The Role of School Quality in Upward Mobility: Evidence from Middlesex County, MA

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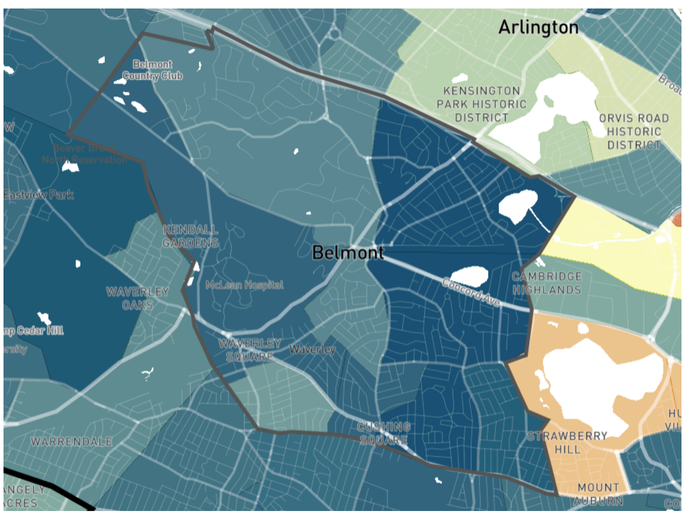
Introduction

For my project, I chose to examine Belmont, MA— my hometown and the place I attended public school from K-12— and its broader context in Middlesex County. Right next to Cambridge, the town of Belmont (pop. ~26,000) is known for its strong public school system, which consistently ranks among the top in the state. Belmont High School routinely posts high SAT scores and ranks among Harvard's top feeder schools (*2023-24 SAT Performance Report*, 2024; Goncalves et al., 2024). More broadly, Middlesex County boasts Massachusetts's highest median income, a dense cluster of universities and biotech firms, and includes many Harvard faculty— making this region a fascinating setting for exploring economic opportunity (*Income*, 2024).



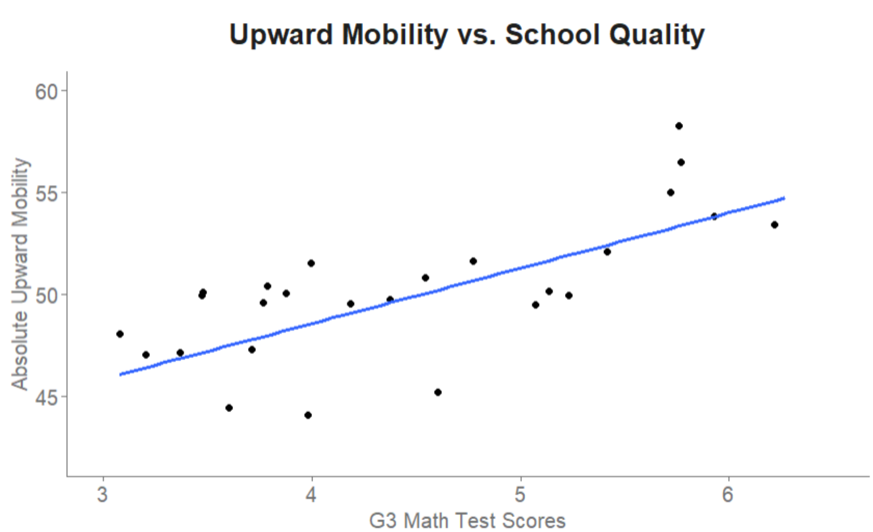
Region <chr>	Mean_Upward_Mobility <dbl>
Belmont	59.35570
Middlesex County	49.45877
MA	46.40324
US	42.85813

Throughout this paper, we will refer to average household income rank at age 35 for people who were born to parents in the 25th income percentile as *absolute upward mobility*. According to the Opportunity Atlas data above, Belmont also has one of the highest rates of absolute upward mobility in the region, especially compared to state and national averages. In fact, multiple census tracts in Belmont are in the 99th percentile for this metric, indicated by the darkest areas on the map (Opportunity Insights, 2024). This paper examines the link between

Belmont's strong schooling system and its high upward mobility, testing the hypothesis that school quality is a major driver of Belmont's exceptional outcomes. In other words, we posit that the exceptional outcomes of children from low-income families in Belmont are significantly attributable to the quality of education and related advantages provided by growing up in Belmont's school district. This hypothesis is grounded in the idea that better schools equip children with skills and opportunities that translate into higher earnings in adulthood.

