# Agglomeration and inequality in educational outcomes: evidence from the United States

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**Abstract**

What explains differences in socioeconomic inequalities in different parts of the country? This paper examines the variation in performance in test scores across different areas and relates it to the levels of population agglomeration. Parts of the country that are denser, such as cities and their suburbs and exurbs have higher inequality levels. Being in a denser area is associated with an increase in the socioeconomic gap by about 1% for each 10% increase in density levels. This is consistent with a framework of Tiebout competition whereby denser areas enable higher socioeconomic status families to attend different schools and districts from those of more disadvantaged families. It contrasts with less dense areas, where different groups live in the same jurisdictions and co-attend the same schools. Despite the differences in outcomes, there is no evidence of differential effects on survey measures of voice for lower socioeconomic status families in denser areas that compensate for the negative effects on outcomes of segregation patterns in denser areas. These findings have implications for the design of jurisdictional boundaries and the levels of support districts in different parts of the country should receive.

## Introduction

Is the distribution of the population across space related with inequality of the delivery of local government services? While cities and higher density areas have agglomeration advantages that have been shown to present them with opportunity, make them more productive and even healthier, they often are also places of great inequality. In this research I intend to, first, document differences in the levels of inequality of educational opportunities across areas of the country. Second, explore the relation of different types of area level settlement or agglomeration with educational opportunity available to people in different areas in K-12 education. Third, investigate the extent to which mechanisms of choice vs voice may serve to explain a portion of the differences in inequality levels. I find that denser areas have higher levels of inequality and that a large part of the differences in performance is likely explained by a framework where denser areas benefit higher socioeconomic status families, particularly through residential segregation –with no compensating benefits for lower socioeconomic status. To the extent that some portion of these differences is hard-wired into fragmented school districts and we expect to see greater urbanization in the future, we may expect increases in inequality levels in the future.

**Motivation and Theory**

I look at whether the population distribution affects the inequality of educational outcomes. In the United States, for students with the same socioeconomic characteristics living in the same area, attending certain districts and commuter zones rather than others explains an additional 50% of the variation in their outcomes. Much of the literature on educational policy focuses on the impact of school inputs such as teacher quality, class size, mode of delivery of instruction. In addition, it is well-known that schooling interacts with the social context and the socioeconomic status of students and their families. Less explored are the consequences of the spatial distribution of the population and the mechanisms that may explain variation in outcomes.

I find that areas that are more densely populated have greater average levels of educational performance but also higher levels of inequality in educational performance across different groups than less populous areas (Figures 1 and 2). This fact stands in between notions of denser cities as engines for opportunity for the disadvantaged and the known challenges of schooling in inner cities.

How may geography affect educational outcomes? There are a variety of mechanisms that are possible, ranging from the narrowly geographical such as the abundance of weather conditions that may make it harder to attend schools (Goodman 2014) to the types of economies that develop near natural harbors and from then, the types of incentives students face for investing in education (e.g. access to a natural port, or natural resources). Focusing on denser areas such as cities and their surrounding areas, may have an effect on the inequality across different groups for a number of reasons. First, the people living in them may be different. For instance, they may attract more immigrants and possibly more ambitious people in search for opportunities. Their attitude to education and their value may also be different. Second, the access to educational opportunities may be different. This is the central mechanism of interest: schools different groups attend may be more different than in less dense areas (in everything from access to resources, differentiated teachers, buildings, etc.). Relatedly, the (smaller) areas where students live may have other non-school differences that are greater, such as other out of school amenities that may have an effect on education. Finally, there may be other broader differences in the economies of the different areas. For instance, in knowledge-intensive local economies, the incentives for students and family to raise achievement levels may be different at different levels. Autor and Dorn (2013) have found, for instance, that there are large variations in the extent to which commuter zone areas, have in the period 1980-2005 have created jobs and raised wages at different points of the skills distribution.

For the purpose of this paper I focus on density as it relates to exit and voice mechanisms described first by Albert Hirschman (1970), as the main ways users have of communicating the "failings" in performance of an organization and hence, of exercising accountability.[1] Hirschman famously worried that when the exit is an important mechanism for asserting their views when unsatisfied with a menu of offers, changes in the composition of failing organizations' clientele would lead to further unraveling of that organization: "those customers who care the most about the quality of the product and who, therefore, are those who would be the most active, reliable, and creative agents of voice are for that very reason also those who […] exit first in case of deterioration".

In the case of public schools in more populous areas, exit becomes a real possibility for the most committed parents since they can find and change schools and school districts, with little disruption to their work or community life. Hence, we would expect the involved or "vociferous" families who would push for improvements of schools in less populous areas to exercise that mechanism and to move their children more. In more populous areas, the families who do not exercise that voice will be less likely to benefit from having people around them who push for the improvement of their schools. Since the degree of involvement in education and vociferousness is likely correlated with socioeconomic

[1] The exit mechanism that Hirschmann analyzes is an expansion of the horizontal competition mechanism first introduced by Tiebout (1956).

status, all things being equal, more availability of exit options would lead to increases in the inequality of educational outcomes across socioeconomic groups. If the groups that in more populous areas benefit from greater exit opportunities already do better educationally and voice mechanisms are equally available as in less dense areas, this would result in steeper socioeconomic gradients in more populous areas.

The framework of exit and voice helps to provide a unified explanation of how this mechanism works. The following matrix synthesizes the expectations in terms of effects on educational outcomes of differences in "exit" and "voice" levels for different groups:

| | **Low voice areas** | **High voice areas** |
|---|---|---|
| **Low exit areas** | Baseline | Poor families: +<br>Rich families: +<br>Inequality: Same as baseline |
| **High exit areas** | Poor families: -<br>Rich families: +<br>Inequality: High | Poor families: -<br>Rich families: ++<br>Inequality: Highest |

While both mechanisms of voice and exit have effects on outcomes the expectation is that the availability of both mechanisms has different effects on poor and rich families. In both cases, the direct effect of greater availability of those mechanisms benefits richer families more. However, in high voice/low exit areas lower SES ("poor") families are able to benefit from the presence and exercise in voice from higher SES ("rich") families. However, whenever exit is more available (in high exit, low voice and high exit, high voice areas), lower socioeconomic status families are no longer able to benefit as much from the presence in their schools and districts of more vociferous families. Variation along the vertical axis may be driven by the level of fragmentation into districts. Institutional differences and differences in the availability of access to information may enable voice mechanisms would drive differences along the horizontal axis. These, in principle, include such factors as whether school boards are appointed or elected, the relation of board decisions with the district's leader and the timing of elections, whether they are off the main cycles or not.[2]

*Density, exit and voice*

In the United States, voice and exit are probably more available for families assessing school districts than in almost any other context, due to the differentiation across districts, that commonly raise taxes and set policy, which are governed by school boards, often elected. As we focus on agglomeration and turn to the specific case of higher density areas, density will more naturally drive higher availability of exit. Assuming schools and districts of roughly similar sizes, similarly sized geographical areas will support more schools and districts. However, this will benefit mostly high socioeconomic status families as it likely driven by the families most committed or knowledgeable about the education of their children and is partly facilitated by income segregation mechanisms, such as shifts in house prices.

We may expect lower socioeconomic status groups to have higher participation levels in denser areas for two reasons. At the same time, the effort involved in exercizing voice may be lower as there is greater ease of in-person meetings and probability of encounters information. Additionally, voice may become more attractive if in denser areas, where the policies that are possible, in particular education reform policies such as the access to vouchers of charters. Second, if choice is in fact a mechanism that comes into play in denser areas we may expect a compensating increase in the exercise of voice for those in certain districts, as lower SES families cannot rely on others to advocate for education improvements. It is an empirical question whether this availability of voice mechanisms will compensate for any negative effects of the segregation of families into different districts for groups with lower socioeconomic status. The aggregate effects of density on

[2] While it may also be the case that denser areas also allow for easier flows of information, be able to sustain thicker media markets and generally support the voice mechanisms, the first-order effect of density seems to be about increasing exit. In any case, if density affects both exit and voice, our predictions should be similar. The differential effect on outcomes of either down or diagonally to the right should be directionally, if not substantially, the same. In addition, I will also show below estimates of the degree of accountability that is in practice in each cell from a proprietary survey.

the levels of inequality in outcomes across groups are therefore ambiguous: while there are certainly reasons why we do not expect socioeconomic gaps to disappear it is unclear if the combination of effects of choice and voice and their interplay will increase the socioeconomic gradient on inequality.

