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Income segregation's impact on local public expenditures: Evidence from municipalities and school districts, 1980–2010

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ABSTRACT

Residential income segregation within local political jurisdictions has risen considerably since 1980 in the U.S. Despite this trend, and a growing body of research on wealth inequality and its impact on public sector size, income segregation's own influence over local public choice has not been thoroughly investigated. Using block-group income distributions for the years 1980, 1990, 2000, and 2010 income segregation is measured for individual U.S. municipalities and school districts, where the spatial distribution of income may carry the most political relevance. Estimates indicate that rising income segregation reduced per-capita spending growth considerably for both municipalities and school districts. These findings are robust to various model specifications and to the use of instrumental variables that adjust for the potential endogeneity of local income segregation. This evidence is consistent with the view that intra-jurisdictional income segregation undermines trust between community members and complicates collective action. However, a-spatial income inequality continues to be positively correlated with local public sector size, as suggested by recent empirical research.

1. Introduction

Local governments in the United States provide a broad set of services that their constituents rely on to conduct many of their day-to-day routines. These include services consumed by nearly every member in a community, such as local streets and public safety, as well as those that are directly enjoyed by only a small subset, such as public education. Although documented evidence points to a gradual convergence in the level of services provided across local jurisdictions (Rhode and Strumpf, 2003), considerable variation persists, the causes of which have been the subject of much academic inquiry since Tiebout's path-breaking work on the subject (Tiebout, 1956).

Theoretical work on this topic points to intra-jurisdictional heterogeneity, such as income inequality or ethnic fragmentation, as a partial determinant of communities' willingness to support public sector expenditures, particularly towards redistributive programs. However, this research yields varied conclusions with respect to how such heterogeneity can be expected to impact local public expenditures.[1] A growing body of empirical research has also begun to address the impact of economic inequality on local government size, particularly with respect to human capital enhancing expenditures. Like the theoretical work that preceded it, the findings are varied. During the first half of the twentieth century, when there was considerable variation in how communities financed public schools within the U.S., research generally suggests that

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[1] Notably, some formal models suggest that rising income inequality may hinder government spending if members of unequal societies are less likely to agree on spending priorities (Benabou, 1996, 2000; Epple and Romano, 1994) or have diminished collective influence over their political representatives (Peltzman, 1980). Conversely, Meltzer & Richard (1981), Alesina and Rodrik (1994), and Persson and Tabellini (1994) have used traditional median-voter frameworks to argue that rising income inequality incentivizes a more expansive government, as the decisive median voter's tax price declines with rising income inequality. Although, each of these models originated out a desire to explain macro-level patterns, their frameworks have since been used to rationalize local public spending as well. Beginning with Alesina et al. (1999), a complementary field of study now addresses the role of ethnic and racial heterogeneity on public sector spending. This literature argues that heterogeneity along racial or ethnic lines results in fewer resources being devoted towards the public sector, largely due to increased political disagreement over spending priorities, concerns regarding inter-group redistribution, and a general distrust between groups. See Alesina and La Ferrara (2002), Lind (2007), and Beach and Jones (2017) for more recent work on this subject and Alesina and La Ferrara (2005) for a broader review of this literature. A separate but related area of research identifies intergenerational conflict as a factor impacting local spending decisions (Poterba, 1997, 1998; Harris et al., 2001; Figlio and Fletcher, 2012; Gallagher et al., 2018).

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local support for public education was strongest within racially homogenous communities that exhibited low levels of wealth inequality.[2] Conversely, studies focused on the latter half of the twentieth century, such as Corcoran and Evans (2010) and Boustan et al. (2013), find that income inequality actually promotes the expansion of local government, both for education and non-educational public services.

Notably absent from much of this research are in-depth considerations for another form of community income heterogeneity that has risen over time and varies considerably across local political jurisdictions in the U.S.: residential income segregation. To date, most empirical research on the subject of income segregation emphasizes its link with income inequality, as well as its long-run trends within metropolitan areas.[3] Income segregation's role within political jurisdictions with taxing and spending authority has received very little attention; however, its impact is potentially quite large. The question of income segregation's effect on public sector outcomes is especially interesting in light of evidence presented here that temporal changes in income inequality and income segregation within jurisdictions are not that highly correlated.[4] This raises the possibility that income segregation has its own effect on public sector outcomes that is independent of a-spatial income inequality.

The current paper addresses this gap in the literature by investigating income segregation's impact on public spending within local political jurisdictions. Exploiting block-group level variation in the household income distribution from 1980 to 2010 this study documents changes in income segregation within two important forms of local government in the U.S.: incorporated municipalities and independent unified school districts.[5] Using two separate measures, household income segregation is shown to have risen rapidly over the 1980–2010 period with the average sampled municipality and school district experiencing a 43 percent and 35 percent increase over the 30 year timeframe, respectively.

Jurisdiction-level measures of income segregation are next combined with detailed municipal and school district finance data in order to assess the causal impact of income segregation on local public spending. In addition to using standard panel data estimation techniques to control for jurisdiction-level time invariant fixed effects and idiosyncratic growth trends, instrumental variables control for any remaining bias that may result from endogenous sorting of households across space. Instruments for income segregation are constructed by freezing each jurisdiction's spatial distribution of family income to what is was in 1970 and then allowing each family's income to grow in accordance with nationwide trends, with separate growth rates applied to families falling along different positions of the 1970 national income distribution. Temporal variation in any instrument constructed from these simulated spatial income distributions is therefore independent of any post-1970 sorting behavior. Identifying variation is instead driven by changes in the nationwide income distribution interacted with the lagged 1970 spatial distribution of family incomes, both of which are presumed to be exogenous to post-1970 changes in local public spending. Tests for robustness suggest that this is a reasonable assumption.

The findings presented below indicate that income segregation within local jurisdictions has a sizeable negative impact on spending for core local public services. Rising income segregation between 1980 and 2010 is estimated to have reduced growth in municipal and school district per-capita spending by about 12 percent and 11 percent, respectively. Within municipalities, these spending reductions are distributed across a broad variety of services, such as transportation and recreation. On the revenue side, these effects appear to be driven primarily by reduced support for property taxation; intergovernmental aid received from outside sources also declines with incomes segregation for municipalities.

Income segregation's observed impact on local public sector outcomes has multiple potential explanations. Here, research into racial/ethnic segregation' effect on public sector activity is quite suggestive. Alesina, Baqir and Easterly (1999) argue that segregation affects spending by facilitating distrust between a community's members and exacerbating the adverse effects of ethnic fragmentation (Alesina and La Ferrara, 2002).[6] Beach and Jones (2017) corroborate this point, reporting that the negative effects of racial fragmentation on public sector spending are magnified within highly segregated communities; here they speculate that concerns over spatial redistribution may underlie this interaction, with policy makers being less supportive of public expenditures that they believe will flow to only certain racial or ethnic groups residing in segregated neighborhoods. Similarly, Trounstine (2016) argues that segregation may exacerbate a municipality's race-based political divisions by reducing the occurrences of regular interactions across racial groups which, otherwise, would help to mitigate feelings of racial intolerance and resentment. Heightened racial divisions along these lines may hinder cooperation and the potential for productive collective action within the jurisdiction's political system, a consequence of which may be reduced levels of locally-financed public spending. Indeed, Trounstine (2016) finds evidence that racial segregation within municipalities correlates with reduced levels of public expenditure. Lastly, a related body of research suggests that racial/ethnic segregation reduces minorities' political strength at the local level, thus making it easier for politicians to deny local public services to segregated minorities (Troesken, 2002; Ananat and Washington, 2009).[7]

Many of the mechanisms through which racial/ethnic segregation is believed to impact local public spending may be applicable to income segregation as well. For example, trust in and sympathy for one's fellow citizens may very well degrade with reduced exposure to households of a different income class. Concerns about spatial redistribution may also be particularly prevalent within jurisdictions that tax income and wealth to finance operations. However, income segregation likely influences spending through direct fiscal channels that are less relevant to other forms of segregation. Not only is income a critical determinant of one's willingness to pay for local public spending regardless of one's race or ethnicity but, as a proxy for wealth, income is a major component of the

[2] See Galor, Moav and Vollrath (2009), Goldin (1998), Goldin and Katz (1999), and Ramcharan (2010).

[3] See Jargowsky (1996), Wheeler and La Jeunesse (2008), Yang and Jargowsky (2006), Watson (2009), and Reardon and Bischoff (2011).

[4] The degree to which income segregation correlates with income inequality is, of course, sensitive to how these respective concepts are measured. Reardon and Bischoff (2011) use a rank-order index and a Gini coefficient to measure income segregation and income inequality, respectively. They find that a 1 standard deviation increase in a metropolitan area's income inequality is associated with a 0.25 standard deviation increase in that area's level of income segregation (pg. 1130). The current study uses alternative measures of income inequality and income segregation that are believed to more consistent with models of local political economy. I discuss these measures in greater detail later in the paper. Here, the correlation between decade-over-decade changes in income segregation and income inequality within a municipality and school district is observed to be 0.21 and 0.24, respectively. See Fig. B1 in the appendix for additional statistics.

[5] Taken together, municipalities and unified school districts accounted for approximately 65 percent of the nation's local public spending in 2012. This figure accounts for all governmental units across the United States classified as municipalities, townships, or school districts in the 2012 Census of Governments. *Source:* 2012 Census of Governments: Finance. Author's calculations.

[6] Alesina and Zhuravskaya (2011) link increased levels of ethnic and linguistic segregation to poorer quality public institutions, arguing that reduced levels of trust between groups in more segregated nations ultimately undermines government quality.

[7] Another paper, by La Ferrara and Mele (2006), addresses the impact that racial segregation has on local public school spending but does *not* observe segregation *within* political jurisdictions with taxing or spending authority (i.e., municipalities and school districts). Rather, they are concerned with studying how segregation across neighborhoods within a metropolitan area influences school district spending.

local tax base and an individual's tax burden. The degree to which income is spatially concentrated within a jurisdiction may therefore influence the formation of coalitions responsive to individuals' income-based preferences in ways that racial/ethnic segregation cannot. Local jurisdictions whose residents (s)elect neighborhood representatives (e.g., city council members) to lobby/vote on their behalf on jurisdiction-wide spending programs may be particularly responsive to income segregation, especially if each representative votes in alignment with their respective neighborhood's median income voter.[8]

If, for example, one's income influences their taste for certain types of local public spending, a simple extension of the public choice model developed by Alesina et al. (1999) suggests that rising income segregation may aggravate disagreements between neighborhood representatives regarding what *types* of jurisdiction-wide investments should be made.[9] Disagreements along these lines are likely to yield reductions in local public spending levels (See Appendix A for a suggestive model.). Alternatively, because income (as a proxy for wealth) is the base upon which local taxes are raised, the distribution of income across space influences the tax price paid by the decisive neighborhood's median voter, with tax prices for a local public good rising continuously with one's own income, all else being equal. If income segregation pushes the lowest income residents into a minority of neighborhoods jurisdiction-wide spending outcomes would likely reflect the higher tax prices paid by the wealthier median voters residing in the majority of neighborhoods (and vice versa).

Note that each of these examples require us to account for *how much* wealthier/poorer one neighborhood's residents are when compared to another's when measuring the magnitude in which a jurisdiction's wealth is spatially concentrated. Unlike race/ethnicity, which are unordered categorical variables, the mechanisms through which income segregation impacts spending will likely be responsive to income's inherent continuity.[10]

In addition to its relevance for the literature citied above, this study also contributes to the body of research investigating the long-term economic effects of residential segregation on disadvantaged groups, particularity children. Works by Cutler and Glaeser (1997), Card and Rothstein (2007), and Ananat (2011) all point to racial segregation as having a disproportionately adverse impact on the outcomes of black youth. Similarly, Chetty et al. (2014) find that low-income children who are raised in more income and/or racially segregated areas are, on average, less upwardly mobile than their less-segregated counterparts. While some of the channels through which segregation likely impacts individuals have been identified, such as adverse neighborhood peer effects (Card and Rothstein, 2007) and reduced access to work opportunities (Kain, 1968; Gobillon et al., 2007), the findings in this study indicate that many of the public services that lower income groups may disproportionally rely on, such as public education and public recreation facilities, are also less likely to receive robust funding in more income segregated communities.

