# The Impact of Intergovernmental Incentives on Disability Rates and Special Education Spending

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**Abstract**

Measured disability rates among school age children and the associated spending on special education programs have risen steeply over the past 30 years. Currently, about 15 percent of U.S. school children are classified as "disabled". Many observers have noted that the special education funding programs established by state and federal governments create an incentive for local school districts to drive up disability rates, potentially accounting for some of the rise in measured disability rates. It is also unclear to what extent the funds from higher levels of government are actually spent on special education programs, versus other spending needs. I use the experiences following a major reform of the special education funding system in California to examine these issues. In 1998, the state converted from a system that awarded funds based on the number of disabled students in a district (with funding rates that varied across districts) to one based on total enrollment. This change induced changes in the total funding awarded to different districts, and also reduced the marginal "price" of an additional disabled student to zero. Consistent with standard models, I find that the California reform created both "income" and "substitution" effects on the number of students classified as disabled. Although in the short run additional state special education grants translate into sizeable increases in special education spending, in the longer run special education funds appear fungible across other spending needs.

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## I. Introduction

Reported disability rates among school-aged children and the amount of resources devoted to their education have both increased steeply over the last 30 years. The share of special education in total school spending rose from 4 percent in 1967 to 19 percent in 1996 and continues to rise (Rothstein and Miles, 1997). Over the last decades, the total number of special education students in the United States rose from 6 percent of total enrollment in 1987-88 to 14 percent of total enrollment in 2001-02 (see Figure 2). These trends raise two related questions. First, what (if any) impact do changes in the funding system for special education have on disability rates? In particular, do fiscal incentives cause more marginal students to be classified disabled? Second, how much (if at all) do additional state special education grants translate into actual increases in special education spending by local school districts?

To answer these questions I use the experiences of individual school districts following a major reform of the special education financing system used in California. Prior to the reform, California used a system that provided each district an amount of funding based on the number of students classified with different disabilities. The funding rates per disabled student varied across districts, based on (inflation adjusted) cost estimates from 1979-80. This system provided a strong fiscal incentive for districts to classify additional students as disabled. The reform switched the funding to a *per-total enrollment* (or "census") basis. Specifically, each district received a grant based on the census rate, calculated to be the per-total enrollment funds received in the previous year. Districts were to receive year to year changes in total funding based on enrollment growth. Furthermore, any re-classification of students from regular to special education did not generate new funds for the district in the new regime.

This reform created changes in the total funding allocated to different districts, and also reduced the marginal "price" of an additional disabled student to zero. Thus, I can measure both "income" and "substitution" effects on the number of students classified as disabled and on special education spending. Furthermore, I can simulate the change in funds due to the reform, holding constant classification rates and use this simulated variable in an instrumental variables strategy. This will overcome problems of endogeneity that plague ordinary least squares estimation. I find that local school districts do respond to fiscal incentives in intergovernmental grants by adjusting rates of disability classification among students, particularly in the categories of learning disabilities and attention deficit disorder. This response varies by district size, with larger districts exhibiting smaller responses. On average, an increase in per-pupil state special education grants does not lead to an increase in local disability rates. However, an increase of $1000 in the price per additional disabled student results in a 1.5 percentage point drop in the student disability rate (Table 5). This implies that for the average district in California, with total regular enrollment of 5000 and total special education enrollment of 600, a $1000 increase leads to classification of 75 marginal students that otherwise would not be.

The second related question is whether and how much these changes in state special education grants translate into increases in actual special education expenditures. The fungibility of education funds allows the possibility of local school boards responding to additional state special education grants by redirecting existing special education funds to other uses. If this happens, an increase in special education revenues will not necessarily result in an increase in special education expenditures. The theory of the "flypaper effect" suggests that local governments respond to additional state grant funding by spending more on the targeted program than would be indicated by its associated marginal propensity to consume

(Hines and Thaler, 1995). This theory suggests that a sizeable portion of each additional dollar of a state special education grant would translate into increases in special education spending. My results suggest that the flypaper effect holds in the very short run, but that districts appear to shift incremental grants to other uses in the long run.[1] Using the same instrumental variables approach as above, I can cleanly estimate the causal effect of state grants on special education expenditures. My analysis shows that an extra dollar of state grant funding results in a $.92 increase in special education expenditures in the very short run, but only a $.16 to $.46 increase in special education expenditures in the longer run (Table 5).

This study contributes to the existing body of knowledge in a number of ways. First, I use variation in changes in state special education grants due to census-based reform and employ an instrumental variables method to credibly estimate a causal effect of fiscal incentives on disability rates. This overcomes issues of endogeneity that often hamper interpretation of estimates in previous studies. Second, I provide an estimate of the "flypaper effect", or the degree to which additional state grants translate into additional local district expenditures. I evaluate both long-term and short-term responses of local governments to these grants. In all cases, I am able to separately identify "income" and "price" effects, an aspect of special education finance that has not been widely explored. Understanding the impact of fiscal incentives on special education programs is not only important for educational policymakers but provides insight into local districts' behavioral responses to intergovernmental grants. This study thus adds to the existing body of literature on fiscal federalism as well as the education policy literature.

The remainder of the paper is as follows: in section II, I provide background on disability funding and classification; in section III, I provide background on California's

[1] Short run refers to the 1996-98 change, long run refers to the 1996-1999 through 1996-2002 changes.

special education finance reform; in section IV I discuss a model of local bureaucratic response to state grants and describe the research design. Section V describes the data. Section VI presents results and section VII concludes.

## II. Background on Disability Funding and Classification

*General Trends*

By far, the bulk of special education students are learning disabled, speech-impaired, or emotionally disturbed.[2] The probability of being diagnosed with a speech disorder is highest in the elementary school years while the probability of being diagnosed with a learning disability is highest in the middle school and high school years (Figure 3). Though all states exhibit an increasing pattern of disability rates over time, they differ quite widely in absolute levels and rates of increase.[3] And while many states have followed the national trend, with disability rates rising from about 6 percent in 1987-88 to 14 percent in 2001-02, others have remained relatively stable.[4]

Along with this variation in rates of disability classification is wide variation in the implementation of public school and special education finance across states.[5] States differ in the shares of total revenues they receive from federal, state, and local sources. They also vary

[2] Learning disabilities affect about half of all disabled children, and speech impairments affect less than a quarter; emotionally disturbed, hearing impaired, "other" (a category which includes students with attention deficit disorder), orthopedically impaired, visually impaired, deaf-blind, autistic, developmentally delayed, and children with traumatic brain injuries comprise the remainder.

[3] For instance, in 2000-01, Colorado identified 9.8 percent of its school-aged population as disabled, while Rhode Island identified 19.4 percent.

[4] Massachusetts, for example, maintained a 15 percent disability rate over this same time period, while Hawaii's rate rose from under 6 percent to over 12 percent.

[5] All states fund their public school systems using funds from four basic sources: federal, state, local property tax, and local miscellaneous revenues. States disburse funds to local school districts through a combination of categorical funding, which specifies the programs to which the money must be applied, and general purpose funding, which leaves the spending decisions to the local school board.

in the criteria used to determine allocations of funds to local districts. The bulk of school funding is usually distributed through general purpose funding which is calculated on a roughly per-pupil basis. However, the exact formulas for determining cross-district allocation within each state are quite complex and differ widely by state (Hurst et al., 2003).[6] States further vary in their distribution of categorical special education funds.[7] The concurrent variation in disability rates and finance systems across states begs the question of how much, if any, of the state variation in disability rates is driven by the disparate fiscal incentives of finance systems across states rather than true differences in incidence of disability across states.

*Disability Classification Process*

Procedures for disability classification, like finance systems, vary widely across states and districts. Typically, the classification process consists of four steps: initial referral, eligibility determination, classification, and finally, placement. These are outlined in the federal Individuals with Disabilities Education Act (IDEA) of 1975 (P.L. 94-142). However, the legislation leaves many procedural details to the discretion of states and districts.

Initial referral of a student for special education can be made by the parent or the teacher. A special services committee, consisting of school and district administrators,

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[6] These formulas often include consideration for between-district differences in local property tax bases, operating costs, and enrollment. Furthermore, most states attempt to equalize per-pupil general funds across districts. These attempts at equalization occur through a variety of different finance schemes and the results are not uniform across states (Hoxby, 2001).

[7] For example, in the 1999-2000 school year, seventeen states distributed special education funds based on the number of disabled students in a district, nine states based on the overall enrollment in a district, six based on the ability of the local district to pay for costs, five used a percentage reimbursement system in which districts were partially reimbursed for each disabled student, three used a variable block grant scheme in which districts received a grant determined by expenditure in previous years, and ten used some combination of the above (Chambers, Parrish, and Harr, 2002).

teachers, and parents then determines eligibility based on evaluations, tests, records, or reports. However, this procedure is poorly defined by federal law; in practice, districts often fail to include teachers and parents on the eligibility committee (Strickland and Turnbull, 2001). As a result, eligibility is often determined almost exclusively by administrators.

The federal law is also vague in its definition of disabilities. It defines a disability as a condition that "adversely affects educational performance." Variation in states' interpretation of this clause may be partly responsible for cross-state variation in disability rates. The lack of reliable psychometric measures for diagnosing learning disabilities and attention deficit disorders may also account for some of this variation. Some educational researchers find that "there appear to be no reliable differences between students classified as having learning disabilities and those considered to be low-achievers" (Strickland and Turnbull, 2001). Others find greater than 96 percent overlap on forty psychometric measures for learning disabled students and low-achieving students (Ysseldyke, Algozzine, Shinn et al, 1982).[8]

Once a student is identified as eligible for special education services, the district convenes a committee including at least one administrator to formulate an Individual Education Plan (IEP). The IEP is a federally mandated statement of the student's present level of functioning and includes annual goals, including short term instructional objectives.[9]

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[8] With no reliable psychometric measures and only widely interpretable federal guidelines, each state and district uses its own set of criteria to determine special education eligibility. For example, some states ban the use of IQ tests for eligibility decisions. Others do not. Some states rely on an achievement-based paradigm, while others rely on an achievement-ability paradigm to determine eligibility. Because eligibility criteria may differ across districts, a child is required to be re-identified and re-evaluated for special education eligibility when he moves to a new district.

[9] The committee creating the IEP consists of at least three of the following: the student, a parent, a regular education teacher, a special education teacher, a school psychologist, a school counselor, the school principal, a district administrator and a special education program administrator. The IEP is developed through one or a series of IEP meetings in which members of the IEP committee assess the student according to a federally-prescribed set of disability descriptions (see Appendix A).

Though the IEP process can be similar from district to district and must follow some broad federal guidelines, it is far from standardized. As with eligibility, if a special education student moves from one district to another, he must undergo the IEP process in the new district, as placement criteria may differ across districts. Given the widely interpretable eligibility and placement criteria and the central role of administrators in the classification process, it is plausible that rising disability rates partly reflect a local bureaucratic response to fiscal incentives in state special education grants.

## III. Census-Based Special Education Finance Reforms

Between 1993 and 2000, nine states instituted census-based special education reforms. These reforms shifted the distribution of state special education funds from systems in which grants were determined by the number of special education pupils to systems in which calculations were made based on total enrollments. These nine states-- Alaska, Alabama, California, Connecticut, Idaho, Massachusetts, Montana, North Dakota, Pennsylvania-- along with South Dakota and Vermont, which instituted partial reforms, vary considerably in pre-reform finance systems, as well as in their implementation of the reforms. However, the reforms divorced funding from disability rates to some degree in all cases. In this section, I give an overview of the California reform.

### *California's Reform*

In 1980, California eliminated its existing patchwork of categorical programs financing special education programs, and instituted the extended Master Plan for Special Education (MPSE). The MPSE used Instructional Personnel Services Units (IPSU) to determine state special education allocations to districts. Each unit represented the number of personnel

required to staff a special day class, a resource program, or a designated instructional service. Its value was calculated based on the local cost of personnel as reported by districts in 1979-80.[10] Between 1980-81 and 1996-97, state special education grants to districts were calculated as follows:

$$TotSpecEd\$_d = \left[ \sum_j (\#units_{dj} * unitrate_{dj}) * (1 + ssr_{dj}) \right] - lcgf_d \qquad (1)$$

where *d* indexes districts, *j* indexes the type of unit[11], *#units* is the number of units of type *j* in each district *d*, *unitrate* is the unit rate for unit type *j* in district *d*, *ssr* is the support service ratio[12], and *lcgf* is the local general fund contribution. The *lcgf* was based on local levels of funding in 1979-80, before it was known that these funding levels would be used to calculate future grants. It, too, varied widely across districts. Because the state awarded special education grants to districts accounting for *lcgf,* the system unfairly penalized those districts that implemented special education programs before the 1980 mandate.

The funding formula represented by equation (1) has three key features. Most importantly, increases in the number of students classified with a given disability lead to proportional increases in the state grant associated with that disability. This feature meant that from 1980-81 to 1996-97, districts had a fiscal incentive to increase the number of disabled students. A second feature is that different disabilities are awarded different funding rates—potentially leading to an incentive to reclassify students in particular ways. A final aspect of

[10] Initially, the MPFM allowed for 10% annual increases in unit rates, but the increases were severely capped due to cost considerations.

