-08, we obtain revenues and enrollment data from the National Public Education Financial Survey [NPEFS], which is distributed by the National Center for Education Statistics [NCES]. Revenues and enrollment data from FYs 1959-60 to 1985-86 were obtained from U.S. Department of Education [DOE] and NCES series reports, including *Digest of Education Statistics* and *Statistics of State School Systems*. These reports are the predecessors of NCES' Common Core of Data [CCD]. Data from these reports were hand-entered by either Paglayan (2019) or the authors

because they had not been previously digitized. Further details on the compilation of and sources for the annual panel dataset can be found in Appendix Table A1.

State education revenues are defined as revenues given to districts by the state and include unrestricted grants-in-aid, restricted grants-in-aid, revenue in lieu of taxes, and payments for, or on behalf of, districts. Federal revenue distributed by state governments is not included in our measure of state education revenues. State student enrollment represents the total count of students enrolled in public elementary or secondary schools (in grades pre-Kindergarten through grade 12) in the Fall (typically October 1) of the academic year. State education revenues are transformed into 2017 USD using the *cpiget* Stata command (Shores & Candelaria, 2019)—nominal dollars were transformed into real dollars using an annual average of monthly Consumer Price Index data over the academic year (i.e., July 1 to June 30). We then divided these inflation-adjusted amounts by state student enrollment to provide per-pupil measures.

We also draw upon a tabulation of documented court-ordered and legislative SFRs throughout our analyses. Our tabulation is a compilation of the SFR lists used in Hoxby (2001), Jackson et al. (2016), Lafortune et al. (2018), Liscow (2018), and Shores et al. (in press).[5] These lists often report the date of an SFR in calendar years; however, the time series of state education revenues data used in this paper is in fiscal years. As such, for each documented SFR included in our compiled tabulation, we gathered the month and year in which the SFR occurred and converted the date into fiscal years. Our compiled tabulation includes documented court-ordered and legislative SFRs that occurred between FYs 1972 and 2014.

To assess whether state partisan factors predict the occurrence of positive changepoints, we use a state-year panel compiled by Klarner (2013) that includes measures of (i) whether a state is controlled by a single party, (ii) whether a state governor is Republican or Democrat, (iii)

whether a supermajority is present to change tax law, and (iv) whether a supermajority is present to pass a budget. For our analyses, we specifically use data from Fys 1987 to 2010.

Lastly, to understand the consequences for causal estimation when researchers use incomplete lists of SFRs, we estimate the effect of SFRs and changepoints on state education spending, tax revenues, and non-education spending. For these analyses, we use the Annual Survey of State Government Finances to obtain data from Fys 1987 to 2008 on state K-12 educational expenditures, tax revenues, and non-educational expenditures, where non-education expenditures include all state expenditures besides expenditures on elementary-secondary education (e.g., expenditures on health and hospitals, higher education, highways, corrections, and welfare). The survey is collected by the U.S. Census Bureau and has been compiled into a panel dataset, the Government Finance Database, by Pierson et al. (2015). We scale these data by state student enrollment and transform all dollar values into 2017 USD (Shores and Candelaria, 2019).

Methods

Our approach is to quantitatively identify changepoints among all states for Fys 1960 to 2008, identify the subset of changepoints that positively increased state educational investment, and document the events that explain how the changepoint occurred for a state in a given year among the subset of positive changepoints that occurred between FYs 1990 to 2008. We describe these steps in detail below.

Quantitative Identification of Changepoints

To detect changepoints in the per pupil state education funding time series data, we use a Bayesian decomposition algorithm called BEAST [A Bayesian Estimator of Abrupt change, Seasonal change, and Trend], developed by Zhao et al. (2019). In what follows, we discuss the

BEAST algorithm in further detail and why we chose it over other time series decomposition methods. Then we discuss the application of BEAST specifically to our state education funding time series data to identify positive changepoints.

In general, decomposition methods decompose a time series into three model components: time trends, which reflect the long-term progression of the series; intercept or trend changes at specific points in the time series, referred to hereafter as "changepoints"; and random error. However, a large or infinite number of model decompositions based on various algorithms can be applied to any one time series; see Aminikhanghahi & Cook (2017) or Burg & Williams (2020) for an overview of decomposition methods. For example, the trend component alone can be parameterized and approximated by a multitude of linear, piecewise-linear, or polynomial specifications. Decomposition methods that are based on frequentist statistics typically try to choose one so-called "single-best" model from among the infinite number of model decompositions using certain selection criteria, such as Akaike's information criterion (AIC) or the Bayesian information criterion (BIC). Nevertheless, various "best" models can be chosen for the same time series depending on the selection criteria used.

To overcome these issues, we use a Bayesian algorithm for time series decomposition called BEAST [A Bayesian Estimator of Abrupt change, Seasonal change, and Trend] (Zhao et al., 2019). Unlike frequentist methods that choose only a single best model, BEAST synthesizes across a large proportion of the almost infinite number of possible model decompositions using a weighted average model. As illustrated in Figure 2, BEAST specifically decomposes a given time series into trend, changepoint, and error components via numerous competing models.[6] In the Bayesian perspective, all these models potentially provide useful information about the true model, which is never observed; as such, synthesizing these models is often better than choosing

a single best model. BEAST quantifies the usefulness of models by assigning each model decomposition a probability of being the true model. Then, the BEAST algorithm uses these probabilities as weights to combine all models into one weighted average model. Applying the weighted average model to a given time series, BEAST can estimate the fitted trend and changepoint components, as well as "uncertainty intervals," which represent an estimated range of years a changepoint may occur. Averaging across many models helps BEAST to capture model uncertainty, reduce concerns regarding model misspecification, and improve the modeling of complex data (Zhao et al., 2019). We decompose each of the fifty per pupil state revenue time series, that span the years 1960 to 2008, individually using the BEAST algorithm.[7, 8]

[FIGURE 2 ABOUT HERE]

Identifying Changepoints for Positive Increases in State Spending

The BEAST algorithm identifies changepoints at specific points in the time series. The algorithm can identify intercept changes (e.g., abrupt changes between time *t* and time *t+1*) or trend changes (e.g., more gradual changes that occur over multiple time points), as well as both positive or negative trend deviations (i.e., increases or decreases in trend), in the time series as changepoints. In this essay, we are specifically concerned with identifying policy changes and events associated with positive deviations in state elementary-secondary education investments. Thus, we limit our selected sample of changepoints and our search for events to the years in which positive changepoints occurred (i.e., we do not include negative changepoints in our selected sample, nor do we search for events associated with negative changepoints).

Because the BEAST algorithm does not provide information on whether identified changepoints are reflective of positive or negative changes in trend, we define a positive changepoint as an identified changepoint that coincides with a positive deviation in the trend line

fitted by BEAST. In technical terms, we are interested in identified changepoints at year *t* that are associated with a positive second difference, meaning the rate of change or slope of the fitted trend line between year *t* and year *t-1* is greater than (i.e., more positive) than the rate of change of the fitted trend line between year *t-1* and year *t-2*. We calculate the second difference, $\hat{\delta}_{st}$, associated with a changepoint in the time series of state *s* in year *t* as follows,

$$\hat{\delta}_{st} = \left(\hat{Y}_{st} - \hat{Y}_{s,t-1} \right) - \left(\hat{Y}_{s,t-1} - \hat{Y}_{s,t-2} \right),$$

Where $\hat{Y}_{st}$ represents the fitted trend value estimated by BEAST. Changepoints identified by the BEAST algorithm that are associated with a second difference value that is greater than zero are considered positive and are included in our selected sample.

A visual depiction of positive and negative changepoints and when they occur is shown below in Figure 3 based on New Hampshire's time series of per pupil state revenues. The grey dotted line indicates per pupil state education revenues and the purple line indicates the fitted trend line estimated by BEAST. Green and red vertical lines represent the years in which positive and negative changepoints occur, respectively, and yellow background shading indicates uncertainty intervals associated with changepoints. The changepoint at FY 2000 is considered positive, as the slope of the fitted trend line between FY 1999 and 2000 is greater in magnitude (i.e., more positive) than the slope of the fitted trend line between FY 1998 and 1999. Thus, the changepoint coincides with a positive trend deviation and is colored green (and is included in our selected sample of positive changepoints). In contrast, the changepoint at FY 2005 coincides with a negative trend deviation, as the slope of the fitted trend line between FY 2005 and 2004 is smaller in magnitude (i.e., less positive) than the slope of the fitted trend line between FY 2004 and 2003. As such, the changepoint at FY 2005 is classified as negative and colored red (and is not included in our selected sample).

[FIGURE 3 ABOUT HERE]

Documentation of Events Explaining Changepoints

Despite the sophistication of BEAST, it is still possible that identified changepoints are spurious or, more generally, not attributable to an observable event (e.g., a legislative statute). We therefore complement the quantitative analysis with a thorough search to identify events that can plausibly be attributed to the observed changepoint. We used multiple types of resources to conduct this search with the goal of identifying state-level events that precede or coincide with the years at which positive changepoints in per pupil state education revenues occurred during the adequacy era (i.e., 1991-2008). Though we identify changepoints for a much longer panel, going back to FY 1960, we focus on the adequacy era for the identification of specific events. Practically, it is much more difficult to identify specific legislation text for multiple states prior to 1990. Further, there is less utility for current policymaking for events predating the 1990s, as tax policy and state obligations as described by state constitutions have changed dramatically (Hanushek & Lindseth, 2009).

Our goal in conducting this search is to identify key events that explain how increases in state education revenues occurred. Our search process is described in Figure 4 below. To briefly summarize, we sought legislative statutes that preceded the changepoint by no more than five years. If a statute was identified, we noted whether either of two conditions were met: the statute explicated a change in budget that corresponded to approximately at least 50 percent of the change in revenues detected by the changepoint or if a new funding formula was introduced.[9] If we could not find at least one statute that fit either of these criteria for a given changepoint, we would expand our search to look after the identified changepoint, with the idea that changepoints can include trend changes as well, and thus may be caused by the passage of multiple statutes

over a longer period of time. We applied the same inclusion criteria for statutes occurring after the changepoint.[10]

This process completed our compilation of statutes that could plausibly be attributed to positive changepoints. In total, we found plausible statutes for all but five changepoints beginning in FY 1990. For Alaska (2006), Maine (1999; 2007), Nevada (1991), Oklahoma (1997), and Pennsylvania (2000) we could not identify a statute that could plausibly explain the changepoint. For Alaska, as we show below, the positive changepoint is very likely explained by the state's petroleum revenues and fluctuations in oil prices, but for the other states the positive changepoint appears to either be a false positive or, more generally, not attributable to events that fit our search criteria.

To supplement this list, we also attempted to provide additional description related to prior legislative efforts and court activity that preceded both the changepoint and the identified legislative statute tied to the changepoint. This process was less rigorous, since, for example, no fixed criteria would determine whether a court ruling was tied to a subsequent statute unless the statute referenced the court case explicitly. Our goal in generating this list was to illustrate the diverse and complex processes states underwent before experiencing a changepoint, but we do not assume that this documented process exhaustively describes all the activities that states underwent. Additional details about this supplemental process are shown in Appendix B.

[FIGURE 4 ABOUT HERE]

Results

Positive Changepoints in the Equity (1960-1990) & Adequacy Eras (1991-2008)

Table 1 lists the states identified as having positive changepoints in per pupil state education revenues between FYs 1960 and 2008, as well as the specific years in which the

positive changepoints occurred.[11] In the equity era (FYs 1960 to 1990), we identify 65 positive changepoints across 35 states, with 14 (40%) of those states experiencing 1 changepoint and the other 21 states (60%) experiencing multiple. In the adequacy era prior to the Great Recession (i.e., 1991-2008), we identify 43 positive changepoints across 35 states' time series, with 28 (80%) of those states experiencing 1 positive changepoint and 7 (20%) experiencing multiple changepoints.[12]

We can also compare our changepoint estimates to extant tabulations of SFRs.[13] The SFR literature has identified 112 SFR events across 39 states, with many more events occurring in the adequacy era relative to the equity era (75 SFRs in 28 states versus 37 SFRs in 30 states). The timing of changepoints and SFRs do not overlap substantially, and states with SFRs often do not have changepoints (and vice-versa). In the equity and adequacy eras, respectively, changepoints on average occurred 7.5 and 3.6 years apart from their most proximal SFR. For 12 states (10 in the equity era and 2 in the adequacy era) more than 10 years separate the most proximal SFR from an identified changepoint. Moreover, the relative proximity of SFRs to changepoints, especially in the adequacy era, is exaggerated since each state, on average, has three SFRs compared to one changepoint. Lastly, we should be careful interpreting the total number of states with SFRs and changepoints, as this does not imply that the same states have SFRs and changepoints. Indeed, about one-quarter of states in each era had a changepoint but not an SFR, while 14% of states in each era had a documented SFR but no changepoint. These results show that the list of SFRs is incomplete, often excessive, and misaligned with the timing of positive changepoints.

[TABLE 1 ABOUT HERE]

Events Motivating Positive Changepoints in the Adequacy Era

Following the identification of positive changepoints, we conducted a search to identify state-level political events in the adequacy era that preceded or coincided with the years at which positive changepoints in per pupil state education revenues occurred during the adequacy era. In total, 80 events were found to be associated with 38 of the 43 (88%) positive changepoints. Events associated with five changepoints were unable to be determined; the five changepoints that we were unable to identify preceding events for occurred in the following states and years: Maine, 1999; Maine, 2007; Nevada, 1991; Oklahoma, 1997; and Pennsylvania, 2000.

Figure 5 characterizes the results of our search process by displaying the sequence of key events—legislative act, court activity, constitutional amendment, or resource shocks—identified as preceding each positive changepoint. Appendix Table E1 complements the figure by including the specific names of the events identified as motivating positive changepoints.[14] In line with the goals of our search process, Figure 5 illustrates that positive changepoints are almost always preceded by legislative acts and legislative acts are prompted by count activity in several states.

More generally, Figure 5 illustrates the diversity of sequences states undergo before changepoints occur. For some states, changepoints are precipitated by statute, which are in turn immediately precipitated by a court ruling; for other states, there is a much longer iterative process of rulings and statutes before changepoints occur; still for other states, changepoints and statutes occur concurrently with no historical evidence suggesting such an event was on the horizon. Overall, the results so far show that nearly all states have made concrete policy choices to substantially increase state investment in education, which indicates a type of homophily in state education finance policy. Yet, states are also very heterogeneous in how they arrived at

changepoints, suggesting that states may still be able to learn from each other to arrive at desired changepoints more expeditiously.

[FIGURE 5 ABOUT HERE]

Legislative activity motivates nearly all changepoints

Legislative acts nearly always precede or coincide with positive changepoints in per pupil state education revenues. Of the 38 changepoints for which we were able to identify preceding events, 37 (97%) were motivated by a legislative statute mandating increased state aid for education either through the passage of a bill by the House or Senate, or through the legislature referring a referendum to be voted on by state citizens. The prevalence of legislative activity prior to significant increases in state education funding is expected, given that state legislatures are the government body tasked with appropriating state funding for education and other state priorities.