**Literature**

We know that agglomeration economies and more broadly spatial distribution can affect levels of economic growth, subjective well-being, entrepreneurship levels or the quality of hospital care (Glaeser and Gottlieb, 2009 and Glaeser, 2010). The reduction of transportation and information costs (agglomeration economies) that these studies document, however, arguably have an effect on the level of performance of the delivery of government services.

I seek to connect the types of geographic differences that in other fields have been shown to result in agglomeration economies to the delivery of local public services and in particular education. In this spirit, Gingrich and Ansell (2014) provide some of the limited evidence on how the mechanism of clustering of similar students through widespread school "exit" in a relatively dense country, the United Kingdom. By analyzing UK educational outcomes, they show that even within more affluent districts we observe greater disparities in educational performance through sorting into schools within the district. They find that in districts that may have been thought to widely benefit from better educational outcomes and where they may not be obvious drivers of inequality levels such as differences in funding across districts, there may still be dramatic differences in outcome levels.[3]

Additionally, Reardon et al. (2016), leverage all the data available from state test scores intra-district and inter-district racial achievement gaps. Their descriptive research finds that a large portion of the variation in racial achievement gaps between districts and metropolitan areas is correlated with levels of inter-district racial and economic segregation as well as differences in racialized socioeconomic status in different areas, which leads itself naturally to the determinants of that income and racial segregation.

[3] One mechanism whereby segregation in the attendance of schools may accentuate any inequality in income at the start are peer effects, which have a large literature of their own. For a review see Lavy et al. (2012).

One mechanism whereby geographic variables have an effect on outcomes is through the type of jurisdictions they result in and the effect of that jurisdictional configuration. On their formation, Alesina and Spolaore (2003) and Alesina et al. (2004) look at the formation of jurisdictions, and school districts in particular, who face a tradeoff in determining their optimal size with two opposing forces: economies of scale (leading to larger jurisdictions) and racial or class heterogeneity (pressing for smaller, more homogeneous). The consequences this may have for the quality of services such as education are not explored. Lassen and Serritzlew (2011), do not look at outcomes directly, but find a stark negative relation between size of jurisdictions and individual citizens' beliefs that they are competent to understand and take part in politics in an experimental setup in Denmark. Grossman and Pierskalla (2014) found that within a panel of countries, the number of administrative units for a given population size has an inverse U-relation with a measure of the quality of public good and service provision, a finding that implies that population per administrative unit also has a similar inverse U-relation.

A large part of the effect of density and urbanization levels in the theory tested here is through choice and voice in school systems. The closest study in the large literature on the effect of choice within the public sector (reviewed in Urquiola 2016) in the United States is Hoxby (2000) Using terrain characteristics as a source of variation in the levels of public school choice, Hoxby finds positive effects of having greater public school choice in metropolitan areas on student achievement and on the productivity of the education system, although she finds little evidence of effects on the socioeconomic gradient. The evidence on the effect of any form of voice on schooling outcomes is more limited. Berry and Howell (2007) and Barrows (2015) provide indirect evidence of a voice (at least voting) being related to education performance. They show that re-election in school board elections is linked to the performance of schools prior to the election.

**Predictions and hypotheses to test**

If density relates to educational outcomes substantially through the framework of exit and voice, a number of predictions follow. In order to test them, the ideal experiment would be to have students with exactly the same characteristics randomly assigned to areas that differ in terms of their density levels but are otherwise similar with respect to characteristics directly outside the education system, such as the composition of the economy. Since differences between schools and school districts are of the greatest importance, commuting zones are, arguably, the main unit of analysis, as it constitutes the level at which exit is least costly. This is because this is the context where the choice of school or district, by change of residence is most salient. It is feasible to change districts or schools within a commuter zone without having to change jobs, break from regular contacts with existing networks, etc. We also know that most of the relevant forces of Tiebout sorting that are relevant to inequality of income occur within metropolitan areas and not through migration of different types of people between metropolitan areas, particularly across school districts (Cutler and Glaeser 1997 and Owens, 2016)).

*Hypotheses to test*

Relation between density levels and inequality in exam outcomes

1) a. Outcomes are more unequal in denser areas

   b. Greater inequality is driven by the higher performance of higher SES students in these jurisdictions

   c. Disadvantaged students do worse or the same in denser areas

Differences in inequality levels between different areas

2) Greater availability and use of exit mechanism in denser areas:
   a. More schools and more school districts in denser areas
   b. More inequality in correlates of educational outcomes across jurisdictional barriers in denser CZ.
   c. Counties themselves are less unequal in denser areas. The mean difference between 75$^{th}$ percentile and 25$^{th}$ percentile is smaller in less dense areas (maybe normalized, as a share of average income in CZ)
   d. Regionally, effect is less strong in the South where the landscape of school districts is more fragmented

3) Voice mechanism

a. Low SES families exercise less voice

b. Low SES families exercise no more voice in denser areas, so there is no countervailing force for the negative density effect from the exit mechanism

**Data**

I use as a primary measure of the variation in exit options the density of enrollment within commuter zones, i.e the enrolled K-12 students per square kilometer. This data comes from the National Center for Education Statistics matched with the Census' TIGER mapping data.

For educational outcome data, I am able to use repeated cross-sections of the bi-annual federal National Assessment of Educational Progress studies in reading and math (NAEP). Their restricted micro-data contains some 150,000 observations per subject (each of reading and math), which are meant to be representative at the state level. This is relatively little used data homogenous across states that has however been exploited for the study of state level distributions of achievement between districts within commuter zones, for instance by Lafortune et al. (2016). In this version of the paper I present results for Reading in 2007 testing cycle alone.

Demographics and other control variables for each district are obtained from the school and student survey that is a companion to the NAEP micro-data, complemented with aggregate data from the National Center for Education Statistics Common Core of Data. Individual data includes, race, free and reduced lunch status, individual learning programs, English learner status, graduation from college of parents, as well as information on classroom assignment to teachers. At the aggregate district level, I have in addition pupil-to-teacher ratios, number of schools in the districts, as well as average house prices. Two financial variables are also added: the current expenditure per pupil and the share of district revenue that comes from local sources, including mostly local taxes but also local fees.

Data on income at the county level for different cohorts is obtained from Chetty et al. (2014), which compiles it from individual tax returns. In addition, aggregate data for commuter zones on income and racial segregation, crime comes from the same source and data on routine jobs comes from Autor and Dorn (2013).

I also use a nationally representative survey on issues of education to establish measures of "voice", with oversamples for teachers and parents and done via computer (the EdNext survey), which data for each year in 2007-2015. It contains an average of 100 observations by commuter zone-year. While the majority of the questions change year to year, there are a few recurring questions that we exploit to increase the sample size to form samples of up to 34,459 observations in the period on the perception about school quality, attention paid to education, voting behavior and policy preferences.

**Empirical strategy**

I first document the extent of the differences in educational outcome and how they benefit certain groups relative to others. As a first approximation I study the relation at different deciles of the distribution of districts within commuting zones, noting that there are an average of 14 districts by commuter zone. I use quantile regression, which allows us to estimate the effect of commuter zone density at different deciles of the distribution of performance. In essence, the quantile regression estimator weighs the observations centered around the specified quantile in a regression framework and linearly decreasing away from the center, introduced by Koenker and Bassett (1978).

