

Neighborhood Violent Crime and Achievement in Chicago:

Quantity versus Relative Change

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Abstract

A growing body of research suggests that living in a neighborhood with high violent crime has a negative impact on academic achievement. In this study, I assess whether annual violent crime rates influence standardized test scores and grades. Using eight years of detailed crime data and public school administrative records from Chicago (2002-2010), I follow over 120,000 students through their high school careers. Levels of neighborhood violence are strongly associated with lower achievement, but student fixed-effects models show that levels of annual violent crime are not associated with either measure of achievement. However, multi-level difference-in-difference models show that declines in annual violent crime rates relative to the previous year do result in improvements in test score growth, but no change in grades. These effects do not appear to vary for different types of students or neighborhoods. The results suggest students experience stress and distraction when violence is high, but are able to recovery and concentrate better as neighborhood violence declines. Overall, this implies that improving safety in Chicago could lead to improvements in academic achievement in addition to quality of life.

Austin, a neighborhood on the West Side of Chicago, is home to around 117,000 people, approximately four percent of the city's population. Around 90 percent of these residents are African-American. This neighborhood alone reported more than 6.5 percent of all violent crimes in the city of Chicago in 2007. That year there were fully 35 murders in Austin along with 100 criminal sexual assaults, 1,013 robberies, and 1,076 aggravated assaults or batteries. Of the 28 schools in Austin, 19 are on academic probation. Together the seven least violent neighborhoods in Chicago, all in the far northwest or southwest areas of the city, have a population of over 140,000, but only reported 257 violent crimes during that same year, less than one percent of all violent crime in the city. There are 26 schools in these seven neighborhoods. Only 2 of them are on academic probation (Chicago Police Department 2008, Chicago Public Schools 2012).

Recently, students' exposure to violence in Chicago's neighborhoods has received a lot of local and national attention. Numerous newspaper articles have been written about the violence that Chicago Public School students have to face in their neighborhoods, and the local media frequently report a running tally of Chicago Public School students who are shot or murdered each year (See, for example, Chicago Tribune 2007). School policy makers have also made violence prevention an important part of their school programming, including "Safe Passage," designed to help students get safely to and from school, and a program that specifically targets after-school programs and mentoring resources at the students deemed most likely to be victims of gun violence (Saulny 2009).

Obviously, exposure to violence and violent environments is a problem and reducing violence is a worthy goal in and of itself. However, it may be even more important than just ensuring students' physical safety and well-being. A growing body of research focuses on the "collateral" consequences of neighborhood violence, especially its potentially negative impact on

educational outcomes (i.e. Harding 2010a, Kirk and Sampson 2013, Sharkey 2010). Living in a violent neighborhood is associated with lower achievement and attendance in school as well as behavioral problems, such as aggression and depression, that may hamper school performance (i.e. Bowen and Bowen 1999, Guerra, Huesmann, and Spindler 2003, Margolin and Gordis 2000). Harding (2010a) has also shown that at the national level, living in a high violence neighborhood is strongly associated with dropping out of high school. In fact, neighborhood violent crime rates can explain a large proportion of the relationship between neighborhood socioeconomic disadvantage and graduation. Sharkey (2010) finds that students who took a test of verbal ability within a few days of a local homicide scored substantially lower on cognitive tests than those in the same neighborhood who took the test farther from the date of a local homicide. In addition, Burdick-Will et al (2011) suggest that city-level differences in the neighborhood distribution of violent crime rates may explain why moving families out of low-poverty neighborhoods during the Moving to Opportunity experiment had larger effects on students' test scores in Chicago and Baltimore than in New York, Los Angeles, and Boston.

These associations are largely based on cross-sectional comparisons between students living in more or less violent neighborhoods. However, such comparisons are subject to a number of different methodological assumptions and concerns. First, residential constraints and selection lead different types of families into different neighborhoods. Since both neighborhood residence and academic achievement are strongly associated with a family's social and economic resources, it is possible that the observed academic differences between students in more or less violent neighborhoods are the result of variation in family resources and not neighborhood violent crime rates. Second, the problem of selection is made even more difficult by uncertainty about the timing and duration of the social and psychological mechanisms that potentially link

neighborhood violence and academic achievement. The long-term, potentially multi-generational, academic consequences of early exposure to neighborhood violence are difficult to separate from the selection of lower achieving kids into more violent neighborhoods without detailed information on early differences between those families (i.e. Sharkey and Elwert 2011).

Assessing the impact of relatively short-term exposure to neighborhood violence is appealing for both methodological and policy reasons. Methodologically, it allows for more rigorous controls for students' experience before the change in violent crime and clear identification of causal timing. For example, shorter periods allow for the creation of multiple observations for each student, and therefore the use of student fixed-effects or other within person comparisons. Randomized housing voucher experiments such as MTO, also rely on relatively short exposure periods because families can only be forced to remain in their assigned neighborhoods for the length of one lease. While these families can be followed up with at much later periods, it is difficult to ensure that they receive very long-term exposure to a different kind of neighborhood. For example, the initial positive effect of moves on adolescent boys' behavior faded after the first few years, in part because many families moved back to neighborhoods that more closely resembled where they started (Kling, Ludwig, Katz 2005, Sampson 2008).

In this sense, short-term exposure periods more closely mimic potential of policy solutions to the problem of concentrated neighborhood disadvantage. Even with place-based interventions in which families are not asked to leave, policy initiatives are often evaluated within a very short time-horizon. Potential long-term effects alone are unlikely to save expensive social programs from being cut if there no measureable shorter-term benefits for students who have already spent most of their childhood exposed to high levels of violence. However studying relatively short time-periods can be more complicated from a theoretical perspective. It requires

not only a theoretical understanding of the potential links between neighborhood environment and achievement, but also an understanding of how those links develop and change over time.

Change in annual neighborhood violence can be thought of in two ways: as an absolute change in the absolute level and as a relative change from the previous year. I argue that order of exposure and past experience matter and therefore relative change should be more relevant to understanding students' response to neighborhood violence. In other words, going from a safe period to a violent period does not necessarily induce the same response as the other way around. Below I elaborate on the importance of understanding how change over time connects with our theories about the link between neighborhood violence and achievement. I will then describe fixed-effects and multi-level difference-in-difference models that do or do not take the order of exposure and direction of change into account. The results of these models suggest that after controlling for observed and unobserved differences between students, the absolute level of annual neighborhood violence does not have a measurable effect on achievement, but that the change in neighborhood violence compared to the previous year does. Specifically, decreases in neighborhood violent crime result in increased growth in test scores, but no change in grades. This suggests that the results are due to stress, preoccupation, or distraction at test time, rather than social adaptation as a form of self-protection that build over the course of the year. I end with a discussion of the limitations of this study as well as the theoretical, methodological, and policy implications of the findings.

