Fight or Flight:

Student Mobility and Violent Crime Exposure Near Baltimore City Public Schools

Julia Burdick-Will

Kiara Millay Nerenberg

Jeffrey Grigg

Faith Connolly

Johns Hopkins University

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Introduction

A growing body of literature has demonstrated the negative impact of exposure to violence on students' academic achievement and attainment (Burdick-Will 2016, Harding 2009, Sharkey 2010, Sharkey et al. 2014). To date, many of the proposed mechanisms driving this association have been based on psychological stress, social or linguistic isolation, or distraction in the classroom (Burdick-Will 2013, Sharkey et al. 2012, Harding 2010, Sampson et al. 2008, Shonkoff et al. 2012). Higher rates of residential and school instability among populations exposed to high levels of violent crime have been noted, but not examined in detail (Alexander, Entwisle, and Dauber 1996, Burdick-Will 2016, Chen 2008, Kerbow 1996).

Similarly, research on school mobility shows that students who change schools frequently score lower on standardized tests and are more likely to drop out (Gasper, DeLuca, and Estacion 2012, Rumberger and Larson 1998, Temple and Reynolds 2000). Changing schools not only disrupts a student's social supports, but can result in improper curricular sequencing that leaves students either repeating material or without the necessary background to keep up with their classmates (Grigg 2012). Again, most of the literature on why students move is limited to vague discussions of student- versus school-driven mobility and does not directly address safety concerns (Welsh 2017).

Finally, research on families' school and neighborhood preferences suggests that parents prioritize their children's safety, perhaps at the expense of academic concerns (Boggess and Hipp 2010, Briggs, Popkin, and Goering 2010, Pettit 2004). For example, residents often choose to leave their disadvantaged neighborhood only after a concrete change in their perception of its safety (Rosen 2017). However, much of the research on school safety focuses on initial enrollment through school choice programs (Bagley, Woods, and Glatter 2001, Bulman 2004,

Goldring and Hausman 1999, Rhodes and DeLuca 2014) and does not examine whether changes in perceived safety lead students to leave their current school.

In this study, we explicitly test whether changes in the violent crime rate very close to the school are associated with an increase in the likelihood of school mobility. To do so, we draw on six years (2010-11 to 2015-16) of administrative enrollment data from Baltimore City Public Schools (BCPS) and incident level crime data from the Baltimore Police Department (BPD). Using multilevel logistic regression with random school intercepts and adaptive centering, we find that students are more likely to leave a school following an increase in violent crime near the school. These associations are strongest for non-free and reduced meals students and in schools with higher proficiency rates. School surveys suggest that changes in parental satisfaction in schools are strongly related to perceptions of school safety. These findings have implications not only for our understanding of the mechanisms linking exposure to violence and academic outcomes, but for the sources of school instability and churning in many urban districts.

Background

Existing research on student mobility tends to focus on either who moves or the consequences of school transfers, rather than the sources of student instability. Minority and low-income students in urban districts are the most likely to change schools and to do so relatively frequently (Welsh 2017). For these students, school transfer represents an additional form of disadvantage and is associated with a range of negative outcomes due to interruptions in curricula and tracking, changes in peer support, lack of communication between families and new schools, and family stress related to moving residences (Beck 1997, Welsh 2017). For example, school transfer is associated with lower achievement scores in math and language arts

(Temple and Reynolds 2000), increased likelihood of high school dropout (Gasper, DeLuca, and Estacion 2012, Rumberger and Larson 1998), and loss of social capital through network reduction (Grigg 2012, Ream 2003). Negative consequences of mobility are particularly well demonstrated for students who move frequently (Temple and Reynolds 2000). Furthermore, student mobility can negatively impact academic outcomes not only at the student-level, but also at the classroom and school levels (Raudenbush, Jean, and Art 2011, Hanushek, Kain, and Rivkin 2004, South, Haynie, and Bose 2007). High mobility rates within classrooms may lead teachers to repeat curriculum and spend less time on long-term lesson planning (Lash and Kirkpatrick 1990, Whitesell, Stiefel, and Schwartz 2016). In these schools, researchers have theorized that high rates of mobility pose an additional problem of reducing the efficacy of long-term school-based reforms seeking to improve the achievement of transient student populations (Kerbow 1996).

The consequences of mobility, however, may depend on why students change schools. Some research on the consequences of student mobility attempts to distinguish between "strategic" and "reactive" moves (Rumberger 2003). Strategic moves refer to moves made purposefully by students and parents to attain a preferred school placement. The presumed increase in academic quality and fit with student needs may be why some moves actually result in improvements academic outcomes after some school transfers (Hanushek, Kain, and Rivkin 2004). On the other hand, reactive moves are thought to be made in reaction to an often unmeasured stressor that is unrelated to school quality or preference, such as an eviction, job loss, or family structure change (i.e. Desmond 2016). For example, Pribesh and Downey (1999) argue the co-occurrence of stressful events affecting children's home and family environments accounts for much of the negative effect of school mobility on academic outcomes. In this study,

we argue that this distinction is perhaps too cut and dry. Students who change schools due to safety concerns are both "reacting" to their experience at the school and "strategically" avoiding perceived danger, but not necessarily making a move that will improve their academic experience.

The literature on school and neighborhood choice provides more concrete evidence of the importance of school safety in school choice and mobility decisions. In interviews, parents express a strong desire to limit children's exposure to violence in their school environment (DeLuca and Rosenblatt 2010, Lindle 2008). Furthermore, students are less likely to attend school after being victims of violence (Swahn and Bossarte 2006, Benbenishty and Astor 2005, Dake, Price, and Telljohann 2003) or witnessing victimization of peers (Akiba 2008). Though much of this literature has focused on victimization, students do not necessarily need to experience victimization personally to feel the effects of increased violence near the school. Burdick-Will (2013) argues that high levels of violent crime in a school can disrupt instruction; thus, school violence can have an impact on all students, regardless of victimization status. Indeed, students who feel unsafe in their classrooms consistently have lower test scores (Lacoe 2016) and student absenteeism and dropout are also more likely in schools that students perceive as violent and unsafe (Kearney 2008, Brookmeyer, Fanti, and Henrich 2006). Together, these studies suggest a potential association between student mobility and violent crime.