[11] For example, special day class, resource program, or designated instructional service.

[12] The support service ratio calculates program support costs such as administration, screening, and testing. As with the unit rates, the *ssr* was based on the cost reports filed by districts in 1979-80, before the districts knew that these reports would be the basis for *ssr* calculations. As a result, there is a wide range of *ssr*'s for any given program type across districts. For example, in 1985, the *ssr* for the category of severely disabled students ranged from .01 to .78 (Parrish, 1985). With such variation, it is difficult to argue that the *ssr* accurately measures cost of support services.

the formula is that different districts faced different unit rates for different disabilities, based largely on levels of services and differences in costs of providing disabled student services in 1979-80. Many of these cost differences presumably reflected random factors. 1979-80 levels of service were determined and reported before districts learned of the upcoming changes to the funding scheme. Thus districts could not know to strategically report the values ultimately used in the funding equation. In addition, from the strikingly wide variation across districts, it appears that the reported values must have been at least somewhat random. Because the MPFM formula "rewarded" districts for classifying more students as disabled, critics claimed that schools faced a fiscal incentive to classify students as disabled. Such critics advocated a system of grants that depended on the overall enrollment of the school rather than the size of its disabled population in order to remove the perceived incentives to classify marginal students as disabled. Given that the average ratio of per-pupil special education expenditures to regular education expenditures in California is 1.9 (Parrish, 2004), reformers saw eliminating this incentive from the funding scheme as an opportunity to curb rising costs.

In response to these pressures, the California legislature passed Assembly Bill 602 in 1997. The bill made two main revisions to the system of special education finance, implemented over the following two academic years. First, it allowed for a one-time updating of per-pupil rates of funding across districts to take effect in 1997-98. This one-time update changed these rates to reflect the 1995-96 staffing costs in each district. Second, AB 602 abolished the MPFM beginning in 1998-99; state funding would no longer be distributed on a per-special education student basis, but rather on a new census-based system which distributed funds based on the district's total average daily attendance. Thus, prior to the reform, each district received a total state grant equal to its unit rate, $UR$, multiplied by the

total number of special education students. After the reform, each district received a total state grant equal to its census rate, $CR$, multiplied by the total district enrollment.

Table A lists marginal benefits and total state special education revenues that districts should have received as a result of the reform in each of four relevant time periods.

Table A. Summary of predicted marginal and total state special education revenues

| School year | Marginal benefit | Total state special education revenue |
|---|---|---|
| 1996-1997 | $UR_{96}$ | $UR_{96} * SE_{96}$ |
| 1997-1998 | $UR_{97}$ | $UR_{97} * SE_{97}$ |
| 1998-1999 | 0 | $CR_{98} * TE_{98}$ |
| 1999-2000 | 0 | $CR_{99} * TE_{99}$ |

Where, for each district *d*, $SE_t^d$ = total special education enrollment, or special education average daily attendance (SPADA) in year t to t+1, $TE_t^d$ = total enrollment, or average daily attendance (ADA) in year t to t+1, $UR_t^d$ = state reimbursement rates per SPADA (pre-reform), also called the unit rate, and $CR_t^d$ = state reimbursement rate per ADA (post-reform), also called the census rate.

Note, $UR_{96}$ is closely approximated by the total amount of special education expenditure in 1979 divided by the total number of *disabled* students in 1979. Due to the updating of unit rates, $UR_{97}$ is calculated to be approximately the total amount of special education expenditure in 1995 divided by the total number of *disabled* students in 1995. Due to the move to a census-based system of finance, $CR_{98}$ and $CR_{99}$ are calculated to be

approximately the total state grant received by the district in 1997 divided by *total* enrollment in 1997 (with an inflation adjustment).

The combined updating of unit rates and the move to a census-based system of finance created a redistribution of fiscal incentives and state special education funds across districts. In particular, the reduction of marginal incentives to zero neutralized the incentive for administrators to classify marginal students into the special education system. The redistribution thus provides a unique opportunity to measure the causal effect of fiscal incentives on districts' disability rates.

## IV. Model of Local Response to State Grants and Research Design

### *A. Model of Disability Classification*

First, I ask whether and to what degree districts respond to fiscal incentives in special education funding by adjusting their rates of disability classification. In order to model the local response to state grants, I assume there is only one type of disability and I ignore the existence of any federal special education aid.[13] Furthermore, I assume that all state special education funds received by the district are spent on special education program expenditures. Formally, districts want to maximize a value function $\mathrm{V}(G^S - c \cdot N,\ N)$, where $G^S$ is the total amount of the special education grant received from the state, $c$ is the cost of educating one special education student, and $N$ is the total number of special education students in the district. Thus, $\mathrm{V}(\cdot)$ is a function of $G^S - c \cdot N$, the net gain from classifying an additional student disabled and $N$, the size of the disabled population in the school. I assume the value

[13] The existence of federal aid implies that even when marginal incentives in state aid disappear in the census-based state reform, total marginal incentives may not be exactly zero. However, federal aid is a small fraction of total special education funding and expected effects from fiscal incentives in federal aid are small. The average federal per-pupil special education grants are about $131 compared to the average state grants of $721.

function is increasing in $N$ and concave down: $V_N > 0$ and $V_{NN} < 0$. This assumption is meant to reflect the idea that there is some gain to classifying students as disabled (reflecting perhaps, the potential improvements in achievement in special education classes) but that this gain is decreasing in the number of students classified. At large $N$, any additions to the special education population will be less severely disabled students for whom potential benefits of special education classes are smaller than those of more severely disabled students.

Recall that under the old system of special education finance, California awarded each district a total grant award equal to a unit rate multiplied by the number of special education students. That is, $G^S = G^O + r \cdot N$ where $r$ is the unit rate. Each district solves the following maximization problem:

$$\max_N \; V(G^O + r \cdot N - c \cdot N, \; N)$$

Taking derivatives yields:

$$V_1 \cdot [r - c] + V_2 = 0$$

$$\frac{V_2}{V_1} = c - r,$$

where $V_1$ is the partial derivative with respect to the first term and $V_2$ is the partial derivative with respect to the second term. Notice $\frac{V_2}{V_1}$ is the marginal rate of substitution in the district's choice between classification of a student as disabled and financial resources available for other uses. $\frac{V_2}{V_1}$ is the slope of the indifference curves in Figure 4A.

Before the reform, each district faces a budget constraint with slope equal to $c - r$. The optimal $N^*$ then occurs at the point where the slope of the indifference curves is equal to the net cost of educating a disabled child, $c - r$ (Point A in Figure 4A).

After the reform, each district solves a new maximization problem:

$$\max_{N} \; V(G' - c \cdot N, \; N)$$

Now the total amount of the special education grant received from the state, $G^S$, is equal to $G'$, where $G'$ is the census based grant received by the district. And the net benefit to the district of classifying a student disabled is given by $G' - cN$. In the new maximization problem, $r = 0$ since districts no longer receive any funds on a per-disabled student basis. Thus each district faces a budget constraint with slope equal to $c$. Ignoring changes in enrollment, the census based grant was set to equal the pre-reform total grant received by the district. Thus, $G' = G^0 + rN^*$. This implies that the switch to the new grant system was a "compensated" change that presented a new higher "price" for each disabled student (c versus c-r) but allowed the district to achieve its pre-reform choice. (In practice there was a lot of slippage and some districts received quite a bit more or less post-reform than they had in the pre-reform year.) The new equilibrium is illustrated in Figure 4B with a level of disability, $N'$.

*B. District-level instrumental variables analysis*

To investigate the predictions of the model, I first consider a simple regression of changes in disability rates on changes in fiscal incentives. This specification exploits the variation in changes in special education funds across districts to identify the effect of interest. Specifically, I consider the following model of district-level disability classification:

$$\Delta\left(\frac{SE_{dt}}{TE_{dt}}\right) \equiv \frac{SE_{dt}}{TE_{dt}} - \frac{SE_{dt-1}}{TE_{dt-1}} = \beta_0 + \beta_1 \Delta G_{dt} + \beta_2 \Delta UR_{dt} + \beta_3 \mathbf{x}_d + \Delta\varepsilon_{dt} \quad (2)$$

where $d$ indicates district, $t$ time, $SE$ is special education enrollment, $TE$ is total enrollment, $G$ is the amount of per-pupil state special education grant the district receives, $UR$ is the unit rate, $\mathbf{x}$ is a vector of other district characteristics, and $\varepsilon$ is an idiosyncratic error term.

If $\Delta G$ and $\Delta UR$ are uncorrelated with any other district characteristics that may also affect changes in disability rates, $\Delta\left(\frac{SE_{dt}}{TE_{dt}}\right)$, $\hat{\beta}_1$ and $\hat{\beta}_2$ can be interpreted as causal parameters. On the other hand, if $\Delta G$ depends directly on $\Delta\left(\frac{SE_{dt}}{TE_{dt}}\right)$ as it did under the old system of special education finance, or if some other district characteristic affects all three, $\Delta G$, $\Delta UR$ and $\Delta\left(\frac{SE_{dt}}{TE_{dt}}\right)$[14], then $\hat{\beta}_1$ and $\hat{\beta}_2$ may be biased and can not be interpreted causally.

The existence of the census-based finance reform in California presents a unique opportunity to avoid this endogeneity problem and estimate $\hat{\beta}_1$ and $\hat{\beta}_2$ as true causal parameters. The change in actual per-pupil funding before and after the reform can be written as follows:

$$Actual\Delta(G) = \frac{CR_{99} * TE_{99}}{TE_{99}} - \frac{UR_{96} * SE_{96}}{TE_{96}} \qquad (3)$$

Since $CR_{99} = \frac{G_{97}}{TE_{97}}$ and $UR_{96} = \frac{G_{96}}{SE_{96}}$, I can re-write (3) as:

$$Actual\Delta(G) = \frac{G_{97}}{TE_{97}} * \frac{TE_{99}}{TE_{99}} - \frac{G_{96}}{SE_{96}} * \frac{SE_{96}}{TE_{96}} \qquad (4)$$

Using the reform, I can approximately predict what per-pupil funding should have been for each district in the school years 1996-97 through 1999-00 holding constant the percent of students labeled as special education:

$$\Pr ed\Delta(G) = \frac{G_{97}}{SE_{97}} * \frac{SE_{96}}{TE_{96}} - \frac{G_{96}}{SE_{96}} * \frac{SE_{96}}{TE_{96}} \qquad (5)$$

Since $UR_{99} = \frac{G_{97}}{SE_{97}}$ and $UR_{96} = \frac{G_{96}}{SE_{96}}$, I can re-write (5) as:

[14] For example, the poverty level or racial composition of the students within a district may affect all three variables (Corman and Chaikind, 1993).

$$\Pr ed\Delta(G) = \frac{UR_{99} * SE_{96}}{TE_{96}} - \frac{UR_{96} * SE_{96}}{TE_{96}}. \qquad (6)$$

This predicted variable, $\Pr ed\Delta(G)$, can then be used to instrument for actual changes in funding, $Actual\Delta(G)$. Using this instrument, I am able to estimate equation (2) above for changes 1996-97 (before the reform) to 1999-00 (after the reform).

C. *Flypaper effect*

Next, I ask to what degree additional state special education grants translate into additional special education spending. The theory of the flypaper effect predicts that an increase in state grants to local districts will result in an increase of special education spending that is greater than basic microeconomic theory would predict (Figure 5). The application in this case differs from a pure flypaper effect due to the added complication of changes in price. Because the census-based reform increases state grants to districts and also increases the net cost of educating a special education pupil, the model predicts changes in spending that are smaller than in the basic model.

I examine these theories, again using the instrumental variables method described in section B. Using district-level data in California, I ask how much these additional state grants increase local special education spending on both the intensive and extensive margins. First, to what degree do additional state special education funds result in additional special education spending and to what extent are they diverted to other uses within the school? In other words, how much do these targeted state funds "stick" to districts' special education budgets? Second, how much of the additional state special education dollars result in increased education spending and how much of it is diverted to tax reduction or to other local public spending, such as police, fire, hospitals, roads, etc.?

A simple analysis would regress the change in total education revenues or education expenditures, $\Delta revenues$ or $\Delta \exp enditures$, on the change in state special education funds, $\Delta G$ and the change in unit rates, $\Delta UR$:

$$\Delta \exp enditures_{dj} = \alpha_j + \beta_j \Delta G_d + \gamma_j \Delta UR_d + \delta_j \mathbf{x}_d + \Delta u_{dj} \quad , \quad \text{for each j} \qquad (7)$$

$$\Delta revenues_{dj} = \alpha_k + \beta_k \Delta G_d + \gamma_k \Delta UR_d + \delta_k \mathbf{x}_d + \Delta u_{dk} \quad , \quad \text{for each k} \qquad (8)$$

where *d* indexes districts, *j* indexes type of education expenditure (for example instructional, support services, cafeteria, transportation, capital outlays, etc.) and *k* indexes type of education revenue (for example local, federal, state, general, categorical, etc.). $\mathbf{x}$ is again a vector of district characteristics and $u$ is an idiosyncratic error term.