In what follows, Section 2 discusses the measures of income segregation used throughout this analysis and reviews data. Section 3 outlines the main empirical design and discusses the approach for addressing estimation bias resulting from any endogeneity of income segregation. Section 4 presents the main empirical results and robustness checks. The findings point overwhelmingly to income segregation having a large negative impact on core local public services. These findings are robust to the use of instrumental variables and alternative specifications. Section 5 concludes and provides direction for future research.

2. Data

2.1. Measuring income segregation

Throughout this paper, residential income segregation within a jurisdiction is measured using block-group level variation in household population and income, as tabulated by the U.S. Census Bureau.[11] Building off of the discussion above, it is important that any measure of income segregation used in this study be sensitive to the absolute magnitude of spatial income differentials when gauging the geographic concentration of wealth within a jurisdiction; the relative size of these income differences is believed to affect the degree to which there is variation across space in the tastes for local public services. Income's inherent continuity must therefore be accounted for when measuring heterogeneity in the spatial distribution of household incomes. This requirement precludes the use of segregation indexes that ignore the magnitude of spatial income differentials, such as multi-group measures of income segregation that assign households into arbitrary and unordered categorical groups. Similarly, indexes that are insensitive to rank-preserving changes in the spatial income distribution, such as those proposed by Reardon (2011) and Reardon and Bischoff (2011) are also inappropriate in this context.[12]

Two measures of income segregation are used in this study, both of which fully account for the continuity of income. The primary index of income segregation is a Gini coefficient that quantifies the concentration of a jurisdiction's household income within its richest block groups. Summing across a jurisdiction's block groups after sorting them from poorest to richest (w.r.t. mean household income), the Gini simply records how the cumulative share of total household income grows with the cumulative share of total households, with higher values indicating higher levels of income segregation.[13] Panels A and B of Fig. 1 convey

[8] Of course, neighborhoods act collectively in any number of ways, such as being part of an official political sub-jurisdiction (e.g., a city ward), or forming local chambers of commerce/community organizations, etc.

[9] That is, neighborhoods whose median income voter experiences growth in relative wealth will be increasingly at odds with neighborhoods whose median voter experiences flat or declining relative wealth. For instance, one's income may be particularly important for determining support for public spending, regardless of race/ethnicity, when private alternatives exist (see Epple and Romano, 1996).

[10] This suggests that belonging to an income "group" matters only to the degree that it implies being a certain degree more/less wealthier than other groups.

[11] The term "block group" is used out of convenience. As late as 1980, small area statistics for some tracted regions were tabulated using enumeration districts instead of block groups. In these instances, the enumeration district is treated as being equivalent to a block group. Within these census-designated small areas, households are tabulated across as few as 16 income bins (2000-current) to as many as 25 bins (1990). All forms of household income measured by the U.S. Census Bureau are included in these tabulations.Block group tabulations from the 1980–2000 decennial censuses are located in that census' STF3 summary files. Block group tabulations centered around 2010 come from the 2008–12 5yr. American Community Survey (ACS). All block group tabulations, with the exception of those from the 1980 decennial census, are distributed by the Minnesota Population Center (Manson et al., 2017). Small area tabulations from the 1980 decennial census are downloaded directly from the U.S. Census Bureau's FTP website (U.S. Census Bureau, 1982a). Please see official U.S. Census Bureau documentation for additional details concerning sampling techniques and definitions.

[12] Multi-group measures of segregation are perhaps most appropriate when measuring segregation across clearly defined and unordered groups, such as racial or ethnic classes. See Reardon and Firebaugh (2002).

[13] See Appendix C for a discussion of how block groups are mapped to jurisdiction boundaries. In order to construct the Gini coefficient, tabulated households are first assigned an income level corresponding to the median household income for their particular income bin and year, as calculated from a nationwide sample of IPUMS microdata (Ruggles et al., 2017). From here, a block group's aggregate household income is computed. The Gini for the ith jurisdiction (with N block groups) is calculated as $Gini_i = 1 - \sum_{j=1}^{N}(I_{j-1} + I_j)(H_j - H_{j-1})$, where H_j and I_j measures the cumulative share of a jurisdiction's households and household income in the jth-ranked block group (ranked from lowest to highest mean household income), respectively, such that $H_0 = I_0 = 0$ and $H_N = I_N = 1$. Notice that replacing block groups with households in this equation returns a traditional a-spatial Gini coefficient for the jurisdiction, such as that used by Boustan et al. (2013).

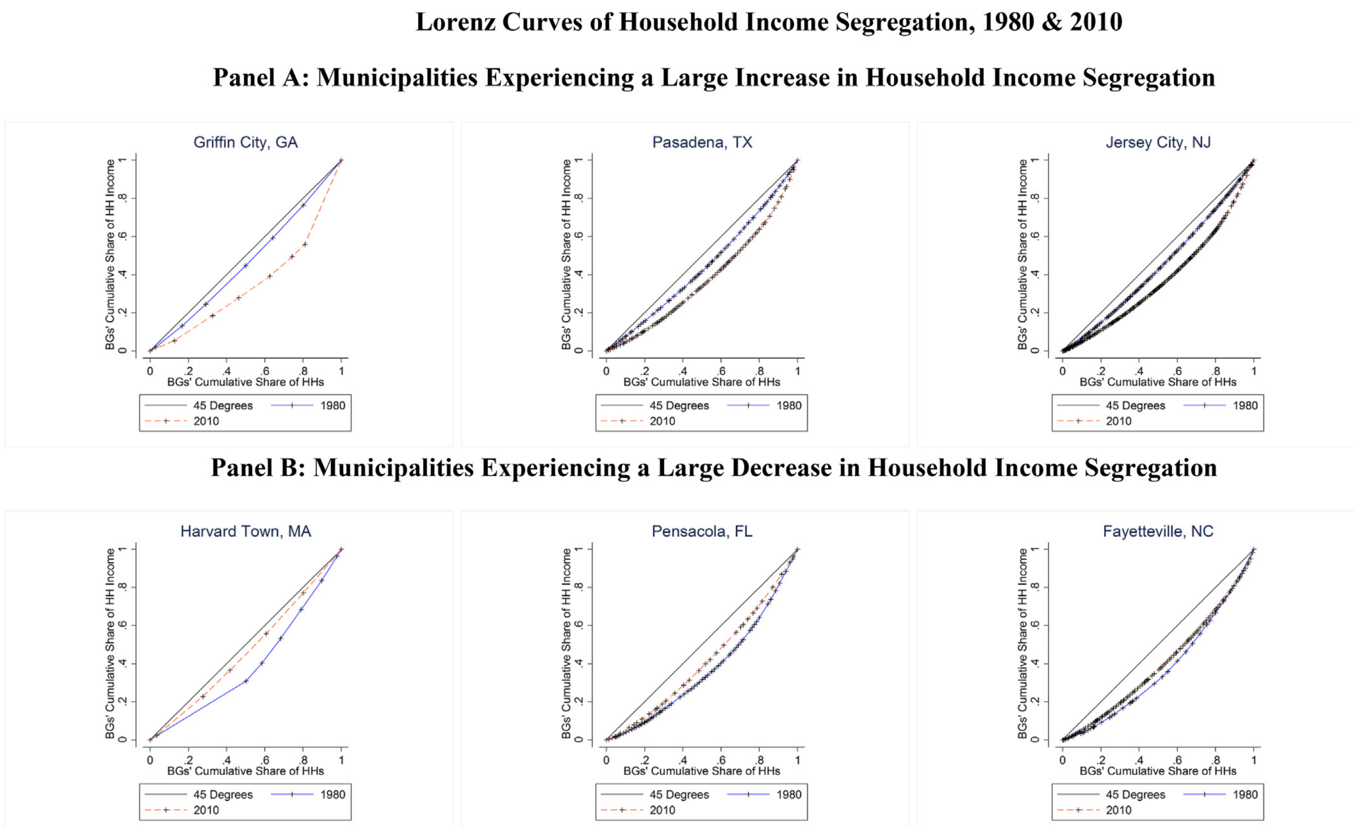

Fig. 1. Lorenz Curves of Household Income Segregation, 1980 & 2010. Lorenz curves are calculated using block group (BG) level household counts and household incomes as described in the text. With the exception of the origin points, the "X" symbol on each figure marks the location of an individual block group within the municipality.

this concept visually with Lorenz curves for municipalities that experienced some of the greatest absolute changes in household income segregation between 1980 and 2010.

Following Rhode and Strumpf (2003), Shorrocks and Wan (2005), and Novotny (2007) the "between" component of Theil's T index for income inequality serves as an alternative measure of income segregation. This index captures the portion of income inequality within a jurisdiction attributable to the average dispersion of incomes *between* block groups and is distinct from the average dispersion of incomes *within* block groups.[14] As is shown in Fig. 2, within-jurisdiction decadal changes of these two measures of income segregation, the Gini and the Theil, track one another quite closely. Because of this, empirical estimates involving the Theil index are largely relegated to a supplemental appendix in order to conserve space.

Descriptive statistics of each income segregation index are presented in Table 1 below. Both indexes reveal a pattern of rapidly rising income segregation over the 1980–2010 timeframe within both municipalities and school districts. Additional patterns not shown here are also worth noting. Over 85% of municipalities and 92% of school districts experienced rising income segregation over the 1980–2010 period, regardless of the income segregation measure used. Using the Gini coefficient, income segregation rose by 43% for the average municipality and 35% for the average school district. These patterns are similar for the Theil index.

Rising income segregation over this period contrasts with contemporaneous declines in racial segregation, as documented by Cutler et al. (1999) and Glaeser and Vigdor (2012). Indeed, within-jurisdiction decadal changes in income segregation are generally uncorrelated with changes in racial segregation. This pattern is consistent with the observation that income segregation is a poor predictor of racial segregation (see Sethi and Somanathan, 2009). A more positive relationship between changes in income segregation and changes in income inequality is observed (see footnote 4 and appendix Fig. B1), which supports the view the rising income inequality is a partial driver of rising income segregation (Watson, 2009; Reardon and Bischoff, 2011). However, these correlations are generally quite small.[15]

2.2. Baseline samples

The baseline samples in Table 1 track individual cities/towns and school districts across each of the four census years from 1980 to 2010. Municipalities are limited to those with at least five full census block groups in each of the four census years, a 1970 population of at least 5,000, at least three block groups in 1970, and whose land area grew or shrank by no more than 10 percent between 1980 and 2010.[16] Because income segregation is measured using block-group variation, the number

[14] The between component for the ith jurisdiction is calculated as $Theil_i = \sum_j s_{ij}\left(\frac{\overline{Y}_{ij}}{\overline{Y}_i}\right) ln\left(\frac{\overline{Y}_{ij}}{\overline{Y}_i}\right)$, where s_{ij} is i's share of households residing in the jth block group and terms $\overline{Y}_i$ and $\overline{Y}_{ij}$ measure average household income in jurisdiction i and block group j, respectively. See Jargowsky (1996), Yang and Jargowsky (2006), and Wheeler and La Jeunesse (2008) for similar measures.

[15] See Fig. B1 in the appendix for these correlations and others.

[16] The requirement of at least three 1970 block groups guarantees that an instrumental variable can be constructed for that observation (see Section 3.1). The land area restriction is designed to facilitate more meaningful longitudinal comparisons, as some municipalities grew their boundaries considerably during this time period. This particular restriction reduces the sample's size considerably and is both relaxed and tightened later on in the analysis. Similar restrictions are placed on the school district sample as well.