## *NEIGHBORHOOD VIOLENCE AND ACADEMIC ACHIEVEMENT*

### Social Adaptation and Protection

Recently, a growing number of researchers have compared students in violent and non-

violent neighborhoods and theorized that living in a violent neighborhood requires students to adapt protective measures to keep safe that may be counter-productive to academic success. Anderson (1999) argues that unsafe neighborhoods encourage young men to earn and maintain a reputation for being tough and willing to fight to discourage others from making them a victim. Jones (2004) and Ness (2004) also describe how girls use similar “tough” behavior to prevent victimization, and how this is often encouraged by young girls’ parents in violent neighborhoods to keep them safe. The same strategies that protect youth from attack can unfortunately be interpreted by teachers and administrators as disrespectful or disengaged in school, leading to more frequent disciplinary action and problematic relationships between students and their teachers (Dance 2002, Devine 1996). In addition, Harding (2009 and 2010b) shows that young students in violent neighborhoods have larger numbers of older friends than students in other neighborhoods. He argues that this is a result of students in violent neighborhoods limiting their geographic mobility to avoid victimization by youth from rival neighborhoods and younger kids seeking the protection of the older youth within their own neighborhood. The older peers who are available on the street in the afternoons tend to be the ones who have dropped out of school or are unemployed. These cross-cohort peers re-enforce anti-academic norms, foster mistrust in teachers, and involve students in webs of obligations to their peers that may seem more important than their schoolwork. Furthermore, in violent neighborhoods the overabundance of negative examples of older peers and family members who have been caught up in webs of crime and violence serves to lower the definition of what it means to “succeed.” When violence is prevalent and requires constant work to avoid, simply “staying out of trouble” is seen as a high bar of achievement. If they can achieve this goal, the rest will follow (Harding 2010b: 54-6).

These comparisons between students in more or less violent neighborhoods are

compelling and important for understanding what adolescents go through in these areas.

However, these cultural and social adaptations to life in violent neighborhoods are more likely to affect long-term educational outlooks and attainment than annual levels of achievement. The cross-sectional nature of the research also makes it difficult to predict how quickly, if at all, any of these social and protective mechanisms would respond to a changing environment.

### Response to Annual Changes

In contrast to the protective social and cultural adaptations that are likely to develop over time and may persist even after violence declines, short term changes are more likely to come from students' psychological response to violent events. Specifically, living in a neighborhood with high rates of violent crime direct is associated with an increased risk of direct experience with violent events, the injury of close friends or relatives, or by just hearing about violent events near one's home, all of which may induce emotional and stress either from. Exposure to these types of stressful events is strongly associated with symptoms of post-traumatic stress regardless of an individual's direct experiences with violent crime (Gorman-Smith and Tolan 1998, Mazza and Overstreet 2000, Osofsky and Osofsky 2004, Ozer and Weinstein 2004). These symptoms can include aggression and depression as well as fighting and property destruction, all of which are likely to impair students' ability to learn and perform well at school (Bell and Jenkins 1993, Bingenheimer, Brennan and Earls 2005, Bowen and Van Dorn 2002, Guerra, Huesmann, and Spidler 2003). If nothing else, students with higher levels of aggression or other behavioral difficulties may be more likely to have disciplinary problems at school, and have fewer opportunities to learn due to suspensions and expulsions.

Experimental psychologists have also found that elevated stress hormones can impair the

working memory functions needed to perform well on cognitive tests (Sauro, Jorgensen, and Pedlow 2003, Mattarella-Micke and Beilock in press). Similarly, Harding (2010b) argues that the basic necessity of staying safe requires much more energy in neighborhoods with high levels of violent crime than in relatively safe neighborhoods. This can leave students and their parents too preoccupied with immediate safety to focus on the day to day requirements of educational success (see also Furstenberg 1999). In this case, stress impairs students' ability to concentrate and access their stored memories and perform well on tests, but may not reflect an actual lack of knowledge or reduction in learning.

These stress induced mechanisms have been shown to change over a relatively short time period. For example, the effect of a single violent event on academic performance appears to fade relatively quickly. Using data from the Project on Human Development in Chicago Neighborhoods, Sharkey (2010) exploits the coincidence of survey dates and homicides to compare students who take an in-home test just a few days after a homicide has occurred in their neighborhood with students in the same neighborhood who took the test before or long after there had been a local homicide. He finds that students who took the test within a few of days of a local homicide had test scores that were more than 0.5 standard deviations lower than their neighbors who took the test on a different day. These effects fade away both geographically and temporally, such that the strongest effects are for homicides within a student's census block group and within four to seven days of the test. After ten days, the effect appears to have faded away.

Other research shows that effect is most likely driven by lower levels of children's attention and impulse control and increases in their caregivers' levels of emotional distress (Sharkey et al 2012). This emotional distress appears to fade relatively quickly when individuals

move to safer neighborhoods. One of the few consistent findings of housing voucher experiments, such as Moving to Opportunity, is the immediate and dramatic improvement in adult mental health for parents who move out of unsafe high poverty neighborhoods (Ludwig et al 2008). This is true even when the adults in the programs were not conscious of toll that the stress and worry that living in a violent neighborhood had on them (Briggs, Popkin, and Goering 2010: 90-91).

There is also some research that might suggest that the direction of change could matter. Researchers have shown, both experimentally and observationally, that the effects of stress on cognitive performance can be dramatically reduced when students are given a social outlet and support for their worries (Ramirez and Beilock 2011). Those supports are more likely to be in place, either at home or in school, for students with lower levels of prior exposure to violence (O'Donnell, Schwab-Stone, and Muyeed 2002), therefore diminishing the short-term effects of increases in neighborhood violence. On the other hand, students who have just experienced a violent year are more likely to be performing below their full abilities. With time, and lower crime rates in the following year, they may be able to fully recover from the stress and trauma of the previous year.

