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Growth and Variability of School District Income Tax Revenues: Is Tax Base Diversification a Good Idea for School Financing?

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Abstract

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 pro-cyclical and fluctuate only mildly. For every dollar increase in average school district income, tax revenues increased by 21 and 3 cents in the long- and short-run. We also find that the school district tax base fully adjusts to its long-run equilibrium within three years. Our results highlight a revenue-stabilizing role of income tax bases on total school district tax revenues.

Keywords: local tax revenue growth and variability, income elasticity, tax base diversification, Ohio

JEL Codes: H71, H75

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1 Introduction

This paper examines the impact of the introduction of school district income taxes on revenue growth and variability of key local tax bases for education financing in Ohio from 1990 through 2008.[1] Given the importance of revenue stability to local school districts, the volatility of school district income taxes over the business cycle is an important policy concern. K-12 education in the U.S. is funded with a combination of federal, state, and local funds. As of 2013, federal sources account for only 9.1% whereas state and local revenue sources contribute 45.6% (30.8% as general formula assistance) and 45.3% (38.9% from taxes and parental contributions), respectively. The percentage of state contributions to K-12 financing is fairly stable overall but revenue from local sources varies considerably across states. For instance, Arkansas and New Mexico received a mere 12.5% and 17% of their public elementary-secondary school system revenue from local sources when in Nebraska and Connecticut these figures stood at 58.3% and 57.4%, respectively. Locally-sourced school finance revenues totaled US$270.6 billions in 2013. The majority (US$184.4 billions) was due to taxes of which US$176.1 billions came from property taxation alone. An additional US$8.3 billion came from other tax sources; namely, school district income taxes. The rest was sourced from parent contributions, school lunch and transportation charges, and transfers from other non-school local governments (U.S. Census Bureau, 2013). A number of states permit local jurisdictions (counties, school districts, cities) to levy local income taxes. But only school districts in Iowa, Kentucky, Maryland, Ohio, and Pennsylvania can levy income taxes as of January 2015.

The variability of revenues from the income tax is important because one of the arguments often given in favor of the property tax for local governments is that it is a stable source of revenue. Alm et al. (2011) find that local government reliance on the property tax was an advantage for many governments in dealing with the Great Recession. This is not surprising, given that in many states - such as 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, this is adjusted upward in the case of a decline in assessed valuation in order achieve the voted upon amount of revenue (**?**). In practice, this tends to mean that revenues from property taxation are very stable over the business cycle. But, because property taxes are levied as an amount not a rate, school districts cannot directly capture much of the upside of housing appreciation. This means that school districts cannot automatically harness the upside of economic growth since they have to return to the voters and ask for additional revenue. The income tax, however, is levied as a rate and therefore school districts are able to automatically capture more in the instance of an economic boom. The potential downside of diversification would be if income tax revenue craters when the economy is in a recession. Alm (2013) provides additional reasons why the property tax is an inelastic source of revenue. Given the problem that exists of going back to the voters too often (so-called "levy fatigue")[2], having a

[1]The school district income tax is a special tax earmarked for providing financial support to a school district.

[2]For more on levy fatigue in the Ohio context, see Johnson and Ingle (2009); Ingle et al. (2013).

revenue source that automatically grows with the economy would seem to be prudent. School districts need to be concerned with whether revenues from a tax base can meet the increased constituent demands that come with rising incomes. This trade-off between volatility and growth goes back to the pioneering work of Groves and Kahn (1952). Income taxes have generally been found to be extremely volatile with respect to changes in income over the business cycle, and certainly more so than other tax bases.

First, to overcome the potentially endogenous decision to enact a school district income tax, we match adopting school districts to non-adopting ones based on recorded motivations for these decisions. Next, we add to the literature that informs our normative views about tax diversification at the local level by deriving the first short- and long-run revenue income elasticity estimates regarding the school district income tax. We use conventional methods in the public finance literature to find that revenue from Ohio's school district income tax fluctuates mildly and pro-cyclically. For every dollar increase (decrease) in household income, school district revenues increased (decreased) by 14 cents per household or 25 cents per pupil. Overall, we find that school district income tax revenue growth exceeded economic growth in Ohio from 1990 through 2008. Finally, we examine how volatile total school district tax revenues become following an enactment of an income tax. Specifically, we use a Difference-in-Differences (DID) approach to estimate the incremental effect of the introduction of school district income taxes on the growth and variability of property and school district income tax revenues in each district. In other words, we examine how volatile school district income tax revenues are relative to property tax revenues. Our findings provide local policy-makers with important insights for school districts debating whether to diversify their tax base by introducing an income tax. They highlight to what extend school districts can rely on income taxes to foster local tax revenue stability.

The rest of the paper is organized as follows. Section 2 provides the necessary institutional background regarding school district income taxes and local taxation in Ohio; namely, property and school district income taxes. It also includes a review of the empirical literature on the determinants of school district income tax adoption, with a particular focus on Ohio. Section 3 discusses the data and methodology and Section 4 presents the results. Section 5 concludes.

2 Institutional Background

Due to the large amount of data available historically through the Ohio Department of Education and Ohio Department of Taxation as part of school finance litigation, Ohio has been the context of several public finance papers looking at different aspects of the decision to utilize the school district income tax. However, a number of different states employ them as well. The following paragraphs provide state-specific overviews of school district income taxes in all other states but Ohio.

