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Estimating permanent and transitory income elasticities of education spending from panel data[☆]

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ABSTRACT

We use a twenty-one year panel of data to examine the role of past income and aid, and expectations of future income, in regressions explaining state and local education spending. We show that simple estimates of the elasticity of spending with respect to financial resources are not robust to specification changes because the variables are non-stationary over time, causing inconsistent estimation of model parameters. Estimation in first differences (or equivalently, in growth rates) solves the time-series problems and produces robust estimates of the model's parameters. We then show that current spending by states responds to changes in expected future income. This explains why using fixed effects in simpler models reduces estimated income elasticities; fixed effects partially capture permanent income effects on spending. Estimates of lagged income are significant when used in models that do not explicitly model the expectations process, but present and past aid both have no effect on education spending. Models with structural assumptions about expected income produce estimates very similar to simpler models which include lagged information on income as a control variable. We conclude with recommendations for estimating models when only cross-section data or only short panels are available.

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1. Introduction

The funding levels that state and local governments choose to allocate to public schools depend on the financial resources available to those governments, the costs of providing education, and willingness of citizens to pay those costs to receive the benefits that education brings. States with high incomes may choose to spend more on education, both because higher-income citizens are willing to spend more on education and because districts in areas with high costs of living may feel pressure to pay higher wages to teachers and other education staff. Empirical work on education spending has produced a wide range of estimates of the effects of income on education spending, with results that are often quite sensitive to model specification.

In the last ten to fifteen years, econometricians have started using panel data, rather than single-year cross-section data, to estimate the elasticities of state and local education spending with respect to aid and income. Panel data offer many advantages for estimating these elasticities, but also present some difficulties. One advantage, widely recognized in the literature, is that panel data sets increase the size of the sample available; cross-section regressions on U.S. states are necessarily limited to 50 observations. Another advantage, less widely recognized, is that panel data permit econometricians to examine the difference

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between permanent and transitory changes in income. A state or school district facing a permanent increase in income or aid is likely to increase school spending by more than one facing a transitory increase that is not expected to continue into the future. Making this distinction requires the use of panel data, so that permanent changes in income and aid can be distinguished from temporary changes. Cross-section regressions will estimate a relationship between income, aid, and spending in the year of the cross-section, but cannot identify whether the relationship is the response of states and school districts to permanent shocks or transitory shocks if those responses are different, as theory suggests they should be.

The difficulties of using panel data arise because panel data include time variance of the variables, and the non-stationarity of these variables over time causes bias in OLS estimates. The long-run relationship of income, aid, and spending may be different from the ceterus paribus response of spending to changes in the first two variables, and there may be spurious correlations between unrelated variables due to their time-series properties. It is not possible to draw valid conclusions about the relationship of education spending, income, and aid from panel data without considering the time-series properties of that data, to be sure that the elasticities produced are estimated consistently.

In this paper we use a twenty-one year panel data set to estimate elasticities of education spending with respect to financial resources by state and local governments in the United States, dealing appropriately both with changes in resources over time and with the time-series properties of the data. Recent literature in state-level public finance using panel data strongly suggests that results are critically dependent on how issues in using panel data, such as lagged independent variables, fixed effects, and period effects, are handled. Misspecifying the error structure of the data can create bias in the parameter estimates; in particular, the literature shows that including fixed effects in a regression often causes substantial changes in the parameter estimates and their interpretation. Failing to include dynamic effects in the model can lead to omitted variable bias as well. Explicitly dynamic equations in education spending models are not common; where dynamic effects such as permanent income are not included, fixed effects may be correlated with them, but may not fully or correctly control for them.

We begin by estimating a simple expenditure equation, and demonstrate the sensitivity of the results to different specifications of fixed and period effects. We show that the variables in the equation are not stationary, which may cause the problem of spurious regression and thus contribute to the instability of the parameter estimates. We consider several different methods of addressing the problem of non-stationary variables, and find that estimating regressions in first differences (or equivalently, in growth rates) is the most satisfactory way to handle the problem.

We then turn to conceptual explanations of why the variables have these properties. We propose a model in which states and school districts use expectations of future income, as well as present income, to set levels of education spending, using lagged income to predict future income. We show that current spending does react to changes in expected future income, but there is little or no effect from current income changes when expected future income is included in the model. This explains why fixed effects are often significant in models without measures of permanent income – they capture the income history of the state, which changes only slowly over time – and why lagged income is statistically significant when added to simpler models that do not explicitly model expectations. It also explains why including fixed effects in models without lagged income changes elasticity estimates so dramatically. The fixed effects are correlated with the omitted permanent income, and when permanent income is included, current income has a much reduced effect, or no effect, on spending. We also show that, in regressions where time issues are addressed, neither present aid nor future aid has any significant effect on spending. We conclude with some implications about alternative ways to estimate income elasticities when fixed effects are not feasible, or to properly control for income differences across states when estimating other parameters of education spending models.

The rest of this paper is organized as follows. Section 2 reviews the literature using panel data and fixed effects in state-level public finance. Section 3 presents a simple reduced-form model to be used as a reference point in the subsequent analysis, and shows that different assumptions about the error structure for the estimates produce greatly varying estimates of the parameters. Section 4 shows that including lagged values of the variables does not eliminate the variation of the estimates, and that the variables in the analysis are not stationary, which explains the instability of the estimates. Section 5 shows that first differencing, or equivalently, estimating models in terms of growth rates, is the most reliable econometric method of resolving the problems. Section 6 presents a two-period model of spending that separates transitory and permanent income effects on spending, and implies that lagged terms should be significant. Estimating the model shows that spending reacts strongly to permanent changes in income, but little or not at all to transitory changes, consistent with theory. Section 7 concludes.

2. Literature review: panel data in empirical public finance

Many studies of state and local government expenditure estimate resource elasticities using single-year cross-section data, often because of difficulty obtaining data for municipalities or school districts on an annual basis. However, a significant number use panel data, either with annual observations or with observations separated by 5 or 10 year intervals. Most papers with panel data include fixed and period effects, and most of those show results of both OLS regressions and regressions that include fixed and period effects. We have identified seven papers, discussed below, that report both types of regressions, allowing us to observe the consequences of including or excluding fixed and period effects. Almost all of these papers report substantially different coefficient estimates when fixed and period effects are included. This pattern is not surprising, as we would expect variation across states and variation within states to be quite different, especially if the variation within states depends on only a few observations for each state, and particularly if variation in financial resources is correlated with unobserved determinants of spending.

Holtz-Eakin (1986) estimates a spending equation using an eight-year panel of municipal governments, and argues that models without fixed effects are misspecified as they exclude unobservable characteristics of municipalities that fixed effects

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