If $\Delta G$ and $\Delta UR$ are exogenous and there are no omitted variables, the models (7) and (8) yield causal parameters. The $\beta_j$'s in the model represent the extent to which state special education grants are spent on special education programs and not on other school programs. The $\beta_k$'s represent the extent to which state special education grants are spent on education and not on other types of local public goods such as police departments or tax reduction.

Because unit rates in 1996 are largely determined by 1979 rates of special education spending which were random, $UR_{96}$ is likely random. Furthermore, since all unit rates are set to zero post-reform, $\Delta UR$ is exogenous for all districts over the period of the reform. However, $\Delta G$, which depends on the total number of students classified disabled, is not determined exogenously. Also, $\Delta \exp enditures$ and $\Delta G$ are likely to be correlated through unobservable district characteristics. Hence, a causal interpretation of the $\beta_j$'s in (10) is problematic. Furthermore, because distribution of local, federal, and state revenues to

districts are simultaneously determined, a causal interpretation of the $\beta_k$'s in (11) is also problematic.

To mitigate the omitted variables problem in the expenditure equations given by (7), I use the simulated change in funds variable, $\Pr ed\Delta(G)$ given in equation (6) to instrument for the change in state special education funds variable, $\Delta G$. I can also calculate $\Pr ed\Delta(G)$ for the changes 1996 to 1998, 1996 to 1999, 1996 to 2000, 1996 to 2001 and 1996 to 2002. I estimate (7) with the instrument and controlling for lagged changes in total local and federal revenues. Furthermore, because California instituted a class-size reduction initiative in 1996-97, I also control for any changes in district-level pupil-teacher ratios as these might affect changes in expenditures.[15] I estimate the regressions given by equation (7) for one- through five-year changes and am thus able to provide short-, medium-, and long-run estimates of the effect of funding on expenditures.

I am unable to estimate equations (7) in a similar way due to the simultaneity in determination of local, federal, and state revenues. Instead, in order to estimate the extent to which additional state grants stick to local education expenditures and are not used for other types of local public goods, I add the $\beta_j$'s for an exhaustive list of education expenditures. I then compare this sum to one. If this sum is much less than one, I can conclude that additional state education grants are being used to boost spending in areas other than schools.

[15] The class-size reduction affected only kindergarten through third grade classrooms and I do not expect it to have an effect on classification of learning disabilities and attention deficit disorders, the majority of which are first diagnosed at much later ages (Figure 4).

*D. State-level analysis*

Finally, a comparison of California to other states serves as a consistency check for the district-level results. Over the period 1987-2001, ten states[16] in addition to California instituted some form of census-based special education reform. I drop these ten states from the analysis and argue that the remaining 39 states-- which did not undergo census-based special education finance reform-- form a valid counterfactual for what would have happened in California in the absence of such a reform. Using this construction of treatment and control groups, I compare differences in trend to see if California (the treatment group) exhibits different patterns of growth of special education populations than do non-reform states (the control group).

I calculate annual changes in the percent of students classified as disabled for California and for non-reform states and run the following regression:

$$y = \alpha + \beta \mathbf{1}(i \in T) + \gamma \mathbf{1}(t > t^*) + \delta \mathbf{1}(i \in T) \cdot \mathbf{1}(t > t^*) + \varepsilon \qquad (9)$$

where $y$ is the change in percent disabled, $i$ indexes states, $t$ indexes years, $t^*$ is the reform year, $y$ is the change in percent disabled, $\mathbf{1}(i \in T)$ is a dummy variable equal to 1 for California, $\mathbf{1}(t > t^*)$ is a dummy variable equal to one in post-reform years, and $\varepsilon$ is a random error term. Then, $\hat{\delta}$ should give an estimate of the desired treatment effect:

$$\hat{\delta} \approx (\bar{y}^{CA}_{post-reform} - \bar{y}^{CA}_{pre-reform}) - (\bar{y}^{non-CA}_{post-reform} - \bar{y}^{non-CA}_{pre-reform}) \ . \qquad (10).$$

$\hat{\delta}$ identifies any breaks in the trend of disability rates in California relative to non-reform states around the time of the reform. A simple graph of California's disability rate and the average non-reform state's disability rate shows a divergence in trend, suggesting that fiscal

[16] These states are: Alabama, Alaska, Connecticut, Idaho, Massachusetts, Montana, North Dakota, Pennsylvania South Dakota, and Vermont.

incentives have a positive effect on take-up rates (Figure 8). Further examination of treatment and control groups broken down by disability types shows that most of the decline in classification in California occurs among students with either learning disabilities or "other" disabilities[17] (Figure 9). Because learning disabilities and attention deficit disorders lack reliable diagnostic criteria, one would expect any marginal manipulation of disability rates in response to fiscal incentives to occur in these categories. Figure 9 is consistent with these expectations.

## V. Data

The data used in this analysis derives from three sources: the Common Core of Data (CCD), the Public Elementary-Secondary School District Financial Data (F33), and the Annual Report to Congress on the Individuals with Disabilities Education Act (IDEA).

State- and district-level data on school characteristics for 1991-2002 come from the Common Core of Data (CCD), a public-use dataset published by the U.S. Department of Education's National Center for Education Statistics. The CCD contains annual, district- and state-level data on all public schools in the United States. It includes the total numbers of special education students, total student enrollments, racial composition of schools, high school completion levels, grade spans[18], total numbers of teachers, total numbers of free-lunch eligible students, and poverty levels.

State-level information on trends in disability classification for 1991-2002 comes from IDEA. IDEA is published by the Office of Special Education and Rehabilitative Services. It reports counts of total public and private special education students by state for the years 1996-2002. IDEA also reports special education counts by disability type and student age

[17] "Other" includes attention deficit disorder.
[18] Grade spans are the range of instructional grade levels offered by the district.

across states and time, allowing for detailed analyses of age profiles and trends in disability counts by type. In addition, I have hand-entered detailed archived information on disability counts by type and age for 1991-1996. I have also hand-entered 1991-2002 data on numbers of students in special education programs according to the following criteria: setting type; whether mainstreamed; whether placed in a public or private separate facility, public or private residential facility, or home hospital environment.

Finally, I obtain district-level financial data for 1991-2002 from the F33, part of the U.S. Census Bureau's Census of Governments. The F33 contains annual, district-level data on total revenues from federal, state, and local sources. In particular, it distinguishes revenues from state sources intended for special education programs from other categorical and general funds. The F33 also contains detailed, itemized information on total expenditures for instructional staff, operation and maintenance, administration, and debt maintenance. However, it does not distinguish expenditures by special education versus general education use. It also does not contain data on costs of special education programs.

For the district-level instrumental variables analysis described above, I merge the CCD and the F33 by school district identifiers to create a dataset of all school districts in California for the years 1991-2002. This merged dataset includes information on district characteristics such as total enrollment, percent of students classified as disabled, racial characteristics of the student body, poverty levels, and pupil-teacher ratios as well as detailed information on expenditures and revenues. Table 1 presents some summary statistics from the merged dataset.

## VI. Results

Recall, I address two questions in this paper. First, what is the impact of changes in state special education grants on local districts' disability rates? Second, how much of an additional dollar of state special education grant translates into actual increases in instructional spending by local districts? The main results for the first question are in Table 4 and the main results for the second question are in Table 5. The results provide evidence of income and substitution effects on disability rates. I find that local administrators adjust disability rates in response to changes in marginal fiscal incentives (price) but they do not immediately respond to changes in total grants (income). Furthermore, in the long run only small amounts of additional grant dollars translate into direct special education spending. I find that local administrators redirect the majority of additional state special education grants to other, non-special education and non-education uses.

### *A. Results for Disability Classification Rates*

First, I verify that the reform in California had a real effect on the distribution of state grants to districts. Table 2 displays the difference in the distribution of changes in special education grants across districts before and after the reform. Before the reform, most of the changes are clustered around zero with a mean change of -$7. After the reform, the distribution widens so that 10 percent of districts now see changes in funds of -$200 or more in magnitude. Another 10 percent see changes of greater than $82. The standard deviation of this distribution increases from $600 to $2102, a greater than three-fold change. Furthermore, the post-reform distribution mean shifts from a mean of $-7 to $195. Figure 7 illustrates this shift. Here, the year-to-year correlation in levels of state special education grant is much

stronger between 1994-95 and 1996-97 (no reform) than it is between 1996-97 and 1996-97 (reform).

Next, I check the level of variation in my independent variables, change in unit rates, $\Delta UR$, and change in total funds, $\Delta G$. Figures 6A demonstrate that there is sizeable variation in unit rates. The changes in unit rates range from below -$5000 to almost $0. Given that average total per-pupil spending for most districts is approximately $7000 in this period, this represents quite a wide range of variation. In contrast, the changes in total state grants given in Figure 6B are smaller in magnitude than those of the unit rates. This is because in the first year of the reform, the finance formula dictated that schools be allocated an amount of grant approximately equal to the amount received prior to the reform. In other words, the move to the new system was to induce a "compensated" change that presented a new higher "price" for each disabled student but allowed the district to achieve its pre-reform choice. In reality the change was not exactly compensated and some districts received quite a bit more or less post-reform than they had in the pre-reform year. Nonetheless, this feature of the reform creates relatively small changes in the amount of the total grant from 1996-97 to 1999-00 (see Figure 6B). While changes in unit rates average in the thousands of dollars, changes in per-pupil grants average in the hundreds of dollars. This affects interpretation of the results as I show later.

Table 3 shows the first stage correlations between the simulated and actual change in special education funds variables for 1996-97 to 1999-00. The F-statistic of 1351.08 lies solidly in the range of significance. The $R^2$ of .65 implies that the simulated variable explains about 65% of the variation in the 1996-99 actual change in per-pupil funds. This indicates there is substantial endogeneity in the actual change in funds variable. Using this instrument, I estimate equation (5) above.

The main results in Table 4A show that a $1000 increase in per-pupil state special education grants results in no significant increase in the disability rate. Furthermore, point estimates are extremely small. Column 1 of Table 4A presents results weighted by enrollment size in 1996, the year before the reform. Controlling for changes in unit rates, the instrumental variables results show that a $1000 increase in per-pupil state special education grants results in a .5 percentage point increase in the disability rate. Column 2 of Table 4A shows that adding some basic control variables, such as race, number of schools in the district and percent free lunch eligible, does not change the estimates. Weighting the regressions by district enrollment size does affect the estimates. In Columns 3 and 4, the estimated response is .9 and .8 percentage points respectively. However, even these larger results are still extremely small, and none are significant. I caution against generalizing interpretation of these estimates as evidence of no effect on disability rates however, because the estimates are being identified from relatively small changes in total state special education funds. It may be the case that states do *not* respond to such small changes in "income", but that they would respond to larger changes.

The second row of estimates in Columns 1 through 4 shows the effect of changes in unit rates on changes in disability rates. The sign of the estimates are negative, as theory predicts; if the net cost or "price" of classifying an additional student as disabled increases, I expect to see classification rates fall. Controlling for changes in total state funds, unweighted estimates in Columns 3 and 4 show that in fact a $1000 increase in the "price" of special education results in a 1.5 percentage point decrease in the disability rate. The estimates in the weighted regressions, however, are much smaller and not significant (Columns 1 and 2). This indicates that smaller districts respond more strongly to changes in unit rates than do larger districts. This is reasonable since it is also the case that smaller districts tend to have higher

per-pupil costs and thus are more fiscally constrained. It is important to note, too, that some of the difference between large and small districts' behavioral responses is due to the fact that there is less variation in changes in unit rates, $\Delta UR$, for large districts. In fact, the standard deviation of $\Delta UR$ for districts in the top third of enrollment size is about $4000 while the standard deviation for districts in the bottom third of this distribution is about $15000.

Columns 5 through 8 report weighted and unweighted ordinary least squares results. The estimates are different from the results in Columns 1 through 4. Row 1 of these columns shows a much larger (and significant) effect of changes in per-pupil grants on disability rates indicating a strong positive omitted variables bias. Again, the magnitude of the estimates increases in the unweighted regressions, indicating that smaller districts exhibit larger responses. Row 2 of Columns 5 through 8 shows similar estimates to those in Columns 1 through 4. This is expected since $\Delta UR$ is not instrumented in the instrumental variables analysis so both sets of columns give ordinary least squares estimates. Since there is only a price effect and no income effect at the state level, the estimates in Row 2 provide a useful context for understanding the state-level results described later in this section. Based on these estimates, I expect to see a decrease in the number of students classified disabled at the state level.

