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The Great Recession, Fiscal Federalism and the Consequences for Cross-District Spending Inequality

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ABSTRACT

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Abstract

We examine the determinants of district spending and revenue shocks following the onset of the Great Recession and the role of fiscal federalism in mitigating these shocks. We test whether spending and revenue shocks were driven primarily by local labor market conditions or state finance centralization efforts. Utilizing population level data for all public school districts in the continental United States and a difference-in-differences strategy that models pre-recession resource trends, we find that local labor market conditions explain district spending loss in the wake of the Great Recession. In contrast, the degree of centralization in a state's education finance system is not correlated with district spending loss. Resource poor districts were especially ill-equipped to offset fiscal fallout, and federal fiscal stimulus did little to mitigate—and, in some cases, exacerbated—differential declines in school spending resulting from local labor market shocks. Together, this paper provides evidence to policymakers that state centralization efforts—often intended to promote school resource equity—did not increase fiscal vulnerability to recessionary events. The results also highlight the potentially unintended role that fiscal federalism might play in widening district spending inequality in the wake of recessionary events.

Keywords: Great Recession; fiscal federalism; educational spending; educational resources
JEL codes: H52, I21, I24, I28

Introduction

December 2007 marked the onset of an 18-month economic recession, referred to as the Great Recession, that had severe and wide-ranging economic and fiscal consequences. Unemployment increased by 5 percentage points, reaching 10 percent by October 2009, and these economic shocks varied widely across counties and commuting zones (Evans, et al., 2017; Hurd & Rohwedder, 2010; Wolff et al., 2011; Yagan, 2017). The fiscal effect of the Great Recession on school districts was similarly pronounced, imposing constraints on state and local funding for schools, resulting in a 3.7 percent decline in public school employment (Business Cycle Dating Committee, 2010; Chakrabarti & Livingston, 2013; Evans, et al., 2017; Leachman & Mai, 2014).

Recent evidence documents significant cross-state variation in school spending following the onset of the recession (Evans et al., 2017; Jackson, Wigger and Xiong, 2018). Evans et al. (2017) find that districts located in states which contribute a larger share of total, within-state education revenues were found to be more vulnerable to fiscal fallout (i.e., declines in education spending) in the wake of the Great Recession. The implication of this result is that districts located in states that had taken on greater fiscal responsibility for funding K-12 public education were more vulnerable to fiscal fallout compared to districts in states in which local school districts bore greater fiscal responsibility for funding K-12 public education.

This finding has important implications for state legislators considering whether to implement (or amend) school finance reform that shifts the burden of education funding away from localities to state central offices. Policymakers may be reluctant to pursue such equalization efforts through centralized funding if, by doing so, district spending becomes vulnerable to recessionary events. As a result, state equalization efforts, which have shown to reduce cross-

district spending inequality (Candelaria and Shores, 2017; Jackson, Johnson & Persico, 2016; Lafortune, Rothstein & Schanzenbach, 2018; Sims, 2011), may be reduced (or abandoned altogether).

However, the degree of centralization in a state's education finance system and a district's fiscal vulnerability following recessionary events are likely correlated with omitted variables. Specifically, districts located in states whose relative contribution to education spending is greater may also have experienced different local labor market shocks following the onset of the Great Recession. If the recession was more severe in districts (nested within states) that were more reliant on state revenues, then the observed fiscal fallout may be due to recessionary intensity – the extent of employment loss – and not the degree of centralized education spending. Therefore, if post-recession shocks to local labor markets explain more of the variation in fiscal fallout than a state's relative contribution to education spending, then the policy response will likely be quite different. Instead of abandoning (or, rolling back) efforts to reduce cross-district spending equity via state equalization efforts, more targeted approaches to distributing aid during recessionary periods should be pursued. Such targeted approaches could consider the magnitude of within-state variation in local labor market shocks (i.e., recession intensity) and seek to provide additional educational resources to school districts disproportionately affected by recessionary events.

In an effort to offset the Great Recession's effects on state and district education budgets, the American Recovery and Reinvestment Act (ARRA) of 2009 appropriated $97.4 billion in federal fiscal stimulus. The largest component was the State Fiscal Stabilization Fund, from which $48.6 billion was apportioned to state education systems based on the state's population share, and then allocated to districts within states based on a state's pre-existing education

funding formula (Evans et al., 2017; Steinberg, Quinn & Anglum, 2018). Notably, however, the provision of federal fiscal stimulus was not targeted at districts where the Great Recession was most severe (i.e., where employment losses were the greatest). While federal fiscal stimulus aimed to mitigate the shock of the recession on district education budgets, ARRA aid was not based on fiscal need. Whether or not this allocation scheme was effective at insulating districts most adversely impacted by the Great Recession is an open question. Currently, we have limited insight into how federal aid was distributed across districts differentially impacted by the economic downturn, or whether fiscal federalism insulated school districts from the adverse economic and resource shock of the Great Recession.

In this paper, we examine the following questions: (1) What explains post-recession shocks to district resources – state investment in education or local labor market shocks? (2) Did federal fiscal stimulus insulate districts from post-recession shocks to school resources?

To address these questions, we construct measures of the degree of centralization in a state's education finance system and the magnitude of the recessionary shock experienced by school districts in the wake of the Great Recession. The first measures a state's overall contribution to total K-12 revenues (i.e., the degree of centralization in a state's education finance system); the second measures the magnitude of cross-district variation in net employment loss (i.e., the recessionary shock following the onset of the Great Recession). We then estimate the magnitude of resource shocks to school revenues and expenditures as a function of a state's relative investment in education and local labor market shocks (i.e., recession intensity). We decompose the relative contributions of these two factors (state investment versus local labor market shocks) to empirically estimate the determinants of post-recession changes in district resources. Finally, we describe and evaluate the role fiscal

federalism played in mitigating (or exacerbating) the post-recession spending gap between districts that varied in the extent of local labor market shocks.

Our findings reveal that local labor market shocks following the Great Recession, and not state efforts to equalize cross-district spending, were the primary driver of district spending loss. These recession-induced declines in spending are driven not by changes in state revenues but by significant and substantive declines in local revenues. The decline in local revenues varied by district wealth, as higher wealth districts were better able to offset spending losses compared to low wealth districts in states where state fiscal centralization was greatest. Given these results, targeted stimulus aid would provide necessary fiscal support to the types of districts most vulnerable to recession-induced spending losses – low wealth districts located in high state investment states who were exposed to the most severe employment shocks of the Great Recession. However, the allocation of federal fiscal stimulus to school districts, funded by ARRA, did not mitigate – and, in some cases exacerbated – spending losses among districts most adversely affected by the recession. Together, this paper provides new insights into the recession's effect on the distribution of district resources, the sources of this effect, and the potentially unintended role that fiscal federalism might play in widening district spending inequality in the wake of recessionary events.

In the proceeding sections, we begin by describing the data and population of U.S. school districts included in our analytic sample. We then describe our approach for measuring the intensity of the recession (i.e., local labor market shocks) and state investment in education. Next, we present our empirical approach for estimating the relative influence of recession intensity and state investment on district educational resources. Then, we describe how federal

fiscal stimulus was distributed across districts, and whether federal aid mitigated any resource shocks associated with the Great Recession. We discuss our findings and conclude.

Data & Sample

We construct a district-level panel dataset consisting of the population of traditional public school districts in the continental United States for the 2002-03 through 2012-13 school years.[1] We combine demographic, revenue and expenditure information from the U.S. Department of Education's Common Core of Data (CCD) with economic, employment and housing information from the U.S. Department of Labor's Bureau of Labor Statistics (BLS), the U.S. Census and American Community Survey (ACS). Data from CCD includes district-by-year totals of ARRA-specific current and capital expenditures.[2]

District-level demographic information includes total K-12 enrollment, proportions of a district's K-12 students who are Asian, black, Hispanic, and white; and proportions of a district's K-12 students who qualify for free- or reduced-price lunch (FRPL), receive special education services (i.e., have an individualized education plan, or IEP), and are English Language Learners (ELL). We also incorporate geographic information about a district's locale (i.e., whether the district is urban, rural, suburban or a town). District-level revenue data are from the CCD Local Education Agency Finance Survey (F-33), and include revenue from state, local and federal sources. District expenditure data also come from the CCD F-33 survey, and include total expenditures, instructional expenditures, and capital expenditures.[3] Finally, in the 2008-09

[1] Data for Washington, DC, Hawaii and Alaska are excluded, as are districts comprised only of charter schools.
[2] For measures of district resources (revenues and expenditures), we consider the 2002-03 through 2007-08 school years as pre-recession years; the 2008-09 through 2012-13 school years are the post-recession years. Though the Great Recession officially began in December 2007, state (and district) education budgets for the 2007-08 academic year are determined prior to the start of the academic year (i.e., September 2007), and therefore prior to the recession's onset.
[3] Instructional expenditures include payments from all district funds for salaries, employee benefits, supplies, materials, and contractual services for elementary/secondary instruction; excludes capital outlay, debt service, and

through 2012-13 school years, the CCD F-33 survey reports two district-level expenditure measures derived from fiscal stimulus provided via ARRA funds – ARRA current expenditures and ARRA capital expenditures. We combine these two variables to measure total district-level ARRA spending for the 2008-09 to 2012-13 period. To generate a variable which measures district-level expenditures in the absence of ARRA aid, we subtract total ARRA expenditures from total district expenditures. We convert all revenue and expenditure variables to real ($2013) per-pupil dollars (using district enrollment totals) and eliminate outliers based on an algorithm akin to Murray, Evans and Schwab (1998) and Berry (2007).[4]

Measuring Recession Intensity

Following Yagan (2017) and Shores and Steinberg (2017), we measure recession intensity as the net change in log employment among all counties in the United States. Specifically, we measure recession intensity as:

$$(1) \qquad Recession_c = \left[\ln\left(\frac{E_{c,2010}}{E_{c,2007}}\right) - \ln\left(\frac{E_{c,2006}}{E_{c,2003}}\right)\right] - \left[\ln\left(\frac{E_{agg,2010}}{E_{agg,2007}}\right) - \ln\left(\frac{E_{agg,2006}}{E_{c,2003}}\right)\right]$$

where E_{ct} denotes the number of employed workers in county *c* in the Spring of academic year *t*,[5] and where *agg* denotes total employment across the continental U.S. in year *t*.[6] Each county's recession intensity is measured as the change in log employment during the recessionary period (Spring 2007 to Spring 2010, or fiscal years 2007 to 2010) relative to the county's pre-recession trend (Spring 2003 to Spring 2006) and is then normalized by subtracting

interfund transfers for elementary/secondary instruction. Capital expenditures include expenditures for construction of buildings, roads, and other improvements, and for purchases of equipment, land, and existing structures.