Pennsylvania was the first state to allow school districts to levy an income tax in 1965 and the majority of districts have exercised the option by now. It is implemented as an earned income tax as opposed to a traditional income tax. The tax is applied to earned income and net profits from business, professions and other self-employment endeavors of school district residents and non-Pennsylvania residents who work in a school district.

Iowa operates a local income tax as a surtax on the state income tax liability. In this case, the school district income tax is calculated as a percentage of a taxpayer's state tax liability. School districts in Iowa can extend their funding up to 10 per cent of their guaranteed budget. The decision is made either by the school district board for up to five years or through a referendum. Currently, 297 out of the 351 school districts in Iowa have opted-in.

Similarly to Iowa, Maryland school districts levy an income tax as a surtax on the state income tax. On the contrary, though, all school districts in Maryland apply the surtax. The level of the surtax may vary from 20 to 60 per cent of the state income tax liability. As a result, school district income taxes in Maryland comprise almost 20 per cent of total revenues, far greater than school district in any other state.

Kentucky permits school districts to tax income through an excise tax on residents up to 20 per cent of state income tax liability. However, not a single school district in Kentucky has ever introduced an excise tax. Instead, an occupational license tax at the county level applies to the salaries or wages of workers and net profits of all businesses, professions, or occupations in a county.

School districts income taxes have been examined in a series of recent papers in public economics. Loeb (2001) provides an excellent review of local income taxation for the mid 1990s when school district income taxes were popularized.

Local Tax Bases in Ohio

Historically, the property tax has been the most important source of funding for Ohio's schools. In 2013, the property tax raised 80.8% of total revenues for K-12 education. Approximately two-third of all property taxes levied in Ohio go to fund schools. In tax year 2008 local property taxes generated over $8.18 billion for operating expenses of local and joint vocational schools. Property taxes are categorized as real property taxes (on land and buildings), classified as residential/agricultural or industrial/commercial and tangible personal property taxes (on machinery, equipment, furniture, fixtures, and inventories), classified as public utility tangible or general businesses tangible. Taxes on residential and agricultural real property account for 68 per cent of all property taxes. The two classes of tangible property together accounted for only 8.7 percent of all taxes charged.

Property taxes in Ohio are not a straightforward application of a uniform per cent rate on taxable value. Instead, the calculation of taxable value requires the determination of the property's true value and the application of a specified percentage (assessment rate) to that value. However, both the method of determining true value and the specified percentage differ by type of property while certain property may be exempted from taxation altogether. As is customary, property tax rates are expressed in terms of mills. The constitution restricts the authority to impose taxes without voter approval to a tax rate equivalent to one percent of the true value of property. By election, voters may authorize levies exceeding this limit.

However, the Ohio Revised Code is even more restrictive as it applies a "10-mill limitation", allowing only one percent (10 mills) of unvoted taxes to be levied against taxable value. Thus, net property taxes are calculated by taking the taxable property values, multiplying them by the appropriate tax rate in effect for each type of property, and subtracting out the effects of three property tax credit programs. The latter are the homestead exemption program, the ten percent rollback credit and the 2.5 per cent rollback credit. (Sullivan and Sobul, 2010).

School district income taxes in Ohio were first introduced in 1981. The law was repealed in 1983 but re-enacted in 1989. The equivalent of a 20-mill property tax levy is mandated by the state and can be raised either through property or income taxes. State law requires that the rate must be uniform within a municipality and cannot exceed one percent without approval by voters. Ohio school districts uniquely levy the income tax solely subject to voter approval. This makes Ohio an ideal study setting because the levy and the size of the tax is truly a choice variable. For example, Gill and Haurin (2001) study the determinants of school district tax base choice in Ohio between property and income taxes. They 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. Spry (2005) uses cross-sectional variation among Ohio school districts by 1997 to explore what drives school district income tax adoption. He highlights the roles of interjurisdictional competition (number of school districts within 10 miles), the property tax price, and property taxes from business property as well as agricultural property. Hall (2006) looks at the role of income inequality with respect to the likelihood of school district income tax adoption. Again, the most important drivers of adoption are interjurisdictional competition, income inequality, percentage of commercial property, and percentage of state revenues. 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. Using survey data, Miko (2006) explores the factors that motivated school district income tax adoption. Ross and Nguyen-Hoang (2013) use annual panel data from 1990 to 2008 to disentangle the effect of school district income tax adoption on operating property tax revenue.

In the paper closest to our own, Ross and Nguyen-Hoang (2013), build on this literature by looking at the effect of income tax adoption on school district revenue. Their work is important because the reasons stated by policymakers for adoption of a school district income tax 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. They find that about one quarter of additional revenue from the school district income tax is used to offset property taxes in the short-run, with the remaining being net new revenue.