Though statutes consistently predicate positive changepoints in states, there is substantial variation in what the increased state education funding was specifically appropriated for. In the case of some changepoints, the legislature appropriated more state aid for education to adequately fund a new school funding formula that was implemented. For example, Nebraska's FY 1999 changepoint was preceded by the Nebraska legislature passing Legislative Bill 806 in FY 1997, which altered the funding formula for calculating state aid and increased appropriations for elementary-secondary education by $110 million. Similarly, prior to its changepoint in FY 1997, Wisconsin's legislature passed Act 27 in FY 1996, which modified the state school funding formula to a three-tiered equalization plan and mandated that the state provide two-thirds funding of schools (the state was only providing 48% of funding in 1994).[15]

In other cases, increased state appropriations for education via legislative activity were related to local property tax relief. For example, New York's FY 1999 changepoint was preceded by the 1998 enactment of the School Tax Relief [STAR] program (see Real Property Tax Law, Section 425), which reduced local property tax rates and increased state education funding to reimburse districts for the foregone tax revenue.[16] In other cases, statutes worked to increase school construction and capital improvement funding, such as in Florida. Under Florida's FY 1998 House Bill 17-A [The Public School Capital Outlay Program Act], the legislature agreed to dedicate $2.7 billion in state funds over five years to build and repair schools, which coincided with the state's FY 1999 changepoint in education revenues.[17] Statutes also precede changepoints designed to reduce class sizes, as took place for example in Nebraska's 1991 Legislative Bill 1059 "Tax Equity and Educational Opportunities Support Act" (TEEOSA), or to expand school choice options, as took place in Connecticut's 1999 bill Public Act 97-290 "Enhancing Educational Choices and Opportunities."

Court activity prompts legislative activity

As described above, legislative statutes are almost always the antecedent to positive changepoints in state revenues. However, we find that legislative activity related to increased state appropriations for education is often preceded by court activity, suggesting that legislation (and subsequent changepoints) is in many cases "litigation-prompted." Specifically, court activity, followed by a legislative act, occurred proximal to 22 of the 38 changepoints (58%). Examples of court activity include the preliminary act of filing a court case, as well as actual court rulings that either uphold or require changes to a state's finance system. We discuss each of these types of court activity below and their prevalence prior to changepoints.

In most cases in which court activity and legislative activity preceded a changepoint, state legislatures were compelled to pass an act that changed their school finance system because of a court order. For example, Missouri's FY 1996 changepoint was preceded by the January 1993 *Committee for Educational Equality v. State* court ruling, in which the court declared Missouri's school funding system unconstitutional and that the state must provide the same educational opportunity to children living in rich and poor districts. Following the court ruling, the state legislature passed Senate Bill 380 in August 1993. The bill enacted a foundation funding formula, as well as increased school funding and improved funding equity by raising taxes. Similarly, New Hampshire's FY 2000 changepoint occurred following court-ordered legislative activity. In the 1997 *Claremont v. Governor II*, the court ruled that New Hampshire's education finance system was unconstitutional because it enabled inequitable local property tax rates and fostered inadequate educational opportunities. In April of 1999, the New Hampshire state legislature passed House Bill 117, which changed the state school funding formula to a foundation program. The bill also established a statewide property tax and raised a variety of other state taxes to provide additional state education funding.[18]

In the case of five other changepoints, we find evidence that legislative acts were passed following the *filing* of a court case (i.e., prior to a potential court ruling), suggesting that the threat of court order is sometimes enough to motivate legislative action. Kansas' 1994 changepoint was preceded by such court-threatened legislative activity. In October 1991, the judge associated with the *Mock v. State* Kansas court case indicated in a pre-trial ruling that if the case went to trial, he would likely declare that Kansas' school funding formula violated the state constitution's requirement that the legislature "make suitable provision for finance of the educational interests of the state." Approximately seven months following the pre-trial ruling, the

Kansas legislature implemented a new school funding formula via the School District Finance & Quality Performance Act [SDFQPA]. The SDFQPA established a foundation aid plan, increased state education funding through raising state tax revenues, and reduced local property tax burdens by imposing a uniform local property tax rate.[19]

Lastly, legislative activity related to increases or changepoints in state education revenues sometimes followed "unsuccessful" court activity. Specifically, in the case of four changepoints, a statute was passed after a dismissed court case or a court ruling in favor of the defendant (i.e., the states). Oregon's 1992 changepoint is illustrative of a situation in which a court case unsuccessfully challenged the state finance system, yet legislative activity followed thereafter. In *Coalition for Equitable School Funding v. State* (1991), the plaintiffs argued that Oregon's education finance system violated the state constitution on "equity" grounds; however, the court upheld the school finance system. In that same year, the legislature passed Senate Bill 814, which created a new equalization formula for distributing state aid. In addition, the bill allocated approximately $9.6 million in state funds to local districts in 1992 to offset loss of local property taxes. Thus, the legislature still acted to increase state education funding, even though they were not compelled to do so by the court.[20]

Constitutional amendments & changepoints

We do find that, in a handful of situations, amendments to state constitutions precede changepoints in state education revenues. Of the 38 changepoints that we were able to identify preceding events for, 3 (8%) were preceded by a constitutional amendment in addition to legislative activity. Michigan's FY 1995 changepoint followed the well-known FY 1994 Proposal A constitutional amendment (we provided a brief description of Proposal A previously in the background section of the paper). In addition, Oregon's FY 1992 changepoint was

preceded by the Measure 5 constitutional amendment in FY 1991, which limited local property tax rates and required the state to increase state education funding to replace lost property tax revenues. Colorado's FY 2003 changepoint was preceded by Amendment 23 [Colorado Funding for Public Schools Initiative] in FY 2000, which mandated various increases to state education funding. Both Oregon and Colorado's constitutional amendments were initiated by state citizens (as opposed to initiation by the state legislature, as was the case in Michigan), suggesting that constitutional amendments offer another means through which citizens can influence state education spending outside of the courts.

Budget Shocks: The Case of Alaska

Only one of the 38 positive changepoints (3%) was *not* preceded by legislative activity but rather a budgetary shock. This one positive changepoint occurred in Alaska in FY 2006. Alaska is unique in that 80-90% of their general fund revenues comes from taxes and fees on oil production (Silverstein et al., 2015). No other state in the nation is as highly dependent on resource/energy production for state revenues—and by extension, elementary-secondary state education funding. Changes in world oil prices and production have a major impact on Alaska's state budget and state aid for education. As shown in Figure 6 below, when state general revenues are increasing because of high oil prices and production, state education revenues also tend to increase, and when state revenues decline as oil prices and production drop, so do state education revenues. Notably, Alaska experienced rising general and state education revenues from Fys 2002-2008, which coincides with the FY 2006 changepoint in state revenues detected by the BEAST algorithm. We thus attribute Alaska's FY 2006 changepoint to a resource shock, specifically, rising oil production. We also note that we did not find any evidence of any policy

change (legislative activity, court activity, or a constitutional amendment) in Alaska in the years around the FY 2006 changepoint.

[FIGURE 6 ABOUT HERE]

Empirical Test of Explanatory Events

The preceding discussion identifies a set of changepoints occurring in specific states and years. These changepoints modestly correspond to previously identified SFR events but with time points that are often delayed relative to the identified SFR event and occur more frequently and in more states than has been previously documented. Here, we wish to empirically show that the probability of a changepoint is associated with statutes and not court rulings, but that court rulings predict statutes. To this end, we fit regression models of the following form:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it-1} + \beta_3 X_{it-2} + \Theta_s + \psi_t + e_{it} \quad (1)$$

where Y_{it} is a binary variable equal to 1 if a changepoint (or statute) occurred and 0 otherwise, and X_{it} is a binary variable equal to 1 if a statute or court order was placed and 0 otherwise. We include first and second lags of this predictor to control for dynamics in the passage of statutes or court orders as well as state (Θ_s) and year (ψ_t) fixed effects. All model standard errors account for clustering within states. In Table 2, we report coefficients for X_{it}. In Model [1], X_{it} represents statutes; in Model [2] X_{it} represents court orders; in Model [3], we include both statute and court order indicators, and in Model [4] the dependent variable is a statute and is predicted by court order.

In summary, we find that statutes do predict changepoints—passage of a bill increases the probability of a changepoint occurring by 12 to 14 percentage points—whereas court orders do not. However, court orders do predict statutes—a court ruling increases the probability of a statute being passed by 49 percentage points.[21] Overall, these results demonstrate what was

apparent to the eye in Figure 5: changepoints are preceded by statutes and statutes are preceded by court rulings.

[TABLE 2 ABOUT HERE]

Political Predictors of Changepoints

What factors give rise to changepoints? We conduct a test of a political hypothesis to see whether changepoints are more likely when states have a government under party control and whether the party with control explains heterogeneity. To accomplish this test, we estimate Equation (1) above but include political variables as predictors of changepoints. We include the following indicators, included separately in seven separate regression: (i) whether the state is controlled by a single party, (ii) whether the state is controlled by the Republican or Democrat party, (iii) whether the governor is Republican or Democrat, (iv) whether a supermajority is present to change tax law, (v) whether the Republican or Democrat party has supermajority to change tax law, (vi) whether a supermajority is present to pass a budget, and (vii) whether the Republican or Democrat party has supermajority to pass a budget. All models again control for first and second lags of the predictor plus state and year effects and account for serial correlation by clustering standard errors at the state level. Results are shown in Table 3.

True party control increases the likelihood of a changepoint occurring but neither governor party nor supermajority do. Having true party control of the state increases the probability of a changepoint occurring by 4.5 percentage points; having a Democrat party in control of the state increases the probability of a changepoint occurring by 8 percentage points, whereas Republican party control does not statistically significantly predict changepoints. The test of equality between these two coefficients cannot be rejected, however. Notably, these same political variables that predict changepoints do not predict SFRs (see Appendix Table F4).

Lastly, party control of the Governor does not differentially predict changepoint occurrences, nor does legislative supermajority to pass taxes or budgets.[22]

[TABLE 3 ABOUT HERE]

Econometric Consequences of Mis-classification

It is known that mis-classification of a binary treatment variable (e.g., by including treated units as controls) can result in biased estimation the treatment effect, depending on the magnitude of the mis-classification (Aigner, 1973; Card, 1996; Pishke, 2007). We investigate this source of bias by estimating two types of difference-in-differences models—the estimator by Callaway and Sant-Anna (2021) [CS] and the imputation estimator by Borusyak, Jaravel, and Spiess (2021) [BJS]—using the following two treatment variables: SFR event indicators and changepoint indicators. Both estimators flexibly control for treatment effect heterogeneity and use both never-treated and not-yet treated states as controls while excluding always-treated units.

SFR events are based on the compiled list of court cases and legislative statutes used by Lafortune et al. (2018) and Shores et al. (in press). Positive changepoints are based on those identified by BEAST and restricted to those that occurred post-1990. For outcomes, we use panel data on K-12 state revenues per pupil (our dependent variable used to identify changepoints) as well as elementary-secondary educational expenditures per pupil, tax revenues per pupil, and non-educational expenditures per pupil. All dollars are CPI adjusted for the 2016–17 school year. Results are shown in Table 4.

With respect to K-12 state revenues and K-12 expenditures, we have evidence of attenuation bias. SFR event effect sizes for the CS and BJS estimators are small in magnitude and are not statistically different from zero. However, the changepoint effect size is between

$853 to $904 for K-12 state revenues and $639 to $704 for K-12 expenditures Both are statistically significant at at least the 5 percent level.[23]

For tax revenues per pupil we see less evidence of attenuation and results are more sensitive to which estimator is used. Using the Callaway and Sant'Anna (2021) estimator, both SFRs and changepoints increase tax revenues per pupil by about $750, though this result is not statistically significant. Using the Borusyak, et al. (2021) estimator, SFRs increase tax revenues per pupil by $481, while changepoints increase tax revenues by $1,179, which would be evidence of attenuation. We find no evidence that SFRs or changepoints increase non-education expenditures.

[TABLE 4 ABOUT HERE]

Conclusion

What, ultimately, is a school finance reform? We have offered one definition, which is that a school finance reform can be said to occur when a state abruptly increases spending on K-12 education. We have also presented a methodology for identifying when such SFRs occur; namely, when quantitative changepoints occur and can then be plausibly linked to legislation, constitutional amendments, or resource shocks that gives rise to the change. We think this formulation and methodology is an improvement on the extant literature since it privileges legislation over more easily observable court-rulings while recognizing the importance of the courts in motivating such legislative action.

This framework and empirical methodology have also generated numerous new insights into school finance. First, there has been much more state political activity, manifested in state investments in education, than has been previously documented. Though this might suggest homophily, the reality is that these state investments reflect a diverse array of policy goals and,

perhaps more importantly, processes. States rarely arrive at changepoints following the same sequence of events. To the extent that processes with shorter timelines or less reliance on the courts to initiate statute-to-changepoint outcomes are less disruptive or more effective, our results suggest states have much to learn from each other about reforming their education finance systems.

Second, despite all this state-level activity, a plausible interpretation of these data is that the states have not initiated school finance reforms—and thereby changepoints—uncompelled. This interpretation is because court activity, including both supreme court rulings as well as lawsuits, increases the probability of an antecedent legislative statute by nearly 50 percentage points. Thus, states are willing to make substantial change, but they often need to be coerced into doing it. Activists and policymakers should be mindful of this as budgets recede during fiscal crises, such as occurred during the Great Recession and the COVID-19 pandemic, as K-12 education spending may not immediately return to pre-crisis levels without pressure from external stakeholders. Similarly, partisan control and Democratic partisan control specifically are important political factors giving rise to change.

Lastly, we wish to highlight two limitations of this study. First, we focused on state investments in education because this outcome represented an immediate policy outcome observable over an extended time horizon (1960–2008) that could plausibly be attributed to state-level equity goals. However, state investments in education are only an indirect measure of equity, and it would be possible to identify changepoints in equality directly (e.g., measured as differences in spending between high- and low-income districts), which could then be linked to state policy events. This approach has notable limitations; namely, the time-dimension would need to be reduced to the post-1990 era, since it would rely on district-level data, and there

would be more noise in the data, giving rise to unreliable identification of changepoints. Nevertheless, we think such an exercise could be fruitful. Second, an outstanding question is the extent to which these changepoints can be attributed in a causal sense to changes in student academic outcomes. Though the recent literature on the causal effects of school spending on student learning is quite robust (see, for example, Jackson & Mackevicius, 2021), it would still be useful to know whether the changepoints identified here have yielded similar benefits to student learning.

Taken together, we believe this paper provides a useful new framework and methodology for thinking about state finance policy, generates multiple useful facts about school finance policy over a long time-horizon, and raises additional questions that would be useful for researchers and policymakers to pursue.

Notes

[1] Studies that rely upon SFR lists comprised entirely of court rulings include Murray et al. (1998), Card and Payne (2002), Corcoran and Evans (2015), Jackson et al. (2016), Liscow (2018), and Candelaria and Shores (2019). Studies that use SFR lists comprised mainly of court orders, but also some legislative statutes, include Hoxby (2001), Lafortune et al. (2018), Brunner et al. (2020), and Shores et al. (in press).

[2] The legislature-initiated constitutional amendment process begins with the legislature passing an act that proposes changes to the state constitution. Citizens then vote on the proposed amendment. In contrast, a citizen-initiated amendment process begins with citizens proposing an amendment and collecting signatures via petition to put the proposal on the ballot. If enough signatures are obtained, citizens then vote on the proposed amendment. Legislature-initiated amendments are allowed in all states, whereas only 18 states currently allow citizen-initiated amendments (Dallman & Nath, 2020).

[3] See http://www.schoolfunding.info/ for a map of the 45 states with school-funding court decisions as of January 2022, as well as for further details on education-finance litigation in each state.

[4] See http://www.schoolfunding.info/ for a map of the 26 states that have ruled that students have a legally enforceable right to "equity" or "adequacy" in school funding as of January 2022.