### Experimental Evidence

The experimental evidence provided by housing voucher studies sheds some light on these questions, but the overall results are mixed and inconsistent. The Moving to Opportunity Experiment randomly assigned families to move from public housing projects in high poverty neighborhoods to lower-poverty neighborhoods in five cities. While the experiment was specifically designed to test the effect of neighborhood poverty, moves to lower poverty

neighborhoods were also associated with substantial improvements in perceived safety and mental health (Briggs, Popkin, and Goering 2010, DeLuca et al 2012, Orr et al 2003, Kling, Ludwig, and Katz 2005, Kling, Leibman, and Katz 2007, Gennetian, Sanbonmatsu, and Ludwig 2011). On average, the results of these moves did not improve children's test scores five to seven years later (Sanbonmatsu et al 2006). Other housing voucher studies also fail to consistently find effects of moves to less poor neighborhoods on test scores (Oreopoulos 2003, see also DeLuca and Dayton 2009 for a summary of such studies). However, within the MTO experiment there were also dramatic city-level differences in the effect of moves on children's test scores. In Chicago and Baltimore, students did measurably improve when they moved to a safer, less-poor neighborhood. Test score improvement was also seen in separate quasi-randomized housing voucher wait list study in Chicago (Ludwig et al 2009). Burdick-Will et al (2011) suggest that violent crime rates and non-linearities in exposure to severely disadvantaged neighborhoods may explain why these experiments tend to have larger effects on test scores in cities with higher violent crime rates like Chicago and Baltimore. Unfortunately, the crime data available during the MTO study period did not allow the authors to fully test these hypotheses.

Despite their suggestive relationship between neighborhood violence and achievement, these experimental studies are unable to test that relationship directly because they focus on differences in neighborhood poverty, not violence. They also rely exclusively on populations of public housing residents and their results cannot be assumed to hold for other less disadvantaged and more typical families. Unlike the results of subsidized housing voucher studies, the results of this study are generalizable to the population of an entire city rather than only its most disadvantaged residents.

## *DATA AND MEASURES*

The data for this study come from three sources: eight years of incident reports generated by the Chicago Police Department, student-level administrative files from the Chicago Public Schools (CPS), and the neighborhood demographics from the 2000 US Census and the 2005-2009 American Community Survey. Students are included in the data if they are first-time freshman (i.e. not in high school in the previous semester) between the fall of 2002 and the fall of 2006. Each student is then followed for the next eight semesters, regardless of the grade they are in. This means that students are followed only long enough for them to be able to graduate from high school if they do not repeat a grade. It is possible that exposure to neighborhood violence leads students to drop out of school or leave the city and therefore leave the administrative data. However, discrete time models (Allison 1982, not shown) indicate that there is no relationship between the annual level or change in neighborhood violence and the probability that a student leaves the district or misses a test.

### Student Variables

The individual student data come from administrative files collected and stored by the Consortium on Chicago School Research (CCSR). Student demographic variables, such as gender, race, and age, and the students' census block group ids, are recorded for every student during every semester. Census block group ids are used to group students within schools and neighborhoods.

The test scores used in this study come from the statewide exams given every year. Standard scale scores on the Iowa Test of Basic Skills are used to measure achievement prior to high school.<sup>1</sup> The EXPLORE and PLAN tests are given to freshmen and sophomores,

respectively, during the early fall, and the PSAE, which includes the complete ACT, is given to 11<sup>th</sup> graders in the spring. All three tests are scored on a single scale. The test documentation suggests an expected gain of around three to four points each year, but the data show that within the Chicago Public Schools students on average gain about one point between tests.<sup>ii</sup> These tests include multiple subsections, but this study will focus on the two main parts: reading and math.

Test scores are not the only important measure of academic achievement. Grades may provide a better overall picture of how a student is performing and engaging in school. No matter how well a student can do on a standardized test, in order to succeed in school, students must sit still, listen to the teacher and each other, and complete assignments on time. These social and behavioral skills are just as important, if not more important, for long-term social and economic outcomes as the specific knowledge measured on tests (Heckman and Rubinstein 2001, see also Farkas 1996). They are also the result of a semester's worth of work and classroom behavior rather than the performance and concentration on the specific day of the standardized test and may be more sensitive to the kind of social and cultural adaptations to life in a violent neighborhood described above. For high school students, weighted semester grade point average is recorded using the transcript entries for grades received and the level of each course. Students may receive up to 4 points for a regular class and up to 6 points for Honors or Advanced Placement classes.

### Neighborhood Demographics

Other neighborhood variables come from the 2000 US Census and are calculated at the block group level. These include an index of concentrated disadvantage based on the male unemployment rate and the proportion of families living under the poverty line, an index of

socioeconomic status based on the average level of adult education and the proportion of adults working in managerial or professional jobs, and the proportion of the block group that is African American or Hispanic.

### Crime Variables

Crime measures for this study come from incident reports made available by the City of Chicago. The database includes the date and place of the incident, as well as detailed crime type (i.e. aggravated assault with a handgun). Crimes were matched with the corresponding census block group using geocoded address blocks. Annual violent crime rates were calculated by summing all violent crimes within each block group during the full year prior to every test date. Change is measured by the difference in the annual neighborhood crime level that each student experienced before consecutive exams.

The census block group will be the focus of this analysis because it is the smallest geographic area available for each student's residence. Recent qualitative urban sociology, such as Harding (2010) and Goffman (2009), suggest that adolescents in violent neighborhoods identify their neighborhoods as very small areas around their home. DeLuca et al (2012) also describe how poor families think about the safety of a neighborhood on a block-by-block basis. When defining neighborhoods as census tracts or the sets of contiguous census block groups surrounding the students' focal block group, none of the violent crime coefficients in any difference-in-difference models are statistically significant and will not be described in detail.

Obviously, only crimes that get reported to the police will be recorded in these official records. Since it is possible that residents in different areas are more or less likely to call the police for the same offense, the neighborhood-level counts may be subject to reporting bias.

These official crime rates may also reflect the number of police on patrol in that area more than the true amount of crime being committed (Levitt 1998). Therefore, it is important to remember that the results of this study do not necessarily reflect the effect of all crime in an area. Instead, they represent the effects of changes in the official crime rates that are likely to under-report the actual levels of crime, especially those crimes that are less severe.<sup>iii</sup> Ideally, one would compare these official reports to victimization surveys or self-reports of violent behavior (Skogan 1974), but neither of these types of measures is available with the geographic and temporal detail needed for this analysis.

### *EMPIRICAL STRATEGY*

Many of studies of “neighborhood effects” rely on cross-sectional data to compare the outcomes of students who live in different types of neighborhoods. (See Brooks-Gunn et al 1993, Dietz 2002, and Sampson, Morenoff, and Gannon-Rowley 2002 for more detailed reviews of the neighborhood effects literature). Such comparisons are subject to a number of different methodological assumptions and concerns. First, of course, is the selection of different types of families into different neighborhoods. Since both neighborhood residence and academic achievement are strongly associated with a family’s social and economic resources, it is possible that the observed academic differences between students in violent and non-violent neighborhoods are the result of differing resources and not the violent crime rate.