Figure 1 show the evolution of school district income taxes from 1990 through 2014 in terms of number of adopting school districts and average rates levied. Clearly, the number of school district that adopted

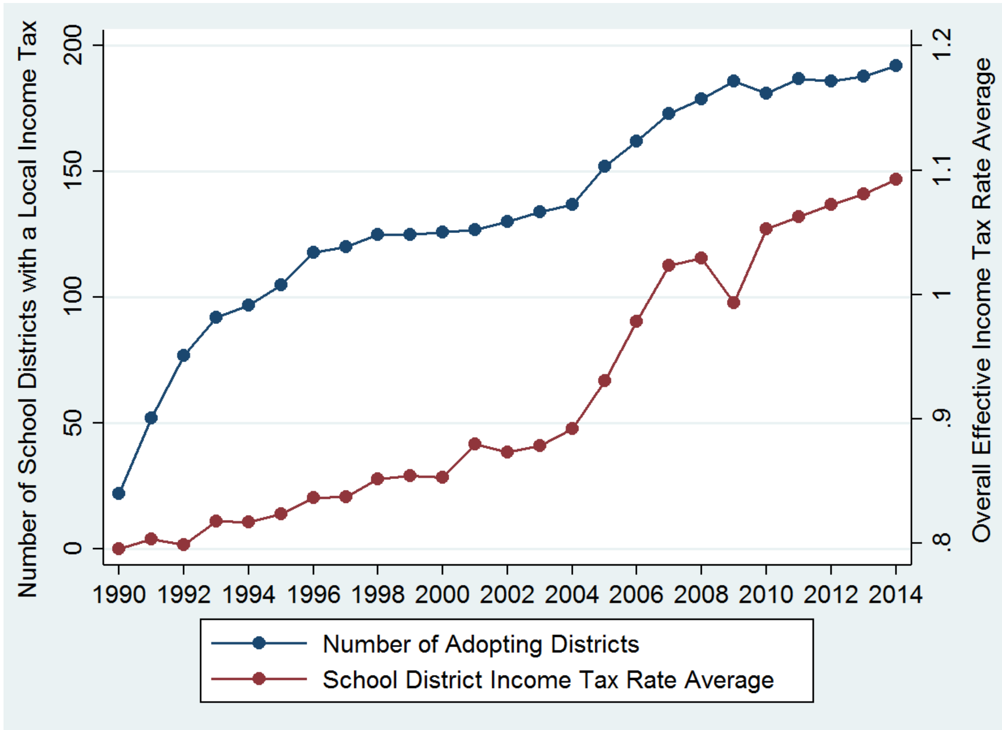

Figure 1

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. On the contrary, school district income tax rates varied only mildly 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. Changes to both the property tax and school funding system enacted in House Bill 66, of the 2006-2007 state biennial budget, permitted school districts to levy, subject to voter approval, an alternate tax base that includes only earned income and self-employment income of the residents of the school district. An "earned income" school district tax applies only to earned income, such as wages and self-employment earnings, and earnings from partnerships. 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 for personal exemptions that are allowed under the traditional tax base or adjustments to income such as IRA contributions, self-employment health insurance deductions, and alimony payments (ohi, 2013). H.B. 66 created reimbursement mechanisms to fully hold school districts harmless through FY 2011 for the tangible personal property tax losses created by the phase-out of the tax. 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. Beginning in 2009, telephone company property was the only type of general business tangible personal property that remained taxable in 2009 and 2010.

In tax year 2009, the school district income tax, the other source of local tax money, provided about $323 million for schools. Finally, the largest overhaul came with House Bill 1, of the 2010-2011 state biennial budget. It included many school funding and policy changes. Due to changes in H.B. 1, the revenue lost to school districts from the phase-out of all tangible property was fully reimbursed by the state through 2013.

3 Empirical Approach

3.1 Data

Due to the very substantial changes in school district revenue administration, both with regards to collection as well as reimbursement that commenced in 2006 and accentuated in 2009, our baseline analysis is restricted to the years 1990-2008. In doing so, we minimize bias in our estimates of school district income tax revenues income elasticity from amendments that introduced automatic stabilizers to school district revenues as H.B. 1. Including post-2008 years in our analysis would introduce upwards bias in our estimates. Since these policies were implemented to smoothen the impact of the tangible property tax revenue phase-outs, it would exaggerate the relative impact of school district income taxes on total local tax revenue growth and variability. In addition, the financial crisis of 2008 affected local jurisdictions fiscal health and the short period thereafter constitutes a somewhat unique period.

The two outcomes we examine are school district income tax revenues and total school district tax revenues. The latter are defined as school district income tax and total property tax revenues which, in turn, is the sum of real property taxes charged and tangible property taxes levied. The fact we employ actual local tax bases constitutes an improvement with regards to the measurement of the tax base relative to the proxies that previous studies have often used. The key independent variable that measures income is the average federal-adjusted income in the school district, normalized by the 2005 price level. It should be noted that previous studies have used the median rather than the average statistic as the measure of income. However, the average metric is more appropriate in our analysis because school district income taxes are flat, not progressive. Any inflation in school district income will be proportionally captured by the effective income tax rate. As a result, the coefficient of the income tax rate will not suffer from a downwards bias. Tax revenue and income information is obtained from the Ohio Department of Education and Taxation, respectively. Table 1 provides summary statistics of all the variables used in our analysis by school district income tax adoption status.