*Robustness and Validity Checks*

In Table 4B I present some robustness checks. I conduct the same instrumental variables analysis as in Table 4A, but drop the smallest ten percent of districts. Columns 1 and 2 in Table 4B show that for the sub-sample of larger districts, an increase of $1000 in per-pupil state funds results in a .06 percentage point increase in the district disability rate with a standard error of .0036. As with the results on the entire sample, these estimates are again

extremely small and indistinguishable from zero. The point estimates in Columns 3 and 4 change sign, but again are close to zero and insignificant. Row 2 of Columns 1 through 4 indicates a reduction in magnitude of response to the "price" changes compared to the results in Table 4A. I conclude that the results in Table 4A are not very robust to dropping these very small districts. In other words, there is heterogeneity in response by size of the district as was foreshadowed in the main results of Table 4A. On the other hand, dropping the largest ten percent of districts, yields estimates that are similar to those found using the full sample. Row 1 of Columns 5 through 8 in Table 4B shows estimates almost identical to those in Row 1 of Table 4A. Similarly, Row 2 of Columns 5 through 8 in Table 4B is almost identical to Row 2 in Table 4A. Thus, the main results are not driven by the behavior of a few large districts.

Finally, as a validity test, I check for an effect of the change in per-pupil state special education funds due to the reform on pre-reform changes in disability rates. If I am estimating a truly causal parameter, I would not expect an effect of reform driven changes in state funds on pre-reform changes in disability rates. Table 4C accordingly shows no effect of 1996-98 change in per-pupil state special education funds on 1994-96 changes in disability rates.

*B. Flypaper effect*

Table 5A presents the main results to the second question I ask in this paper: How much of each additional dollar in state special education grants 'sticks' to special education spending? I estimate equation (7) using the instrumental variables approach described above. Table 3 shows the first stage correlations between the simulated and actual change in special education funds variables for one-, two-, three-, four-, and five-year changes. The F-statistic is

as low as 11.93 and as high as 1351.08 but all lie solidly in the range of significance. The coefficient is closest to one in the two- and three-year changes indicating the instrument most closely approximates the actual changes in those years. The $R^2$ is low in the one-year change which implies that the simulated variable explains a very small portion of the variation in the actual change in per-pupil funds in that year. This indicates there is very little endogeneity in the actual change in funds variable because of the reform-driven redistribution of funds in the previous year. The $R^2$ becomes larger in subsequent years. Five years after the reform, $R^2$ is .43, indicating that 43% of the variation in the actual change in funds variable can be explained by the instrument.

Because I do not have data on expenditures broken down by special-education and non-special education, I am unable to determine explicitly how much of each dollar results in increases in special education spending. However, special education expenditures are captured almost exclusively in current expenditures. Thus, an examination of changes in current expenditures is a reliable upper-bound for changes in special education expenditures.

Current expenditures are the sum of instructional expenditures and support-services expenditures. Instructional expenditures include special education teacher salaries. Support-services expenditures include salaries and incidental expenses for counselors, school psychologists, physical therapists, and other special education personnel. The first column of Table 5A shows that in the first year of the reform, $.92 of every dollar is spent on current expenditures. More specifically, Table 5A shows that $.53 of every grant dollar goes toward instructional salaries, and $.39 goes toward increases in support services expenditures.

In the same year, the change in state special education funds does not result in any statistically significant changes in other non-special education expenditures such as capital

expenditures, non-instructional expenditures, and non-elementary secondary expenditures.[19] I conclude, therefore, that in the first year of the reform, a dollar increase in targeted special education revenue from the state results in a $92 increase in special education spending.

This result changes quite substantially however when I look at two-, three-, four-, or five-year changes in spending patterns. Column 2 in Table 5A shows that in the second year of the reform, an additional dollar of state special education grant revenue results in only a $.26 increase in current expenditures, broken down into a $.14 increase in instructional expenditures and a $.12 increase in support services expenditures. By the fifth year after the reform, the coefficient on support services expenditures has recovered slightly to $.23, but the overall effect on current expenditures is still much smaller than in Column 1.

In addition, there is a statistically significant increase of $.04 in capital expenditures and a $.11 increase in non elementary-secondary expenditures in the first year following the reform. It is important to note that these increases are sustained five years after the reform (Table 5A, Column 5). Since capital outlays and spending on non elementary-secondary programs do not include any direct special education component, I conclude that districts redistribute funds so as to permanently divert additional state special education grants to non-special education uses. Though I do not know the average marginal propensity to consume of special education program expenditures, these estimates seem to indicate that the flypaper effect does not hold on the intensive margin in the long run.

Next, I ask how much of each dollar of targeted state grant results in increases in education revenue. I skirt the difficulties in estimating equation (8) by estimating (7) for an

[19] Capital expenditures include upkeep of existing buildings and equipment as well as acquisition of new ones. Non-instructional expenditures include operating expenditures for food services and enterprise operations. Non elementary-secondary programs include current operating expenditures for community services, adult education, and other non elementary-secondary programs.

exhaustive list of expenditures. If a dollar increase in targeted state grant results in changes in *total education* expenditures of less than one dollar, I can conclude that some of the targeted grant is leaked out to non-education uses. For example, localities may substitute the state targeted grant for existing special education funding. They can then shift existing special education funds toward local tax relief or increased spending on crime, health, or other infrastructure. The rows in Table 5A make up an exhaustive list of education expenditures. Adding up these rows, I see that in the first year $.92 of each additional dollar of the targeted grant is translated into education revenue. However, in the second and fifth years, an additional dollar of state special education grant translates into only $.41 and $.66 of education revenue, respectively. The remainder is leaked out to spending on other local public goods. Thus, the flypaper effect holds on the extensive margin in the short run, but fails to hold in the long run.

Table 5B presents coefficients on the unit rate from estimation of equation (6). Point estimates are almost uniformly zero and none of the results is significant with the exception of a response in support services expenditures in the fourth and fifth years of the change. I conclude that there is no price effect.

*Validity Check*

Finally, as a validity test, I check for an effect of the change in per-pupil state special education funds due to the reform on pre-reform changes in special education expenditures. If I am estimating a truly causal parameter, I would not expect an effect of reform driven changes in state funds on pre-reform changes in disability rates. Table 5C accordingly shows no effect of 1996-98 change in per-pupil state special education funds on 1994-96 changes in disability rates.

*C. State-level analysis*

The state-level results are useful as a consistency check for the district-level results. The state-level difference-in-difference analysis tests whether changes in the unit rates have an effect on rates of special education classification. However, at the state-level I am unable to capture the effects of the change in total per-pupil grants on classification behavior. In other words, I am able to capture the price effects but am unable to capture the income effects.

Results suggest that changes in the price of special education have a negative effect on disability rates and a negative effect on total state special education expenditures. In other words, when price of special education increases, as it did for all districts in California, the quantity of special education program dollars districts choose to spend falls. This is in keeping with the theory (Figures 5B, 5C, and 5D). The raw correlation indicating the state-level trends in disability rates is plotted in Figure 8. The reduced form difference-in-difference regression estimates for trend breaks in percent special education are presented in Table 6.

Figure 8 shows the trend in growth of special education populations for California versus other non-reform states. Consistent with the positive effect of fiscal incentives on disability classification, California breaks from trend in 1998-99, the first year of the census reform. That is, when fiscal incentives decrease as a result of the reform, disability rates follow. Furthermore, Figure 9 shows that much of this fall in disability classification occurs in the categories of learning disabilities and other disabilities, a category which includes attention deficit disorder.

Panel A in Table 6 quantifies the effect shown in Figure 8. The point estimate indicates that the growth of California's disability rate is .4% lower than the growth of the disability rate in the average non-reform state, though the t-statistic is only 1.61. Over a five

year period, this translates into an increase of roughly two percentage points in the difference between disability rates in California and the average non-reform state.

As a falsification test, I contrast this result to a test for a break in trend at 1993-94, a non-reform year. Because there was no reform in 1993-94, I expect to see no trend break in this year. The result for this falsification test shows no difference between California's rate of growth in the disability rate and that of the average non-reform states' rate of growth.

## VII. Conclusion

By leveraging California's census-based special education finance in an instrumental variables design, I am able to improve on existing ordinary least squares regression estimates and case studies. This instrumental variables estimation strategy overcomes potential problems of endogeneity that make ordinary least squares estimates difficult to interpret. The instrumental variables estimates presented in this paper provide a closer approximation of the true causal estimate of interest.

In keeping with predictions of an economic model of behavior, I find that local school districts respond to fiscal incentives in state grants by adjusting the percent of students labeled disabled. Smaller districts, in particular, exhibit strong responses to changes in the price of special education programs. I also find that additional state special education grants to localities initially result in almost dollar for dollar increases in local special education spending. However, over the longer run, the additional grants are redirected to other uses.

These findings are important to both public finance economists and to educational policymakers. Understanding the impact of fiscal incentives on school districts' disability classification rates and spending behavior is crucial to designing effective special education policies. The estimates in this paper provide a crucial first step in this understanding. It may

be possible in future work to map these reduced form parameters into structural parameters. By assuming a functional form, I can use estimates of the reduced form parameters to identify the indifference curves of the typical district's preference between special education and other programs. This exercise would allow simulation of district behavior under a variety of different cost and revenue levels.

Furthermore, the results help shape expectations about special education program efficacy, a question that has proven difficult to answer given data constraints. Researchers currently know little to nothing about the effectiveness of special education programs on student outcomes. However, if administrators respond to fiscal incentives by shifting added revenues to other, non-special education programs or if these additional funds are redistributed to increase spending on other public goods, such as tax reduction, maintenance of roads, local public health services, police departments, or fire services, we should not be surprised to find zero positive effects of these programs on student outcomes.

The findings in this paper also provide general insight into local districts' behavioral responses to intergovernmental grants. The study thus adds to the existing body of literature on fiscal federalism. Though it is unclear the extent to which I can generalize these results, the estimates provide evidence for the existence of a flypaper effect in the education context, especially in the short-run. The estimates also show that the theory of the flypaper effect does not hold in the longer run, at least in this context. If states increase special education funding to local districts in order to increase spending on disabled students, their goals may be stymied by the offsetting behavior of local districts.

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Figure 1. Trend in special education rates among U.S. school children

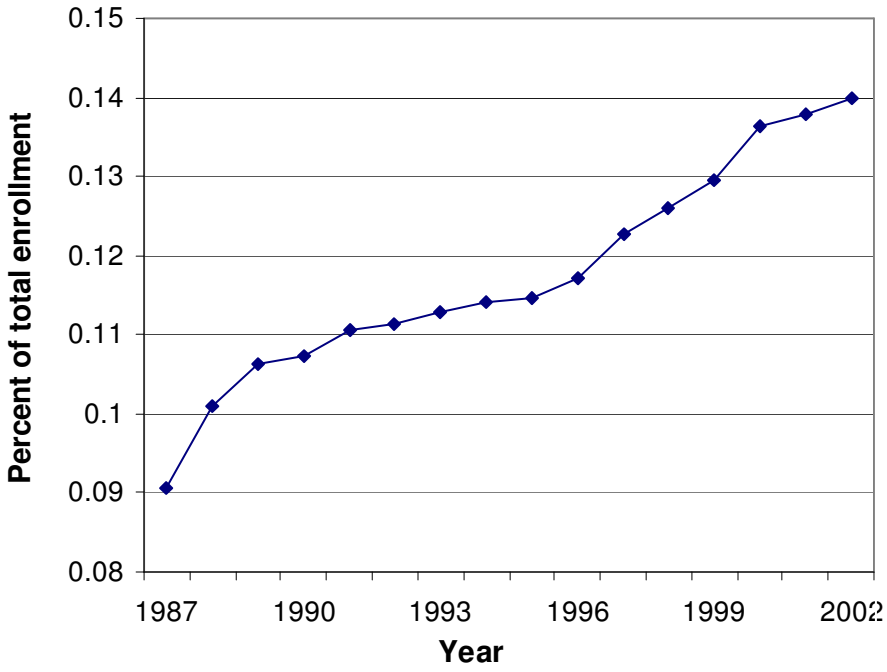



Figure 2. Distribution of states' disability rates in 1987 and 2002.