The data structure described above provides multiple observations for each student. Therefore, fixed-effect models seem like an appealing solution to this problem. With this model, bias from any constant differences, whether observed or unobserved, is removed from the estimates by including a dummy variable for each student. In this way, students are essentially

compared to themselves at different points in time.

Model 1: Student Fixed-Effects

$$Y_{ikt} = \beta_0 + \beta_1 V_{ikt} + \beta_2 W_{ikt} + \beta_3 M_{it} + \beta_4 N_k + S_{it} + Y_t + u_i + \varepsilon_{ikt} \quad (1)$$

Where  $Y_{ikt}$  is the outcome,  $V_{ik}$  is the level of violence experienced by student  $i$ , in neighborhood  $k$  at time  $t$ .  $W_{ikt}$  are the time varying student characteristics, such as grade and age, for student  $i$  in neighborhood  $k$ , during semester  $t$ .  $M_{it}$  is an indicator for whether or not the student changed census block groups between time  $t-1$  and time  $t$  and  $N_k$  are the neighborhood disadvantage and social status measures for the students' current neighborhood.  $S_{it}$  are dummy variables for each semester that the student has been enrolled in high school. This accounts for any differences in grade repetition that might influence change in test scores.  $Y_t$  are dummy variables for each calendar year; and  $u_i$  are fixed effects for each student; and  $\varepsilon_{ikt}$  are the observation level error terms.<sup>iv</sup>

However, this model includes implicit assumptions about the mechanisms driving exposure that are not often considered. In order for there to be any variation from which to estimate an effect, students must experience changes in their neighborhood violence levels, but within the fixed effects framework, one must assume that the order of exposure does not matter. In other words, a student who experiences a period of high violence and then one of low violence is assumed to react in the same way to the absolute level of neighborhood violence in each year as a student whose experiences were reversed.

To account for the issue of timing, I will compare the results of a student fixed-effect model with a multi-level difference-in-difference model that compares relative changes in violent crime to changes in academic achievement. Similar models were used in Greenbaum and Tita (2004) to estimate the effect of surges in violence on local economic development. While,

this model does not remove as much potential unobserved confounding as Model 1, any confounding factor in this model would have to be related to both the amount of change in violent crime as well as the growth rate in test scores after controlling for both prior test scores and the baseline level of violence. As described in more detail below, the change measure of neighborhood violent crime is only very weakly correlated with any of the observed characteristics of students or neighborhoods. In case there is remaining student- or neighborhood-level unobserved confounding, I have included random intercepts for each of these levels.

Model 2: Linear Difference-in-Difference

$$Y_{ikt} - Y_{ikt-1} = \beta_0 + \beta_1(V_{ikt} - V_{ikt-1}) + \beta_2V_{ikt-1} + \beta_3X_{it} + \beta_4M_{it} + \beta_5N_k + Y_t + S_{ti} + u_i + b_k + \epsilon_{ikt},$$

where  $u \sim N(0, \sigma^2)$  and  $b \sim N(0, \pi^2)$  (2)

$Y_{ikt}$ ,  $V_{ikt}$ ,  $M_{it}$ ,  $N_k$ ,  $Y_t$ ,  $S_{ti}$  are the same as above.  $Y_{ikt-1}$  and  $V_{ikt-1}$  are the outcome and annual violent crime count for that same student in the previous year.  $X_{it}$  are all constant and time-varying controls for student characteristics, such as age, grade, gender, ethnicity, and middle school achievement.  $\mu_i$  is a random intercept for each student.  $b_k$  is a random intercept for census block group. Students are clustered at this level based on the neighborhood that they lived in in eighth grade since any change in neighborhood during high school may be a result of exposure to neighborhood violence. Each of these random intercepts is assumed to be normally distributed with a mean of zero, and a standard deviation of  $\sigma^2$  and  $\pi^2$ , respectively.  $\epsilon_{ikt}$  is the individual level error term.<sup>v</sup>

This model assumes that the relationship between change in violent crime and change in achievement is linear and therefore treats increases in violent crime exactly the same as decreases in violent crime. Model 3 loosens this assumption and allows the slope changes in

violent crime to vary by the direction of that change.

Model 3: Non-Linear Difference-in-Difference

$$Y_{ikt} - Y_{ikt-1} = \beta_0 + \beta_1(V_{ikt} - V_{ikt-1}) + \beta_2(V_{ikt} - V_{ikt-1} < 0) + \beta_3(V_{ikt} - V_{ikt-1}) * (V_{ikt} - V_{ikt-1} < 0) + \beta_4 V_{ikt-1} + \beta_5 X_{it} + \beta_6 M_{it} + \beta_7 N_k + \beta_8 Y_t + \beta_9 S_{it} + \epsilon_{ikt} \quad (3)$$

Where  $V_{ikt} - V_{ikt-1} < 0$  is a dummy variable indicating whether the violent crime count declined between time t-1 and t and all other terms are the same as above. The interaction term in this model allows the slope to vary depending on the direction of change from the previous year.

*VIOLENT CRIME IN CHICAGO*

Throughout this period, violent crime across Chicago declined dramatically. Figure 1 describes the trend in violent crime and achievement between academic years 2002-2003 and 2009-2010. The gray line is the average annual violent crime rate for the city as a whole. Overall, violent crime rates have decreased steadily and substantially over this period. The average block group reported more than 85 violent crimes per year in 2002-2003, but only reported around 60 violent crimes in 2009-2010. The black line is the average annual violent crime rate experienced by Chicago public high school students. The average neighborhood for Chicago public high school students is substantially more violent than the average city neighborhood. Furthermore, violent crime decreased more rapidly during this period for public high school students than for the city as a whole. In 2002-2003 CPS students experienced more than 120 violent incidents each year, but by 2009-2010, that number had fallen close to 80. The dashed line represents average eleventh grade reading and math test scores, with possible values ranging from 1 to 36. (Trends in the ninth and tenth grades are identical and not shown separately). The dotted line represents the average eleventh grade point average (on a possible scale of 0 to 6). Unlike violent crime

rates, test scores and grades show only very small increases in this period.