Pre-Processing via Propensity Score Matching

In nonexperimental studies, we must posit an assignment mechanism, which determines which units receive treatment and which do not. Matching provides this opportunity based on the following identifying assumptions. The assumption of strongly ignorable treatment assignment requires that: (1) treatment

Table 1: Summary Statistics

Variables	Mean	Std Dev	Min	Max
Income Tax Adopting School Districts (N = 2,253)				
Mean SDIT in Surrounding SDs	0.491	0.340	0	1.375
Tax Price	0.704	0.119	0.187	0.938
State Aid per Pupil (in $)	3,459	1,059	360	7,435
Federal Aid per Pupil (in $)	339	240	1	4,888
School District Income Taxes per Pupil (in $)	844.33	515.85	0.0026	3948.10
Percentage of Renters	20.02	7.96	1.22	56.84
Percentage of Seniors	12.32	2.79	4.06	30.74
Average School District Income (in $)	37,933.9	11,333.89	19,831	168,263.2
Total Tax Revenues (in thousand $)	4,925.226	5,176.454	381.986	47,013.092
Real Property Tax Revenues (in thousand $)	3,170.435	3,673.039	259.995	32,951.241
Tangible Personal Property Taxes (in thousand $)	733.194	792.486	42.905	4,979.651
Total School District Income Taxes (in thousand $)	1,021.597	1,170.936	0	12,811.200
School District Income Tax Rate (in %)	0.89	0.30	0	2
Income Tax Adopting School Districts (N = 9,318)				
Mean SDIT in Surrounding SDs	0.137	0.224	0	1.278
Tax Price	0.582	0.157	0.025	0.955
State Aid per Pupil (in $)	2885	1265	170	11,020
Federal Aid per Pupil	354	316	1	3755
Percentage of Renters	23.52	10.04	4.71	63.02
Percentage of Seniors	13.55	3.63	3.56	38.95
Average School District Income (in $)	39,313.61	19,875.07	16,993	371,802.8
Total Tax Revenues (in thousand $)	12.400	23.700	139.641	431,000
Real Property Tax Revenues (in thousand $)	9,450.959	18,600	114.742	400,097.341
Tangible Personal Property Taxes (in thousand $)	297.458	5,898.962	21.527	84141015

Source: Ohio Department of Education, Ohio Department of Taxation assignment (T) is independent of the potential outcomes $(Y(0), Y(1))$ given the covariates $(X) : T \perp Y(0), Y(1)|X$, (2) there is a positive probability of receiving each treatment for all covariate values $X : 0 < P(T = 1|X) < 1 \forall X$ (Rosenbaum and Rubin, 1983). The first component of the definition of strong ignorability is sometimes termed "ignorable," "no hidden bias" or "unconfounded." This is a reasonable assumption since controlling for the observed covariates also matches on the unobserved covariates to the extent they are correlated. Thus, the only unobserved covariates of concern are those unrelated to the observed covariates ("selection on observables"). The second component ensures the existence of common overlap in the sense that any unit is likely to be treated. In addition, the stable unit treatment value assumption (SUTVA) requires "no spillovers" (Rubin, 1980). In other words, the outcomes of one unit are not affected by treatment assignment to any other unit.

Next, we estimate the conditional probability of school district income tax adoption given the vector of observed covariates from 1990 through 2008. Our choice of variables for the construction of the propensity score is guided by the findings of the pre-existing empirical literature on school district income tax adoption Ohio. We select five key determinants of school district income tax adoption and 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, too. Second, we use the average income tax rate among the district's surrounding neighbors as measure of interjurisdictional competition. Arguably, this covariate is also capturing spatial dependence in the school district income tax adoption that makes the SUTVA more tenable. Third, we balance on tax price, defined as the ratio of median housing price to total residential property values per pupil. We additionally match on the percentage of the population over age 65, and the percentage of renters. Finally, we control for the percentage of revenues from state and federal sources.

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, pre-processing 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 and are absent in our post-matching sample.

Figure 1 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 school district income tax 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 upwards bias that would have overwhelmed the impact of all other determinants.

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	3209.9	0.03
	M	924.44	1023.9	1.33
State Aid per Pupil (in $)	U	3155.8	2931.4	0.65
	M	3155.8	3180.8	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