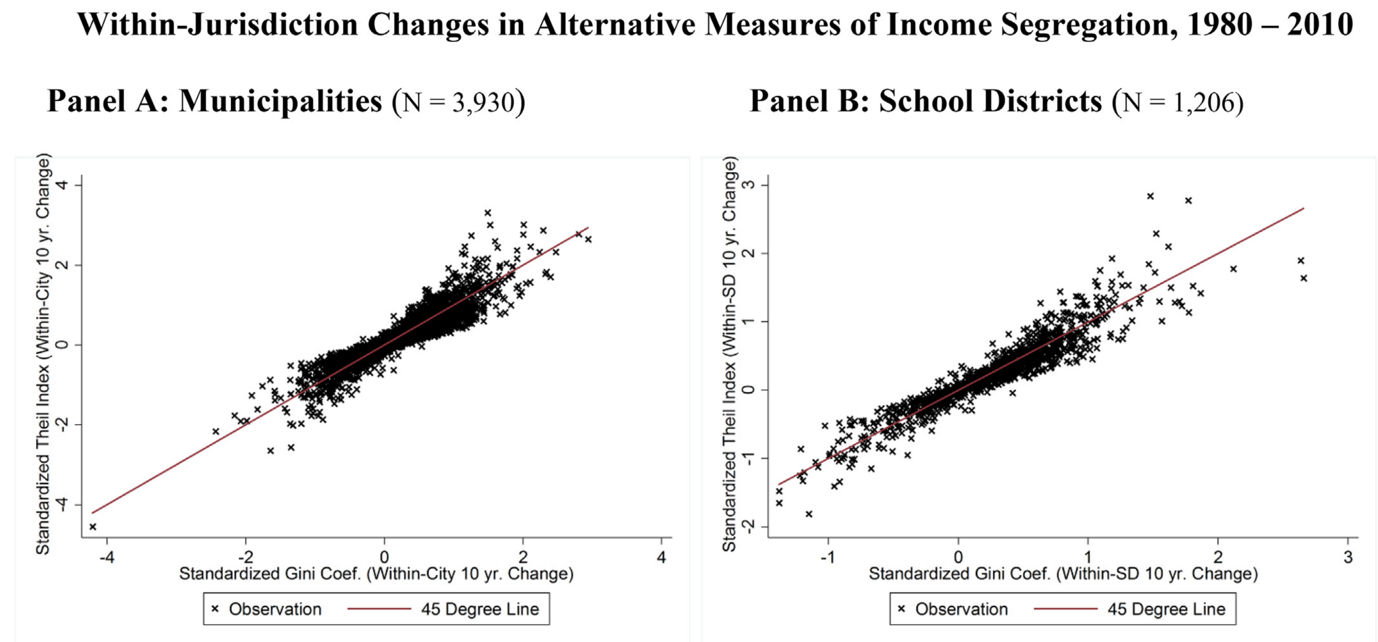

Fig. 2. Within-Jurisdiction Changes in Alternative Measures of Income Segregation, 1980–2010. Decadal changes in the Gini and Theil indexes are measured along the x-axis and y-axis, respectively. For comparability, theses indexes are standardized to have a mean 0 and standard deviations of 1. These standardizations are not used anywhere else in the study. Please see the text for further discussion.

Table 1
Summary statistics for selected variables.

	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
	Panel A: Municipalities (N = 5240)				Panel B: School Districts (N = 1608)			
1980 Levels								
Gini	0.10	0.04	0.02	0.27	0.13	0.04	0.04	0.27
Theil	0.02	0.02	0.00	0.12	0.03	0.02	0.00	0.12
Mean-to-Median Income	1.12	0.08	0.87	1.63	1.13	0.09	0.98	1.45
Exp. Per Capita ($k)	0.58	0.30	0.09	2.89	6.48	1.80	3.44	15.13
Changes (1980–2010)								
Δ Gini	0.03	0.03	−0.14	0.21	0.04	0.03	−0.07	0.15
Δ Theil	0.01	0.02	−0.07	0.13	0.02	0.02	−0.03	0.09
Δ Mean-to-Median Income	0.11	0.12	−0.47	0.60	0.13	0.10	−0.30	0.47
Δ Exp. Per Capita ($k)	0.47	0.32	−0.63	2.39	5.57	2.81	0.35	20.95

All samples constitute balanced panels. The municipality sample tracks 1310 individual cities/towns over four time periods (N = 5240). Municipalities are limited to those fully containing at least five block groups for each of the years 1980–2010, a 1970 population of at least 5,000, having at least three block groups in 1970, and whose land area increased or declined by no more than 10 percent between 1980 and 2010. Municipal expenditures exclude education spending. The school district sample tracks 402 individual unified school districts over four time periods (N = 1608). Independent unified school districts are limited to those fully containing at least five block groups for each of the years 1980–2010, having at least 100 students enrolled in 1970, having at least three block groups in 1970, and whose estimated land area increased or declined by no more than 25 percent between 1980 and 2010. The term "Per-capita" means "per-person" for municipalities and "per-student" for school districts. All dollar values are reported in terms of 2010 dollars. Please see text for further details.

of useful municipalities observed consistently over the 1980–2010 period is somewhat limited, as the U.S. was not fully blocked until 1990. The baseline sample, which is balanced, contains 1310 individual municipalities for the each of four census years for a total of 5240 unique observations. The baseline sample of school district is also balanced and covers the same 1980–2010 period. Districts are limited to those that are independent and unified (i.e., K – 12), contain at least five block groups in each of the four years, have a 1970 enrollment of at least 100 students, contained at least three 1970 block groups, and whose observed land area grew or shrank by no more than 25 percent between 1980 and 2010.[17] As with municipalities, these restrictions are modified later on in the paper. Altogether, the school district sample tracks 402 independent

[17] The land area restriction for school districts is purposefully weaker than that for municipalities (25 percent versus 10 percent) in order to allow for a large enough baseline sample. School district boundaries changed considerably over the 1980–2010 period and imposing a 10 percent land area restriction would have returned a very small baseline sample. See Appendix C for a discussion of the method used to calculate municipality and school district land areas.

unified districts over four periods of time, for a total of 1608 unique observations.

Financial statistics for incorporated cities, towns, and independent unified school districts come from digitized Census of Governments (COG) data for each of the years ending in '2' from 1982 to 2012 (U.S. Census Bureau, 2015). For school districts, which provide a narrower range of services than cities and towns do, the financial statistics of primary interest are total current expenditures and intergovernmental aid received, both measured in per-student terms. For cities and towns, which provide a broader range of services, data on current per-person expenditures, both in the aggregate and for particular uses (e.g., public safety, sanitation, and health and hospitals, etc.) are collected, as is information on non-education intergovernmental aid received. Socio-economic variables are taken from a variety of sources.[18]

An area's level of a-spatial income inequality is measured using its mean-to-median income ratio. This metric carries the advantage of being grounded in standard models of public choice. Notably, under conditions where income or wealth is taxed this ratio can be interpreted as the inverse of the tax price faced by the decisive median voter (Alesina et al., 1999, 2000; Corcoran and Evans, 2010; Meltzer and Richard, 1981). Summary statistics for key variables in the baseline samples are reported in Table 1. While each sample constitutes only a subset of the larger population of local jurisdictions that existed during this timeframe, their characteristics are generally representative of the larger populations.[19]

3. Empirical design

For both municipalities and school districts, the relationship between income segregation and per-capita spending in jurisdiction i during time t is modeled as:

$$lny_{it} = \beta_1 seg_{it}^{inc} + \boldsymbol{x}_{it}\boldsymbol{\beta} + \alpha_{r(i),t} + \alpha_i + tg_i + \varepsilon_{it} \tag{1}$$

where lny_{it} measures the natural logarithm of a particular type of per-capita spending, $\boldsymbol{x}_{it}$ is a vector of time varying co-variates likely to influence per-capita spending, such as income inequality, log median income, log population, and log per-capita intergovernmental aid received; $\alpha_{r(i),t}$ is a time-varying region-by-year fixed effect for i's census region, r, during period t. The term α_i is a jurisdiction-level fixed effect capturing permanent unobserved heterogeneity across areas and g_i is a heterogeneous growth trend unique to i; ε_{it} accounts for unobserved time-varying idiosyncrasies. The variable of primary interest, seg_{it}^{inc}, is one of the two proposed measures of income segregation, Gini or Theil. The parameter β_1 therefore reflects the causal effect of income segregation on per-capita spending.

Unobserved time-invariant cross-jurisdictional variation implicit in α_i is controlled for by taking decade-over-decade first differences of (1). This yields the following estimating equation:

$$\Delta lny_{it} = \beta_1 \Delta seg_{it}^{inc} + \Delta\boldsymbol{x}_{it}\boldsymbol{\beta} + \Delta\alpha_{r(i),t} + g_i + \Delta\varepsilon_{it}, \tag{2}$$

which can be estimated using traditional fixed-effects techniques. Notice that this approach allows the idiosyncratic growth term, g_i, to be controlled for across all jurisdiction, thus neutralizing a major potential source of unobserved variation and bias – fixed jurisdiction-specific growth trends. With the inclusion of region-by-year fixed effects unobserved time-varying regional trends, such as those tied to deindustrialization in the Midwest or growth in the Sunbelt, also become weaker threats to identification.

3.1. Correcting for the endogeneity

Of course, even in light of the strong set of statistical controls discussed above, simple OLS estimates of Eq. (2) are unlikely to return unbiased estimates of income segregation's impact on per-capita spending, as segregation is almost certainly endogenous. For example, per-capita spending on specific services may itself influence income segregation through sorting. Highly localized public services such as parks, public transportation, or public housing may disproportionally attract (or drive out) particular income classes to (from) a neighborhood, thus resulting in increased income segregation. Reductions in local public spending may also promote income segregation if, for example, said reductions incentivize the wealthy to form and locate near self-financed clubs/amenities as an alternative.[20] A failure to account for these and other sources of reverse causality may bias estimates of income segregation's true impact by confounding segregation's response to spending with its impact on spending. Notice that the direction of this potential bias is ambiguous.

Alternatively, unobserved factors that impact public expenditure, such as a community's taste for redistributive spending or the presence of spatially fixed amenities or commercial/industrial activity that influence the tax base, may also be correlated with income segregation. For example, in a closed system where spatial sorting occurs only within jurisdictions, it is not unreasonable to expect that communities with a higher concentration of tax base enhancing commercial/industrial activity also exhibit higher levels of income sorting.

Allowing for interjurisdictional mobility, fiscal sorting in the spirit of Tiebout (1956) suggests that households will move across jurisdictions in order to better align a community's provision of local public services (and taxes) with their own preference ordering, often with an eye towards limiting the level of redistributive payments they will have to make. Evidence also suggests that racial sorting explains much of the suburbanization that occurred in the U.S. after World War II (Boustan, 2010). If interjurisdictional sorting along either of these lines, fiscal or demographic, impacts income segregation within origin and/or destination communities[21] in a way that is correlated with the presence of commercial/industrial activity or tastes for redistributive public spending, then the impact of segregation may be confounded with unobserved variation the community's tax base or in its median voter's preferences. Again, the direction of this potential bias is ambiguous.

To control for these potential sources of endogeneity, I instrument for seg_{it}^{inc} using a shift-share index designed to capture temporal variation in income segregation within a jurisdiction that is independent of reverse causality or spatial sorting. Notably, this instrument predicts the variation in seg_{it}^{inc} that would have occurred if the spatial distribution of family incomes within the jurisdiction did not change after 1970 and 1970

[18] The Minnesota Population Center (Manson et al., 2017) provides all socio-economic data for cities and towns, including tabulations from the 1980–2000 decennial censuses and the 2008–2012 American Community Survey (5-year sample). Data for school districts comes from several sources. Tabulations from the 1980 decennial census are provided by the U.S. Census Bureau (U.S. Census Bureau, 1982b), data from the 2000 census are provided by the U.S. Department of Education (U.S. Census Bureau, 2003), and 2008–2012 American Community Survey data is again provided by Manson (2017). Although the U.S. Department of Education also provides school district tabulations from the 1990 census, this file has contained inaccuracies in the past. Thus, school district data for 1990 is constructed by aggregating block-group level data provided by Manson (2017) up to the level of individual school districts using the same geographic crosswalk used to measure of income segregation. See Appendix C.

[19] See Table B1 in the appendix for summary statistics of considerably larger balanced samples of municipalities and school districts.

[20] See Banzhaf and Walsh (2008, 2013) for models relating exogenous variation in localized public goods to economic and racial segregation. See Diamond (2016), Couture et al. (2020) and Almagro and Domínguez-Iino (2020) for recent research on endogenous amenities and spatial sorting.

