CONTEMPORARY ECONOMIC POLICY

GROWTH AND VARIABILITY OF SCHOOL DISTRICT INCOME TAX REVENUES: IS TAX BASE DIVERSIFICATION A GOOD IDEA FOR SCHOOL FINANCING?

JOSHUA C. HALL and ANTONIOS M. KOUMPIAS*

School districts in Ohio have the option of diversifying their revenue base by adopting income taxes. Using a panel of Ohio school districts that adopted a local income tax from 1990 to 2008, we find that revenues are procyclical and fluctuate only mildly. The estimated short- and long-run income elasticity of school district income tax revenues is 1.05 and 1.04, respectively. We also find that the school district tax base fully adjusts to its long-run equilibrium within 2 years. Finally, we show that school district income tax adoption does not provide more stability to total school district tax revenues in the short or the long run. (*JEL* H71, H75)

I. INTRODUCTION

The school district income tax (SDIT) is a special tax earmarked for providing financial support to a local school district. As of January 2015, school districts in Iowa, Kentucky, Maryland, Ohio, and Pennsylvania can levy income taxes. Given the reliance of K-12 financing on local taxes, the cyclicality of local tax revenues is an important policy concern.[1] School districts need to ensure that revenues from a tax base can meet the increased constituent demands coming from rising incomes. This trade-off between growth and variability goes back to the seminal work of Groves and Kahn (1952).

From a policy perspective, the effect of tax base diversification (through the enactment of a SDIT) on total local tax revenue growth is of great interest. On the one hand, SDITs directly increase total local tax revenue for schools. There is evidence, however, that school districts use income taxes to substitute away from property taxes, leading to a reduction in total local tax revenue (Ross and Nguyen-Hoang 2013). The net effect of SDIT adoption on total local tax revenue is thus an open empirical question.

Similarly, tax base diversification might affect the variability of local tax revenues, which is also of importance to policymakers given the need to negotiate multiyear teacher contracts. One of the arguments often given in favor of the property tax for local governments is that it is a stable source of revenue due to its inelasticity and lagged incidence (Alm 2013). Alm et al. (2011) find that local government reliance on the property tax was an advantage in dealing with the Great Recession.

*The authors like to thank Justin Ross and Phuong Nguyen-Hoang for sharing their data with us and very helpful comments. Thanks are due to Denvil Duncan, Tima Moldogaziev, and conference participants at the 2014 Southern Economic Association Meetings. Two anonymous referees provided very helpful comments that improved the paper tremendously.

Hall: Associate Professor, College of Business and Economics, Faculty Research Associate, Regional Research Institute, West Virginia University, Morgantown, WV 26505-6025. Phone 304-293-7870, Fax 304-293-5652, E-mail joshua.hall@mail.wvu.edu

Koumpias: Assistant Professor, Department of Social Sciences, Economics Division, University of Michigan Dearborn, Dearborn, MI 48128. Phone 313-583-6555, Fax 313-593-5645, E-mail koumpias@umich.edu

1. K-12 education in the United States is funded with a combination of federal, state, and local funds. As of 2013, federal sources account for only 9.1% whereas state revenue sources contribute 45.6% (30.8% as general formula assistance) and 45.3% (38.9% from taxes and parental contributions), respectively (U.S. Census Bureau 2013). School districts need revenues from a tax base to meet the increased constituent demands that come with rising incomes. Locally sourced school finance revenues totaled $270.6 billion. The majority ($184.4 billion) was due to taxes of which $176.1 billion came from property taxation alone. An additional $8.3 billion came from other local taxes; namely, the SDIT.

ABBREVIATIONS

ADF: Augmented Dickey-Fuller
DID: Difference-in-Differences
DOLS: Dynamic Ordinary Least Squares
ECM: Error Correction Model
LSD: Local School District
SDIT: School District Income Tax

Contemporary Economic Policy (ISSN 1465-7287)
Vol. 36, No. 4, October 2018, 678–691
Online Early publication January 18, 2018

doi:10.1111/coep.12276

In many states, including Ohio, much of local government own-source revenues are voted upon as an amount, not a rate. While a millage rate will be listed at the time of voting, it can be adjusted upward in the case of a decline in assessed valuation in order to achieve the voted upon amount of revenue (Ross and Hummel 2012). In practice, this tends to mean that revenues from property taxation are very stable over the business cycle.

Property taxes being levied as an amount, not a rate, also mean that school districts cannot automatically capture the upside of housing appreciation through the property tax. Instead, school officials have to return to the voters and ask for additional revenue. The income tax, however, is levied as a rate and school districts therefore should be able to automatically increase revenues during times of growth, reducing the need for additional levies just to keep up with inflation.[2] The potential downside of diversification would be if income tax revenue craters when the economy is in a recession. Thus, it is important to examine whether the adoption of a SDIT would make total local tax revenues more procyclical and, thus, more susceptible to shortfalls during recessions. Likewise, from a local policymaker perspective, if SDIT revenues grow more reliably than property tax revenues, the benefit may outweigh any short-run volatility.

The purpose of this paper is to estimate the first measure of growth and variability of SDIT revenues with respect to the business cycle. In addition, it examines the impact of the introduction of a SDIT on the growth and variability of total local tax revenues for education financing in Ohio from 1990 through 2008. We estimate the impact of tax base diversification on the cyclicality of total local tax revenues to assess whether SDIT adoption was a good idea for stabilizing school financing.

First, we use a reduced form approach to estimate long- and short-run income elasticity via a log–log specification. Our long-run estimate is based on a dynamic ordinary least squares (DOLS) model whereas the short-run one is obtained from an error correction model (ECM). Next, we employ a difference-in-differences (DID) design to estimate the incremental effect of the introduction of SDITs on the growth and variability of total local tax revenues in each school district. To overcome the potentially endogenous decision to enact a SDIT, we match adopting school districts to non-adopting ones based on recorded motivations for these decisions. Using both the matched and unmatched samples, we examine whether the combination of SDIT and property tax revenues is more stable in the long and short run relative to property tax revenues alone.

The contribution of this work is twofold. First, we provide the first short- and long-run revenue income elasticity estimates regarding the SDIT in the literature. Second, we add to the empirical literature that examines the interaction of SDIT and property tax revenues by distinguishing between short- and long-run effects. In line with Ross and Nguyen-Hoang (2013), we find evidence of substitutability between property tax and SDIT revenue. We additionally show that this finding does not differ in the short run relative to that of the long run. Our findings offer useful insights for school districts debating whether to diversify their tax base by introducing an income tax. They indicate that school districts cannot rely on income taxes to foster local tax revenue stability. Our results also help to inform the decision of state policymakers to allow local governments such as school districts to tax income, as the Ohio legislature first did in 1981.

Using conventional methods in the public finance literature, we find that revenue from Ohio's SDIT fluctuates mildly and procyclically. Overall, we find that SDIT revenue growth exceeded economic growth in Ohio from 1990 through 2008. The estimated short- and long-run income elasticities of SDIT revenues are 1.05 and 1.04, respectively. Our DID findings suggest that income taxes do not affect short-run total tax revenue variability and long-run total tax revenue growth in a significant way. Therefore, our results could be interpreted as evidence that SDITs cannot have a tax revenue-stabilizing role in the long or the short run.

