Do Long Bus Rides Drive Down Academic Outcomes?

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Abstract

School buses may be a critical education policy lever, breaking the link between schools and neighborhoods and facilitating access to school choice. Yet little is known about the commute for bus riders, including the average length of the bus ride or whether long commutes harm academic outcomes. We begin to fill this gap using data from New York City to explore the morning commutes of over 120,000 bus riders. We find that long bus rides are uncommon and that those with long bus rides are disproportionately Black and more likely to attend charter or district-choice schools. We find deleterious effects of long bus rides on attendance and chronic absenteeism of district-choice students.

Keywords: Pupil Transportation, School Buses, Academic Outcomes

Introduction

More than half of the nation's 49.5 million public school students use a school bus to get to school, costing districts roughly $1,000 per pupil on average (School Bus Fleet, 2020; National Center for Education Statistics, 2019, Table 203.10). While largely ignored in the literature until recently, school buses may be a critical education policy lever, allowing students to attend schools too far to walk to and facilitating reforms such as desegregation or district consolidation. School buses may also be key to breaking the link between schools and neighborhoods and facilitating school choice as they enable access to higher quality schools regardless of residential location. Indeed, author (2018) finds that students who use the school bus are more likely to attend a school other than their zoned school and are also more likely to attend higher quality schools than their peers who do not use the bus.

Despite the potential for school buses to improve educational access and outcomes, a broad range of concerns about school buses are reported in popular media and discourse. These include concerns about reliability (late pick-ups or no-shows), timing (early pick-ups, late drop-offs), safety (lack of seatbelts, bullying), and access (limiting school choice). One of the most common complaints is that bus rides are too long, with some news reports citing cases where students are on the bus for 4-5 hours each day (Chapman, 2019). Yet little is known about the commute for bus riders, including the average length of the bus ride, which students experience long bus rides, or whether long commutes are deleterious for academic outcomes. In this paper we begin to fill this gap using data from New York City (NYC) to explore the morning commutes of over 120,000 bus riders in grades 3- 6 over the period of 2011-2017, focusing specifically on the prevalence of long bus rides and examining the link between commuting and academic outcomes. We then exploit plausibly random variation in the within-route commute time due to idiosyncrasies in routing to identify the causal effect of long commutes on student outcomes.

To preview our results, we find that the average bus ride is relatively short—only 21 minutes—and the majority of students have commutes of less than 30 minutes. Only 6.1 percent of students have long bus rides (45-60 minutes) and rides over one hour – which we term "very long bus rides" – are, by definition, uncommon, with only 3.3 percent of bus riders, or 517 students. Students with very long bus rides are disproportionately Black and almost exclusively attend district choice or charter schools. Commute times negatively impact both attendance and chronic absenteeism, particularly among students in district choice schools, for whom long and very long commutes decreases attendance 0.330 and 0.625 percentage points and increases the probability of chronic absenteeism by 1.8 and 3.2 percentage points, respectively. Although neither long nor very long commutes affect test scores overall, they may have negative effects on charter school students, particularly those who are poor. We find little evidence of heterogeneity by race.

Literature

Previous research offers limited insight into the link between the school bus and student outcomes. Rather, it tends to focus on safety concerns, such as seat belts or bus driver training (for example, Henderson, 2009; Cook & Shinkle, 2012), bullying and managing disruptive behavior (for example, deLara, 2008; Krueger, 2010), or the consequences of busing in the context of desegregation efforts (for example, Floyd, et al., 1983; Lu & Tweeten, 1973). Other work examines the role of the school bus in rural school district consolidation (for example, Killeen & Sipple, 2000; Spence, 2000) and the environmental consequences of school bus emissions on student health and academic outcomes (Austin, et al., 2019; Laurito, 2017). We begin to fill this gap in the literature by examining the link between long bus rides and student outcomes.

Why Might Long Commutes Affect Student Outcomes?

There are a variety of ways in which school buses or the length of the bus ride may affect academic outcomes. To begin, school buses might improve outcomes if they enable students to

attend higher-quality schools they would have otherwise been unable to attend. Indeed, authors (2018) show that NYC elementary school students who take the school bus are more likely to attend a choice school (rather than their zoned school) and attend a significantly better school than other students attending choice schools who do not ride the bus. Riding the bus may also improve student performance regardless of ride length, if taking the bus eases school-going logistics in the morning, reduces absenteeism, and/or increases participation in before-school activities, such as school breakfast. Consistent with this, authors (2019) and Gottfried (2017) report that students taking the bus have lower absenteeism. <endnote 1> That said, none of these papers examine the length of the bus ride or how students with long bus rides perform relative to other bus riders with shorter commutes.

Conversely, riding the school bus or the length of the bus ride may *harm* performance if it encroaches on time for homework, extracurricular activities, or sleep, or increases absenteeism– due either to the timing of pick-up or drop-off or the length of the commute itself. Long bus rides may mean early pick-ups, which require early wake up calls and less sleep. While we are aware of no existing research that explicitly examines the effects of early bus pick-ups, a lengthy literature documents the impact of early school start times on student outcomes.

Exploiting changes to start time or random assignment into class schedule, previous research finds increased performance following later school start times, suggesting that sleep is the mechanism that affects performance (Owens et al., 2010, Carrell et al., 2011, Heissel & Norris 2017, and Dunster et al., 2018). This could mean that long bus rides will negatively impact performance if long bus rides mean early pickup and less sleep. In addition, long bus rides should lead to higher absenteeism if students are more likely to miss the bus due to early pick-ups or find long bus rides unpleasant. Indeed, Blagg, et al. (2018) find that Washington, D.C. students with longer commutes have higher absenteeism.

Evidence on Long Commutes and Academic Outcomes

Only two existing studies we are aware of explicitly examine the link between commute times and academic outcomes. In the study most similar to ours, Blagg, et al. (2018) use student-level data from Washington, DC to compare test scores and attendance rates for students with long and short commutes by car or public transit both between and within schools. They find that students with commutes at the 75th percentile (14 minutes) are absent about one more school day per year than classmates with commutes at the 25th percentile (3 minutes). Despite increased rates of absenteeism, they find no difference in test scores for students with longer commutes. Thus, students with longer commutes might have unobserved characteristics, like motivation, that lead them to commute further to school and enable them to score similarly on standardized tests, despite higher absenteeism rates.

Stein, Burdick-Will, and Grigg (2020) use student-level data from Baltimore to examine the relationship between travel time using public transit and likelihood of school transfer. They find that high school students with commutes over an hour are about three times more likely to transfer schools than students with commutes less than ten minutes. After transferring, students attend schools that are closer to home than the previous school attended, with nearly half of all students attending a school both closer to home and lower ranked and 70 percent attending a school not listed in their top five choices for school choice. This suggests students may value short travel times above school quality and that students might underestimate travel times when choosing schools.

Contribution

Our study improves on prior work in several ways. First, while Blagg et al. (2018) and Stein et al. (2020) estimate travel times for students using a public transit or private automobile, they are unable to link students with actual transportation usage or commute length. Further, the reliance on estimated – rather than measured – travel time may cause attenuation bias – biasing

estimated impacts toward zero. Our data provides specific information on school bus transportation assignment, including pick-up time. Since the pick-up time is fixed, it provides more accurate estimates of individual commute times, ameliorating the attenuation bias.

Second, neither of these studies consider long commutes using the school bus, since DC Public Schools does not offer school buses for general education students and Baltimore City Public Schools does not offer school buses for high school students. Both papers instead explore commute times using public transit, while Blagg et al. (2018) also explore commute times for students traveling in cars. School bus commute times are likely longer than car travel times, which are more direct, and more comparable to public transit commute times, but may be less complicated to navigate because school bus commutes do not require transfers. Our study focuses on students commuting using the school bus.

Third, while Blagg et al. (2018) and Stein et al. (2020) examine the relationship between commute length and student outcomes, they do not explicitly distinguish *long* commute times. Instead, the relationship between commute time and outcomes is assumed to be linear, which may not be the case. Furthermore, Blagg et al. (2018) define a long commute as the 75th percentile of student commutes, which is just 14 minutes. This commute length may not be long enough to affect student outcomes and may not reflect "long" commutes in other contexts. We address this by exploring varying definitions of long bus rides.

Fourth, using information on route assignment and prior outcomes, we are able to estimate models with route fixed effects and lagged outcomes – value-added models – to produce credibly causal estimates of a long bus ride on student outcomes. By comparing students on the same route, we capture differences in performance between students (for idiosyncratic reasons) picked up earlier – and therefore with longer bus rides – and students picked up later with shorter bus rides. Lagged outcomes account for unobserved characteristics, such as motivation, which may have

biased previous estimates.

Setting

New York City (NYC) is an ideal context to explore these questions for four key reasons. First, the NYC Department of Education (NYCDOE) has provided unique, detailed, longitudinal student- and school-level data on pupil transportation, which makes this study possible. Second, we observe students attending a variety of school settings, including their zoned school, district-choice schools – a traditional public school other than their zoned school, and charter schools, so we can estimate the link between busing and academic performance among students who attend these different types of schools, which may involve different commutes. Third, the diversity of NYC public school students allows us to explore the differential effect of long bus rides by a variety of characteristics including poverty, gender, and race/ethnicity. Lastly, there is wide variation in the size and density of NYC neighborhoods, which allows us to explore the incidence and effect of long bus rides across neighborhoods of different density and character, from hyper-dense neighborhoods in Manhattan to less-dense neighborhoods in Queens and Staten Island that more closely resemble smaller cities or outer-ring suburbs.

Eligibility for bus service in NYC is based on several factors, including district-level policies governing how far students in elementary school grades must live from school to be eligible for subsidized transportation, restrictions on the length and destination of bus routes, and school-level decisions about whether to offer bus service. According to district policy, general education students in grades K-2 (3-6) must live at least one-half (one) mile from school to receive free transportation in the form of either the school bus or full-fare MetroCards, which can be used on public buses and the subway. In addition, district-level routing guidelines limit bus rides to five miles from first stop to school and prohibit buses from crossing subcity administrative school district (called community school districts or CSDs) boundaries for students attending traditional public schools, and borough boundaries for students attending charter schools. Therefore, some

students who may be eligible for the bus because they live outside the walk-zone for their school are ineligible because they live too far from school to be accommodated on a route or attend a school in a different CSD or borough.