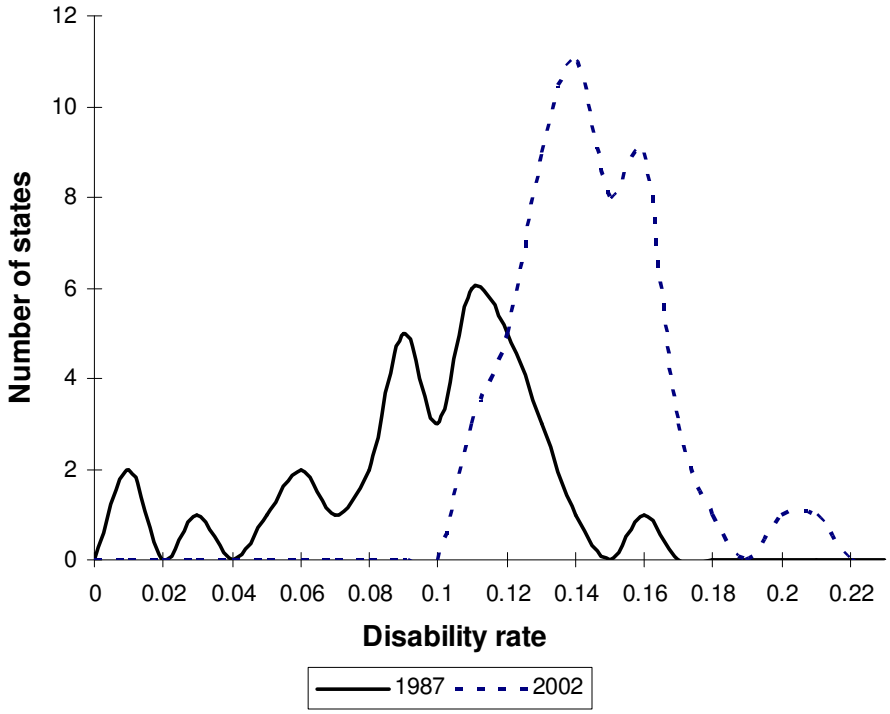


Figure 3. Age profile of disability diagnosis

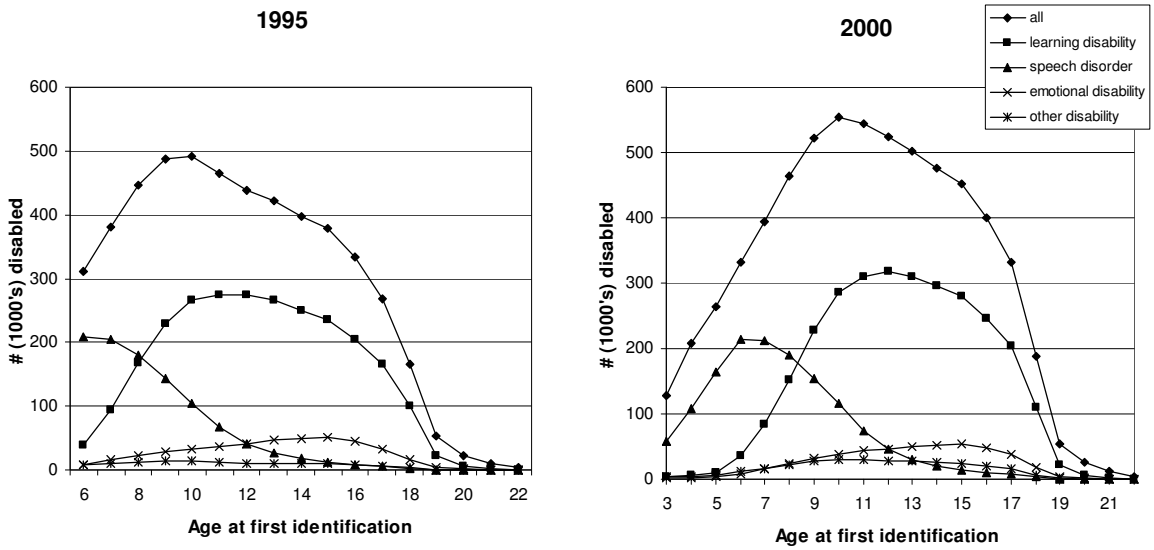


Figure 4A. Effects of increased grants on disability classification, pre-reform

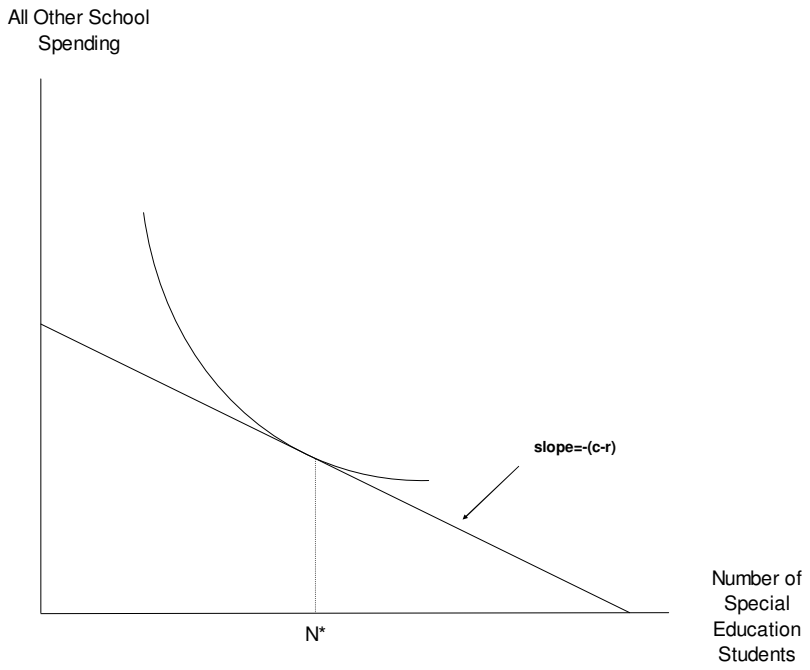



Figure 4B. Effects of increased grants on disability classification, post-reform

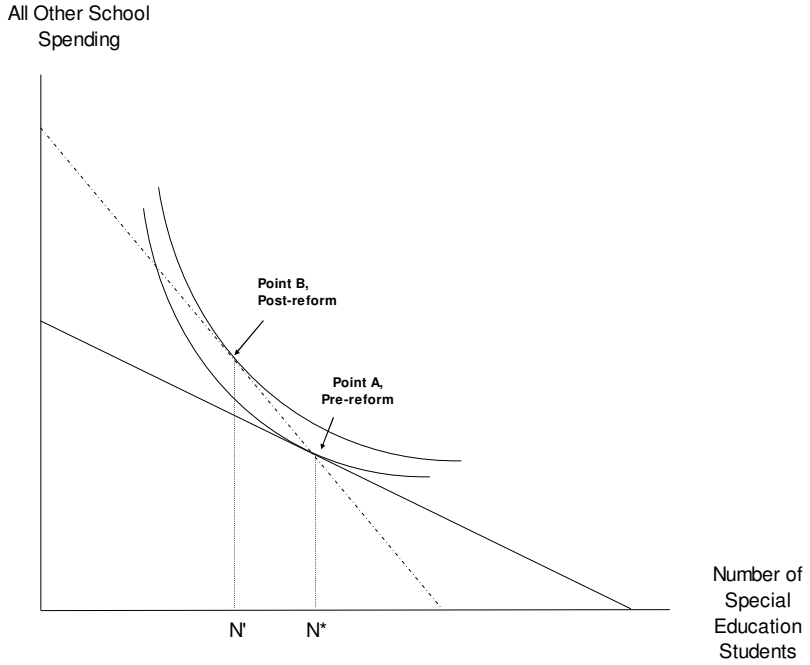


Figure 5. Pure flypaper effect with no change in price

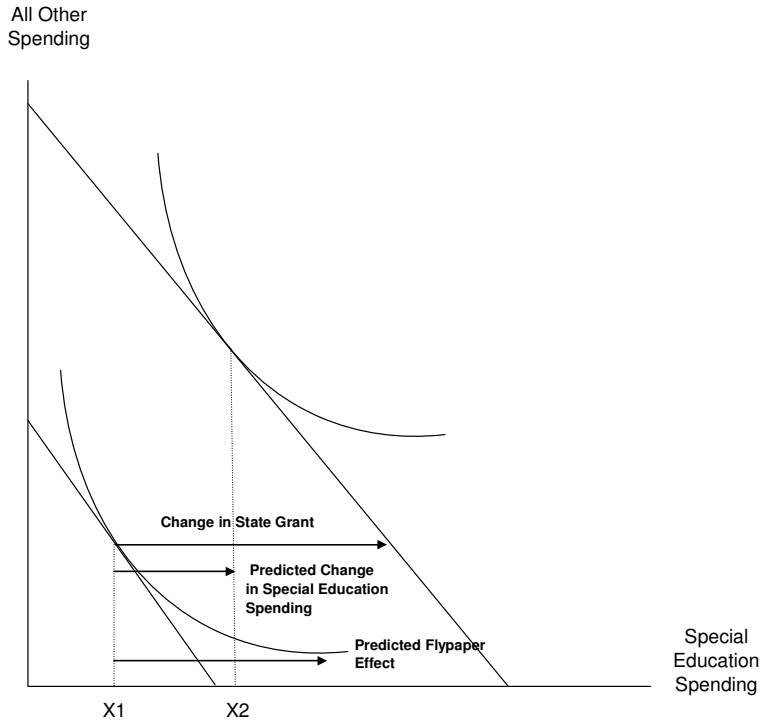


Figure 6A. Variation in change in unit rates 1996 to 1999

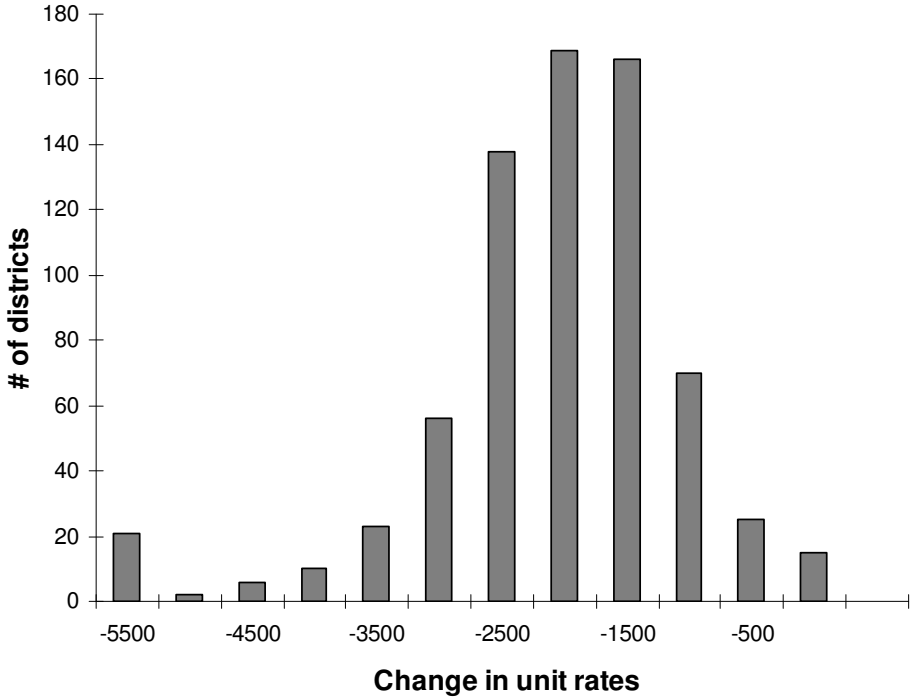



Figure 6B. Variation in change in per-pupil state special education funds 1996 to 1999

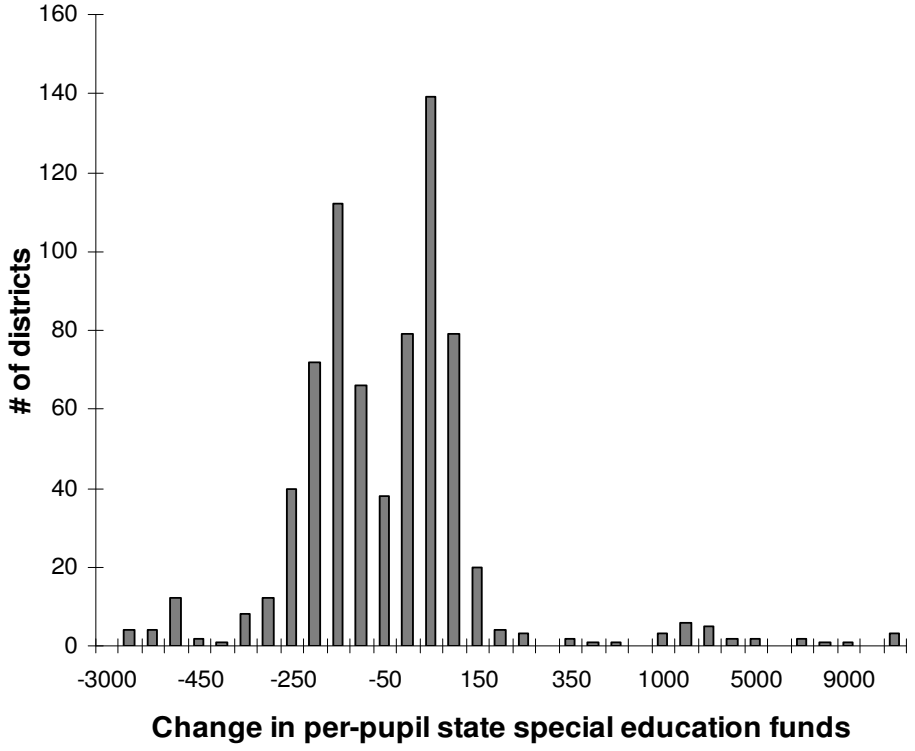
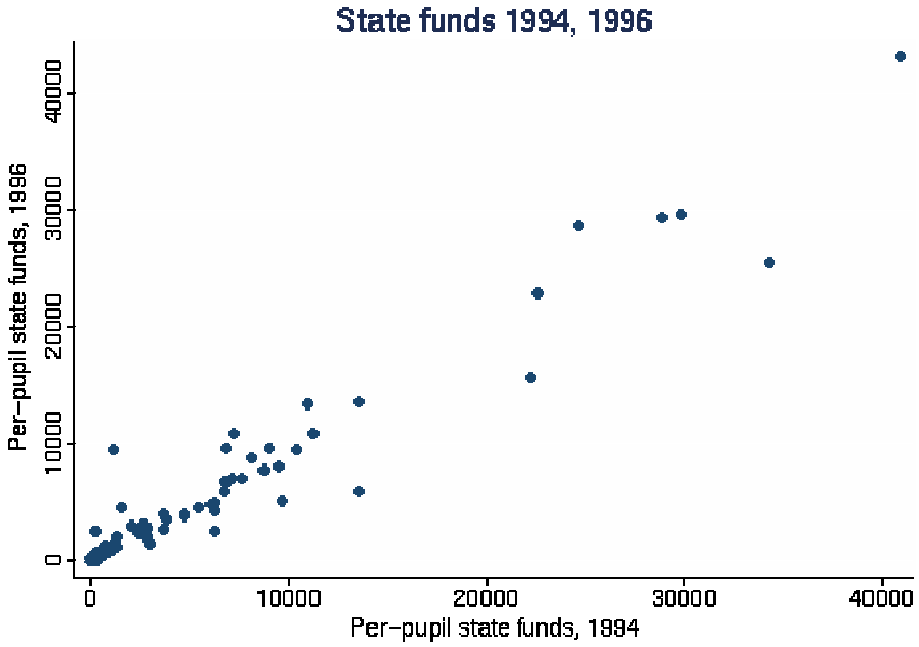