The rest of the paper is organized as follows. Section II provides the necessary institutional background regarding SDITs and local taxation in Ohio; namely, property and SDITs. It also includes a review of the empirical literature on the determinants of SDIT adoption, with a particular focus on Ohio. Section III discusses the data and methodology and Section IV presents the results. Section V concludes.

2. It should be noted that so-called levy fatigue is primarily a concern of school officials, not citizen-voters. For more on levy fatigue in the Ohio context, see Johnson and Ingle (2009) and Ingle et al. (2013).

II. INSTITUTIONAL BACKGROUND

A. Local Tax Bases in Ohio: Property Taxes

As in other states, the property tax is the most important source of funding for Ohio's schools. Approximately two-thirds of all property taxes levied in Ohio were directed to K-12 education financing, making up about 80% of total own-source revenues for local school districts. Property taxes are categorized as real property taxes (on land and buildings) which account for 68% of all property taxes and tangible personal property taxes (on machinery, equipment, furniture, fixtures, and inventories) which represent a mere 8.7%. They are determined based on the property's true value and the application of a specified percentage (assessment rate) to that value that may differ by type of property. The Ohio constitution restricts the taxing authority (i.e., county, city, township, school district, special district, etc.) from imposing new taxes without voter approval up to 10 mills, a tax rate equivalent to 1% of the true value of the property. Voters may authorize levies exceeding this limit by election only. These levies are then subject to tax reduction factors, which restrict the growth (decline) in taxes due to valuation increases (decreases) that occur after reappraisal or triennial updates.[3] The effective tax rate cannot be lowered below 20 mills. Property tax relief on real property taxes is available through three credit programs: the homestead exemption, the 10% rollback credit, and the 2.5% rollback credit (Sullivan and Sobul 2010).

B. Local Tax Bases in Ohio: SDITs

SDITs in Ohio were first introduced in 1981. The law was repealed in 1983 but reenacted in 1989. The five school districts that adopted a SDIT before 1983 were grandfathered to be allowed to continue to levy a SDIT.[4] Ohio school districts uniquely levy the income tax solely subject to voter approval, specifying if property taxes are to be reduced (levy and amount of gross millage to be reduced) as compensation for increased income taxes.[5] However, the reasons stated by policymakers for adoption of a SDIT are often unclear or in conflict. For example, while income tax levies are often put on the ballot together with reductions in the property tax, they are often touted as a complementary way to raise revenue to meet rising school expenditures (Miko 2006). It is therefore unclear whether total local school tax revenue increases in the event of income tax adoption. In the paper closest to our own, Ross and Nguyen-Hoang (2013) examine the effect of income tax adoption on operating property tax revenue. Using annual panel data from 1990 to 2008, they find that about one quarter of additional revenue from the SDIT is used to offset property taxes in the short run, with the remaining being net new revenue. This finding should be interpreted as evidence of substitutability that our findings confirm as well. Our analysis adds to the prior knowledge by distinguishing the long- and short-run effects of the introduction of SDIT on total tax revenues (Ohio Department of Taxation 2013).

Figure 1 shows the evolution of SDITs from 1990 through 2014 in terms of number of adopting school districts and average rates levied. Clearly, the number of school districts that adopted income taxes grew substantially in the early 1990s. Only 22 school districts had enacted an income tax in 1990, a figure that rose up to 179 by 2008 and 197 by 2014. SDIT rates varied from an average of 0.79% in 1990 to 1.02% in 2008 and 1.09% in 2014.

In recent years, there have been a number of legislative actions that significantly altered the operation of local taxation in Ohio. House Bill 66 of the 2006–2007 state biennial budget permitted school districts to levy, subject to voter approval, an "earned income" school district tax, an alternate tax base that includes only earned income and self-employment income of the residents of the school district.[6] House Bill 66 introduced a phase-out of all tangible property taxes

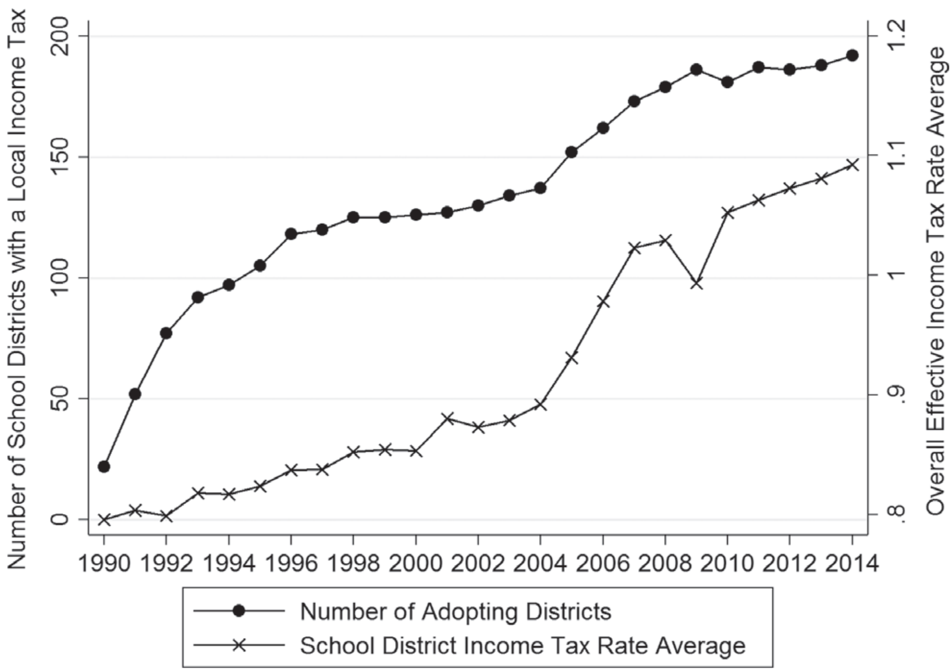
3. Applicable only to real property taxes.

4. These school districts are Bradford Exempt Village School District, Anna Local School District (LSD), West Liberty Salem LSD, Arlington LSD, and McComb LSD.

5. The net effect of a millage reduction on real property taxes could be negligible for school districts with effective rates at or near 20 mills.

6. The earned income tax base excludes all other types of income that would be taxable under the traditional income tax base such as interest, dividends, capital gains, or pensions, rental income, lottery winnings, and income earned by estates. Finally, the earned income base does not permit personal exemptions that are allowed under the traditional tax base or adjustments to income such as Individual Retirement Account contributions, self-employment health insurance deductions, and alimony payments (Ohio Department of Taxation 2013). One could think of the earned income tax base as endogenous since it is determined based on voter approval. Since the earned income base is smaller, however, this makes our estimates more conservative. More importantly, this endogeneity is not likely to drive our overall results given that the earned income base is a significant part of the total income base and 1.5% of our sample utilizes the earned income base.