There are exceptions to these guidelines that provide bus service to otherwise ineligible students. These include students living in temporary shelters, those with certain medical conditions, students with dangerous walking routes, those who exercise choice because their zoned school is designated as failing under No Child Left Behind, and part-time special education students who ride general education buses as specified in their individualized education program.

Why do commute times differ?

A student's commute time depends on three key factors: distance, neighborhood characteristics, and idiosyncratic bus routing. Perhaps most important is distance between home and school, which reflects families' decisions about residential location and where to send their children to school. Some students, for example, may live relatively far away from their zoned school as parents make residential location decisions based on multiple factors including housing prices and their commute to work, in addition to considering their child's commute to school. For some students, distance to school reflects decisions by students and parents to attend schools other than their zoned school. Students may choose to attend a school, such as a magnet or charter school or a school with a gifted and talented program, which is often farther from home than their zoned school. As a consequence, we would expect that district choice and charter school students would have longer bus rides, on average.

Second, bus rides depend on the street network, including the availability of highways, the absence (or presence) of one-way streets, and obstacles in a student's neighborhood. For example, a bus stop located on a one-way street may require a longer route, increasing bus ride length.

Finally, bus ride length depends on the route designated by the Office of Pupil

Transportation (OPT) and the location of other students from the same school that also ride the bus. For example, consider two students that live the same distance from school: student A who lives north of school and student B who lives south of school. If student A is the closest of all bus riders who live north of school, he may be the last student picked up on his route and have a shorter ride than student B if she lives further from school than other bus riders living south of school. Similarly, commute length may depend on the number of stops on a route--a student placed on a direct route with few stops will likely have a shorter bus ride than another student who lives a similar distance to school but is placed on a less direct route with more stops. Finally, the number of students being picked up at each stop will also lead to variation in commute times, as buses will have to wait longer for students to load at large stops. Indeed, we find that students with long or very long bus rides are more likely to be picked up first on their route, have longer routes, and are on routes with more stops (Table 1A). There is little certainty in bus routing from year to year and a student's route or bus stop can change, making it unlikely that students use school or residential moves to obtain a shorter bus ride. We exploit this variation in commute times to identify the impacts of long and very long bus rides.

Methods

To explore the number of students experience long bus rides, we examine the distribution of commutes to determine the share of students with morning commute times in excess of 30, 45, and 60 minutes. We then explore whether certain groups of students are more likely to experience long bus rides using a parsimonious regression model linking long bus ride length to student characteristics as follows:

$$\text{LONGRIDE}_{ist} = \alpha + \boldsymbol{\beta}\,\textbf{STUDCHAR}_{it} + \gamma \text{OUTCOME}_{it\text{-}1} + \boldsymbol{\theta}\,\textbf{SCHOOLTYPE}_{it} + \boldsymbol{\mu}_g + \boldsymbol{\delta_t} + \varepsilon_{isgt} \qquad (1)$$

Where LONGRIDE is an indicator equal to one if student i, in school s, has a long bus ride in year t, **STUDCHAR** is a vector of the following student characteristics: race/ethnicity (measured as

indicators for whether a student is Black, white, Asian, or Hispanic), poor (measured by indicator of free and reduced price lunch eligibility) and sex, $OUTCOME_{it-1}$ is a student's outcome in the previous year (standardized math or reading scores or attendance), and **SCHOOLTYPE** is a vector of school type (district choice or charter), **μ** are a set of grade effects, and **δ** are a set of year effects. We estimate this model with three different definitions of long bus ride: 30 or more minutes (RIDE30+), 45 or more minutes (RIDE45+), and 60 or more minutes (RIDE60+). In this model, **β,** γ, and **θ** indicate whether there are disparities in the characteristics of students who experience long bus rides, the types of schools that they attend, or prior outcomes. Disparities will, in part, reflect differences in both schools and routing assignments. For example, some schools may draw from wider catchment areas and have students traveling greater distances and some routes may have more stops, which add more time to the bus ride. Therefore, we re-estimate (1) first with school fixed effects and then with route fixed effects, which capture disparities in the characteristics of students with long bus rides among bus riders who attend the same school or are assigned to the same route at the same school, respectively.

Finally, to determine whether long bus rides are deleterious to student outcomes, we estimate a model linking student outcomes to commute length variables:

$$Y_{irt} = \alpha + \theta_1 RIDE30to45_{irt} + \theta_2 RIDE45to60_{irt} + \theta_3 RIDE60+_{irt} + \boldsymbol{\gamma STUDCHAR}_{irt} + \boldsymbol{\alpha}_r + \boldsymbol{\mu}_g + \boldsymbol{\delta}_t$$

$$+ \varepsilon_{irt} \quad (2)$$

Where Y is a measure of performance (standardized test scores in reading or math, attendance rate, and chronic absenteeism - an indicator equal to 1 if a student is absent for 10 percent or more of the days in a school year), RIDE30to45 is an indicator equal to 1 if student i, on route r, in year t has a bus ride between 30 and 45 minutes, RIDE45to60 is equal to 1 if a student has a bus ride that is between 45 and 60 minutes, and RIDE60+ is an indicator equal to 1 if a student has a bus ride that is 60 minutes or longer, and **α** are route effects. In this model, θ_1, θ_2, and θ_3 capture the

difference in outcomes between students with long bus rides and students with bus rides of less than 30 minutes, who serve as the reference group. These estimates can reasonably be interpreted as causal, if conditional on student characteristics, commute length among students on the same route is as good as random.

We conduct separate analyses for traditional public school (TPS) and charter school students because routing restrictions differ between traditional public and charter schools and charter school students live further from school, on average. For similar reasons, we also allow the relationship between commute length and performance to vary between TPS students who attend zoned schools versus those who attend district-choice schools. We do so by interacting our commute length variables (RIDE30to45, RIDE45to60, and RIDE60+) with an indicator for whether student i attends his/her zoned school or a district-choice school.

Even with the inclusion of route fixed effects, estimates from (2) do not fully account for student sorting into schools. Of particular concern is that more motivated students might be willing to travel longer distances to attend a better matched school and would therefore be overrepresented among students with long bus rides. In this case, coefficients from (2) may underestimate any negative consequences of long bus rides – if greater motivation ameliorates the negative effects of long commutes. Therefore, we re-estimate (2) including a control for lagged outcomes, which capture unobserved factors such as prior schooling inputs and motivation. To the extent that students experienced similar rides in previous years and there are cumulative effects of commutes, these will likely be underestimates.

Finally, we explore whether these effects differ by poverty, gender, and race/ethnicity. To do so, we fully interact each of our long commute measures with indicators for these student characteristics. As with our main estimates, we also estimate this link separately for district-choice and charter school students. We omit zoned school students from this analysis because only a small

number of students who attend their zones school experience long bus rides.

Data, Measures, and Sample

Data

We use unique individual-level, longitudinal data on the transportation provided to all NYC public school students, including transportation assignment. We link these to data on student characteristics (e.g., race/ethnicity, gender, poverty, English Language Learner status), participation in special education, attendance, and test scores.

Transportation data are provided by the NYCDOE Office of Pupil Transportation (OPT) from end-of-year reports, for academic year (AY) 2010-11 to 2016-17. These include categorical measures of *distance between home and school,* which are used to determine *eligibility for transportation services* (school bus, half or full fare MetroCards for public transit). Transportation data also include transportation *assignment* (school bus, full-fare MetroCard, half-fare MetroCard, or none), *location of bus stop* (latitude and longitude), *morning bus route number*, *morning pick-up*, and *school start and end times*. In addition, these data provide information on *exceptions*, when distance ineligible students are provided transportation services due to special circumstances. Exceptions fall into five primary categories: medical (e.g., injury or illness), hazard (e.g., unsafe traffic or dangerous crossings), emergency condition (e.g., threat of crime victimization while travelling to school), temporary housing (e.g., residing in homeless or domestic violence shelter), or special education (e.g., mandated general education bus service for a part-time special education student).

Transportation data are point-in-time as of June in each academic year and therefore reflect a student's transportation assignment, including whether they are assigned to a bus route, their bus route, and pick-up time, at the end of the year. Therefore, bus assignment and commute times will be measured with error some students if they move mid-year. However, we note that this is an

extremely rare occurrence due to union contracts and how students are assigned to bus routes. This should bias our estimates towards zero.

Measures

Key to this study is defining long bus rides. The New York State Education Department (NYSED) provides guidelines for bus eligibility but no regulations for the maximum time of a bus ride. The only mention of long bus rides is in reference to the New Paltz school district, which strives to limit one-way bus rides to 60 minutes or less. While it does not provide explicit time limits on routes, OPT limits the distance of routes to five miles, which effectively places an upper bound on bus ride length, subject to traffic, travel speeds, and number of stops.

The academic literature is similarly silent on the nature of what constitutes a long bus ride. We could locate only two sources that define long bus rides, both of which use a threshold of 30 minutes to examine long bus rides in a rural context (Zars, 1998; Howley et al., 2001).

The limited guidance and consensus from these sources suggests a range of definitions for long bus rides between 30 and 60 minutes. Based on the academic literature, we set a lower bound on long bus rides at 30 minutes. We also consider alternative definitions of this lower bound at 45 and 60 minutes to test whether students with rides longer than these times have different outcomes than those with rides between 30 and 45 minutes and 45 and 60 minutes.

Thus, we create three measures of long bus ride – moderate bus rides (30-45 minutes), long bus rides (45-60 minutes), and very long bus rides (60+ minutes) - based upon a student's morning pickup time, the location and pick-up time of the last stop on that student's route, and school location as follows. First, we calculate the time between each student's scheduled pick-up time and the scheduled pick-up time of the last stop on the route to that student's school. Second, we estimate the drive time from the last pickup on a route to school using HERE Location Services (HERE). <endnote 2> Total bus ride length is then calculated by combining the time from own

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pick-up to last pick-up and the estimated drive time from the last pickup to school.