[4] Specifically, the algorithm calculates the average spending in each state and year and eliminates district values in that state-year which are less than 25 percent of the bottom 5th percentile or greater than 200 percent of the top 95th percentile.

[5] For example, the Spring academic year 2010 corresponds to the academic year 2009-10, which in turn corresponds to fiscal year 2010. Years are indexed in Spring academic years to correspond to the student achievement data used below.

[6] Annual employment data are taken from the Quarterly Census of Employment and Wages (QCEW).

the aggregate employment trend. This measure of recession intensity accounts for counties' pre-recession secular trends in log employment. Notably, recession intensity is predominantly a within-state phenomenon – 76 percent of the variation in recession intensity occurred within states.[7]

Measuring State Investment in Education

Following Evans et al. (2017) and Jackson et al. (2018), we quantify a state's relative investment in total education spending as:

$$(2) \qquad StateShare_s = \frac{\sum_{d=1}^{D_s} StateRevenue_{d,07/08}}{\sum_{d=1}^{D_s} TotalRevenue_{d,07/08}}$$

where $StateShare_s$ is equal to total state revenues across all *d* districts in state *s* in 2007-08 divided by total education revenues (i.e., revenues from state, local, federal and other sources) across all *d* districts in state *s* in 2007-08. $StateShare_s$ measures the relative contribution to total revenues in state *s* just prior to the recession.[8]

We generate three versions of $Recession_c$ and $StateShare_s$. First, we convert the continuous measures $Recession_c$ and $StateShare_s$ into four quartiles. For example, quartile four of $Recession_c$ includes districts (nested within counties) that experienced the largest net employment loss; quartile four for $StateShare_s$ includes districts (nested within states) located in a state that contributes the largest share of total K-12 revenues.

Because $Recession_c$ and $StateShare_s$ are measured on different scales, we also convert them into two common metrics. For the first common metric, we standardize the variables to be

[7] The variable $Recession_c$ will contain multiple districts *d* for every county *c*, as there are 3,051 counties in the continental U.S. for which we have school finance and employment data. The regression equation, described below, will include the subscript *d* for this reason, but recession intensity varies only across counties *c*.

[8] Although the Great Recession officially began in December 2007, state (and district) education budgets for the 2007-08 academic year are determined prior to the start of the academic year (i.e., September 2007). Therefore, education revenues and spending in the 2007-08 school year will not be affected by the official onset of the Great Recession.

mean zero and standard deviation one (i.e., $\sim N(0,1)$). Here, a 1-unit change is equivalent to a one standard deviation increase in either net job loss or state contribution to total revenues. For the second common metric, we convert the variables to rank-units (Chetty, et al., 2014). Here, a 1-unit change is equivalent to a one rank-unit increase in either of the two measures.

Sample

Our analytic sample consists of 14,139 unique districts for the continental United States across the 2002-03 through 2012-13 school years, including 145,880 district*year observations.[9] Table 1 summarizes district demographic characteristics for the entire analytic sample, as well as populations disaggregated into recession intensity quartiles and state share quartiles.[10] On average, districts that experienced the most net job loss following the recession had higher student enrollment, a higher proportion of white students (and a lower proportion of minority students), a lower proportion of students receiving free/reduced-price lunch, and were less likely to be located in urban communities. In contrast, districts located in states that contributed the largest share of total K-12 revenues had, on average, a lower proportion of white students (and a higher proportion of minority students), a higher proportion of students receiving free/reduced-price lunch and were more likely to be located in urban communities. These patterns indicate that districts serving fewer economically disadvantaged and minority students in non-urban communities where most adversely affected by the economic shock of the recession, while

[9] Districts need not be present for each year in the sample. In no individual year is the number of districts greater than 14,000. The average number of districts by year is 13,267 and ranges from 12,942 in the 2012-13 school year to 13,772 in the 2002-03 school year. For 2012-13, the NCES reports 13,515 school public school districts in the United States (including Washington DC, Hawaii and Alaska); our sample therefore includes 95.7 percent of the population of all U.S. school districts.

[10] Note that recession intensity is measured within states while state share is measured across states; i.e., recession intensity varies across districts (nested within counties), while state share varies across states (but is constant across districts within states).

districts serving more economically disadvantaged and minority students in urban communities were located in states that contributed the greatest share of education spending.

<Table 1 about here>

Table 2 summarizes district revenues and expenditures. On average, districts that experienced the greatest net job loss following the recession received significantly less total education revenue – nearly $2,000 per pupil less – than districts least affected by the economic recession. These districts, in turn, had fewer resources to dedicate to total and instructional education expenditures. Similarly, districts located in states that contributed the largest share of total K-12 revenues received significantly less total education revenue – approximately $1,250 per pupil less – than districts located in states that contributed the least toward education spending. Districts in high state share states received approximately half of the local education revenue received by districts in the lowest state share states. However, part of this difference is made up by state revenues, as districts located in the highest state share states received approximately $1200 more per pupil, on average, in state revenues than districts located in the lowest state share states.

<Table 2 about here>

These patterns reveal that districts experiencing the greatest economic shock of the recession and located in states that contributed the most to education revenues spent, on average, the least on education during the study period (i.e., 2002-03 to 2012-13 school years). In districts with the greatest economic shock, this spending difference is attributable to differences in both local and state revenues. In districts (within states) with the greatest state revenue share, the spending difference is driven solely by differences in local revenues and is partially offset by

differences in state revenues. We next describe the empirical approach we use to identify the determinants of post-recession changes in education revenues and expenditures.

Empirical Approach

We estimate the magnitude of district-level resource shocks in the wake of the Great Recession in two stages. In the first stage, we estimate the following model:

(3) $$Resources_{dt} = \lambda_d + \lambda_d t + \varepsilon_{dt};\ \ t \in \{2003, 2004, 2005, 2006, 2007, 2008\}$$

In equation (3), $Resources_{dt}$ corresponds to a measure of: (i) per-pupil revenue (state, local or federal revenues) in district *d* in school year *t*; or (ii) per-pupil expenditures (total, instructional or capital expenditures) in district *d* in school year *t* (a total of six separate outcomes). The variable λ_d are district fixed effects and t is a continuous variable for the academic year, such that *t*=1 in the 2002-03 school year, 2 in the 2003-04 school year, up to the 2007-08 school year.

This first-stage equation purges estimates of district resource changes of unit-specific variation that is time-invariant and unit-specific time-varying secular trends prior to the onset of the Great Recession. From equation (3), we predict $\widehat{Resources}_{dt}$ for the entire period, i.e., 2002-03 through 2012-13 school years. The residuals from this prediction ($\widetilde{Resources}_{dt} = Resources_{dt} - \widehat{Resources}_{dt}$) form the outcome variables used in the second stage, which we discuss below. Detrending the data in this way parallels our approach to defining and measuring $Recession_c$; that is, both recession intensity and our analytic strategy account for pre-recession secular trends.

To estimate the change in district revenues and expenditures in the years following the onset of the Great Recession as a function of recession intensity and state investment in education, we estimate the following models:

(4a) $$\widetilde{Resources}_{dt} = \beta_q\left[\sum_{q=1}^{Q}\left(Recession_d^q * Post_t\right)\right] + \varepsilon_{dt}$$

(4b) $$\widetilde{Resources}_{dt} = \gamma_q\left[\sum_{q=1}^{Q}\left(StateShare_s^q * Post_t\right)\right] + \varepsilon_{dt}$$

(4c) $$\widetilde{Resources}_{dt} = \beta[Recession_d * Post_t] + \gamma[StateShare * Post_t] + \varepsilon_{dt}$$

In equations (4a) - (4c), the variable $Post_t$ is equal to unity in the 2008-09 through 2012-13 school years, and zero otherwise. $Post_t$ provides an estimate of the average change in resources (relative to pre-recession trends) in the post-recession period as a function of either recession intensity or state investment in education, and ε_{dt} is a mean-zero random error term. [11] We cluster the standard errors at the district level to account for serial correlation across time within a district.

Because we detrend each district's pre-recession outcome trends, estimates of β_q from Equation (4a) correspond to the average net change in $Resources_{dt}$ in $Recession_d^q$ (i.e., recession intensity quartile q) following the onset of the Great Recession (i.e., 2008-09 through 2012-13 school years), net of each district's pre-recession outcome slope. Similarly, from Equation (4b), estimates of γ_q correspond to the average net change in $Resources_{dt}$ in $StateShare_s^q$ (i.e., state share quartile q) following the onset of the Great Recession, net of each district's pre-recession outcome slope. Thus, detrending the data allows us to report estimates of $\widehat{\beta_q}$ and $\widehat{\gamma_q}$ as effect sizes.

In Equation (4c), we estimate marginal coefficients for β and γ, net of recession intensity and state revenue share. To reduce the dimensionality of the estimating equation, we replace the

[11] Note that if we include the terms λ_d and $\lambda_d t$ (from equation (3)) in Equations (4a-4c) and replace $\widetilde{Resources}_{dt}$ with $Resources_{dt}$, estimates of β_q and λ_q will be identical insofar as we estimate each of the post-recession effects non-parametrically by replacing $Post_t$ with year indicators θ_t for years 2008-09 to 2012-13. By estimating more traditional effect sizes that replace θ_t with a single indicator variable $Post_t$, including unit-specific time trends is not equivalent to estimating on the residuals. See Wolfers (2006) for discussion and explanation in the context of unilateral divorce laws.

quartile indicators of $Recesion_d$ and $StateShare_q$ with their continuous counterparts, described above. Specifically, we estimate two separate equations in which recession intensity and state revenue share are standardized to be either $\sim N(0,1)$ or converted to rank-units. Equation (4c) is akin to a horse-race model, testing whether district resource outcomes are differentially related to recession intensity and state investment in education, net of the correlation between these two variables.

Heterogeneity in Local District Response

With measures of both recession intensity and state investment in education, we can explore potentially important heterogeneity in district response to the magnitude of local labor market shocks. Assuming districts have a preferred education budget, state centralization efforts enable districts to fund that budget with a lower local tax rate. By subsidizing a district's tax effort, localities can increase local revenues (via increases in local tax rates) to offset declines in state revenues during recessionary periods. This potential response by local districts is informed by prior evidence on the substitution of local revenues (via increases in property tax rates) for state support during recessionary periods (Chakrabarti, Livingston & Roy, 2014; Dye & Reschovsky, 2008) and the crowding-out of state equalization funding whereby state grant aid is used as local property tax relief (Lutz, 2010; Steinberg et al., 2016). What follows are three empirical predictions.