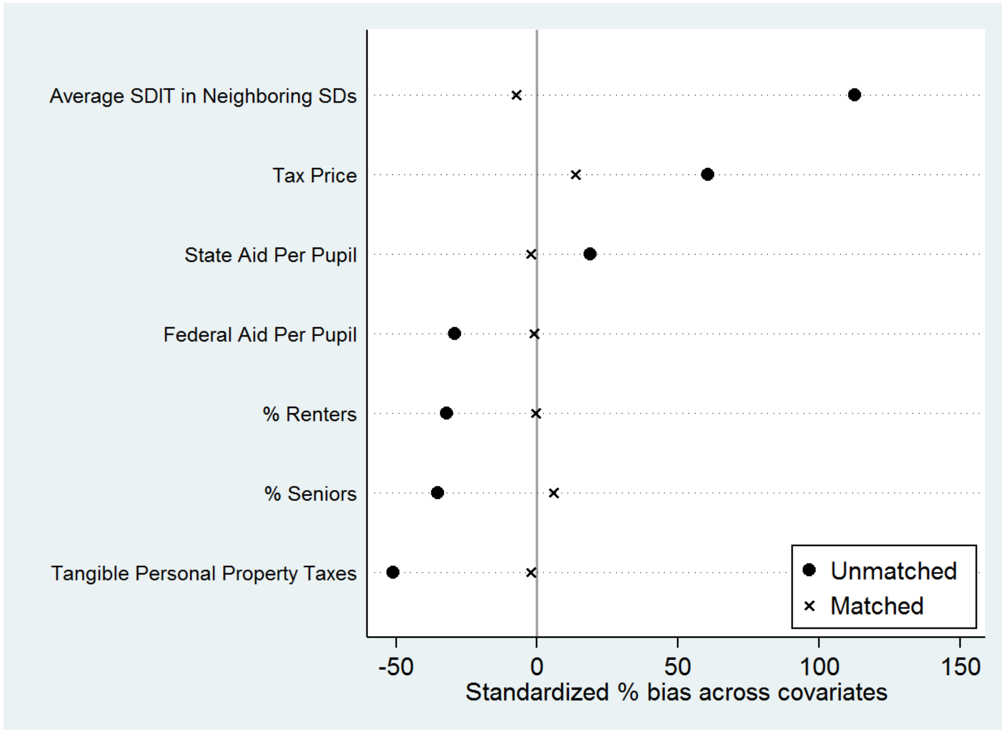

Figure 2: Covariate Imbalance before and after propensity score matching

3.2 Approaches in Measuring Revenue Growth and Variability

The seminal paper in the literature of revenue growth and variability is by Groves and Kahn (1952) who highlighted the trade-off between these two properties - a stylized fact, by now. A log-log regression is specified to estimate the income elasticity of state and local tax revenues. Relevant to this study, they show that most state income taxes are, however, less stable (more income-elastic) to the federal one. Fox and Campbell (1984) question the validity of Groves and Kahn's approach to explain short-run revenue stability because it employs long-run measures. These authors focus on short-run revenue fluctuations over the business cycle; a stable tax is less responsive to fluctuations. In their empirical investigation, they derive income elasticities for ten disaggregated Tennessee sales taxes using a fixed coefficients model. Otsuka and Braun (1999) show that the results of Fox and Campbell (1984) are robust to a random coefficient model specification. Dye and McGuire (1997) dismiss previous findings as too broad and link the trade-off between revenue stability and revenue growth of income and sales taxes to the components of their tax base.

Sobel and Holcombe (1996) introduce a methodological innovation in the estimation of income elasticities. They call our attention to the fact that income and tax bases have consistently been trending upwards over time; that is, the income and tax bases typically used to derive income elasticities are non-stationary variables. As a result, using a single regression equation fails to distinguish between long-run and short-run relationships. The authors propose the use of the non-stationary variables for the estimation of the long-run relationship via a levels regression. To recover the short-run income elasticity stationary variants (e.g. differenced) should be used instead that omit the time-series trend. However, their estimates of income elasticities of state tax bases are proxied by national aggregate time series data. In a follow-up, Holcombe and Sobel (1997) re-estimate long- and short-run income elasticities of the most important state tax bases.

Bruce et al. (2006) popularized Dynamic Ordinary Least Squares (DOLS) and Error Correction Models (ECM) for the estimation of long- and short-run elasticity estimates. The authors also distinguish between short-run elasticities and speed of adjustment parameters. They also contribute an approach that can explore asymmetric responses in both the short-run tax base elasticity and the long-run speed of adjustment. Relevant to our context, they 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.

A number of other studies confirm that personal income tax can be regarded as a reliable revenue source in the long-run despite its cyclical variability.[3]

A different strand of the literature uses portfolio theory to investigate whether revenue portfolio diversification enhances revenue stability (Markowitz, 1952). White (1983) uses the residual variance from a levels regression of tax revenue on time as an alternative metric of revenue instability. Overall instability of a tax structure is measured as the variance of each tax and their respective covariance. Under his definition, a stable tax structure is "one that contains taxes that are not perfectly correlated (i.e. one in which taxes do not move in exactly the same direction and proportion)." Despite the methodological differences, his findings are in agreement with the ones by Groves and Kahn (1952); there is a trade-off between revenue growth and revenue stability. A number of empirical studies ensued that followed from White's definition of revenue instability.[4] We do not follow this approach in measuring revenue variability since findings of these studies largely conform with the stylized facts from the empirical literature using reduced form models.

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 school district income taxes. Our study fills the empirical gap at the local level by estimating the first school district income tax elasticities.

[3]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.

[4]For examples, see Garrett (2009) and Yan (2012).

Table 3: Augmented Dicker-Fuller Unit Root Tests

Variables	Statistic	P-value
Stationarity Tests in Levels		
Log School District Income Tax Revenues	0.8095	0.8095
Log Average School District Income	4.4018	1.0000
Stationarity Tests in Differences		
Log School District Income Tax Revenues	-84.3368	0.0000
Log Average School District Income	-24.3440	0.0000

Notes: Fisher test assumes data generated by an AR(5) process. Series mean across panels subtracted from the series, linear time trend included.

3.3 Reduced-Form Short- and Long-Run Elasticity Models

First, we calculate a measure of long-run school district income elasticity in levels. In the presence of a unit root, a levels specification could lead to spurious results. We examine whether a unit root exists in the logarithms of school district income tax revenues per pupil and average school district income base. Given the unbalanced panel, we use a Fisher-type panel unit root test whose null hypothesis is that all the panels contain a unit root (Choi, 2001). Specifically, the Augmented Dickey-Fuller (ADF) test conducts unit-root tests for each panel individually, and then combines these 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 augmented Dickey-Fuller tests, we cannot reject the null hypothesis that all panels contain unit roots both in the logarithm of the tax base and average income. Thus, we interpret the results of the unit root tests as evidence of non-stationarity in the levels. To avoid spurious regression, we transform our time series by taking the first difference. As the last two rows of Table 3 indicate, the first-differenced time-series are stationary. As a result, our results from first-differenced estimations are less susceptible to differential trends across school districts.