The relatively smooth decline in city-wide averages masks substantial variation across neighborhoods and within neighborhoods over time. Figure 2 shows the geographic distribution of average annual violent crime rates for the entire city at the census block group level. Each shade of grey denotes a distinct quintile of the distribution. Dark areas are those that experience higher crime rates. It is clear from the map that the South and West sides of Chicago are much more violent than the rest of the city. These are also areas with generally high concentrations of minorities, low levels of socioeconomic resources, and large numbers of underperforming schools. The Getis-Ord general G statistic (Getis and Ord 1992) confirms this pattern statistically by indicating that there is significant clustering of higher and lower values of violent crime in neighboring (contiguous) census block groups ( $Z = 10.51$ ).

In contrast, Figure 3 shows the spatial distribution of the average amount of annual change in violent crime for each census block group. This map shows that this measure is not clustered in specific areas of the city ( $Z = 0.196$ ). In other words, there are census block groups that tend to have increasing annual measures of violent crime that are right next to block groups that have the opposite trend. Measures of change within each year are similarly unclustered. This suggests that the hotspots for violent crime are both very localized and move around the city over time, perhaps because of the demolition of large-scale public housing projects, the breakdown of some of the major gang organizations over this time period, or shifting local opportunity structures (Rosin 2008, Marx and Coen 2007, Bernasco, Block, and Ruiters 2013). For a researcher interested in looking at long term crime trends this annual change may seem like “noise,” but for the specific students living in these neighborhoods changes of this magnitude are likely to represent real reductions in their risk of victimization and indirect contact with violent

events.

Figure 4 shows what this change looks like for specific census block groups. The top line represents a single high violence neighborhood, the middle is a single medium violence neighborhood and the bottom is a single low violence neighborhood (based on their average violence level over the whole period). These trends represent the potential variation experienced by a student who stayed in each of these neighborhoods during the whole period. There is substantial non-linear change in crime rates over time in all three neighborhoods. Average crime rates in the city dropped steadily over time, but the amount of crime in any specific census block group neighborhood tends to bounce up and down, rather than steadily decline. The lowest crime neighborhood even seems to show an overall positive trend.

This figure shows three important things. First, there is substantial variation in the direction as well as the quantity of change within neighborhoods. These neighborhoods do not appear to be steadily increasing or decreasing in their crime rates. Second, the year-to-year change does not appear to be strongly related to the absolute level of violence. The changes in violent crime in some years are substantial even for relatively low violent crime neighborhoods. For example, the change marked by *a* is approximately the same size as *b* despite taking place at very different absolute levels of violence and *c* starts at a much higher level of violence but is a relative decrease in crime, while *b* is an increase in crime despite starting quite low. Finally, the large changes from year to year mean that variation in violence from a student fixed-effects model and a difference in difference model may be quite different. For example, points *d* and *e* represent similar levels of neighborhood violence, as measured by the absolute level, or by the deviation from the mean of a student who lived continuously in that neighborhood. However, the change that each of these points represents is quite different since *d* is preceded by a substantially

more violent year and while  $e$  is almost identical to the year that preceded it.

The first column of Table 1 describes the neighborhoods of public school students in more detail. One year before the test students had experienced over 100 violent crimes on average. Simple battery is the most common type of violent crime, while homicides and sexual assaults are quite rare, even in high violence neighborhoods. On average, the violent crime rates in students' neighborhoods are declining slightly. However, the standard deviation of the change measure highlights is more than one third of the overall variation in annual crime rates. This highlights the fact that in any given year there is considerable change within specific neighborhoods. The final rows of that column describe the demographic characteristics of residents in these neighborhoods. The measures of neighborhood disadvantage and social status are centered on the mean for Chicago, indicating that, on average, CPS students tend to live in the more disadvantaged areas of the city. They also appear to live in neighborhoods with high minority concentrations.

The second column in Table 2 describes the mean and standard deviation for each of the student level variables included in the analysis. On average, about half of the students in the sample are African-American, and a little more than one-third are Hispanic. The omitted category includes White, Asian, and Native American students and accounts for approximately ten percent of the sample. On average, students gain around one point in test scores between tests, but there is substantial variation in the amount of change students experience each year. In contrast, grades do not appear to change very much at all from year to year. This suggests that grades may be less sensitive to short-term changes of any kind in students' experiences.

Figure 5 shows the correlations between each measure of achievement and violent crime. The association between the amount of violent crime is approximately -0.17, -0.20, and -0.12

with reading, math, and grades, respectively. Annual neighborhood violence is also highly correlated with measures of middle school achievement ( $r = -0.18$ ), suggesting that there may be strong selection of already lower achieving students into violent neighborhoods. On the other hand, the correlation between annual change in neighborhood violent crime and all of the other measures is extremely small. The largest correlation ( $r = -0.05$ ) is with the dummy variable for residential moves. Furthermore, the direction of the correlation is not always consistent. For example, larger increases in violent crime are weakly associated with both higher disadvantage *and* higher socioeconomic status. Together with the spatial distribution of the change measure, this suggests that the relationship between change in neighborhood violence and achievement is unlikely subject to substantial confounding, at least from observed differences between students.

## *RESULTS*

The results of the fixed-effects model are shown in Table 2. None of the coefficients for the amount of annual violent crime are very small and not at all statistically significant. At first glance, the same appears to be true for relative change in violence as well. Table 3 shows the results of the difference-in-difference models. The linear coefficient for change in neighborhood violent crime in Model 2 is highly insignificant for all three outcomes. Model 3 allows the slope to differ for increases and decreases in violent crime. None of the coefficients are significant predictors of grade point averages, but the interaction term is a significant predictor of test scores. The results indicate that increases in violent crime do not result in any significant change, but that decreases in violent crime are significantly related to greater increases in test scores. Including this interaction term also makes the baseline neighborhood violence measure that was positive and significant in Model 2 statistically insignificant.

The magnitude of these coefficients is substantively meaningful when considering how much students tend to gain on these tests during the course of a year. The measures of violence and change in violence have been standardized, but the outcome has not. On average, students gain about one point per year. Therefore, a student who experiences a two standard deviation decrease in neighborhood violent crime (about forty incidents) is expected to gain and approximately 0.1 additional points, or around one tenth of a year's growth in test scores. Considering that students in generally higher violence neighborhoods begin high school with test scores that are substantially lower than their peers from low violence neighborhoods, this increased growth rate is not likely to reduce the test score gaps across neighborhoods. However, for any specific student, a ten percent increase in growth could represent a meaningful improvement on standardized test scores.