Importantly, violence need not necessarily occur in the school building to affect students' outcomes. Bryk and colleagues (2010) demonstrate that schools located in communities with higher rates of violent crime have much more difficulty improving math achievement, reading achievement, and student attendance. Along these lines, some have argued that definitions of school violence should be broadened to include violence that occurs when a student is traveling

to and from school as this is when many students may be most vulnerable to witnessing or experiencing violent crime (Lintott 2004, see also Steinberg, Allensworth, and Johnson 2011).

Moreover, studies on school choice have demonstrated that parents prioritize safety when considering where to send their children to school. Especially in urban school districts, families report that safety is an important factor they consider in their school enrollment decisions (Goldring and Hausman 1999, Kleitz et al. 2000). Based on interviews with parents of students enrolling in high school, Bulman (2004) finds that families emphasize the importance of safety and are more likely to identify schools as "good" schools when they perceive them as less violent. Given that perceptions of school safety play a significant role in the school choice process, we would expect them to also play a role in student mobility. While student mobility can be an indicator of an unstable academic trajectory, it can also be a mechanism by which families engage in school choice (Hanushek, Kain, and Rivkin 2004).

Together, the literature on school and neighborhood violence, student mobility, and parental preferences suggests that parents pay particular attention to safety in and around their children's school and that increases in violent crime are likely to be a driver of school exits. Therefore, we expect that increases in violent crime in the area immediately surrounding the school will predict increased likelihood of students transferring to another school for the following school year.

Data

Data for this analysis comes from the city of Baltimore. BCPS has had a high student mobility rate for decades (Alexander, Entwisle, and Dauber 1996). Student mobility rates at the elementary, middle, and high school levels were between 20 and 25 percent for the 2015-16 school year with significant variation in student mobility across schools and neighborhoods in

Baltimore City (MSDE 2017). There is also significant variation in rates of violent crime across city neighborhoods (see Morgan and Pally 2016).

Student-level data for this study come from de-identified BCPS administrative records from the 2010-11 through 2015-16 school years that are stored at the Baltimore Education Research Consortium. The records include gender, race/ethnicity, grade level, free and reduced-price meal status (FARMS), special education status, and English language learner status (ELL) for every child enrolled in the district at any point in time. We use the residential addresses recorded by the district at the end of each school year to connect students to neighborhoods and to create an indicator of students' residential mobility.

Most importantly for the purposes of this study, the records include the date of enrollment and withdrawal for each school attended. We limit our analysis to the 2011-12 through 2014-15 school years, and we use the first and last years of the dataset (2010-11 and 2015-16 school years) to calculate change in enrollment before and after each school year. Our outcome of interest is whether a student changed schools during the summer after the completion of the school year. We use only summer moves for two reasons. First, by restricting our mobility measure to the summer months we ensure that the timing of the move necessarily comes after the measurement of violent crime during the school year. If we were to count moves that took place earlier in the school year, we might mistakenly attribute the mobility to crimes that had not yet taken place. Second, throughout the literature on student mobility, summer moves are considered to be, on average, more strategic and intentional than moves that occur during the school year. Disrupting a students' academic year can be detrimental to their studies and social life and parents who are not just reacting to external circumstances, such as eviction, job loss, or

discipline problems are more likely to keep their child enrolled for the entire academic year before making a change.

In this study, we limit our analysis to students enrolled in kindergarten through fifth grade. There is substantially more mobility in these lower grades and although there are generally lower levels of violent crime in the area around elementary schools than around high schools, there is also substantial variation in student exposure. We exclude middle and high school students because the open enrollment choice process makes changing schools more difficult. There are not always seats available at desirable schools and it is often difficult to move to a better school after the initial lottery assignment has been made. In contrast, residential mobility provides direct access to any elementary school with a catchment zone, and many Baltimore elementary schools are under-enrolled and accept students from out of zone to fill their seats (BCPS 2018). There is also substantially less curricular differentiation between elementary schools and there are no selective enrollment or vocational schools that provide a unique experience and would therefore be likely to retain students regardless of local safety concerns.

The school mobility literature distinguishes between promotional and non-promotional school moves (Welsh 2017). Promotional moves are made by students who change schools because they have reached the highest grade available for their current school. These moves are not voluntary and therefore do not represent an active decision to move on the part of the family. While this is relatively rare in grades K-5, some schools do close or have limited grade offerings. Observations in which students' only option at the end of the year is to change schools are not included in the analysis.

In order to ensure that all students in a school were exposed to the same violent crime rate, we limit our analytic sample to observations in which students are stably enrolled in a single school for the whole year. Midyear mobile students contribute to school-level measures, but their individual observations are not included in the analysis. Including observations for midyear mobile students along with an indicator for midyear mobility yields substantively similar results.

Additional school-level data is collected from the National Center for Education Statistics (NCES) Common Core of Data (NCES 2017) and the MSDE School Report Cards (MSDE 2017). We use the geocoded school addresses reported in the NCES data to identify the city block in which the school is located. We use annual standardized test score proficiency rates reported by MSDE to create a rough measure of school quality. In 2014-15 Maryland adopted the Common Core-aligned test (the Partnership for Assessment of Readiness for College and Careers [PARCC]) and pass rates on standardized tests were lower than in previous years. To account for this discrepancy, we measure school-level achievement by ranking schools by percentile within years according to their test scores rather than comparing raw test score data. Relative differences in test performance across schools are therefore comparable to other years in the dataset.[1] School-level racial composition and proportion of special education students, ELL, and FARMS recipients and mobility metrics, such as the number of new students in each year, and the number of midyear exits, are calculated by aggregating the individual level data to the school level.

[1] Individual level standardized test scores are only available for students starting in third grade. Analysis using only third grade and older students and including the test scores shows that the test scores are not predictive of mobility after adjusting for the other covariates and the coefficients for exposure to violence are substantively similar.