Following Bruce et al. (2006), we derive a long-run elasticity estimate using a single-equation cointegration technique, namely Dynamic Ordinary Least Squares (DOLS) (Watson and Stock, 1993). This a particularly useful technique when observations are non-stationary because it allows us to obtain a cointegration regression between the income tax base and average income in the school district. The DOLS correction is implemented by introducing j leads and lags of the change in average school district income.

$$lnB_{it} = \beta_1 lnY_{it} + \sum_{g=-j}^{j} \gamma_g \Delta lnY_{it+g} + \alpha_2 \tau_{it} + \alpha_3 I[EI_{it}] + \phi_{it} \tag{1}$$

Equation (1) above gives our baseline long-run income elasticity measure by regressing logged school district income tax base lnB_{it} on logged average income lnY_{it} in school district i at year t. We further adjust by an earned income tax base indicator and the school district income tax rate. The latter controls for variability due to changes in the school district income tax base's structure over time (Felix, 2008). We also specify school district fixed effects γ_i. The parameter of interest is β_1. This coefficient captures the long-run, stable relationship between school district income tax bases 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 school district income tax revenue grows in comparison to income. Values greater than unity suggest that tax revenue grows faster than income, and slower otherwise.

The variability of tax revenues reflects the relationship between the school district's income taxes and its business cycle. The short-run elasticity entails the estimation of the cyclical component of school district income tax revenues. We take the first-difference to de-trend lnB_{it} and lnY_{it} in order to obtain the short-run metrics. Our baseline short-run elasticity estimates are based on the error correction model (ECM) specified in equation 2. Our specification restricts the tax base to adjust toward the estimated long-term relationship. This permits the estimation of speed of adjustment parameters that indicate how fast the school district income tax base converges to a new equilibrium following changes in average income. The observed change in the school district tax base is the combination of two effects: (i) changes in tax base due to changes in average income; (ii) adjustment to existing disequilibrium.

In equation (2), we treat short-run disequilibria symmetrically. That is, we do not distinguish between positive and negative short-run deviations lnB_{it} from the long-run equilibrium base lnB^*_{it}. But, in equation (3) the analysis differentiates between symmetric and asymmetric short-run elasticities. This modeling adjustment is necessary if the school district tax base responds asymmetrically to changes in institutional factors such as education financing needs. We use an indicator to capture the instance of deviations below the equilibrium tax base value. This allows us to assess to what extent the short-run tax base elasticity responds to income changes asymmetrically to a positive relative to a negative disequilibrium.

In (2) and (3), we use fixed effects γ_i to control for time-invariant unobservable characteristics of each school district. Note that a constant α_0 is also included in our estimation but omitted from presentation.

$$ln\dot{B}_{it} = \alpha_1 ln\dot{Y}_{it} + \alpha_2 \epsilon_{it-1} + \alpha_3 \dot{\tau}_{it} + \alpha_4 I[EI_{it-1}] + \gamma_i + \mu_{it} \tag{2}$$

$$ln\dot{B}_{it} = \alpha_1 ln\dot{Y}_{it} + \theta_1 \mathbf{1}[B_{it-1}] \cdot ln\dot{Y}_{it} + \alpha_2 \epsilon_{it-1} + \theta_2 \mathbf{1}[B_{it-1}] \cdot \epsilon_{it-1} + \alpha_3 \dot{\tau}_{it} + \alpha_4 \mathbf{1}[EI_{it-1}] + \gamma_i + \nu_{it} \tag{3}$$

Parameter α_1 captures the immediate, intra-period 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 pro-cyclically. A negative short-run elasticity would imply that school district income tax revenue increases in recessions and decreases in economic booms, counter to the business cycle, which seems counterintuitive. The degree of adjustment of the tax base to its long-run equilibrium value is denoted by the parameter α_2 in Equations (3) and (4). It is interpreted as the percentage of disequilibrium removed in every period. Lastly, parameter θ_1 indicates whether short-run upwards adjustments are different to short-run downward future adjustments when in disequilibrium and, similarly, θ_2 for the long-run adjustments.

For robustness, we alternatively use the Hodrick-Prescott filter to de-trend the time series and derive the cyclical component of the school district income tax revenues. Given the annual frequency of our observations, we set the penalty parameter λ equal to 6.25 following Ravn and Uhlig (2002). Essentially, equations (2) through (4) are re-specified with pre-estimated cyclical components take the place of first-differenced variables. However, to keep the estimand comparable and circumvent the existence of gaps in our panel, we transform the school district income tax base by the inverse hyperbolic sine function(Burbidge et al., 1988). This is a convenient transformation because it is well-defined over zero but retains logarithmic properties. Its first attribute prevents from discarding observations that take zero values, unlike the log transformation. Even if these estimates are based on a log-like - log regression, the interpretation of the income coefficient as a short-run measure of elasticity is maintained. This is the case because the inverse hyperbolic sine behaves like the natural logarithm for values away from zero; a condition school district income tax revenues satisfy ($\mu = 134.27; \sigma = 327.89$).