[5] The list in Shores et al. (in press) includes both court-ordered and legislative SFRs that occurred between academic years 1990 and 2012. The list in Lafortune et al. (2018) includes both court-ordered and legislative SFRs that occurred between calendar years 1990 and 2011. The list in Liscow (2018) includes court-ordered SFRs that occurred between calendar years 1971 and 2013. The list in Jackson et al. (2016) includes court-ordered SFRs that occurred between calendar years 1971 and 2010. The list in Hoxby (2011) includes both court-ordered and legislative SFRs that occurred between calendar years 1972 and 1989.

[6] BEAST can also identify a seasonal trend component if desired; however, our data are at the annual level, so we do not use this feature.

[7] The unique weighted average model decomposition applied to each time series was synthesized across 5 million "competing" models.

[8] We also used the BEAST algorithm to decompose per pupil state revenues time series data from 1960 to 2017 (i.e., the full panel) and found similar results to those obtained from our decompositions of the pre-recession (i.e., 1960 to 2008) per pupil state revenues time series data. For example, 158 changepoints were identified in the time series decompositions using the pre-recession panel. Of those 158 changepoints, 131 (83%) were also identified in the exact same or similar (i.e., within the confidence interval associated with the changepoint) year in the time series decompositions using the full panel.

[9] We chose five years to allow for statutes with longer budget periods and because the confidence interval from the Bayesian algorithm included about five years of data. The change in revenues is based on the observed or predicted increase relative to the change preceding the changepoint, and a new funding formula would be observed if, for example, a foundation plan was introduced, or if a new categorical aid category was created, or if the foundation plan allotment was increased.

[10] Post-changepoint legislation was observed only for New Mexico.

[11] Appendix D contains figures that visually depict the occurrence of both positive and negative changepoints in each state's time series between FYs 1960 and 2008.
[12] In total, 108 positive changepoints occurred in 43 states between FYs 1960 and 2008.
[13] In Appendix Table B1 we provide the full list of positive changepoints for FYs 1960–2008 along with all identified SFRs from Shores et al. (in press), Liscow (2018), Jackson et al. (2016), and Hoxby (2011).
[14] We also created an Excel spreadsheet that contains additional details—such as data related to our inclusion criteria—for the court and legislative events preceding positive changepoints. We indicate whether the legislation created a new foundation plan or expansion of an existing plan or, when available, the dollar amount the new legislation provided. We further detail the changepoint magnitude – i.e., how much state revenues per pupil increased at the onset of the changepoint. The Excel spreadsheet will be publicly posted on a website when this manuscript is published; however, a draft copy is available now, upon request, from the authors.
[15] See Appendix Table C1 for other examples of changepoints preceded by legislative activity related to funding formula changes, such as Kansas' FY 1994 changepoint, Kentucky's FY 1991 changepoint, Maryland's FY 2005 changepoint, and New Hampshire's FY 2000 changepoint. .
[16] See Appendix Table C1 for other examples of changepoints preceded by legislative activity related to property tax relief, including South Dakota's FY 1997 changepoint, South Carolina's FY 1996 changepoint, Oregon's FY 1991 changepoint, Nebraska's FY 1991 changepoint, and Michigan's FY 1994 changepoint.
[17] See Appendix Table C1 for other examples of changepoints preceded by legislative activity related to school construction and capital improvement funding, including North Carolina's FY 1998 changepoint, Colorado's FY 2003 changepoint, and Texas' FY 1998 changepoint.
[18] Additional examples of court-ordered legislative activity can be found in Appendix Table C1 by referencing changepoints in the following states and fiscal years: Colorado 2003, Connecticut 1999, Kentucky 1991, Maryland 2005, Michigan 2001, Montana 2006, New Mexico 1994, North Dakota 1995, Ohio 2002, and Vermont 1999.
[19] Additional examples of court-threatened legislative activity can be found in Appendix Table C1 by referencing changepoints in the following states and years: Nebraska 1991, Ohio 1996, South Carolina 1996, and Tennessee 1992.
[20] See Appendix Table C1 for other examples of legislative activity following unsuccessful court cases, including New Mexico's 1994 changepoint, South Dakota's 1997 changepoint, and Vermont's 2005 changepoint.
[21] For robustness, we present results in Appendix Table F1 from models that exclude lags of the independent indicator variables (i.e., we estimate two-way fixed effects regressions). Effect sizes are very similar in these models but less precisely estimated, suggesting the lagged independent variables usefully increase signal but do not substantially affect bias.
[22] In Appendix Table F2, we show that these results are robust to an alternative model specification that excludes lags of the indicator variables, and in Appendix Table F3 we show that these results are robust to alternative definitions of party control.
[23] Lafortune, et al. (2018) show that K-12 expenditures increased after an SFR event using the same tabulation of SFR events we do here. We can replicate their result when estimating two-way fixed effects regressions, much as the authors do, but not when estimating the newer event analysis estimators that account for treatment effect heterogeneity. Estimates using two-way

fixed effect estimators with changepoints as treatment variables are very similar to estimates from the newer estimators we show here. Thus, it seems like SFR events are more susceptible to bias from treatment effect heterogeneity relative to changepoints, though we cannot say why.

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Tables

Table 1. States with & years of positive changepoints, Fiscal Years 1960-2008

State	Year of Positive Changepoint				
	Equity Era (1960—1989)	Adequacy Era (1990—2008)		Equity Era (1960—1989)	Adequacy Era (1990—2008)
Alaska	1970	2006	New Hampshire	1965	2000
Arizona	1969	–––		1988	
	1975		New Jersey	1974	
Arkansas	1989	2005		1977	
California	1973	–––	New Mexico	1972	1994
	1979			1983	
	1986		New York	1983	1999
Colorado	1974	2003	North Carolina		1998
	1979		North Dakota	1974	1995
Connecticut	–––	1999		1983	
Florida	1969	1999	Ohio	1968	1996
	1974			1989	2002
Georgia	1968	–––	Oklahoma	1967	1997
	1980		Oregon	1974	1992
Illinois	1970	2000		1978	
	1976		Pennsylvania	1970	2000
	1985		South Carolina	1985	1996
Indiana	1985	–––	South Dakota	1981	1997
Iowa	1966	–––	Tennessee	1975	1992
Kansas	–––	1994		1985	
Kentucky	1977	1991		1989	
	1986		Texas		1998
Maine	1988	1999	Utah		1996
		2007	Vermont	1968	1999
Maryland	1973	2005		1970	2005
	1981			1979	
Massachusetts	1987	–––		1988	
Michigan	–––	1995	Virginia		2000
		2001	Washington	1977	2007
Minnesota	1972	1993		1980	
		2003	West Virginia	1986	1991
Missouri	1987	1996	Wisconsin		1997
Montana	1966	1993	Wyoming	1976	
	1974	2001		1984	
	1976	2006			
	1983				
Nebraska	1969	1991			
	1974	1999			
	1981				
Nevada	1972	1991			
	1980				
	1986				

Notes: All years refer to fiscal years.

Table 2: Probability of Changepoint Occurring from Statutes or Court Order

	[1]	[2]	[3]	[4]
Legislative Statute	0.121**		0.141**	
	(0.055)		(0.060)	
Court Ruling		-0.027	-0.085*	0.491***
		(0.032)	(0.049)	(0.110)
N	980	980	980	980

Notes: Models [1] through [3] predict the probability of a changepoint occurring, and Model [4] predicts the probability of a legislative statute being passed. All models control for first and second lags of each predictor, in addition to state and year fixed effects. The panel dataset includes fiscal years 1987–2008. Standard errors clustered at the level of the state.

Table 3: Probability of Changepoint Occurring from State Governmental Policy

	True Government Control		Governor Party	Legislative Supermajority: Tax		Legislative Supermajority: Budget	
Either Party	0.045*		N/A	0.026		0.025	
	(0.023)			(0.032)		(0.029)	
Republican		0.015	0.142		0.017		0.008
		(0.013)	(0.100)		(0.032)		(0.031)
Democrat		0.080*	0.167		0.035		0.043
		(0.047)	(0.104)		(0.050)		(0.042)
N	980	980	980	980	980	980	980
Rep=Dem		0.175	0.104		0.731		0.431

Note: All models estimate the probability of a changepoint occurring. Models control for first and second lags of the independent variable, as well as state and year fixed effects. Standard errors are clustered at the state level. The panel dataset includes fiscal years 1987–2008. Positive changepoints are based on those identified by BEAST and restricted to those that occurred post-1990 and have identified statutes preceding the changepoint (see Figure 4). Test shows the p-value of the test for whether the coefficient for Republican equals Democrat.

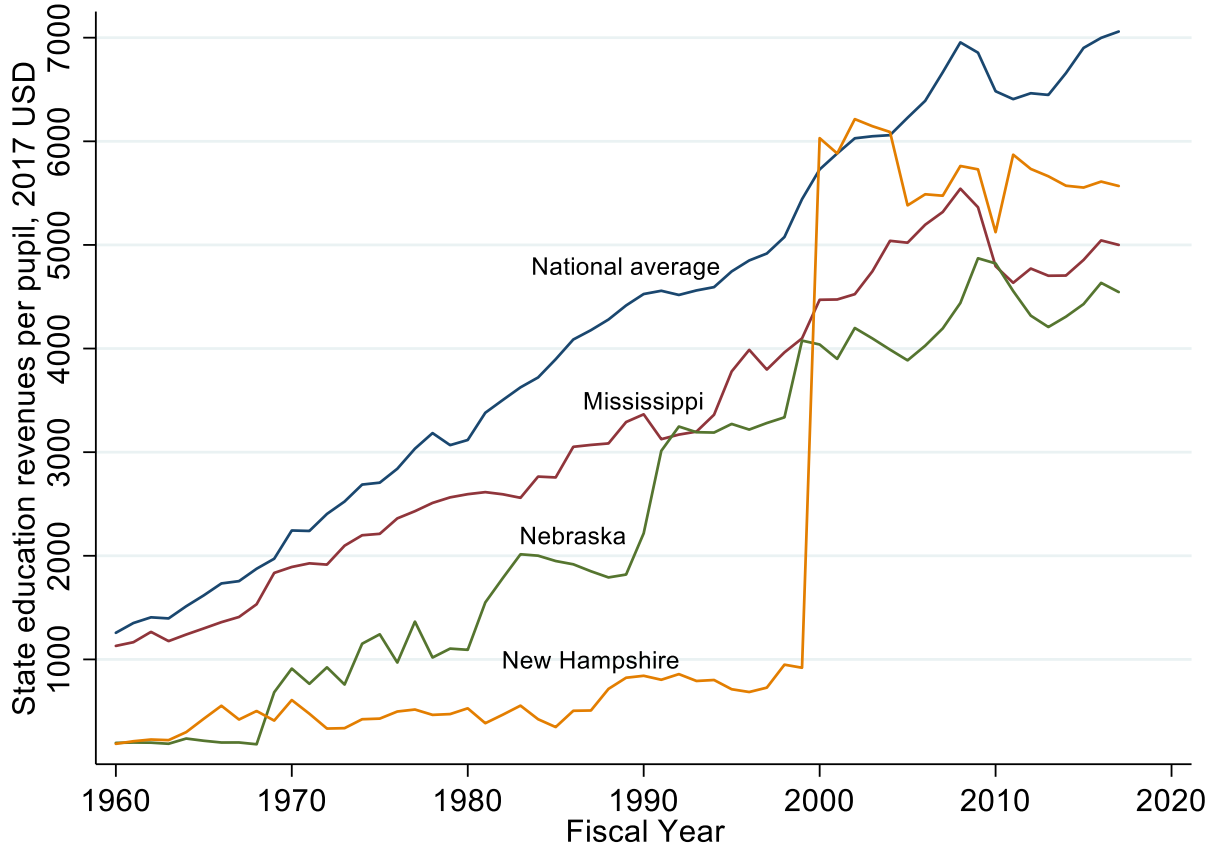
Table 4: Effect of SFRs and Changepoint on K-12 Expenditures, Tax Revenues, and Non-Educational Expenditures

	K-12 State Revenues			
	SFR Events		**Changepoints**	
	[1]	[2]	[1]	[2]
After event	152.5	125.7	903.6***	852.5***
	(196.5)	(202.2)	(321.5)	(316.6)
	K-12 Expenditures			
	SFR Events		**Changepoints**	
	[1]	[2]	[1]	[2]
After event	10.62	31.84	638.8**	703.6**
	(166.6)	(180.8)	(306.2)	(302.3)
	Tax Revenues			
	SFR Events		**Changepoints**	
	[1]	[2]	[1]	[2]
After event	757.6	480.7*	758.6	1178.9**
	(536.0)	(245.9)	(623.5)	(540.3)
	Non-Educational Expenditures			
	SFR Events		**Changepoints**	
	[1]	[2]	[1]	[2]
After event	627.0	518.2	804.3	648.9
	(595.4)	(570.0)	(710.0)	(725.3)
N	912	893	1078	1078

Notes: Model [1] is based on the csdid estimator of Callaway and Sant'Anna (2021), and Model [2] is based on the did_imputation estimator of Borusyak, Jaravel, and Spiess (2021). Both estimators flexibly control for treatment effect heterogeneity and use both never-treated and not-yet treated states as controls while excluding always-treated units. In the absence of covariates, point estimates will differ between the two models because of the relative importance of never treated units between the two models and sample size adjustments did_imputation makes when imputation is impossible. Treatment is defined as 0 before a changepoint or SFR event and 1 subsequently. SFR events are based on the compiled list of court cases and statutes used by Lafortune et al. (2018) and Shores et al. (in press). Positive changepoints are based on those identified by BEAST and restricted to those that occurred post-1990 and have identified statutes preceding the changepoint (see Figure 4). Sample sizes vary for the Borusyak et al. (2021) because the estimator cannot impute counterfactuals for certain units and so those units are removed. Sample sizes for changepoints include all states for fiscal years 1987—2008; sample sizes for SFR events include all states for fiscal years 1990—2008, since the SFR list is restricted to events in the adequacy era post-1990. Standard errors are clustered at the state level.

Figures

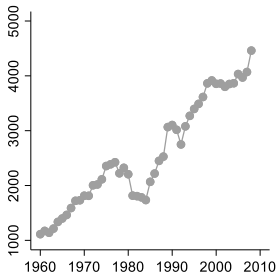
Figure 1. State education revenues per pupil over time, select states



Notes: Data was compiled from various sources; see the Data section of the paper for further details.