Crime data for this study come from incident reports of victim-based crimes published by the BPD on OpenBaltimore for 2010 through 2016 (BPD 2017). This dataset includes the date, time, location, code, and description of all officially reported incidents during this time period. Violent crimes include all assaults, robberies, rapes, shootings, and homicides. We create two measures of violent crime exposure for every student. First, we measure violent crime exposure at school. Unlike some other cities, the Baltimore crime data does not include a location code that would identify crimes that take place inside the school versus directly outside. However, the majority of school buildings are large enough that they encompass a whole city block. Any crime that took place at the school would be given a location on the street just outside the school. To capture crimes that take place at or directly outside of the school we include all crimes that occur on either side of all streets that define each school's city block. We include only violent crimes that occur during the day (6:00am to 7:00pm) on weekdays between the first and last days of school. These crimes represent events that students and their families are most likely to be aware of and to which students are most likely to be exposed. This time period is long enough so that we can reasonably assume that there will be some students in the vicinity of the school, even if just for a one-time event, but not so short that it removes all variation in students' exposure. Our second measure of violent crime captures students' exposure in their neighborhood. Here we count all violent crimes that take place in each students' residential census tract at any time of day and day of the week during the full calendar year from the first day of school to the start of the next school year. Given the skewed distribution of exposure to violent crime, both measures have been transformed using the inverse hyperbolic sine (IHS) function. This transformation is frequently used when modeling wealth and has the benefit of a similar interpretation as the log transformation, but can be used when values include zero (Burbridge et al. 1988). This means

that the coefficients represent percent change in exposure rather than an increase in a specific number of crimes.

One limitation of the administrative data is that it does not include any direct measures of family background. Instead, we rely on student addresses to capture at least some differences in socio-economic circumstances and adjust for other aspects of the students' neighborhood that may be associated with violent crime exposure. Specifically, we include tract-level measures of median household income and percent of residents with a bachelor's degree or higher from the 2011-15 American Community Survey. Including additional neighborhood measures, such as the poverty, unemployment, or welfare rates does not add anything to the models.

Finally, we use school-level surveys produced and made public by BCPS (BCPS 2017) to explore the relationship between nearby violent crime rates and parental satisfaction with their child's school. These surveys are conducted with students, parents, and teachers every year. Here we use only parents' responses because surveys are not administered to students below third grade and parents are more likely to be making decisions about school enrollment for young children. Surveys are available to parents on paper and online. Parental satisfaction is captured with the school-level percent of parents who agree with the following statements: "Overall, I am satisfied with my child's school." We compare satisfaction rates to parental perceptions of student safety ("My child's school is a safe place"), the school administration ("The school administration promptly responds to my concerns"), the physical environment ("The school building is clean and well maintained"), the school climate ("Teachers at this school care about my child" and "My child feels like she/he belongs at this school"), and the resources available at the school ("Teachers provide extra academic help to students who need it" and "My child's school has programs that support students' emotional and social

development"). The response rates for these surveys is unknown because the total number of eligible parents is unknown and parents may have more than one student in a school. On average, 83 parents responded per school per year.

The use of administrative enrollment records means that every student has a complete record and there are no missing values in our population of stably enrolled students. Around 4.5 percent of midyear mobile observations, mostly late entry kindergarteners, have addresses that we were not able to geocode, but these observations are not included in the analytic sample. Moreover, since we count a student as leaving their school regardless of their destination, leaving the district does not generate any missing values.

Methods

The analytic dataset for this study includes repeated annual measures of students nested within schools. Assessing the relationship between exposure to violent crime and school mobility is difficult due to the selection of different types of students into different schools. In order to adjust for as much of this selection as possible we include a number of individual- and school-level characteristics in the model as well as a school-level random intercept.[2] The co-variates include not only demographic and academic student- and school-level characteristics, but also indicators of prior mobility for both students and their peers. The random intercept also adjusts for some of the normally distributed unobserved differences between schools that might confound the relationship between safety and mobility.

The formal model is as follows:

$$\log (Y_{tijk} /(1- Y_{tijk})) = \eta_{tijk} \quad (1)$$

[2] School mobility is too rare to use a student fixed-effects model and compare students to themselves over time.

$$\eta_{tijk} = \beta_0 + \beta_1 V_{tj} + \beta_2 X_{ti} + \beta_3 M_{ti} + \beta_4 N_{tik} + \beta_5 S_{tj} + d_t + s_j + \varepsilon_{tijk}, \;\; s_j \sim N(0,\tau)$$

Where Y_{tijk} is an indicator for whether or not student *i* living in neighborhood *k* made a non-promotional exit from school *j* in the summer following school year *t*; V_{tj} is the IHS-transformed measure of daytime violent crimes around school *j* in school year *t*; X_{ti} are the individual-level characteristics of student *i* in school year *t* (including gender, race/ethnicity, special education status, English Language Learner status, FARMS, and grade-level); M_{ti} are additional mobility indicators for student *i* in year *t*, including whether the student changed addresses in the prior calendar year or changed schools last summer; N_{tik} are the characteristics of the student's census tract including the IHS-transformed violent crime count, median household income, and percent of residents with a bachelor's degree or higher; S_{tj} are time-varying characteristics of school *j* in year *t*, including total enrollment, total number of student entries and exits during the school year, and percentages of students who are identified as Black, Hispanic, ELL, FARMS, and special education eligible; d_t are dummy variables for each school year; ε_{tijk} are the individual-level error terms; and s_j are the random intercepts for each school, which are assumed to be normally distributed with a mean of zero and a standard deviation of τ. All standard errors are robust and clustered at the school level.

To further adjust for unobserved differences between schools we then compare the standard random-intercept model to a similar model with adaptive centering at the school-level. Instead of using the raw measure of violent crime, this model focuses on how different each year is from the overall school average. In doing so, the coefficient for the annual deviation estimates the coefficient of a standard school fixed-effect with more efficiency (Raudenbush 2009). In other words, the coefficient for the annual deviation represents the estimated relationship between mobility and year-to-year changes in violent crime near the school.

$$\log\left(Y_{tijk}/(1-Y_{tijk})\right) = \eta_{tijk} \qquad (2)$$

$$\eta_{tijk} = \beta_0 + \beta_1(V_{tj} - \bar{V}_j) + \beta_2 \bar{V}_j + \beta_3 X_{ti} + \beta_4 M_{ti} + \beta_5 N_{tik} + \beta_6 S_{tj} + d_t + s_j + \varepsilon_{tijk},\ s_j \sim N(0,\tau)$$

Since the centered measure of violent crime exposure is independent of the average exposure for each school, it is also independent of any constant characteristics of the school that might predict generally higher or lower crime such as proximity to transit and commercial areas (Cohen and Felson 1979) or structural features of the school building that limit adult supervision (Sánchez-Jankowski 2016).