3.4 Difference-in-Differences Design

Finally, we examine the impact of school district income tax adoption on the long- and short-run income elasticity of total school district tax revenues. We use the matched sample following to reduce model dependence (Ho et al., 2007). Preprocessing raw data via matching procedures makes our parametric estimates more insensitive to seemingly arbitrary choices in model specification. We regress logged total school district tax revenues $lnTB_{it}$ 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 γ_i, the level of the income tax rate and an earned income tax indicator as controls in the estimation but omit them from equations (4)-(6).

$$lnTB_{it} = \beta_1 lnY_{it} + \beta_2 \mathbf{1}[IT_{it}] + \beta_3 \mathbf{1}[IT_{it}] \cdot lnY_{it} + \sum_{g=-j}^{j} \gamma_g \Delta lnY_{it+g} + \phi_{it} \tag{4}$$

$$ln\dot{TB}_{it} = \alpha_1 ln\dot{Y}_{it} + \alpha_2 \epsilon_{it-1} + \alpha_3 \mathbf{1}[IT_{it}] + \alpha_4 ln\dot{Y}_{it} \cdot \mathbf{1}[IT_{it}] + \mu_{it} \tag{5}$$

$$ln\dot{TB}_{it} = \alpha_1 ln\dot{Y}_{it} + \theta_1 \mathbf{1}[B_{it-1}] ln\dot{Y}_{it} + \alpha_2 \epsilon_{it-1} + \theta_2 \mathbf{1}[B_{it-1}] \epsilon_{it-1} + \alpha_3 \mathbf{1}[IT_{it}] + \alpha_4 ln\dot{Y}_{it} \mathbf{1}[IT_{it}] + \nu_{it} \tag{6}$$

The parameter of interest is the coefficient of the school district income tax adoption indicator interaction with average income (β_3 in (4), α_4 in (5) and (6)). It reflects the incremental variability of total school district tax revenue growth due to school district income tax adoption. The parameter β_3 is interpreted as the averaged effect (i.e. slope) of not adopting income taxes in a school district. It measures the difference between the tax revenue slopes among non-adopting and adopting school districts. The effect of school district income tax adoption is measured as the sum of β_2 and β_3 ($\alpha_3 + \alpha_4$ for (5) and (6)). This is the policy relevant estimand as it shows the direction and magnitude of the income tax's influence. Standard errors are clustered at the school district level.

4 Results

Estimates of the long-run income elasticity of school district income tax revenues per pupil are presented in Table 4. Note that balanced panels are required for DOLS estimation and, thus, a large number of school districts are discarded. This explains the mere 352 number of observations. Columns (1) and (2) present estimates from unadjusted and adjusted (by the school district income tax rate) DOLS regressions, respectively. In column (3) we add an indicator for school districts that enacted an earned income tax base as opposed to the traditional tax base by residence. The effect of this tax base differentiation is inconsequential for the estimates of our parameters of interest. Still, the insignificance of findings regarding earned income tax base adoption might also be due to the lack of power of this test. Recall that only 20 school districts in 2006, 9 in 2007, and 13 in 2008 had an earned income tax base in place. Thus, our preferred long-run elasticity estimate is in column (2) at 1.09 as evidence of a fairly stable tax base. This elasticity estimate is fairly constant up the inclusion of five leads and lags. We use a single lead and lag for the DOLS correction on the basis of the values of the R-squared, and the adjusted R-squared statistic, as well as the standard error of the regressions. Overall, long run elasticity school district income tax base measures indicate that school district income taxes are, if anything, only very mildly volatile. An explanation for this finding could be the fact that school district income taxes are proportional with very low tax rates that are applicable to all income earners either residing or employed in the school district. As a result the scope of the tax base is fairly constant over time. Any fluctuations in tax revenues are mainly coming from variation in aggregate income smoothened out over the school district.

Table 4: Long-Run School District Income Tax Revenue Income Elasticity

Variables	(1) DOLS	(2) Adjusted DOLS	(3) Augmented DOLS
Income	1.21899***	1.09404***	1.0995***
	(0.25730)	(0.25746)	(0.25699)
SD Income Tax Rate		0.90336***	0.90854***
		(0.15218)	(0.15209)
Earned Income Income Tax'			-0.61328
			(0.67877)
School District Fixed Effects	NO	NO	NO
Observations	9,744	2,074	2,074
R-squared	0.81682	0.23223	0.28890

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Our short-run Ohio school district income tax base estimates are presented in Table 5. Columns (1) and (2) show findings from the first-differenced symmetric and asymmetric error-correction models, respectively. Columns (3) and (4) present variant models where detrending is based on a Hodrick-Prescot filter instead.

In the short run, changes to the tax base may come from changes in income or an adjustment toward the long-run cointegrating relationship from equation (2). Our baseline short-run income elasticity of the school district income tax base is 1.03881 from column (1). This suggests stability in revenue variability. However, as column (2) indicates this is coming mainly from substantial short-run downwards adjustments to the long-run equilibrium rather than a stable tax base. The short-run elasticity estimate is not robust to the de-trending method. Columns (3) and (4) present results that fail to estimate the short-run income elasticity to be statistically different from zero. On the basis of their poor predictions and lower R-squared, we disregard the HP filtered short-run elasticity estimates. Contrary to the (1) and (2), filtering revealed a positive relationship between school district income tax revenues and rates. In the same fashion, this set of results hints towards a counter-cyclical effect of the implementation of an earned income tax base. Column (4) presents evidence of long-run adjustments to equilibrium, in addition to short-run ones. The adjustment to the long-run equilibrium tax base when average income grows by one per cent ranges from -0.29 to -0.38. This implies that the school district income tax base adjusts to its long-run equilibrium value in roughly three years. Overall, we deduce that the school district income tax base is stable and fairly insensitive to changes in income.