In regression form, the link between student density in enrollment and outcomes, by running a series of regressions of the form:

$$Y_{\theta ics}= \alpha \log d_c+ \boldsymbol{\beta} X_{ics} + State_s+e_{ics}$$

For a subject *i* in commuter zone *c* in state *s*, $d_{ics}$ is the enrollment density variable and indicates enrollment in K-12 education per square kilometer in the commuter zone, $X_i$ are student level controls and $State_s$ are state fixed effects. I run this for the cross-section of student outcomes (the $Y_i$). Error terms are clustered at the commuter zone level. $\theta$ is the quantile level of performance.

In order to test this relationship more systematically, as the main specification I look at disadvantaged students explicitly by running a series of mean (non-quantile) regressions which interact indicators of socioeconomic status (SES) with density, of the form:

$$Y_{ics}= \alpha \log d_c+ g \log d_c \text{ x } SES_i +\boldsymbol{\beta} X_{ics} + CommuterZone_c +e_{ics}$$

These specifications would include as the dependent variables test scores as well as survey results.

*Causality of the relation*

The concern with OLS models is that density has a multitude of effects on educational outcomes through a variety of mechanisms. The main goal of this study is to document the overall descriptive relation between density and outcomes of different groups. However, it is much harder to try to disentangle the causal effects of the mechanisms that may be underneath the descriptive relations between density levels and outcomes. In particular, reverse causality may significantly overstate the reading of the relation as an *effect* of outcomes on density. The concern is that educational success of certain areas may attract people to those areas and drive their density in that way. Migration specifically in looking for educational purposes will likely be mostly within commuter zones and so our specifications using variation at the commuting zone level would not be overstating the effect of density due to education-only sorting. An additional concern that may bias any models is that if places that have more successful economies tend to have or attract families at extreme ends of the socioeconomic distribution, such as workers in finance or recent immigrants we may expect that, given correlations between socioeconomic status and educational outcomes, gradients would be bigger without any need for differences in school inputs or even the availability of choice mechanisms. While a lot of concerns about individuals can be controlled for statistically, there are likely to be unobservable characteristics not captured. In addition, systemic differences in the economy that may lead students to exercise different levels of effort will not be controlled for using individual characteristics. To deal with such concerns about specific mechanisms I attempt two main instrumental variable strategies, described below. I regard, however, the descriptive analyses and the suggestive evidence on the choice and voice mechanisms as the most important contribution.

## Results

*Differences across commuter zones*

As predicted, there are very substantial differences between the performance of otherwise similar students. If we take the distribution of commuter zones effects, the difference between the effect on scores of commuter zones that perform at the 75th percentile and those at the 25th percentile is .26 standard deviations in student test scores, after the addition of demographic controls. That between the 90th and 10th is of half a standard deviation. This is shown in Table 1 (panel A). By contrast, the average white non-white gap in our sample is .32 SD. To give a tangible sense of what the commuter zones are and how they stack in terms of density and performance, we also show the top 10 commuter zones in terms of density, all of which are in the top quarter of performance in Panel B. They all feature in the top 20% of commuter zones by student outcomes.

*Reduced form relation between density and outcomes and their inequality*

As a first approximation to the question, Figure 1 shows that on average, the effects of density are positive once we control for some individual demographics. Figure 2 shows that while the effect of density may be positive, effects are different at different points of the distribution of outcomes. Denser commuter zones are more unequal than the rest: those above the 30th percentile of outcomes benefit from being in denser commuter zones while those underneath that level benefit less. In fact, without individual controls, below the 30th percentile density seems to be associated with lower outcomes, although once individual controls are added, effects are positive throughout the distribution of outcomes. This is shown by the negative and significant interaction effects of density with being a recipient of free and reduced lunch and, similarly, the positive and significant coefficient of the interaction between density and having parents who attended college, robust to the addition of state fixed effects.[4] Columns 1 and 3 of Table 2 suggest, moreover, that part of the explanation is indeed that the effect of being in a denser district is *positive* for children higher socioeconomic backgrounds while it is *negative* for those who do not belong to them. Once we control for individual demographics in columns 2 and 4, however, he results for all groups are positive but larger for those of high socioeconomic status. Since those demographic controls are correlated with the indicator for socioeconomic status, this

[4] Upon the addition of district fixed effects (not shown), the results become insignificant. This suggests that a lot of the variation we are capturing is related to this inequality is driven by between-district inequality within commuter zones.

specification may underestimate effects on the socioeconomic gradient. These are relatively large differences: from columns 1 to 4 we can see that whether we measure socioeconomic status by free or reduced lunch status (columns 1 and 2) or parental college attendance (columns 3 and 4), being in a 10% denser commuter zone is related to a .2-.4% SD increase in the outcome inequality across groups, or between 1-2% of the average gap in outcomes between groups. In Figure 3, we see graphically the same pattern of differential effects of density on outcomes once we divide the sample by socioeconomic status, using Free and reduced lunch as well as four additional indicators: having one college graduated from college, disability status, being an English learner or being non-white, as well as being above or below the average score in an index of all five indicators. The pattern of divergence for both groups as density increases is similar for the index, for parents' college graduation, free and reduced or English learner status. For minority status as well as having a certified disability, we see no pattern of divergence (or indeed convergence) as density levels rise.

*Evidence on exit mechanism in denser districts*

In Table 3, we can see that it is indeed the case that some of the mechanisms that should facilitate the exercise of the exit mechanism are indeed more prevalent in denser areas. Using income data aggregated at the county level, I report greater availability of public school choice in denser areas as well as greater heterogeneity across different jurisdictions within commuter zones but more homogeneity within jurisdictions.[5]

In panel A of Table 3 I look at results on the availability of choice available in denser areas. Regressing the number of school and school districts on the commuter zone density levels shows that there is indeed a relation between denser districts and areas that are more fragmented or otherwise have greater availability of choice of public schools, at least according to these crude indicators.

Regarding the type, rather than the quantity of choice available, the first three columns of table 3, panel B show that denser areas are associated with greater levels of between-county inequality, measured in three ways: by the standard deviation of the average income in the

[5] County-level data coming from tax returns has been made available from Chetty et al. (2014). Unfortunately, similar data at the school district level is not available.

district, the size of the range of the difference between the 90th and 10th percentile in county mean income, and the difference between the 75th and 25th percentile (all adjusted by mean income in the commuter zone). In columns 4 and 5, we see the opposite pattern for inequality within counties: denser areas have more homogeneous sub-divisions: lower Gini coefficients and lower within-county ranges between the 75th and 25th percentile.[6]. In other words, there seems to be more sorting across sub-divisions due to socioeconomic circumstances in denser areas and consequently, less interaction between people of different backgrounds.

*Availability of choice and regional differences*

It is, in principle, possible to look further at the extent to which district fragmentation may constitute a mediator using regional variation in geographical fragmentation that stems from regional differences in the size of school districts. It is certainly the case that outcomes inequality levels are clearly different by region. Figure 4 plots in a map the inequality levels of commuter zones. In Table 4, Column 2 we see explicitly how those patterns of inequality relate to density levels by looking at the interaction between density and indicators for each of the four regional divisions of the United States. It suggests density has a positive average effect in every region but with highest effects in the South and lowest in the West. Further, if the only or most significant mediator for density were the fragmentation of the school district into smaller geographies being a mediating factor in the effect of density on outcomes we would expect the effect of density on socioeconomic gradient to be smallest in the South, where school districts are large and coincide with counties I find a different pattern. In fact the South is the region of the country where the effect of density on socioeconomic gradient is largest. In column 3, we see a larger effect of density on the socioeconomic gradient in the South than in any other region. The direct effect of having more consolidated school districts may be counter-balanced by long-standing patterns of racial segregation within the large counties in the South. After all,

[6] The question remains of whether this relation between counties within a commuter zone is illustrative of relation between districts within a commuter zone. While it would be surprising that a different jurisdictional subdivision often with similar taxes and service responsibilities has different consequences, lack of data prevents the direct testing of this hypothesis and I have no reason to think that they do not. At the same time, we see in Appendix table A1 that in the South, where school districts are largely collinear to counties, the relations are the same as in the rest of the country.

according to Fischel (2009) school districts in the South were so large precisely so that racially segregated education systems.