Results

Descriptive Summary

Table 1 reports the distribution of the types of crimes that occur around schools during the 2010-11 through 2014-15 school years. In the average school year there are around 7 reported assaults and 1 robbery, leading to a total of approximately 8 violent crimes. However, these distributions are quite skewed with a few schools reporting more than 50 violent crimes in a single school year. Most schools do not have any serious crimes taking place nearby, but there are schools that have dealt with up to 3 homicides and 2 rapes or shootings in one school year.

[Table 1 about here]

Table 2 compares the observations for students who stay in the same school all year with those that make midyear moves and are therefore excluded from the analysis. Around 10 percent of observations are excluded due to a midyear move. As expected, midyear movers are generally more mobile by other measures as well. They are substantially more likely to have changed residences in the last year and to have changed schools during the previous summer. They are slightly more likely to be black and disadvantaged than the rest of the population in terms of special education, English language learning, free and reduced meals, tract demographics, and

violent crime exposure in both their neighborhoods and schools, but these differences are relatively small. The number of students in the stable and midyear-mobile groups does not add up to the total number of students because some students a mobile in some years and stable in others. There are approximately 2.25 observations per student in the final analytic sample.

[Table 2 about here]

Table 3 presents the school characteristics in years with low, medium, and high levels nearby violent crime. School years in the bottom third of violent crime (fewer than 3 reported crimes) are considered low, schools in the top third of average violent crime (more than 8 reported crimes) are considered high, and all other schools fall in the medium category. Exposure to violent crime is somewhat associated with school size, with highest-exposure school years enrolling approximately 48 students more than the lowest-exposure schools on average. The biggest differences between high and low violent crime school years is reflected in their racial composition. More than 90 percent of the students in the high violent crime school years are black, compared to 75 percent in the low violent crime years. Only 5.5 percent and 2.7 percent of students in high violent crime school years are white or Hispanic, respectively. These numbers show that while not all students in predominantly black schools in Baltimore are exposed to violent crime, those who are exposed are much more likely to be black. Schools in the highest-exposure category also serve the most advantaged students in terms of free and reduced-priced meals and special education, although they serve fewer ELL students than schools in the other two exposure categories. Test scores are also somewhat lower in the highest exposure years. Importantly for our analysis, higher violent crime school years also have somewhat higher turnover rates with larger numbers of new students (123 in the lowest violent crime years versus 152 in the highest) and midyear movers (34 versus 53). The last row of the table shows how

many schools are represented in each of these groups. The numbers in each column do not sum to the total because many schools change categories from year to year.

[Table 3 about here]

Figure 1 shows the distribution of these violent crimes across Baltimore for the 2013-14 academic year. Tract level violent crime is shown in the background as a reference. The schools with no reported violent crimes are marked in gray. Larger black circles represent schools with larger numbers of reported violent crime. Two things are worth noting about the spatial distribution of school violence. First, while the most violent schools are generally closer to more violent neighborhoods, there are still quite a few reported school crimes in what otherwise appear to be relatively safe areas of the city and very safe schools in otherwise dangerous neighborhoods. Second, schools that are very close to one another geographically can have dramatically different violent crime rates. This spatial variability is due to the highly concentrated nature of violent crime. Even in the most dangerous neighborhoods in Baltimore and elsewhere, most crimes take place on a relatively low number of specific block faces (Braga et al. 2010, Cohen and Felson 1979, St. Jean 2008).

[Figure 1 about here]

There is also quite a bit of temporal variability from year to year, especially in schools on the higher end of the violent crime distribution. Figure 2 shows reported violent crime rate for 12 randomly selected schools over time. Violent crime rates in some of these schools vary dramatically from year to year with the most violent school year's peaking near 60 incidents, but dropping below 20 in other years. Even in the lowest crime schools there is variability. In fact, only one elementary school in the city (a charter school in the northwest part of the city) reported no violent crimes in any year.

[Figure 2 about here]

Multilevel Results

Table 4 presents results for the multilevel logistic regressions of student mobility on school violent crime. Model 1 includes student-level covariates and the school random intercept. Unsurprisingly, the largest predictor of school mobility is prior residential mobility. The log odds of school mobility for students with an address change in the prior calendar year is more than 2 points higher than those who did not change addresses. Students who changed schools during the previous summer are also more likely to move again, reflecting the general instability among some Baltimore City Schools students. On average, black students are more likely to change schools than non-black and non-Hispanic students. Hispanic and free and reduced meals recipients are less likely to change schools. Since we have used the IHS transformation for the measure of violent crime, this coefficient represents predicted change in the log odds of mobility for an approximately one percent change in violent crime near school. Adjusting for student characteristics, a one percent change in violent crime predicts a .085 (s.e. 0.18) change in the log-odds of a student leaving the school.

[Table 4 about here]

Model 2 adds the neighborhood and school characteristics. With all of the student and school-level adjustments, tract median household income and education levels do not predict school mobility, but a one percent increase in the violent crime rate in students' neighborhoods is associated with a 0.10 reduction in the log-odds of school mobility. Students are more likely to leave schools with higher midyear mobility rates, lower test scores, and higher proportions of black, ELL, and FARMS students. In this model, the relationship between a one percent change in violent crime and the log odds of student mobility is reduced to 0.052 (s.e. 0.16). The

predicted marginal association between a one percent change in violent crime near school and summer student mobility, holding all covariates at their mean, is 0.48 percentage points. For context, the predicted probability of leaving the school over the summer for students with otherwise average characteristics in schools with no nearby violent crimes is 11.5, with average violent crime exposure (8 violent crimes in a year) is 12.8, and with exposure one standard deviation above the mean (17 violent crimes in a year) is 13.2.

Despite the inclusion of the random school intercept it is possible that there are unobserved differences between schools that are not normally distributed and are confounding the relationship between exposure to violent crime and mobility. Therefore, the third model uses adaptive centering to estimate the relationship between mobility and year to year changes in the school violent crime rate. The coefficient for nearby violent crime in this model is almost identical ($\beta = 0.052$, s.e. = .019). While the standard error is very slightly larger in this model, the similarity in the coefficients between models two and three along with the very small proportion of variance that is explained by between school differences (approximately 3 percent) suggests that there is not additional time-invariant, school-level confounding that is biasing the standard random-intercept model.