FIGURE 1
Evolution of SDIT Adoption and Average Rate across Ohio



but also created reimbursement mechanisms to fully hold school districts harmless through FY 2011. Following changes in House Bill 119, of the 2008–2009 state biennial budget, tax year 2008 was the final year business tangible property was generally taxable. Finally, House Bill 1 of the 2010–2011 state biennial budget extended the state's full reimbursement of school districts for their foregone tax revenues due to the phase-out of all tangible property through 2013.

Due to the substantial changes in school district revenue administration with regards to collection and reimbursement that peaked in 2009, we restrict our analysis to the years 1990–2008. In doing so, we avoid contaminating our estimates of growth and variability from amendments that introduced automatic stabilizers to school district tax revenues as part of House Bill 1. Including post-2008 years in our analysis would confound our analysis because the policies implemented during those years aimed to lessen the impact of the tangible property tax revenue phase-outs. Ohio moved to phase-out local tangible (business) personal property taxation in 2009. As a result, our baseline estimates of the true relative impact of SDITs on total local tax revenue growth and variability would suffer from downwards bias in the inclusion of post-2008 years. In addition, the Great Recession had a fundamental institutional impact on local jurisdictions that adversely affected their fiscal health, making the excluded years clearly an outlier period. At the same time, it offers a unique opportunity to test the resilience of SDIT revenue in a steep recession. Thus, we offer a supplementary set of results in Tables A1 and A2 over an extended period with post-2008 information through 2015. Thus, our analysis also covers the Great Recession's full effect on property values and average income in Ohio.

III. EMPIRICAL APPROACH

A. Data

The main two outcomes of interest are SDIT revenues per pupil and total school district tax revenues per pupil. The latter are defined as SDIT and total property tax revenues per pupil which, in turn, is the sum of real property taxes charged per pupil and tangible property taxes levied per pupil. For brevity, we drop the per pupil denomination throughout our analysis, but we urge the reader to recall that revenue measures are not totals but normalized by the school district pupil population. The key independent variable that measures income is the average adjusted gross federal income in the school district, normalized by the 2005 price level. All tax-related (SDIT and property tax) information is from the Ohio Department of Taxation. Information on the levels of state and federal aid per pupil, and average daily membership of pupils in each school district is extracted from publications of the Ohio Department of Education. The tax price (defined as the ratio of median housing price to total residential property values per pupil), the percentages of renters and seniors, and the average SDIT rate in surrounding school districts were generously made available by Ross and Nguyen-Hoang (2013). Table 1 provides summary statistics of all the variables used in our analysis by SDIT adoption status. We split the sample into a subsample of 2,253 school district year observations in which a SDIT was adopted and a subsample of 9,318 observations of school districts in years when no SDIT was in place.

B. Reduced-Form Short- and Long-Run Elasticity Models

Groves and Kahn (1952) were the first to estimate the income elasticity of state and local tax revenues by specifying a log–log regression. Fox and Campbell (1984) question the validity of Groves and Kahn's approach for explaining short-run revenue stability because it employs long-run measures. Fox and Campbell (1984) focus on short-run revenue fluctuations over the business cycle; a stable tax is less responsive to fluctuations. Similarly, Sobel and Holcombe (1996) distinguish between long- and short-run relationships due to the non-stationarity of income and tax bases (trending upward over time). Specifically, the authors use non-stationary variables for the estimation of the long-run relationship via a levels regression and stationary variants (e.g., differenced) by omitting the time trend to recover the short-run income elasticity. Bruce et al. (2006) introduce DOLS and ECM for the estimation of long- and short-run elasticity estimates. Their approach also distinguishes between short-run elasticities and speed of adjustment parameters as well as the symmetry of their responses to changes in income. Anderson and Shimul (2016) offer Newer Mean Group and Pooled Mean Group estimators of long- and short-run buoyancy (elasticity measure unadjusted for tax rate changes) and resilience based on dynamic fixed effects. The estimators offered by Anderson and Shimul (2016) are recommended for dynamic heterogeneous panels in setting with a long time-series dimension. Unfortunately, we only have 19 time units at our disposal and therefore cannot adopt their approach.

Instead we follow Bruce et al. (2006) and derive a long-run elasticity estimate using DOLS for co-integrated panel data with homogeneous covariance structure (Kao and Chiang 2000; Watson and Stock 1993). This single-equation cointegration technique is particularly useful when observations are non-stationary because it allows us to obtain the cointegration regression between the income tax base and average income in the school district. The variability of tax revenues reflects the relationship between the SDIT and its business cycle. For the short-run elasticity, we estimate the cyclical component of SDIT revenues. We take the first-difference to detrend lnB_{it} and lnY_{it} in order to obtain the short-run metrics. This transformation gives rise to stationary income and SDIT revenue time series.[7] Our baseline short-run elasticity estimates are based on the symmetric ECM specified in Equation (2). Our specification restricts tax revenues to adjust toward the estimated long-term relationship. This permits the estimation of speed of adjustment parameters that indicate how fast the SDIT revenue converges to a new equilibrium following changes in average income. The observed change in the school district tax revenue is the combination of two effects: (1) change in tax revenues due to change in average income and (2) adjustment to existing disequilibrium.

Equation (1) gives our baseline long-run income elasticity measure by regressing logged SDIT revenues lnR_{it} on logged average income lnY_{it} in school district i at year t.[8] The DOLS correction is implemented by introducing j leads and lags of the first difference of average school

7. For robustness, we also use the Hodrick-Prescott filter to detrend the time series and derive the cyclical component of the SDIT revenues.

8. We examine whether a unit root exists in the logarithms of SDIT revenues and income, using a Fisher-type panel unit root test whose null hypothesis is that all the panels contain a unit root (Choi 2001). The Augmented Dickey-Fuller (ADF) test we employ conducts unit-root tests for each panel individually, and then combines the associated p values to an overall test. To account for any global (all-Ohio) trend the observations may exhibit, we include a time trend and subtrack cross-sectional means to mitigate the impact of cross-sectional dependence. Based on ADF tests, we cannot reject the null hypothesis that all panels contain unit roots both in the logarithm of the tax revenue and average income.

TABLE 1
Summary Statistics

Variables	Mean	Standard Deviation	Min	Max
Income tax adopting school districts—$N = 2,253$				
Mean SDIT rate in surrounding SDs (in %)[1]	0.49	0.34	0.00	1.38
Tax price[1]	0.70	0.12	0.19	0.94
State aid per pupil (in $)[2]	3,460	1,059	361	7,435
Federal aid per pupil (in $)[2]	339	240	0.59	4,888
Percentage of renters[1]	20.02	7.96	1.22	56.85
Percentage of seniors[1]	12.32	2.79	4.07	30.74
Average adjusted gross federal income (in $)[3]	37,934	11,335	19,831	168,263
Total tax revenues per pupil (in $)[3]	3,265	1,150	615	11,665
Real property tax revenues per pupil (in $)[3]	1,999	828	424	8,799
Tangible personal property taxes per pupil (in $)[3]	515	387	52	4,672
Total SDIT revenues per pupil (in $)[3]	751	421	0.01	3,948
SDIT rate (in %)[3]	1.04	0.46	0.50	2.00
Income tax non-adopting school districts—$N = 9,318$				
Mean SDIT rate in surrounding SDs (in %)[1]	0.14	0.22	0.00	1.28
Tax price[1]	0.58	0.15	0.02	0.95
State aid per pupil (in $)[2]	2,885	1,266	171	11,020
Federal aid per pupil[2]	355	317	0.15	3,755
Percentage of renters[1]	23.52	10.04	4.71	63.02
Percentage of seniors[1]	13.55	3.63	3.57	38.96
Average school district income (in $)[3]	39,313	19,875	16,993	371,802
Total tax revenues per pupil (in $)[3]	4,105	2,591	561	41,458
Real property tax revenues per pupil (in $)[3]	2,660	2036	311	32,125
Tangible personal property taxes per pupil (in $)[3]	905	850	70	16,033