*Voice mechanism*

Using the EdNext survey data, I am able to investigate the levels of voice exercised by socioeconomic status at different density levels to see if there is evidence of forces in the opposite direction that may improve the outcomes of disadvantaged students in denser areas.[7] The main relation of socioeconomic status and voice in education is in line with the longstanding general findings about political engagement, as being correlated with income and education (e.g. Brady et al. 1995). As one may expect, we see that there is a gradient whereby the more socioeconomically advantaged group, as signified by having completed college (comparable to those students with parents who graduated from college), pay more attention to education and tend to vote more in school board elections. In Table 5, panel A, we see that college graduation, which drives the socioeconomic gradient identified in Table 2 is predictive of substantial voice differentials for our measures of voice, such as attention paid to education and self-declared participation in school board elections (columns 3 and 4). College graduates are significantly more likely to say they pay more attention to education and to say they voted in the last school board election. Columns 1 and 2 suggest that the assessment they make of the quality of schools is, however, similar, although this does not take into account the actual quality of schools. They give the same grade to their local public schools as their non-graduate counterparts.

Looking at the differential involvement by subgroup in denser areas, however, it would seem that density does not have an effect on lower socioeconomic status groups (coefficient on log density in columns 4 and 5). Higher socioeconomic status families, however, seem to get *less* involved or exercise less voice in denser districts, although only by a small amount: a 10% increase in density would only be associated with a reduction of the gap in voice between high and low density places of about 1.6% (.0029/.18).

At the same time, we see in panel B of Table 5 that support for measures of reform towards education are overall not very different between college graduates and those who are not,

[7] I do not have an exogenous source of variation in the availability of voice such as variation in presence of school board, since this typically vary, like many education policies, by state

suggesting similar policy interests. For a series of education reform policies (vouchers, charters and teacher variable pay), there are no clear differences by socioeconomic status. We do observe that these reforms are more popular in denser areas, although these are not driven particularly by higher or lower socioeconomic status groups.[8] This would not predict differential effectiveness levels of voice by different groups, since pressures for reform are no different, in denser areas, for districts or schools attended by low socioeconomic status individuals.

In summary, there is no countervailing increase in voice for low SES in responding to lesser outcomes they experience in denser areas. The analyses suggests no additional exercise of voice, no different assessments of quality of schools and no different levels of support for education reform. We also see a move that is consistent with the greater availability and usage of exit by higher socioeconomic status individuals: they use voice mechanisms less in denser areas. As a result, it would seem that while there is a clear cleavage between the exercise of voice between groups with different socioeconomic status, it is somehow reduced in denser areas, but only because higher socioeconomic status individuals exercise it a little less. Moreover, contrary to what may have been expected, the greater availability of information, media outlets ease of organization and, ultimately, lesser quality of schooling, do not result in greater voice in denser areas for low SES groups.

**Causality of mechanisms and instrumental variable specifications**

We first use as is common in the literature the geographic determinants of density (see for example Combes et al. 2010 or Puga and Nunn, 2012), such as the nature of the terrain and its role in enabling the settlement of different population levels. A plausible instrument is the fertility of the land along with closeness to sea in so far as it conditioned the capacity to feed large numbers of people in an agricultural economy. This provides a historical determinant of contemporary density levels that cannot be due to the quality of education

[8] Although I focus on whether density generates any new cleavages between these groups, one hypothesis for why we may see people in denser areas be more supportive of education reform is that the likelihood of there being more information and policy entrepreneurs in denser areas. Two of these three policies (charters and vouchers) involve choice, which we have seen is generally more feasible in greater density areas.

system. Since these physical determinants of density have little immediate relation with the structure of the economy in cities today and possible gradients, and in particular with the importance of human capital in economy, reverse causality is less of a concern. An argument relating to the explicit mechanism of presence of greater choice in denser areas is made by Fischel (2009) to the effect that school districts were by and large fixed during the high school movement to be of sufficient size to be able to encompass a high school (1910-1940). This meant that the geographical size of districts today is heavily influenced by their density during that period (in turn related to geographical determinants). Density in the 1930s thus influences the physical size of districts today and so the availability of commutable districts in a given area and so we explicitly use this fixed in time density levels that arguably determined the institutional variation that drives the mechanism we are capturing.

The main concern about the use of this instrument is that this longstanding determinants set agglomeration processes in motion so that even if the relation has originally little to do with education, denser places over time become different places in ways that may be related with education outcomes. If, for instance, they attract different people from other types of areas we may observe the education gradient to be larger. One story may be that historically denser areas are also first movers to have the critical mass to create schools and universities, that benefit and attract higher socioeconomic status groups, contributing to biases. The conclusion is that this instrument may be biased to overstate the effect of density on the socioeconomic gradients in student outcomes.

An alternative specification attempts to produce estimates free of the biases that these longstanding processes may generate. Instead we use shorter term predictor of density of the student body: the local number by cohort a 8 years before (population in in 2000) combined with national fertility levels to predict student density in 2008.[9] Predicted density of K-12 students at time $t$ is then given by the (national) fertility rate at the start of the period $t-x$ (x=8) for each age cohort, multiplied by the density of the females in each age

[9] This is similar to Maestas et al.'s (2016) instrument for the ageing of the population and inspired by Bartik (1991)

cohort.[10] This number is given by the ageing by *x* years of the cohorts of females present in the district in time *t-x.* The predicted density would match density exactly if there was no in-out migration from the areas, fertility rates remained the same in the x years in the period and, given that we use national rates, if there was no across-district variation in rates.

With this instrument, the variation used is the predicted part of density levels, discounting any adjustments to the education system and recent migration of different types of people and short-term economic fluctuations that may affect the education system. The remaining variation that using predicted density will not take into account is the short-term changes in the attractiveness of areas or districts. In so far as the migration adjustments are exercized in the short term by higher socioeconomic status families, we expect the relation between predicted density and outcomes, rid of gradient-increasing short-term movements of people to understate the true causal relation between density and outcomes.

Table 6 presents results from instrumenting density with the three instruments described. They show, as expected, larger coefficients on the interaction term for density levels in the 1930s and the nature of the terrain (columns 2 and 3), while they are about the same size as the OLS estimates when using as instrument for density short-term predictors of density using the sizes of previous cohorts (column 4).

**Interpretation and Discussion**

This paper has documented differences in the heterogeneity in student outcomes across local areas systematically by trying to isolate the effects of variation in density within a framework that considers how socioeconomic groups benefit differentially from being in denser areas. In short, denser areas seem to contribute to increased inequality levels in outcomes and this appears to be mediated by higher levels of choice available to students in these areas combined with higher levels of income and racial segregation across jurisdictions.