Figure 7. Year-to-year correlation of state funds before and after the reform



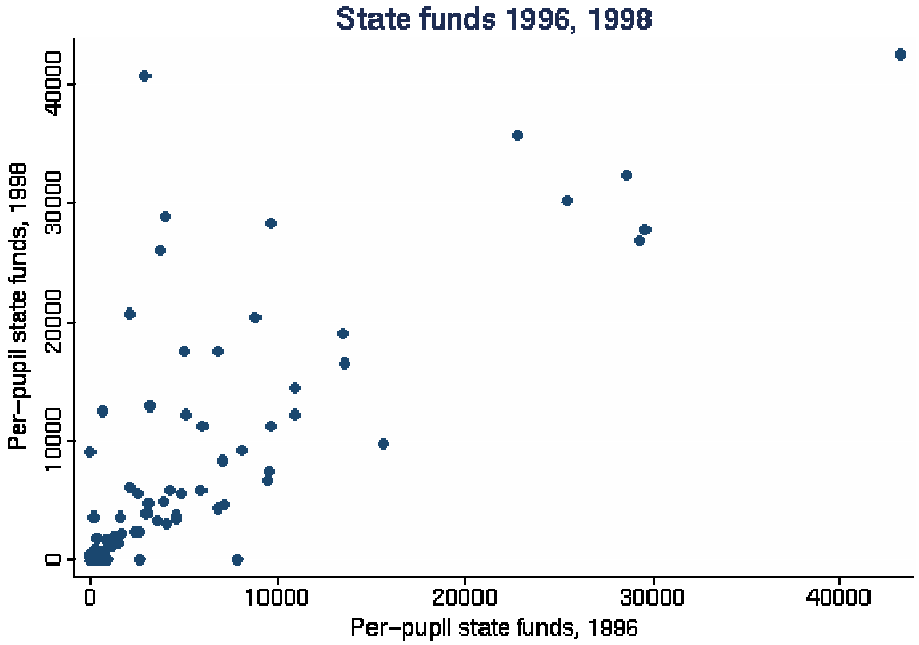



Figure 8. State trends in percent of students classified as disabled

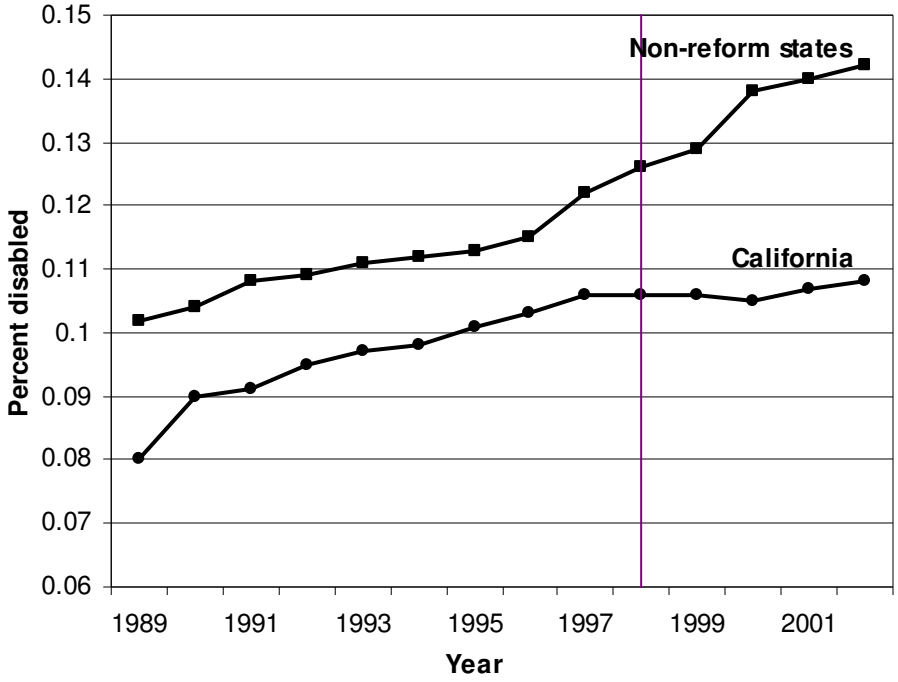


Figure 9. California trends by disability

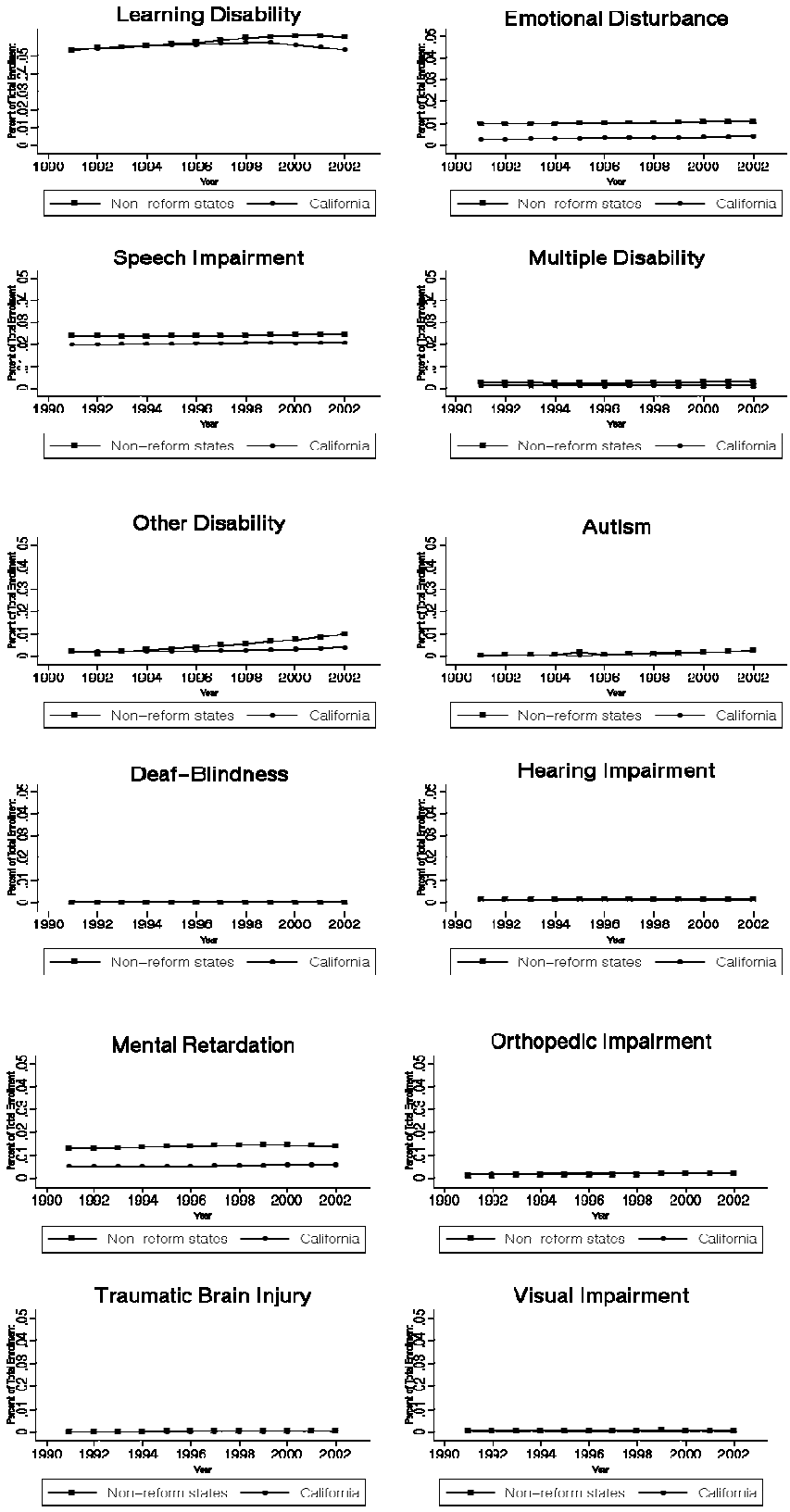


Table 1. Summary statistics by district size

| | Small | Medium | Large | Total |
|---|---|---|---|---|
| Total enrollment | 216.27 | 1569.87 | 14448.89 | 5423.71 |
| | (154.13) | (791.40) | (37639.43) | (22675.21) |
| Number of schools | 1.35 | 3.54 | 18.13 | 7.69 |
| | (.73) | (1.91) | (37.50) | (22.94) |
| Pupil-teacher ratio | 18.77 | 20.82 | 23.32 | 20.97 |
| | (5.34) | (4.36) | (2.10) | (4.56) |
| Total expenditures[1, 2] | 8811.75 | 7362.26 | 4790.16 | 7002.11 |
| | (13917.67) | (8428.03) | (1538.55) | (9602.00) |
| Instructional | 4077.22 | 3649.15 | 2572.01 | 3437.96 |
| expenditures | (4718.98) | (3901.12) | (603.68) | (3616.63) |
| Support services | 3022.00 | 2366.38 | 1385.13 | 2263.04 |
| expenditures | (5410.05) | (3470.53) | (570.19) | (3794.13) |
| Capital expenditures | 716.37 | 809.14 | 482.14 | 670.74 |
| | (1034.41) | (1081.06) | (490.53) | (921.11) |
| Other expenditures | 184.66 | 191.94 | 172.01 | 183.04 |
| | (161.88) | (324.34) | (68.40) | (213.70) |
| Total revenues | 9399.57 | 7668.02 | 4967.40 | 7360.83 |
| | (14223.58) | (9029.04) | (1521.17) | (9956.89) |
| Federal revenues | 1095.08 | 894.33 | 312.92 | 770.70 |
| | (3778.37) | (2576.12) | (316.38) | (2673.42) |
| State revenues | 5195.73 | 3849.27 | 2807.22 | 3958.26 |
| | (7771.50) | (4234.05) | (938.60) | (5241.16) |
| Local revenues | 3108.77 | 2924.42 | 1847.26 | 2631.88 |
| | (4287.90) | (3482.37) | (1048.83) | (330.52) |
| State special ed | 930.02 | 551.40 | 224.35 | 570.92 |
| revenues | (4121.37) | (2026.07) | (223.07) | (2676.05) |
| Change in state | 223.59 | 300.40 | 14.69 | 181.30 |
| special ed revenues[3] | (3061.38) | (3296.84) | (1240.96) | (2703.02) |
| Percent special ed | .11 | .14 | .10 | .12 |
| enrollment | (.22) | (.20) | (.05) | (.18) |
| Change in percent of | .09 | .01 | .00 | .03 |
| students special ed[3] | (.69) | (.13) | (.02) | (.41) |
| Percent black | .02 | .03 | .07 | .04 |
| | (.05) | (.07) | (.08) | (.07) |
| Percent white | .68 | .61 | .46 | .59 |
| | (.25) | (.27) | (.25) | (.27) |
| Percent hispanic | .24 | .28 | .36 | .29 |
| | (.25) | (.26) | (.23) | (.25) |
| Percent free-lunch | .42 | .36 | .41 | .40 |
| eligible | (.30) | (.27) | (.23) | (.27) |

Notes: Standard deviations in parentheses.