Interestingly, the random intercepts for students and neighborhoods do not add much to the test score models. The estimated variance of both of these terms is zero in the models for test scores. Including fixed-effects instead of random-intercepts (not shown) removes much of the statistical power in the models, but does not change the coefficients at all. This confirms that the unobserved differences between students are as unrelated to change in annual neighborhood violent crime as the observed characteristics available in the data.

This lack of heterogeneity is evident in the observed characteristics of students as well. One would not necessarily expect the effects of neighborhood violence to be the same for every student in the Chicago Public Schools. (See Harding et al 2011 for a detailed discussion of the importance of considering heterogeneity in neighborhood effects research). The results described above have all been based on the average effect of neighborhood violence for all students. It is possible that there may be larger effects for specific subgroups of students or students living in

different kinds of neighborhoods or schools. However, running these models with different interaction terms and different sub-samples suggests that this is not the case, at least not for any of the observed student characteristics. There is no evidence that the effect of relative change in neighborhood violent crime varies substantially based on students' such as race, age, grade, gender, prior ability, neighborhood disadvantage, social status, neighborhood racial composition or baseline levels of violent crime. There is also no significant difference when the decrease in violent crime was the result of a residential move or a natural decline within the same neighborhood.

#### *DISCUSSION AND CONCLUSIONS*

This study examines the relationship between changes in annual neighborhood violent crime and academic achievement. The results show that after controlling for all constant differences between students, the level of violence in a given year is unrelated to students' test scores or grades. However, taking into account that students may respond to levels of violence differently based on their prior experience, it appears that relative declines in violence do predict more rapid growth in test scores, but not in grades. While relatively small, these effect sizes are not inconsequential. Students gain approximately one tenth more in their test scores than they would have if neighborhood violent crime had stayed the same. These gains are not likely to dramatically change the distribution of test scores across neighborhoods, but they do represent a meaningful improvement in test performance for individual students.

These findings are not without their limitations. The most important limitations come from the use of administrative data to track students over time. These data provide a broad picture of the city and the school district as a whole and allow for numerous repeated

observations of each student. However, for any given student there is very little detail on his or her family background, behavior, or specific exposure to violent events. It is difficult to tease apart the mechanisms that are driving these average effects without knowing exactly who was exposed to what and how individual students reacted to that exposure. Similarly, these data are unable to provide a picture of what is going on at school, where the learning actually takes place. Most importantly, I am unable to differentiate between students who attend a school with a supportive environment and teachers who are able to help students cope with trauma and loss and those who do not (Patton and Johnson 2010). These limitations may partially explain the relatively small size of the coefficients and the overall low explanatory power of each of the models. They represent averages across all students in the system. It is very possible that these small average effects are a reflection of large effects for students with the most direct contact with violence and no effect for other students. As one respondent from the Moving to Opportunity program put it: “It’s trouble everywhere, it’s not where you live, it’s how you live. You mind your own business, you don’t have to worry about nothing” (DeLuca et al 2012: 207). More research, with different types of data, is necessary to understand the heterogeneity in responses related to different students’ personal experience with violence as well as their social support and coping mechanisms.

Despite their limitations, the findings described here have important theoretical and policy implications. One important implication of these findings is that relative short term change does have academic consequences. While the annual variation in relatively small geographic areas may seem like “noise” when trying to assess long term trends in violence, those fluctuations have real consequences for the people living in those areas. For example, one high violence year may be an anomaly for researchers or policy makers interested in touting declining

city-wide crime rates, the people living in those areas are likely to be directly affected by those changes. In the past, criminological research has focused on longer time periods and geographic areas. (Notable exceptions are St. Jean 2006, Greenbaum and Tita 2004, Bernasco, Block, and Ruiter 2013). However, as more detailed data becomes available directly from police departments, it will be possible to look more closely at both the causes and consequences of geographically small and relatively short-lived spikes in crime.

In addition, these findings highlight the importance of relative change versus absolute levels, particularly when considering a relatively short term intervention or exposure. “Neighborhood effects” theories tend to emphasize the relatively static differences between neighborhoods and generally imply that short-term change in neighborhood context comes only from residential mobility. When discussing heterogeneity within neighborhoods, most only consider comparisons between students and families with different levels of social and economic resources, not differences in prior experiences (Harding et al 2011, Sampson, Morenoff, and Gannon-Rowley 2002, Jencks and Meyer 1990). Neighborhoods are not just static demographic or social units that only change every ten years with the Census. Their physical and social composition is constantly changing as people interact with one another on the streets. Residents are likely to interpret those changes, whether consciously or unconsciously, in very different ways based on their prior experiences. Taking the idea that neighborhoods can shape behavior seriously means taking that change, and heterogeneous responses to that change, seriously as well.

Part of taking change seriously is examining the direction of change as well as quantity. This study highlights how important that direction is and suggests that students respond more rapidly to periods of calm than to spikes in violence. The importance of declines in crime may be

a reflection of the large numbers of Chicago Public School students who live in some of the most dangerous areas of the city. Students tend to live in areas with higher levels of violent crime than the rest of the city. This may mean that many students feel relatively unsafe in their neighborhoods on a regular basis and are routinely taking steps to protect themselves and avoid victimization. Like many of the participants in MTO, students and families have learned to live with the violence around them and many may not even be aware of the toll that adjusting to live in a highly violent neighborhood is taking on them (Briggs, Popkin, Goering 2010: 90-91). It is only when the violent crime rate is lower than they experienced earlier that they are able to relax, let down their guard, get a good night's sleep and concentrate on school work. In some ways, this is related to Small's (2004) illustrates of neighborhood narrative frames. Within the same Boston neighborhood, residents of different generations used their past experience in the neighborhood to create a narrative frame of collective struggle or of deterioration and neglect. These frames then shaped how they interpreted their neighbor's actions and their involvement in neighborhood-based activities.

The differing effects for grades and test scores are also theoretically important. Grades and test scores measure different aspects of achievement and are likely to respond differently to the potential mechanisms linking neighborhood violence and achievement. Tests only capture a student's ability to concentrate and perform individually on a single day. They also test specific content knowledge and test taking skills. Since tests require concentration and attention during a specific period of time, relatively small changes in test scores are likely to reflect differences in performance due to stress or anxiety than real differences in learning. Even small changes in a students' ability to concentrate may result in meaningful changes in the results of a standardized test. This difference in performance may not even be conscious. Psychologists who study

working memory have shown that many forms of anxiety can hinder cognitive functioning even when test takers are unaware of those anxieties. Whether conscious or not, worry and distress take cognitive work and occupy some of the working memory needed to perform any tasks that require short-term memory, such as math problems or reading comprehension questions (Beilock 2011).