Note: Data covering 1990–2008. SDs, school districts.
[1]Source is from Ross and Nguyen-Hoang (2013).
[2]Source is from Ohio Department of Education.
[3]Source is from Ohio Department of Taxation.

district income. In estimation, this causes the loss of 1 year of panel data. We further adjust by an earned income tax base indicator and the SDIT rate. The latter controls for variability due to changes in the SDIT base's structure over time (Felix 2008). The parameter of interest is β_1. This coefficient captures the long-run, stable relationship between SDIT revenue and school district average income. It reflects the responsiveness of tax revenues per pupil to changes in average income. Estimated over time, it shows how fast SDIT revenue grows in comparison to income. Values greater than unity suggest that tax revenue grows faster than income, and slower otherwise. We also specify school district fixed effects but omit from the presentation of the model.

$$lnR_{it} = \beta_1 lnY_{it} + \sum_{g=-j}^{j} \gamma_g \Delta lnY_{it+g} + \alpha_2 \tau_{it} + \alpha_3 \mathbf{1}\left[EI_{it}\right] + \phi_{it} \quad (1)$$

Tax revenue disequilibria from the long-run value lnR^*_{it} are computed by $\varepsilon_{it} = lnR_{it} - \beta_0 - \beta_1 lnR_{it} - \alpha_2 \tau_{it} - \alpha_3 \mathbf{1}[EI_{it}]$. This formulation closely follows Bruce et al. (2006), only adding the SDIT rate and the earned income tax base indicator in calculation. We calculate short-run deviations separately for each school district in every year with a SDIT in place by estimating ordinary least squares regressions with no leads or lags and predicting residuals. Then, we use an indicator variable to denote the existence of a short-run disequilibrium. In Equation (2), we treat short-run disequilibria symmetrically. That is, we do not distinguish between positive and negative short-run deviations lnR_{it} from the long-run equilibrium tax revenue lnR^*_{it}. But, in Equation (3) the analysis differentiates between symmetric and asymmetric short-run elasticities. This modeling permits us to examine if the school district tax revenue responds asymmetrically to changes in institutional factors such as education financing needs. We use the indicator $\mathbf{1}[R_{it-1}]$ to capture the instance of deviations above the equilibrium long-run SDIT revenues value. This allows us to assess whether that period's downward adjustment in revenues to the long-run equilibrium value is statistically different from the upward adjustment. We also specify school district fixed effects but omit from the presentation of the model. Note that a constant α_0 is also included in our estimation but omitted from presentation.

$$\ln \dot{R}_{it} = \alpha_1 \ln \dot{Y}_{it} + \alpha_2 \varepsilon_{it-1} + \alpha_3 \dot{\tau}_{it} + \alpha_4 \mathbf{1}\left[EI_{it-1}\right] + \mu_{it} \quad (2)$$

$$\ln \dot{R}_{it} = \alpha_1 \ln \dot{Y}_{it} + \theta_1 \mathbf{1}\left[R_{it-1}\right] \cdot \ln \dot{Y}_{it} + \alpha_2 \varepsilon_{it-1} + \theta_2 \mathbf{1}\left[R_{it-1}\right] \cdot \varepsilon_{it-1} + \alpha_3 \dot{\tau}_{it} + \alpha_4 \mathbf{1}\left[EI_{it-1}\right] + \nu_{it} \quad (3)$$

Parameter α_1 captures the immediate, intraperiod effect of a change in average income. A coefficient greater than one shows that tax revenue fluctuates more than income over the business cycle. Positive short-run elasticity estimates are expected by theory, suggesting that income tax revenue varies procyclically. A negative short-run elasticity would imply countercyclical SDIT revenues that increase in recessions and decrease in economic booms. The degree of adjustment of the tax revenue to its long-run equilibrium value is denoted by the parameter α_2 in Equations (2) and (3). It is interpreted as the percentage of disequilibrium removed in every period. Since we introduce a dummy variable for the years when SDIT revenues are above their long-run equilibrium value, we capture downward adjustments with the interaction term whereas upward adjustments are represented by the coefficient of the income variable. Thus, the parameter θ_1 indicates whether the short-run downward adjustments in tax revenues are different from the upward ones and, similarly, θ_2 for the long-run adjustments. To derive the above equilibrium, short-run income elasticity of SDIT revenue of the asymmetric ECM one should sum the coefficients of income and the interaction term of the above equilibrium dummy variable and income. Alternatively, when tax revenues are below long-run equilibrium the short-run income elasticity can be read directly from the coefficient of income.

C. DID Design

Next, we focus on the impact of SDIT adoption on the long- and short-run income elasticity of total school district tax revenues. However, the fact that the levy and the size of the SDIT is subject to voter approval makes SDIT adoption an endogenously determined, choice variable. Indeed, there is extensive evidence that SDIT adoption decisions are not randomly distributed throughout the state of Ohio.[9] Thus, our empirical strategy should address the underlying differences in the determinants of adoption. To minimize the influence of any covariate imbalance in school district-level determinants of income tax adoption on our estimates on total local tax revenue growth and variability we employ a matching strategy. Clearly, school districts which adopt an income tax are different from the ones which do not adopt one on a number of observable characteristics. By reducing imbalance in the empirical distribution of the pretreatment characteristics of adopting and nonadopting school districts, we lower the degree of model dependence in our estimates which, in turn, decreases inefficiency and bias (Ho et al. 2007).

We estimate the conditional probability of SDIT adoption based on a vector of adoption determinants from 1990 through 2008 (propensity score). We select five key determinants of SDIT adoption based on the findings of the preexisting empirical literature on SDIT adoption Ohio and add two other covariates of importance. First, we match on tangible personal property taxes (on machinery, equipment, furniture, fixtures, and inventories), classified as public utility tangible or general businesses tangible. We expect that this variable should be highly correlated with other important factors of adoption such as property taxes on business property (Gill and Haurin 2001). Second, we use the average income tax rate among the district's surrounding neighbors as measure of interjurisdictional competition (Hall 2006; Spry 2005). Inclusion of this covariate also addresses the spatial dependence in the SDIT adoption (Hall and Ross 2010). Third, we balance on tax price (Spry 2005). We additionally match on the percentage of revenues from

9. Gill and Haurin (2001) identify the percentage of business property tax base and percentage of farm population and the likelihood of a voter approval of tax levies as the three most important factors of income tax base choice. Spry (2005) highlights the roles of interjurisdictional competition (number of school districts within 10 miles), the property tax price, and property taxes from business and agricultural property as drivers of income tax adoption at the school district level. Hall (2006) confirms the importance of interjurisdictional competition in the decision to adopt a SDIT and adds income inequality, the percentage of commercial property, and the percentage of state revenues to the list of key factors. Hall and Ross (2010) provide evidence of spatial dependence among school districts when it comes to levying a personal income tax. Additionally, they also underline the importance of interjurisdictional competition, the property tax share, the income tax share, property taxes on mineral and business property, property taxes on agricultural property, and an indicator of the presence of city tax.

state and federal sources (Hall 2006). Finally, we control for the percentage of the population over age 65 and the percentage of renters.