[1] All dollar amounts are expressed in 1990 dollars.

[2] All revenues and expenditures are in per-pupil terms.

[3]Change between 1996-1997 and 1999-2000 school years.

Table 2. Distribution of change in per-pupil state special education revenues

| | 1994-96 change | 1996-98 change |
|---|---|---|
| 1st percentile | -1198 | -1008 |
| 10th percentile | -25 | -200 |
| 20th percentile | -9 | -132 |
| 30th percentile | -1 | -20 |
| 40th percentile | 0 | 0 |
| 50th percentile | 0 | 0 |
| 60th percentile | 3 | 7 |
| 70th percentile | 11 | 24 |
| 80th percentile | 22 | 43 |
| 90th percentile | 41 | 82 |
| 99th percentile | 629 | 9798 |
| Mean | -7 | 195 |
| Standard deviation | 600 | 2102 |
| N | 1017 | 1017 |

Note: All amounts expressed in 1990 dollars.

Table 3. First-stage results: Correlation between simulated and actual change in funds

| Dependent variable | Independent variable | Coefficient | F | $R^2$ |
|---|---|---|---|---|
| Actual change in per-pupil state funds 1996-97 to 1998-99 | Simulated change in per-pupil state funds 1996-97 to 1998-99 | .2755 | 11.93 | .0160 |
| Actual change in per-pupil state funds 1996-97 to 1999-00 | Simulated change in per-pupil state funds 1996-97 to 1999-00 | .8367 | 1351.08 | .6489 |
| Actual change in per-pupil state funds 1996-97 to 2000-01 | Simulated change in per-pupil state funds 1996-97 to 2000-01 | .6372 | 429.99 | .3720 |
| Actual change in per-pupil state funds 1996-97 to 2001-02 | Simulated change in per-pupil state funds 1996-97 to 2001-02 | .2538 | 442.94 | .3815 |
| Actual change in per-pupil state funds 1996-97 to 2002-03 | Simulated change in per-pupil state funds 1996-97 to 2002-03 | .0008 | 547.67 | .4348 |

Table 4A. Effects of change in state special education funds on change in disability rates

| | Dependent variable: change in disability rates | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | IV 1996-99 | | | | OLS 1996-99 | | | |
| | (1) | (2) | (3) | (4) | (9) | (10) | (11) | (12) |
| Change in per-pupil state funds ($1000) | .0049 (.0043) | .0048 (.0044) | .0088 (.0128) | .0078 (.0130) | .0089 ** (.0038) | .0088 ** (.0038) | .0356 ** (.0172) | .0360 ** (.0175) |
| Change in unit rate ($1000) | -.0027 (.0021) | -.0024 (.0021) | -.0153 ** (.0071) | -.0146 ** (.0070) | -.0023 (.0020) | -.0021 (.0021) | -.0139 ** (.0070) | -.0138 ** (.0067) |
| Controls | N | Y | N | Y | N | Y | N | Y |
| Weighted by enrollment | Y | Y | N | N | Y | Y | N | N |
| N | 785 | 785 | 785 | 785 | 795 | 795 | 795 | 795 |

Notes: Robust standard errors in parentheses. Weighted regressions are weighted by 1996 total enrollment. Controls include race, number of schools in the district, and percent of enrollment that is free-lunch eligible. * indicates significance at 10% level, ** indicates 5% level and *** indicates 1% level.

Table 4B. Robustness checks: Dropping smallest or largest districts in sample

| | Dependent variable: change in disability rates | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | IV Dropping smallest 10% of districts | | | | IV Dropping largest 10% of districts | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Change in per-pupil state funds ($1000) | .0006 (.0036) | .0004 (.0036) | -.0052 (.0041) | -.0065 (.0044) | .0035 (.0034) | .0033 (.0035) | .0075 (.0171) | .0090 (.0191) |
| Change in unit rate ($1000) | -.0014 (.0017) | -.0009 (.0017) | -.0035 (.0044) | -.0027 (.0041) | -.0028 (.0022) | -.0026 (.0022) | -.0152 ** (.0071) | -.0145 ** (.0071) |
| Controls | N | Y | N | Y | N | Y | N | Y |
| Weighted by enrollment | Y | Y | N | N | Y | Y | N | N |
| N | 701 | 701 | 701 | 701 | 700 | 700 | 700 | 700 |

Notes: Robust standard errors in parentheses. Weighted regressions are weighted by 1996 total enrollment. Controls include race, number of schools in the district, and percent of enrollment that is free-lunch eligible. * indicates significance at 10% level, ** indicates 5% level and *** indicates 1% level.

Table 4C. Validity check: Effects of change in state special education funds on pre-reform change in disability rates

| | Dependent variable: change in disability rates | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Change in per-pupil state funds ($1000) | .0246 (.0189) | .0250 (.0191) | .0349 (.0267) | .0360 (.0268) |
| Change in unit rate ($1000) | .0017 (.0028) | .0015 (.0027) | .0099 (.0018) | .0026 (.0015) |
| Controls | N | Y | N | Y |
| Weighted by enrollment | Y | Y | N | N |
| N | 738 | 738 | 738 | 738 |

Notes: Robust standard errors in parentheses. Weighted regressions are weighted by 1996 total enrollment. Controls include race, number of schools in the district, and percent of enrollment that is free-lunch eligible. * indicates significance at 10% level, ** indicates 5% level and *** indicates 1% level.

Table 5A. IV Estimates: Income effects of change in state special education funds on change in local expenditures

| Dependent variables | Instrumented variable: change in state special education funds | | | | |
|---|---|---|---|---|---|
| | First year change 1996-1998 | Second year change 1996-1999 | Third year change 1996-2000 | Fourth year change 1996-2001 | Fifth year change 1996-2002 |
| | (1) | (2) | (3) | (4) | (5) |
| Change in per-pupil current expenditures | .92 *** | .26 *** | .26 *** | .16 *** | .46 *** |
| | (.26) | (.09) | (.08) | (.06) | (.11) |
| Change in per-pupil instructional expenditures | .53 *** | .14 *** | .12 *** | .01 | .23 ** |
| | (.16) | (.03) | (.05) | (.04) | (.08) |
| Change in per-pupil support-services expenditures | .39 ** | .12 * | .14 * | .15 *** | .23 *** |
| | (.15) | (.07) | (.08) | (.04) | (.05) |
| Change in per-pupil capital expenditures | .03 | .04 ** | .05 *** | .01 | .03 |
| | (.07) | (.02) | (.02) | (.04) | (.03) |
| Change in per-pupil non-instructional expenditures[1] | .01 | -.00 | -.00 | -.00 | .01 |
| | (.01) | (.00) | (.01) | (.00) | (.01) |
| Change in per-pupil non el-sec expenditures [2] | -.00 | .11 ** | .14 ** | .04 | .21 *** |
| | (.00) | (.05) | (.07) | (.04) | (.06) |
| Change in all other expenditures [3] | .00 | -.00 | -.01 ** | -.01 * | -.01 ** |
| | (.01) | (.00) | (.00) | (.00) | (.00) |
| N | 793 | 785 | 778 | 772 | 769 |

* indicates significance at 10% level, ** indicates 5% level, and *** indicates 1% level.

[1]Non-instructional spending includes current operation expenditures for food services, enterprise operations.

[2]Non el-sec programs include current operating expenditures for community services, adult education and other non elementary-secondary programs.

[3]All other expenditures include payments to local and state governments and interest payments on debt.

Notes: Robust standard errors in parentheses. Regressions are weighted by 1996 total enrollment. Regressions include controls for 1991 to 1995 changes in per-pupil federal and local revenues. Each cell represents a separate regression.

Table 5B. IV Estimates: Price effects of change in state special education funds on change in local expenditures

| Dependent variables | Instrumented variable: change in state special education funds | | | | |
|---|---|---|---|---|---|
| | First year change 1996-1998 | Second year change 1996-1999 | Third year change 1996-2000 | Fourth year change 1996-2001 | Fifth year change 1996-2002 |
| | (1) | (2) | (3) | (4) | (5) |
| Change in per-pupil current expenditures | .01 | .00 | -.00 | -.06 ** | -.05 |
| | (.03) | (.02) | (.03) | (.03) | (.03) |
| Change in per-pupil instructional expenditures | -.01 | -.02 | -.01 | -.02 | -.01 |
| | (.03) | (.01) | (.02) | (.02) | (.03) |
| Change in per-pupil support-services expenditures | .02 | .02 | .01 | -.04 ** | -.04 ** |
| | (.02) | (.02) | (.03) | (.02) | (.02) |
| Change in per-pupil capital expenditures | -.01 | -.01 | .00 | -.02 | -.02 |
| | (.01) | (.01) | (.01) | (.01) | (.02) |
| Change in per-pupil non-instructional expenditures[1] | .00 | -.00 | -.00 | -.00 | -.00 |
| | (.00) | (.00) | (.00) | (.00) | (.00) |
| Change in per-pupil non el-sec expenditures [2] | .00 | -.01 | -.01 | -.04 | -.02 |
| | (.00) | (.01) | (.02) | (.02) | (.02) |
| Change in all other expenditures [3] | .00 | -.00 | -.00 | -.00 | -.00 |
| | (.00) | (.00) | (.00) | (.00) | (.00) |
| N | 793 | 785 | 778 | 772 | 769 |

* indicates significance at 10% level, ** indicates 5% level, and *** indicates 1% level.

[1]Non-instructional spending includes current operation expenditures for food services, enterprise operations.

[2]Non el-sec programs include current operating expenditures for community services, adult education and other non elementary-secondary programs.

[3]All other expenditures include payments to local and state governments and interest payments on debt.

Notes: Robust standard errors in parentheses. Regressions are weighted by 1996 total enrollment. Regressions include controls for 1991 to 1995 changes in per-pupil federal and local revenues. Each cell represents a separate regression.

Table 5C. Validity Check: Effects of change in state special education funds on pre-reform change in local expenditures

| Dependent variables | Instrumented variable: change in state special education funds | | |
|---|---|---|---|
| | First year change 1996-1998 | Second year change 1996-1999 | Fifth year change 1996-2002 |
| | (1) | (2) | (5) |
| Change in per-pupil current expenditures | .22<br>(.19) | .06<br>(.03) | .12 **<br>(.05) |
| Change in per-pupil instructional expenditures | .04<br>(.10) | .00<br>(.02) | .04<br>(.04) |
| Change in per-pupil support-services expenditures | .23<br>(.17) | .06 **<br>(.02) | .08 ***<br>(.02) |
| Change in per-pupil capital expenditures | -.05<br>(.06) | -.06<br>(.04) | -.05<br>(.04) |
| Change in per-pupil non-instructional expenditures[1] | -.04<br>(.05) | -.00<br>(.00) | -.00<br>(.00) |
| Change in per-pupil non el-sec expenditures [2] | -.00<br>(.08) | -.09 *<br>(.05) | -.13<br>(.08) |
| Change in all other expenditures [3] | -.01<br>(.01) | .00<br>(.00) | .00<br>(.00) |
| N | 793 | 785 | 769 |

* indicates significance at 10% level, ** indicates 5% level, and *** indicates 1% level.

[1]Non-instructional spending includes current operation expenditures for food services, enterprise operations.

[2]Non el-sec programs include current operating expenditures for community services, adult education and other non elementary-secondary programs.

[3]All other expenditures include payments to local and state governments and interest payments on debt.

Notes: Robust standard errors in parentheses. Regressions are weighted by 1996 total enrollment. Regressions include controls for 1991 to 1995 changes in per-pupil federal and local revenues. Each cell represents a separate regression.

Table 6. State-level reduced form difference-in-difference estimates for percent disabled

| | Treatment status | |
|---|---|---|
| | California | Non-California |
| | (1) | (2) |
| A. Break in trend, 1998-99 | | |
| Change in percent special education | | |
| 1989-90 to 1997-98 | .0031810 | .0026083 |
| 1998-99 to 2002-03 | -.0006533 | .0030988 |
| *Difference:* | -.0038343 | .0004905 |
| *Difference in Difference:* | **-.0043248** | |
| | (.0026846) | |
| | [-1.61] | |
| B. Break in trend, 1993-94 | | |
| Change in percent special education | | |
| 1989-90 to 1992-93 | .0041462 | .0036568 |
| 1993-94 to 1996-97 | .0025564 | .0021703 |
| *Difference:* | -.0015898 | -.0014865 |
| *Difference in Difference:* | -.0001033 | |
| | (.0034845) | |
| | [-.03] | |

Notes: "Non-CA" excludes ten states that have had census-based reforms over the time period in question. Standard errors are in ( ), t-statistics are in [ ].

**APPENDIX A. Descriptions of Disability Categories As Defined By IDEA**
Reference: Federal Register, Vol. 64, No. 48, March 12, 1999. Rules and Regulations, pp. 12421-2.