Interactions

There is no evidence of differential associations by race, gender, English language learner, and special education status (results not shown in tables). However, there is some evidence that the relationship between violent crime exposure and school transfer is stronger for more advantaged students. Model 4 shows the interaction between exposure to violent crime near school and both FARMS status and school-level proficiency. Coefficients are almost identical when the two interactions are run separately, but a three-way interaction does not add anything to

the model. Non-FARMS students are much more likely to leave their school in years with high violent crime. In fact, the predicted marginal increase in the probability of mobility given a one percent increase in violent crime and all other covariates at their mean for FARMS students is only 0.41 percentage points (s.e. 0.16), but 1.22 percentage points (s.e. 0.37) for non-FARMS students. Similarly, the relationship between violent crime and mobility is much stronger in schools with higher proficiency rates. Figure 3 graphs the marginal association between nearby violent crime and school mobility in different types of schools by FARMS status. While there is no relationship in schools with below average test scores, there is a strong association in schools with higher proficiency rates and even larger associations for the non-FARMS students in those schools. The estimated difference between FARMS and non-FARMS students also narrows in higher proficiency schools.

Finally, there is no evidence that students are more likely to leave the entire district, rather than just their school, in summers following exposure to violent crime near their school (results not shown). In other words, increased rates of violent crime are related to churning within the city of Baltimore, not flight to the suburbs.

School Surveys

In order to better understand the link between exposure to violent crime and student mobility we now examine school-level surveys of parental satisfaction. Since the survey measures are only available at the school level, they do little to explain the individual variation in mobility rates. Nevertheless, we are able to explore school level changes from year to year and show that in years where nearby violent crime rates are higher parents are less satisfied with their school. Table 5 shows the results of a school fixed-effects regression of parental satisfaction on nearby violent crime adjusting for student test scores (other school-level demographics were not

statistically significant). Adjusting for school-level proficiency levels, a one percent change in the violent crime rate in a given year predicts a 1.58 point (s.e. 0.75) reduction in parental satisfaction. On the other hand, there is no relationship between nearby violent crime and satisfaction when violent crime is measured in the following academic year (β = -0.52, s.e. 0.76). The next model adds adjustments for other aspects of the school climate, administration, and resources that might lead to lower satisfaction. Indeed, these measure are predictive of satisfaction and the r-squared in this model is much higher (0.53 versus 0.03), but these climate measures do not explain much of the relationship between nearby violent crime and parental satisfaction. The coefficient for nearby violent crime is only reduced to -1.26 (s.e. 0.53). The final model adds parents' perception of student safety. Not only is safety very predictive of parental satisfaction, but it also explains the relationship between nearby violent crime and parental satisfaction. The violent crime coefficient is now only -0.45 (s.e. 0.49). These results suggest that families become unsatisfied with their school due to safety concerns, not potentially co-occurring changes in the way the school itself is being run.

[Table 5 about here]

Discussion and Conclusion

Student mobility and exposure to violence are both well documented problems in many urban school districts. In this study, we show that these two phenomena should not be considered in isolation and are in fact related. Specifically, we show that in academic years with higher levels of reported violent crime on the streets surrounding a school, students are more likely to transfer from that school at the end of the year. For the average student, this means that a one standard deviation increase in violent crime predicts an increase in mobility of around 1 percentage point. Summer school transfer is relatively rare (only 12.3 percent of stably-enrolled

students change schools during the summer, on average), so this represents around an 8% increase in the predicted mobility rate. Given the rigorous individual, neighborhood, and school-level covariates, this represents a substantial increase in the predicted mobility rate for these students. Moreover, these predicted associations are substantially larger for students who do not qualify for free or reduced meals and who are enrolled in higher-achieving schools. This suggests that it is more advantaged students who are most sensitive to and able to respond to changes in safety around their school. This does not mean that lower income families are not aware of or worried by nearby violent crime, but that they may feel less empowered to take concrete action in response (see Pattillo 2015). Therefore, violent crime around a school may not only influence individual students' transfer rates, but it may shape the composition of the student body by pushing out some of the most advantaged students.

These findings are not without their limitations. Administrative data allow us to examine the entire population of Baltimore City public school students, but do not provide detailed information on family background or on the kinds of acute stressors, such as eviction or family change, that might lead to school mobility. We have tried to adjust for as much of this as possible with the available demographic and mobility measures, but it is possible that unobserved differences between students account for some of the association between nearby school violent crime and student mobility. In addition, the estimated relationships are averaged over all students in a school. It is possible that the associations might be even stronger for students who were directly involved in any violent incidents at school as either witnesses, victims, or even perpetrators.

Despite these limitations and our inability to say for sure whether these associations represent causal effects, the association between exposure to violence and student mobility has

important implications for educational inequality. First, it provides even more evidence of the collateral damage of violent crime on urban areas. Not only do high crime rates cause stress and trauma for individual students, but it may be a source of churning and instability in already disadvantaged areas. This instability may, in turn, be part of the mechanism linking exposure to high violence schools and neighborhoods to lower academic outcomes.

Second, the literature on student mobility tends to focus on purely academic rationales for defining how students make "strategic" moves between schools. Consequently, existing studies generally treat other types of moves as less rational or as evidence of "churning" aimlessly between schools of similar academic quality. Kerbow (1996) and others have argued that high rates of student mobility in urban districts reflects the instability in students' home lives and indicates a lack of rationality in school choice decisions. By contrast, we argue that students and their families may be behaving with much greater rationality than this literature generally attributes to them and in response to factors that previous studies have not fully considered. By demonstrating that changes in violent crime near the school help to predict student mobility, we provide evidence for the perspective that student mobility is about more than just students' own residential instability. Moreover, we suggest that even in the face of instability, this study demonstrates that there is still plenty of room for agency and rationality of various types within student mobility, even mobility which may not appear strategic by traditional metrics of school academic quality but may be strategically oriented around other metrics of quality, such as exposure to violent crime.

Finally, instability and churning in urban school systems is a serious problem in and of itself. Not only do individual students tend to do poorly after a school transfer, but schools and classrooms with high mobility rates are harder to teach (Raudenbush, Jean, and Art 2011).

Students with higher exposure to violence on the way to school may also be less likely to show up in class and teachers who fear for their safety are more likely to leave their school (Author under review, Boyd et al. 2011). Moreover, students exposed to violent crime near their previous school who then transfer to other schools may bring with them stress and trauma that can negatively impact their new peers (Burdick-Will 2018). Unfortunately, this relationship between violence exposure and mobility is likely dynamic and magnified over time. Given the year-to-year fluctuations in school violent crime rates, students may leave one school because they experienced violence for another they think is safer, only to find that in the next year, their new school experiences as much or more violence than what they expected.