We implement 1:1 nearest neighbor matching with replacement based on the estimated propensity score. We use the generated matching weights to achieve covariate balance across income tax adopting and nonadopting school districts. Table 2 summarizes the covariate imbalance of the matched and unmatched samples. Columns (2) and (3) present the means of treated and control school districts. Clearly, preprocessing resulted to a substantially more balanced post-matching sample. Columns (4) and (5) show the variance ratio of each covariate with values equal to 1 indicating perfect balance. This ratio should equal 1 if there is perfect balance. Ratios within [0.5, 0.8) or (1.25, 2] indicate mediocre balance. Ratios even further away from unity are evidence of very poor covariate balance (Ho et al. 2007). There are no such instances in our post-matching sample.

Figure 2 displays a graphical summary of covariate imbalance before and after matching that illustrates the gains from matchings. The resulting propensity score leads to a significant reduction in standardized percentage bias for all of the determinants of SDIT adoption in Ohio. The most pronounced improvement came for a key determinant, interjurisdictional competition. Failing to balance on this covariate would have led to an upward bias that would have overwhelmed the impact of all other determinants.

We regress logged total school district tax revenues $lnTR_{it}$ on average income lnY_{it} which gives rise to a balanced panel. The key independent variable is the interaction of average income with the school district-year-specific income tax adoption indicator. We also include school district fixed effects, the level of the income tax rate, and an earned income tax indicator as controls in the estimation but omit them from Equations (4) to (6).

We focus on the coefficient of the SDIT adoption indicator interaction with average income. It shows the incremental variability of total school district tax revenue growth due to SDIT adoption. It is denoted differently across specifications to highlight the distinction between effects on growth as opposed to variability of total SDIT revenues. Specifically, the coefficient β_3 in Equation (4) captures the long-run effect whereas coefficient α_4 in Equations (5) and (6) the short-run one. The parameter β_3 is interpreted as the effect of adopting income taxes on the long-run elasticity of total school district tax revenues. The aggregate income elasticity of total school district tax revenues in school districts that adopted an income tax is obtained as the sum of β_1 and β_3 ($\alpha_1 + \alpha_4$ for Equations (5) and (6)). This is the policy relevant parameter of interest as it shows the direction and magnitude of the income tax's influence on total school district tax revenue growth and variability. Standard errors are clustered at the school district level.

IV. RESULTS

Our long- and short-run income elasticity estimates presented in Table 3. Column (1) of Table 3 contains the long-run income elasticity of SDIT revenues per pupil whereas columns (2) and (3) provide the short-run ones. The DOLS long-run estimate in column (1) is estimated controlling for the SDIT rate and an indicator for school districts that enacted an earned income tax base as opposed to the traditional tax base by residence. A large number of school districts are discarded in the long-run analysis because balanced school district panels are required for DOLS estimation. Thus, it should be noted that the results reported in column (1) of Table 3 are based on the 22 Ohio school districts that did have an income tax in place in 1990. We estimate the long-run income elasticity of SDIT revenues at

$$lnTR_{it} = \beta_1 lnY_{it} + \beta_2 \mathbf{1}\left[IT_{it}\right] + \beta_3 lnY_{it} \cdot \mathbf{1}\left[IT_{it}\right] + \sum_{g=-j}^{j} \gamma_g \Delta lnY_{it+g} + \phi_{it} \quad (4)$$

$$\ln TR_{it} = \alpha_1 \ln \dot{Y}_{it} + \alpha_2 \varepsilon_{it-1} + \alpha_3 \mathbf{1}\left[IT_{it}\right] + \alpha_4 \ln \dot{Y}_{it} \cdot \mathbf{1}\left[IT_{it}\right] + \mu_{it} \quad (5)$$

$$\ln TR_{it} = \alpha_1 \ln \dot{Y}_{it} + \theta_1 \mathbf{1}\left[R_{it-1}\right] \ln \dot{Y}_{it} + \alpha_2 \varepsilon_{it-1} + \theta_2 \mathbf{1}\left[R_{it-1}\right] \varepsilon_{it-1} + \alpha_3 \mathbf{1}\left[IT_{it}\right] + \alpha_4 \ln \dot{Y}_{it} \cdot \mathbf{1}\left[IT_{it}\right] + \nu_{it} \quad (6)$$

TABLE 2
Pre- and Post-Matching Covariate Balance, Ohio School Districts 1990–2008

Variables	Unmatched/Matched	Mean, Treated	Mean, Control	Var(T)/Var(C)
Mean SDIT in surrounding SDs	U	0.42864	0.1139	2.86
	M	0.42864	0.44868	0.97
Tax price	U	0.66946	0.5803	0.69
	M	0.66946	0.64947	0.92
Tangible personal property tax (in '000 $)	U	924.44	3,209.9	0.03
	M	924.44	1,023.9	1.33
State aid per pupil (in $)	U	3,155.8	2,931.4	0.65
	M	3,155.8	3,180.8	0.73
Federal aid per pupil (in $)	U	294.09	375.57	0.47
	M	294.09	296.48	1.10
Percentage of renters	U	20.726	23.724	0.68
	M	20.726	20.752	1
Percentage of seniors	U	12.487	13.657	0.64
	M	12.487	12.292	1.28

Source: Ohio Department of Education, Ohio Department of Taxation. SDs, school districts.

1.04 specifying 4-year leads and 5-year lags for the DOLS correction as shown in column (1).[10] We interpret this estimate as evidence of a fairly stable tax base.

The long-run income elasticity estimate indicates that SDIT revenues growth tracks closely income growth. An explanation for this finding could be the fact that SDITs are proportional with very low tax rates. As a result the scope of the tax base is fairly constant over time. The effect of adopting an earned income tax base regime cannot be estimated given the use of four leads for the DOLS correction because it only came into effect in 2006.