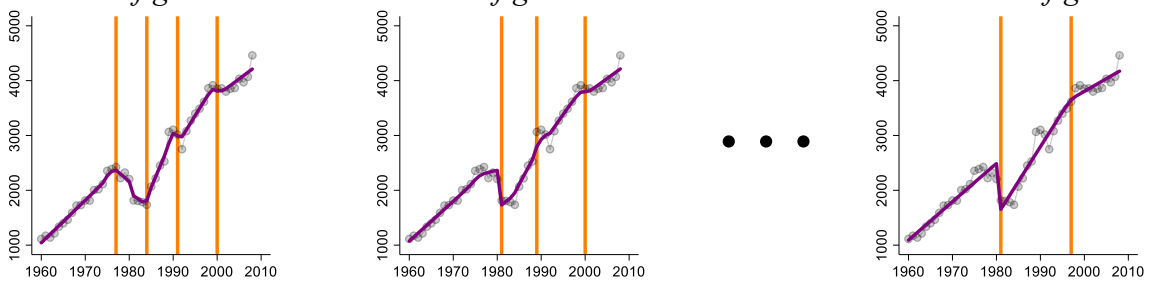
Figure 2. Illustration of rBEAST

Time series of per pupil state revenues



BEAST decomposes the time series into trend & changepoint components via numerous models

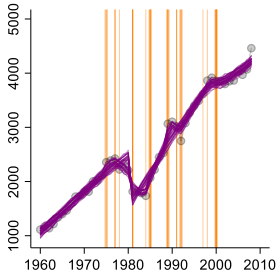
Model Configuration #1 *Model Configuration #2* *Model Configuration #N*



Notes: **trend component=purple line**; **changepoint component=orange line**

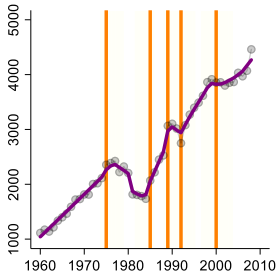
All these models provide useful information about the "true" model; synthesizing across models is often better than choosing a "single-best" model

Model Configuration #1 through Model Configuration #N



BEAST quantifies the usefulness of each model; then combines all models into a weighted average model

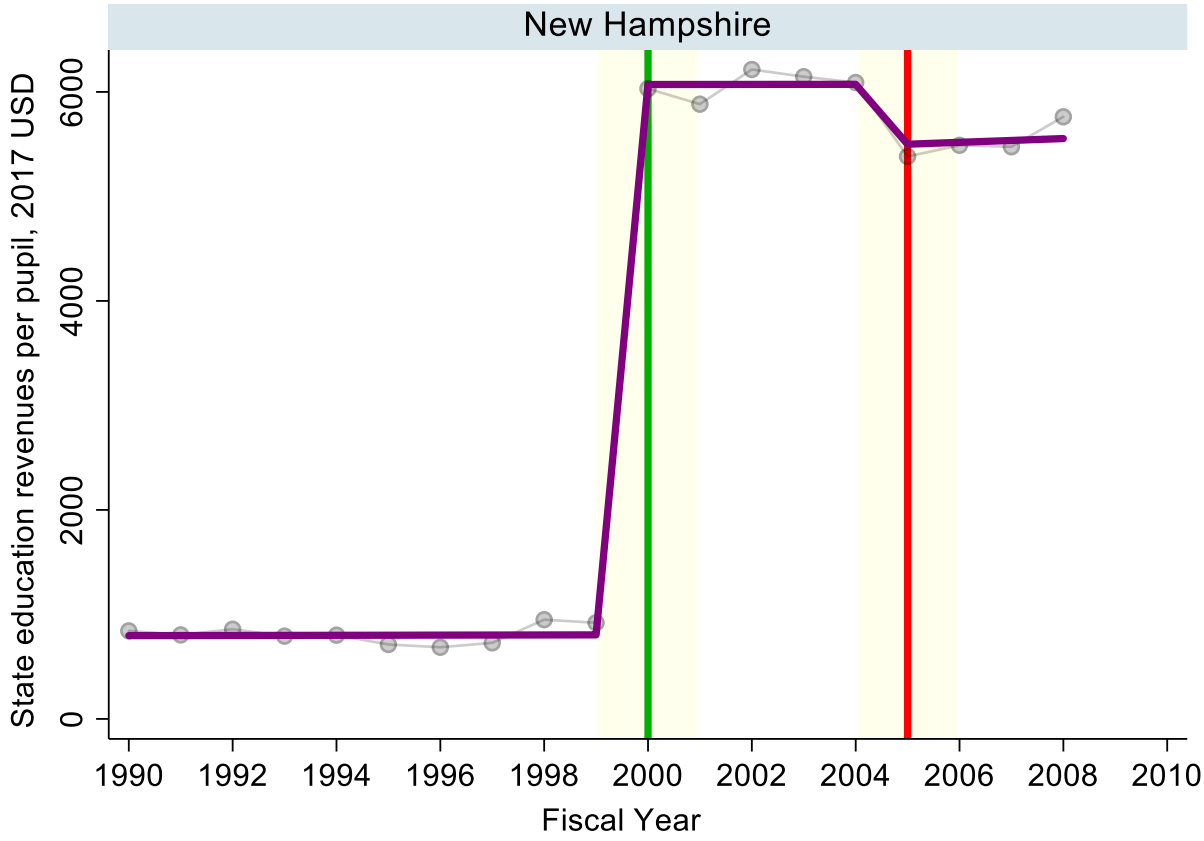
Weighted average model



Notes: Confidence intervals associated with changepoints=yellow background shading

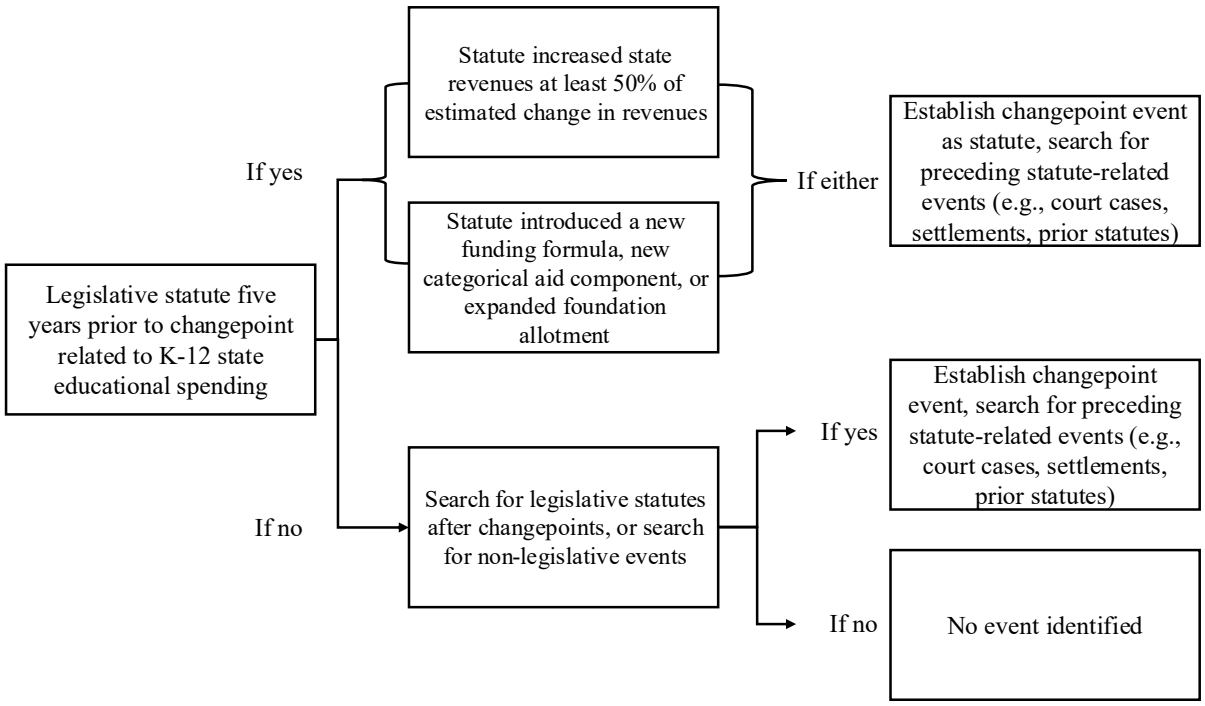
Notes: This illustration is modeled after a similar diagram provided in Zhao et al. (2019). It depicts how BEAST identifies changepoints.

Figure 3. Positive and negative changepoints, New Hampshire



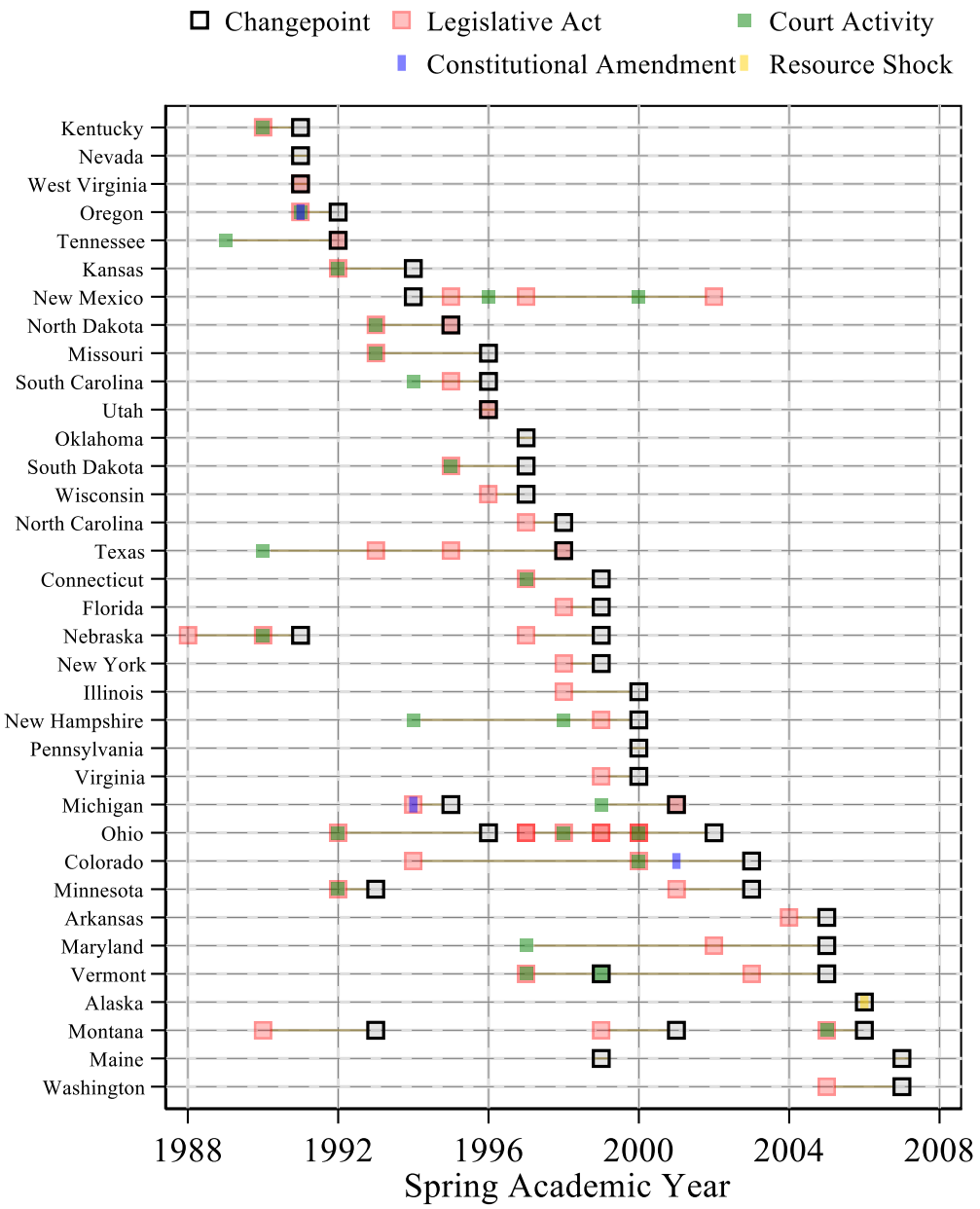
Notes: This illustration describes how positive and negative changepoints can be differentaited. The sign of changepoints are identified based on the change in state revenues per pupil before and after the changepoint, relative to the change in statte revenues per pupil in the two years preceding the changepoint. When the second difference is positive we define the changepoint as positive (green); when the second difference is negative we define the changepoint as negative (red). See methods for additional details.

Figure 4. Flowchart Describing Process for Identifying Statutes that can be Attributed to Positive Changepoints



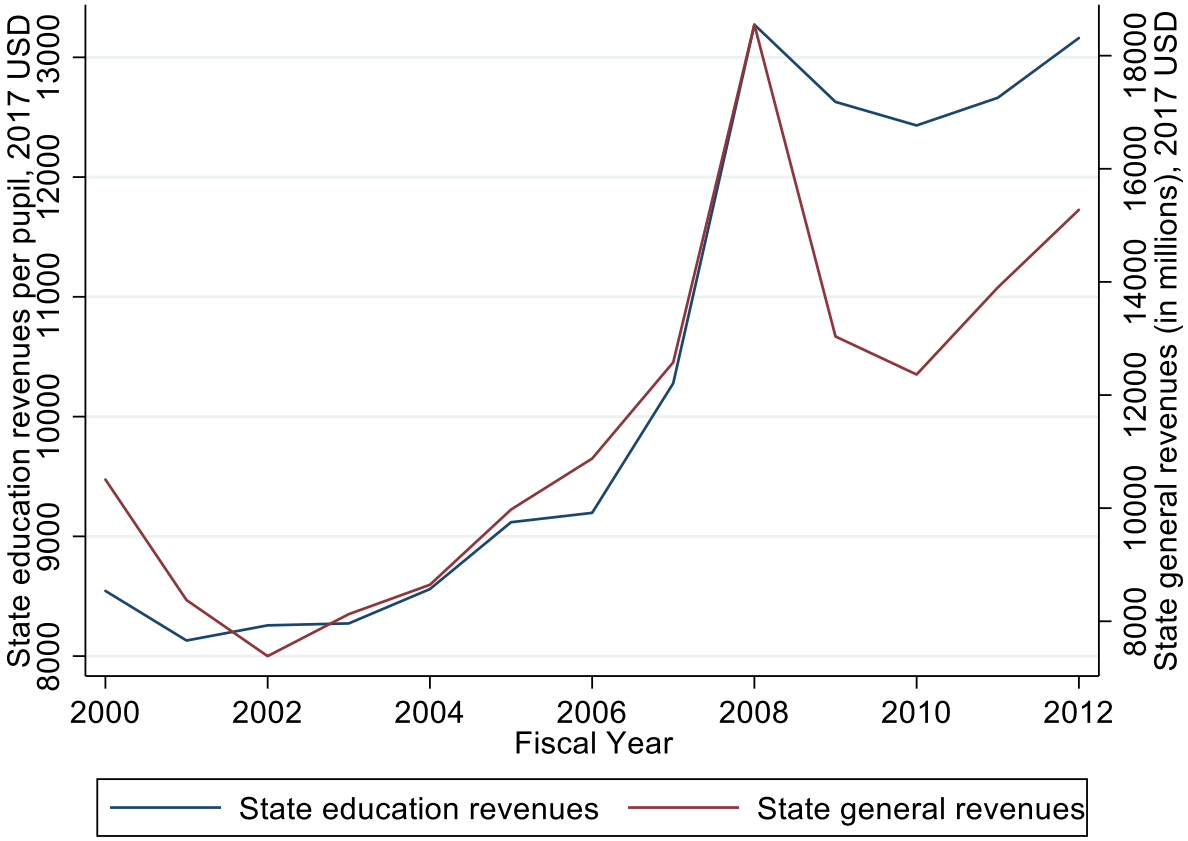
Notes: This flowchart depicts our criteria and process for determining whether an event can be attributed to a changepoint. See methods for details.

Figure 5. Pathways of positive changepoints



Notes: This illustration represents the culmination of our search process, which quantitatively identifies positive changepoints (black boxes) and the antecedent events. See Appendix E for the list of events contributing to this figure. We also created an Excel spreadsheet that includes more detailed information on the events motivating positive change points. This spreadsheet will be publicly posted on a website when this manuscript is published; however, a draft copy is available, upon request, from the authors.

Figure 6. Alaska's state education & general revenues, 2000-2012



Note: Data on state general revenues was obtained from the Annual Survey of State Government Finances. The survey is collected by the U.S. Census Bureau and has been compiled into a panel dataset, the Government Finance Database, by Pierson et al. (2015).