Correlational Evidence

We assume that if school quality is a key causal factor, then other communities within Middlesex County with similarly high-performing schools should also exhibit higher upward mobility for low-income kids. Thus we will first examine whether school quality has a significant positive association with upward mobility across neighborhoods. There are a lot of factors that play into education quality, but it is unrealistic to capture all of them given the data available. For the purposes of this project, we will use 2013 average school district level standardized math test scores in 3rd grade as a proxy for school quality. We start by visualizing trends with a binned scatterplot:



This indicates a clear positive association between absolute upward mobility and grade 3 math test scores. Next, we run a linear regression and test for statistical significance. Throughout the project, we pay attention to statistical significance (using conventional thresholds like $p < 0.05$ for significance, $p < 0.01$ for high significance). We will report t-statistics or p-values for key coefficients.

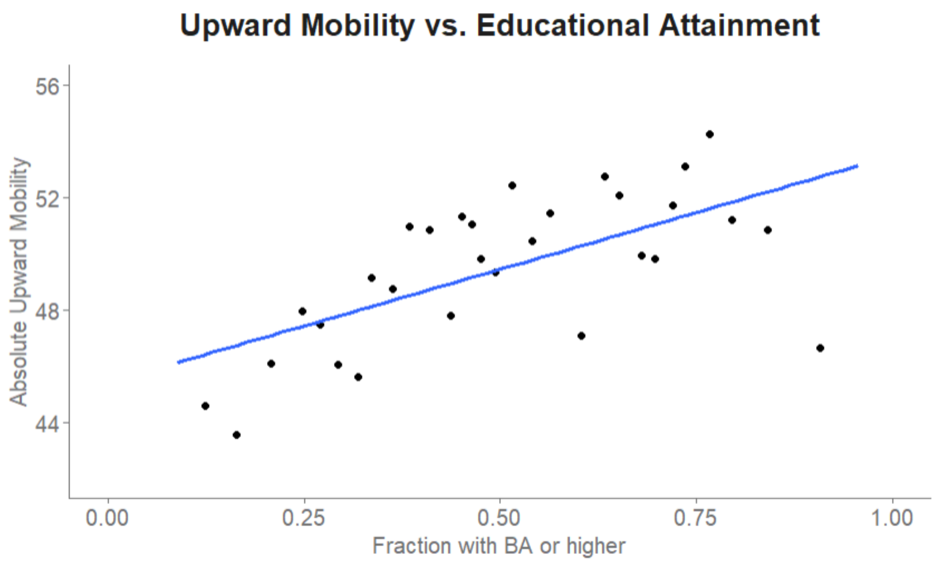
```
t test of coefficients:

                  Estimate Std. Error t value             Pr(>|t|)
(Intercept)       37.74052    1.42690 26.4494 < 0.00000000000000022 ***
gsmn_math_g3_2013  2.70947    0.32821  8.2554  0.00000000000004289 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Given the extremely small p-values, we are confident that this positive association is statistically significant and not due to chance. However, statistical significance does not imply causality, and further adjustment for potential confounders are necessary to assess the validity and practical relevance of this association.

We will include two important covariates that potentially affect both student achievement and economic mobility. The first is college education rate, the percentage of age 25+ residents in 2010 who have a bachelor’s degree or higher. This variable serves as a proxy for the overall educational attainment and human capital in the community, which could influence children through peer effects, role models, or expectations. We expect that areas with more college-educated adults provide environments that foster higher aspirations and opportunities for youth. The second is 1990 median household income (in 2015 dollars). Median income captures the general socioeconomic status and resources of the neighborhood. Wealthier communities tend to have better-funded schools, safer environments, and more enrichment opportunities.

These covariates are especially important to consider for Belmont, which has quite high college education rates (80.2%) and median household incomes ($178,188) especially compared to national and state averages (*Census Profile*, 2023). Furthermore, the below binned scatterplots, paired with regressions and significance tests, indicate that both covariates are statistically significantly positively associated with upward mobility in Middlesex County:




```
t test of coefficients:

                   Estimate Std. Error t value              Pr(>|t|)
(Intercept)        45.41317    0.76367 59.4668 < 0.00000000000000022 ***
frac_coll_plus2010  8.06179    1.67089  4.8249           0.000002186 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
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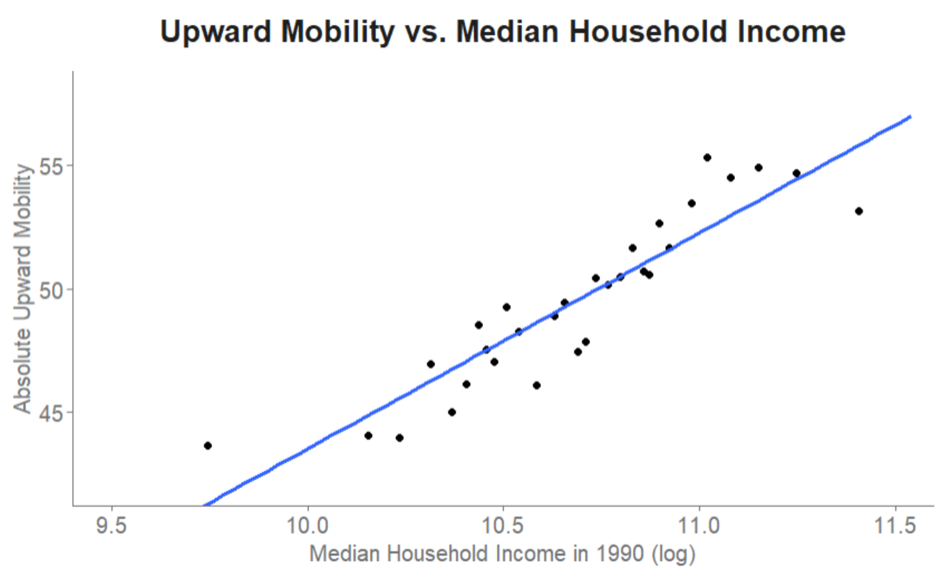

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t test of coefficients:

                   Estimate Std. Error t value              Pr(>|t|)    
(Intercept)       -43.88663    8.73772 -5.0227          0.0000008551 ***
log(med_hhinc1990)  8.74062    0.82284 10.6225 < 0.00000000000000022 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Note that because median household income is highly right-skewed, we log-transformed it to improve linearity, reduce heteroskedasticity, and achieve a better overall fit in our regression diagnostics.

Regression Model

To further test for causation, we proceed with a multivariate regression model, allowing us to adjust for residents' education and income concurrently, thereby reducing confounding bias and enabling a more credible test of the causal impact of school quality on student outcomes. The baseline model can be expressed as (*i* indexes the census tract):

$$\text{UpwardMobility}_i = \beta_0 + \beta_1\,\text{Grade3MathScore}_i + \beta_2\,\%\text{CollegeGrads}_i + \beta_3\,\log(\text{MedianIncome}_i) + \varepsilon_i$$