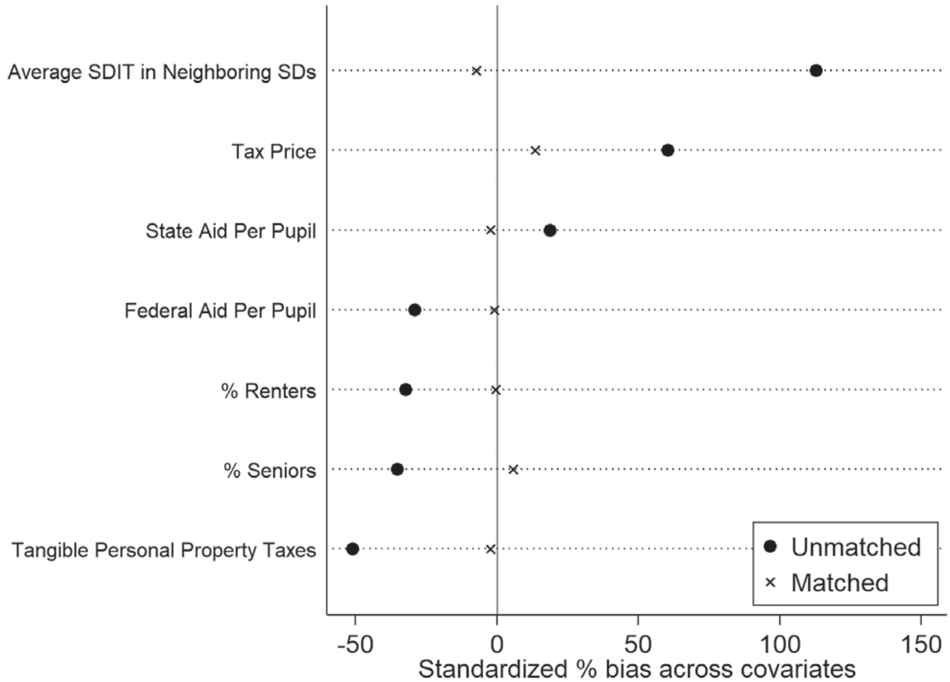
Table 3 also contains two short-run income elasticities of SDIT revenues. It is worth noting that, in the short run, changes to SDIT revenues may come from changes in income or an adjustment toward the long-run co-integrating relationship. Column (2) presents our estimates using a symmetric error-correction model. Column (3) shows our findings from an error-correction model that examines asymmetric responses to disequilibria that arise when SDIT revenues are below and above equilibrium levels. Our baseline short-run income elasticity of SDIT revenues is equal to 1.05 and is given in column (2).[11] The coefficient of the symmetric ECM's lag residual suggests that the adjustment of SDIT revenues per pupil to its long-run equilibrium occurs in 2 years.

Overall, we interpret these findings as evidence that the SDIT base is stable and fairly insensitive to changes in income in the short-run. This suggests stability in revenue variability. However, as column (3) indicates SDIT revenue is indeed subject to significant adjustments in the short run. First, the substantial magnitude and statistical significance of the coefficient of the above long-run equilibrium tax revenue level indicator and income shows that downward adjustments to the long-run equilibrium are markedly different from upward future adjustments when revenues are above equilibrium. Moreover, the large magnitude of the coefficient of income (2.54) suggests substantial upward adjustments of SDIT revenue when below long-run equilibrium level. The even larger coefficient of the interaction term between income and the above long-run equilibrium revenue level (−2.69) implies the absence of any sizable short-run downward adjustments to the long-run equilibrium. Recall from the discussion above that the adjustment is equal to the

10. We choose 4-year leads and 5-year lags for the DOLS correction on the basis of the output from the Schwarz Bayesian Criterion after evaluating 12 different models that include up to 6-year lags and leads. Our long-run elasticity estimate is robust to the reshaping of the panel by shortening the number of time units to include more cross-sectional units (school districts with an income tax from the first time unit) for the purposes of the DOLS estimation. Restricting the sample to 1995–2008 and 1998–2008 time windows increases the number of included school districts to 105 and 125, giving rise to panels of 1,122 and 960 observations, respectively. However, the estimated long-run elasticities in the latter samples are 1.28 and 1.74. These are qualitatively similar to the baseline results as the magnitudes rise only modestly with a five- or sixfold increase in the number of observations with a less restrictive sample.

11. Using the Hodrick Prescott (HP) filter, we estimate short-run income elasticities that are not statistically different from zero. However, the R^2 indicates the HP filter specification yields inferior predictions to the primary specification of our analysis.

FIGURE 2
Covariate Imbalance before and after Propensity Score Matching



combined size of the coefficients of income and its interaction term with the above equilibrium indicator, a mere −0.15. The discrepancy is not surprising as the SDIT revenue level at a given year is typically above its long-run equilibrium level because both income and income tax rates trended upward such that the tax base increased net of tax rate changes.[12]

Table 4 presents the results of the DID analysis of the impact of SDIT adoption on total school district tax revenue per pupil growth and volatility.

Here, our interest lies primarily on the incremental effect of adopting a SDIT on total tax revenue growth. Thus, the key parameter of interest in this exercise is the coefficient of the interaction term of income with the SDIT adoption indicator. In the long run, school districts without an income tax in place raised 46 cents per extra dollar of school district income. This estimate is less than half the long-run income elasticity estimate of SDIT revenues in column (1) of Table 3. The long-run income elasticity of total tax revenues in school districts with an income tax is virtually the same as it does not differ in a statistically significant manner. Thus, SDIT adoption has virtually no effect on total school district tax revenue growth. In the short run, local tax revenues in school districts that do not adopt the SDIT grow substantially more slowly than income (by 14 or 13 cents per 1 dollar of income growth based on

12. SDIT revenue levels were below long-run equilibrium levels in only 5.25% of all school district-year observations. It should also be noted that this contrast resembles a number of reported elasticities in Bruce et al. (2006) from the asymmetric ECM specification where coefficients of short-run elasticities and speed-of-adjustment parameters alternate signs between instances of below and above long-run equilibrium levels. The estimated long-run income elasticity for the extended sample that covers post-2008 years up to 2015 is 0.84 which is significantly smaller to the baseline sample's one. Restricting the samples to the 1995–2015 and 1998–2015 time windows, leads to an estimated long-run income elasticity of SDIT revenues of 0.90 (N = 1,649) and 1.01 (N = 1,596), respectively. Again, these are comparable to the estimated long-run elasticity of 0.84 (N = 315) based on the 1990–2015 sample. The estimated short-run income elasticity for the extended sample is substantially smaller than the baseline sample's one at 0.64 for the symmetric and 1.65 for the asymmetric error-correction model specification, respectively. The smaller magnitudes of the estimated short-run elasticities are not a surprise but the product of automatic stabilizers to smoothen the phase-outs of business property taxation instituted by the state of Ohio to mechanically reduce SDIT revenue volatility in the affected school districts.