ONLINE APPENDIX

Appendix A: Data Sources

The authors compiled an annual panel of state education revenues and student enrollment data from 1959-1960 to 2007-08. For years 1986-87 to 2007-08, we obtain revenues and enrollment data from the National Public Education Financial Survey (NPEFS), which is distributed by the National Center for Education Statistics (NCES) and is easily accessible online.[1] Revenues and enrollment data from 1959-60 to 1985-86 were obtained from U.S. Department of Education (DOE) and NCES series reports, including *Digest of Education Statistics* and *Statistics of State School Systems*. These reports are the predecessors of NCES' Common Core of Data (CCD). Data collection for these reports typically proceeded as follows, as described in the data appendix of Paglayan (2019):

> "The DOE (and its predecessor, the U.S. Office of Education) mailed out to each state a common questionnaire, as part of an initiative known as *The Common Core of State Educational Information.* The states had previously obtained the data from their respective local school districts which, in turn, based their reports on data furnished by administrative, instructional, and other employed personnel. Each completed state questionnaire was carefully reviewed by the DOE for mathematical accuracy, internal consistency, and general adherence to prescribed definitions and terminology. The data were then compared to those of previous years and when questions arose, follow-up letters were sent to the corresponding state requesting an explanation" (pg. 2 of data appendix).

Thus, most data from these reports represent *actual* state revenues and student enrollment counts. However, for a few years (1962-63, 1966-67, 1968-69, 1970-71, 1972-73), state education revenues reported in the DOE/NCES reports were *estimated* and obtained from the National Education Association's *Estimates of School Statistics* reports.

[1] See https://nces.ed.gov/ccd/stfis.asp

Data from the DOE/NCES reports were hand-entered because they had not been previously digitized. Student enrollment counts were entered by Paglayan (2019), and state education revenues were hand-entered by either Paglayan (2019) or the authors (see Appendix Tables A1 and A2 for which years of data were hand-entered by which individuals). Paglayan (2019) followed standard procedures "to ensure the accuracy of the hand-entry process (e.g., calculating column totals and comparing them to the totals reported in the printed reports, graphing individual time series to check for abnormalities, etc.)" (data appendix, pg. 2). The authors followed similar procedure as Paglayan (2019) when verifying the accuracy of their hand-entered data.

State education revenues data is missing for all states in years 1960-61, 1964-65, and 1981-82. Additionally, Wisconsin is missing state education revenues in 1977-78; Alaska, Georgia, Illinois, and Wisconsin are missing state education revenues in 1978-79; and Virginia is missing state education revenues in 1985-86, 1986-87, and 1987-88. After viewing graphical depictions of state-specific trends, we chose to estimate any missing years through linear interpolation using data from the year prior and the year after.

A detailed overview of original sources of the data and which individual(s) hand-entered data for each year of the panel can be viewed in Appendix Tables A1 and A2.

Appendix Table A1. State student enrollment data

Academic Years	Individual(s) that hand-entered data	Original Source(s) of data
1959-60 to 1985-86	Paglayan (2019)	U.S. Department of Education (DOE) and National Center for Education Statistics (NCES) series reports; for more information, see data appendix of Paglayan (2019)
1986-87 to 2007-08	Not applicable	National Public Education Financial Survey (NPEFS); for more information, see https://nces.ed.gov/ccd/stfis.asp

Appendix Table A2. State education revenues data

Academic Years	Individual(s) that hand-entered data	Original Source(s) of data	Other notes
1959-60	Paglayan (2019)	U.S. Department of Education (DOE) and National Center for Education Statistics (NCES) series reports; for more information, see data appendix of Paglayan (2019)	
1960-61	missing (interpolated)	Missing data was estimated through linear interpolation using data from the year prior and year after	
1961-62	Paglayan (2019)	DOE and NCES series reports; for more information, see data appendix of Paglayan (2019)	
1962-63	The authors	U.S. Department of Health, Education, and Welfare, Office of Education. 1963. *Digest of Educational Statistics, 1963*. Washington, DC: U.S. Government Printing Office. Table 31; pg. 42	State revenues are estimates

Continued on next page.

Appendix Table A2 - continued from previous page.

Academic Years	Individual(s) that hand-entered data	Original Source(s) of data	Other notes
1963-64	Paglayan (2019)	DOE and NCES series reports; for more information, see data appendix of Paglayan (2019)	
1964-65	missing (interpolated)	Missing data was estimated through linear interpolation using data from the year prior and year after	
1965-66	Paglayan (2019)	DOE and NCES series reports; for more information, see data appendix of Paglayan (2019)	
1966-67	The authors	U.S. Department of Health, Education, and Welfare, Office of Education. 1967. *Digest of Education Statistics, 1967*. Washington, DC: U.S. Government Printing Office. Table 68; pg. 54	State revenues are estimates
1967-68	Paglayan (2019)	DOE and NCES series reports; for more information, see data appendix of Paglayan (2019)	
1968-69	The authors	NCES. 1969. *Digest of Education Statistics, 1969*. Washington, DC: U.S. Government Printing Office. Table 66; pg. 49	State revenues are estimates
1969-70	Paglayan (2019)	DOE and NCES series reports; for more information, see data appendix of Paglayan (2019)	
1970-71	The authors	NCES. 1972. *Digest of Education Statistics, 1971*. Washington, DC: U.S. Government Printing Office. Table 70; pg. 52	State revenues are estimates
1971-72	Paglayan (2019)	DOE and NCES series reports; for more information, see data appendix of Paglayan (2019)	
1972-73	The authors	NCES. 1974. *Digest of Education Statistics, 1973*. Washington, DC: U.S. Government Printing Office. Table 69; pg. 58	State revenues are estimates

Continued on next page.

Appendix Table A2 - continued from previous page.

Academic Years	Individual(s) that hand-entered data	Original Source(s) of data	Other notes
1974-75	The authors	NCES. 1998. *State Comparisons of Education Statistics: 1969-70 to 1996-97.* Washington, DC: U.S. Government Printing Office. Table 32; pg. 83	
1975-76 to 1980-81	Paglayan (2019)	DOE and NCES series reports; for more information, see data appendix of Paglayan (2019)	
1981-82	missing (interpolated)	Missing data was estimated through linear interpolation using data from the year prior and year after	
1982-83	The authors	NCES.1986. *Digest of Education Statistics, 1986*. Washington, DC: U.S. Government Printing Office.Table 70; pg. 81	
1983-84	The authors	NCES.1987. *Digest of Education Statistics, 1987*. Washington, DC: U.S. Government Printing Office.Table 95; pg. 109	
1984-85	The authors	NCES. 1988. *Digest of Education Statistics, 1988*. Washington, DC: U.S. Government Printing Office.Table 109; pg. 126	
1985-86	The authors	NCES. 1989. *Digest of Education Statistics, 1989*. Washington, DC: U.S. Government Printing Office. Table 140; pg. 150	
1986-87 to 2008-08	Not applicable	National Public Education Financial Survey (NPEFS); for more information, see https://nces.ed.gov/ccd/stfis.asp	

Appendix B: Primary Resources for Identifying Statutes Linked to Changepoints

Here we provide additional details about our search process. For each changepoint, the search process generally proceeded as follows. First, we reviewed a set list of 6 websites, books, and journal articles that were known by the authors to provide general state-by-state overviews of state school finance systems, as well as histories of legislative and court activity related to school finance (specifics on these six sources are listed in Table B1 below). We reviewed the state-specific information that each of these six sources provided for all 35 states that experienced a positive changepoint to ensure that we obtained a broad understanding of the state school finance contexts in which changepoints occurred. If any of these sources mentioned an event that a) appeared to be associated with increases in state education revenues in the year of the changepoint and b) occurred in the years prior to a changepoint, we then searched for more detailed information regarding this potential event.

When a potential event was related to legislative activity (e.g., a House or Senate Bill, law, or legislative referendum), we specifically looked for evidence linking the event to increased appropriations for state education. For example, if we found that a House Bill which mandated changes to the school funding formula was passed in the year prior to a changepoint, we reviewed the text of the bill for information on whether increased state funds were appropriated as part of the funding formula change (because changes to funding formulas, though impactful for how funds are distributed, do not always entail increases in state aid). When there was the potential that a changepoint may have been caused by a resource shock that induced increased state revenues, we quantitatively examined longitudinal state revenues data available from the US Census Bureau's Annual Survey of State Government Finances. We also

reviewed any secondary sources (academic journal articles, news articles, published briefs or reports) we found with relevant information about events.

In some cases, our initial review of the six sources with state-specific information on school finance systems (listed in Table B1) did not provide any clues on potential events that could be motivating a positive changepoint. When this occurred, we conducted a general internet search using an internet search engine (i.e., Google) and the following search string: *[State] AND [Year of changepoint] AND ("state education funding" OR "school finance system" OR "school funding formula)*.[2] If any of the sources found using this general search process mentioned an event that appeared to be related to a given changepoint, we then searched for more detailed information regarding this event using the tactics described in previous paragraphs (i.e., finding and reviewing the actual text of the act, order, or amendment; searching for and reviewing other secondary sources with relevant information).

Information obtained in the search process was recorded and organized in Excel spreadsheets. Specifically, for a given event that was determined to be associated with a changepoint, the following information was recorded: the historical date the event occurred; the type of event (i.e., court order, legislative act, constitutional amendment, resource shock, other event); a brief synopsis of the event, with details on how the event was associated with significant increases in education spending; source(s) where event information was obtained (i.e., specific website or journal article); and any other notes. When possible, we recorded the amount of money authorized for education, K-12 enrollment in that year, and the estimated magnitude of the changepoint.

[2] If unsuccessful, we also tried inputting years prior to the changepoint in the search string.

Table B1. Reference sources with state-specific information on school finance systems

Reference	**Type of source**	**General information provided**
SchoolFunding.Info: http://www.schoolfunding.info/	Website	Overview of school-funding court decisions in each state
50 State Survey of School Finance Policies (2009): https://schoolfinancesdav.wordpress.com/	Website	Overview of history of school finance in each state
Public School Finance Programs of the United States and Canada (1998-99): https://nces.ed.gov/edfin/state_financing.asp	Website	Overview of history of school finance in each state
Education Law Center Litigation State Profiles: https://edlawcenter.org/litigation/states/	Website	Overview of school-funding court decisions in each state
Thompson, D. C., Wood, R. C., Neuenswander, S. C., Heim, J. M., & Watson, R. D. (Eds.). (2019). *Funding public schools in the United States and Indian country*. IAP.	Book	Overview of history of school finance in each state
Shores, K., Candelaria, C., & Kabourek, S. E. (in press). Spending more on the poor? A comprehensive summary of state-specific responses to school finance reforms from 1990–2014. *Education Finance and Policy*.	Journal article	List of legislative and court-ordered SFRs that occurred between 1989-2011

Appendix C: Complete Tabulation of Positive Changepoints and Documented School Finance Reforms

Appendix Table C1: Tabulation of Positive Changepoints and Documented SFRs

State	Fiscal Year	Event Name	Data Source	CP	SFR
AK	1970	------ Changepoint; no SFR ------	- rBEAST -	1	0
AK	2000	Kasayulie v. Alaska, 1999	JJP	0	1
AK	2006	------ Changepoint; no SFR ------	- rBEAST -	1	0
AK	2007	Moore v. State, 2007	L	0	1
AL	1993	Alabama Coalition for Equity v. Hunt, 1993	JJP	0	1
AR	1983	Dupree v. Alma School District No. 30, 1983	JJP	0	1
AR	1989	------ Changepoint; no SFR ------	- rBEAST -	1	0
AR	1995	Lake View School District, No. 25 v. Huckabee I, 1994 [+] Approved Equitable School Finance Plan (Acts 917, 916, and 1194)	JJP [+] SCK	0	1
AR	2003	Lake View School District, No. 25 v. Huckabee III, 2002	JJP	0	1
AR	2005	Lake View School District, No. 25 v. Huckabee, 2005	JJP	1	1
AR	2007	Various acts resulting from Master's Report findings	SCK	0	1
AZ	1969	------ Changepoint; no SFR ------	- rBEAST -	1	0
AZ	1975	------ Changepoint; no SFR ------	- rBEAST -	1	0
AZ	1980	Unnamed legislative act	H	0	1
AZ	1995	Roosevelt v. Bishop, 1994	JJP	0	1
AZ	1998	Hull v. Albrecht, 1997 [+] Hull v. Albrecht, 1998	JJP [+] JJP	0	1
AZ	2007	Flores v. Arizona, 2007	JJP	0	1
AZ	2014	Cave Creek unified School District et al. v. State, 2013	L	0	1
CA	1972	Serrano v. Priest I, 1971	JJP	0	1
CA	1973	------ Changepoint; no SFR ------	- rBEAST -	1	0
CA	1977	Serrano v. Priest II, 1976	L	0	1
CA	1978	Serrano v. Priest III, 1977	JJP	0	1
CA	1979	------ Changepoint; no SFR ------	- rBEAST -	1	0
CA	1986	------ Changepoint; no SFR ------	- rBEAST -	1	0
CA	1999	Leroy F. Greene School Facilities Act of 1998	SCK	0	1
CA	2005	Senate Bill 6, Senate Bill 550, Assembly Bill 1550, Assembly Bill 2727, and Assembly Bill 3001 [+] Williams v. State, 2004	SCK [+] JJP	0	1
CO	1974	------ Changepoint; no SFR ------	- rBEAST -	1	0
CO	1979	------ Changepoint; no SFR ------	- rBEAST -	1	0
CO	2000	Senate Bill 181	SCK	0	1
CO	2001	Various Other Acts	SCK	0	1
CO	2003	------ Changepoint; no SFR ------	- rBEAST -	1	0
CT	1977	Horton v. Meskill I, 1977	JJP	0	1
CT	1982	Horton v. Meskill II, 1982	JJP	0	1
CT	1997	Sheff v. O'Neill, 1996	JJP	0	1
CT	1999	------ Changepoint; no SFR ------	- rBEAST -	1	0
CT	2010	Coalition for Justice in Education Funding, Inc v. Rell, 2010	JJP	0	1
FL	1969	------ Changepoint; no SFR ------	- rBEAST -	1	0

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Appendix Table C1 – continued from previous page