This analysis is at least partly motivated by the attempt to document those relations, prior to making causal claims. Nevertheless, I explore the issue of whether the relation between agglomeration and the divergence in outcomes documented is causal. Denser places may be

[10] Specifications using x=18, using data from the 1990 census lead to similar results.

different in many ways beyond our mechanisms of interest and the people living in them may be different in more ways than the observables we can statistically control for. The OLS coefficients may be overstating causal relations if, for instance, differential characteristics between low status and high status groups, conditional on observables are larger in denser areas. For these coefficients to be biased, it cannot be that the unobserved differentials between denser and less dense areas are homogeneously large across the distribution of student outcomes. It would have to be a more complicated story, e.g. higher socioeconomic status students have greater aptitude in denser areas than those who look just like them on observables but lower socioeconomic status are no different or have even less aptitude in denser areas. Obvious candidates for differential characteristics of differences between cities and less dense areas would include the number of minorities or English learners at the lower end of the distribution in denser areas. Those differences are controlled for, although there may be other confounders.[11]

*Mechanisms*

It is worth considering in more detail the terms of the plausible ways in which denser commuter zones may be different. Many of them are compatible with the framework I am proposing in so far as they are channeled via the education system and connected with the picture of increased separation of students by socioeconomic status in denser areas. The mechanisms I aim to capture include the divergence in the schools that students from different groups attend in denser areas, in so far as they result directly from increased segregation in schools, relating to differences in the availability of exit mechanism and less pooling into the same schools of students from different groups, which I have argued density enables. Differences in finances, types of teachers for higher SES students but not for others are explanations that are subsumed in the variety of mechanisms included in the segregation explanation. The same applies to classroom practices, types of facilities, subjects of specialization, etc.

[11] In fact, the estimates for the interaction between socioeconomic status and density in the models with all individual controls (e.g. Table 4) is likely to underestimate any differences across groups, given that individual controls included are all correlated with the individual demographic controls.

Less relevant to the education system mechanisms I would like to capture would be other structural differences in the commuter zones that are exogenous to the school system. In additional specifications shown in Table, I control for some of those channels, such as crime levels, share foreign born, violent crime rates or the degree of social capital. I also control for the economic characteristics in the area that may affect differential incentives for students at different ends of the distribution of income performance by including the share of routine of employment in the commuter zone in the 1980s. This indicator has been generated and used by Autor and Dorn (2013) and is predictive of increases in the inequality of the labor market: regions with greater shares of routine tasks resulted in greater increases in the top and bottom of the skills distributions.

These are all conceivable channels that may affect school performance and that are correlated with density but that are distinct from the main channel of school performance I identify. I show in Table 7 that the magnitude of the relation is hardly altered if we add these controls. In the last two columns of Table 7 I, additionally, show that after adding income segregation and racial segregation directly, the magnitude of the coefficient on log density is approximately halved. This would be at least suggestive evidence that these latter two constitute potential mediating channels of the relatively large density effect on outcomes I have identified consistent with the exit theory developed.

In addition, in order to tackle remaining biases, especially due to the systemic differences between denser areas and less dense ones, I use instruments that are meant to use variation in the levels of density that is not subject to those same biases. On one hand, I use long-range determinants of density that result in differences in the level of fragmentation in different school districts (fertility of the land and closeness to cities) as well as, more directly, historic density levels at the start of the school district consolidation movement. On the other, I use recent determinants to predict density (the density of cohorts 8 and 18 years prior along with the natural expectation of aging and fertility). Both approaches would be complementary in that the remaining biases they would generate would be of opposite signs. The range of estimates for the relation between density and the SES gradient in educational outcomes is similar when instrumenting density. This would suggest that any effects from differential economic conditions of denser commuter zones, either by short- or long-term adjustments that may bias OLS estimates are relatively small.

**Next steps**

As it turns out, the voice mechanism seemed to carry no force empirically as a countervailing effect for exit and density. The evidence is stronger in the case of the exit mechanism rather than the voice mechanism. For a true picture of the importance of the voice mechanism it would be necessary to look at instances where they may be sharper variation on the institutionally-determined availability of "voice" across different areas. Exploring the voice mechanism in full will have to be embedded in further research and can at least leverage variation in participation in school boards as well as include the use of the Census of Government data on which districts have appointed vs elected school boards. Whether school districts are special districts or integrated with other parts of government could also provide useful variation.

Combining this data with the availability of other types of exit such as charter and voucher programs, typically more available in denser areas would also be useful. While about 5% of public school students are enrolled in charters, a larger number would be enrolled in denser areas, especially urban areas. One may expect the effects of those should be considered and we can expect them to mitigate some of the negative effects of density through public school choice. At the same time the very specific nature of those effects may make them only benefit certain subgroups.

Although a lot of the variation in the availability of an exit mechanism such as school district lines is given by institutional differences that are enduring and justify the use of historic levels of density and their determinants, others, such as the availability of more or less schools will be more proximally determined. Hence, alternative models such as panel models of outcomes and density could be explored.

**Conclusion**

I have presented an exploration of the variation in educational outcomes across commuter zones and of the relation between the agglomeration of school-age children in certain areas and inequality in those outcomes. I document that density is associated not only, on average, with better outcomes but also with greater inequality in those outcomes. Districts at the 90th percentile of performance gain from increases in density about twice as much as those at the 10th percentile. This seems to be driven by greater beneficial effects of density for more socioeconomically advantaged students within commuter zones: while density is associated with higher performance throughout the distribution, high performing districts seem to benefit more. Evidence that less fragmentation of school districts and income segregation results in less inequality is consistent with the view that the availability of more public school choice is driving the results. My results would suggest that denser areas do not "lift all boats" equally but that children who are disadvantaged on observable characteristics are in fact lifted less, by no longer being pooled with more advantaged peers.

At the same time, I also present some preliminary evidence that the greater exit mechanism in denser areas that benefits higher SES students more is not compensated by greater assertiveness or "voice" by families with lower socioeconomic status, who in both dense and less dense areas participate less in activities that may contribute to improving school districts.

This constitutes the beginnings of a research agenda that roots education inequality on persistent jurisdictional characteristics, such as geography and its institutional consequences, such as the fragmentation of school catchment areas through differentiated school districts. It is, naturally, connected to the stark differences that different metropolitan areas experience in intergenerational mobility levels and that has been documented by Chetty et al. (2014) and will need continual exploration. To the extent that agglomeration constitutes a driver of educational inequalities still today, the increasing urbanization of the United States, where the United Nations (2014) predicts that 85% of the population will be urban by 2050 (compared to 50% in 1950) will bring this issues even more to the fore.

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## Figures

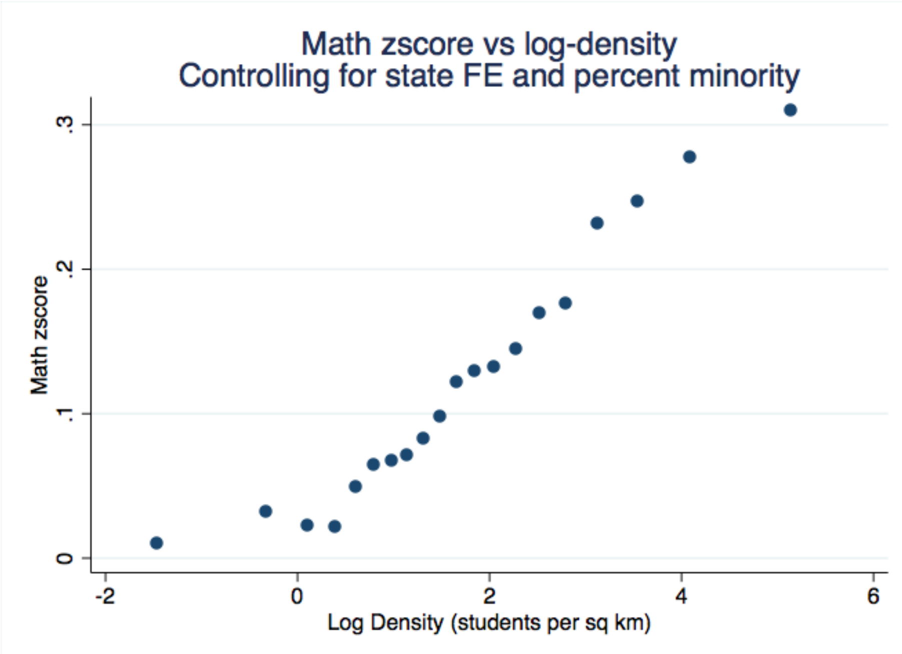



Figure 1: Plotted relation between math z score percentile and density of student enrollment with no controls (top) and log density with state fixed effects and contols (bottom), both at the district level. Each of the dots represents the average zscore of the observations in each equally sized intervals of the variable in the x-axis.