First, we expect total per pupil district spending to increase as a function of recession intensity and state investment. That is, we expect the recession to catalyze spending increases in districts located in states with greater fiscal centralization. Second, we expect these spending increases to be driven by increases in local revenues. Third, property wealthy districts will increase spending more, via increases in local revenues, than districts with less property wealth,

holding constant recession intensity and state investment in education. Thus, we expect the local subsidy resulting from the degree of centralization in a state's finance system to be disequalizing.

We evaluate these empirical predictions in the context of the following triple-interaction model:

(5) $\widetilde{Resources}_{dt} = \beta[Recession_d * Post_t] + \gamma[StateShare_s * Post_t] + \psi[Recession_d * StateShare_s * Post_t] + \varepsilon_{dt}$

The interaction term ($Recession_d$*$StateShare_s * Post_t$) provides insight into the extent to which district resources changed in the post-recession period in districts most adversely affected by the recession (i.e., districts with the most net job loss) located in states with the greatest investment in education (i.e., states that contributed the largest relative share toward education spending). We evaluate the first empirical prediction by assessing estimates of ψ where $\widetilde{Resources}_{dt}$ equals (detrended) per pupil total expenditures. If $\hat{\psi} > 0$, then the recession will have catalyzed spending increases in districts (within states) in which the state's relative contribution to educational revenues is greater. We evaluate the second prediction by estimating two regressions, alternatively replacing $\widetilde{Resources}_{dt}$ with detrended per pupil local and state revenues, respectively. We predict that increases in total spending will be attributable to increases in local revenues and not to state revenues. To evaluate the third prediction, we generate measures of district housing values and household income from the 2000 decennial Census ACS and convert these measures into within states terciles.[12] We then estimate Equation (5) for each of these property wealth terciles and compare estimates for $\hat{\psi}_w$, where *w* indexes

[12] Specifically, we use two variables from the 2000 decennial Census from the American Community Survey (ACS) Education Demographic and Geographic Estimates (EDGE). The variables are median home values and median family income. We construct within-state terciles for each of the two measures.

terciles of housing values and household income, respectively (i.e., $w = 1$ corresponds to low wealth districts and $w = 3$ corresponds to high wealth districts). If $\hat{\psi}_{w=3} > \hat{\psi}_{w=1}$, then high property wealth districts will have raised spending and local revenues more than low property wealth districts, controlling for recession intensity and a state's contribution to education.

Estimating the Role of Federal Fiscal Stimulus

Finally, we examine whether federal fiscal stimulus was allocated in relation to the magnitude of the economic shock of the Great Recession. To do this, we estimate a variant of Equation (4c). Specifically, we include two outcome variables for $\widetilde{Resources}_{dt}$ described above: (i) total expenditures ($\widetilde{Resources}_{dt}^{Exp}$); and (ii) total expenditures minus ARRA-specific expenditures ($\widetilde{Resources}_{dt}^{NetExp}$).[13] Using a seemingly unrelated regression framework, we estimate the following system of equations:

$$\text{(6a)} \quad \widetilde{Resources}_{dt}^{Exp} = \beta_q^t\left[\sum_{q=1}^{Q}\left(Recession_d^q * \theta_t\right)\right] + \gamma^t[StateShare_s * \theta_t] + \varepsilon_{dt}$$

$$\text{(6b)} \quad \widetilde{Resources}_{dt}^{NetExp} = \lambda_q^t\left[\sum_{q=1}^{Q}\left(Recession_d^q * \theta_t\right)\right] + \gamma^t[StateShare_s * \theta_t] + \varepsilon_{dt}$$

In Equation (6a), the β_q^t coefficients describe total spending losses in each year following the Great Recession in $Recession_d^q$ in years θ_t (i.e., 2008-09 through 2012-13). In Equation (6b), the λ_q^t coefficients describe total spending losses *in the absence of ARRA* in each year following the Great Recession. In Equations (6a) and (6b), we also replace $\theta_t$with $Post_t$ to provide the average change in spending for the entire post-recession period (i.e., β_q^t becomes $\beta_q$and λ_q^t becomes λ_q). In both models, we control for the effect of $StateShare_s$ on spending loss by including interactions of year effects and state revenue share, where $StateShare_s$ is

[13] The amount of total ARRA aid per district is recorded in the NCES Common Core of Data F-33 file. We subtract total ARRA expenditures from total expenditures to recover spending in the absence of ARRA.

standardized $\sim N(0,1)$.[14] Comparing estimates of β_q^t and estimates of λ_q^t allow us to examine spending changes with and without federal stimulus for districts most and least affected by the recession, controlling for year-specific changes in spending correlated with state revenue contributions.

Results

Our primary analysis is concerned with characterizing the relative contributions of state revenue share and local labor market conditions to fiscal fallout following the onset of the Great Recession. To begin, we present estimates of the change in total education expenditures, by recession intensity and state share quartiles, following the onset of the Great Recession (see Figure 1 and Table 3). Our main finding is that the post-recession decline in district spending is highly correlated with recession intensity. For districts experiencing the largest net employment loss (i.e., recession intensity quartile 4), total expenditures declined annually by $1,917 per pupil, on average, across the post-recession period (i.e., 2008-09 through 2012-13 school years). Compared to districts least affected by the recession (i.e., recession intensity Q1), our difference-in-differences estimates suggest that the recession reduced total expenditures annually by $1,042 per pupil, on average, across the post-recession period for those districts most adversely affected by the recession (see Panel B, Table 3). Further, the recession's impact on total per pupil expenditure loss is monotonic (i.e., the Q4-Q1 difference is larger than the Q4-Q2 difference, which is, in turn, larger than the Q4-Q3 difference).[15]

[14] For robustness, Table A1 presents results in which the standardized version of $StateShare_s$ is replaced with the rank-unit version.

[15] Note also that in the absence of detrending, we may mistakenly attribute post-recession spending declines to pre-recession secular trends. For example, districts with the lowest net job loss and lowest state revenue share were increasing total per pupil spending at a relatively lower rate compared to districts with the greatest job loss and state revenue share. In regression estimates not shown, the pre-recession annual increase for districts most affected by the recession (i.e., recession intensity Q4) was $247 per pupil greater than it was for districts least affected by the

<Figure 1 about here>

<Table 3 about here>

In contrast, we do not find an association between state share and expenditure loss. The quartile-specific main effects for total expenditures lack monotonicity (see Panel A, Table 3). Further, the difference-in-difference estimates are not significantly different from zero for districts located in states that contributed the largest share of total K-12 revenues (i.e., state share Q4) compared to districts in states that contributed the least and second least toward total K-12 revenues (i.e., state share Q1 and Q2).

Second, we find that the recession negatively affected spending on capital but did not differentially impact instructional spending (see Figure 2). Among recession intensity Q4 districts, capital expenditures declined annually by $832 per pupil, on average, across the post-recession period. Compared to recession intensity Q1 districts, our difference-in-differences estimates suggest that the recession reduced capital expenditures annually by $665 per pupil, on average, across the post-recession period (see Panel B, Table 3). In contrast, we see little to no difference among recession intensity quartiles in instructional spending declines. Thus, it appears that districts suffering the most from the economic shock of the recession substituted away from capital spending to smooth out instructional expenditures. This finding on the substitution away from capital to instructional expenditures among districts most adversely impacted by the economic shock of the recession is consistent with evidence from Jackson et al. (2018). Again, we find little evidence of a correlation between state share and declines in either instructional or capital expenditures.

recession (i.e., recession intensity Q1). Similarly, the pre-recession annual increase for districts with the most state share (i.e., state share Q4) was $187 per pupil greater than it was for districts with the lowest state share.

<Figure 2 about here>

To what extent do the sources of district revenue change post-recession? Table 4 summarizes these results. We find that the recession negatively affected local revenues, with little consistent effect on revenues from state sources. Compared to recession intensity Q1 districts, our difference-in-differences estimates suggest that the recession reduced local revenues annually by $588 per pupil, on average, across the post-recession period for those districts most adversely affected by the recession (see Panel B, Table 4). The recessionary effect on local revenues is also monotonic; the difference-in-differences estimate comparing Q4 to Q3 districts is nearly half the magnitude – $342 – of the estimated effect comparing Q4 to Q1 districts. These results provide further confirmation that the recession was largely a within-state phenomenon, given that state revenue losses are relatively uncorrelated with the recessionary effect on local employment loss.

<Table 4 about here>

In contrast, state share is associated with declines in state revenues. This result is not unexpected, given that districts more reliant on state aid realized fewer state revenues in the wake of the recession. However, relative declines in state revenue were approximately offset by relative gains in local revenues. The difference-in-differences estimate for state revenues (comparing state share Q4 to Q1 districts) suggests that state share reduces state revenues by $772 per pupil annually. Conversely, the difference-in-differences estimate for local revenues (again comparing state share Q4 to Q1) reveals that local revenues increased by $1133 per pupil annually in districts with the greatest state share. These results suggest that districts located in low state share states – those states that contribute the least to education revenues – may be 'maxed out' with respect to their local tax effort since they contribute a larger share toward

education revenues. The consequence of these results is that local support of education may be more susceptible to recessionary shocks in states where the state contributes the *least* toward education. Note that these models do not control for recessionary intensity and state revenue share simultaneously, so we cannot separate the revenue losses due to state share from the recession's impact. Next, we present results which jointly condition on recession intensity and state share to further explore this empirical result.

Marginal Contributions of Recession Intensity and State Share to Education Resources

We next consider the marginal contribution of recession intensity and state share on education spending. Table 5 summarizes these results. We find that, conditional on state share, recession intensity is highly correlated with expenditure loss. Specifically, a one standard deviation increase in recession intensity is associated with a $518 per pupil annual decline in total expenditures across the recessionary period. As shown in Table 3, the post-recession decline in total expenditures are driven by significant declines in capital spending among districts most adversely affected by the recession. Indeed, a one standard deviation increase in recession intensity is associated with a $333 per pupil annual decline in capital expenditures across the recessionary period. We again find no association between recession intensity and instructional expenditures. These results are robust to the scaling of the explanatory variables (i.e., SD units or rank units).

<Table 5 about here>

Conditional on recession intensity, we find no relationship between state share and total expenditures. Indeed, while total spending and instructional spending did not decline with state share (net of recession intensity), capital spending increased by $98 per pupil annually for each standard deviation increase of state share. These results can be further explained by the

differential change in revenues sources following the recession (see Table 6). Specifically, while recession intensity is uncorrelated with state revenues, local revenues decline significantly, by $295 per pupil annually for each year after the Great Recession. In contrast, state share is negatively correlated with state revenues (a one standard deviation increase in state share is associated with a $315 per pupil annual decrease in state revenues) but positively predicts local revenues (a one standard deviation increase in state share is associated with a $343 per pupil annual *increase* in local revenues). Thus, net of recession intensity, districts in high state share states increased local revenues in support of education to offset declines in state revenues. Whether the recession catalyzed local effort in support of education spending is a question we take up in the next section.