In order to reduce student turnover rates, policymakers in urban districts must think beyond students' individual-level rationale for school transfer and begin to consider the larger urban context. The results of this study suggest that districts may be able to reduce student turnover rates by expanding their definition of school safety. Although many districts have begun to place safety officers inside school buildings, violent crime that occurs just outside of the school building can significantly impact families' decisions about school enrollment. Focusing on reducing exposure to violent crime in the area surrounding the school and having more adult supervision outside the school building can help prevent students' exposure to crime, with potential implications for students' enrollment and mobility patterns at the district level.

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Table 1. Violent Crimes Near Baltimore City Elementary Schools Per Academic Year (2010-11 through 2014-15

	Mean	Standard deviation	Minimum	Maximum
Violent	7.93	9.00	0	56
Assault	6.63	7.53	0	52
Robbery	1.11	2.14	0	19
Sexual Assault	0.06	0.25	0	2
Shooting	0.07	0.28	0	2
Homicide	0.06	0.30	0	3

Source: Authors' calculation based on data from the Baltimore City Police Department and the Baltimore City Public Schools.

Table 2: Student Characteristics by Midyear Move Status

	Stable	Midyear Move	All
Midyear School Move	0	100	10.05
	(0)	(0)	(30.07)
Summer School Move	12.31	19.77	13.06
	(32.86)	(39.82)	(33.70)
School Move Last Summer	15.83	25.58	16.81
	(36.50)	(43.63)	(37.40)
Residential Move	30.02	62.47	33.28
	(45.83)	(48.42)	(47.12)
Male	51.26	52.76	51.41
	(49.98)	(49.93)	(49.98)
Black	80.36	83.86	80.71
	(39.73)	(36.79)	(39.46)
Hispanic	8.323	7.420	8.232
	(27.62)	(26.21)	(27.49)
Special Education	11.86	13.73	12.05
	(32.34)	(34.42)	(32.56)
English Language Learner	4.747	6.213	4.895
	(21.26)	(24.14)	(21.58)
Free and Reduced Meals	88.92	92.64	89.30
	(31.39)	(26.12)	(30.92)
Grade	2.218	1.968	2.193
	(1.610)	(1.606)	(1.612)
Tract Median Household Income	39477.0	36497.3	39177.4
	(17989.3)	(14942.6)	(17729.3)
Tract Percent with Bachelor's Degree	19.58	16.79	19.30
	(16.42)	(13.91)	(16.21)
Tract Violent Crime	107.5	113.5	108.1
	(55.94)	(56.21)	(56.00)
Violent Crime Near School	8.038	8.801	8.115
	(9.186)	(9.415)	(9.212)
Observations	122,245	13,666	135,911
Students	54,235	11,958	60,971

Note: Percent for dichotomous variables and mean for continuous variables. Standard deviation in parentheses.

Source: Authors' calculation based on data from the Baltimore City Police Department and the Baltimore City Public Schools.

Table 3: School Characteristics by Thirds of Nearby Violent Crime

	Low	Medium	High	All
Total Enrollment	423.4	440.4	470.4	443.2
	(203.7)	(208.7)	(174.5)	(197.6)
Number of New Students	122.6	136.3	152.0	136.0
	(72.13)	(68.64)	(59.95)	(68.43)
Number of Midyear Exits	33.80	44.42	52.80	43.00
	(19.32)	(22.51)	(23.77)	(23.12)
Proficiency Percentile	60.13	54.30	52.63	55.97
	(28.10)	(26.94)	(25.70)	(27.16)
Proportion Black	0.75	0.83	0.90	0.82
	(0.28)	(0.22)	(0.17)	(0.24)
Proportion Hispanic	0.09	0.08	0.028	0.07
	(0.16)	(0.14)	(0.042)	(0.13)
Proportion English Language Learner	0.05	0.04	0.016	0.04
	(0.10)	(0.10)	(0.04)	(0.07)
Proportion Special Education	0.12	0.125	0.14	0.13
	(0.04)	(0.04)	(0.04)	(0.04)
Proportion Free and Reduced Meals	0.85	0.89	0.94	0.90
	(0.16)	(0.14)	(0.07)	(0.14)
Nearby Violent Crimes	1.56	5.77	18.06	7.93
	(1.04)	(1.47)	(10.29)	(9.0)
Number of School-Years	188	163	153	504
Number of Schools	79	82	65	129

Note: Standard deviations in parenthesis. Low violent crime school years have fewer than 3 violent crimes reported nearby. High violent crime years have more than 8 violent crimes reported nearby. Medium violent crime school years are those in between. The number of schools in each category does not add up to the total number of schools because schools may be counted in multiple groups depending on the violent crime count in each year.
Source: Authors' calculation based on data from the Baltimore City Police Department and the Baltimore City Public Schools.

Table 4: Predicted Log Odds of Student Mobility

	Model 1	Model 2	Model 3	Model 4
Nearby Violent Crime	0.085***	0.052**		0.115**
	(0.018)	(0.017)		(0.035)
Nearby Violent Crime (Deviation)			0.052**	
			(0.019)	
Nearby Violent Crime (School Mean)			0.050	
			(0.037)	
Male	0.065***	0.064***	0.064***	0.065***
	(0.019)	(0.019)	(0.019)	(0.019)
Black	0.191***	0.163***	0.163***	0.159***
	(0.046)	(0.047)	(0.047)	(0.047)
Hispanic	-0.287***	-0.285***	-0.285***	-0.290***
	(0.067)	(0.068)	(0.068)	(0.068)
Special Education	-0.009	-0.010	-0.010	-0.010
	(0.030)	(0.030)	(0.030)	(0.030)
English Language Learner	-0.133	-0.139	-0.139	-0.141
	(0.072)	(0.073)	(0.073)	(0.073)
Free and Reduced Meals	-0.195***	-0.202***	-0.202***	-0.047
	(0.039)	(0.040)	(0.040)	(0.083)
Residential Move	2.148***	2.147***	2.147***	2.147***
	(0.020)	(0.020)	(0.020)	(0.020)
Change Schools Last Summer	0.219***	0.221***	0.221***	0.221***
	(0.029)	(0.029)	(0.029)	(0.029)
Tract Median Household Income		0.013	0.013	0.013
		(0.021)	(0.021)	(0.021)
Tract Percent Bachelor's Degree		0.016	0.016	0.016
		(0.021)	(0.021)	(0.021)
Tract Violent Crime		-0.094***	-0.094***	-0.094***
		(0.022)	(0.022)	(0.022)
Total Enrollment		-0.064	-0.064	-0.082
		(0.045)	(0.045)	(0.045)
Total New Students		-0.018	-0.018	-0.027
		(0.030)	(0.030)	(0.030)
Total Midyear Moves		0.133***	0.133***	0.138***
		(0.023)	(0.023)	(0.023)
Test Score Percentile		-0.131***	-0.131***	-0.209***
		(0.030)	(0.030)	(0.040)
School Percent Black		0.304***	0.304***	0.299***
		(0.064)	(0.064)	(0.063)
School Percent Hispanic		-0.059	-0.060	-0.082
		(0.078)	(0.078)	(0.077)
School Percent English Language Learners		0.168*	0.168*	0.185**
		(0.066)	(0.066)	(0.066)
School Percent Special Education		0.021	0.021	0.022
		(0.021)	(0.021)	(0.021)