**Autism** means a developmental disability significantly affecting verbal and nonverbal communication and social interaction, generally evident before age 3, that adversely affects a child's educational performance. Other characteristics often associated with autism are engagement in repetitive activities and stereotyped movements, resistance to environmental change or change in daily routines, and unusual responses to sensory experiences. The term does not apply if a child's educational performance is adversely affected primarily because the child has an emotional disturbance, as defined in this section. A child who manifests the characteristics of "autism" after age 3 could be diagnosed as having "autism" if the criteria of this section are satisfied.

**Deaf-blindness** means concomitant hearing and visual impairments, the combination of which causes such severe communication and other developmental and educational needs that they cannot be accommodated in special education programs solely for children with deafness or children with blindness.

**Deafness** means a hearing impairment that is so severe that the child is impaired in processing linguistic information through hearing, with or without amplification, that adversely affects a child's educational performance.

**Emotional disturbance** means a condition exhibiting one or more of the following characteristics over a long period of time and to a marked degree that adversely affects a child's educational performance:
(A) An inability to learn that cannot be explained by intellectual, sensory, or health factors.
(B) An inability to build or maintain satisfactory interpersonal relationships with peers and teachers.
(C) Inappropriate types of behavior or feelings under normal circumstances.
(D) A general pervasive mood of unhappiness or depression.
(E) A tendency to develop physical symptoms or fears associated with personal or school problems.
The term includes schizophrenia. The term does not apply to children who are socially maladjusted, unless it is determined that they have an emotional disturbance.

**Hearing impairment** means an impairment in hearing, whether permanent or fluctuating, that adversely affects a child's educational performance but that is not included under the definition of deafness in this section.

**Mental retardation** means significantly sub-average general intellectual functioning, existing concurrently with deficits in adaptive behavior and manifested during the developmental period, that adversely affects a child's educational performance.

**Multiple disabilities** means concomitant impairments (such as mental retardation-blindness, mental retardation-orthopedic impairment, etc.), the combination of which causes such severe educational needs that they cannot be accommodated in special education programs solely for one of the impairments. The term does not include deaf-blindness.

**Orthopedic impairment** means a severe orthopedic impairment that adversely affects a child's educational performance. The term includes impairments caused by congenital anomaly (e.g., clubfoot, absence of some member, etc.), impairments caused by disease (e.g., poliomyelitis, bone

tuberculosis, etc.), and impairments from other causes (e.g., cerebral palsy, amputations, and fractures or burns that cause contractures).

**Other health impairment** means having limited strength, vitality or alertness, including a heightened alertness to environmental stimuli, that results in limited alertness with respect to the educational environment, that—
(i) Is due to chronic or acute health problems such as asthma, attention deficit disorder or attention deficit hyperactivity disorder, diabetes, epilepsy, a heart condition, hemophilia, lead poisoning, leukemia, nephritis, rheumatic fever, and sickle cell anemia; and
(ii) Adversely affects a child's educational performance.

**Specific learning disability** is defined as follows:
(i) *General.* The term means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia.
(ii) *Disorders not included.* The term does not include learning problems that are primarily the result of visual, hearing, or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage.

**Speech or language impairment** means a communication disorder, such as stuttering, impaired articulation, a language impairment, or a voice impairment, that adversely affects a child's educational performance.

**Traumatic brain injury** means an acquired injury to the brain caused by an external physical force, resulting in total or partial functional disability or psychosocial impairment, or both, that adversely affects a child's educational performance. The term applies to open or closed head injuries resulting in impairments in one or more areas, such as cognition; language; memory; attention; reasoning; abstract thinking; judgment; problem-solving; sensory, perceptual, and motor abilities; psychosocial behavior; physical functions; information processing; and speech. The term does not apply to brain injuries that are congenital or degenerative, or to brain injuries induced by birth trauma.

**Visual impairment including blindness** means an impairment in vision that, even with correction, adversely affects a child's educational performance. The term includes both partial sight and blindness.

## APPENDIX B. District-level Fixed Effects Analysis

A simple regression of disability rates on fiscal incentives exploits the variation in changes in special education funds across districts. Under certain circumstances, such a regression identifies the responsiveness of district special education rates to state fiscal incentives. I model district-level disability classification in the following way:

$$piep_{dt} \equiv \frac{speced_{dt}}{enroll_{dt}} = \beta_0 + \beta_1 funds_{dt} + \beta_2 \mathbf{x}_{dt} + \beta_3 need_{dt} + \beta_4 politics_{dt} + \mathbf{d} + \mathbf{t} + u_{dt} \quad \text{(B1)}$$

where *d* indicates district, *t* time, *piep* is the percent of students classified disabled, *speced* is the number of students in special education, *enroll* is total enrollment, *funds* is the amount of state special education funds the district receives, *need* is a measure of the district's fiscal constraint given some 'true' disability rate, and *politics* measures degree of lobby power and political sway of the district over the distribution of state funds. $\mathbf{x}$ is a vector of time varying district characteristics and $\mathbf{d}$ is a vector of district dummies. $\mathbf{t}$ is a vector of time effects and *u* is an error term.

The problem with estimating this model is that variables such as *need* and *politics* are not easily or accurately measured. As a result, I am only able to estimate the following sparser model:

$$piep_{dt} = \beta_0 + \beta_1 funds_{dt} + \beta_2 \mathbf{x}_{dt} + \mathbf{d} + \mathbf{t} + \varepsilon_{dt} \quad \text{(B2)}$$

where the error term $\varepsilon_{dt}$ is given by $\varepsilon_{dt} = \beta_3 need_{dt} + \beta_4 politics_{dt} + u_{dt}$. For equation (B2) to offer unbiased estimates of $\beta_1$, the following two assumptions must hold:

1) $\mathrm{E}[\varepsilon_{dt} \mid funds_{dt}, \mathbf{x}_{dt}, \mathbf{d}, \mathbf{t}] = 0$,

and 2) $\mathrm{Cov}(\varepsilon_{ds}, \varepsilon_{dt} \mid funds_{dt}, \mathbf{x}_{dt}, \mathbf{d}, \mathbf{t}) = 0$.

If either of these assumptions is violated, estimation of $\beta_1$ will be biased.

For example, I may be concerned that the state's distribution of per-pupil special education funds to districts, which I call unit rates or *urate,* is determined by an omitted variable *need*:

$$urate_d = \kappa_0 + \kappa_1 \overline{need_d^{t<T}} + \zeta_d^{t=T} \quad \text{(B3)}$$

Here *d* refers to district, *t* to time, *urate* is the district specific per-disabled pupil special education revenue received from the state, $\overline{need_d^{t<T}}$ is a measure of average need in previous years, and $\zeta_d^{t=T}$ is the idiosyncratic error term. If $\kappa_1 > 0$, assumption 1) is violated and estimation of (B2) is biased. However, because unit rates were largely random prior to the 1997 updating, one way to skirt this possible source of bias is to estimate (B2) using data from years prior to the update.

I may also be concerned that *need* is determined autoregressively:

$$need_{dt} = \eta_0 + \eta_1 need_{dt-1} + \nu_{dt} \quad \text{(B4)}$$

If $\kappa_1 > 0$ in equation (4) and $0 < \eta_1 < 1$ in equation (B4), then assumption 2) is violated and estimation of $\beta_1$ in equation (B2) above is biased due to the serial correlation of error terms.

*Results*

Columns 1 and 2 in Table B report results of this fixed effects regression for twelve years of data, 1991-2002. I find that a $1000 increase in per-pupil state funds results in a 1.1% increase in disability rates. The estimate is significant at the 1% level and robust to the inclusion of time-varying district-level controls.

However, recall the model as stated makes two important assumptions:

1) $\mathrm{E}[\varepsilon_{dt} \mid funds_{dt}, \mathbf{x}_{dt}, \mathbf{d}, \mathbf{t}] = 0$,

and 2) $\text{Cov}(\varepsilon_{ds}, \varepsilon_{dt} \mid \mathit{funds}_{dt}, \mathbf{x}_{dt}, \mathbf{d}, \mathbf{t}) = 0$.

As discussed in section IVA, one or both of these may be violated and the fixed effects estimates may be biased. In order to circumvent the violation of assumption 1), I estimate the fixed effects model using only 1991-96 data. Column 4 of Table B reports that a $1000 increase in per-pupil state funds results in a 1.5% increase in disability rates. Again, these results hold only if assumptions 1) and 2) are not violated.

Table B. All years: Effects of change in state special education funds on change in disability rates

| | Dependent variable: Disability rates | | | | | |
|---|---|---|---|---|---|---|
| | Fixed Effects | | | | OLS | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Change in per-pupil state funds ($1000) | .011*** (.001) | .011*** (.001) | .028 (.033) | .015*** (.001) | .040*** (.001) | .030*** (.001) |
| Controls | N | Y | Y | Y | Y | Y |
| Instrument | N | N | Y | Y | -- | -- |
| Years | 1991-02 | 1991-02 | 1991-02 | 1991-96 | 1991-02 | 1991-96 |
| N | 11397 | 11397 | 11397 | 4249 | 11395 | 5308 |

Notes: Robust standard errors in parentheses. Weighted regressions are weighted by 1996 total enrollment. Controls include race, number of schools in the district, and percent of enrollment that is free-lunch eligible. * indicates significance at 10% level, ** indicates 5% level and *** indicates 1% level.

## APPENDIX C. District-level First Differences Analysis

Since I suspect that *need* is serially correlated and that $\eta_1$ is substantially large in (B4) above, I consider the following transformed model of district-level disability:

$$\Delta piep_{dt} \equiv \frac{speced_{dt}}{enroll_{dt}} - \frac{speced_{dt-1}}{enroll_{dt-1}} = \beta_0 + \beta_1 \Delta funds_{dt} + \beta_2 \Delta x_{dt} + \Delta\varepsilon_{dt} \quad \text{(C1)}$$

The district fixed effects are differenced out and the time effects are present in the constant. Notice, $\varepsilon_{dt}$ may be serially correlated due to the correlation of $need_{dt}$ with $need_{dt-1}$, but if $\eta_1 = 1$ in (B4), $\Delta\varepsilon_{dt}$ in equation (C1) is not serially correlated. Because there is no reason to suspect $need_{dt}$ varies systematically from year to year for a given district, an assumption of $\eta_1 = 1$ is not unreasonable.

However, the first differencing does not solve the potential omitted variables problem in this model if the omitted variables are time-varying. If the change in state special education revenues, $\Delta funds$, is uncorrelated with any other district characteristics that may also affect changes in disability rates, $\beta_1$ can be interpreted as a causal parameter. On the other hand, if $\Delta funds$ depends directly on

$\Delta piep$ as it did under the old system of special education finance, or if some other district characteristic affects both $\Delta funds$ and $\Delta piep$[20], then $\hat{\beta}_1$ is biased and can not be interpreted causally.

*Results*

Recall that using a fixed effects analysis, I find a $1000 increase in per-pupil state funds results in a 1.1% increase in disability rates. The estimate is significant at the 1% level and robust to the inclusion of time-varying district-level controls.

However, the model as stated in Appendix B makes two important assumptions:

$$1)\ \ \mathrm{E}[\varepsilon_{dt} \mid funds_{dt}, \mathbf{x}_{dt}, \mathbf{d}, \mathbf{t}] = 0,$$

$$\text{and } 2)\ \ \mathrm{Cov}(\varepsilon_{ds}, \varepsilon_{dt} \mid funds_{dt}, \mathbf{x}_{dt}, \mathbf{d}, \mathbf{t}) = 0.$$

One or both of these may be violated and the fixed effects estimates may be biased.

Because of the possible violation of assumption 2) above, I estimate the first differences model specified in equation (C1) using twelve years of data, 1991-2002. Columns 1 and 2 in Table C report these results. Here I find that a $1000 increase in per-pupil funds results in a 4% increase in disability rates. These estimates possibly mitigate bias due to violation of assumption 2) above. However, they do not solve the potential omitted variables problem in this model if the omitted variables are time-varying. Thus the estimates may still be biased.

Table C. All years: Effects of change in state special education funds on change in disability rates

| | Dependent variable: Disability rates | | | | |
|---|---|---|---|---|---|
| | First Differences | | | OLS | |
| | (1) | (2) | (3) | (4) | (5) |
| Change in per-pupil state funds ($1000) | .020*** (.002) | .040*** (.001) | .014 (.120) | .040*** (.001) | .030*** (.001) |
| Controls | N | Y | Y | Y | Y |
| Instrument | N | N | Y | -- | -- |
| Years | 1991-02 | 1991-02 | 1991-02 | 1991-02 | 1991-96 |
| N | 9623 | 9623 | 9623 | 11395 | 5308 |

Notes: Robust standard errors in parentheses. Weighted regressions are weighted by 1996 total enrollment. Controls include race, number of schools in the district, and percent of enrollment that is free-lunch eligible. * indicates significance at 10% level, ** indicates 5% level and *** indicates 1% level.

[20] For example, the poverty level or racial composition of the students within a district may affect both variables (Corman and Chaikind, 1993).