<Table 6 about here>

Heterogeneity in Local District Response

To what extent, then, do local district resources vary in the post-recession period as a function of recession intensity and state investment? Our primary hypothesis is that the recession catalyzed local effort in districts located in states that provide a relatively larger share of education revenues. Here, we present results from three empirical predictions that lend insight into this hypothesis.

First, we expect district spending to increase as a function of recession intensity and state investment. If local revenues are counter-cyclical and substitute for state support during recessionary periods (Chakrabarti, Livingston & Roy, 2014; Dye & Reschovsky, 2008) and state aid subsidizes local tax effort in support of education spending (Lutz, 2010; Steinberg et al., 2016), then districts most adversely affected by the recession in high state share states should increase education spending, conditional on recession intensity and state share. This is indeed

what we find. Districts that jointly have one standard deviation greater recession intensity and one standard deviation greater state share realized average annual increases in education spending of $260 per pupil across the post-recession period (see Table 5). This result is robust to the functional form of the explanatory variables (i.e. SD units or rank units).

Second, we expect increases in educational expenditures to be driven by increases in local revenues. Again, if a state's (pre-recession) share of education revenues subsidizes local spending and the onset of the recession catalyzes a revenue generating effort on behalf of local school districts, we would expect spending increases to be driven by increases in local revenues. Indeed, we find that most of the spending increase – approximately 54 percent – is due to increases in local revenues. Districts with one standard deviation greater recession intensity and one standard deviation greater state share increased average annual revenues from local sources by $141 per pupil across the post-recession period (see Table 6). In contrast, state revenues are not statistically significantly correlated with the interaction term.

Third, the consequences of a state's subsidy for local effort in support of education spending during recessionary periods will be disequalizing. Higher wealth districts – those with greater median home prices and higher household incomes – will be more equipped to increase spending via increases in local revenues than resource poor districts, holding constant recession intensity and state investment in education. Results summarized in Table 7 support this prediction. Namely, wealthier districts – those with either higher mean housing values or higher mean household income – generate significantly greater expenditures in the post-recession period than their resource poor counterparts, between $381 and $430 per pupil annually, depending on the measure of wealth used. Moreover, these differential expenditure increases are

funded in large part by differential increases in local revenues, between $168 and $215 per pupil annually.

<Table 7 about here>

The Role of Federal Stimulus in Post-Recession Spending Loss

In this section, we examine the extent to which federal fiscal stimulus, funded via the American Recovery and Reinvestment Act (ARRA), mitigated (or even exacerbated) the gap in spending loss between districts differentially exposed to net job loss as a result of the Great Recession.

Table 8 summarizes the distribution of expenditures funded by ARRA stimulus aid across the post-recession period. On average, districts spent $112 per pupil annually in ARRA-supported expenditures. Though we find statistically significant variation in ARRA-supported expenditures across quartiles of both recession intensity and state share, we observe little substantive variation in quartile-specific expenditures. For example, districts most adversely affected by the recession (i.e., Quartile 4) spent, on average, $103 per pupil annually in ARRA-supported expenditures across the post-recession period; this compares to $129 per pupil in ARRA-supported expenditures among Quartile 1 districts. By state share, results are similar. Districts in states with the greatest state share (i.e., Quartile 4) spent, on average, $103 per pupil annually in ARRA-supported expenditures compared to $131 among Quartile 1 districts. These results confirm that federal stimulus was distributed to districts in ways that were largely orthogonal to the magnitude of the recessionary shock that local school districts experienced. Indeed, as we describe above, ARRA stimulus aid was distributed to states in block grants, based on a state's population share, and not based on where the Great Recession was most severe.

<Table 8 about here>

While the provision of ARRA-funded expenditures varied little by recession intensity, we have previously shown that recession intensity was a key driver in post-recession spending loss. Indeed, post-recession spending loss was significantly greater for districts most adversely affected by the Great Recession (see Figure 1 and Table 3). To what extent, then, did ARRA aid reduce spending loss among districts differentially impacted by the onset of the Great Recession?

Table 9 summarizes estimates of the extent of spending loss funded by ARRA-specific expenditures across recession intensity quartiles (Figure 3 presents estimates of the post-recession spending loss, by recession quartile, with and without ARRA-supported expenditures). Panel A displays regression estimates of ARRA expenditures by recession intensity quartile (i.e., $\beta_q^t - \lambda_q^t$ from Equations (6a) and (6b)). Districts least affected by the recession spent slightly more ARRA-supported funds compared to districts most affected; these differences, however, are relatively minor in an absolute sense.

Panel B shows the ratio of ARRA expenditures relative to expenditure declines in the post-recession period (i.e., $\frac{\beta_q^t - \lambda_q^t}{\lambda_q^t}$). Here we find meaningful differences across recession intensity quartiles. For example, across all post-recession years (i.e., 2008-09 through 2012-13), ARRA-specific expenditures accounted for 24 percent of total spending loss among districts least impacted by the Great Recession (i.e., Q1 districts). In contrast, ARRA-specific expenditures accounted for just 11 percent of total spending loss among districts most impacted by the Great Recession (i.e., Q4 districts). This 13 percentage-point difference in the ratio of ARRA-specific expenditure to post-recession spending loss is highly significant (see Panel C, Table 9).

<Table 9 about here>

<Figure 3 about here>

These results suggest two key findings with respect to the role that federal fiscal stimulus played in the wake of the Great Recession. First, while there were few substantive differences across quartiles of recession intensity in the magnitude of ARRA expenditures, we find significant differences in the extent to which ARRA aid offset post-recession spending losses across districts differentially impacted by the economic shock of the Great Recession. And second, ARRA aid was not distributed to school districts in a way that insulated districts from the recession's effect on education spending; instead, the distribution of ARRA aid, at best, did little to reduce the spending gap between districts and, at worst, exacerbated those gaps (see Figure 4).

<Figure 4 about here>

Conclusion

In this paper, we examine the determinants of district spending and revenue shocks following the onset of the Great Recession and the role of fiscal federalism in mitigating these shocks. Our findings point to the deleterious effect of recessionary events on district budgets, while revealing that the degree of fiscal centralization in state education finance systems plays no meaningful role in explaining post-recession declines in district spending. Our results differ from existing evidence on the determinants of post-recession declines in district resources (Evans et al., 2017), which suggest that both recession intensity and state revenue share are correlated with declines in district spending.

Though we measure state revenue share in the same way as Evans et al. (2017), our analytic strategy departs from theirs in important ways. First, Evans et al. (2017) leverage only

post-recession declines in employment to capture recession intensity; our measure of recession intensity accounts for pre-recession secular trends in employment. Similarly, our econometric approach leverages the panel nature of these data by accounting for pre-recession secular trends in district spending; absent this, post-recession changes in spending may be confounded by pre-recession trends.[16] Thus, our estimates of post-recession changes in district resources will differ from Evans et al. (2017) to the extent that pre-recession resource trends correlate with recession intensity. By conditioning on pre-recession trends in both employment and district resources, we find that district spending declined primarily because of recession-induced local labor market shocks, and not because of a state's relative contribution to education spending.

These results have important policy implications, especially since another economic recession is an empirical certainty. If the degree of centralization in a state's education finance system—which is largely the consequence of efforts to equalize school resources among property poor and rich districts—makes district spending more vulnerable to recessionary events, then policymakers may (rightly) reduce efforts to promote equality and, instead, shift the responsibility for funding schools back to school districts. Because districts can respond more quickly to changes in economic conditions than can states, a shift away from state to local aid in support of funding schools would better insulate school district finances during fiscal downturns. However, if local labor market shocks are primarily responsible for declines in district spending, then the policy response will be quite different. That is, efforts to equalize cross-district, within-state differences in spending need not be abandoned. Instead, state and federal policy can be used to provide targeted aid to districts most affected by fiscal downturns.

[16] Indeed, as shown in Figure 1, districts least affected by the recession and those with the lowest state revenue share were increasing spending in the pre-recession period at relatively lower rates compared to districts more affected by the recession or those with greater state contributions.

Our findings support the latter policy response: the recession was the primary driver of fiscal loss and state efforts to equalize spending through centralization had no aggregate effect on district spending loss. While state revenues did decline more in districts located in states with greater school finance centralization, these losses were offset by increases in local revenues. Reliance on local revenues to offset losses to state revenues increased resource inequality among property poor and rich districts, as poor districts in states most reliant on state revenues were especially ill-equipped to offset recession-induced fiscal fallout. These findings motivate a policy response that targets stimulus aid towards districts with the least property wealth and greatest net job loss in the wake of recessionary events. Unfortunately, our results indicate that federal fiscal stimulus following the onset of the Great Recession did little to mitigate the differential fallout resulting from the Great Recession, and, in some cases, exacerbated differences in spending loss.

Taken together, our findings suggest that the degree of centralization in a state's education finance system has no meaningful effect on overall district spending during recessionary periods. This means that states need not abandon efforts to reduce cross-district spending inequality through state-level finance reforms, given that we find no correlation between a state's relative contribution to education funding and post-recession declines in district spending. Moreover, federal efforts to minimize the adverse fiscal consequences of recessionary events would be more effective if targeted aid was provided to school districts. Specifically, targeting aid to low-wealth districts experiencing severe employment loss will help offset spending declines and reduce cross-district spending inequality in the wake of future recessions.