TABLE 3
Long- and Short-Run Income Elasticity of SDIT Revenues per Pupil

Variables	(1) Long-Run DOLS	(2) Short-Run Symmetric ECM	(3) Short-Run Asymmetric ECM
Income	1.04***	1.05***	2.54**
	(0.46)	(0.24)	(1.12)
SD income tax rate	1.04***	−0.33	−0.38*
	(0.28)	(0.21)	(0.22)
Earned income tax		−0.06	−0.07
		(0.14)	(0.14)
		−0.53***	−0.49***
		(0.07)	(0.09)
Above equilibrium • income			−2.69**
			(1.12)
Above equilibrium lag • residual lag			−0.19
			(0.17)
Observations	198	2,069	2,069
R^2	.65	.43	.44

Notes: Four-year leads and 5-year lags of average income omitted from presentation in column (1). School district fixed effects are included in all specifications but not displayed to conserve space. Standard errors clustered at the school district level in columns (2) and (3).
$^{*}p < .1$, $^{**}p < .05$, $^{***}p < .01$.

the symmetric and asymmetric ECMs, respectively). Adopting an income tax has a trivial, positive effect on the income elasticity of total school district tax revenues. According to columns (3) and (2) of Table 4, it is insignificantly increased by 1 per dollar of income growth which is an economically non-meaningful expansion. Finally, we find that adopting an earned income tax base has a meaningful impact only on the short-run variability of total school district tax revenues.[13]

Lastly, we consider how our findings compare to previous literature on subnational income tax elasticity in Ohio. Relevant to our study, Bruce et al. (2006) estimate the Ohio personal income tax long- and short-run elasticity at 3.983 and 2.529, respectively, whereas the sales tax bases are much less inelastic at 1.033 in the long and 1.802 in the short run. Our estimates suggest that local income tax revenues, in the form of SDIT, are much more stable to fluctuations in income both in the long and short run. However, the discrepancy of our findings with those of Bruce et al. (2006) is likely due to the progressive nature of the state income tax in Ohio. The latter was highly graduated from 1990 through 2008 whereas the SDIT and the sales tax were flat. Thus, it is not surprising that Bruce et al. (2006) find much larger income elasticities than our study since they examine a tax base with both larger rates and eight more income tax brackets.

In addition, our results are generally in line with the prior evidence of substitutability of property taxes with SDITs (Ross and Nguyen-Hoang 2013). Looking more closely, we are able to tease out the long- and short-run effects of local income tax adoption on total local tax revenues. We find that income taxes neither affect long-run growth nor influence short-run total tax revenue variability. We add to the knowledge from Ross and Nguyen-Hoang (2013) by hinting that the extent of substitutability between the SDIT and property tax bases does not differ along the time horizon.

V. CONCLUSIONS

A number of other studies confirm that the personal income tax can be regarded as a reliable revenue source in the long run despite

13. Only a small number of school districts enacted an earned income tax (as opposed to a traditional local income tax) over the course of our analysis. Thus, our test might be underpowered. Considering an extended sample that includes post-2008 information does not change the takeaways substantially. As Table A2 shows, the long-run income elasticity is 0.33 and the short-run one based on a symmetric ECM is 0.14 and an asymmetric ECM is 0.12 in school districts without an income tax. SDIT adoption has a regressive effect on total local revenues in the long run but not in the short run. Specifically, total tax revenues grew at a slower rate in school districts that adopted an income tax. These SDIT revenue losses could be attributed to the Great Recession and reduced average income across Ohio school districts in 2009 and 2010.

TABLE 4
Incremental Effect of SDIT Adoption per Pupil on Total Tax Revenue Income Elasticity

Variables	(1) Long-Run DOLS	(2) Short-Run Symmetric ECM	(3) Short-Run Asymmetric ECM
Income	0.46***	0.14***	0.13***
	(0.11)	(0.04)	(0.04)
Income • SDIT adoption	0.01	0.01	0.01
	(0.15)	(0.02)	(0.08)
SDIT adoption	−0.11	0.02**	0.02**
	(1.54)	(0.01)	(0.01)
SD income tax rate	0.14*	−0.06***	−0.06***
	(0.11)	(0.01)	(0.01)
Earned income tax		−0.03***	−0.03***
		(0.01)	(0.01)
Lag residual		−0.21***	−0.23***
		(0.08)	(0.08)
Above equilibrium • income			0.06
			(0.10)
Above equilibrium lag • residual lag			0.04
			(0.04)
Observations	1,552	4,766	4,766
R^2	.97	.15	.24

Notes: Four-year leads and 5-year lags of average income omitted from presentation in column (1). School district fixed effects are included in all specifications but not displayed to conserve space. Standard errors clustered at the school district level in columns (2) and (3).
$^{*}p<.1$, $^{**}p<.05$, $^{***}p<.01$.

its cyclical variability.[14] Despite the plethora of studies exploring revenue variability, the level of geographical aggregation of elasticity estimates has typically been at the state level, with only one work assessing county level data. This literature is, still, missing an estimate of short- and long-run elasticity of local taxes such as SDITs. Our study fills this empirical gap at the local level by estimating the first SDIT elasticities.

Our long- and short-run elasticity estimates at 1.04 and 1.05 suggest that SDIT revenues did not exhibit substantial growth and variability from 1990 through 2008, respectively. Overall, SDIT revenues fluctuated procyclically. Over the long run, income tax revenues per pupil grew by approximately 1.04 dollars for every dollar of additional income within the school district, on average. In the short run, SDIT revenues fluctuated very mildly by 1.05 dollars. Our estimated rate of adjustment indicates that SDIT revenues per pupil rebound to their long-run equilibrium value in about 2 years. Our second key finding is that school districts with an income tax in place experience significantly less growth in total local tax revenues in the long run but not substantially different variability in the short run. From a policy perspective, our DID findings highlight the substitutability between SDIT and property tax revenue over time. SDIT adoption does not lead to any meaningful growth in total school district tax revenues per pupil in the long run or variability in the short run. Thus, tax base diversification through the adoption of local income taxation is not a good idea for school financing. Our results could not be interpreted as evidence of a revenue-stabilizing role of the SDIT base.

Our estimates suggest that implementing income taxation on income earned in the school district does not have any meaningful effect in the long run. However, this might be the case because fewer than a quarter of school districts exercised this option in Ohio by 2008. This feature of Ohio may make our results

14. Fox and Campbell (1984) find dramatic shifts in the income elasticities of 10 disaggregated Tennessee sales taxes and provide evidence that the sales tax is unstable using a varying elasticity, fixed coefficients model. Their results are also robust to a random coefficient model specification (Otsuka and Braun 1999). Nichols and Tosun (2008) compare casino revenue to income and sales tax short- and long-run elasticities using DOLS and ECM, respectively. Felix (2008) investigates the growth and variability of five sources of state tax revenues from 1967 through 2007 with a particular focus on the Tenth Federal District. Wagner (2006) focuses on North Carolina's composition of state revenues. Cornia and Nelson (2010) employ data from 1989 to 2009 for a comparative case study of revenue growth and variability of state tax portfolios.

not generalizable to a state like Pennsylvania that has widespread use of earned income tax bases (Strumpf 2001). However, our estimates can provide useful insights for policy makers in school districts in Iowa, Maryland, or Kentucky that levy income taxes as a surtax or an excise tax.

APPENDIX

TABLE A1
1990–2015 Long- and Short-Run Income Elasticity of SDIT Revenues per Pupil

Variables	**(1) Long-Run DOLS**	**(2) Short-Run Symmetric ECM**	**(3) Short-Run Asymmetric ECM**
Income	0.84***	0.64***	1.65***
	(0.28)	(0.11)	(0.42)
SD income tax rate	0.87***	−0.27*	−0.28*
	(0.17)	(0.14)	(0.15)
Earned income tax	−0.38	−0.11	−0.11
	(0.81)	(0.07)	(0.08)
Residual lag		−0.51***	−0.49***
		(0.06)	(0.08)
Above equilibrium • income			−1.81***
			(0.45)
Above equilibrium lag • residual lag			−0.04
			(0.15)
Observations	315	3,153	3,153
R^2	0.93	0.42	0.43

Notes: Four-year leads and 5-year lags of average income omitted from presentation in column (1). School district fixed effects are included in all specifications but not displayed to conserve space. Standard errors clustered at the school district level in columns (2) and (3).