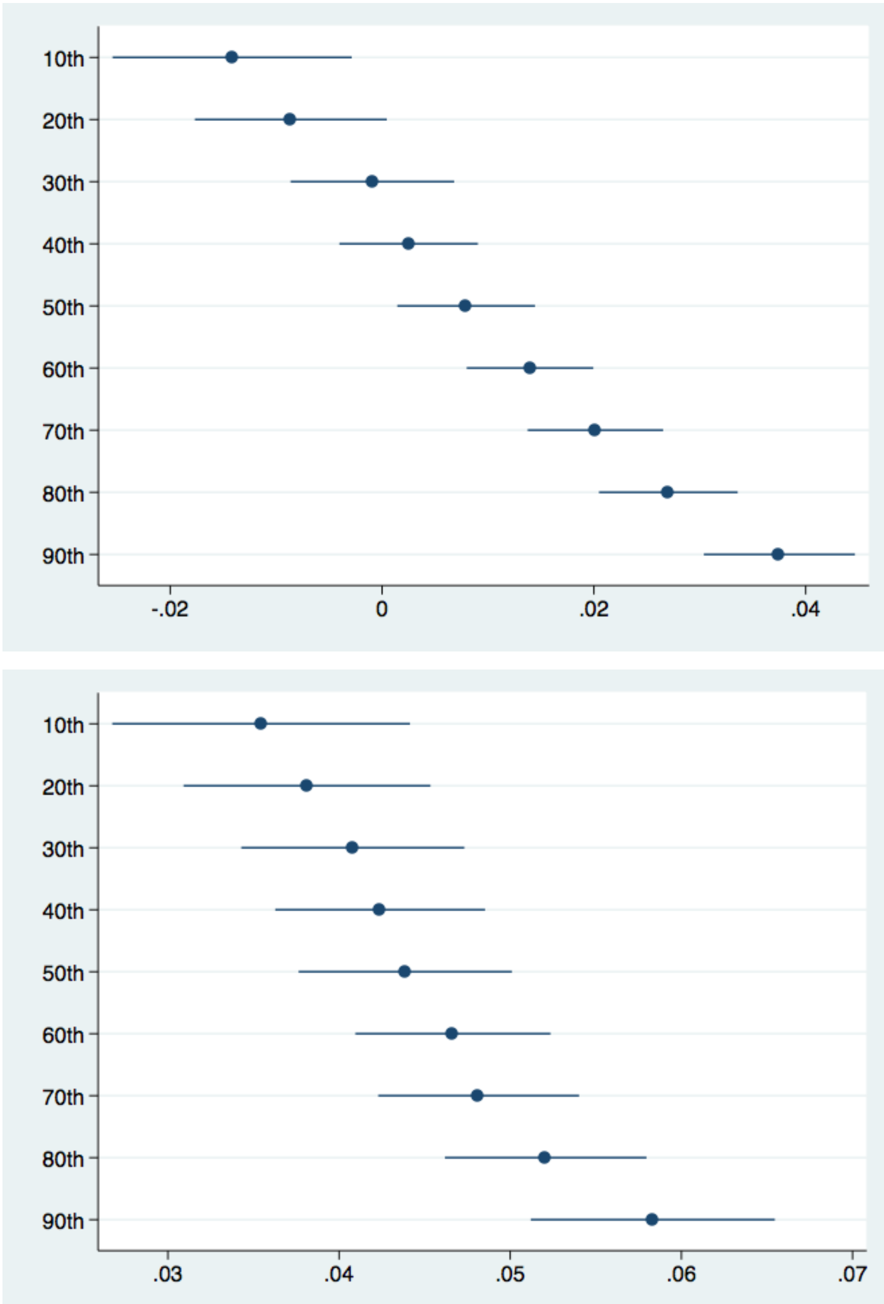
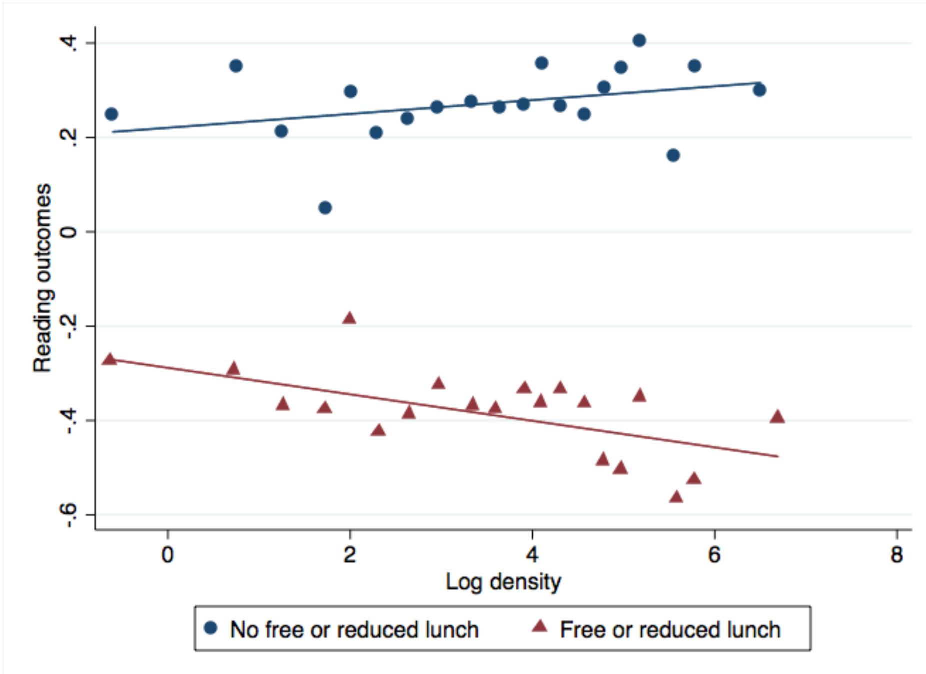



Figure 2: Plot of coefficients from a series of quantile regressions between reading zscores and district log density. Graphs include commuter zone fixed effects. The top graph does not have individual demographic controls while the bottom one does.