[21] See Shertzer and Walsh (2016, 2019) for recent evidence of the effect that in-migrants' settlement patterns, and native residents' subsequent sorting responses, have on racial segregation within a community.

family incomes simply grew every decade in accordance with their national trend, with a different growth rate applied to each income level based on its position along the 1970 income distribution.[22]

In practice, this instrument simply extrapolates the spatial distribution of family incomes from the 1970 census onto future decades.[23] Digitized block-group (and enumeration district) income tabulations from the 1970 census' STF5C file allow me to first determine the spatial distribution of families across 15 income bins (U.S. Census Bureau, 1970a). Using microdata, a nationally representative sample of families from the 1970 census is then used to calculate the percentile range corresponding to each income bin based on its upper and lower bound.[24] For each subsequent decade, 1970 families are then assigned the income level that corresponds to the median income of their respective income bin's percentile range for that year. By anchoring a jurisdiction's spatial distribution of family incomes to its lagged 1970 level and then simulating future distributions by allowing these 1970 values to evolve over time only in accordance with a-spatial nationwide trends, the temporal variation in the simulated distributions should be independent of spatial sorting at the local level as well as contemporary sources of reverse causality between public sector spending and income segregation. Instruments are developed by simply applying the appropriate formulas for the Gini and Theil indexes to the simulated block-group level income distributions.[25]

Because incomes falling along the highest end of the income distribution have typically experienced some of the highest rates of growth since 1970, cities whose wealthiest families were more unevenly distributed across block-groups in 1970 are likely to experience the greatest increases in simulated income segregation over time. Of course, there must be a sufficient amount of "stickiness" in a jurisdiction's spatial distribution of incomes in order for this type of instrument to have much strength. While observed patterns of gentrification and neighborhood change in large central cities suggests that the assumption of pure neighborhood stickiness is quite strong, housing's general durability as well as the spatial fixedness of many amenities and infrastructure investments give reason to believe that many neighborhood's that were relatively wealthy in 1970 are likely still relatively well-off today, as are those that were middle class and lower income in 1970.[26]

Indeed, the instruments constructed for each sample are very strong predictors of the temporal variation in income segregation occurring within jurisdictions. To see this, Panels A and B of Fig. 3 plot out the conditional first-stage relationship between decadal changes in the Gini index of income segregation and decadal changes in its instrument for municipalities and school districts, respectively. In both cases, changes in the instrument track closely with changes in income segregation. The first-stage coefficients reported in Panel A and Panel B are 1.006 and 1.224, respectively and the F-statistic for each excluded instrument indicates a strong first-stage (Panel A: F = 89.1; Panel B: F = 59.7). Altogether, these patterns suggest that much of the temporal variation in a community's spatial income distribution can be explained by changes in the nationwide family income distribution interacted with pre-existing spatial patterns. A more complete set of first-stage statistics is provided in appendix Table B2.

Alternative instruments built up from 1960 tract-level family income distributions supplement the 1970 block-group level instruments. With the exception of their reliance on census tracts, these 1960 instruments are constructed in nearly identical fashion to their 1970 block-group counterparts. Because these 1960 instruments are grounded in a deeper temporal lag they offer the advantage of being arguably more likely to satisfy the necessary exclusion restriction; the spatial distribution of 1960 family incomes is less likely than the 1970 distribution to influence the future growth trajectory of local public spending. However, drawbacks include fewer observations and, due to tracts' broader geographic coverage, noisier instruments.[27]

4. Results

OLS estimates for municipalities and unified school districts are provided in Table 2. Due to the potential endogeneity of segregation, these estimates should be interpreted with a bit of caution. Still, it is worthwhile noting that across all columns the estimated coefficients for income segregation are negative and statistically precise. Higher levels of income segregation do appear to be associated with lower levels of per-capita spending. These estimates remain relatively stable as additional covariates are added to the model (moving left to right). This is reassuring in that it suggests omitted variables are perhaps unlikely to be a major source of estimation bias on their own. The coefficient estimates for the mean-to-median income ratio also corroborate the view that decisive (median) voters respond to lower tax prices by broadening their support for a more expansive local government (Metlzer and Richard, 1981). Although these estimates lose precision with the inclusion of jurisdiction-level fixed effects, these findings are generally consistent with earlier estimates provided by Corcoran and Evans (2010) and

[22] Notice that the lagged distribution of *family* incomes is used to predict the distribution of *household* income. One problem with relying on the 1970 household income distribution to simulate household income segregation for later years is that the 1970 Census tabulates households across only eight income bins. All later censuses (and the American Community Survey) allowed for far more variation in household incomes (a minimum of 15 bins). Information on the 1970 household income distribution is therefore relatively coarse which, in turn, weakens the instrument. For reasons that are unclear, the 1970 Census does tabulate families across 15 income bins, thus allowing for a better instrument. More importantly, the 1970 Census tabulates household incomes for only relatively large units of geography (tracts+) and not for geographically fine block groups and enumeration districts, which are the primary geographic units used to construct measures of income segregation in this study. However, family income tabulations (across 15 income bins) for block-groups and enumeration districts are available for the 1970 Census, as are income tabulations for primary individuals.

[23] To qualify for the baseline sample, jurisdictions must have contained at least three full blocks groups in 1970.

[24] The 1970 STF5C file (U.S. Census Bureau, 1970a) is distributed by the National Archives and Records Administration. Go to https://www.archives.gov/research/census/1970-statistics for further details. Microdata is provided by (Ruggles et al. (2017)).

[25] For example, the second-highest income bin from the 1970 census includes families reporting annual incomes between $1000 and $1,999, which corresponds to the 2.3rd and 5.6th percentile of the 1970 family income distribution. The median income for families within the 2.3rd and 5.6th percentile of the 1980 U.S. income distribution was $3110 (up from $1450 in 1970). This shift-share approach to simulating the local income distribution mirrors that of Boustan et al. (2013), although I rely on 1970 block-group level income distributions in place of a-spatial citywide distributions.

[26] The high degree of stickiness in a neighborhood's relative income is evident in the data. Ranking a jurisdiction's census tracts by median household income for the years 1970 and 2010 (with separate rankings for each jurisdiction) and regressing a tract's 2010 percentile rank onto its 1970 percentile rank, while controlling for jurisdiction-level fixed effects, returns a conditional rank-rank correlation coefficient of 0.532 (with a jurisdiction-level clustered standard error of 0.022). A one percentage point increase in a tract's 1970 position along the household income distribution corresponds to a 0.532 percentage point increase in its 2010 position. This suggests a considerable level of persistence in a tract's relative position over a 40 year timespan. To better frame this observation, Chetty et al. (2014) estimate a rank-rank coefficient of 0.341 for the relative rate of intergenerational mobility within the U.S (across a narrower window of time, 1996–2000 to 2011–2012). The persistence in relative income appears to be greater for neighborhoods than it is for families. Jurisdictions are limited to cities from the baseline sample that could be matched to the longitudinal census tract data provided by Logan et al. (2014) and having at least five census tracts. N = 15,374. Full estimates are available upon request.

[27] See Appendix C for a discussion of how 1960 census tracts are assigned to jurisdictions.

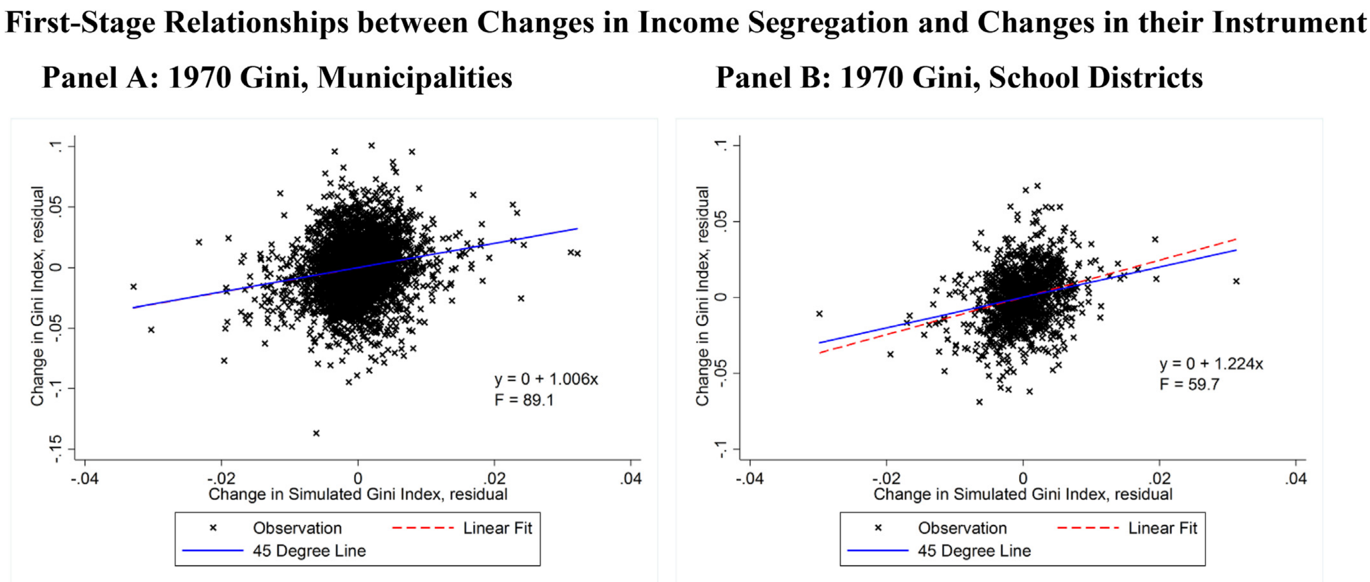

Fig. 3. First-Stage Relationships between Changes in Income Segregation and Changes in their Instrument. Plotted points measure residuals from a first-stage regression of the variable measured along the axis onto all of the covariates included in Eq. (2). Please see the text for further details. Coefficient estimates and F-statistic for the excluded instrument (taken from first-stage of 2SLS regression) are reported. See Table B2 in the appendix for a complete set of first-stage estimates.

Table 2
OLS estimates of local public expenditures, 1980–2010.

	Panel A: Municipalities (N = 3930)			Panel B: School Districts (N = 1206)		
	[a]	[b]	[c]	[d]	[e]	[f]
Δ Income Segregation (Gini)	−0.580***	−0.381**	−0.452**	−0.335**	−0.258*	−0.561***
	[0.172]	[0.167]	[0.190]	[0.160]	[0.150]	[0.169]
Δ Mean-to-Median Inc.		0.142***	0.115*		0.199***	0.084
		[0.049]	[0.060]		[0.047]	[0.057]
Adj. R^2	0.17	0.24	0.26	0.66	0.69	0.76
Additional RHS	No	Yes	Yes	No	Yes	Yes
City-Level FEs (trend)	No	No	Yes	No	No	Yes
Region-by-Year FEs	Yes	Yes	Yes	Yes	Yes	Yes

All values reflect OLS estimates of Eq. (2). The dependent variable is log(per-person expenditures) and log(per-student expenditures) for municipalities and school districts, respectively. Municipal expenditures account for all non-education general expenditures as defined by the Census of Governments. Additional right-hand-side controls included in the equations (when indicated) but not reported here include log(population) (or log(# students) for school districts), log(median household income), population share black, population share Hispanic, adult share age 65+, the black-white dissimilarity index, and the log of per-person or per-student inter-governmental aid received. For municipalities, only intergovernmental aid for non-educational purposes is included. Standard errors are clustered at the level of individual municipality and are reported in brackets. See text for further details. ***$p \leq 0.01$, **$p \leq 0.05$, *$p \leq 0.1$.

Table 3
IV estimates of local public sector expenditures, 1980–2010.

	Panel A: Municipalities				Panel B: School Districts			
	1970 IV (N = 3930)		1960 IV (N = 2943)		1970 IV (N = 1206)		1960 IV (N = 1104)	
	[a]	[b]	[c]	[d]	[e]	[f]	[g]	[h]
Δ Income Segregation (Gini)	−1.785***	−3.101***	−1.871**	−2.703**	−1.757***	−2.519***	−2.103***	−3.093***
	[0.650]	[0.942]	[0.768]	[1.145]	[0.512]	[0.689]	[0.566]	[0.811]
Δ Mean-to-Median Inc.		0.314***		0.340***		0.234***		0.311***
		[0.097]		[0.122]		[0.087]		[0.098]
First-Stage F-Stat.	166.8	89.1	106.9	60.1	89.4	59.7	65.1	37.7
Additional RHS	No	Yes	No	Yes	No	Yes	No	Yes
City-Level FEs (trend)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region-by-Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

All values reflect 2SLS estimates of Eq. (2) using instruments discussed in the text. The dependent variable is log(per-person expenditures) and log(per-student expenditures) for municipalities and school districts, respectively. Municipal expenditures account for all non-education general expenditures as defined by the Census of Governments. Additional right-hand-side controls included in the equations (when indicated) but not reported here include log(population) (or log(# students) for school districts), log(median household income), population share black, population share Hispanic, adult share age 65+, the black-white dissimilarity index, and the log of per-person or per-student inter-governmental aid received. For municipalities, only inter-governmental aid for non-educational purposes is included. Additional first-stage and second-stage estimates are provided in tables B2 and B3 of the appendix, respectively. Standard errors are clustered at the level of individual jurisdiction and are reported in brackets. See text for further details. ***$p \leq 0.01$, **$p \leq 0.05$, *$p \leq 0.1$.