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Tables & Figures

Table 1. District Demographic Characteristics, by Recession Intensity and State Investment in Education

		Recession Intensity				State Investment in Education (State Share)			
	Analytic Sample	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Enrollment	3553.2	3063.9	3071.6	3794.4	4282.1*	3324.7	3903.4	2541.6	4187.0*
	(14682.99)	(18891.26)	(10000.56)	(15865.89)	(12388.36)	(15404.73)	(17510.41)	(5929.85)	(15041.18)
White	0.56	0.47	0.60	0.56	0.61***	0.61	0.54	0.67	0.50 ***
	(0.31)	(0.33)	(0.30)	(0.32)	(0.27)	(0.29)	(0.32)	(0.26)	(0.31)
Black	0.17	0.20	0.19	0.15	0.14***	0.19	0.19	0.15	0.12 ***
	(0.20)	(0.22)	(0.22)	(0.20)	(0.17)	(0.19)	(0.22)	(0.22)	(0.17)
Hispanic	0.21	0.27	0.15	0.24	0.20***	0.16	0.22	0.12	0.29 ***
	(0.24)	(0.26)	(0.19)	(0.28)	(0.22)	(0.18)	(0.25)	(0.17)	(0.28)
Free/Reduced Lunch	0.42	0.48	0.39	0.40	0.40***	0.39	0.40	0.45	0.44 ***
	(0.24)	(0.25)	(0.25)	(0.25)	(0.22)	(0.22)	(0.26)	(0.23)	(0.24)
IEP	0.13	0.12	0.13	0.13	0.13***	0.14	0.12	0.14	0.12 ***
	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.06)	(0.05)	(0.03)
ELL	0.08	0.09	0.06	0.09	0.08***	0.06	0.07	0.06	0.12 ***
	(0.11)	(0.10)	(0.09)	(0.12)	(0.10)	(0.07)	(0.09)	(0.09)	(0.14)
City	0.46	0.54	0.47	0.46	0.39***	0.42	0.47	0.39	0.52 ***
Suburb	0.25	0.17	0.26	0.28	0.26***	0.32	0.26	0.16	0.21 ***
Town	0.11	0.11	0.10	0.08	0.13***	0.09	0.09	0.19	0.10 ***
Rural	0.19	0.18	0.16	0.17	0.22***	0.17	0.18	0.26	0.17 ***
Observations	145880	36461	36546	36243	36630	34095	47137	30203	34445
Districts	14139	3646	3515	3473	3581	3427	4428	3002	3282

Notes. Each cell reports mean (standard deviation), except for geographic indicators, which report proportions. Analytic sample is for the 2002-03 to 2012-13 school years. Recession Intensity Q1 – Q4 indicates quartiles of recession intensity; State Investment in Education (State Share) Q1 – Q4 indicates quartiles of the state's contribution to K-12 total education revenues. The number of districts for each recession intensity quartile do not sum to the analytic sample number of districts since 102 districts changed counties over time and are therefore present in different recession intensity quartiles. Group mean differences (i.e., Q1=Q2=Q3=Q4) statistically significant at the *10%; **5% and ***1% levels.

Table 2. District Revenue and Expenditures, by Recession Intensity and State Investment in Education

		Recession Intensity				State Investment in Education (State Share)			
	Analytic Sample	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Panel A: Revenues ($1000s)									
Total	12.45	13.06	13.77	12.43	11.08***	12.61	13.91	10.74	11.36***
	(3.92)	(4.43)	(4.61)	(3.47)	(2.74)	(3.17)	(4.99)	(2.50)	(2.59)
State	5.66	5.71	5.91	5.87	5.26***	4.44	5.78	5.36	6.62***
	(2.62)	(2.86)	(3.07)	(2.46)	(2.12)	(1.95)	(3.27)	(1.68)	(2.08)
Local	5.68	6.00	6.78	5.49	4.83***	7.11	7.00	4.23	3.65***
	(3.64)	(3.47)	(4.56)	(3.67)	(2.63)	(3.46)	(4.18)	(2.10)	(2.12)
Federal	1.11	1.34	1.08	1.07	0.99***	1.06	1.13	1.15	1.09***
	(0.72)	(0.82)	(0.77)	(0.65)	(0.64)	(0.72)	(0.69)	(0.80)	(0.72)
Panel B: Expenditures ($1000s)									
Total	12.66	13.44	13.84	12.61	11.30***	12.82	14.17	10.78	11.61***
	(4.14)	(4.86)	(4.75)	(3.63)	(2.99)	(3.35)	(5.21)	(2.66)	(2.92)
Instructional	6.52	7.03	7.21	6.48	5.69***	6.48	7.51	5.38	5.88***
	(2.27)	(3.02)	(2.57)	(1.87)	(1.21)	(1.59)	(3.11)	(1.21)	(1.03)
Capital	1.30	1.37	1.26	1.28	1.30***	1.29	1.39	1.07	1.32***
	(1.53)	(1.50)	(1.65)	(1.51)	(1.47)	(1.42)	(1.70)	(1.28)	(1.48)
Observations	145880	36461	36546	36243	36630	34095	47137	30203	34445
Districts	14139	3646	3515	3473	3581	3427	4428	3002	3282

Notes. Each cell reports mean (standard deviation). Analytic sample is for the 2002-03 to 2012-13 school years. Recession Intensity Q1 – Q4 indicates quartiles of recession intensity; State Investment in Education (State Share) Q1 – Q4 indicates quartiles of the state's contribution to K-12 total education revenues. The number of districts for each recession intensity quartile do not sum to the analytic sample number of districts since 102 districts changed counties over time and are therefore present in different recession intensity quartiles. Data are from the NCES F-33 and Common Core of Data. Revenue and Expenditure values are per-pupil 2013 dollars and divided by 1,000. Group mean differences (i.e., Q1=Q2=Q3=Q4) statistically significant at the *10%; **5% and ***1% levels.

Table 3. Estimated Post-Recession Change in Expenditures, by Quartile of Recession Intensity and State Investment in Education

	Total Expenditures		Instructional Expenditures		Capital Expenditures	
	Recession Intensity	**State Share**	**Recession Intensity**	**State Share**	**Recession Intensity**	**State Share**
Panel A: Main Effects						
Quartile 1 (Q1)	-874.89*** (200.12)	-1629.18*** (274.16)	-627.14*** (202.45)	-404.07*** (89.03)	-167.03 (104.95)	-827.57*** (168.71)
Quartile 2 (Q2)	-921.27*** (107.82)	-1257.17*** (118.60)	-458.22*** (55.23)	-776.52*** (114.38)	-282.37*** (78.60)	-387.64*** (70.74)
Quartile 3 (Q3)	-1501.59*** (211.34)	-1050.38*** (90.58)	-584.28*** (56.53)	-452.21*** (21.07)	-533.21*** (134.76)	-394.44*** (78.46)
Quartile 4 (Q4)	-1917.09*** (126.94)	-1478.56*** (131.69)	-647.34*** (32.56)	-553.85*** (43.17)	-831.54*** (93.70)	-411.87*** (93.13)
Panel B: Difference-in-Difference Estimates						
Q4 - Q1	-1042.20*** (236.98)	150.62 (304.15)	-20.20 (205.06)	-149.79 (98.94)	-664.51*** (140.69)	415.71** (192.71)
Q4 - Q2	-995.81*** (166.55)	-221.39 (177.22)	-189.12*** (64.12)	222.67* (122.25)	-549.17*** (122.30)	-24.23 (116.95)
Q4 - Q3	-415.49* (246.53)	-428.19*** (159.84)	-63.06 (65.24)	-101.64** (48.04)	-298.33* (164.13)	-17.43 (121.78)
Observations	145880	145880	145880	145880	145880	145880
Districts	14139	14139	14139	14139	14139	14139

Notes. Coefficients reported with robust standard errors (clustered at the district level) in parentheses. Expenditure estimates are per-pupil ($2013). In Panel A, *Recession Intensity* columns report coefficients from equation (4a); *State Share* columns report coefficients from equation (4b). In Panel B, coefficients reported are difference-in-difference estimates of quartile 4 (Q4) relative to the other three quartiles. All regressions control for district fixed effects and district-specific linear time trends. Coefficients are statistically significant at the *10%, **5% and ***1% levels.

Table 4. Estimated Post-Recession Change in Revenues, by Quartile of Recession Intensity and State Investment in Education

	State Revenues		Local Revenues		Federal Revenues	
	Recession Intensity	**State Share**	**Recession Intensity**	**State Share**	**Recession Intensity**	**State Share**
Panel A: Main Effects						
Quartile 1 (Q1)	-989.56*** (250.45)	-590.77*** (78.97)	-391.61*** (63.30)	-1366.65*** (119.72)	185.00*** (31.04)	271.70*** (17.04)
Quartile 2 (Q2)	-675.98*** (44.64)	-872.47*** (160.38)	-562.77*** (42.71)	-684.72*** (56.24)	195.74*** (12.77)	156.55*** (15.79)
Quartile 3 (Q3)	-938.72*** (159.27)	-682.79*** (45.21)	-637.94*** (93.67)	-442.71*** (39.57)	201.24*** (8.91)	186.22*** (14.40)
Quartile 4 (Q4)	-1017.46*** (59.90)	-1362.61*** (134.81)	-979.91*** (89.78)	-233.84*** (53.48)	235.34*** (8.68)	232.74*** (10.43)
Panel B: Difference-in-Difference Estimates						
Q4 - Q1	-27.90 (257.51)	-771.85*** (156.24)	-588.29*** (109.85)	1132.81*** (131.12)	50.34 (32.23)	-38.97* (19.98)
Q4 - Q2	-341.48*** (74.70)	-490.14** (209.51)	-417.14*** (99.42)	450.88*** (77.61)	39.60** (15.44)	76.18*** (18.93)
Q4 - Q3	-78.74 (170.17)	-679.82*** (142.19)	-341.97*** (129.75)	208.87*** (66.52)	34.11*** (12.44)	46.52*** (17.78)
Observations	145880	145880	145880	145880	145880	145880
Districts	14139	14139	14139	14139	14139	14139

Notes. Coefficients reported with robust standard errors (clustered at the district level) in parentheses. Revenue estimates are per-pupil ($2013). In Panel A, *Recession Intensity* columns report coefficients from equation (4a); *State Share* columns report coefficients from equation (4b). In Panel B, coefficients reported are difference-in-difference estimates of quartile 4 (Q4) relative to the other three quartiles. All regressions control for district fixed effects and district-specific linear time trends. Coefficients are statistically significant at the *10%, **5% and ***1% levels.

Table 5. Estimated Post-Recession Change in Expenditures

	Total Expenditures				Instructional Expenditures				Capital Expenditures			
	SD Units		Rank Units		SD Units		Rank Units		SD Units		Rank Units	
Recession Intensity	-517.56***	-487.90***	-19.53***	-36.57***	-45.81	-37.98	-1.45	-6.65*	-333.25***	-318.26***	-12.54***	-19.89***
	(74.92)	(65.95)	(3.27)	(6.42)	(47.07)	(45.85)	(2.36)	(3.66)	(49.83)	(44.47)	(2.06)	(4.72)
State Share	-38.45	-57.38	0.48	-19.97***	-36.63	-41.63	-0.84	-7.08**	97.67*	88.13*	4.36**	-4.46
	(79.26)	(74.72)	(3.12)	(5.64)	(29.93)	(30.00)	(1.09)	(2.95)	(53.74)	(51.65)	(2.09)	(4.48)
Recession Intensity*State Share		259.75***		0.36***		68.55***		0.11***		131.39***		0.15**
		(53.58)		(0.09)		(21.78)		(0.04)		(43.78)		(0.08)
P-value from F-Test: *Recession = State Share*	0.000	0.000	0.000	0.000	0.843	0.936	0.799	0.856	0.000	0.000	0.000	0.000
Observations	145880	145880	145880	145880	145880	145880	145880	145880	145880	145880	145880	145880
Districts	14139	14139	14139	14139	14139	14139	14139	14139	14139	14139	14139	14139

Notes. Coefficients reported with robust standard errors (clustered at the district level) in parentheses. Estimates of equation (4c) and (5) are reported. Coefficients reported in the SD Units columns show the change in expenditures (which are reported in per-pupil $2013) with a one standard deviation change in either *Recession Intensity* or *State Share*. Coefficients reported in the Rank Units columns show the change in expenditures (which are reported in per-pupil $2013) with a one-unit rank change in the predictor (either *Recession Intensity* or *State Share*). All regressions control for district fixed effects and district-specific linear time trends. Coefficients are statistically significant at the *10%, **5% and ***1% levels.