$^{*}p < .1$, $^{**}p < .05$, $^{***}p < .01$.

TABLE A2
1990–2015 Incremental Effect of SDIT Adoption on Total Tax Revenue per Pupil Income Elasticity

Variables	**(1) Long-Run DOLS**	**(2) Short-Run Symmetric ECM**	**(3) Short-Run Asymmetric ECM**
Income	0.33***	0.14***	0.12***
	(0.06)	(0.04)	(0.04)
Income • SDIT adoption	−0.04***	0.01	−0.01
	(0.07)	(0.08)	(0.08)
SDIT adoption	0.47	0.03***	0.03***
	(0.76)	(0.01)	(0.01)
SD income tax rate	0.11***	−0.07***	−0.07***
	(0.03)	(0.01)	(0.01)
Earned income tax	−0.11***	−0.03***	−0.03
	(0.04)	(0.01)	(0.01)
Lag residual		−0.25***	−0.29***
		(0.08)	(0.09)
Above equilibrium • income			0.11
			(0.09)
Above equilibrium lag • residual lag			0.08
			(0.05)
Observations	2,265	4,766	4,766
R^2	.95	.27	.26

Notes: Four-year leads and 5-year lags of average income omitted from presentation in column (1). School district fixed effects are included in all specifications but not displayed to conserve space. Standard errors clustered at the school district level in columns (2) and (3).

$^{*}p < .1$, $^{**}p < .05$, $^{***}p < .01$.

REFERENCES

Alm, J. "A Convenient Truth: Property Taxes and Revenue Stability." *Cityscape*, 15(1), 2013, 243–5.

Alm, J., R. D. Buschman, and D. L. Sjoquist. "Rethinking Local Government Reliance on the Property Tax." *Regional Science and Urban Economics*, 41(4), 2011, 320–31.

Anderson, J. E., and S. N. Shimul. "State and Local Property, Income, and Sales Tax Resilience: Estimates from Dynamic Heterogeneous Data Panels." Working Paper, University of Nebraska, Department of Economics, Lincoln, NE, 2016.

Bruce, D., W. F. Fox, and M. H. Tuttle. "Tax Base Elasticities: A Multi-State Analysis of Long-Run and Short-Run Dynamics." *Southern Economic Journal*, 73(2), 2006, 315–41.

Choi, I. "Unit Root Tests for Panel Data." *Journal of International Money and Finance*, 20(2), 2001, 249–72.

Cornia, G. C., and R. D. Nelson. "State Tax Revenue Growth and Volatility." *Federal Reserve Bank of St. Louis Regional Economic Development*, 6(1), 2010, 23–58.

Felix, R. A. "The Growth and Volatility of State Tax Revenue Sources in the Tenth District." *Federal Reserve Bank of Kansas City Economic Review*, 93(3), 2008, 63–88.

Fox, W. F., and C. Campbell. "Stability of the State Sales Tax Income Elasticity." *National Tax Journal*, 37(2), 1984, 201–12.

Gill, H. L., and D. R. Haurin. "The Choice of Tax Base by Local Authorities: Voter Preferences, Special Interest Groups, and Tax Base Diversification." *Regional Science and Urban Economics*, 31(6), 2001, 733–49.

Groves, H. M., and C. H. Kahn. "The Stability of State and Local Tax Yields." *American Economic Review*, 42(1), 1952, 87–102.

Hall, J. C. "Fiscal Competition and Tax Instrument Choice: The Role of Income Inequality." *Economics Bulletin*, 8(12), 2006, 1–8.

Hall, J. C., and J. M. Ross. "Tiebout Competition, Yardstick Competition, and Tax Instrument Choice: Evidence from Ohio School Districts." *Public Finance Review*, 38(6), 2010, 710–37.

Ho, D. E., K. Imai, G. King, and E. A. Stuart. "Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference." *Political Analysis*, 15(3), 2007, 199–236.

Ingle, W. K., P. A. Johnson, M. Ryan Givens, and J. Rampelt. "Campaign Expenditures in School Levy Referenda and Their Relationship to Voter Approval: Evidence from Ohio, 2007–2010." *Leadership & Policy in Schools*, 12(1), 2013, 1–36.

Johnson, P. A., and W. K. Ingle. "Campaign Strategies and Voter Approval of School Referenda: A Mixed Methods Analysis." *Journal of School Public Relations*, 30(1), 2009, 51–71.

Kao, C., and M. H. Chiang. "On the Estimation and Inference of a Cointegrated Regression in Panel Data." *Advances in Econometrics*, 15, 2000, 179–222.

Miko, S. "The Impact of School District Income Tax on the Frequency of Requests for New Operational Tax Levies in Rural Ohio School Districts," Ph.D. thesis, Bowling Green State University, 2006.

Nichols, M., and M. Tosun. "The Income Elasticity of Gross Casino Revenues: Short-Run and Long-Run Estimates." *National Tax Journal*, 61(4), 2008, 635–52.

Ohio Department of Taxation. "Guide to Ohio's School District Income Tax." Technical Report, Ohio Department of Taxation, Columbus, OH, 2013. https://www.tax.ohio.gov/portals/0/tax_analysis/tax_data_series/school_district_data/sditqa.pdf

Otsuka, Y., and B. M. Braun. "The Random Coefficient Approach for Estimating Tax Revenue Stability and Growth." *Public Finance Review*, 27(6), 1999, 665–76.

Ross, J. M., and D. J. Hummel. "Property Taxes and Polycentricity." *The Annual Proceedings of the Wealth and Well Being of Nations*, 4, 2012, 129–44.

Ross, J. M., and P. Nguyen-Hoang. "School District Income Taxes: New Revenue or a Property Tax Substitute?" *Public Budgeting & Finance*, 33(2), 2013, 19–40.

Sobel, R. S., and R. G. Holcombe. "Measuring the Growth and Variability of Tax Bases over the Business Cycle." *National Tax Journal*, 49(4), 1996, 535–52.

Spry, J. A. "The Effects of Fiscal Competition on Local Property and Income Tax Reliance." *The BE Journal of Economic Analysis & Policy*, 5(1), 2005, 1–19.

Strumpf, K. S. "Government Credibility and Policy Choice: Evidence from the Pennsylvania Earned Income Tax." *Journal of Public Economics*, 80, 2001, 141–67.

Sullivan, M., and M. Sobul. "Property Tax and School Funding." Tax Research Series No. 1, Ohio Department of Taxation, Columbus, OH, 2010.

U.S. Census Bureau. "Public Education Finances: 2013." Technical Report No. G13-ASPEF. Washington, DC: Government Printing Office, 2013.

Wagner, G. "Financing Government: Revenue Variability and the Role of Rainy-Day Funds." *Popular Government*, 71, 2006, 24–30.

Watson, M. W., and J. H. Stock. "A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems." *Econometrica*, 61(4), 1993, 783–820.