Boustan et al. (2013). All in all, the local public sector appears to respond considerably differently to rising income segregation than it does to rising income inequality. The potential implications of this divergence are examined more thoroughly below.

Turning to the IV estimates reported in Table 3, income segregation does appear to have a strong negative impact on municipal spending. These estimates are considerably larger in magnitude than those reported in Table 2, thus supporting the view that sorting within and between jurisdictions is a potentially major source of upward bias in the OLS estimates. As discussed above, this is consistent with scenarios where public spending incentivizes income sorting. Alternatively, this could be explained if increased income sorting through either intra-interjurisdictional mobility was associated with an unobserved rise in the community's tax base, perhaps due to increased commercial or industrial activity. This observation is also in line with other studies into the causal impact of demographic characteristics on local public spending when spatial sorting is potentially confounding (see Boustan et al., 2013; Ananat and Washington, 2009; Figlio and Fletcher, 2012). Alternative explanations, such as the instrument's ability to correct for measurement error, are also plausible.[28]

Notice also that income segregation's impact on expenditures is considerably more pronounced when the control for a-spatial income inequality, the mean-to-median income ratio, is included as a covariate. This likely reflects the IV's conditional exogeneity (conditional on the mean-to-median ratio) since both the mean-to-median income ratio and the IV likely rise with a widening of the nationwide income distribution. The estimates presented columns [b], [d], [f], and [h] of Table 3 are therefore likely to most accurately reflect the causal impact of income segregation.

To the extent that these IV estimates can be interpreted as causal, they suggest that the average increase in city/town income segregation from 1980 to 2010 caused a $56 real decline in per-capita municipal spending.[29] Real growth in per-capita expenditures over this timeframe would therefore have been approximately 12 percent higher on average had it not been for income segregation's rise; 2010 per-capita expenditures would have been just above 5 percent higher. Estimates derived from the 1960 tract-based instruments corroborate these results. Income segregation appears to have a considerable downward effect on school district spending as well, as reported in columns [e] and [f] of Table 3. Rising income segregation between 1980 and 2010 is estimated to have reduced real per-pupil spending by an average of $600. This translates to a real per-capita expenditure growth rate that would have been 11 percent higher had it not been for rising income segregation. Average 2010 per-pupil expenditures would therefore be about 5 percent higher. The 1960 tract-based instruments presented in rows [g] and [h] are quite similar. Altogether, these findings strongly support the hypothesis that rising income segregation places downward pressure on local public spending.

At this point it is worthwhile revisiting the role of a-spatial income inequality, as measured by the mean-to-median income ratio, and how it interacts with income segregation in the present context. The IV estimates presented in Table 2 clearly point to a strong positive association between a-spatial income inequality and public spending, which is consistent with the theoretical and empirical local public finance literature to date. However, a widening income distribution also appears to contribute to rising income segregation. Income inequality therefore influences local public spending through at least these two channels: the median voter's tax prices and income segregation. These two channels, however, have opposing effects. Indeed, over the 1980–2010 period the negative effect of rising income segregation on public spending overwhelms considerably the positive impact of rising a-spatial inequality (by a nearly 3-to-1 ratio). This emphasizes the need to take a fuller accounting of the various channels through which a widening income distribution may influence local public finances. Studies that focus exclusively on the role a-spatial income inequality may be overlooking a critical input into local spending decisions: income segregation. For example, Boustan et al. (2013) predict that growth in per-capita municipal spending over the 1970–2000 period would have been 22 percent lower had it not been for rising a-spatial income inequality over that same timeframe. Similarly, Corcoran & Evans (2010) estimate that per-pupil education expenditures would have grown 12 to 22 percent slower over the 1970 to 2000 period if it had not for rising income inequality. The estimates presented here suggest that rising income segregation may act as a considerable counterweight to these fiscal effects of a widening income distribution.

Table 4 reports the main results from a series of robustness checks where alternative samples and specifications are used to re-estimate models similar to Eq. (2). Row [a] of Table 4 establishes a point of reference by re-publishing the baseline IV estimates of income segregation's impact, β_1, taken from columns [b] and [f] of Table 3, respectively. Subsequent rows then report estimates of β_1 after introducing the change (vis-à-vis the baseline) summarized in that row's header. For example, Row [b] provides estimates after introducing outlier observations back into the sample. This includes all observations where the decadal change in per-capita spending fell within the top or bottom percentile. Rows [c] – [e] address lingering concerns that rising income segregation may be positively correlated with unobserved increases in a-spatial income inequality through growth in the upper tail of the community's income distribution. Any unobserved growth in upper-tail incomes may increase the local tax base or reduce the median voter's tax price in a way that is correlated with income segregation, thus resulting in upwardly biased estimates of income segregation's true impact. Row [c] adds the log of the 75th percentile of household income as an additional control for income. Row [d] simply replaces the log of median household income with the log of mean household income, whereas row [e] expands upon row [d] by including a 4th-order polynomial of the log of mean household income. There is generally little evidence presented in these rows to suggest that the baseline estimates are overly biased from unobserved growth in high incomes. However, the estimates presented in row [e] for municipalities

Table 4
Alternative IV estimates of local public sector expenditures, 1980–2010.

	Municipalities	School Districts
[a] Baseline	−3.101***	−2.519***
	[0.942]	[0.689]
[b] Add Outliers (N = 4104; 1275)	−3.215***	−2.673***
	[0.959]	[0.825]
[c] Add log(75th Ptile. Inc.)	−3.211***	−2.638***
	[1.001]	[0.720]
[d] Use log(Mean Inc.)	−3.091***	−2.532***
	[0.940]	[0.687]
[e] Use log(mean Inc.) 4th-order Poly.	−4.902***	−2.749***
	[1.443]	[1.026]
[f] No %Δ Area Limit (N = 6066. 2658)	−4.146***	−2.782***
	[0.908]	[0.607]
[g] Limit to |%Δ Area| ≤ 5% (N = 3690; 513)	−2.661***	−2.963***
	[0.917]	[0.909]
[h] Add 1970 Gini by Year	−2.551**	−1.710***
	[1.164]	[0.635]

The first line of each cell reports the estimate of the coefficient for income segregation from Eq. (2). The dependent variable is log(per-person expenditures) and log(per-student expenditures) for municipalities and school districts, respectively. All right-hand-side variables, including jurisdiction-level fixed effects and region-by-year fixed effects are included. All samples are balanced. N = 3930 for municipalities and N = 1206 for school districts unless noted otherwise in the row header. Standard errors are clustered at the level of individual jurisdiction and are reported in brackets. See notes to Table 3 and text for further details. ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.1.

[28] See Logan et al. (2018) and Reardon et al. (2018) regarding the potential for bias in sample-based estimates of income segregation.

[29] All calculations are based on the statistics summarized in Table 1 and the estimates presented in columns [b] and [f] of Table 3.

indicate that this type of confoundedness cannot be ruled out entirely. Still, the estimates for income segregation remain negative, large, and statistically precise within each of these rows, thus reinforcing the evidence of income segregation's negative effect of local public expenditures.

Rows [f] and [g] relax and tighten the land area sample restriction, respectively. If, for example, changes in a jurisdiction's land area impacted the per-capita cost of services and changes in land area were also correlated with simulated changes in income segregation, then the IV estimates could be biased. This could occur if, for example, a jurisdiction's initial level of income segregation influenced its future annexation decisions. Row [f] addresses this by eliminating the land area restriction entirely from the balanced samples; these larger samples are summarized in Panel A of Table B1 in the appendix. Row [g] tightens the land area restriction considerably for both municipalities and school districts, requiring that the observed increase or decrease in land area between 1980 and 2010 be no more than five percent. Altogether, varying these restrictions has little impact on the estimates' general interpretation; however, the municipality estimates do appear to be more sensitive to how much land area is allowed to change. This is perhaps because the per-capita cost of certain municipal services, such as sewers and roads, are more sensitive to population density.[30]

The last row of Table 4, [h], further addresses the concern that the shift-share instrument itself may violate the critical exclusion restriction. One could argue, for example, that a municipality's *level* of income segregation in 1970 set off a series of unobserved events that explain *future changes* in that city or town's per-capita spending. Because these unobserved events would also be correlated with the instrument (via the 1970 distribution) they could be driving the IV results.[31] To test for this possibility, Row [h] introduces 1970 income segregation-by-year effects into the model. These terms effectively control for any unobserved time-varying influence that 1970 income segregation levels have on future changes in per-capita spending. The estimates reported in [h] do not deviate much from those provided in [a], suggesting that the IV approach adopted here has successfully identified exogenous variation in income segregation.[32]

Altogether, the values reported in Rows [b] – [h] suggest that the model's baseline IV estimates are relatively robust to the composition of the sample as well as to a host of potentially confounding unobservables. Income segregation's estimated effect does vary from row to row but the estimates are nearly all negative, large in magnitude, and statistically precise. These patterns are therefore reassuring in that they point to only weak influence of model misspecification or omitted variables. Income segregation appears to have a negative impact on per-capita spending across wide variety of assumptions.

Municipalities provide a broad range of services so it is useful to decompose income segregation's impact across separate spending categories. Table 5 reports estimates of Eq. (2) across six types of local public service. Because municipalities vary in the services that they provide, only those reporting positive expenditures on a particular service in each of the four census years from 1980 to 2010 are included in that service's sample. This restriction helps to assure that the municipalities reflected in a given set of estimates are relatively comparable. For reference, row [a] of Table 5 re-publishes column [b] of Table 3. With the exception of

Table 5
IV estimates of municipal expenditures by service type, 1980–2010.

[a] Baseline (N = 3930)	−3.101***
	[0.942]
[b] Public Safety (N = 3834)	−0.607
	[1.548]
[c] Transportation (N = 3864)	−4.863**
	[2.137]
[d] Water + Sewer (N = 3129)	−5.672*
	[3.333]
[e] Solid Waste Mgmt. (N = 2856)	−9.313*
	[5.563]
[f] Low Income Assistance (N = 2790)	−1.38
	[6.653]
[g] Parks + Recreation (N = 3666)	−7.671***
	[2.675]

The first line of each cell reports the estimate of the coefficient for income segregation from Eq. (2). The dependent variable is log(per-person expenditures) for a particular service type. Public safety expenditures include those for police, fire, and corrections. Transportation spending includes transit subsidies and highway expenditures. Low income assistance expenditures include those for health and hospitals, housing and community development, and welfare payments. All right-hand-side variables, including jurisdiction-level fixed effects and region-by-year fixed effects are included. The size of each balanced sample is noted in the row header. Standard errors are clustered at the level of individual municipality and are reported in brackets. See note to Table 3 and text for further details. $^{***}p \leq 0.01$, $^{**}p \leq 0.05$, $^{*}p \leq 0.1$.

public safety, which bulks large in most municipal budgets, income segregation's negative effect on spending appears to be distributed broadly across service categories. Notice, however, that the geographic distribution of service reductions is unknown, which is certainly a topic that warrants further investigation in the future.

Lastly, it is natural to inquire about the sources of revenue that fund local government spending and how these revenue streams themselves respond to rising income segregation. Presumably, reduced support for local public expenditure translates directly to declines in revenues. However, more nuanced aspects of this relationship, such as the responsiveness of intergovernmental aid to changing income segregation, require attention. The types of local government studied here, municipalities and school districts, rely heavily on the property tax to finance their operations; within the baseline samples an average of 41.3% of municipal revenues and 48.3% of school district revenues come from the property tax. The next largest funding source is intergovernmental aid (24.3% for municipalities and 43.9% for school districts). Other major sources of revenue, such as sales taxes and user fees, account for smaller shares. Of these revenue sources, the property tax is arguably the most responsive to the local political mechanisms linking income segregation to public spending, as it provides a considerable share of own-source revenues and is a very salient base from which redistributive local spending is financed (Cabral and Hoxby, 2012). Intergovernmental aid may also respond to changes in income segregation if, for instance, the aid is conditional on local spending levels, such as with federal matching grants. In cases such as these, it is reasonable to expect intergovernmental aid to decline with rising income segregation. Matching grants will naturally decline as self-financed expenditures shrink. Other forms of intergovernmental aid, such as state aid for school finance equalization, may be less directly responsive to income segregation if they are based on a pre-determined formula that mostly ignore issues related to income segregation. For example, state aid for school finance equalization is largely determined by a district's per-pupil property tax base (Hoxby, 2001).