Sample

We draw on data on the universe of NYC public school students in grades K-6; Students in K-2 are excluded because they do not take standardized tests. <endnote 3> We exclude students in full-time special education schools and those in temporary housing because they are subject to different eligibility, routing restrictions, and bus service. The study sample is students in grades 3-6 assigned to general education bus service for AY 2011-2017. We also exclude observations that are missing critical transportation, demographic, and test score data. We also exclude students with missing lag outcomes because our preferred specification is a value-added model.

Finally, we exclude students on bus routes that serve more than one school building non-sequentially (i.e., students from school B are picked up before students from school A are dropped off). We do so because our estimates of bus ride length are calculated based on the assumption that the bus drives directly to school from the last stop on the route serving that school. Therefore, we include only those routes that serve one school (76.7% of routes), serve one school building that houses multiple schools, or serve multiple schools sequentially (all students from the first school are picked up before any students from a subsequent school are picked up). Our final sample includes 90.1 percent of all AM bus routes and 89.4 percent of all student-year observations for academic years 2011-2017. Our sample includes 805 route-school pairs where at least one student experiences a 60+ minute ride and 2,140 route-school pairs with at least one student with a 45+ minute ride. When we compare characteristics of this sample to all bus riders, we find that it is representative.

Results

A portrait of bus rides

As shown in Table 1, the average bus ride to school is short- only 21.11 minutes, with 75.6 percent of students having bus rides under 30 minutes and another 15 percent having rides between

30 and 45 minutes. This masks considerable variation by school type, however, as students in choice and charter schools have longer bus rides than students who attend their zoned school. While students who attend their zoned school are only on the bus for an average of 12.21 minutes, those at district choice and charter schools have almost double the bus ride at 24.46 and 25.50 minutes, respectively. This likely reflects that students travel farther to attend choice schools, district choice students live an average of 2.41 miles from school and charter school students live an average of 2.23 miles from school as compared to zoned school students, who live only 1.62 miles from school.

We also observe considerable variation in bus ride length by school context. Students who attend school in Staten Island are overrepresented among students with short commutes, while bus riders from Brooklyn and Queens are underrepresented. For example, students from Queens represent almost half of those with bus rides over one hour (47.00 percent), but only about one third (34.37 percent) of all bus riders. Conversely, students in Staten Island make up only 20.02 percent of all bus riders, but 24.30 percent of those with short bus rides. This could reflect differences in density and traffic between boroughs but may also be due to differences in bus service – such as the number of routes or buses serving each school.

However, time on the bus represents only one part of the commute and ignores other key aspects of the trip to school including the time spent walking to the bus stop and the time waiting at school after the bus drops students off. Total commute times, which incorporate these parts of the commute, are more than twice as long as time spent on the bus—50.68 minutes (Table 1a). Since the average student lives 2.14 miles from school, the total commute on the bus is about equal to, if not slightly longer, than the time it would take to walk to school. Once again, we observe substantial differences by school type. While the average total commute for zoned school students is 38.40 minutes, students at district choice and charter schools have total commutes of almost an

hour. Not only do these students have longer bus rides, but they also live further from their assigned bus stop. Since zoned schools operate within a more confined geographic area, this may indicate that it is easier for zoned school principals to site bus stops close to where students live while still meeting guidelines for the distance of bus routes.

Disparities in long bus rides

On average, bus rides are relatively short, and very long bus rides quite uncommon, with only 3.3 percent, or 517 students experiencing bus rides over one hour in 2017. Of these, almost 95 percent attend a choice or charter school. That is, the vast majority of students with long bus rides are traveling well outside of their neighborhoods to attend a school of their choosing. Given that students are choosing to attend these schools, long commutes are not necessarily a concern, but there may be important equity implications if particular groups are overrepresented among those with long bus rides even among students at the same school or on the same route.

Indeed, we find that by any definition, Black students are overrepresented among those with long bus rides. While Black students account for only 26.73 percent of all bus riders, they represent 43.57 percent of bus riders with long bus rides (45-60 minutes) and 45.07 percent of bus riders with very long bus rides (over 60 minutes). Conversely, white students, who make up 24.00 percent of all bus riders are underrepresented among those with long bus rides (14.73 percent) and even more so among those with very long bus rides (10.44 percent). Hispanic students are also underrepresented among those with long or very long bus rides, although to a lesser degree. These findings are largely consistent with previous literature that Black students tend to live further from high quality schools and that Hispanic students attend school closer to home (Authors, 2018). We also find that English language learners and special education students are slightly underrepresented on long bus routes. This may reflect that both groups of students are less likely to participate in school choice.

As previously mentioned, these raw disparities may reflect differences in where students live and where they choose to go to school. In order to parse these differences within schools and bus routes, we estimate a series of linear probability models where the outcomes are alternative measures of long bus rides and the independent variables include indicators for student race/ethnicity, poverty, and gender as well as school and route fixed effects (Table 2).

Similar to descriptive statistics we find that students in choice schools tend to have longer commutes. For example, students in district choice and charter schools are 8.9 and 12.0 percentage points more likely to have long bus rides and 3.7-4.3 percentage points more likely to have very long bus rides, which likely reflects that students tend to travel further to attend these schools.

We also find racial/ethnic disparities by race/ethnicity, even within the same school or on the same bus route. Black bus riders are 4.9-5.6 percentage points more likely to experience long bus rides and 2.3-2.5 percentage points more likely to experience very long bus rides than Hispanic students in the same school or on the same bus route. This is in contrast to White bus riders, who are 3.3 percentage points less likely than Hispanic students on the same route to have commutes over 30 minutes, 1.7 percentage points less likely to have a long bus ride, and no more likely to have a very long bus ride. This may indicate that even among students in the same school or on the same route, Black students live further from school and consequently have longer commutes.

Importantly for our identification strategy, while we find that some evidence that students with commute times over 30 minutes are positively selected—with prior math scores that are 0.023 SDs higher than students with short commutes—prior performance does not predict long or very long commutes in models with school and route fixed effects. This suggests that compared to other students in the same school or on the same route, high achievers are no more or less likely to have a long or very long bus ride. Models that include prior reading scores and attendance show similar results (see Appendix B Tables B1 and B2).

Overall, this suggests that Black students are disproportionately more likely to experience long or very long bus rides than students at the same school or on the same route—about 2-5 percentage points. While we highlight results for all schools in 2017, we find a similar pattern of results when we estimate the same models with all years (Appendix A Table A1).

Are long bus rides harmful?

Although our sample scores above average on both reading and math exams, students with long and very long bus rides outperform those with short bus rides by between 0.02 and 0.11 standard deviations (Table 1). However, this may reflect positive selection if more motivated students are willing to travel to schools far from home, as well as the types of schools that students are willing to travel long distances to attend, for example magnet schools or schools with city-wide gifted and talented programs.

Once we better account for this selection, by estimating models with route fixed effects, we find no relationship between length of bus ride and test scores in either math or reading, but significant relationships between long bus rides and attendance and chronic absenteeism. Students with long bus rides have attendance rates that are 0.397 percentage points lower and are 1.9 percentage points more likely to be chronically absent than bus riders on the same route with short bus rides (Table 3, Panel 1). Very long rides are similarly deleterious—decreasing attendance by 0.301 percentage points and increasing chronic absenteeism by 1.9 percentage points. While the attendance rate results are not practically meaningful (students with very long bus rides are absent for slightly more than one day per year), the relationships between very long bus rides and chronic absenteeism are quite large, given that chronic absenteeism rate in the sample is around 12 percent.

These results mask considerable heterogeneity between zoned, district-choice, and charter schools. Specifically, we find no relationship between commute times and academic outcomes among zoned school students (Table 3, Panel 2). Among district-choice students, we find no

relationship between commute times and test scores, but significant and monotonically increasing relationships with attendance and chronic absenteeism. District-choice school students with long (very long) bus rides have attendance that is 0.419 (0.461) percentage points lower than students with short bus rides and are 2.3 (2.4) percentage points more likely to be chronically absent. In charter schools, we find no significant relationship between commute length and student outcomes.

While it is likely that once we account for student characteristics, much of the within-route variation in commute times is somewhat idiosyncratic, our estimates may still be biased if more motivated students travel further to school and are overrepresented among those with long or very long bus rides, even among students on the same route. To address this, we re-estimate our models controlling for prior outcomes.

We find no effects of long or very long bus rides on zoned school students, but negative effects on attendance and chronic absenteeism among district choice students. Long or very long bus rides decrease attendance by 0.170-0.279 percentage points and increase chronic absenteeism by 1 percentage point. In contrast, there is no effect of long bus rides on test scores for charter school students, but very long bus rides decrease reading scores by 0.042 standard deviations, with no effects of commute length on attendance or chronic absenteeism.

Overall, the results from our preferred specification, which controls for prior performance, indicate that commutes less than 45 minutes have little to no effect on student outcomes—either performance or attendance—and that very long bus rides have small, deleterious effects, reducing attendance among students in district-choice schools.

Even in models with route fixed effects, it is possible that our estimates do not account for students' willingness to travel. Of particular concern might be if those students facing a local hardship such as a low-quality zoned school or impoverished neighborhood are more willing to travel long distances to attend a higher quality school. In this case, the negative relationship we

observe between long commutes and student outcomes in Table 4 may be spurious. To address this possibility, we re-estimate our models controlling for distance. In these models, coefficients are identified by students on the same bus route, who live the same distance to school, but have different commute times. As shown in Table 5, the results for attendance and chronic absenteeism become smaller and insignificant, but the magnitude and direction of coefficients for charter schools in these models remains largely unchanged, suggesting that differences in willingness to travel are not driving our results. Further, we find that students with long commutes appear to be positively selected relative to other students in the same census tract or school zone (Appendix B Table B3). Further, students with long commutes appear to attend schools with slightly higher proficiency rates (Appendix Table B4). Taken together, this suggest that if anything, our results may underestimate the negative effects of long commutes

Heterogeneity

Next, we examine whether the effects of long bus rides differ based on student characteristics including poverty, and race/ethnicity. We find no differences in the impacts of commute length among district-choice school students--both non-poor and poor students with long or very long bus rides have lower attendance and are more likely to be chronically absent than non-poor students with short bus rides, and the estimates for poor and non-poor students are statistically indistinguishable. Among charter school students, however, the negative effects of very long bus rides are concentrated among poor students, for whom very long commutes decrease reading scores by 0.057 standard deviations. This is of concern given that a key motivation for charter schools is to increase educational access and opportunity for low-income students and may suggest the need for either different siting or better transportation to decrease the likelihood of students experiencing these very long commutes. We find little evidence of heterogeneity by race/ethnicity (see Appendix A Table A2).