Table 6 presents the results of the DID analysis of the impact of school district income tax adoption on total school district tax revenue growth and volatility. As the panel we use is strongly balanced, DOLS

Table 5: Short-Run School District Income Tax Revenue Elasticity and Equilibrium Adjustment

Variables	(1) ECM	(2) Asymmetric ECM	(3) Filtered ECM	(4) Filtered Asymmetric ECM
Income	1.03881^{***}	2.35747^{**}	0.08495	0.80159
	(0.22103)	(0.93040)	(0.33251)	(0.59197)
Tax Rate	-0.33271	-0.38500^{**}	2.13969^{***}	2.05550^{***}
	(0.20997)	(0.22412)	(0.32283)	(0.30649)
Earned Income Indicator	0.03365	0.03723	-0.83359^{***}	-0.85565^{***}
	(0.13932)	(0.13822)	(0.11485)	(0.11009)
Lag Residual	-0.54141^{***}	-0.48692^{***}	-0.14460^{***}	-0.10034^{*}
	(0.06991)	(0.08330)	(0.05373)	(0.05970)
Lag Below Equil·Lag Residual		-0.29386		-0.38066^{***}
		(0.18328)		(0.14556)
Below Equil·Income		-2.38432^{**}		-1.37967^{**}
		(0.93762)		(0.64907)
School District Fixed Effects	YES	YES	YES	YES
Constant	0.22548^{***}	0.34560^{***}	0.11524^{***}	0.25263^{***}
	(0.00715)	(0.06584)	(0.00110)	(0.05264)
Observations	2,069	2,069	2,074	2,074
R-squared	0.4536	0.46490	0.25072	0.26742

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. Standard errors clustered at the school district level.

Table 6: Incremental Effect of School District Income Tax Adoption on Total Tax Revenue Income Elasticity

Variables	(1) DOLS	(2) CEM	(3) Asymmetric CEM
Income	1.24434***	0.02029	0.08318*
	(0.01699)	(0.03226)	(0.05018)
Income·SDIT Adoption	−0.03849	−0.13858***	−0.14447***
	(0.03114)	(0.01888)	(0.01886)
SDIT Adoption	0.23506	1.79545	1.97777
	(0.32238)	(1.54215)	(2.42744)
Lag Residual		−0.03345***	−0.01833***
		(0.00461)	(0.00358)
Lag Below·Income			−0.04240
			(0.06393)
Lag Below·Lag Residual			−0.12000***
			(0.01827)
SD Income Tax Rate	0.10004***	−0.02484	−0.04110
	(0.02301)	(0.02841)	(0.03095)
Earned Income Income Tax‘	−0.00143	−0.01835	−0.02443
	(0.03254)	(0.02154)	(0.02190)
School District Fixed Effects	NO	YES	YES
Observations	352	352	352
R-squared	0.24798	0.62016	0.6163

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. Standard errors clustered at the school district level in (2) and (3).

estimation is performed under relatively high power.

The long-run income elasticity estimate of total school district tax revenue growth is 1.24. This figure is very close to the one for school district income tax revenue growth we derived above. Overall, school districts with an income tax in place raised 20 cents per dollar of total school district tax revenues. The fluctuations ranged from 1.66 to 1.83 per 1 dollar of revenue variability. To examine the incremental effect of adopting a school district income tax on total tax revenue growth, we narrow in the coefficient of the interaction terms. In the long run, school district income tax adoption has a small, counter-cyclical effect on total school district tax revenue growth which is not statistically significant. Specifically, school districts with an income tax saw their total tax base grow by 3 cents less per 1 dollar of growth. However, in the short-run this counter-cyclical effect is more significant and substantial. The stabilizing effect on total school district tax revenues reached 14 cents per 1 dollar of total school district tax revenue growth.

Finally, adopting an earned income tax base does not have an effect on total school district tax revenues.

5 Conclusions

Our findings suggest that tax base diversification through the adoption of income taxation is a good idea for school financing due to its counter-cyclical properties. Our elasticity estimates generally suggest that school district income tax revenues exhibited stability in growth and variability from 1990 through 2008. Overall, the positive sign of all tax base elasticity estimates confirms our expectation that school district income tax revenues fluctuate pro-cyclically. Over the long-run, we find that school district income tax revenue growth exceeded economic growth in Ohio. Specifically, revenues per pupil increased by 21 extra cents for every dollar of additional income within the school district, on average. In the short-run, school district income tax revenues fluctuate very mildly and pro-cyclically; that is, the tax is relatively stable and records increases in economic booms and decreases during busts. We estimate a short-run rate of adjustment that indicates that the income tax base rebounds to its long-run equilibrium value in about three years.

From a policy perspective, our DID findings confirm an important role for income taxes can play in balancing total school district tax revenues. Their counter-cyclical nature relative to the property taxes confirms their substitutability that Ross and Nguyen-Hoang (2013) find. However, our results highlight that income taxes appear to smooth short-run total tax revenue variability rather than long-run growth. Therefore, our estimates for school district income taxes should not be interpreted as evidence of a revenue-stabilizing tax base in the long run. However, we do find that income taxes can have a favorable impact on total school district tax revenue variability in the short-run. Given the long process of property tax assessment, income tax can serve as short-term stabilizers of total school district tax revenues. This beneficial feature dissipates in the long-term, however, because the property tax base has time to re-adjust.

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 less than a quarter of school districts exercised this option in Ohio by 2008. This feature of Ohio may make our results not generalizable to a state like Pennsylvania that has widespread use of earned income tax bases. 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.

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