Table 6 documents IV estimates of Eq. (2) for municipalities using the

[30] See Holcombe and Williams (2008), Hortas-Rico and Solé-Ollé (2010), De Duren and Compeán (2016), and Ahlfeldt and Pietrostefani (2019) for recent research on this subject.

[31] See Figlio and Fletcher (2012) and Bouston et al. (2013) for similar approaches to addressing this concern within a panel framework. Jaeger, Ruist and Stuhler (2018) and Borusyak et al. (2018) provide formal treatments of this problem. See also Jaeger et al. (2020) and Goldsmith-Pinkham, Sorkin and Swift (2020).

[32] The first-stage estimates underlying the values reported in [h] also retain considerable predictive power. These estimates are available upon request.

Table 6
IV estimates of municipal revenues, 1980–2010.

	Total Revenue		Property Tax Revenue		IG Aid
	[a]	[b]	[c]	[d]	[e]
Δ Income Segregation (Gini)	−2.720***	−4.628***	−2.824**	−3.164**	−8.652***
	[0.860]	[1.069]	[1.414]	[1.428]	[2.464]
Δ Mean-to-Median Inc.	0.289***	0.584***	0.464***	0.517***	1.337***
		[0.118]	[0.162]	[0.161]	[0.270]
Δ log(IG Aid)	0.220***		0.037**		
	[0.017]		[0.019]		
N	3930		3875		3930

All values reflect 2SLS estimates of Eq. (2) using balanced samples. The dependent variable is the log of the per-person revenue source identified in the column header. All right-hand-side variables, including jurisdiction-level fixed effects and region-by-year fixed effects are included. Standard errors are clustered at the level of individual municipality and are reported in brackets. See notes to Table 3 and text for further details. ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.1.

log of per-capita total revenues, per-capita property tax receipts, or per-capita total intergovernmental aid received as dependent variables.[33] Table 7 provides the same set of estimates for school districts. Estimates of income segregation's impact on total revenues are summarized in columns [a] and [b] and closely mirror the estimates presented in Table 3 in sign, magnitude, and precision. This is not unexpected given that most local governments are subject to balanced budget constraints requiring them to closely align expenditures with revenues. The estimates for property tax collections summarized in columns [c] and [d] are also quite similar. Given that the property tax constitutes the main type of own-source revenues for municipalities and school districts, these estimates point to the property tax as a major channel through which local government spending likely responds to changing income segregation.[34] Turning to column [e] of Table 6, income segregation's negative impact on municipal intergovernmental aid is consistent with the view that weakened support for locally-financed spending reduces the level of external aid that is available through matching grants. This of course magnifies the downward pressure that income segregation has on overall revenues, as is evident in column [b] of Table 6 (which allows intergovernmental aid to vary with income segregation).

Returning to Table 7, the strong negative relationship between school district property tax collections and intergovernmental aid is of particular interest, as it points to outside aid's role as an important fiscal offset for districts with low property tax collections. This is consistent with the literature on state equalization financing (Hoxby, 2001; Card and Payne, 2002). However, income segregation's estimated impact on property taxes is relatively insensitive to the inclusion of intergovernmental aid as a covariate, suggesting that income segregation and outside aid are largely uncorrelated. Column [e] makes this point more explicitly. Intergovernmental aid appears to provide very little to offset changes in districts' own-source revenues resulting from rising or falling income segregation. This supports the idea that pre-determined formulas determining intergovernmental aid to school districts are generally insensitive to income sorting within districts. In this regard, income segregation has a potentially more potent overall impact on school districts' finances when compared to a-spatial income inequality, as the direct effect of the latter is more likely to be at least partially offset by state aid intended to equalize school district finances.[35]

Table 7
IV estimates of school district revenues, 1980–2010.

	Total Revenue		Property Tax Revenue		IG Aid
	[a]	[b]	[c]	[a]	[e]
Δ Income Segregation (Gini)	−2.942***	−3.109***	−3.760***	−3.297**	−1.41
	[0.684]	[0.719]	[1.378]	[1.468]	[2.251]
Δ Mean-to-Median Inc.	0.380***	0.368***	0.541***	0.574***	−0.099
	[0.089]	[0.091]	[0.162]	[0.188]	[0.261]
Δ log(IG Aid)	0.118***		−0.328***		
	[0.019]		[0.029]		
N	1206		1206		1206

All values reflect 2SLS estimates of Eq. (2) using balanced samples. The dependent variable is the log of the per-student revenue source identified in the column header. All right-hand-side variables, including jurisdiction-level fixed effects and region-by-year fixed effects are included. Standard errors are clustered at the level of individual municipality and are reported in brackets. See notes to Table 3 and text for further details. ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.1.

5. Conclusion

Income inequality's rapid rise in the United States since 1980 is well documented (Piketty and Saez, 2003; Piketty, 2014), as are some of its potential consequences (Bouston et al., 2013; Corak, 2013; Pickett and Wilkinson, 2015). Another aspect of the income distribution that changed considerably over this timeframe, but which has received far less attention, is the manner in which communities' households are distributed across space by income class. Notably, metropolitan areas have become increasingly income segregated since 1980 (Reardon and Bischoff., 2011; Bischoff and Rearden, 2014), as have local political jurisdictions such as the municipalities and school districts documented above. Although some observers have speculated on income segregation's societal impact, the causal effects of this growing source of social stratification have been largely overlooked in the empirical research to date.

Using block-group level variation in the household income distribution from 1980 to 2010, this paper documents the rapid rise of household

33 For the property tax regressions, the samples used are balanced subsets of the baseline sample whose estimates are presented in Table 3, with the added restriction being that the local units of government must report positive property tax revenues for each of the four sample years.

34 Similar regressions using per-capita sales tax collections and per-capita fees collected yield much weaker results, all lacking in statistical precision. These estimates are available upon request.

35 The forces most often associated with rising a-spatial income inequality, i.e., growth in the upper tail of a community's income distribution, have the effect of increasing a community's average income and, consequently, are more directly accounted for in the equalization formulas many states use to determine aid to school districts. Because equalization programs work to transfer resources from high average wealth jurisdictions to those with lower average wealth, formulas determining state aid are likely to (partially) offset any income inequality induced changes in own-source revenues. For example, the estimates provided here suggest that school districts exhibiting relatively low levels a-spatial income inequality (i.e., a mean-to-median income ratio close to one) may be less inclined to tax themselves in order to fund local public education services but, by virtue of having relatively low mean income, they may receive higher levels of state aid (and vice versa). Boustan et al. (2013) provide evidence of this offsetting effect for school districts. However, it appears that the fiscal effects of income segregation are not subject to this same type of countervailing mechanism, most likely because the forces determining income segregation do not enter as directly into formulas determining intergovernmental aid.

income segregation within two important forms of local government in the United States: municipalities and independent unified school districts. When combined with data on local public expenditures, rising income segregation within these jurisdictions is shown to have a large and negative impact on the size of local government, measured as the local public sector's level of per-capita spending. All else being equal, the general rise in income segregation over the 1980–2010 period is estimated to have reduced growth in municipal and school district spending by approximately 12 percent and 11 percent, respectively. These effects offset a considerable portion of the increase in local public sector size that researchers have recently attributed to growth in local income inequality.

Spending reductions within municipalities appear to be driven by lost revenues from the property tax and intergovernmental aid, while reductions within school districts are driven only by lost property tax collections. Although the estimates reported above are based on observed spatial variation in local distributions of money income, spatial heterogeneity in other unobserved factors that enter into the household budget, such as the cost-of-living and receipt of in-kind governmental transfers, are also likely to influence the segregation of broader well-being within a community. While it has been argued that a more thorough accounting of these factors likely narrows the distribution of household living standards and well-being (Burkhauser et al., 2012; Kaestner and Lubotsky, 2016), it is unclear how such an accounting would impact changes in local income segregation over time. I leave it to future inquires to investigate this issue more fully.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

A Appendix. A Simple Model Income Segregation and Local Political Economy

The following stylized model formalizes some of the economic rationale for income segregation's impact on local public spending discussed in the text. This model is only intended to be suggestive.

Setting aside for the moment the issues of space and segregation, the ith individual's utility function is assumed to take the following quasi-linear form:

$$u_i = u(q, c_i; \theta_i, \alpha) = \frac{q^\alpha}{e^{\theta_i}} + c_i, \quad 0 < \alpha < 1, \tag{A1}$$

where q is the quantity of local public service consumed (measured at cost) and c_i measures private consumption. Here, the parameter $\theta_i \in [0, \infty]$ measures the absolute distance between i's preferred type of local public service bundle and the type actually consumed, with higher values of θ_i corresponding to a poorer match.[36] An individual's budget constraint balances the cost of private consumption against local public taxation:

$$y_i = c_i + T_i,$$

where T_i is i's unique tax burden. Because q is measured at cost, a balanced public sector budget requires that $q = \sum_{i=1}^{N} T_i$ where N indexes for the total number of tax-paying individuals. Assuming all individuals pay the same lump sum tax $q = NT_i \Rightarrow T_i = \frac{q}{N}$. This simply states the each individual faces a tax burden equivalent to their share of the public service's overall cost. Substituting this into the constraint yields:

$$y_i = c_i + \frac{1}{N} q, \tag{A2}$$

where $\frac{1}{N}$ is simply the ith individual's tax price (i.e., the tax i pays for \$1 of q consumed). Rearranging (A2) and substituting back into (A1) returns the following objective function:

$$u_i = \frac{q^\alpha}{e^{\theta_i}} + y_i - \frac{1}{N} q, \tag{A3}$$

which the ith individual seeks to maximize by voting for their optimal quantity of local public good, q_i. This maximization problem implies that individuals decide on q_i only after considering taxation's impact on their budget and the degree to which the type of public service bundle provided deviates from their preferred bundle.

To see the influence of the θ_i parameter in more useful detail we define the various types of potential service bundles along a continuum, x, and treat the ith individual's optimal service bundle, x_i, as an increasing function of their income, such that $x_i = x(y_i)$ and $\frac{dx_i}{dy_i} > 0$. Defining X as the service bundle actually provided by the local jurisdiction allows θ_i to be restated as $\theta_i = |X - x(y_i)|$. Equation (A3) then becomes:

$$u_i = \frac{q^\alpha}{e^{|X - x(y_i)|}} + y_i - \frac{1}{N} q, \tag{A4}$$

which makes it clear that a voter's tastes are single-peaked in the type of local service bundle provided jurisdiction-wide, X, such that higher income

[36] This function is modeled off of earlier work by Alesina et al. (1999).

voters prefer higher value for X. (See Fig. A1). Similarly, individual preferences are single-peaked in q such that voters with higher $|X - x(y_i)|$ and $\frac{1}{N}$ prefer lower q. To see this, an individual's optimal quantity of public spending, q_i, is solved for as:

$$q_i = \left(\frac{\alpha N}{e^{|X - x(y_i)|}}\right)^{\frac{1}{1-\alpha}},$$

where the i subscript on q denotes the ith individual's optimal quantity. (See Fig. A2.)

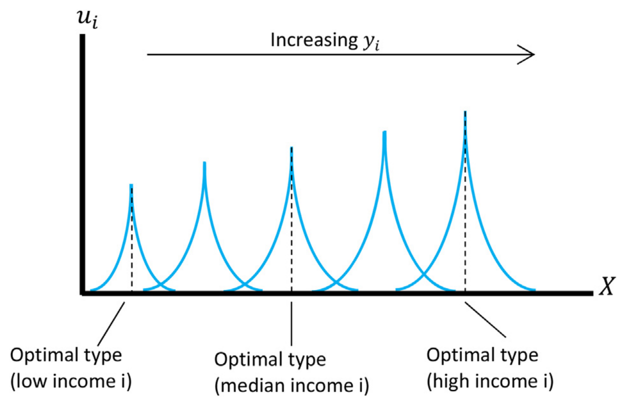

Fig. A1. Single-Peaked Preferences in X.