Table 6. Estimated Post-Recession Change in Revenues

	State Revenues				Local Revenues				Federal Revenues			
	SD Units		Rank Units		SD Units		Rank Units		SD Units		Rank Units	
Recession Intensity	-23.89 (63.70)	-16.70 (64.23)	-0.62 (3.05)	-4.34 (4.35)	-294.94*** (44.90)	-278.81*** (41.39)	-11.49*** (1.65)	-21.07*** (3.72)	20.22** (10.05)	22.15** (9.77)	0.88** (0.42)	-0.62 (0.77)
State Share	-314.69*** (51.34)	-319.29*** (51.83)	-11.02*** (1.97)	-15.49*** (3.92)	343.05*** (33.48)	332.76*** (32.14)	13.56*** (1.31)	2.06 (2.96)	-12.00* (6.69)	-13.24** (6.60)	-0.51** (0.24)	-2.31*** (0.82)
Recession Intensity* State Share		62.93 (43.05)		0.08 (0.06)		141.29*** (37.90)		0.20*** (0.06)		16.83** (7.21)		0.03*** (0.01)
P-value from F-Test: *Recession = State Share*	0.000	0.000	0.005	0.002	0.000	0.000	0.000	0.000	0.003	0.001	0.002	0.000
Observations	145880	145880	145880	145880	145880	145880	145880	145880	145880	145880	145880	145880
Districts	14139	14139	14139	14139	14139	14139	14139	14139	14139	14139	14139	14139

Notes. Coefficients reported with robust standard errors (clustered at the district level) in parentheses. Estimates of equation (4c) and (5) are reported. Coefficients reported in the SD Units columns show the change in revenues (which are reported in per-pupil $2013) with a one standard deviation change in either *Recession Intensity* or *State Share*. Coefficients reported in the Rank Units columns show the change in revenues (which are reported in per-pupil $2013) with a one-unit rank change in the predictor (either *Recession Intensity* or *State Share*). All regressions control for district fixed effects and district-specific linear time trends. Coefficients are statistically significant at the *10%, **5% and ***1% levels.

Table 7. Estimated Post-Recession Change in Total Expenditures and Local Revenues, by Household Wealth

	Housing Values			Household Income		
	Bottom Tercile	**Top Tercile**	**DD Estimate** $\hat{\psi}_{w=3} - \hat{\psi}_{w=1}$	**Bottom Tercile**	**Top Tercile**	**DD Estimate** $\hat{\psi}_{w=3} - \hat{\psi}_{w=1}$
Panel A: Total Expenditures						
Recession Intensity	-312.02***	-456.23***		-117.68	-614.67***	
	(73.56)	(102.66)		(147.20)	(84.49)	
State Share	-310.45***	85.42		-411.50***	-27.35	
	(86.77)	(102.84)		(154.43)	(75.93)	
Recession Intensity* State Share	-161.23**	269.13***	430.37***	-46.75	334.61***	381.36***
	(76.43)	(70.44)	(111.36)	(90.37)	(89.65)	(139.09)
Panel B: Local Revenues						
Recession Intensity	-97.53*	-364.56***		-145.60*	-341.48***	
	(53.68)	(65.55)		(75.53)	(64.52)	
State Share	168.07***	360.08***		253.19***	332.67***	
	(41.13)	(41.66)		(57.39)	(40.11)	
Recession Intensity *State Share	-66.32	101.90*	168.22*	12.50	226.39***	213.90**
	(68.52)	(57.99)	(92.73)	(43.26)	(66.32)	(88.06)
Observations	45775	46624	92399	45790	47128	92918
Districts	4389	4364	8753	4374	4406	8780

Notes. Coefficients reported with robust standard errors (clustered at the district level) in parentheses. Estimates of equation (5) are reported by tercile of either median housing value or median family income using data from the decennial 2000 Census ACS. *Recession Intensity* and *State Share* are measured in standard deviation units. All regressions control for district fixed effects and district-specific linear time trends. *DD Estimate* is the difference between top and bottom terciles for the interaction term Recession Intensity*State Share. Coefficients are statistically significant at the *10%, **5% and ***1% levels. Table A1 reports results where *Recession Intensity* and *State Share* are measured in rank-unit changes.

Table 8. Distribution of ARRA Expenditures, by Year

	Recession Intensity						State Share					
	2008-09	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**All Years**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**All Years**
All Quartiles	93.51 (195.09)	566.13 (352.39)	433.50 (294.16)	100.43 (144.60)	30.77 (149.91)	111.73 (249.79)	93.51 (195.09)	566.13 (352.39)	433.50 (294.16)	100.43 (144.60)	30.77 (149.91)	111.73 (249.79)
Quartile 1	69.93 (188.12)	632.26 (338.11)	556.49 (383.66)	102.70 (133.53)	38.58 (84.74)	128.54 (282.29)	128.47 (256.63)	598.32 (325.03)	530.02 (368.78)	133.25 (163.41)	50.57 (94.31)	130.65 (274.47)
Quartile 2	119.36 (237.40)	577.22 (469.54)	447.85 (296.64)	107.76 (146.27)	26.78 283.28)	115.80 (282.08)	38.77 (115.13)	596.29 (418.12)	449.35 (300.68)	89.31 (127.55)	25.01 (66.82)	110.34 (260.03)
Quartile 3	92.55 (185.65)	549.57 (338.61)	385.49 (247.08)	99.24 (150.61)	26.52 (80.93)	104.58 (231.03)	156.61 (251.38)	479.79 (278.54)	365.85 (263.87)	105.10 (178.11)	20.09 (84.50)	104.39 (221.89)
Quartile 4	92.67* (170.98)	525.47* (257.98)	377.66* (220.36)	94.71* (145.53)	31.62 (80.59)	103.13** (212.99)	102.00* (165.29)	548.86* (303.64)	372.77* (193.44)	86.43* (123.53)	28.56 (254.64)	102.56** (228.43)
Districts	13208	13096	13026	13012	12942	65284	13208	13096	13026	13012	12942	65284

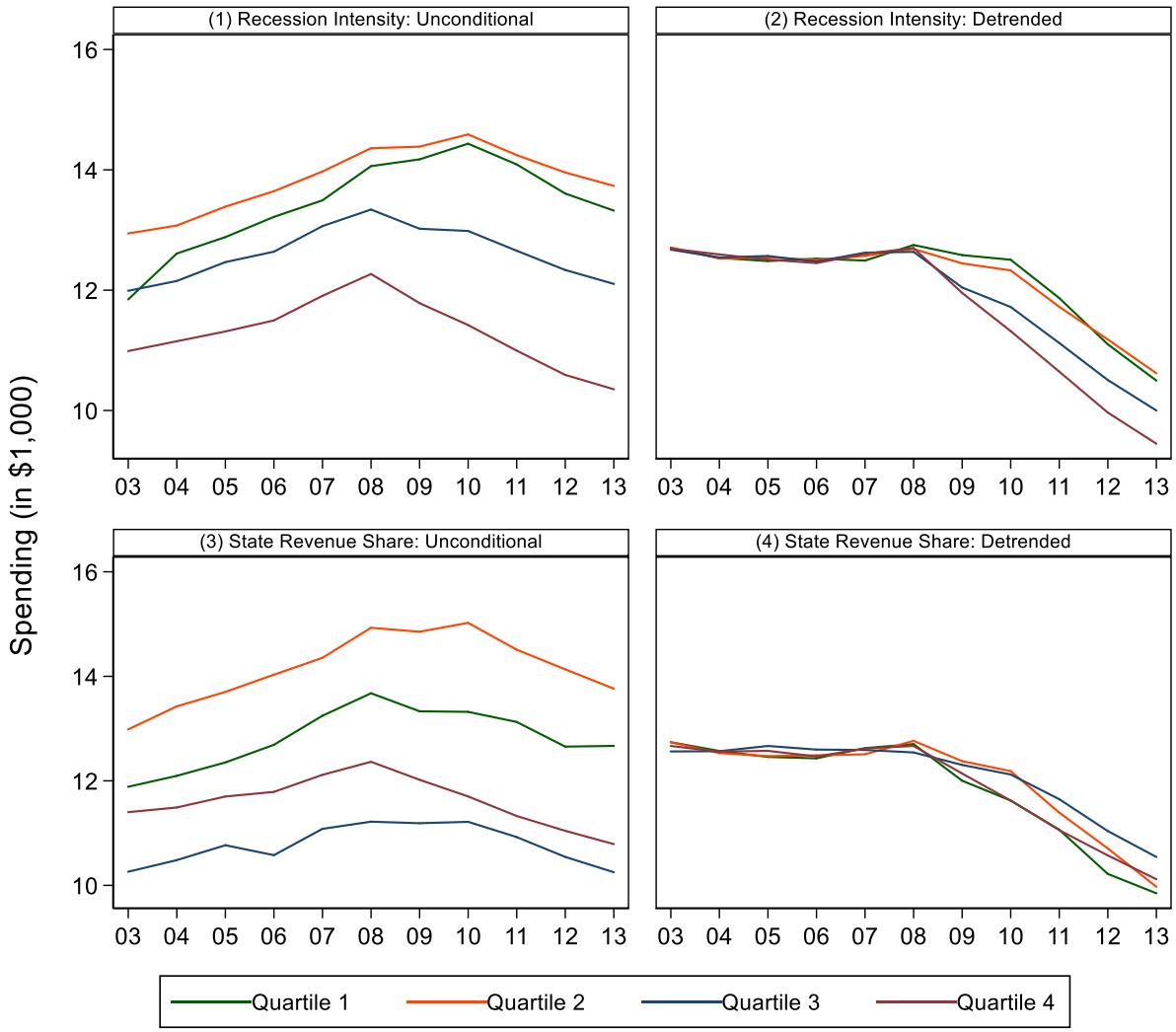
Notes. Each cell reports mean (standard deviation). ARRA expenditures are the sum of district-specific current and capital expenditures from ARRA funds. Group mean differences (i.e., Q1=Q2=Q3=Q4) statistically significant at the *10%; **5% and ***1% levels.