School Percent Free and Reduced Meals		0.113*	0.113*	0.108*
		(0.045)	(0.046)	(0.044)
Nearby Violent Crime*FARMS				-0.072*
				(0.034)
Nearby Violent Crime*Test Score Percentile				0.032**
				(0.011)
Constant	-2.727***	-2.049***	-2.044***	-2.177***
	(0.088)	(0.145)	(0.164)	(0.158)
τ	0.50	0.34	0.34	0.33
	(.04)	(0.03)	(0.03)	(0.03)
ρ	0.07	0.03	0.03	0.03
	(0.01)	(0.01)	(0.01)	(0.01)
Observations	122,245	122,245	122,245	122,245
Number of Schools	129	129	129	129

Note: Robust standard errors in parentheses. Violent crime measures have been transformed using the inverse hyperbolic sine function. All other continuous measures have been standardized. All models include a school level random intercept. Models 2-4 include indicators for grade and school year. *** p<0.001, ** p<0.01, * p<0.05.
Source: Authors' calculation based on data from the Baltimore City Police Department and the Baltimore City Public Schools.

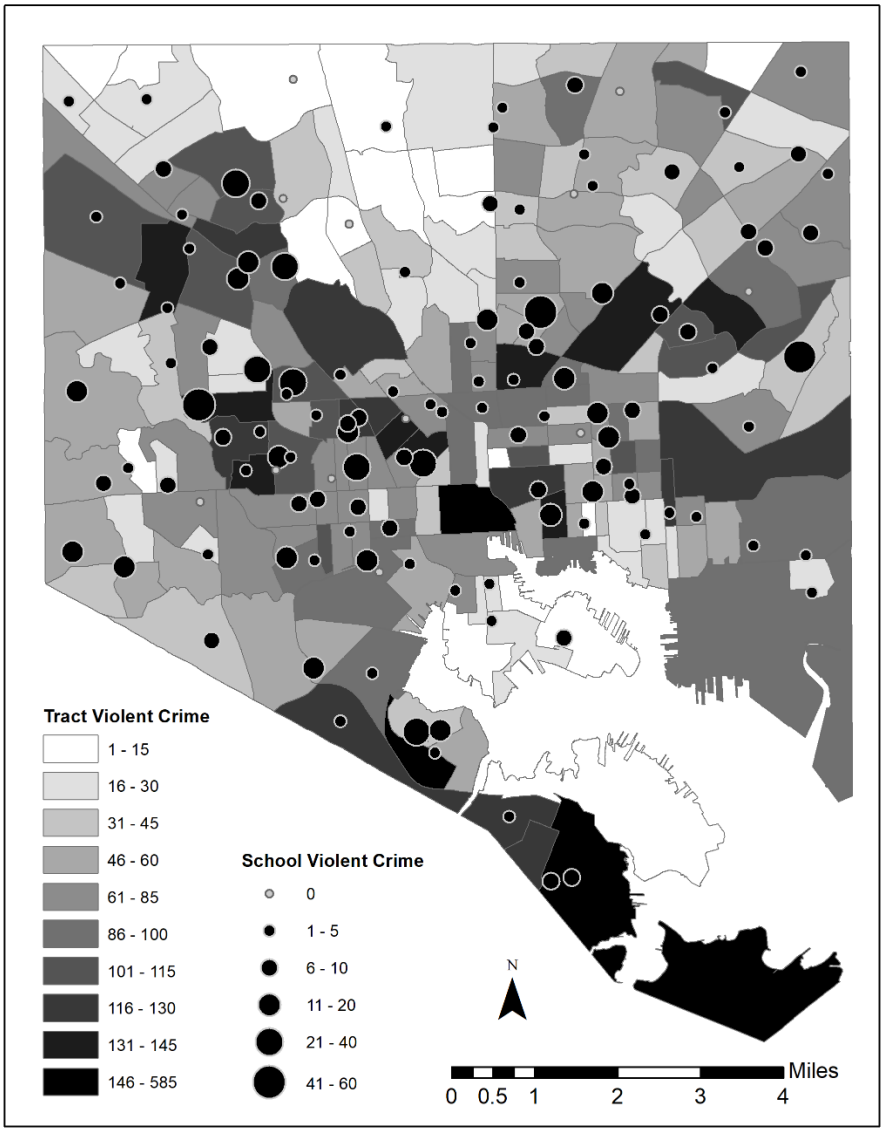
Table 5: Predicted School-Level Parental Satisfaction

	Model 1	Model 2	Model 3	Model 4
Nearby Violent Crime	-1.58*		-1.26*	-0.45
	(0.75)		(0.53)	(0.49)
Standardized Test Percentile	-1.04*	-1.04*	-1.09**	-0.73*
	(0.44)	(0.45)	(0.37)	(0.34)
Administration			7.12***	5.29***
			(0.53)	(0.52)
Physical Environment			-0.15	-1.14
			(0.63)	(0.59)
Climate			0.89	1.01
			(0.67)	(0.61)
Resources			0.57	0.53
			(0.69)	(0.62)
Nearby Violent Crime (Next Year)		-0.52		
		(0.76)		
Safety				4.43***
				(0.52)
Constant	86.70***	84.31***	86.12***	84.32***
	(1.71)	(1.71)	(1.22)	(1.12)
School Fixed-effects	X	X	X	X
R-squared	0.03	0.02	0.53	0.61
Observations	471	471	471	471
Number of Schools	129	129	129	129

Note: Robust standard errors in parentheses. Violent crime measures have been transformed using the inverse hyperbolic sine function. All other measures have been standardized. *** p<0.001, ** p<0.01, * p<0.05.