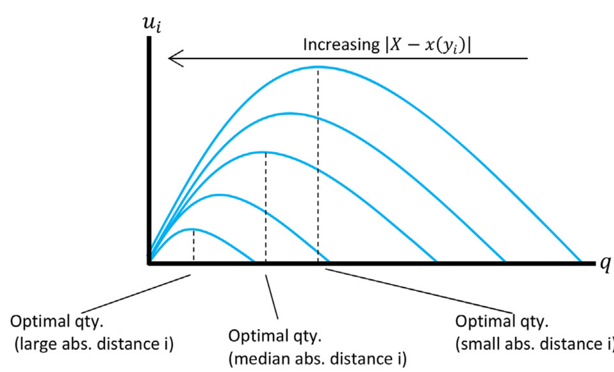

Fig. A2. Single-Peaked Preferences in q.

This simple model of consumer choice can be straightforwardly extended to show how the spatial distribution of income interacts with the organization of local government to impact local public spending outcomes. Here, emphasis is placed on the special role of geographically delineated political districts within representative democracies and how the distribution of income across space influences the behavior of a jurisdiction's decisive district. This approach is consistent with the model of representative democracy adopted in most local jurisdictions within the U.S., whereby, for example, elected city council or school board members who vote on jurisdiction-wide outcomes each represent only those residents residing within a specific area of the jurisdiction, such as a city ward or school district attendance zone.

Consider a local jurisdiction that is subdivided into D non-overlapping geographic districts, such as city wards or school district attendance zones, where voters' incomes are assumed to be identical within districts but potentially varying across districts.[37] Each district directly elects a representative to serve on a committee that decides jurisdiction-wide outcomes, such as a city council or school district board. Committees themselves decide spending outcomes through two sequential rounds of voting, with the winning outcome from each round determined by majority rule. The first committee vote determines the *type* of public service bundle to be provided jurisdiction-wide whereas the second committee vote determines the *level* of spending to allocate towards the chosen service bundle.[38] Representatives' second round votes are therefore responsive to the type of public service bundle that is to be supported, just as individuals base their optimal quantity of public spending on how well the service bundle matches their unique tastes.

Because a voter's optimal type of service bundle increases along a continuum with her income and because tastes are single-peaked in the type of service bundle actually consumed, X, districts will elect by majority rule representatives whose preferences align with the district's median income voter. Defining y_d as the single income level within the dth district (and therefore the income of the dth district's median income voter), $x_d = x(y_d)$ becomes the dth representative's preferred type of public service bundle.

[37] This model does not require that these districts be *de jure* political entities. All that matters is that geographic areas have the ability and capacity to act collectively in a way that can influence jurisdiction-wide local public spending, such as through neighborhood community groups or local chambers of commerce. The assumption of identical incomes within a district is made for notational convenience so that all of a district's voters have an income equivalent to the district's median. This assumption is relaxed at the end of this discussion in order to highlight the ways in which income segregation is independent from a-spatial income inequality.

[38] This is similar to the two-stage voting procedure outlined by Alesina et al. (1999), although the order has been reversed. Making these votes sequential instead of simultaneous avoids complexities associated with multi-dimensional voting.

Next, during the first round of committee voting the *type* of service bundle chosen for the entire jurisdiction will be that preferred by whichever district's median income reflects the median across all districts, $\hat{y}$.[39] Therefore, $X^* = x(\hat{y})$ defines the type of public service bundle provided jurisdiction wide, where the * superscript denotes a political outcome (See Fig. A3.). Note that if median incomes were the same across districts each would then get the type of public service bundle that it most desired, $X^* = x_1 = x_2 = \ldots = x_D$. However, if income segregation were to yield complete heterogeneity in district median incomes such that $x_1 \neq x_2 \neq \ldots \neq x_D$ then the type of jurisdiction-wide service bundle ultimately chosen will deviate from most of the districts' ideal outcomes. Notice that neither of these scenarios is sensitive to how household incomes are distributed around a districts median.

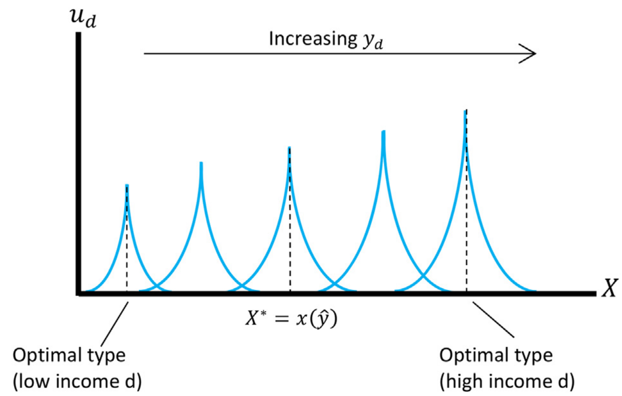

Fig. A3. Choosing X^*.

Turning to the second round of committee voting, because individual preferences are single-peaked in q *and* q_i declines continuously in absolute deviation, $|X^* - x(y_i)|$, individual representatives (now knowing the type of public service bundle to be provided jurisdiction wide) will prefer whichever level of spending maximizes the utility of the voter with their district's median absolute deviation. Because voters have identical incomes within a district we get $q_d = \left(\frac{\alpha N}{e^{|X^* - x(y_d)|}}\right)^{\frac{1}{1-\alpha}}$ as the dth representative's preferred level of spending.

Notice that individual representatives' preferences, mirroring those of their voters, are also single-peaked in q such that q_d declines in $|X^* - x(y_d)|$; the winning jurisdiction-wide level of spending, q^*, is therefore whichever quantity is demanded by the district with the median absolute deviation, $|\widehat{X^* - x(y)}|$[40]

$$q^* = \left(\frac{\alpha N}{e^{|\widehat{X^* - x(y)}|}}\right)^{\frac{1}{1-\alpha}} \Rightarrow ln(q^*) = -\frac{1}{1-\alpha}|\widehat{X^* - x(y)}| + \gamma,$$

where $\gamma = \frac{ln(\alpha N)}{1-\alpha}$ is treated as a constant. (See Fig. A4.)

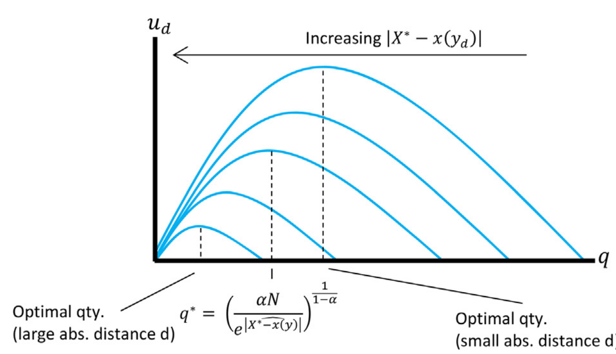

Fig. A4. Choosing q^*.

Differentiating $ln(q^*)$ with respect to income segregation, *seg*, identifies the median absolute deviation from the median, $\left|\widehat{X^* - x(y)}\right|$, as the single channel through which income segregation potentially impacts local public spending levels:

$$\frac{dln(q^*)}{dseg} = -\frac{1}{1-\alpha}\frac{\partial|\widehat{X^* - x(y)}|}{\partial seg}. \tag{A5}$$

Income segregation's hypothesized impact on public spending therefore rests on the degree to which it creates distance between a jurisdiction's two decisive districts' preferences: the preferences of the median income district which determines public spending *type*, X^*, and the median absolute

[39] Going forward, the $\widehat{}$ symbol always identifies the median value across districts.

[40] It is important to point out here that the district with the median income across districts will have an absolute deviation of zero. In the presence of income segregation it is therefore unlikely that this same district has the median absolute deviation.

deviation district which ultimately determines the *level* of public spending, q^*. Because a district's preferred public service type increases in its income, this distance can be summarized by the magnitude of the absolute income difference between these two decisive districts.[41]

Within the context of this model rising income segregation can be portrayed simplest as a median-preserving widening of the distribution of median incomes across a jurisdiction's fixed number of districts. A widening of this type unambiguously increases $|X^* - \widehat{x(y)}|$, thus allowing us to substitute $\frac{\partial |\widehat{X^* - x(y)}|}{\partial seg} > 0$ into (A5) above.[42] Rising income segregation is therefore hypothesized to reduce local public spending levels in a way that is proportional to the degree to which it amplifies the absolute income differences between a jurisdiction's two decisive districts. Empirical investigations into income segregation's impact on local public spending should therefore be sure to account for the absolute magnitude of income differences across districts when measuring income segregation. The Gini coefficient, which is a measure of the relative mean absolute deviation in incomes, is therefore a potentially useful measure of income segregation.

Relaxing the assumption that household incomes be identical within a district helps clarify the important differences between changes in a-spatial inequality and changes in income segregation within the context of this model. For example, the widening of a jurisdiction's overall income distribution will not impact income segregation if household incomes are already identically distributed within each district; rising income inequality would on its own not affect the relative concentration of income across districts. Additionally, overall income inequality within a jurisdiction need not change in order for income segregation to rise or fall. Holding a jurisdiction's overall income distribution fixed, increased income sorting across districts is sufficient to increase income segregation; a decline in sorting is similarly sufficient for there to be a reduction in income segregation. Once districts are sorted by income, however, a widening of the overall income distribution would contribute to the growing concentration of income across districts (i.e., increase rising income segregation). These examples highlight the degree of freedom that exists between changes in a jurisdiction's overall level of income inequality and changes in its level of income segregation. One cannot therefore assume that patterns of income inequality and income segregation are always highly correlated. It is therefore appropriate to treat the political economy and comparative statics described above as being potentially independent of any changes in a-spatial income inequality that might also occur within a jurisdiction.

B Appendix. Supplementary Statistics

Table B1
Summary Statistics for the Unrestricted and IV Samples, 1980 and 2010

	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Panel A: Balanced Samples without Land Area Restriction								
	Panel A1: Municipalities (N = 8088)				**Panel A2: School Districts (N = 3544)**			
1980 Levels								
Gini	0.12	0.05	0.01	0.28	0.14	0.04	0.04	0.27
Theil	0.03	0.02	0.00	0.12	0.03	0.02	0.00	0.12
Mean-to-Median Income	1.14	0.10	0.87	1.63	1.14	0.09	0.98	1.48
Exp. Per Capita ($k)	0.60	0.28	0.09	2.89	5.82	1.60	3.02	15.13
Changes (1980–2010)								
Δ Gini	0.03	0.04	−0.14	0.21	0.04	0.03	−0.07	0.15
Δ Theil	0.02	0.02	−0.07	0.14	0.02	0.02	−0.03	0.13
Δ Mean-to-Median Income	0.12	0.12	−0.47	0.84	0.13	0.10	−0.30	0.53
Δ Exp. Per Capita ($k)	0.44	0.32	−0.64	2.39	4.66	2.44	0.35	20.95
Panel B: Balanced Samples without Land Area and IV Restrictions								
	Panel B1: Municipalities (N = 9980)				**Panel B2: School Districts (N = 4396)**			
1980 Levels								
Gini	0.12	0.05	0.01	0.31	0.14	0.04	0.04	0.27
Theil	0.03	0.02	0	0.16	0.03	0.02	0	0.12
Mean-to-Median Income	1.15	0.1	0.87	1.66	1.14	0.09	0.98	1.5
Exp. Per Capita ($k)	0.59	0.27	0.09	2.89	5.63	1.55	3.02	15.13
Changes (1980–2010)								
Δ Gini	0.03	0.04	−0.14	0.23	0.04	0.03	−0.07	0.15
Δ Theil	0.01	0.02	−0.07	0.17	0.02	0.02	−0.03	0.13
Δ Mean-to-Median Income	0.12	0.12	−0.47	1.21	0.13	0.1	−0.3	0.53
Δ Exp. Per Capita ($k)	0.45	0.32	−0.67	2.97	4.58	2.3	−0.06	20.95

Panel A: The municipality sample tracks 2022 individual cities/towns over four time periods (N = 8088). Municipalities are limited to those fully containing at least five block groups for each of the years 1980–2010, a 1970 population of at least 5,000, and having at least three block groups in 1970. The school district sample tracks 886 individual unified school districts over four time periods (N = 2658). Independent unified school districts are limited to those fully containing at least five block groups for each of the years 1980–2010, having at least 100 students enrolled in 1970, and containing at least three block groups in 1970. Municipal expenditures exclude education expenditures.
Panel B: The municipality sample tracks 2495 individual cities/towns over four time periods (N = 9980). Municipalities are limited to those fully containing at least five block groups for each of the years 1980–2010 and a 1970 population of at least 5000. The school district sample tracks 1099 individual unified school districts over four time periods (N = 4396). Independent unified school districts are limited to those fully containing at least five block groups for each of the years 1980–2010 and having at least 100 students enrolled in 1970.
The term “per-capita” means "per-person" for municipalities and “per-student” for school districts. All dollar values are reported in terms of 2010 dollars. See text for further details.