Are these results credibly causal?

Our estimates can reasonably be interpreted as causal if student-level covariates and fixed effects fully account for student sorting across schools based on preferences and willingness to travel. As previously discussed, we find that including controls for distance to school does not materially change our main findings, but we also conduct a series of additional robustness checks to assess the credibility of these assumptions.

First, we re-estimate our models replacing route fixed effects with zoned school and census tract fixed effects. This allows us to compare outcomes between students with longer and shorter commutes who live in the same neighborhoods and who should face the same, or similar, local conditions in terms of access to high quality schools or neighborhood amenities. These results, shown in Appendix A Tables A3 and A4, are nearly identical to our main results from Table 4.

Second, to address concerns that students who changed schools may be "newer" to the route and therefore more likely to have longer commutes, we re-estimate our model with a control for whether a student moved schools and again results are largely unchanged (Appendix A Table A5). Third, we re-estimate models with school fixed effects and controls for distance, rather than route fixed effects and distance and also obtain similar results (Appendix A Table A6).

Finally, we explore whether more advantaged families appear to make residential or school decisions to decrease commute times. While such residential moves are unlikely due to the tight housing market in NYC coupled with the uncertainty of routes from one year to the next, to verify this we examine whether students with long commutes in year t are more likely to make residential moves or school moves in t+1. We find some evidence that students with long commutes are slightly more likely to make residential moves, but the magnitude of the difference is small (0.7 percentage points off an average residential mobility rate of 6.53 percent) and those with very long rides are no more likely to make a residential move. Further, long or very long commutes do not appear to

increase the probability of school moves in the following year.

It is still possible that there are unobserved factors that we have not accounted for. For example, if students with long bus rides are disproportionately those who are facing a local hardship such as high neighborhood crime or a dearth of high-quality schools close to home, this may explain our negative findings. Similarly, if more advantaged parents can lobby principals to obtain shorter bus-rides for their children, this could also explain our negative results. However, our set of robustness checks do not point to any systematic bias in our estimates and increase our confidence that our findings are causal.

Conclusion and Policy Implications

Overall, we find that the vast majority of students (75 percent) have short bus rides and that very long bus rides are rare for zoned school students, with only 0.6 percent or 36 zoned school students with commutes over an hour in 2017. Rather, long and very long bus rides appear to be a feature of attending a choice school, although even among these students commutes in excess of one hour are uncommon. This is perhaps unsurprising, as school zones are geographically constrained and students tend to travel farther to attend both district choice and charter schools. Black students are also more likely to experience long or very long bus rides than either Hispanic or white students in the same school or the same route, on the order of 2-5 percentage points. This may indicate that Black students are willing to travel further to school or that there are fewer high quality schools located near to where they live.

We find that there is no effect of commute length on test scores overall, but negative effects of long commutes on attendance and chronic absenteeism. These averages mask important differences by school type, however. Long and very long bus rides decrease attendance and increase chronic absenteeism among district choice school students but have no effect on test scores. By contrast, commute length has no effect on attendance or chronic absenteeism among

charter school students, but very long bus rides may decrease reading test scores particularly among poor students.

Taken together, these results suggest that some of the potential benefits of attending a more preferred school may be outweighed by very long commutes.

This suggests the potential to improve outcomes by improving bus service either through optimizing routes or increasing the number of buses to ensure shorter commutes. In addition, our findings highlight the importance of school location and the availability of transportation for determining student outcomes in the context of school choice, particularly when school choice is coupled with historic patterns of neighborhood segregation.

Endnotes

Endnote 1: Gottfried (2017) uses ECLS-K data and finds that kindergartners taking the bus are absent about 0.4 fewer days per year than those who use other modes of transportation. Author (2019) uses NYC data and finds that bus riders are absent about one fewer day per school year than peers who do not ride the bus.

Endnote 2: HERE is an application programming interface that provides real-time routing between pairs of coordinates. The application finds the fastest travel route between pairs of coordinates and returns the travel time with traffic, the travel time without traffic, and the distance. We estimated driving time at 7:30AM on a weekday morning in May 2019 when there were no major incidents or crashes that would overstate travel estimates. Commute times are based on *scheduled* pickups.

Endnote 3: Students in Staten Island who live far enough from school are eligible to receive bus service through 8th grade.

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Table 1 - Value Added Sample. Descriptive Statistics, All Bus Riders by Bus Ride Length and School Type, 2017

	All Bus Riders					School Type		
	0-30 mins	30-45 mins	45-60 mins	60+ mins	Total	Zoned	District Choice	Charter
Female	50.80	53.79	51.04	52.61	51.32	48.92	52.44	51.37
Asian	22.21	23.19	19.92	21.28	22.19	26.70	30.51	4.93
Black	23.24	33.43	43.57	45.07	26.73	9.44	20.75	55.64
Hispanic	27.91	25.86	21.78	23.21	27.08	27.15	22.15	33.78
White	26.62	17.52	14.73	10.44	24.00	36.64	26.42	5.59
Free or Reduced-price Lunch	63.29	64.54	66.91	67.31	63.83	58.75	55.42	80.17
English Language Learner	5.05	4.19	2.49	1.16	4.64	8.22	3.54	5.54
Students with Disabilities	16.01	11.72	12.24	11.41	14.99	21.33	11.41	15.89
Borough								
Bronx	13.07	17.90	18.78	14.70	14.19	5.79	9.98	29.06
Brooklyn	23.97	26.41	33.71	30.17	25.14	6.96	26.28	45.46
Manhattan	6.18	7.45	4.98	5.61	6.28	0.74	11.31	6.89
Queens	32.48	40.33	36.41	47.00	34.37	39.34	41.21	16.26
Staten Island	24.30	7.91	6.12	2.51	20.02	47.17	11.23	2.32
Zoned School	38.75	11.55	6.33	5.42	31.60	100.00	0.00	0.00
District Choice School	36.97	54.72	47.51	50.68	40.72	0.00	100.00	0.00
Charter School	24.28	33.73	46.16	43.91	27.68	0.00	0.00	100.00
Distance - Home to School	1.88	2.68	3.02	3.91	2.14	1.62	2.41	2.23
Bus Ride (minutes)	13.42	36.40	51.22	72.53	21.11	12.21	24.46	25.50
Attendance Rate	95.75	95.97	95.98	94.95	95.77	95.42	96.18	94.78
Chronic Absenteeism	9.59	8.35	7.81	11.75	9.39	11.24	7.65	12.64
Z-Math	0.40	0.53	0.44	0.39	0.42	0.26	0.64	0.19
Z-Read	0.36	0.48	0.44	0.45	0.39	0.24	0.64	0.15
N	**11,930**	**2,363**	**964**	**517**	**15,774**	**4,985**	**6,423**	**4,366**
	75.6%	**15.0%**	**6.1%**	**3.3%**	**100.0%**	**31.6%**	**40.7%**	**27.7%**

Note: Sample is general education bus riders in grades 3-6 for 2017 **with lagged dependent variables** on one-school routes, routes serving multiple schools sequentially, and co-located schools+. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. Data for Attendance Rate and Chronic Absenteeism is for 17,911 students.

Table 1a Total Commute from Home to School, All Bus Riders by Bus Ride Length and School Type, 2017
(percentages)

	All Bus Riders					School Type		
	0-30 mins	30-45 mins	45-60 mins	60+ mins	Total	Zoned	District Choice	Charter
Distance - Home to School	1.88	2.68	3.02	3.91	2.14	1.64	2.46	2.22
Distance - Home to Bus	0.41	0.51	0.61	0.65	0.44	0.28	0.46	0.61
Total Commute (minutes)	43.11	65.03	82.15	101.05	50.68	38.40	56.76	55.75
Walk to Bus (minutes)	9.16	11.50	13.83	15.04	9.99	6.14	10.26	13.99
Bus Ride (minutes)	13.42	36.40	51.22	72.53	21.11	12.68	24.60	25.60
Wait at School (minutes)	20.53	17.12	17.10	13.48	19.58	19.58	21.90	16.17
First on route	18.07	34.70	41.80	59.84	23.32	28.28	22.36	19.08
Route Driving Distance (miles)	2.09	2.95	3.42	4.46	2.37	1.74	2.76	2.53
Number of stop on route	15.29	22.54	18.57	17.63	16.65	19.24	14.96	16.19
N	**11,930**	**2,363**	**964**	**517**	**15,774**	**4,985**	**6,423**	**4,366**
	75.6%	**15.0%**	**6.1%**	**3.3%**	**100.0%**	**31.6%**	**40.7%**	**27.7%**

Note: Sample is general education bus riders in grades 3-6 for 2017 **with lagged dependent variable** on one-school routes, routes serving multiple schools sequentially, and co-located schools. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. Data for Attendance Rate and Chronic Absenteeism is for 17,911 students.