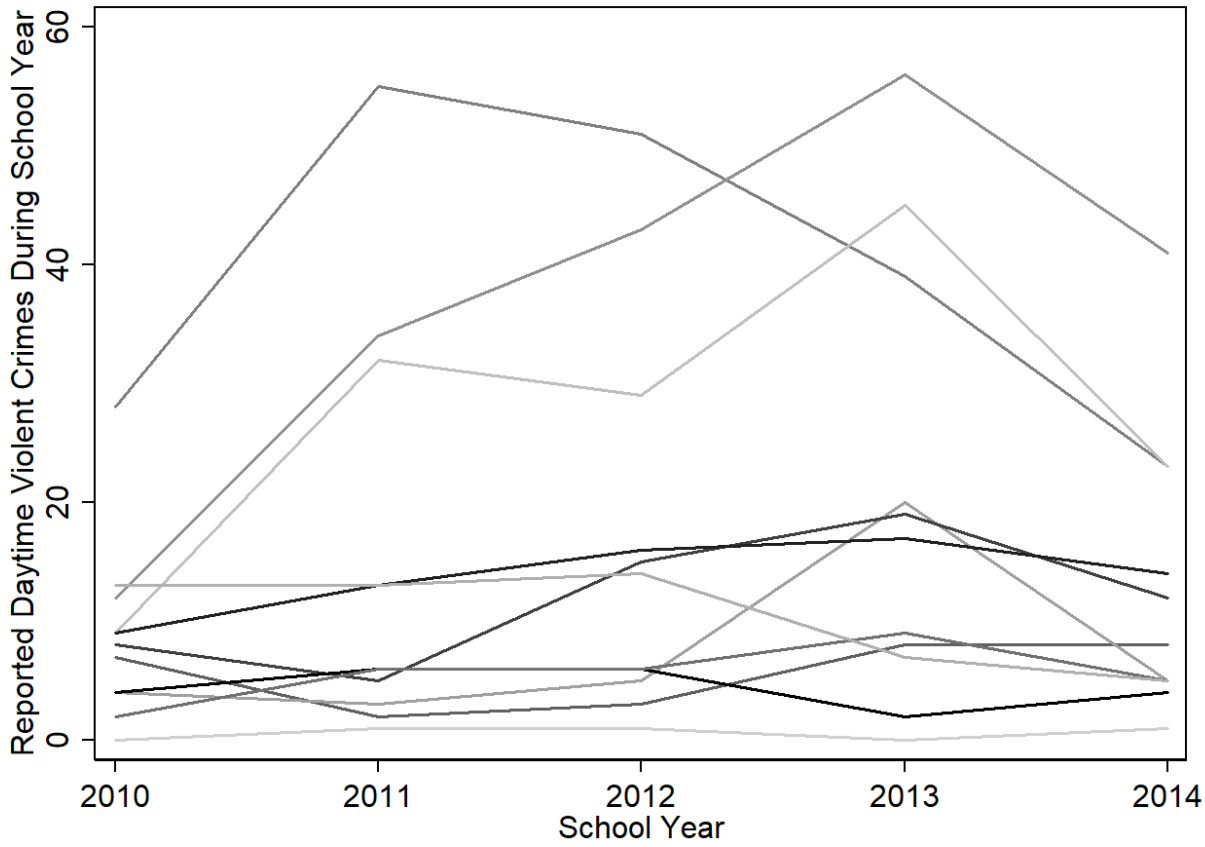
Source: Authors' calculation based on data from the Baltimore City Police Department and the Baltimore City Public Schools.

Figure 1: Reported Violent Crimes Near Baltimore City Public Elementary Schools and Census Tracts during the 2013-14 School Year



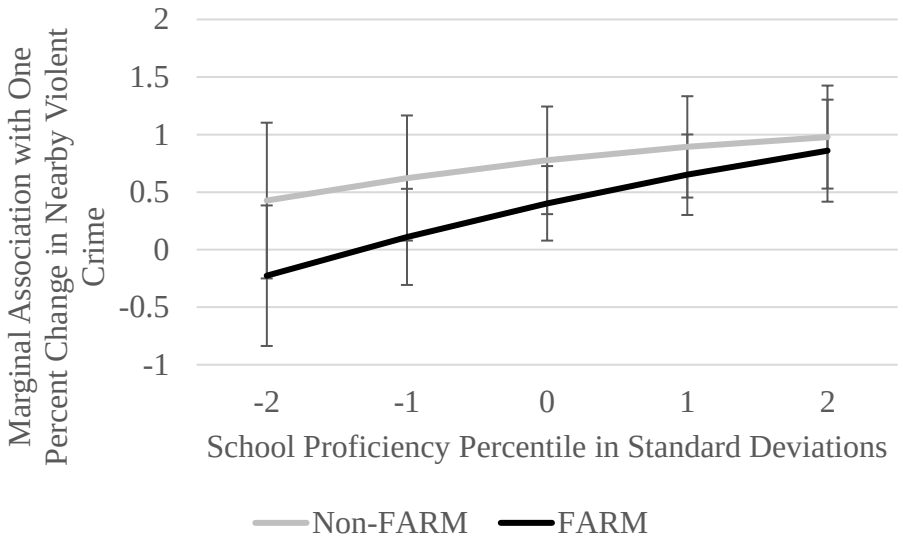
Source: Authors' calculation based on data from the Baltimore City Police Department and the Baltimore City Public Schools.

Figure 2: Trend in Nearby Violent Crime in Randomly Selected Baltimore City Public Elementary Schools (2010-2014 School Years)



Note: Each line represents a single, randomly selected elementary school.
Source: Authors' calculation based on data from the Baltimore City Police Department and the Baltimore City Public Schools.

Figure 3: Marginal Effect of Violent Crime by School Proficiency and Free and Reduced Meals Status



Source: Authors' calculation based on data from the Baltimore City Police Department and the Baltimore City Public Schools.