[41] Notice that a more appropriate measure of distance will be likely “unit free”, such as the absolute percentage difference, $\frac{|X^* - x(y_d)|}{x(y_d)}$.
[42] Notice that $|X^* - \widehat{x(y)}|$ is simply the median absolute deviation (MAD) of the distribution of median incomes across districts; this rises with a distribution's standard deviation.

Table B2
First-Stage Regression Statistics

	Panel A: Municipalities		Panel B: School Districts	
	1970 IV (N = 3930)	1960 IV (N = 2943)	1970 IV (N = 1206)	1960 IV (N = 1104)
Δ Income Segregation IV (Gini)	1.006***	0.951***	1.224***	1.163***
	[0.106]	[0.123]	[0.158]	[0.19]
Δ Mean-to-Median Inc.	0.049***	0.07***	0.039***	0.051***
	[0.008]	[0.007]	[0.013]	[0.014]
Δ log(Population)	0.04***	0.03**	0.017**	0.011
	[0.014]	[0.012]	[0.009]	[0.009]
Δ log(Median Income)	0.002	0.016**	−0.01	−0.013
	[0.009]	[0.008]	[0.014]	[0.013]
Δ Pop. Share Black	0.007	−0.003	0.053	0.043
	[0.017]	[0.019]	[0.035]	[0.034]
Δ Pop. Share Hispanic	0.018	0.008	−0.0129	−0.054
	[0.026]	[0.0278]	[0.05]	[0.015]
Δ Adult Share 65+	0.03	0.005	0.04	0.029
	[0.029]	[0.032]	[0.046]	[0.046]
Δ log(IG Aid per Capita)	0.000	-0.4×10^{-3}	0.000	0.001
	[0.001]	[0.001]	[0.002]	[0.002]
Δ B–W Dissimilarity	0.006*	0.003	−0.002	−0.007
	[0.003]	[0.004]	[0.006]	[0.006]
F-stat. for Excluded Instrument	89.1	60.1	59.7	37.7
Jurisdiction-Level FEs (trend)	Yes	Yes	Yes	Yes
Region-by-Year FEs	Yes	Yes	Yes	Yes

All values reflect the first-stage of 2SLS estimates of Eq. (2) using the baseline samples summarized in Table 1. The dependent variable is the Gini of income segregation, as described in the text. School district population is measured using student enrollment. Intergovernmental aid for municipalities is for non-education transfers only. Standard errors are clustered at the level of the individual jurisdiction and are reported in brackets. See text for further details. ***$p \leq 0.01$, **$p \leq 0.05$, *$p \leq 0.1$.

Table B3
Complete IV Estimates

	Panel A: Municipalities		Panel B: School Districts	
	1970 IV (N = 3930)	1960 IV (N = 2943)	1970 IV (N = 1206)	1960 IV (N = 1104)
Δ Income Segregation IV (Gini)	−3.101***	−2.703**	−2.519***	−3.093***
	[0.942]	[1.145]	[0.689]	[0.811]
Δ Mean-to-Median Inc.	0.314***	0.340***	0.234***	0.311***
	[0.097]	[0.122]	[0.087]	[0.098]
Δ log(Population)	−0.282***	−0.215*	−0.380***	−0.367***
	[0.101]	[0.127]	[0.049]	[0.055]
Δ log(Median Income)	0.424***	0.447***	0.094	0.088
	[0.080]	[0.093]	[0.066]	[0.068]
Δ Pop. Share Black	0.177	0.059	0.173	0.064
	[0.139]	[0.171]	[0.198]	[0.217]
Δ Pop. Share Hispanic	−0.491*	−0.319	−0.023	0.124
	[0.286]	[0.263]	[0.227]	[0.269]
Δ Adult Share 65+	0.345	0.534*	−0.377*	−0.422*
	[0.262]	[0.300]	[0.228]	[0.242]
Δ log(IG Aid per Capita)	0.085***	0.082***	0.068***	0.069***
	[0.012]	[0.013]	[0.011]	[0.011]
Δ B–W Dissimilarity	−0.090***	−0.090**	−0.043	−0.047
	[0.033]	[0.038]	[0.032]	[0.034]
Jurisdiction-Level FEs (trend)	Yes	Yes	Yes	Yes
Region-by-Year FEs	Yes	Yes	Yes	Yes

All values reflect the full set of 2SLS estimates of Eq. (2) reported in Table 3. See note to Table 3 for further details.

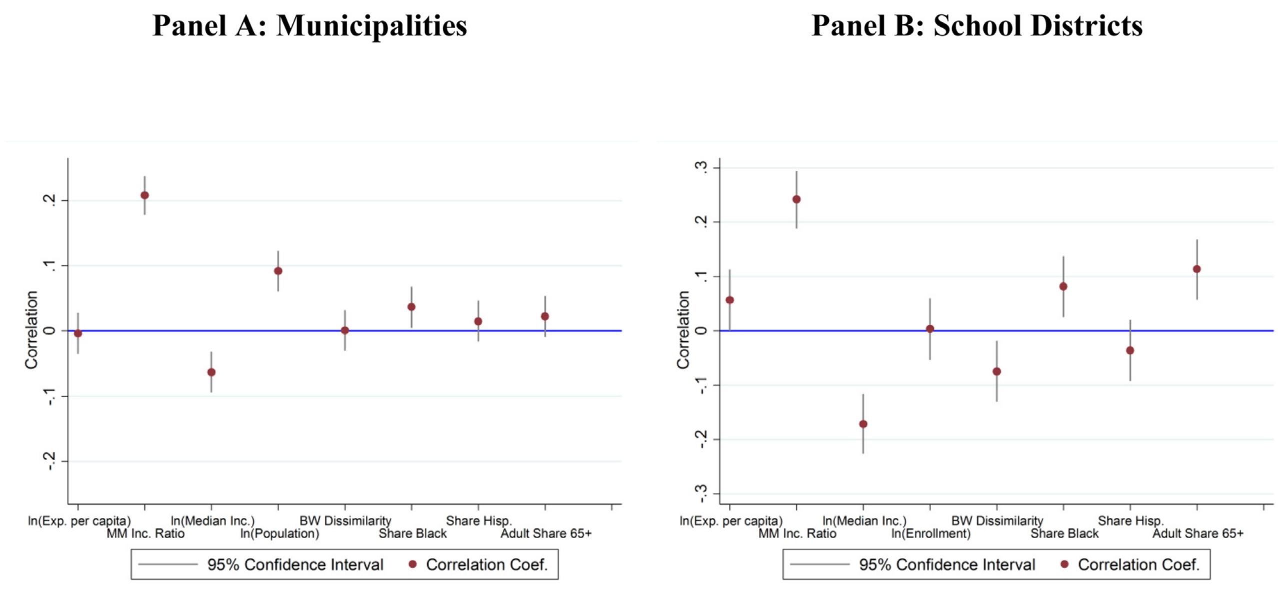

Fig. B1. Correlations Between Decadal Changes in Gini for Income Segregation and Other Key Variables: Municipalities.

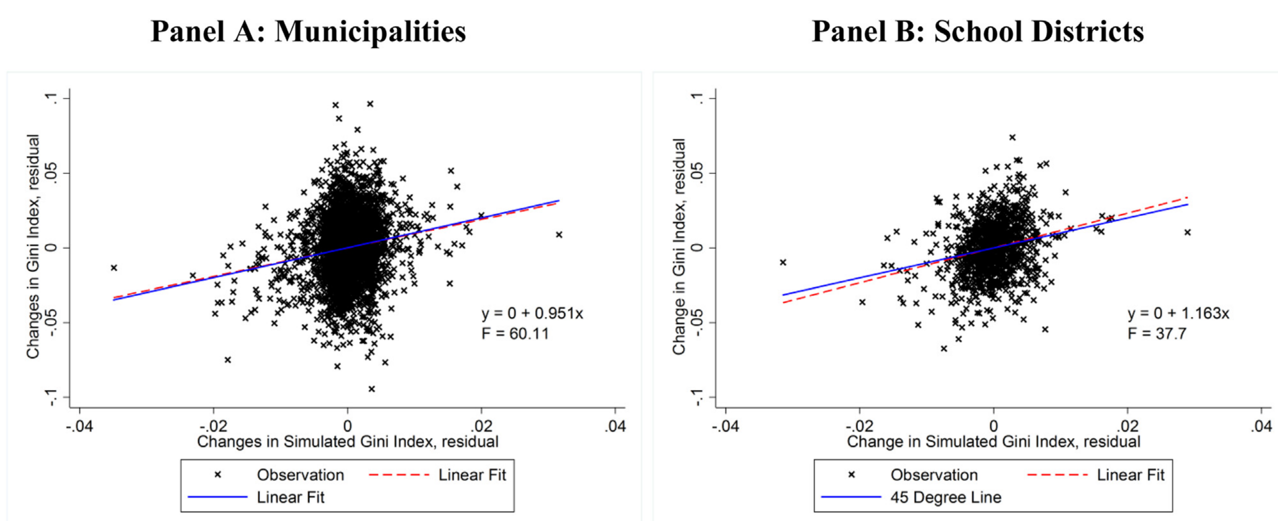

Fig. B2. First-Stage Relationship between Changes in Gini for Income Segregation and its Instrument, 1960 Tract-Based IV.

Appendix C. Geographic Crosswalks and Land Areas

Geographic crosswalks assigning census block groups to jurisdiction borders are constructed from a variety of sources. The 1970 crosswalk for cities and towns comes from the Master Enumeration District (MED) List published as part of the 1970 decennial census (U.S. Census Bureau, 1971). The 1970 crosswalk for school districts was produced from the School District Geographic Reference file for 1969–70, also published by the Census Bureau (U.S. Census Bureau, 1970b). The 1980 crosswalk for cities and towns comes from the Master Area Reference File 2 (MARF2) published as part of the 1980 decennial census (U.S. Census Bureau, 1984a). The MARF3 is used for 1980 school districts (U.S. Census Bureau, 1984b). The 1990 crosswalk for cities and towns is taken from the Missouri Census Data Center's Geographic Correspondence Engine (Geocorr). For 1990 school districts, the crosswalk is constructed from the U.S. Census Bureau's 1992 TIGER/Line files (U.S. Census Bureau (1993)). City, town, and school district crosswalks for 2000 and 2010 are all taken from the Missouri Census Data Center's Geographic Correspondence Engine (Geocorr). For any particular year, a crosswalk includes only those block groups whose boundaries fall 100% within a single jurisdiction.

Crosswalks assigning 1960 census tracts to 1980 city/town boundaries are constructed using digitized 1960 census tract maps and digitized 1980 city/town maps provided by Manson et al. (2017). Geographic information system (GIS) software is used to assign 1960 census tracts to 1980 city and town boundaries. Tracts are limited to those with 90–100% of their land area within a single city or town. Digitized city/town maps provided by Manson et al. (2017) are also used to measure a city's or town's for each of the decennial census years 1980–2010.

Digitized school district (SD) maps are not readily available for 1980 or 1990. In order to construct a crosswalk that assigns 1960 tracts to 1980 SDs, 1980 SD boundaries first are approximated by assigning 1980 block group (BG) coordinates to the BG-to-SD crosswalk discussed above. Coordinates for 1980 block groups are provided by the U.S. Census Bureau, 1993 and are digitized using GIS software. Like with cities/towns, a crosswalk assigning

1960 census tracts to 1980 school districts is then put together by assigning the 1960 tract map provided by Manson et al. (2017) to the digitized map approximating 1980 school district boundaries. Tracts are limited to those with 90–100% of their land area within a single district. For consistency of method in measuring school district land areas over time, BG-to-SD crosswalks, along with digitized block group maps, are used to approximate a district's land area for each of the census years 1980–2010.

Author statement

All work was completed by Ryan M. Gallagher. I have no financial sources to disclose.

Appendix D. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.regsciurbeco.2021.103710.

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