Table 2 - Linear Probability Regression Results, Long Bus Rides, All Bus Riders, 2017

Bus Ride Length	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	30+ minutes			45+ minutes			60+ minutes		
Lag z-math	0.023***	0.007	0.007*	0.007	-0.001	0.001	-0.000	-0.002	-0.000
	(0.006)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
Black	0.073***	0.074***	0.067***	0.052***	0.056***	0.049***	0.019**	0.023*	0.025***
	(0.022)	(0.023)	(0.016)	(0.015)	(0.018)	(0.011)	(0.009)	(0.014)	(0.008)
White	-0.036*	-0.019	-0.033**	-0.007	-0.010	-0.017*	-0.006	-0.013	-0.009
	(0.020)	(0.015)	(0.013)	(0.009)	(0.010)	(0.009)	(0.005)	(0.008)	(0.006)
Asian	0.017	-0.014	-0.009	0.015	0.004	0.002	0.004	-0.004	-0.004
	(0.016)	(0.016)	(0.012)	(0.010)	(0.009)	(0.007)	(0.007)	(0.005)	(0.005)
Free or Reduced-price	-0.013	-0.006	0.002	-0.007	0.002	0.008	-0.003	0.003	0.005
Lunch	(0.012)	(0.009)	(0.007)	(0.006)	(0.005)	(0.005)	(0.003)	(0.004)	(0.003)
Female	0.010	0.007	0.006	-0.001	-0.005	-0.004	0.001	-0.002	-0.002
	(0.007)	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.002)	(0.002)	(0.002)
District choice	0.224***	0.204***	0.127***	0.089***	0.072***	0.042***	0.037***	0.013***	0.011***
	(0.026)	(0.023)	(0.020)	(0.013)	(0.016)	(0.011)	(0.007)	(0.003)	(0.003)
Charter	0.232***			0.120***			0.043***		
	(0.031)			(0.017)			(0.009)		
Constant	0.066***	0.144***	0.175***	0.009	0.051***	0.062***	0.001	0.023***	0.021***
School FE		X			X			X	
Route FE			X			X			X
Observations	15,746	15,746	15,746	15,746	15,746	15,746	15,746	15,746	15,746
R-squared	0.086	0.238	0.451	0.044	0.200	0.416	0.018	0.179	0.379
Number of Schools	815	815	815	815	815	815	815	815	815
Number of Routes	8,708	8,708	8,708	8,708	8,708	8,708	8,708	8,708	8,708

Robust standard errors in parentheses and clustered at the school level.

*** p<0.01, ** p<0.05, *p<0.

Note: Sample is general education bus riders in grades 3-6 for 2017 on one-school routes, routes serving multiple schools sequentially, and co-located schools. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. The bus ride variables are dummy variables that take a value of 1 if a student's bus ride is greater than 30, 45, or 60 minutes.

Table 3 - Panel 1 - Regression Results, Academic Outcomes and Bus Ride, 2011-2017

	(1)	(2)	(3)	(4)
	Z-Math	Z-Read	Attendance Rate	Chronic Absenteeism
30-45 mins	0.001	-0.008	-0.126**	0.008*
	(0.013)	(0.013)	(0.063)	(0.004)
45-60 mins	-0.013	-0.000	-0.406***	0.020***
	(0.019)	(0.021)	(0.120)	(0.008)
60+ mins	-0.020	-0.017	-0.247*	0.016*
	(0.025)	(0.025)	(0.144)	(0.009)
Constant	0.574***	0.494***	96.235***	0.054***
	(0.026)	(0.026)	(0.101)	(0.006)
Route FE	X	X	X	X
Observations	96,967	96,341	88,444	88,444
R-squared	0.464	0.421	0.315	0.179
Number of Schools	815	815	811	811
Number of Routes	8,708	8,708	8,471	8,471

Robust standard errors in parentheses and clustered at the school level.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note: Sample is general education bus riders in grades 3-6 for 2011-2017 **with lagged dependent variables** on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, race/ethnicity, gender, special education status, English language status, and poverty status. The bus ride variables are dummy variables that take a value of 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes.

Table 3 - Panel 2 - Regression Results, Academic Outcomes and Bus Ride by School Type, 2011-2017, Route effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Z-Math	Z-Read	Attendance Rate	Chronic Absenteeism	Z-Math	Z-Read	Attendance Rate	Chronic Absenteeism
Zoned	-0.175***	-0.191***	-0.177	0.005				
	(0.031)	(0.031)	(0.113)	(0.006)				
Zoned								
30-45 mins	-0.039	-0.052*	-0.169	0.002				
	(0.030)	(0.031)	(0.151)	(0.010)				
45+ mins	-0.071	-0.002	-0.407	0.029				
	(0.114)	(0.065)	(0.913)	(0.050)				
Choice								
30-45 mins	-0.005	-0.006	-0.180**	0.010*				
	(0.018)	(0.018)	(0.073)	(0.005)				
45-60 mins	-0.031	-0.035	-0.433***	0.024***				
	(0.029)	(0.029)	(0.110)	(0.008)				
60+ mins	-0.029	-0.021	-0.461***	0.024**				
	(0.035)	(0.034)	(0.171)	(0.010)				
Charter								
30-45 mins								
45-60 mins						0.002	-0.019	0.069
						(0.018)	(0.016)	(0.166)
60+ mins						-0.003	0.018	-0.431
						(0.019)	(0.027)	(0.299)
Constant	0.698***	0.590***	96.437***	0.050***		0.535***	0.337***	96.381***
	(0.032)	(0.032)	(0.107)	(0.006)		(0.030)	(0.030)	(0.212)
Observations	76,732	76,143	77,010	77,010		20,235	20,198	11,434
R-squared	0.483	0.428	0.259	0.179		0.351	0.326	0.558
Number of Routes	684	684	684	684		129	129	127

Robust standard errors in parentheses and clustered at the school level. *** p<0.01, ** p<0.05, * p<0.1

Note: Sample is general education bus riders in grades 3-6 for 2011-2017 with lagged dependent variables on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, race/ethnicity, gender, special education status, English language status, and poverty. Bus ride variables are indicators equal to 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes.

Table 4. Regression Results, Academic Outcomes and Long Bus Rides, Value-Added Model, 2011-2017, Route Effects

	(1) Z-Math	(2) Z-Read	(3) Attendance Rate	(4) Chronic Absenteeism	(5) Z-Math	(6) Z-Read	(7) Attendance Rate	(8) Chronic Absenteeism
Zoned	-0.044***	-0.076***	0.077	-0.005	-	-	-	-
	(0.013)	(0.016)	(0.061)	(0.004)				
Zoned								
30-45 mins	-0.006	-0.012	-0.119	-0.002	-	-	-	-
	(0.015)	(0.019)	(0.092)	(0.008)				
45+ mins	0.021	0.035	-0.404	0.025	-	-	-	-
	(0.048)	(0.037)	(0.560)	(0.033)				
Choice								
30-45 mins	-0.002	-0.008	-0.059	0.005	-	-	-	-
	(0.009)	(0.013)	(0.047)	(0.004)				
45-60 mins	-0.003	-0.011	-0.180***	0.011**	-	-	-	-
	(0.015)	(0.014)	(0.062)	(0.005)				
60+ mins	-0.038**	0.003	-0.284**	0.013	-	-	-	-
Charter								
30-45 mins	-	-	-	-	0.001	-0.017	0.048	0.006
					(0.010)	(0.011)	(0.092)	(0.006)
45-60 mins	-	-	-	-	-0.006	0.018	-0.319	0.004
					(0.012)	(0.018)	(0.196)	(0.013)
60+ mins	-	-	-	-	-0.008	-0.042**	-0.023	-0.004
					(0.022)	(0.021)	(0.257)	(0.016)
Constant	0.723***	0.629***	37.463***	-0.527***	0.570***	0.479***	44.820***	-0.466***
	(0.054)	(0.059)	(0.793)	(0.015)	(0.033)	(0.039)	(3.022)	(0.034)
Observations	76,927	76,338	97,287	97,287		20,553	20,516	17,045
R-squared	0.740	0.663	0.559	0.363		0.679	0.613	0.649
Number of Routes	685	685	685	685		130	130	122

Robust standard errors in parentheses and clustered at the school level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note: Sample is general education bus riders in grades 3-6 for 2011-2017 on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, race/ethnicity, gender, special education status, English language status, and poverty. Bus ride variables are indicators equal to 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes. Lagged dependent variable for chronic absenteeism is lagged absenteeism rate.

Table 5. Academic Outcomes, Long Bus Rides, and Distance to School, Value-Added Model, 2011-2017, Route Effects

	(1) Z-Math	(2) Z-Read	(3) Attendance Rate	(4) Chronic Absenteeism	(5) Z-Math	(6) Z-Read	(7) Attendance Rate	(8) Chronic Absenteeism
Zoned	-0.047***	-0.079***	-0.064	-0.002	-	-	-	-
	(0.013)	(0.016)	(0.070)	(0.004)				
Zoned								
30-45 mins	-0.004	-0.010	-0.024	-0.004	-	-	-	-
	(0.015)	(0.019)	(0.092)	(0.008)				
45+ mins	0.023	0.037	-0.058	0.022	-	-	-	-
	(0.048)	(0.037)	(0.525)	(0.032)				
Choice								
30-45 mins	0.001	-0.004	0.016	0.001	-	-	-	-
	(0.009)	(0.013)	(0.056)	(0.004)				
45-60 mins	0.003	-0.005	-0.007	0.003	-	-	-	-
	(0.015)	(0.014)	(0.073)	(0.006)				
60+ mins	-0.025	0.015	0.111	-0.001	-	-	-	-
	(0.020)	(0.023)	(0.129)	(0.009)				
Charter								
30-45 mins	-	-	-	-	-0.003	-0.018*	0.070	0.004
					(0.011)	(0.011)	(0.093)	(0.006)
45-60 mins	-	-	-	-	-0.012	0.015	-0.286	0.000
					(0.014)	(0.017)	(0.195)	(0.013)
60+ mins	-	-	-	-	-0.016	-0.045**	0.021	-0.009
					(0.023)	(0.022)	(0.262)	(0.017)
Distance (miles)	-0.005**	-0.004*	-0.096***	0.005***	0.006**	0.003	-0.034	0.004*
	(0.002)	(0.002)	(0.026)	(0.001)	(0.003)	(0.003)	(0.028)	(0.002)
Constant	0.732***	0.638***	37.010***	-0.537***	0.557***	0.473***	44.909***	-0.473***
	(0.054)	(0.059)	(0.993)	(0.016)	(0.034)	(0.040)	(3.047)	(0.033)
Observations	76,927	76,338	97,287	97,287	20,553	20,516	17,045	17,045
R-squared	0.740	0.663	0.562	0.363	0.679	0.613	0.649	0.363
Number of Routes	7,081	7,081	7,081	7,081	2,002	2,002	1,495	1,495

Robust standard errors in parentheses and clustered at the school level. *** p<0.01, ** p<0.05, * p<0.1

Note: Sample is general education bus riders in grades 3-6 for 2011-2017 on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, race/ethnicity, gender, special education status, English language status, and poverty. Bus ride variables are indicators equal to 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes. Lagged dependent variable for chronic absenteeism is lagged absenteeism rate.