State	Fiscal Year	Event Name	Data Source	CP	SFR
FL	1973	Unnamed legislative act	H	0	1
FL	1974	------ Changepoint; no SFR ------	- rBEAST -	1	0
FL	1999	------ Changepoint; no SFR ------	- rBEAST -	1	0
GA	1968	------ Changepoint; no SFR ------	- rBEAST -	1	0
GA	1980	------ Changepoint; no SFR ------	- rBEAST -	1	0
GA	1986	Unnamed legislative act	H	0	1
IA	1966	------ Changepoint; no SFR ------	- rBEAST -	1	0
IA	1972	Unnamed legislative act	H	0	1
ID	1978	Unnamed legislative act	H	0	1
ID	1993	Idaho Schools for Equal Educational Opportunity v. State I, 1993	SCK	0	1
ID	1994	Senate Bill 1560	SCK	0	1
ID	1999	Idaho Schools for Equal Educational Opportunity v. State III, 1998	JJP	0	1
ID	2006	Idaho Schools for Equal Educational Opportunity v. State V, 2005	JJP	0	1
IL	1970	------ Changepoint; no SFR ------	- rBEAST -	1	0
IL	1976	------ Changepoint; no SFR ------	- rBEAST -	1	0
IL	1985	------ Changepoint; no SFR ------	- rBEAST -	1	0
IL	2000	------ Changepoint; no SFR ------	- rBEAST -	1	0
IN	1985	------ Changepoint; no SFR ------	- rBEAST -	1	0
IN	2012	HB 1001 (Pl229)	SCK	0	1
KS	1973	Caldwell v. State, 1972	L	0	1
KS	1976	Knowles v. State Board of Education, 1976	JJP	0	1
KS	1992	The School District Finance and Quality Performance Act	SCK	0	1
KS	1994	------ Changepoint; no SFR ------	- rBEAST -	1	0
KS	2005	Montoy v. State, 2005	JJP	0	1
KY	1977	------ Changepoint; no SFR ------	- rBEAST -	1	0
KY	1986	------ Changepoint; no SFR ------	- rBEAST -	1	0
KY	1990	Rose v. Council for Better Education, Inc., 1989 [+] Kentucky Education Reform Act (HB 940)	JJP [+] SCK	0	1
KY	1991	------ Changepoint; no SFR ------	- rBEAST -	1	0
MA	1985	Unnamed legislative act	H	0	1
MA	1987	------ Changepoint; no SFR ------	- rBEAST -	1	0
MA	1993	McDuffy v. Secretary of the Executive Office of Education, 1993 [+] Massachusetts Education Reform Act	JJP [+] SCK	0	1
MD	1973	------ Changepoint; no SFR ------	- rBEAST -	1	0
MD	1981	------ Changepoint; no SFR ------	- rBEAST -	1	0
MD	1987	Unnamed legislative act	H	0	1
MD	1997	Bradford v. Maryland State Board of Education I, 1996	SCK	0	1
MD	2002	Bridge to Excellence in Public Schools Act (Senate Bill 856)	SCK	0	1
MD	2005	Bradford v. Maryland State Board of Education II, 2005	JJP	1	1
ME	1978	Unnamed legislative act	H	0	1
ME	1988	------ Changepoint; no SFR ------	- rBEAST -	1	0
ME	1999	------ Changepoint; no SFR ------	- rBEAST -	1	0
ME	2007	------ Changepoint; no SFR ------	- rBEAST -	1	0

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Appendix Table C1 – continued from previous page

State	Fiscal Year	Event Name	Data Source	CP	SFR
MI	1995	------ Changepoint; no SFR ------	- rBEAST -	1	0
MI	1998	Durant v. State, 1997	JJP	0	1
MI	2001	------ Changepoint; no SFR ------	- rBEAST -	1	0
MN	1972	------ Changepoint; no SFR ------	- rBEAST -	1	0
MN	1973	Unnamed legislative act	H	0	1
MN	1993	------ Changepoint; no SFR ------	- rBEAST -	1	0
MN	2003	------ Changepoint; no SFR ------	- rBEAST -	1	0
MO	1977	Unnamed legislative act	H	0	1
MO	1987	------ Changepoint; no SFR ------	- rBEAST -	1	0
MO	1993	Committee for Educational Equality v. State, 1993	JJP	0	1
MO	1994	Outstanding Schools Act (S.B. 380)	SCK	0	1
MO	1996	------ Changepoint; no SFR ------	- rBEAST -	1	0
MO	2005	Senate Bill 287	SCK	0	1
MT	1966	------ Changepoint; no SFR ------	- rBEAST -	1	0
MT	1974	------ Changepoint; no SFR ------	- rBEAST -	1	0
MT	1976	------ Changepoint; no SFR ------	- rBEAST -	1	0
MT	1983	------ Changepoint; no SFR ------	- rBEAST -	1	0
MT	1989	Helena Elementary School District No. 1 v. State, 1989	JJP	0	1
MT	1993	House Bill 667	SCK	1	1
MT	1994	Montana Rural Ed. Association v. Montana, 1993	JJP	0	1
MT	2001	------ Changepoint; no SFR ------	- rBEAST -	1	0
MT	2005	Columbia Falls Public Schools v. State, 2005	JJP	0	1
MT	2006	------ Changepoint; no SFR ------	- rBEAST -	1	0
MT	2008	M.C.A. § 20-9-309	SCK	0	1
MT	2009	Montana Quality Education Coalition v Montana, 2008	JJP	0	1
NC	1998	Leandro v. State, 1997	JJP	1	1
NC	2005	Hoke County Board of Education v. State, 2004	JJP	0	1
ND	1974	------ Changepoint; no SFR ------	- rBEAST -	1	0
ND	1983	------ Changepoint; no SFR ------	- rBEAST -	1	0
ND	1995	------ Changepoint; no SFR ------	- rBEAST -	1	0
ND	2007	SB 2200	SCK	0	1
NE	1969	------ Changepoint; no SFR ------	- rBEAST -	1	0
NE	1974	------ Changepoint; no SFR ------	- rBEAST -	1	0
NE	1981	------ Changepoint; no SFR ------	- rBEAST -	1	0
NE	1991	------ Changepoint; no SFR ------	- rBEAST -	1	0
NE	1999	------ Changepoint; no SFR ------	- rBEAST -	1	0
NH	1965	------ Changepoint; no SFR ------	- rBEAST -	1	0
NH	1985	Unnamed legislative act	H	0	1
NH	1988	------ Changepoint; no SFR ------	- rBEAST -	1	0
NH	1994	Claremont v. Governor I, 1993	JJP	0	1
NH	1998	Claremont v. Governor II, 1997	JJP	0	1
NH	2000	Claremont v. Governor III, 1999	JJP	1	1
NH	2001	Opinion of the Justices–School Financing (Claremont VI)	SCK	0	1
NH	2002	Claremont v. Governor IV, 2002	JJP	0	1
NH	2007	Londonderry School District v. State, 2006	JJP	0	1
NH	2008	SB 539	SCK	0	1

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Appendix Table C1 – continued from previous page

State	Fiscal Year	Event Name	Data Source	CP	SFR
NJ	1973	Robinson v. Cahill, 1973	JJP	0	1
NJ	1974	------ Changepoint; no SFR ------	- rBEAST -	1	0
NJ	1976	Robinson v. Cahill, 1976	JJP	0	1
NJ	1977	------ Changepoint; no SFR ------	- rBEAST -	1	0
NJ	1990	Abbott v. Burke II, 1990	JJP	0	1
NJ	1991	The Quality Education Act	SCK	0	1
NJ	1995	Abbott v. Burke III, 1994	JJP	0	1
NJ	1997	Comprehensive Educational Improvement and Financing Act of 1996 [+] Abbott v. Burke IV, 1997	SCK [+] L	0	1
NJ	1998	Abbott v. Burke V, 1998	SCK	0	1
NJ	2000	Abbott v. Burke VI, 2000	SCK	0	1
NJ	2008	The School Funding Reform Act of 2008	SCK	0	1
NM	1972	------ Changepoint; no SFR ------	- rBEAST -	1	0
NM	1974	Unnamed legislative act	H	0	1
NM	1983	------ Changepoint; no SFR ------	- rBEAST -	1	0
NM	1994	------ Changepoint; no SFR ------	- rBEAST -	1	0
NM	2000	Zuni School District v. State, 1999	JJP	0	1
NM	2001	Deficiencies Corrections Program; Public School Capital Outlay	SCK	0	1
NV	1972	------ Changepoint; no SFR ------	- rBEAST -	1	0
NV	1980	------ Changepoint; no SFR ------	- rBEAST -	1	0
NV	1986	------ Changepoint; no SFR ------	- rBEAST -	1	0
NV	1991	------ Changepoint; no SFR ------	- rBEAST -	1	0
NY	1983	------ Changepoint; no SFR ------	- rBEAST -	1	0
NY	1999	------ Changepoint; no SFR ------	- rBEAST -	1	0
NY	2003	Campaign for Fiscal Equity, Inc. v. State I, 2003	JJP	0	1
NY	2007	Campaign for Fiscal Equity, Inc. v. State III, 2006 [+] Education Budget and Reform Act	JJP [+] SCK	0	1
OH	1968	------ Changepoint; no SFR ------	- rBEAST -	1	0
OH	1989	------ Changepoint; no SFR ------	- rBEAST -	1	0
OH	1996	------ Changepoint; no SFR ------	- rBEAST -	1	0
OH	1998	DeRolph v. State I, 1997	JJP	0	1
OH	2000	DeRolph v. State II, 2000	JJP	0	1
OH	2002	DeRolph v. State III, 2001	L	1	1
OH	2003	DeRolph v. State IV, 2002	JJP	0	1
OK	1967	------ Changepoint; no SFR ------	- rBEAST -	1	0
OK	1987	Unnamed legislative act	H	0	1
OK	1997	------ Changepoint; no SFR ------	- rBEAST -	1	0
OR	1974	------ Changepoint; no SFR ------	- rBEAST -	1	0
OR	1978	------ Changepoint; no SFR ------	- rBEAST -	1	0
OR	1992	------ Changepoint; no SFR ------	- rBEAST -	1	0
OR	2009	Pendleton School District v. State, 2009	JJP	0	1
PA	1970	------ Changepoint; no SFR ------	- rBEAST -	1	0
PA	2000	------ Changepoint; no SFR ------	- rBEAST -	1	0
PA	2009	Act 61	SCK	0	1
RI	1985	Unnamed legislative act	H	0	1

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Appendix Table C1 – continued from previous page

State	Fiscal Year	Event Name	Data Source	CP	SFR
SC	1977	Unnamed legislative act	H	0	1
SC	1985	------ Changepoint; no SFR ------	- rBEAST -	1	0
SC	1996	------ Changepoint; no SFR ------	- rBEAST -	1	0
SC	2006	Abbeville County School District v. State, 2005	JJP	0	1
SD	1981	------ Changepoint; no SFR ------	- rBEAST -	1	0
SD	1986	Unnamed legislative act	H	0	1
SD	1997	------ Changepoint; no SFR ------	- rBEAST -	1	0
TN	1975	------ Changepoint; no SFR ------	- rBEAST -	1	0
TN	1977	Unnamed legislative act	H	0	1
TN	1985	------ Changepoint; no SFR ------	- rBEAST -	1	0
TN	1989	------ Changepoint; no SFR ------	- rBEAST -	1	0
TN	1992	The Education Improvement Act	SCK	1	1
TN	1993	Tennessee Small School Systems v. McWheter I, 1993	JJP	0	1
TN	1995	Tennessee Small School Systems v. McWheter II, 1995	JJP	0	1
TN	2003	Tennessee Small School Systems v. McWheter III, 2002	JJP	0	1
TX	1986	Unnamed legislative act	H	0	1
TX	1990	Edgewood ISD v. Kirby I, 1989	JJP	0	1
TX	1991	Edgewood ISD v. Kirby II, 1991	JJP	0	1
TX	1992	Carrollton-Farmer's Branch ISD v. Edgewood ISD, 1992	JJP	0	1
TX	1993	Senate Bill 7	SCK	0	1
TX	1998	------ Changepoint; no SFR ------	- rBEAST -	1	0
TX	2006	West Orange-Cove Consolidated ISD v. Neely, 2005	L	0	1
UT	1996	------ Changepoint; no SFR ------	- rBEAST -	1	0
VA	1975	Unnamed legislative act	H	0	1
VA	2000	------ Changepoint; no SFR ------	- rBEAST -	1	0
VT	1968	------ Changepoint; no SFR ------	- rBEAST -	1	0
VT	1970	------ Changepoint; no SFR ------	- rBEAST -	1	0
VT	1979	------ Changepoint; no SFR ------	- rBEAST -	1	0
VT	1987	Unnamed legislative act	H	0	1
VT	1988	------ Changepoint; no SFR ------	- rBEAST -	1	0
VT	1997	Brigham v. State, 1997	JJP	0	1
VT	1999	------ Changepoint; no SFR ------	- rBEAST -	1	0
VT	2003	Revisions to Act 68; HB 480	SCK	0	1
VT	2005	------ Changepoint; no SFR ------	- rBEAST -	1	0
WA	1977	------ Changepoint; no SFR ------	- rBEAST -	1	0
WA	1979	Seattle School District No. 1 v. State, 1978	JJP	0	1
WA	1980	------ Changepoint; no SFR ------	- rBEAST -	1	0
WA	2007	------ Changepoint; no SFR ------	- rBEAST -	1	0
WA	2010	Federal Way School District v. State, 2009 [+] McCleary v State, 2010 (Superior Court ruling)	L [+] SCK	0	1
WA	2012	McCleary v State, 2012 (Supreme Court ruling)	L	0	1
WI	1973	Unnamed legislative act	H	0	1
WI	1977	Buse v. Smith, 1976	JJP	0	1
WI	1997	------ Changepoint; no SFR ------	- rBEAST -	1	0

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Appendix Table C1 – continued from previous page

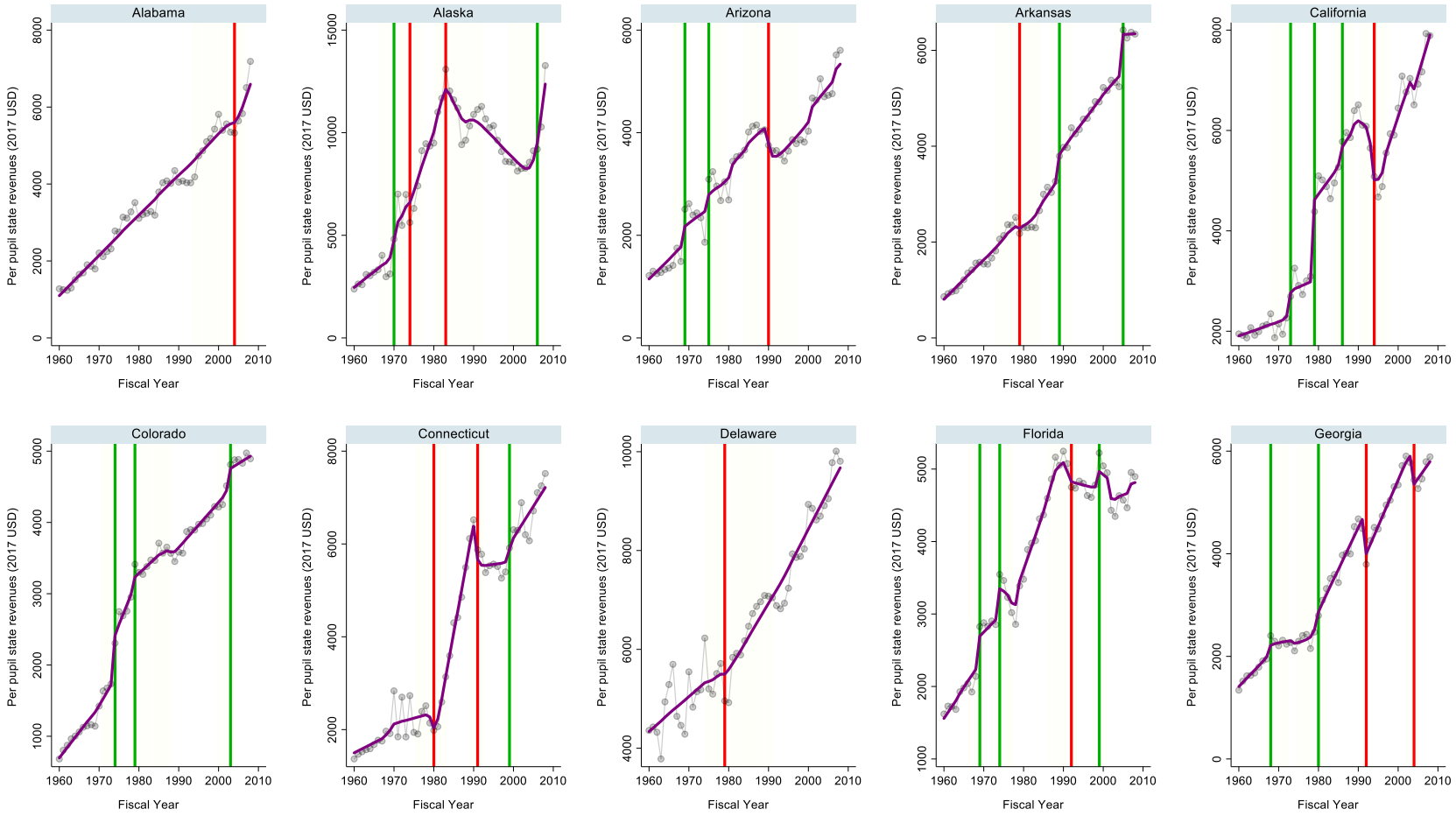
State	Fiscal Year	Event Name	Data Source	CP	SFR
WV	1979	Pauley v. Kelly, 1979	JJP	0	1
WV	1985	Pauley v. Bailey, 1984	JJP	0	1
WV	1986	------ Changepoint; no SFR ------	- rBEAST -	1	0
WV	1991	------ Changepoint; no SFR ------	- rBEAST -	1	0
WV	1995	Tomblin v. Gainer, 1995	JJP	0	1
WY	1976	------ Changepoint; no SFR ------	- rBEAST -	1	0
WY	1980	Washakie County School District v. Herschler, 1980	JJP	0	1
WY	1984	------ Changepoint; no SFR ------	- rBEAST -	1	0
WY	1996	Campbell County School District v. State I, 1995	JJP	0	1
WY	1997	The Education Resource Block Grant Model [+] Wyoming Comprehensive Assessment System	SCK [+] SCK	0	1
WY	2001	Campbell County School District v. State II, 2001	JJP	0	1

Notes: This table represents the complete list of changepoints (CP) identified using the Bayesian changepoint estimator described in methods (-rBEAST-) and the complete list of SFRs (SFR) tabulated from Shores et al. (in press) (SCK), Liscow (2018) (L), Jackson et al. (2016) (JJP), and Hoxby (2011) (H). In the few cases where the changepoint estimator and the SFR matched the state-year, the data source only references the original SFR tabulation.