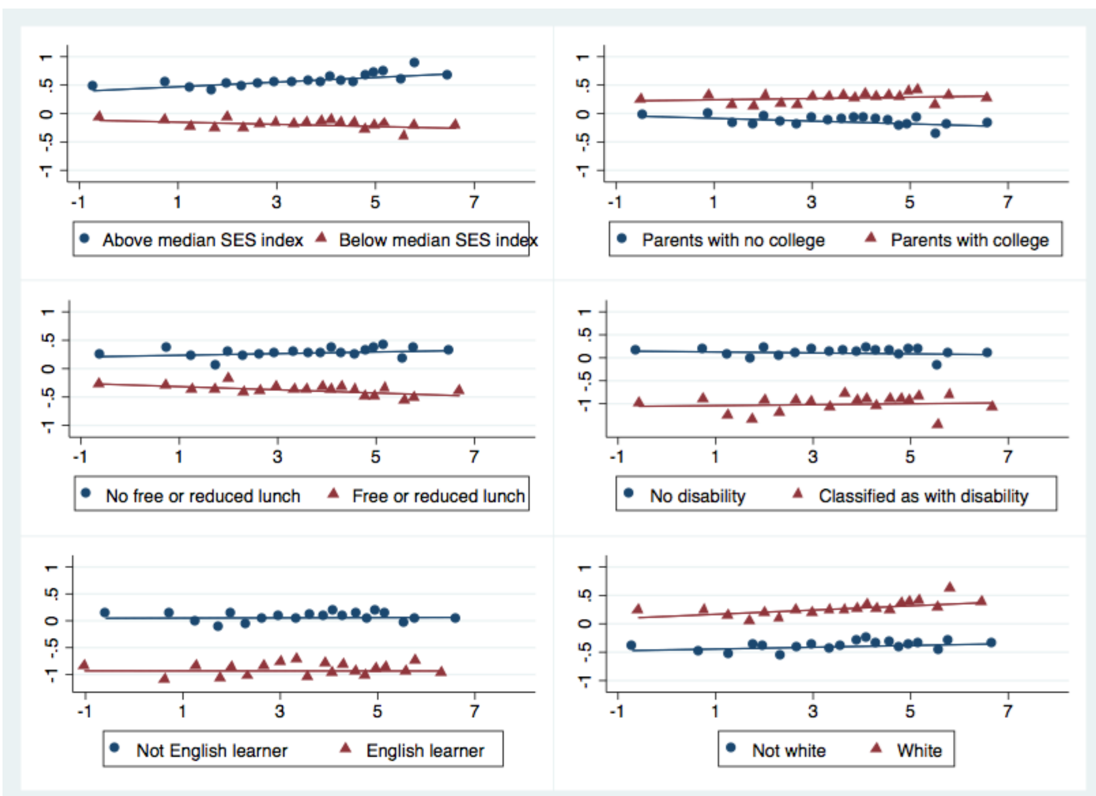




Figure 3: Relation between density and outcomes for students with and without Free or reduced lunch (top) and four additional indicators of socioeconomic status, as well as an index of all five indicators (bottom), including . Plots binned residuals from regressions with no additional controls.

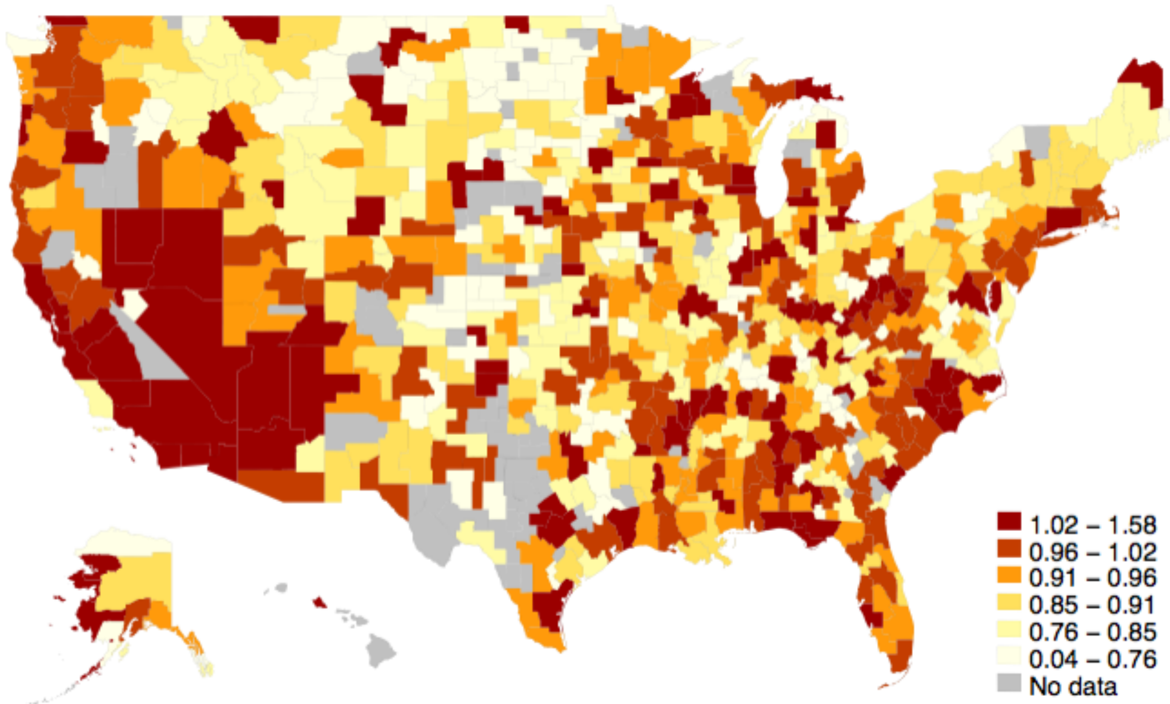



Figure 4: Map of inequality of educational opportunity by commuter zone, measured by the standard deviation of z-scores in reading within the commuter zone.

Table 1: Descriptive differences in density across commuter zones

*Panel A: Differences in average performance by commuter zone*

| | Model without controls | Model with controls |
|---|---|---|
| Maximum CZ coefficient | 2.30 | 2.03 |
| Minimum CZ coefficient | -0.03 | -0.78 |
| *Difference* | *2.33* | *2.80* |
| | | |
| Quartile 90 CZ coefficient | 1.17 | 0.58 |
| Quartile 10 CZ coefficient | 0.46 | 0.06 |
| *Difference* | *0.71* | *0.51* |
| | | |
| Quartile 75 CZ coefficient | 2.22 | 0.47 |
| Quartile 25 CZ coefficient | -0.03 | 0.20 |
| *Difference* | *2.25* | *0.26* |

*Panel B: Top 10 commuter zones by student density levels and performance rank*

| **CZname** | **Average student density** | **Effect Rank** |
|---|---|---|
| Chicago-Naperville-Joliet, IL | 1,259 | 125 |
| New York-Wayne-White Plains, NY-NJ | 852 | 103 |
| Philadelphia, PA Metropolitan Division | 487 | 155 |
| Phoenix-Mesa-Scottsdale, AZ | 366 | 67 |
| Washington-Arlington-Alexandria, DC-VA-MD-WV | 311 | 53 |
| Los Angeles-Long Beach-Glendale, CA | 291 | 58 |
| Houston-Baytown-Sugar Land, TX | 274 | 159 |
| Milwaukee-Waukesha-West Allis, WI | 254 | 66 |
| Dallas-Plano-Irving, TX | 210 | 50 |
| San Diego-Carlsbad-San Marcos, CA | 206 | 133 |

Panel A: Coefficients on commuter zone dummies from regressions of student outcomes (624 commuter zones). Panel B: Effect rank is the rank of the coefficient dummies in regression of student outcomes with individual controls.

Table 2: Effect of commuter zone density on the socio-economic gradient of performance

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| CZ log density | 0.0204*** | 0.0360*** | -0.0159* | 0.0285*** |
| | (0.00536) | (0.00605) | (0.00634) | (0.00534) |
| CZ Log density X | -0.0434*** | -0.0134 | | |
| Free Reduced Lunch | (0.00790) | (0.00907) | | |
| Free or reduced lunch | -0.471*** | -0.397*** | | |
| | (0.0265) | (0.0289) | | |
| CZ Log density X | | | 0.0407*** | 0.0165* |
| Parents graduated college | | | (0.00758) | (0.00700) |
| Parent graduated ollege | | | 0.242*** | 0.258*** |
| | | | (0.0254) | (0.0236) |
| Individual demographics | | X | | X |
| Observations | 136734 | 136716 | 119383 | 119365 |
| $R^2$ | 0.127 | 0.196 | 0.074 | 0.175 |

Coefficients of OLS model regressing z-scores of individual reading test scores on commuter zone density levels and socioeconomic status. Includes individual demographic controls and state fixed effects. Standard errors, clustered by commuter zone, in parentheses.