Grades, on the other hand, capture a semester's worth of social interaction and academic behavior as well as cognitive performance. Grades are also more likely to be a relative and socially-scaled measure of achievement. The best performing student in any class is likely to get an A in a class even if that class covered less material than the one down the hall. Students in higher level courses, like advanced calculus, may actually get worse grades, but learn more material than their peers in lower level classes. This can lead to the paradoxical combination of increased content knowledge, but more course failure and worse grades (Nomi and Allensworth Forthcoming).

In addition, teachers tend to weigh participation and homework assignments heavily when assigning grades. These are not timed performances like standardized tests. For example, if a student is having trouble concentrating they can take the time they need to finish an assignment. Grades are more likely to change when students' behavior and study habits change substantially. As is clear from the descriptive statistics in Table 1, grades tend to change very little over the course of high school. This may reflect between student differences in personality, reputation, motivation and study skills that emerge before they even reach high school. Therefore, if grades are influenced by neighborhood violence, it appears they are more likely to respond to the social adaptations associated with longer term, possibly early in life, exposure to neighborhood violence, if at all.

These findings also have important implications for urban policy. They highlight the nature of testing as a performance and the potential problems that distractions and stress play in that performance. Clearly, neighborhood violence is not the only thing that can distract students and lead to lower test score performance. There are other aspects of school and neighborhood life that are equally if not more distracting. However, in an era where more and more depends on the results of annual standardized tests it is important to realize that students' performance depends on more than just what goes on in the classroom, and that providing students with a safe and calm environment may lead to improvements in short-term concentration and sustained learning.

Overall, these findings point to the resilience of students when it comes to adverse neighborhood conditions. Despite starting lower than their peers from safer neighborhoods, students are able to improve when their neighborhood environment improves. They are not doomed to do poorly forever simply because they were exposed to high levels of violence at a young age. In a school district strapped for cash devoting any resources whatsoever to helping students deal with violent crime in their neighborhood means that there are fewer resources available for other social and academic activities. By comparison, increasing the capacity of the police force has been shown to have a direct impact on the levels of violent crime in the city (Evans and Owens 2007, Levitt 1997) and on a per-pupil basis increasing the size of the police force could be a relatively inexpensive thing to do. Therefore, if reducing crime can improve students' test scores, even a little, then a substantial improvement in safety in the city's most dangerous neighborhoods could have ramifications for the educational system as a whole, on top of any improvements to quality of life in Chicago in general.

Finally, it is important to remember that the null effect of annual neighborhood violent crime on any kind of achievement does not mean that levels of neighborhood violence never

matter. Student fixed-effects are able to control for all constant differences between students, but this means they are ill-equipped to estimate to capture the effects of exposure that takes place before students even reach school. Therefore, these methods and data cannot speak to the potential long-term social, emotional, or cognitive effects of growing up in an extremely violent neighborhood. However, if students respond to short-term declines in violence it is likely that longer term exposure to neighborhood violence has at least some influence on their behavior.

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Table 1: Composition of Chicago Public High School Students and Their Neighborhoods

Neighborhood Characteristics			Student Characteristics		
	Mean	St Dev		Mean	St Dev
Annual Violent Crime Count	104.96	86.75	Reading	15.019	4.45
Change in Violent Crime	-2.221	20.80	Change - Reading	1.126	3.39
Homicides	0.286	0.61	Math	15.211	4.23
Sexual Assault	0.756	1.05	Change - Math	0.918	2.88
Aggravated Assault	3.919	3.57	Grades	2.054	1.15
Aggravated Battery	5.473	5.79	Change - Grades	-0.006	0.65
Simple Assault	10.466	8.74	Male	0.479	0.50
Simple Battery	21.260	21.35	African American	0.540	0.50
Robbery	8.075	7.54	Hispanic	0.342	0.47
Disadvantage	0.271	0.78	8th Grade Achievement	248.34	30.65
Social Status	-0.321	0.79	Grade 9	0.341	0.47
Percent African American	0.496	0.45	Grade 10	0.275	0.45
Percent Hispanic	0.275	0.32	Grade 11	0.208	0.41
			Grade 12	0.176	0.38
			Age	15.542	1.18
Neighborhoods	2373		Students	122608	
			N Tests	351327	
			N Grades	367675	

SOURCE: Author's calculation based on data from the Chicago Police Department and the 2000 United States Census.

Table 2: Predicting Achievement Using Annual Neighborhood Violent Crime and Student Fixed-Effects

	Reading <sup>a</sup> Model 1	Math <sup>a</sup> Model 1	Grades <sup>a</sup> Model 1
Annual Violent Crime <sup>a</sup>	0.008 (0.005)	0.004 (0.004)	-0.002 (0.002)
10th Grade	0.176** (0.013)	0.119** (0.011)	-0.049** (0.006)
11th Grade	0.249** (0.018)	0.207** (0.015)	-0.096** (0.006)
Age <sup>b</sup>	0.026 (0.042)	-0.025 (0.031)	-0.106 (0.053)
Neighborhood Disadvantage <sup>a</sup>	0.013 (0.009)	0.003 (0.007)	0.010 (0.006)
Neighborhood Social Status <sup>a</sup>	0.007 (0.009)	-0.008 (0.007)	-0.006 (0.006)
Constant	0.206 (0.096)	0.320** (0.071)	0.152** (0.011)
R-squared:			
Within	0.229	0.222	0.043
Between	0.109	0.125	0.039
Overall	0.099	0.089	0.032

SOURCE: Author's calculation based on data from the Chicago Public Schools, the Chicago Police Department, and the 2000 United States Census.

NOTE: \* p-value < 0.01, \*\* p-value < 0.001. All models include dummy variables for the calendar year and the number of semesters since each student started high school. <sup>a</sup> Standardized values. <sup>b</sup> Centered at age 16.