Appendix D: State-Specific Figures of Changepoints

Appendix Figure D1 (displayed on subsequent pages) visually depicts the occurrence of changepoints in each state's time series between fiscal years 1960 and 2008. Grey dotted lines indicate per pupil state education revenues and purple lines indicate the fitted trend lines estimated by BEAST. Green and red vertical lines represent the years in which positive and negative changepoints occurred, respectively, and yellow background shading indicates confidence intervals associated with changepoints.

Appendix Figure D1. State-Specific Figures of Changepoints, Fiscal Years 1960-2008



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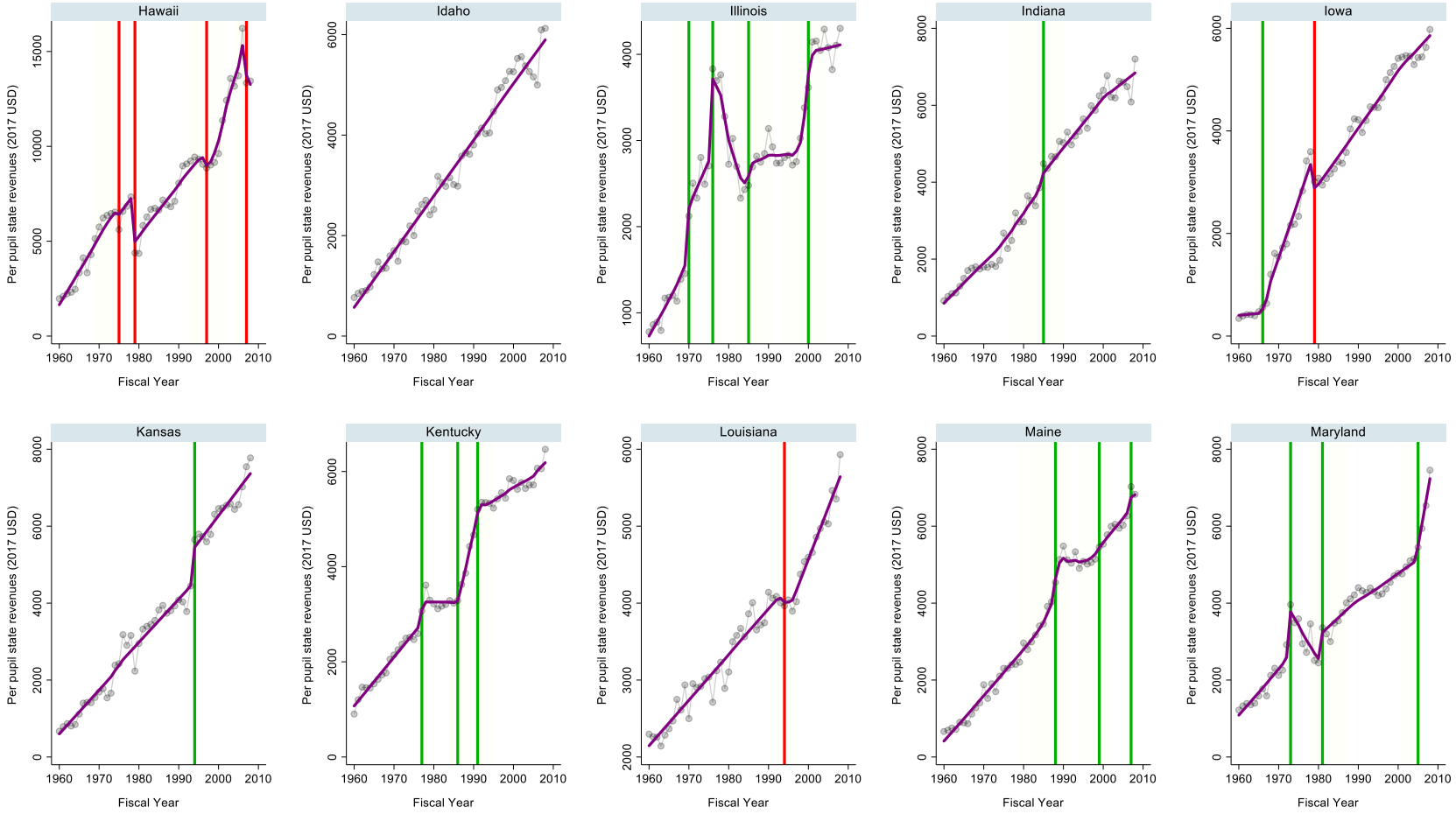
Appendix Figure D1. State-Specific Figures of Changepoints, Fiscal Years 1960-2008



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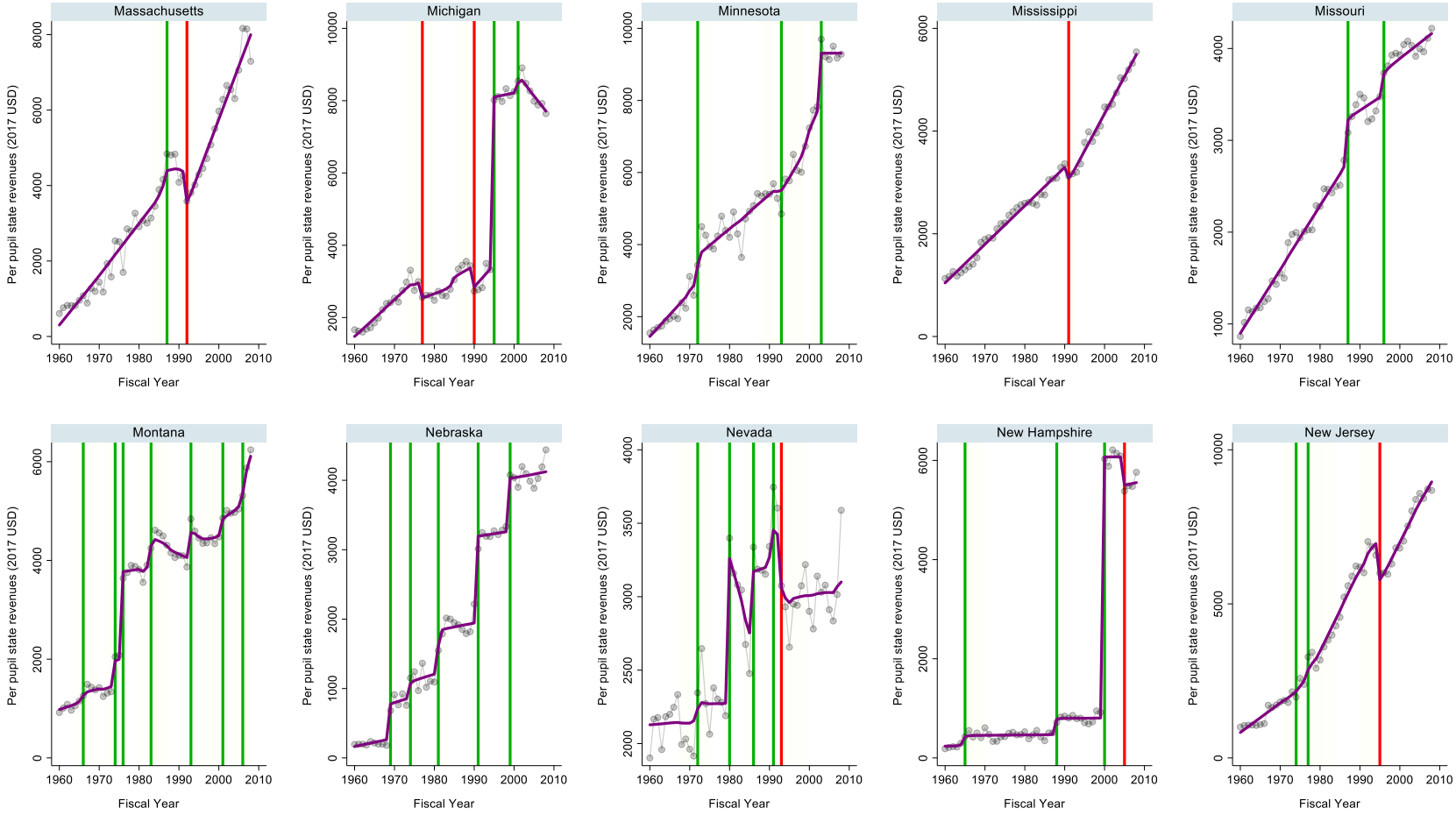
Appendix Figure D1. State-Specific Figures of Changepoints, Fiscal Years 1960-2008



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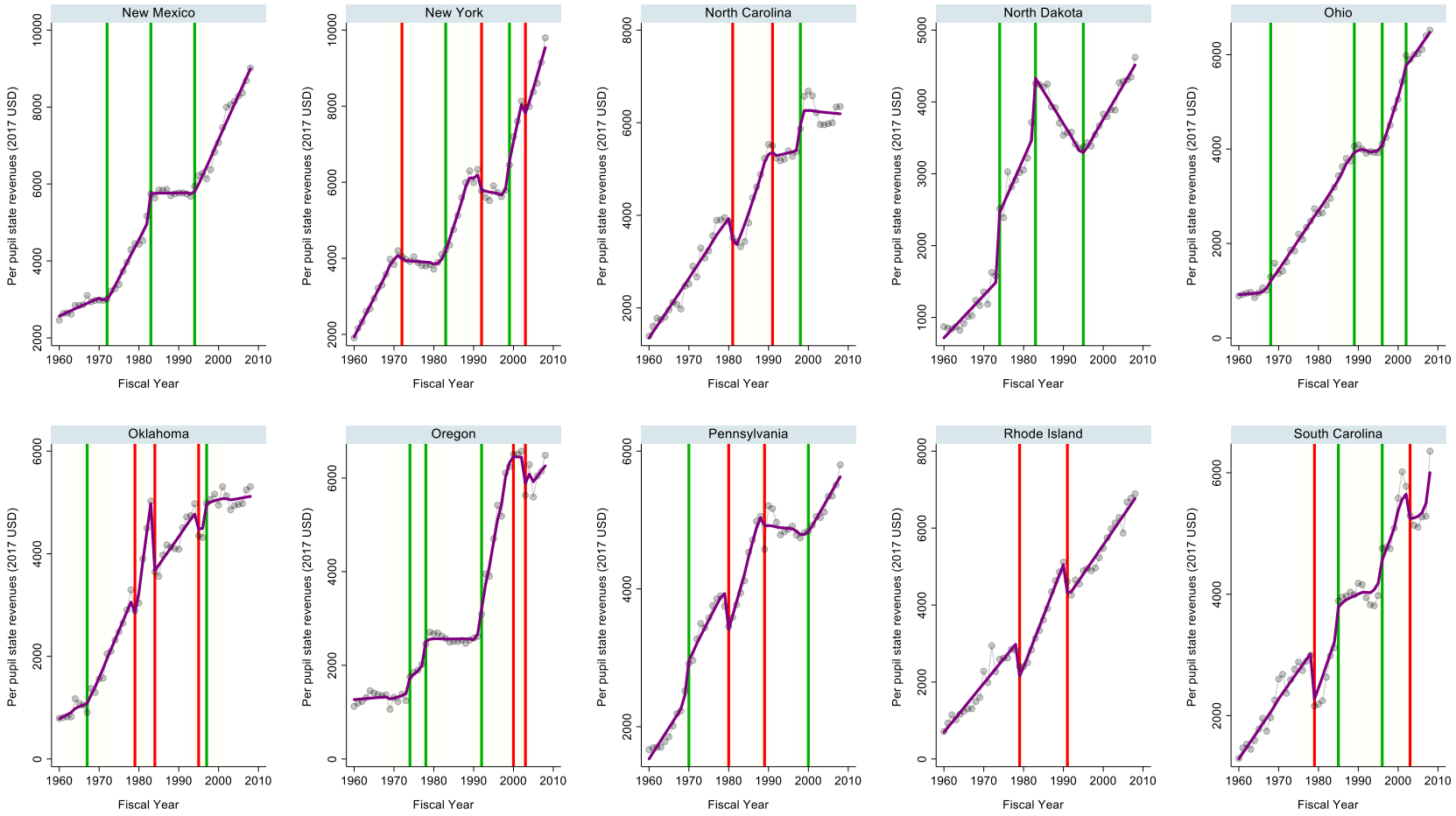
Appendix Figure D1. State-Specific Figures of Changepoints, Fiscal Years 1960-2008