Table 6. Regression Results, Academic Outcomes, Bus Rides, and FRPL, by School Type, Value-Added Model, 2011-2017

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Z-Math	Z-Read	Attendance Rate	Chronic Absenteeism	Z-Math	Z-Read	Attendance Rate	Chronic Absenteeism
		District Choice Sample				Charter Sample		
Not FRPL								
30-45 mins	-0.002	-0.003	-0.029	-0.002	0.011	-0.023	-0.159	0.003
	(0.014)	(0.019)	(0.052)	(0.004)	(0.019)	(0.022)	(0.166)	(0.009)
45-60 mins	-0.012	-0.023	-0.212***	0.009*	-0.027	0.024	-0.286	-0.004
	(0.020)	(0.019)	(0.074)	(0.005)	(0.030)	(0.029)	(0.436)	(0.017)
60+ mins	-0.020	-0.012	-0.298**	0.019*	0.057*	0.002	0.012	-0.026
	(0.026)	(0.036)	(0.121)	(0.010)	(0.034)	(0.052)	(0.233)	(0.016)
FRPL								
30-45 mins	-0.008	-0.020	-0.100	0.011**	-0.000	-0.014	0.109	0.007
	(0.011)	(0.015)	(0.075)	(0.006)	(0.011)	(0.012)	(0.110)	(0.007)
45-60 mins	-0.008	-0.021	-0.169*	0.013	-0.001	0.015	-0.326	0.006
	(0.019)	(0.023)	(0.095)	(0.009)	(0.014)	(0.021)	(0.203)	(0.015)
60+ mins	-0.051***	-0.004	-0.293**	0.011	-0.031	-0.057**	-0.039	0.005
	(0.020)	(0.026)	(0.143)	(0.011)	(0.024)	(0.026)	(0.326)	(0.022)
FRPL	-0.069***	-0.075***	-0.347***	0.025***	-0.011	-0.041***	-0.178**	0.010
	(0.008)	(0.011)	(0.041)	(0.004)	(0.014)	(0.014)	(0.081)	(0.007)
Constant	0.247***	0.243***	40.038***	-0.463***	0.124***	0.066***	44.837***	-0.465***
	(0.017)	(0.020)	(1.028)	(0.016)	(0.018)	(0.017)	(3.032)	(0.033)
Route FE	X	X	X	X	X	X	X	X
Observations	40,893	40,746	53,713	53,713	20,553	20,516	17,045	17,045
R-squared	0.775	0.695	0.597	0.415	0.675	0.609	0.649	0.363
# of Schools	671	668	709	709	130	130	135	135
Number of Routes	6,090	6,083	6,764	6,764	2,003	2,002	1,970	1,970

Robust standard errors in parentheses and clustered at the school level.
*** p<0.01, ** p<0.05, * p<0.1

Note: Sample is general education bus riders in grades 4-6 for 2011-2017 on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, race/ethnicity, gender, special education status, English language status, and poverty. Bus variables are indicators equal to 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes. Lagged dependent variable for chronic absenteeism is lagged absenteeism rate

Appendix Table A1 - Value Added Sample. Linear Probability Regression Results, Long Bus Rides, All Bus Riders, <u>2011-2017</u>

Bus Ride Length	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	30+ minutes			45+ minutes			60+ minutes		
Lag z-math	0.013***	0.003	-0.001	0.005**	0.001	-0.001	0.002	0.000	0.000
	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Black	0.065***	0.058***	0.046***	0.037***	0.035**	0.026***	0.014	0.018	0.012
	(0.020)	(0.023)	(0.012)	(0.012)	(0.018)	(0.009)	(0.009)	(0.015)	(0.008)
White	-0.026*	-0.017**	-0.026***	-0.009*	-0.015***	-0.017***	-0.005**	-0.011*	-0.009**
	(0.014)	(0.008)	(0.007)	(0.005)	(0.005)	(0.004)	(0.002)	(0.006)	(0.004)
Asian	0.005	-0.007	-0.010	-0.004	-0.008	-0.008*	-0.002	-0.005*	-0.005
	(0.013)	(0.011)	(0.007)	(0.006)	(0.006)	(0.004)	(0.003)	(0.002)	(0.003)
Free or Reduced-price Lunch	-0.021***	-0.005	0.006	-0.010***	-0.001	0.004*	-0.003**	0.000	0.003**
	(0.007)	(0.005)	(0.004)	(0.003)	(0.003)	(0.002)	(0.001)	(0.002)	(0.001)
Female	-0.001	-0.002	-0.000	0.001	0.000	0.001	-0.000	-0.001	-0.001
	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
District choice	0.186***	0.119***	0.105***	0.076***	0.042***	0.034***	0.026***	0.012***	0.009***
	(0.020)	(0.018)	(0.011)	(0.012)	(0.008)	(0.005)	(0.007)	(0.003)	(0.002)
Charter	0.219***			0.086***			0.021***		
	(0.022)			(0.012)			(0.006)		
Constant	0.051***	0.134***	0.093***	0.001	0.041***	0.036***	0.001	0.015***	0.013***
	(0.014)	(0.012)	(0.009)	(0.006)	(0.006)	(0.005)	(0.002)	(0.003)	(0.002)
School FE		X			X			X	
Route FE			X			X			X
Year FE	X	X		X	X		X	X	
Observations	97,493	97,493	97,493	97,493	97,493	97,493	97,493	97,493	97,493
R-squared	0.087	0.185	0.439	0.041	0.140	0.399	0.015	0.101	0.361
Number of Schools	863	863	863	863	863	863	863	863	863
Number of Routes	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343	9,343

Robust standard errors in parentheses and clustered at the school level, *** p<0.01, ** p<0.05, * p<0.1

Note: Sample is general education bus riders in grades 3-6 for 2017 on one-school routes, routes serving multiple schools sequentially, and co-located schools. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. The bus ride variables are dummy variables that take a value of 1 if a student's bus ride is greater than 30, 45, or 60 minutes.

Appendix Table A2. Academic Outcomes, Long Bus Rides, and Race/Ethnicity, Value-Added Model, 2011-2017, Route Effects

	(1) Z-Math	(2) Z-Read	(3) Attendance Rate	(4) Chronic Absenteeism	(5) Z-Math	(6) Z-Read	(7) Attendance Rate	(8) Chronic Absenteeism
		District Choice Sample				Charter Sample		
Asian								
30-45 mins	-0.009	0.008	-0.012	-0.006	0.011	0.076	-0.128	-0.012
	(0.016)	(0.023)	(0.079)	(0.006)	(0.042)	(0.062)	(0.296)	(0.019)
45-60 mins	0.014	0.036	-0.198*	0.003	-0.040	0.022	0.104	0.014
	(0.026)	(0.026)	(0.108)	(0.009)	(0.066)	(0.055)	(0.295)	(0.032)
60+ mins	-0.027	-0.020	-0.164	0.007	-0.105	-0.035	-0.562	0.041
	(0.047)	(0.046)	(0.140)	(0.012)	(0.095)	(0.139)	(0.603)	(0.046)
Black								
30-45 mins	-0.026	-0.022	-0.097	0.011	0.007	-0.023	0.126	0.000
	(0.016)	(0.017)	(0.101)	(0.008)	(0.013)	(0.015)	(0.109)	(0.007)
45-60 mins	-0.044*	-0.044*	-0.171	0.012	-0.010	0.000	-0.428*	0.007
	(0.024)	(0.023)	(0.120)	(0.011)	(0.015)	(0.019)	(0.224)	(0.013)
60+ mins	-0.074	0.007	-0.328	0.007	0.027	-0.049**	-0.332	0.005
	(0.054)	(0.050)	(0.208)	(0.016)	(0.030)	(0.022)	(0.329)	(0.019)
Hispanic								
30-45 mins	0.005	-0.015	-0.215*	0.020**	-0.011	-0.008	-0.061	0.021**
	(0.020)	(0.026)	(0.129)	(0.010)	(0.017)	(0.020)	(0.143)	(0.010)
45-60 mins	0.014	-0.050	-0.320*	0.022	0.009	0.048	-0.185	-0.011
	(0.030)	(0.031)	(0.170)	(0.014)	(0.019)	(0.030)	(0.358)	(0.025)
60+ mins	-0.042	-0.006	-0.656***	0.054**	-0.049	-0.003	0.490	-0.022
	(0.036)	(0.038)	(0.242)	(0.026)	(0.038)	(0.052)	(0.312)	(0.026)
White								
30-45 mins	0.008	-0.020	0.010	-0.001	0.008	-0.056	-0.066	0.007
	(0.014)	(0.023)	(0.080)	(0.006)	(0.027)	(0.038)	(0.241)	(0.020)
45-60 mins	-0.011	-0.030	-0.100	0.009	-0.023	0.114**	-0.287	0.062*
	(0.025)	(0.026)	(0.097)	(0.010)	(0.082)	(0.057)	(0.470)	(0.036)
60+ mins	0.005	-0.013	-0.069	-0.002	-0.413***	-0.243	0.628	-0.029
	(0.047)	(0.037)	(0.126)	(0.017)	(0.098)	(0.262)	(0.604)	(0.044)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Z-Math	Z-Read	Attendance Rate	Chronic Absenteeism	Z-Math	Z-Read	Attendance Rate	Chronic Absenteeism
Asian	0.215***	0.161***	0.799***	0.003	0.124***	0.093***	0.528***	0.002
	(0.014)	(0.017)	(0.090)	(0.006)	(0.030)	(0.031)	(0.197)	(0.012)
Black	-0.008	-0.017	0.403***	-0.003	-0.016	0.002	0.586***	-0.006
	(0.012)	(0.014)	(0.092)	(0.007)	(0.014)	(0.014)	(0.130)	(0.008)
White	0.095***	0.107***	0.149**	-0.009	0.118***	0.137***	0.243	-0.005
	(0.014)	(0.014)	(0.065)	(0.007)	(0.026)	(0.028)	(0.168)	(0.013)
Constant	0.246***	0.247***	40.108***	2.865***	0.128***	0.062***	44.791***	2.808***
	(0.018)	(0.019)	(1.022)	(0.076)	(0.018)	(0.017)	(3.031)	(0.170)
Observations	40,893	40,746	53,713	53,713	20,553	20,516	17,045	17,045
R-squared	0.775	0.695	0.597	0.416	0.675	0.609	0.649	0.364
Number of Routes	6,090	6,083	6,764	6,764	2,003	2,002	1,495	1,495

Robust standard errors in parentheses and clustered at the school level.
*** p<0.01, ** p<0.05, * p<0.1

Note: Sample is general education bus riders in grades 4-6 for 2011-2017 on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, race/ethnicity, gender, special education status, English language status, and poverty status. Bus variables are indicators equal to 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes.