Table 9: Estimated Contribution of ARRA to Spending Loss, by Recession Intensity

	2008-09	2009-10	2010-11	2011-12	2012-13	All Years
Panel A: ARRA Expenditures ($\beta_q^t - \lambda_q^t$)						
Quartile 1 (Q1)	67.57*** (11.74)	630.10*** (48.87)	550.32*** (57.73)	100.82*** (6.83)	38.09*** (8.98)	276.99*** (22.23)
Quartile 2 (Q2)	117.59*** (21.48)	575.65*** (24.74)	443.64*** (16.34)	106.48*** (10.46)	26.46*** (4.49)	254.01*** (12.80)
Quartile 3 (Q3)	94.20*** (6.60)	551.06*** (22.31)	389.58*** (17.40)	100.52*** (9.29)	26.87*** (5.61)	232.83*** (8.87)
Quartile 4 (Q4)	94.20*** (7.54)	526.88*** (13.29)	381.30*** (12.51)	95.87*** (5.57)	31.92*** (5.78)	225.80*** (5.09)
Panel B: Ratio of ARRA Expenditures to Spending Loss $\left(\frac{\beta_q^t - \lambda_q^t}{\lambda_q^t}\right)$						
Quartile 1 (Q1)	1.04 (1.24)	0.87*** (0.14)	0.43*** (0.06)	0.06*** (0.01)	-0.02*** (0.00)	0.24*** (0.03)
Quartile 2 (Q2)	0.46*** (0.16)	0.69*** (0.07)	0.34*** (0.04)	0.07*** (0.01)	-0.01*** (0.00)	0.22*** (0.02)
Quartile 3 (Q3)	0.15*** (0.03)	0.39*** (0.04)	0.21*** (0.02)	0.05*** (0.00)	-0.01*** (0.00)	0.13*** (0.01)
Quartile 4 (Q4)	0.13*** (0.02)	0.30*** (0.02)	0.16*** (0.01)	0.04*** (0.00)	-0.01*** (0.00)	0.11*** (0.01)
Panel C: Gap in Ratio of ARRA Expenditures to Spending Loss $\left(\frac{\beta_{q=4}^t - \lambda_{q=4}^t}{\lambda_{q=4}^t}\right) - \left(\frac{\beta_{q=q}^t - \lambda_{q=q}^t}{\lambda_{q=q}^t}\right)$						
Q4 – Q1	0.91 (1.24)	0.58*** (0.15)	0.27*** (0.07)	0.03*** (0.01)	0.01*** (0.00)	0.13*** (0.03)
Q4 – Q2	0.33** (0.16)	0.39*** (0.08)	0.17*** (0.04)	0.04*** (0.01)	0.00 (0.00)	0.11*** (0.03)
Q4 – Q3	0.02 (0.03)	0.10** (0.05)	0.05** (0.02)	0.01* (0.01)	0.00 (0.00)	0.03* (0.02)
Observations	145880	145880	145880	145880	145880	145880
Districts	14139	14139	14139	14139	14139	14139

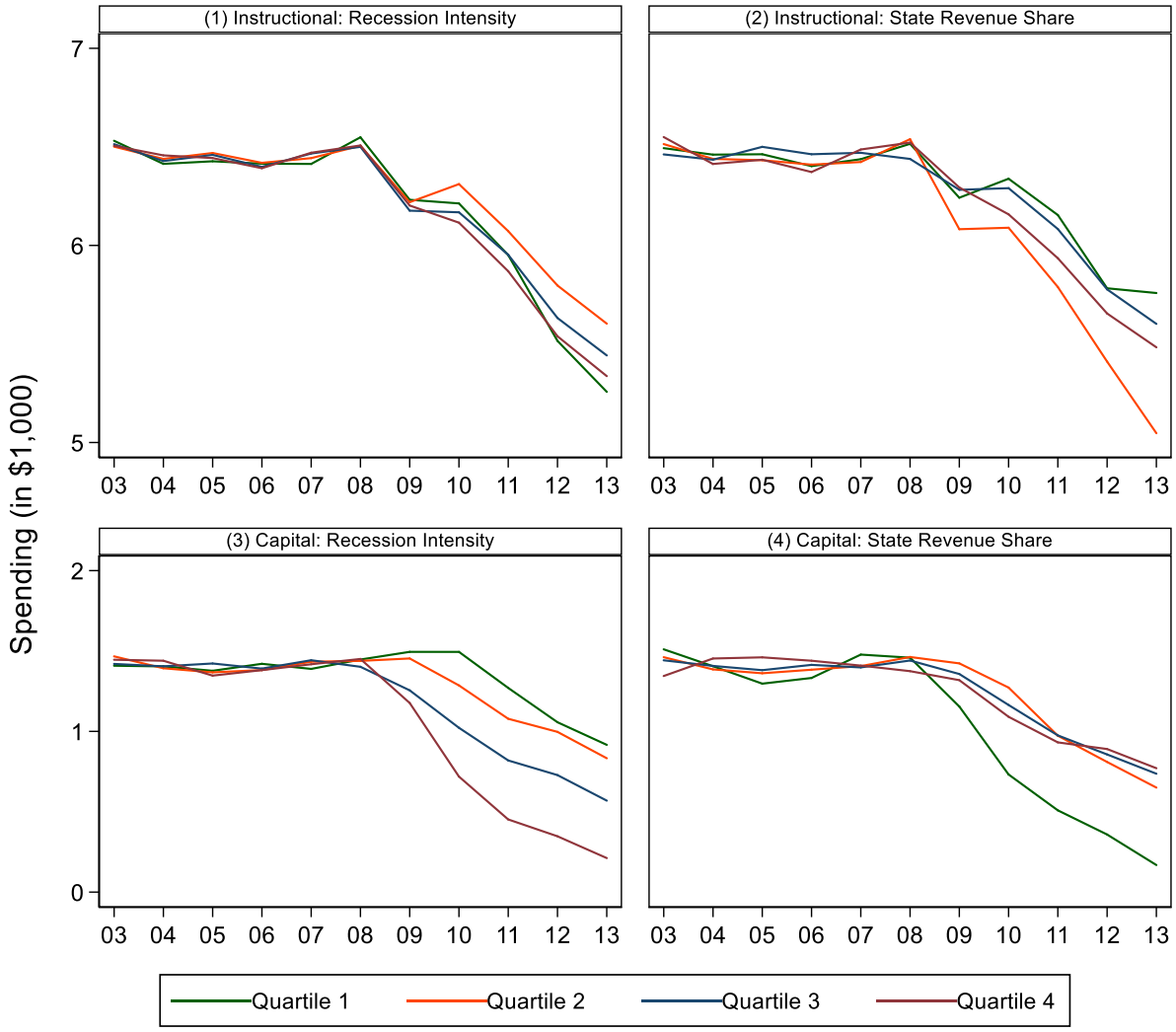
Notes. Coefficients reported with robust standard errors (clustered at the district level) in parentheses. Each cell reports estimates from Equations (6a) and (6b). Panel A describes estimated expenditures from ARRA Aid (i.e., $\beta_q^t - \lambda_q^t$); Panel B describes the ratio of expenditures from ARRA aid relative to estimated spending loss without ARRA aid (i.e., $\frac{\beta_q^t - \lambda_q^t}{\lambda_q^t}$); Panel C describes gaps, by recession intensity quartile, in the ratio of expenditures from ARRA aid to spending loss without ARRA aid (i.e., $\left(\frac{\beta_{q=4}^t - \lambda_{q=4}^t}{\lambda_{q=4}^t}\right) - \left(\frac{\beta_{q=q}^t - \lambda_{q=q}^t}{\lambda_{q=q}^t}\right)$). All regressions control for district fixed effects and district-specific linear time trends. Coefficients are statistically significant at the *10%, **5% and ***1% levels.

Figure 1. Total Expenditures, by Recession Intensity and State Investment in Education



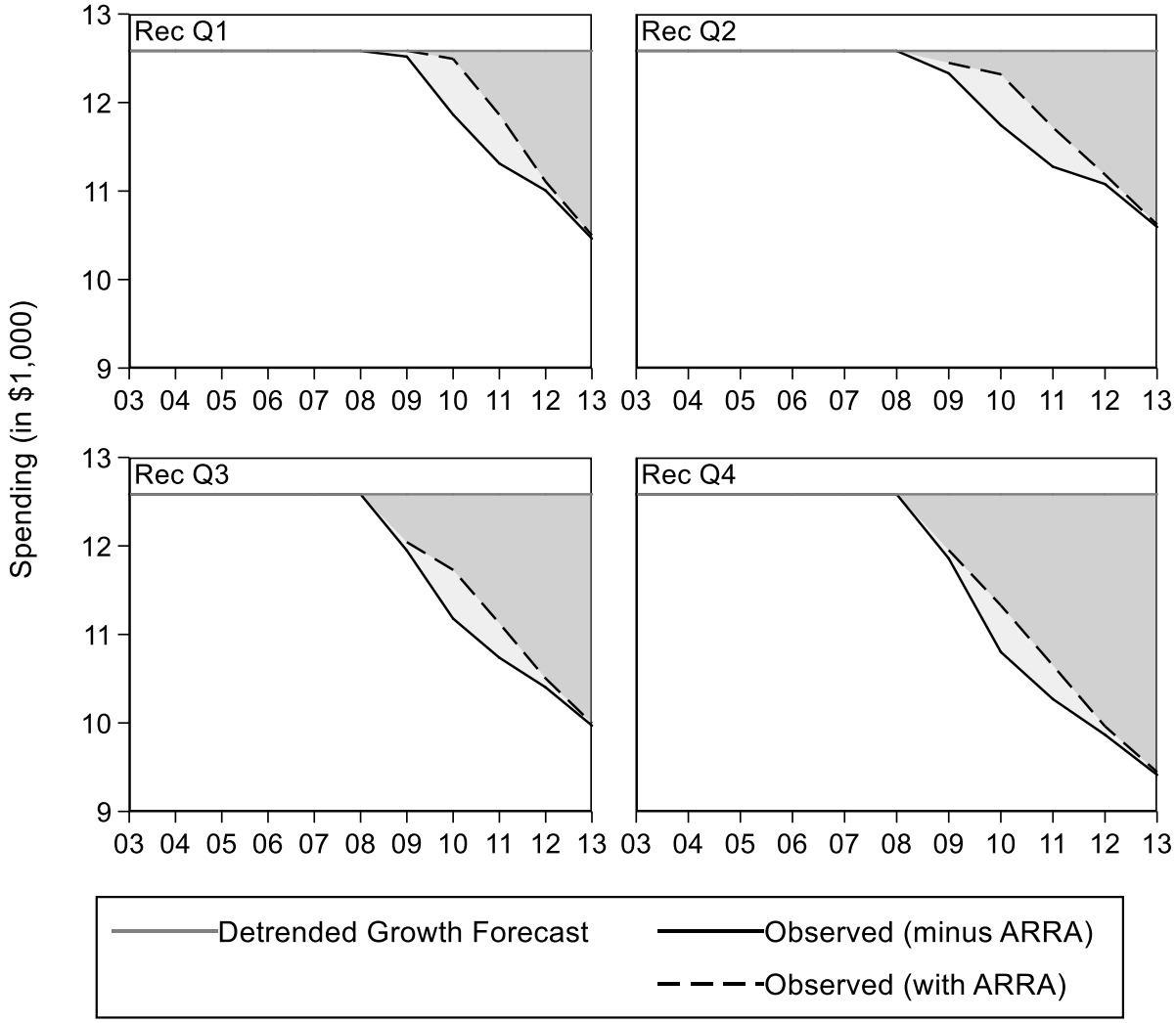
Notes. Panels (1) and (3) show unconditional trends in total expenditures (in $2013) by quartiles of recession intensity and state investment in education, respectively. Panels (2) and (4) show trends in total expenditures (in $2013) by quartiles of recession intensity and state investment in education, respectively, which are detrended by controlling for district fixed effects and district-specific linear time trends. The value 03 on the x-axis refers to the 2002-03 school year.