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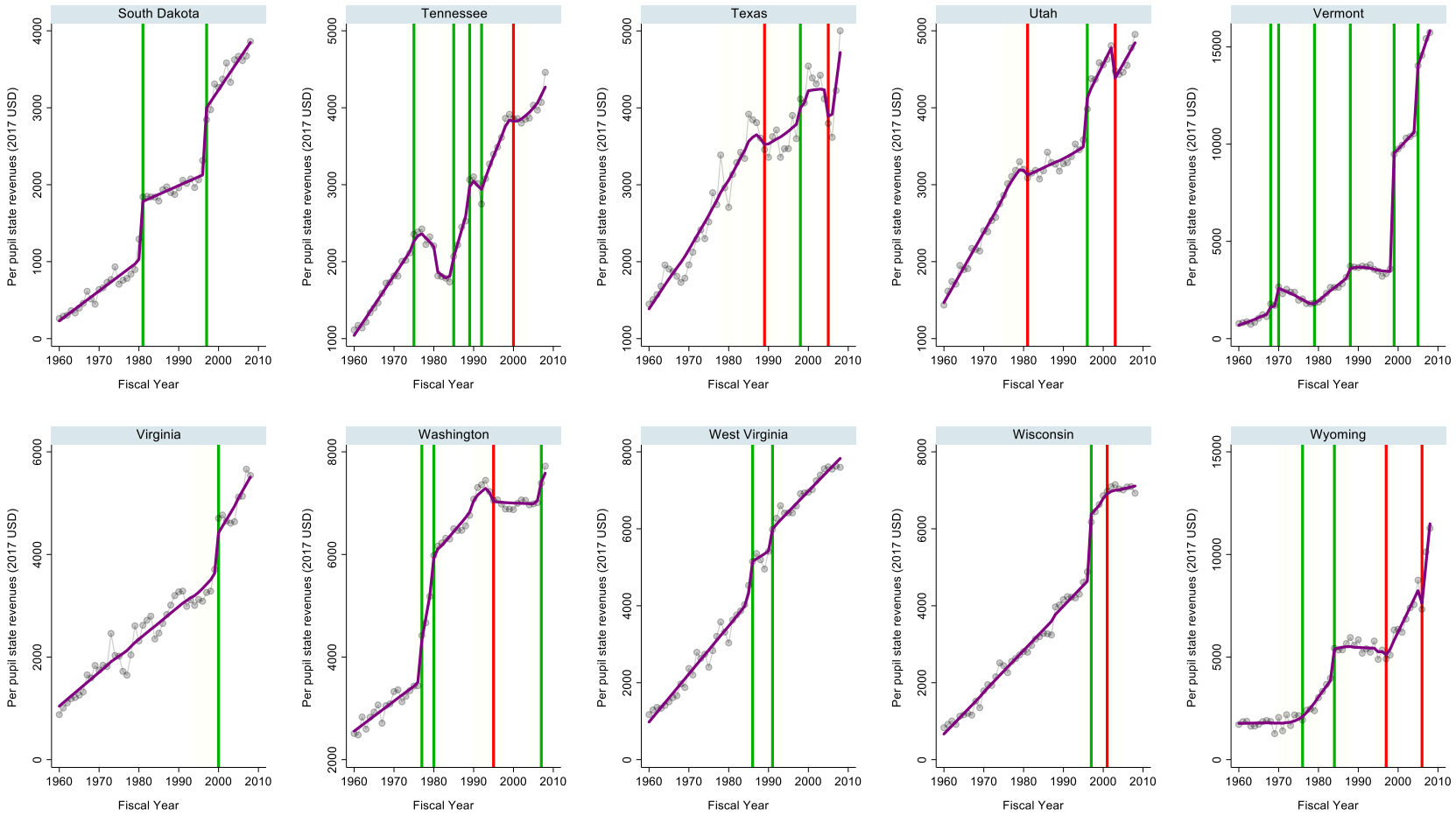
Appendix Figure D1. State-Specific Figures of Changepoints, Fiscal Years 1960-2008



Appendix E: List of Positive Changepoints & Associated Events

Appendix Table E1 (displayed on subsequent pages) lists all events found to be associated with the 43 positive changepoints identified during the pre-Great Recession adequacy era (i.e., fiscal years 1991-2008). The table also lists the fiscal year of the event, type of event (i.e., legislative activity, court activity, constitutional amendment, or resource shock), whether a legislative event met the funding formula (indicated with a "F") and/or resource increase (indicated with a "R") identification criteria,[3] and which events are also listed in the compiled tabulation of documented legislative and court-ordered SFRs (indicated with a "Yes").

[3] If a legislative statute was identified, we noted whether either of two conditions were met: the statute explicated a change in budget that corresponded to approximately 50 percent of the change in revenues detected by the changepoint or if a new funding formula was introduced

Appendix Table E1. List of Positive Changepoints & Associated Events

Changepoint Information		Event Information					
State	**Fiscal Year of Changepoint**	**Event #**	**Event**	**Fiscal Year**	**Event Type**	**Identification Criteria Fulfilled**	**Included in compiled tabulation of SFRs**
Alaska	2006	1	Oil boom		Resource	N/A	
Arkansas	2005	1	Act 107 (Second Extraordinary Session, 2003)	2004	Legislative Act	R	
Colorado	2003	1	Public School Finance Act of 1994	1994	Legislative Act		
		2	Giardino v. Colorado Board of Education, 2000	2000	Court Activity		
		3	Senate Bill 181	2000	Legislative Act	R	Yes
		4	Amendment 23 [Colorado Funding for Public Schools Initiative]	2001	Constitutional Amendment		
Connecticut	1999	1	Sheff v. O'Neill, 1996	1997	Court Activity		Yes
		2	Public Act 97-290 [An Act Enhancing Educational Choices and Opportunities]	1997	Legislative Act	R	
Florida	1999	1	House Bill 17-A [Public School Capital Outlay Program Act]	1998	Legislative Act	R	
Illinois	2000	1	House Bill 452	1998	Legislative Act	R	
Kansas	1994	1	Mock v. State (pre-trial opinion)	1992	Court Activity		
		2	School District Finance and Quality Performance Act [SDFQPA]	1992	Legislative Act	F	Yes
Kentucky	1991	1	Rose v. The Council for Better Education, Inc., 1989	1990	Court Activity		Yes
		2	House Bill 940 [Kentucky Education Reform Act]	1990	Legislative Act	F	Yes
Maine	*1999*		*Could not determine*				
Maine	*2007*		*Could not determine*				
Maryland	2005	1	Bradford v. Maryland State Board of Education, 1996	1997	Court Activity		Yes
		2	Senate Bill 856 [Bridge to Excellence in Public Schools Act]	2002	Legislative Act	F&R	Yes

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Appendix Table E1 – continued from previous page

Changepoint Information		Event Information					
State	**Fiscal Year of Changepoint**	**Event #**	**Event**	**Fiscal Year**	**Event Type**	**Identification Criteria Fulfilled**	**Included in compiled tabulation of SFRs**
Michigan	1995	1	Public Act 145	1994	Legislative Act		
		2	Michigan Tax Amendment [Proposal A]	1994	Constitutional Amendment	F	
Michigan	2001	1	Durant v. State II, 1999	1999	Court Activity		
		2	Public Act 297	2001	Legislative Act	F	
Minnesota	1993	1	Skeen v State of Minnesota	1992	Court Activity		
		2	1992 Legislation	1992	Legislative Act	R	
Minnesota	2003	1	2001 Legislation	2001	Legislative Act	R	
Missouri	1996	1	Committee for Educational Equality v. State, 1993	1993	Court Activity		Yes
		2	Senate Bill 380 [Outstanding Schools Act]	1993	Legislative Act	F&R	Yes
Montana	1993	1	House Bill 283	1990	Legislative Act	R	
Montana	2001	1	Senate Bill 100	1999	Legislative Act	R	
Montana	2006	1	Columbia Falls Public Schools v. State, 2005	2005	Court Activity		Yes
		2	2005 Legislation	2005	Legislative Act	R	
Nebraska	1991	1	Legislative Bill 940	1988	Legislative Act		
		2	Filing of Gould v. Orr	1990	Court Activity		
		3	Legislative Bill 1059 [Tax Equity and Educational Opportunities Support Act (TEEOSA)]	1990	Legislative Act	F	
Nebraska	1999	1	Legislative Bill 806; Legislative Bill 806A (companion appropriations bill)	1997	Legislative Act	F&R	
Nevada	*1991*		*Could not determine*				

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Appendix Table E1 – continued from previous page

Changepoint Information		Event Information					
State	**Fiscal Year of Changepoint**	**Event #**	**Event**	**Fiscal Year**	**Event Type**	**Identification Criteria Fulfilled**	**Included in compiled tabulation of SFRs**
New Hampshire	2000	1	Claremont v. Governor I, 1993	1994	Court Activity		Yes
		2	Claremont v. Governor II, 1997	1998	Court Activity		Yes
		3	House Bill 117	1999	Legislative Act	F	
New Mexico	1994	1	New Mexico Lottery Act	1995	Legislative Act		
		2	1996 court ruling	1996	Court Activity		
		3	Senate Bill 100	1997	Legislative Act	F	
		4	Zuni School District v. State, 1999	2000	Court Activity		Yes
		5	2001 Legislation	2002	Legislative Act	R	
New York	1999	1	Real Property Tax Law, Section 425 [New York State School Tax Relief (STAR) program]	1998	Legislative Act	R	
North Carolina	1998	1	North Carolina School Bonds Referendum (Referendum 1), Nov 1996	1997	Legislative Act	R	
North Dakota	1995	1	Bismarck Public School District No. 1 v. State of North Dakota, 1993 (district court)	1993	Court Activity		
		2	House Bill 1003	1993	Legislative Act	R	
		3	1995 Legislation (including Senate Bills 2059, 2063, and 2519)	1995	Legislative Act		
Ohio	1996	1	Filing of DeRolph v. Ohio	1992	Court Activity		
		2	House Bill 671	1992	Legislative Act	F & R	
Ohio	2002	1	Senate Bill 102	1997	Legislative Act		
		2	Biennial budget bill	1997	Legislative Act		
		3	DeRolph v. State I, 1997	1998	Court Activity		Yes
		4	House Bill 650 & House Bill 770	1998	Legislative Act		
		5	House Bill 282	1999	Legislative Act		

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Appendix Table E1 – continued from previous page

Changepoint Information		Event Information					
State	**Fiscal Year of Changepoint**	**Event #**	**Event**	**Fiscal Year**	**Event Type**	**Identification Criteria Fulfilled**	**Included in compiled tabulation of SFRs**
Ohio	2002	6	House Bill 283	1999	Legislative Act		
		7	DeRolph v. State II, 2000	2000	Court Activity		Yes
		8	House Bill 640	2000	Legislative Act		
		9	Biennial budget bill	2000	Legislative Act		
		10	House Bill 94	2001	Legislative Act	F&R	
Oklahoma	*1997*		*Could not determine*				
Oregon	1992	1	Measure 5	1991	Constitutional Amendment		
		2	Coalition for Equitable School Funding v. State, 1991	1991	Court Activity		
		3	Senate Bill 814	1991	Legislative Act	F	
Pennsylvania	*2000*		*Could not determine*				
South Carolina	1996	1	Filing of Abbeville County School District v. State	1994	Court Activity		
		2	Act 145, Part II, Section 119A (General Appropriations Act for 1995-96 year)	1995	Legislative Act	R	
South Dakota	1997	1	Bezdichek v. State, 1994	1995	Court Activity		
		2	1995 legislation acts	1995	Legislative Act	F	
Tennessee	1992	1	Filing of Tennessee Small School Systems v. McWheter I	1989	Court Activity		
		2	Education Improvement Act	1992	Legislative Act	F	Yes
Texas	1998	1	Edgewood ISD v. Kirby I, 1989	1990	Court Activity		
		2	Senate Bill 7	1993	Legislative Act	F	
		3	School Facilities Assistance Program	1995	Legislative Act	F	
		4	House Bill 4	1998	Legislative Act	F	
Utah	1996	1	Minimum School Program Act	1996	Legislative Act	R	

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Appendix Table E1 – continued from previous page

Changepoint Information		Event Information					
State	**Fiscal Year of Changepoint**	**Event #**	**Event**	**Fiscal Year**	**Event Type**	**Identification Criteria Fulfilled**	**Included in compiled tabulation of SFRs**
Vermont	1999	1	Brigham v. State, 1997	1997	Court Activity		Yes
		2	Act 60 [Equal Educational Opportunity Act]	1997	Legislative Act	F	
Vermont	2005	1	Anderson and Stevens v. State, 1998	1999	Court Activity		
		2	Act 68	2003	Legislative Act	F	Yes
Virginia	2000	1	House Bill 1450 budget amendment	1999	Legislative Act	F	
Washington	2007	1	2005 Legislation	2005	Legislative Act	R	
West Virginia	1991	1	House Bill 2131 & New Teacher Retirement System	1991	Legislative Act	R	
Wisconsin	1997	1	Act 27	1996	Legislative Act	F&R	

Appendix F: Additional Results

Table F1: Probability of Changepoint Occurring from Statutes or Court Order

	[1]	[2]	[3]	[4]
Legislative Statute	0.080		0.104	
	(0.059)		(0.068)	
Court Ruling		-0.035	-0.085	0.483***
		(0.041)	(0.058)	(0.112)
N	1078	1078	1078	1078

Notes: Models [1] through [3] predict the probability of a changepoint occurring, and Model [4] predicts the probability of a legislative statute being passed. All models control for state and year fixed effects. The panel dataset includes fiscal years 1987—2008. Standard errors clustered at the level of the state.

Table F2: Probability of Changepoint Occurring from State Governmental Policy

	True Government Control		Governor Party		Legislative Supermajority: Tax		Legislative Supermajority: Budget	
Either Party	0.018		N/A		0.005		-0.005	
	(0.015)				(0.019)		(0.002)	
Republican		0.012		0.059***		0.005		-0.008
		(0.014)		(0.022)		(0.021)		(0.022)
Democrat		0.025		0.074***		0.004		-0.002
		(0.025)		(0.022)		(0.023)		(0.024)
N	1078	1078	1078	1078	1078	1078	1078	1078
Rep=Dem		0.628		0.167		0.940		0.754

Note: All models estimate the probability of a changepoint occurring. Models control for state and year fixed effects. Standard errors are clustered at the state level. The panel dataset includes fiscal years 1987—2008. Positive changepoints are based on those identified by BEAST and restricted to those that occurred post-1990 and have identified statutes preceding the changepoint (see Figure 5). Test shows the p-value of the test for whether the coefficient for Republican equals Democrat.

Table F3: Probability of Changepoint Occurring from True Government Control

	True Government Control b2		True Government Control c2		True Government Control d2		True Government Control e2	
Either Party	0.040*		0.036		0.043*		0.039	
	(0.022)		(0.025)		(0.024)		(0.027)	
Republican		0.011		0.014		0.013		0.018
		(0.011)		(0.013)		(0.013)		(0.015)
Democrat		0.088*		0.069		0.079*		0.062
		(0.050)		(0.058)		(0.047)		(0.053)
N	980	980	980	980	980	980	980	980
Rep=Dem		0.133		0.358		0.165		0.413

Note: All models estimate the probability of a changepoint occurring. Models control for first and second lags of the independent variable, as well as state and year fixed effects. Standard errors are clustered at the state level. The panel dataset includes fiscal years 1987—2008. Positive changepoints are based on those identified by BEAST and restricted to those that occurred post-1990 and have identified statutes preceding the changepoint (see Figure 5). Test shows the p-value of the test for whether the coefficient for Republican equals Democrat. Definitions for True Government Control b2, c2, d2, and e2 are based on Piersen, Hand, and Thompson (2015).

Table F4: Probability of SFR Occurring from State Governmental Policy

	True Government Control		Governor Party		Legislative Supermajority: Tax		Legislative Supermajority: Budget	
Either Party	-0.022		N/A		-0.017		-0.021	
	(0.015)				(0.019)		(0.018)	
Republican		-0.021		0.120		-0.014		-0.020
		(0.019)		(0.024)		(0.022)		(0.021)
Democrat		-0.022		0.015		-0.019		-0.021
		(0.022)		(0.019)		(0.026)		(0.025)
N	980	980	980	980	980	980	980	980
Rep=Dem		0.961		0.864		0.873		0.955

Note: All models estimate the probability of an SFR event occurring based on the SFR tabulation of Lafortune, et al. (2018) and Shores, et al. (in press). Models control for first and second lags of the independent variable, as well as state and year fixed effects. Standard errors are clustered at the state level. The panel dataset includes fiscal years 1987—2008. Test shows the p-value of the test for whether the coefficient for Republican equals Democrat.