Appendix Table A3. Academic Outcomes and Distance to School, Value-Added Model, 2011-2017, Zoned School Effects

	(1) Z-Math	(2) Z-Read	(3) Attendance Rate	(4) Chronic Absenteeism	(5) Z-Math	(6) Z-Read	(7) Attendance Rate	(8) Chronic Absenteeism
Zoned	-0.118***	-0.139***	-0.288***	0.012***				
	(0.018)	(0.017)	(0.065)	(0.004)				
Zoned								
30-45 mins	0.021	0.006	-0.025	-0.004				
	(0.014)	(0.013)	(0.092)	(0.007)				
45-60 mins	0.003	-0.016	-0.289	0.019				
	(0.026)	(0.027)	(0.440)	(0.026)				
Choice								
30-45 mins	0.015	0.012	0.020	-0.001				
	(0.013)	(0.014)	(0.049)	(0.004)				
45-60 mins	0.036	0.021	-0.051	0.003				
	(0.024)	(0.020)	(0.066)	(0.004)				
60+ mins	0.019	0.055***	-0.261***	0.017**				
	(0.020)	(0.018)	(0.095)	(0.007)				
Charter								
30-45 mins					0.003	0.002	-0.081	0.011*
					(0.011)	(0.013)	(0.124)	(0.006)
45-60 mins					-0.012	0.033**	-0.362*	-0.006
					(0.017)	(0.015)	(0.217)	(0.011)
60+ mins					-0.030	-0.025	-0.920	0.002
					(0.024)	(0.021)	(0.579)	(0.019)
Constant	0.765***	0.645***	95.065***	-3.501***	0.744***	0.606***	96.870***	-3.130***
	(0.057)	(0.057)	(0.116)	(0.071)	(0.048)	(0.042)	(0.416)	(0.195)
Observations	76,667	76,085	76,753	96,976	20,489	20,452	16,972	16,972
R-squared	0.700	0.620	0.500	0.298	0.611	0.565	0.311	0.286
Number of Schools	685	685	685	685	130	130	122	122

Robust standard errors in parentheses and clustered at the school level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note: Sample is general education bus riders in grades 3-6 for 2011-2017 on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, race/ethnicity, gender, special education status, English language status, and poverty status. The bus ride variables are dummy variables that take a value of 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes. Lagged dependent variable for chronic absenteeism is lagged absenteeism rate.

Appendix Table A4. Academic Outcomes and Long Bus Rides, Value-Added Model, 2011-2017, Tract Effects

	(1) Z-Math	(2) Z-Read	(3) Attendance Rate	(4) Chronic Absenteeism	(5) Z-Math	(6) Z-Read	(7) Attendance Rate	(8) Chronic Absenteeism
Zoned	-0.112***	-0.133***	-0.270***	0.011***				
	(0.017)	(0.015)	(0.055)	(0.003)				
Zoned								
30-45 mins	0.024	0.010	-0.020	-0.005				
	(0.016)	(0.014)	(0.085)	(0.006)				
45-60 mins	0.004	-0.018	-0.336	0.025				
	(0.026)	(0.026)	(0.414)	(0.024)				
Choice								
30-45 mins	0.010	0.007	0.006	0.001				
	(0.014)	(0.014)	(0.051)	(0.004)				
45-60 mins	0.025	0.012	-0.074	0.003				
	(0.023)	(0.020)	(0.068)	(0.005)				
60+ mins	0.014	0.042**	-0.234**	0.013**				
	(0.022)	(0.020)	(0.099)	(0.007)				
Charter								
30-45 mins					0.004	0.002	-0.025	0.006
					(0.010)	(0.013)	(0.129)	(0.006)
45-60 mins					-0.012	0.026*	-0.502**	-0.001
					(0.018)	(0.015)	(0.241)	(0.010)
60+ mins					-0.041	-0.016	-0.858	0.006
					(0.027)	(0.023)	(0.556)	(0.017)
Constant	0.799***	0.667***	95.100***	-3.493***	0.713***	0.608***	97.073***	-3.088***
	(0.055)	(0.053)	(0.102)	(0.069)	(0.046)	(0.039)	(0.400)	(0.193)
Observations	76,888	76,301	76,971	97,256	20,494	20,458	16,984	16,984
R-squared	0.696	0.620	0.499	0.298	0.608	0.564	0.307	0.294
Number of Schools	685	685	685	685	130	130	122	122

Robust standard errors in parentheses and clustered at the school level. *** p<0.01, ** p<0.05, * p<0.1

Note: Sample is general education bus riders in grades 3-6 for 2011-2017 on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, race/ethnicity, gender, special education status, English language status, and poverty status. The bus ride variables are dummy variables that take a value of 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes. Lagged dependent variable for chronic absenteeism is lagged absenteeism rate.

Appendix Table A5. Academic Outcomes, Long Bus Rides, and School Moving, Value-Added Model, 2011-2017, Route effects

	(1) Z-Math	(2) Z-Read	(3) Attendance Rate	(4) Chronic Absenteeism	(5) Z-Math	(6) Z-Read	(7) Attendance Rate	(8) Chronic Absenteeism
Zoned	-0.043***	-0.075***	0.080	-0.006				
	(0.013)	(0.016)	(0.062)	(0.004)				
Zoned								
30-45 mins	-0.005	-0.012	-0.117	-0.002				
	(0.015)	(0.019)	(0.091)	(0.008)				
45+ mins	0.023	0.036	-0.394	0.024				
	(0.047)	(0.037)	(0.553)	(0.032)				
Choice								
30-45 mins	-0.002	-0.008	-0.057	0.005				
	(0.009)	(0.013)	(0.047)	(0.004)				
45-60 mins	-0.003	-0.010	-0.175***	0.010*				
	(0.015)	(0.014)	(0.062)	(0.005)				
60+ mins	-0.036*	0.004	-0.274**	0.012				
	(0.019)	(0.021)	(0.111)	(0.008)				
Charter								
30-45 mins					0.001	-0.016	0.043	0.007
					(0.010)	(0.011)	(0.091)	(0.006)
45-60 mins					-0.006	0.018	-0.310	0.004
					(0.012)	(0.018)	(0.196)	(0.013)
60+ mins					-0.010	-0.038*	-0.010	-0.005
					(0.022)	(0.021)	(0.258)	(0.017)
School Mover	-0.048**	-0.036**	-0.215***	0.019***	0.047**	-0.085***	0.490***	-0.020*
	(0.022)	(0.015)	(0.072)	(0.005)	(0.022)	(0.018)	(0.159)	(0.012)
Constant	0.736***	0.640***	37.562***	-0.530***	0.560***	0.498***	44.592***	-0.464***
	(0.054)	(0.059)	(0.795)	(0.015)	(0.034)	(0.040)	(2.999)	(0.034)
Observations	76,926	76,338	97,287	97,287	20,553	20,516	17,045	17,045
R-squared	0.740	0.663	0.559	0.363	0.679	0.613	0.649	0.363
Number of Routes	7,081	7,081	7,081	7,081	2,002	2,002	1,495	1,495

Robust standard errors in parentheses and clustered at the school level, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note: Sample is general education bus riders in grades 3-6 for 2011-2017 on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, race/ethnicity, gender, special education status, English language status, and poverty. Bus ride variables are indicators equal to 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes. Lagged dependent variable for chronic absenteeism is lagged absenteeism rate. School mover is an indicator equal to 1 if a student attends a different school in year t than year t-1.

Appendix Table A6. Academic Outcomes, Long Bus Rides, & Distance, Value-Added Model, 2011-2017, School Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Z-Math	Z-Read	Attendance Rate	Chronic Absenteeism	Z-Math	Z-Read	Attendance Rate	Chronic Absenteeism
Zoned	-0.065***	-0.085***	-0.010	-0.003				
	(0.016)	(0.018)	(0.074)	(0.004)				
Zoned								
30-45 mins	0.026**	0.011	-0.083	-0.001				
	(0.013)	(0.014)	(0.088)	(0.007)				
45-60 mins	-0.040	-0.018	-0.317	0.022				
	(0.051)	(0.027)	(0.491)	(0.029)				
Choice								
30-45 mins	0.004	0.003	-0.002	0.000				
	(0.009)	(0.011)	(0.054)	(0.004)				
45-60 mins	0.012	0.011	-0.041	0.005				
	(0.015)	(0.013)	(0.073)	(0.005)				
60+ mins	-0.022	0.034*	-0.059	0.005				
	(0.018)	(0.019)	(0.119)	(0.008)				
Charter								
30-45 mins					0.000	-0.009	-0.028	0.009
					(0.009)	(0.009)	(0.106)	(0.006)
45-60 mins					-0.026*	0.016	-0.301	-0.004
					(0.014)	(0.013)	(0.193)	(0.010)
60+ mins					-0.043*	-0.038*	-0.549	-0.006
					(0.025)	(0.020)	(0.498)	(0.017)
Distance	-0.001	-0.002	-0.069***	0.003**	0.007**	0.002	-0.042	0.003
(miles)	(0.002)	(0.002)	(0.026)	(0.001)	(0.003)	(0.003)	(0.028)	(0.002)
Constant	0.735***	0.619***	95.104***	-3.467***	0.689***	0.583***	97.090***	-3.134***
	(0.054)	(0.057)	(0.112)	(0.072)	(0.044)	(0.042)	(0.570)	(0.198)
Observations	76,926	76,338	77,010	97,287	20,553	20,553	20,516	17,045
R-squared	0.705	0.624	0.502	0.299	0.616	0.616	0.560	0.320
# of Schools	685	685	685	685	130	130	122	122

Robust standard errors in parentheses and clustered at the school level. *** p<0.01, ** p<0.05, * p<0.1

Note: Sample is general education bus riders in grades 3-6 for 2011-2017 on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, race/ethnicity, gender, special education status, English language status, and poverty status. The bus ride variables are dummy variables that take a value of 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes. Lagged dependent variable for chronic absenteeism is lagged absenteeism rate.