The coefficient β_1 captures the association between school quality (test scores) and absolute upward mobility, controlling for the educational attainment of the community and its income level. If our hypothesis is correct, we expect β_1 to be positive and statistically significant, indicating that areas with higher test scores (better schools) tend to produce more upward mobility, even after accounting for how rich or educated the community is on average. We also expect β_2 and β_3 to be positive, as having more college-educated neighbors and higher local income could each contribute to better outcomes for kids. In addition, comparing these to the bivariate results earlier lets us see how the relationships change when controls are added (for instance, whether the school quality effect is partly mediated by income or vice versa). The table below includes the results of the regression.

```
t test of coefficients:

                    Estimate Std. Error t value          Pr(>|t|)    
(Intercept)        -32.49109    9.93951 -3.2689          0.001201 ** 
gsmn_math_g3_2013    1.14173    0.43617  2.6176          0.009288 ** 
frac_coll_plus2010  -1.39985    1.82203 -0.7683          0.442897    
log(med_hhinc1990)   7.27742    1.01754  7.1519 0.000000000006155 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Holding other factors constant, a one-point increase in a tract’s average grade-3 math score is associated with a 1.14-point rise in upward mobility ($p \approx 0.009$), indicating that higher grade 3 math scores— our proxy for school quality— is associated with greater upward mobility, even after accounting for community socioeconomic factors. The coefficient on Grade 3 scores is somewhat reduced compared to the bivariate case, but it is still positive and statistically significant, lending direct support to our hypothesis. By contrast, the percentage of college-educated residents shows a negative coefficient (–1.40) but fails to reach significance ($p \approx 0.44$), indicating no clear independent effect once we account for income and early math scores. The lack of a significant independent effect for the share of college-educated residents suggests that adult education levels do not drive mobility above and beyond what’s already captured by student performance and local wealth. Finally, logged median household income is statistically important: a one-unit increase in log income corresponds to a 7.28-point gain in upward mobility ($p < 0.001$), underscoring the strong role of community wealth. The large, highly significant income effect shows that neighborhood resources remain a powerful determinant of economic opportunity.

To assess the robustness of our school quality effect and further guard against omitted‑variable bias, we now estimate an expanded model that adds a comprehensive set of area‑level controls— racial and ethnic composition, family‑structure shares, homeownership rates, local job and population density, and urbanization— to more completely account for community context when estimating the causal impact of Grade-3 math achievement on upward mobility.

```
t test of coefficients:

                          Estimate     Std. Error t value   Pr(>|t|)
(Intercept)            -32.5417159164  20.0900511705 -1.6198   0.106321
gsmn_math_g3_2013        0.8330142253   0.4987952468  1.6701   0.095945 .
log(med_hhinc1990)       6.1131623739   1.8721839247  3.2653   0.001219 **
frac_coll_plus2010      -2.9471043182   2.5284643839 -1.1656   0.244708
singleparent_share2010   3.7167020865   3.1451033971  1.1817   0.238238
share_white2010         10.9504234940   3.6780645404  2.9772   0.003144 **
share_black2010         -2.9615290340   5.7939257898 -0.5111   0.609624
share_hisp2010           8.8190197281   5.9715433131  1.4768   0.140760
share_asian2010         32.8278134366   7.5277423221  4.3609 0.00001779 ***
homeownership2010        0.4566923608   3.0627021206  0.1491   0.881563
job_density_2013        -0.0000093008   0.0000388864 -0.2392   0.811128
popdensity2010          -0.0000366205   0.0000541933 -0.6757   0.499724
share_urban2010          2.7888530446   2.1254918640  1.3121   0.190484
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

In this multivariate regression model, the estimated effect of Grade-3 math achievement on upward mobility falls to 0.83 ($p \approx 0.096$), rendering it only significant at the 10% level once we control for a broad set of community characteristics. Logged median household income remains a strong, positive predictor ($\beta = 6.11$, $p < 0.01$), underscoring the persistent importance of local wealth. Among the newly added covariates, the racial‑composition measures stand out: a higher share of Asian residents is associated with a large, highly significant increase in mobility ($\beta = 32.83$, $p < 0.001$), and the White share also shows a positive, significant coefficient ($\beta = 10.95$, $p < 0.01$). By contrast, the shares of Black or Hispanic residents, single‑parent family rates, homeownership, job and population density, and urbanization all have non‑significant coefficients. In sum, once we account for demographic composition and density measures, the direct link between early math scores and upward mobility weakens, suggesting that part of the "school‑quality" signal captured by Grade-3 scores in simpler models may actually reflect underlying community socioeconomic and demographic context. This provides only weak support for our hypothesis.