Figure 2. Instructional and Capital Expenditures, by Recession Intensity and State Investment in Education



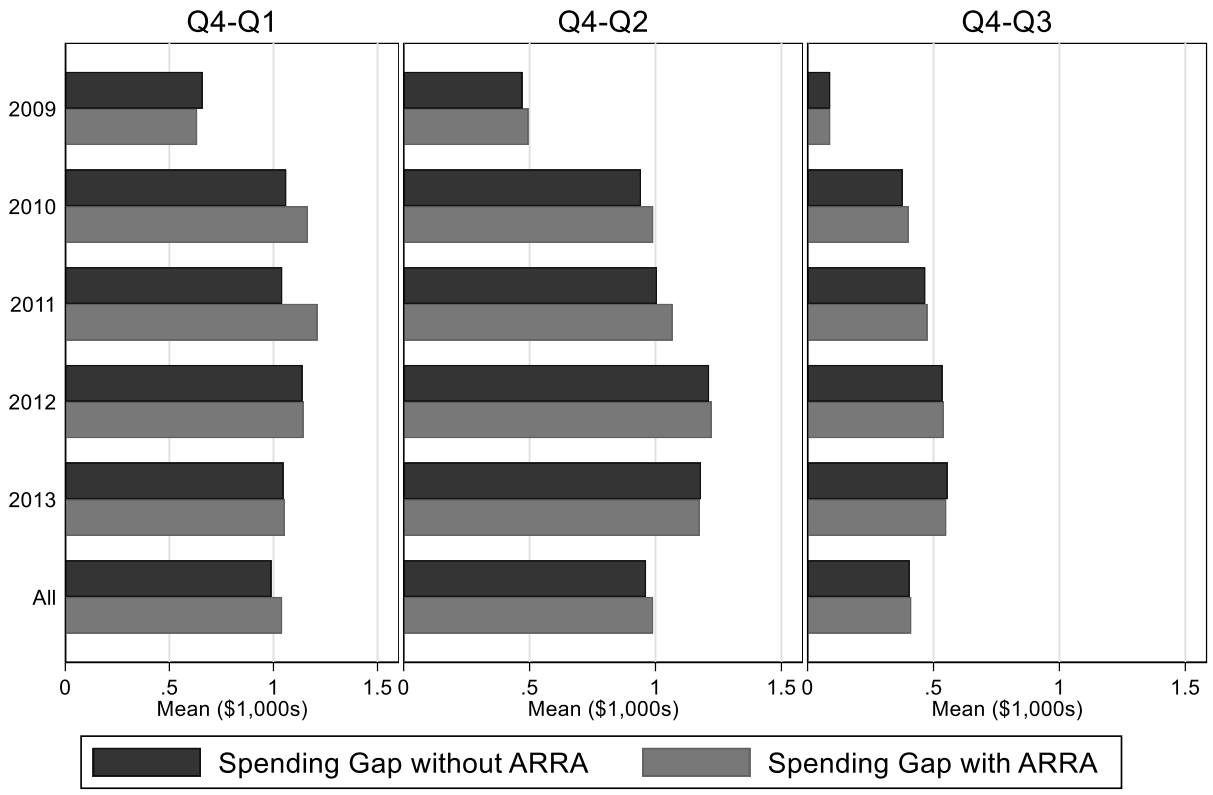
Notes. Panels (1) and (2) show trends in instructional expenditures (in $2013) by quartiles of recession intensity and state investment in education, respectively, which are detrended by controlling for district fixed effects and district-specific linear time trends. Panels (3) and (4) show trends in capital expenditures (in $2013) by quartiles of recession intensity and state investment in education, respectively, which are detrended by controlling for district fixed effects and district-specific linear time trends. The value 03 on the x-axis refers to the 2002-03 school year.

Figure 3. Estimated Total Expenditures with and without ARRA, by Recession Intensity Quartiles



Notes: Estimates derived from Equations (6a) and (6b). Dashed lines correspond to estimates for each β_q^t from equation (6a). Solid lines correspond to estimates for each λ_q^t from equation (6b). A scalar value equal to the pre-recession mean total (per-pupil) expenditures is added to each of the estimates. The value 03 on the x-axis refers to the 2002-03 school year.

Figure 4. Estimated Differences in Expenditure Loss with and without ARRA, by Recession Intensity Quartiles



Notes: Estimates derived from Equations (6a) and (6b). Grey bars correspond to estimates of $\beta^t_{q=4} - \beta^t_{q=q}$ from equation (6a). Black bars correspond to estimates of $\lambda^t_{q=4} - \lambda^t_{q=q}$ from equation (6b). Q4-Q1 represents the difference in expenditure loss between districts with the greatest (i.e., recession intensity Q4) and least (i.e., recession intensity Q1) net job loss following the onset of the recession. The y-axis indicates the spring of the academic year (e.g., 2009 represents the 2008-09 school year).

Appendix

Table A1. Estimated Post-Recession Change in Total Expenditures and Local Revenues, by Household Wealth (Rank Units)

	Housing Values			Household Income		
	Bottom Tercile	**Top Tercile**	**DD Estimate** $\hat{\psi}_{w=3} - \hat{\psi}_{w=1}$	**Bottom Tercile**	**Top Tercile**	**DD Estimate** $\hat{\psi}_{w=3} - \hat{\psi}_{w=1}$
Panel A: Total Expenditures						
Recession Intensity	3.11	-36.30***		8.35	-43.16***	
	(7.36)	(8.50)		(10.09)	(8.27)	
State Share	5.80	-15.61***		-7.07	-20.12***	
	(6.56)	(7.93)		(9.99)	(7.30)	
Recession Intensity* State Share	-0.29**	0.38***	-0.68***	-0.15	0.37***	-0.53***
	(0.12)	(0.13)	(0.20)	(0.14)	(0.13)	(0.20)
Panel B: Local Revenues						
Recession Intensity	1.22	-22.29***		-3.13	-25.73***	
	(5.23)	(5.13)		(4.67)	(6.45)	
State Share	11.22***	5.22		10.07**	-1.16	
	(5.31)	(4.34)		(4.68)	(4.53)	
Recession Intensity *State Share	-0.09	0.17**	-0.27**	-0.02	0.26***	-0.28**
	(0.10)	(0.08)	(0.13)	(0.07)	(0.09)	(0.13)
Observations	45775	46624	92399	45790	47128	92918
Districts	4389	4364	8753	4374	4406	8780

Notes. Coefficients reported with robust standard errors (clustered at the district level) in parentheses. Estimates of equations (5) are reported, by tercile of either median housing value or median family income using data from the decennial 2000 Census ACS. *Recession Intensity* and *State Share* are measured in rank units. All regressions control for district fixed effects and district-specific linear time trends. Coefficients are statistically significant at the *10%, **5% and ***1% levels.

Table A2: Estimated Change in Total Expenditures with and without ARRA, by Year and Recession Intensity

	2008-09		2009-10		2010-11		2011-12		2012-13		All Years	
	$\beta_q^{t=09}$	$\lambda_q^{t=09}$	$\beta_q^{t=10}$	$\lambda_q^{t=10}$	$\beta_q^{t=11}$	$\lambda_q^{t=11}$	$\beta_q^{t=12}$	$\lambda_q^{t=12}$	$\beta_q^{t=13}$	$\lambda_q^{t=13}$	β_q	λ_q
Quartile 1	2.56	-65.0	-90.5*	-720.6***	-722.0***	-1272.3***	-1476.9***	-1577.8***	-2083.1***	-2121.2***	-876.3***	-1153.3***
	(50.20)	(50.30)	(50.02)	(50.12)	(50.26)	(50.37)	(50.03)	(50.13)	(49.93)	(50.03)	(22.85)	(22.81)
Quartile 2	-136.0***	-253.6***	-264.5***	-840.2***	-865.2***	-1308.8***	-1398.3***	-1504.8***	-1962.5***	-1988.9***	-922.3***	-1176.3***
	(50.03)	(50.13)	(50.21)	(50.32)	(50.32)	(50.43)	(50.39)	(50.50)	(50.32)	(50.43)	(22.93)	(22.89)
Quartile 3	-540.9***	-635.1***	-853.9***	-1404.9***	-1457.3***	-1846.9***	-2081.2***	-2181.7***	-2586.6***	-2613.4***	-1500.7***	-1733.5***
	(45.28)	(45.37)	(45.37)	(45.46)	(45.38)	(45.48)	(45.47)	(45.56)	(45.58)	(45.67)	(20.72)	(20.68)
Quartile 4	-631.1***	-725.3***	-1255.6***	-1782.5***	-1933.4***	-2314.7***	-2621.7***	-2717.6***	-3137.7***	-3169.6***	-1916.2***	-2142.0***
	(42.16)	(42.25)	(42.17)	(42.26)	(42.28)	(42.37)	(42.14)	(42.23)	(42.13)	(42.22)	(19.24)	(19.21)
Observations	145880	145880	145880	145880	145880	145880	145880	145880	145880	145880	145880	145880
Districts	14139	14139	14139	14139	14139	14139	14139	14139	14139	14139	14139	14139

Notes. Coefficients reported with robust standard errors (clustered at the district level) in parentheses. Each cell reports estimates from Equations (6a) and (6b). Estimates from Equation (6a) are shown under column β_q^t; estimates from Equation (6b) are shown under column λ_q^t. These estimates are used to draw Figures 3 and 4 (see notes for those figures) and for estimates shown in Table 9. All regressions control for district fixed effects and district-specific linear time trends. Coefficients are statistically significant at the *10%, **5% and ***1% levels