Appendix Table B1: Linear Probability Regression Results, Long Bus Rides, Lag Reading Control, 2017

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Bus Ride Length	30+ minutes			45+ minutes			60+ minutes		
Lag Z-Read	0.028***	0.013***	0.009**	0.010**	0.002	0.004	0.004	0.000	0.002
	(0.006)	(0.005)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)
Black	0.072***	0.074***	0.067***	0.053***	0.055***	0.049***	0.019**	0.021	0.022**
	(0.021)	(0.023)	(0.016)	(0.015)	(0.018)	(0.011)	(0.009)	(0.014)	(0.009)
White	-0.038*	-0.021	-0.034***	-0.010	-0.013	-0.018**	-0.011*	-0.016*	-0.010
	(0.020)	(0.015)	(0.013)	(0.009)	(0.011)	(0.009)	(0.006)	(0.008)	(0.006)
Asian	0.025	-0.012	-0.006	0.018	0.004	0.002	0.005	-0.004	-0.003
	(0.016)	(0.016)	(0.012)	(0.012)	(0.010)	(0.008)	(0.008)	(0.006)	(0.006)
Free or Reduced-price Lunch	-0.011	-0.004	0.003	-0.006	0.003	0.008	-0.003	0.003	0.005
	(0.012)	(0.009)	(0.007)	(0.007)	(0.006)	(0.005)	(0.004)	(0.004)	(0.003)
Female	0.003	0.004	0.004	-0.004	-0.005	-0.005	-0.000	-0.002	-0.003
	(0.007)	(0.007)	(0.006)	(0.005)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)
District choice	0.217***	0.187***	0.123***	0.083***	0.054***	0.035***	0.030***	-0.008	-0.004
	(0.026)	(0.023)	(0.020)	(0.012)	(0.016)	(0.011)	(0.007)	(0.010)	(0.008)
Charter	0.230***			0.115***			0.036***		
	(0.031)			(0.017)			(0.009)		
Constant	0.071***	0.152***	0.179***	0.015	0.059***	0.066***	0.007	0.034***	0.029***
	(0.025)	(0.016)	(0.013)	(0.010)	(0.010)	(0.008)	(0.005)	(0.006)	(0.006)
School FE		X			X			X	
Route FE			X			X			X
Year FE									
Observations	15,774	15,774	15,774	15,774	15,774	15,774	15,774	15,774	15,774
R-squared	0.083	0.238	0.454	0.041	0.202	0.423	0.014	0.179	0.386
Number of Schools	815	815	815	815	815	815	815	815	815
Number of Routes	8,708	8,708	8,708	8,708	8,708	8,708	8,708	8,708	8,708

Robust standard errors in parentheses and clustered at the school level, *** p<0.01, ** p<0.05, * p<0.1

Note: Sample is general education bus riders in grades 3-6 for 2017 on one-school routes, routes serving multiple schools sequentially, and co-located schools. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. The bus ride variables are dummy variables that take a value of 1 if a student's bus ride is greater than 30, 45, or 60 minutes.

Appendix Table B2: Linear Probability Regression Results, Long Bus Rides, Lag Attendance Control, 2017

Bus Ride Length	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	30+ minutes			45+ minutes			60+ minutes		
Lag Attendance Rate	-0.000	-0.002*	-0.001	-0.001	-0.001**	-0.001**	-0.001*	-0.001*	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Black	0.061**	0.065**	0.050***	0.045***	0.056***	0.043***	0.020*	0.025	0.020**
	(0.024)	(0.027)	(0.017)	(0.016)	(0.021)	(0.011)	(0.011)	(0.017)	(0.010)
White	-0.031	-0.021	-0.035***	-0.004	-0.012	-0.016*	-0.007	-0.013	-0.008
	(0.021)	(0.015)	(0.013)	(0.009)	(0.011)	(0.009)	(0.005)	(0.008)	(0.007)
Asian	0.038**	-0.005	-0.003	0.025**	0.008	0.005	0.010	0.000	0.001
	(0.018)	(0.017)	(0.012)	(0.012)	(0.010)	(0.008)	(0.009)	(0.006)	(0.006)
Free or Reduced-price Lunch	-0.023*	-0.012	-0.002	-0.010	0.001	0.005	-0.004	0.002	0.003
	(0.013)	(0.010)	(0.008)	(0.007)	(0.006)	(0.005)	(0.004)	(0.005)	(0.003)
Female	0.006	0.005	0.005	-0.005	-0.006	-0.004	-0.000	-0.002	-0.003
	(0.007)	(0.007)	(0.006)	(0.005)	(0.005)	(0.004)	(0.003)	(0.002)	(0.002)
District choice	0.229***	0.190***	0.137***	0.087***	0.054***	0.038***	0.032***	-0.007	-0.004
	(0.026)	(0.023)	(0.020)	(0.013)	(0.015)	(0.011)	(0.008)	(0.010)	(0.008)
Charter	0.231***			0.119***			0.039***		
	(0.036)			(0.019)			(0.011)		
Constant	0.087	0.302***	0.264***	0.070	0.181***	0.162***	0.069*	0.120***	0.074**
	(0.104)	(0.094)	(0.082)	(0.066)	(0.063)	(0.046)	(0.040)	(0.046)	(0.035)
School FE		X			X			X	
Route FE			X			X			X
Year FE									
Observations	13,961	13,961	13,961	13,961	13,961	13,961	13,961	13,961	13,961
R-squared	0.084	0.250	0.466	0.039	0.204	0.438	0.015	0.185	0.410
Number of Schools	815	815	815	815	815	815	815	815	815
Number of Routes	8,708	8,708	8,708	8,708	8,708	8,708	8,708	8,708	8,708

Robust standard errors in parentheses and clustered at the school level, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Note: Sample is general education bus riders in grades 3-6 for 2017 on one-school routes, routes serving multiple schools sequentially, and co-located schools. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. The bus ride variables are dummy variables that take a value of 1 if a student's bus ride is greater than 30, 45, or 60 minutes.

Appendix Table B3: Regression Results, Academic Outcomes and Bus Ride, 2011-2017

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Z-Math	Z-Read	Attendance Rate	Chronic Absenteeism	Z-Math	Z-Read	Attendance Rate	Chronic Absenteeism
	Census Tract FE				Zoned School FE			
30-45 mins	0.082***	0.078***	0.077	-0.002	0.084***	0.077***	0.078	-0.003
	(0.018)	(0.018)	(0.066)	(0.004)	(0.018)	(0.018)	(0.062)	(0.004)
45-60 mins	0.101***	0.111***	-0.263**	0.004	0.114***	0.114***	-0.160	-0.000
	(0.033)	(0.032)	(0.122)	(0.006)	(0.034)	(0.033)	(0.120)	(0.006)
60+ mins	0.097***	0.117***	-0.483**	0.015*	0.114**	0.128***	-0.450**	0.014*
	(0.037)	(0.030)	(0.208)	(0.008)	(0.045)	(0.037)	(0.200)	(0.008)
Constant	0.500***	0.364***	96.035***	0.062***	0.574***	0.458***	96.210***	0.052***
	(0.034)	(0.031)	(0.128)	(0.006)	(0.050)	(0.051)	(0.185)	(0.010)
Observations	96,870	96,247	88,368	88,368	96,644	96,025	88,138	88,138
R-squared	0.327	0.300	0.128	0.070	0.337	0.307	0.129	0.068
Number of Schools	815	815	811	811	815	815	811	811
Number of Routes	8,708	8,708	8,471	8,471	8,708	8,708	8,471	8,471

Robust standard errors in parentheses and clustered at the school level

*** p<0.01, ** p<0.05, * p<0.1

Note: Sample is general education bus riders in grades 3-6 for 2011-2017 with lagged dependent variables on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, and student characteristics, including race/ethnicity, gender, special education status, English language status, and poverty status. The bus ride variables are dummy variables that take a value of 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes.

Appendix Table B4: Value Added Sample. Regression Results, Academic Outcomes and Bus Ride, 2011-2017

	(1) ELA Prof %	(2) Math Prof %	(3) Sci4 Prof %	(4) Sci8 Prof %	(5) Teachers Ma+ %
30-45 mins	0.024***	0.023***	0.010***	0.011***	-0.628***
	(0.001)	(0.002)	(0.001)	(0.003)	(0.107)
45-60 mins	0.034***	0.033***	0.017***	0.012**	-0.431**
	(0.002)	(0.002)	(0.001)	(0.005)	(0.169)
60+ mins	0.050***	0.047***	0.018***	0.004	2.818***
	(0.003)	(0.004)	(0.002)	(0.008)	(0.254)
Constant	0.575***	0.758***	0.905***	0.740***	51.186***
	(0.007)	(0.007)	(0.004)	(0.021)	(0.506)
Observations	97,316	97,332	60,023	50,226	97,326
R-squared	0.407	0.433	0.117	0.100	0.800

Robust standard errors in parentheses and clustered at the school level.

*** p<0.01, ** p<0.05, * p<0.1

Note: Sample is general education bus riders in grades 3-6 for 2011-2017 with lagged dependent variables on one-school routes, routes serving multiple schools sequentially, and routes serving only one school building. Sample excludes students with shelter exceptions. All bus ride variables are constructed using HERE API and estimates for travel time include traffic at 730AM. All models include grade effects, year effects, and student characteristics, including race/ethnicity, gender, special education status, English language status, and poverty status. The bus ride variables are dummy variables that take a value of 1 if a student's bus ride is between 30-45 minutes, 45-60 minutes, or greater than 60 minutes.