Reasoning by Conditioning

We further investigate the causal relationship between school quality and upward mobility through reasoning by conditioning. If our hypothesis were true, then we should still see a positive association between school quality and upward mobility across tracts with different levels of income. However, conditioning on tracts being in the bottom median income quintile, we get an interesting regression result:

```
t test of coefficients:

                  Estimate Std. Error t value             Pr(>|t|)
(Intercept)        59.3995     6.1164  9.7115 0.00000000000006398 ***
gsmn_math_g3_2013  -4.0952     1.7154 -2.3873             0.02014 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

If stronger school quality really drives upward mobility, we should still see a positive Grade 3 math score coefficient even in the poorest neighborhoods. Instead, when we restrict our sample to tracts in the bottom quintile of median income, the relationship flips— our regression yields a statistically significant negative slope on Grade-3 math ($\beta = -4.10$, $p = 0.02$). In these low-income areas, a one-point increase in average third-grade math scores is associated with a 4.10-point decrease in upward mobility. This counterintuitive result suggests that in the most disadvantaged communities, higher test scores alone may not translate into greater economic opportunity— perhaps because of limited local resources, unmeasured barriers beyond school quality, or measurement noise in mobility estimates. Rather than supporting our hypothesis, this implies that the school-quality signal captured by early achievement interacts with deeper structural constraints in low-income settings.

As an additional check, we replicate the regression analysis for census tracts in the highest median income quintile to see if the patterns hold.

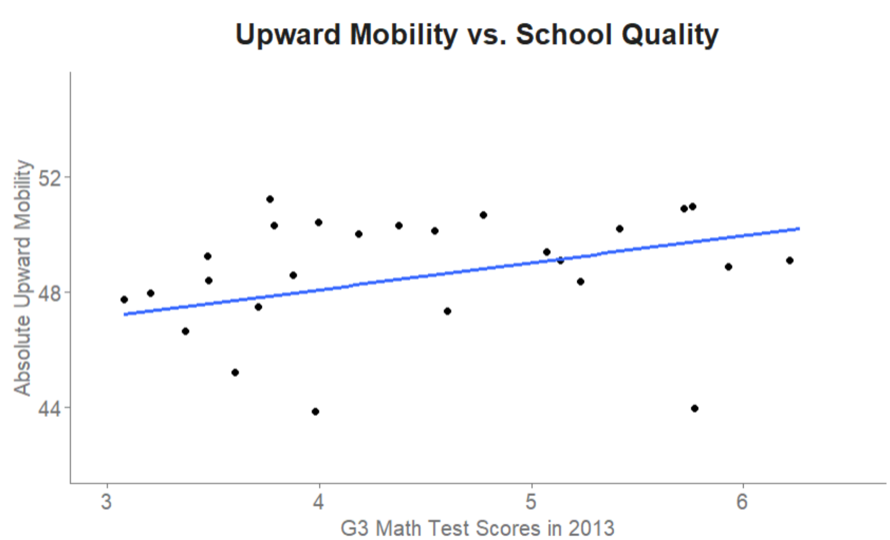
```
t test of coefficients:

                  Estimate Std. Error t value            Pr(>|t|)
(Intercept)        44.2421     2.3775 18.6089 < 0.00000000000000022 ***
gsmn_math_g3_2013   1.6222     0.4913  3.3019            0.001191 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

In the richest quintile of neighborhoods, the Grade-3 math coefficient returns to a positive, statistically significant value: a one-point gain in early math scores predicts a 1.62-point increase in absolute upward mobility ($p \approx 0.0012$). This contrasts sharply with the negative slope we saw in the poorest quintile. A plausible explanation for this is that higher early achievement only translates into greater mobility where sufficient community resources already exist. In other words, school‑quality, as measured by third‑grade math performance, appears to drive long‑term opportunity in affluent areas but is insufficient on its own to overcome structural constraints in low-income settings.