Table 3: Relation between Commuting Zone density and predictors of education inequality

*Panel A: Relation between CZ density and potential measures of availability of exit mechanism*

| | (1) SD reading | (2) Log students | (3) Log no. schools | (4) Log no. districts |
|---|---|---|---|---|
| Log density | 0.0222*** | 1.074*** | 1.223*** | 0.437*** |
| | (0.00482) | (0.0209) | (0.0407) | (0.0162) |
| Observations | 624 | 625 | 625 | 625 |
| $R^2$ | 0.210 | 0.905 | 0.756 | 0.793 |

*Panel B: Inequality of income across counties and within counties, and commuter zone density*

| | (1) SD county percentile difference | (2) 90th-10th county percentile difference | (3) 75th-25th county percentile difference | (4) Within county Gini coefficient mean | (5) Within county 75th-25th percentile difference |
|---|---|---|---|---|---|
| Log density | 1636.9*** | 0.0749*** | 0.0308*** | -0.000596 | -0.00805** |
| | (174.7) | (0.00571) | (0.00425) | (0.00182) | (0.00257) |
| Observations | 542 | 599 | 599 | 599 | 599 |
| $R^2$ | 0.327 | 0.420 | 0.254 | 0.574 | 0.567 |

Coefficients of regression models regressing variables aggregated at the commuter zone level on commuter zone density levels. Robust standard errors in parentheses.

Table 4: Regional variation in the relation between CZ and socioeconomic gradients

| | (1) | (2) | (3) |
|---|---|---|---|
| CZ log density | 0.0372*** | 0.0588*** | 0.0367*** |
| | (0.00658) | (0.0129) | (0.0108) |
| CZ Log density X | 0.0184** | | 0.0204** |
| Parents who attend college | (0.00632) | | (0.00623) |
| Log density X MW | | -0.0388** | |
| | | (0.0149) | |
| Log density X SO | | 0.0469** | |
| | | (0.0149) | |
| Log density X WE | | -0.0502*** | |
| | | (0.0142) | |
| Log density X | | | -0.0335* |
| College parents X MW | | | (0.0137) |
| Log density X | | | 0.0481*** |
| College parents X SO | | | (0.0139) |
| Log density X | | | -0.0393** |
| College parents X WE | | | (0.0125) |
| Midwest | | 0.0469 | 0.0281 |
| | | (0.0589) | (0.0545) |
| South | | -0.283*** | -0.290*** |
| | | (0.0591) | (0.0546) |
| West | | 0.0794 | 0.0399 |
| | | (0.0592) | (0.0534) |
| Observations | 129307 | 148923 | 129307 |
| $R^2$ | 0.254 | 0.255 | 0.260 |

Coefficients of regression models regressing individual student z-scores. The omitted category is the Northeast region.
Standard errors, clustered by commuter zone, in parentheses.

Table 5: Opinion about schools, density and participation in public schools and socioeconomic gradient.

*Panel A: Opinion about schools, density and participation in school elections*

| | (1) Grade given to local school (zscore) | (2) Grade given to national school (zscore) | (3) Attention paid to education | (4) Voting in board election |
|---|---|---|---|---|
| Log density (CZ) | -0.00103 | 0.00572 | -0.0216 | -0.000692 |
| | (0.00786) | (0.00855) | (0.0148) | (0.00631) |
| Log density X College | 0.0157 | 0.00868 | 0.0758*** | 0.0292** |
| | (0.0128) | (0.0136) | (0.0202) | (0.00904) |
| College graduate | 0.00210 | 0.0236 | -0.708*** | -0.187*** |
| | (0.0617) | (0.0642) | (0.0859) | (0.0402) |
| Observations | 24317 | 22864 | 15983 | 11475 |
| $R^2$ | 0.081 | 0.025 | 0.040 | 0.269 |

*Panel B: Support for reform measures*

| | (1) Reform index | (2) Support for vouchers | (3) Support for charter schools | (4) Support for variable pay |
|---|---|---|---|---|
| Log density (CZ) | -0.0361*** | -0.0425* | -0.0325* | -0.0238* |
| | (0.01000) | (0.0198) | (0.0126) | (0.0111) |
| Log density X College | 0.0108 | -0.0384 | 0.0249 | -0.00420 |
| | (0.0161) | (0.0275) | (0.0178) | (0.0190) |
| College graduate | 0.000593 | 0.330* | -0.214* | 0.247** |
| | (0.0707) | (0.130) | (0.0857) | (0.0864) |
| Age | -0.00371*** | 0.00264 | -0.00334** | -0.00414*** |
| | (0.000805) | (0.00165) | (0.00103) | (0.000867) |
| Income (Tsd. USD) | -0.000953** | 0.000368 | -0.00164*** | -0.000468 |
| | (0.000328) | (0.000570) | (0.000409) | (0.000348) |
| Female | 0.133*** | 0.00326 | 0.106*** | 0.199*** |
| | (0.0229) | (0.0462) | (0.0268) | (0.0308) |
| Constant | 2.964*** | 2.776*** | 2.925*** | 2.734*** |
| | (0.0808) | (0.123) | (0.0774) | (0.0921) |
| Observations | 15126 | 7473 | 19244 | 18189 |
| $R^2$ | 0.024 | 0.012 | 0.046 | 0.024 |

Coefficients of OLS models regressing individual survey responses. Responses coded as follows: Panel A: 1 Highest opinion/participation; 5 Lowest opinion/participation. Panel B: 1 Highest Support; 5 Lowest support. Standard errors, clustered by commuter zone, in parentheses.

Table 6: Instrumental variable estimates of effect of commuter zone density on the socio-economic gradient of performance

| | (1) OLS | (2) IV 30s density | (3) IV terrain | (4) IV density predicted by earlier cohorts |
|---|---|---|---|---|
| CZ log density | 0.0285*** | 0.00853 | 0.0277 | 0.0214* |
| | (0.00534) | (0.0101) | (0.0174) | (0.00930) |
| CZ Log density X Parents graduated college | 0.0165* | 0.0475*** | 0.0347* | 0.0187+ |
| | (0.00700) | (0.0138) | (0.0163) | (0.0104) |
| Parent graduated College | 0.258*** | 0.129* | 0.193** | 0.249*** |
| | (0.0236) | (0.0524) | (0.0598) | (0.0387) |
| Observations | 119365 | 112952 | 104315 | 107941 |
| $R^2$ | 0.175 | 0.178 | 0.167 | 0.176 |

Coefficients of OLS and 2 stage least squares models regressing z-scores of individual reading test scores on commuter zone density levels and socioeconomic status. In the IV columns, commuter zone density is instrumented as indicated. Individual demographics controls and state fixed effects included. Standard errors, clustered by commuter zone, in parentheses.

Table 7: Variation in reading outcomes and regressions with density

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Log density | 0.0852*** | 0.0871*** | 0.0748*** | 0.0951*** | 0.0920*** | 0.0507*** | 0.0446*** |
| | (0.00707) | (0.00728) | (0.0106) | (0.00862) | (0.0120) | (0.00734) | (0.00950) |
| Violent crime | -9.564 | | | | -2.693 | | |
| | (6.924) | | | | (13.76) | | |
| Share foreign born | | -0.530 | | | -0.101 | | |
| | | (0.369) | | | (0.512) | | |
| Share routine jobs | | | 0.691 | | 0.396 | | |
| | | | (0.631) | | (0.668) | | |
| Social capital index | | | | 0.0525*** | 0.0431** | | |
| | | | | (0.0129) | (0.0141) | | |
| Racial segregation | | | | | | 1.353*** | |
| | | | | | | (0.137) | |
| Segregation of income | | | | | | | 2.916*** |
| | | | | | | | (0.597) |
| Observations | 613 | 638 | 624 | 624 | 599 | 638 | 638 |
| $R^2$ | 0.232 | 0.218 | 0.206 | 0.228 | 0.238 | 0.342 | 0.246 |

Coefficients of OLS models regressing standard deviations in reading outcomes for commuter zones, as in panel A of Table 4. Additional variables are included as commuting zone aggregates. Robust standard errors, clustered by commuter zone, in parentheses.