Lockbox Replication

To guard against snooping, we perform out-of-sample validation with the lockbox data. First, we confirm the positive association between upward mobility and school quality:



```
t test of coefficients:

                  Estimate Std. Error t value              Pr(>|t|)    
(Intercept)       44.31891    1.09388 40.5153 < 0.00000000000000022 ***
gsmn_math_g3_2013  0.94199    0.25652  3.6722             0.0002828 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Indeed, there is a statistically significant ($p \approx 0.00028$), positive ($\beta \approx 0.94$) association between Grade 3 math scores and absolute upward mobility, which is fairly consistent with our previous findings. Next, we replicate the multivariate regression with three variables, which yielded some interesting results:

```
t test of coefficients:

                  Estimate Std. Error t value     Pr(>|t|)    
(Intercept)        0.90477    8.29354  0.1091      0.91320    
gsmn_math_g3_2013  0.36022    0.39981  0.9010      0.36830    
frac_coll_plus2010 -3.83094   1.66333 -2.3032      0.02193 *  
log(med_hhinc1990)  4.48104   0.86216  5.1975 0.0000003666 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

In the lockbox validation sample, the Grade-3 math coefficient loses statistical significance ($p \approx 0.368$). Unexpectedly, the share of adults with at least a college degree now has a significant negative association ($\beta = –3.83$, $p \approx 0.022$), while logged median income remains a strong positive predictor ($\beta = 4.48$, $p < 0.001$). Therefore once we control for local income, areas with a higher college-graduate share paradoxically show lower upward mobility here, and the school quality proxy (early math scores) no longer predicts mobility. This suggests that our earlier findings around Grade 3 achievement may not generalize fully out-of-sample, and that the interplay between school quality, educational attainment, and community wealth can shift depending on the data subset. These out-of-sample results weaken support for our school quality hypothesis.

Discussion

Our empirical analysis explored the hypothesis that school quality significantly contributes to upward economic mobility, specifically in Middlesex County, MA, using Grade-3 standardized math scores as a proxy. Initially, our bivariate analysis revealed a strongly significant positive relationship between school quality and absolute upward mobility, indicating preliminary support for our hypothesis.

However, as we introduced controls for community-level socioeconomic characteristics, such as median household income and residents' educational attainment, this association weakened. While Grade-3 math scores remained statistically significant after controlling for these confounders, the strength of this relationship notably diminished, highlighting that neighborhood socioeconomic status independently plays a substantial role in determining upward mobility. This finding emphasizes that local wealth likely provides crucial resources and opportunities that enhance long-term economic outcomes.

Our analysis further complicated the picture through reasoning by conditioning on income quintiles. Intriguingly, when examining census tracts within the lowest income quintile, the relationship between school quality and upward mobility turned negative and significant. This unexpected result suggests that in severely disadvantaged communities, high early educational achievement alone does not necessarily translate into economic advancement, potentially due to structural barriers that educational quality alone cannot overcome. Conversely, in high-income communities, the positive association between school quality and upward mobility persisted strongly, reaffirming that favorable community resources amplify the benefits of strong educational foundations.

Lastly, our robustness check using lockbox (out-of-sample) validation data reduced our confidence further. Although Grade-3 math scores again positively correlated with upward mobility initially, their predictive power vanished once socioeconomic factors were included in the regression model. In fact, higher adult educational attainment exhibited a surprising negative relationship with mobility in this out-of-sample test, which signals complex underlying dynamics not captured by our initial models.

In summary, while initial analyses appeared to support our hypothesis that school quality significantly drives upward mobility, deeper examinations incorporating additional socioeconomic and demographic controls indicate that the reality is far more nuanced. School quality does contribute positively to upward mobility, especially in affluent contexts, but its impact significantly diminishes or even reverses in economically disadvantaged areas. Therefore, our empirical findings only partially and conditionally support the original hypothesis.

Limitations

Our analysis has several important limitations that affect the interpretation and generalizability of our results. First, causal inference remains challenging due to potential omitted variable bias. Although we controlled for some socioeconomic and demographic factors, unobserved characteristics— such as school funding levels, teacher quality, parental involvement, or broader community support— could still confound the observed relationships. Such omitted variables might either overstate or understate the true impact of school quality. We cannot definitively say that Belmont's high test scores cause its children to have higher incomes. We echo the caution of Chetty et al. (2014) that one should not interpret cross-area correlations as causal effects.

Second, measurement error presents another key limitation. Using Grade-3 standardized math test scores as a proxy for school quality simplifies a complex construct into a single metric, possibly overlooking other important educational dimensions like instructional quality, student engagement, extracurricular opportunities, and non-cognitive skill development. Measurement error in either the mobility or school-quality variables could bias our estimates, potentially weakening observed associations.

Third, the scope and external validity of our study are limited. Our results are based specifically on Middlesex County, a uniquely affluent and education-rich region in Massachusetts, which may limit the generalizability of our findings to less advantaged or demographically distinct regions. Consequently, the observed patterns might not translate directly to other counties, states, or national contexts with differing socioeconomic and demographic compositions.

Lastly, data constraints pose practical limitations. The cross-sectional nature of our data restricts our ability to explore longitudinal impacts and dynamic interactions between school quality and socioeconomic context over time. Furthermore, the aggregate, tract-level data we used masks individual-level heterogeneity, potentially obscuring nuanced individual experiences and pathways that influence upward mobility. Overall, while informative, our analysis should be viewed as exploratory rather than definitive, highlighting critical associations and areas for further, more granular research.

Further Research

To address the question of causality, researchers could employ quasi-experimental methods. One such method is Regression Discontinuity Design (RD), where we utilize school district boundary discontinuities. We can compare children who grow up geographically near each other but on opposite sides of a school district boundary, i.e. a boundary between Belmont and Waltham, a neighboring town. Families just inside the Belmont border send their kids to Belmont public schools, while those just outside go to a different school system, yet these families may be very similar in socioeconomic status and other characteristics due to their close proximity. If we focus on families living very near the boundary, we can treat the assignment to Belmont schools vs. the neighboring schools as if it were random. We must check that there is no manipulation at the boundary, or that people do not intentionally sort right around the boundary just for schools. This creates a quasi-experiment where the running variable is distance to the Belmont border, and the cutoff is the border itself determining school assignment. For an RD to yield causal estimates, we need the assumption that no other factors change discretely at the boundary, and that families just inside vs. outside are comparable except for the school district. We would examine the discontinuity in absolute upward mobility at that boundary. Also note that RD designs, while providing strong causal inference locally, may offer limited external validity beyond the immediate boundary area. We are essentially asking: holding location constant (within a few blocks), does being on the Belmont side of the line boost economic opportunity?

Another approach is Difference-in-Differences (DiD), where we find a policy change or shock that affected Belmont (or similar towns) but not other areas, or vice versa, and then track outcomes before and after that change in a comparative way. For example, suppose Belmont undertook a major school reform or infrastructure investment, such as building a new high school or reducing class sizes that significantly improved its already good schools, while a comparable town did not. One could compare cohorts of children who were educated before the reform and after the reform in Belmont, using the neighboring town's children as a control group over the same period. This DiD setup would account for any fixed differences between Belmont and the comparison town, focusing on the change in outcomes attributable to the timing of the reform. Crucially, this method relies on the parallel trends assumption—that without the reform, Belmont and comparison town outcomes would have evolved similarly over time. Implementing this would require longitudinal data by area on children's outcomes by birth year, such as test scores, college attendance, or earnings.

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