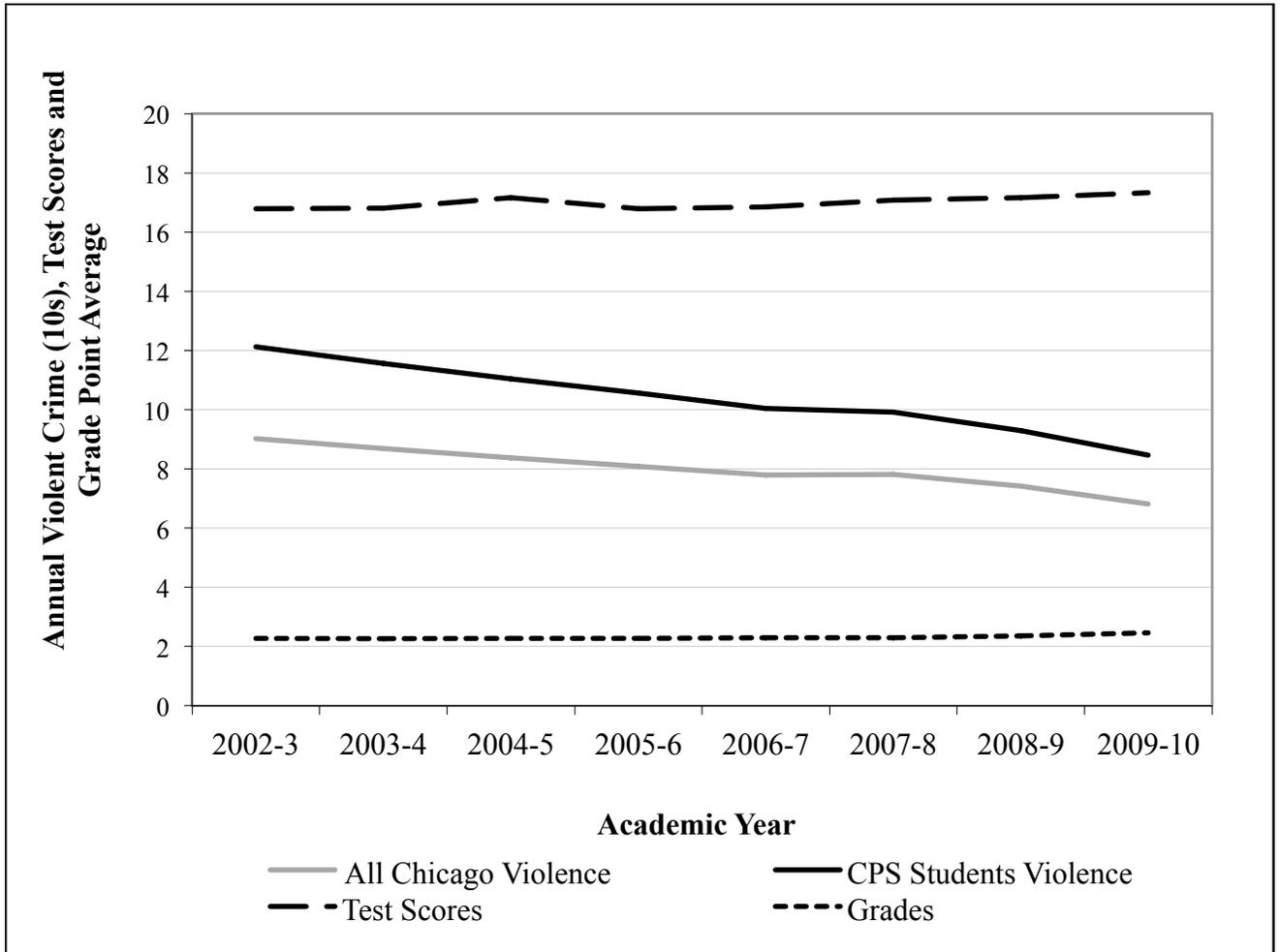
Table 3: Predicting Change in Achievement Using Change in Neighborhood Violent Crime

	Reading		Math		Grades	
	Model 2	Model 3	Model 2	Model 3	Model 2	Model 3
Change in Violent Crime <sup>a</sup>	-0.012 (0.009)	0.026 (0.016)	0.002 (0.007)	0.028 (0.014)	0.001 (0.003)	-0.007 (0.005)
Drop in Crime		0.018 (0.017)		-0.0037 (0.014)		0.001 (0.006)
Change*Drop		-0.059* (0.022)		-0.051** (0.018)		0.015 (0.007)
Previous Violent Crime <sup>a</sup>	0.020* (0.009)	0.014 (0.009)	0.018* (0.008)	0.012 (0.008)	0.000 (0.004)	0.002 (0.004)
Male	0.049** (0.014)	0.049** (0.014)	0.140** (0.012)	0.140** (0.012)	-0.072** (0.005)	-0.072** (0.005)
10th Grade	0.792** (0.036)	0.793** (0.036)	0.665** (0.031)	0.666** (0.031)	(0.258) (0.440)	(0.255) (0.440)
11th Grade	0.654** (0.046)	0.657** (0.046)	0.839** (0.039)	0.841** (0.039)	(0.113) (0.437)	(0.110) (0.437)
Age <sup>b</sup>	-0.073** (0.015)	-0.073** (0.015)	0.020 (0.013)	0.020** (0.013)	-0.021** (0.005)	-0.021** (0.005)
8th Grade Achievement <sup>a</sup>	0.275** (0.008)	0.275** (0.008)	-0.182** (0.007)	-0.181** (0.007)	0.089** (0.003)	0.089** (0.003)
African American	-0.488** (0.024)	-0.490** (0.025)	-0.432** (0.021)	-0.433** (0.021)	-0.063** (0.009)	-0.063** (0.009)
Hispanic	-0.292** (0.023)	-0.293** (0.023)	-0.445** (0.020)	-0.445** (0.020)	-0.060** (0.008)	-0.060** (0.008)
Neighborhood Disadvantage <sup>a</sup>	-0.022 (0.012)	-0.024* (0.012)	0.025* (0.011)	0.025* (0.011)	0.004 (0.005)	0.004 (0.005)
Neighborhood Social Status <sup>a</sup>	0.063** (0.011)	0.062** (0.011)	0.031** (0.009)	0.031** (0.009)	0.017** (0.004)	0.017** (0.004)
Constant	1.932** (0.114)	1.903** (0.115)	1.356** (0.098)	1.342** (0.098)	0.426** (0.438)	0.431** (0.438)
<i>Random Effects:</i>						
Student	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.046 (0.215)	0.046 (0.215)
Neighborhood	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.002 (0.049)	0.002 (0.049)
Residual	11.128 (3.336)	11.128 (3.336)	8.100 (2.846)	8.100 (2.846)	0.358 (0.599)	0.358 (0.599)
AIC	1232838	1232829	1157676	1157667	140646	140663
R-squared	0.03	0.03	0.027	0.027	0.478	0.478

SOURCE: Author's calculation based on data from the Chicago Public Schools, the Chicago Police Department, and the 2000 United States Census.

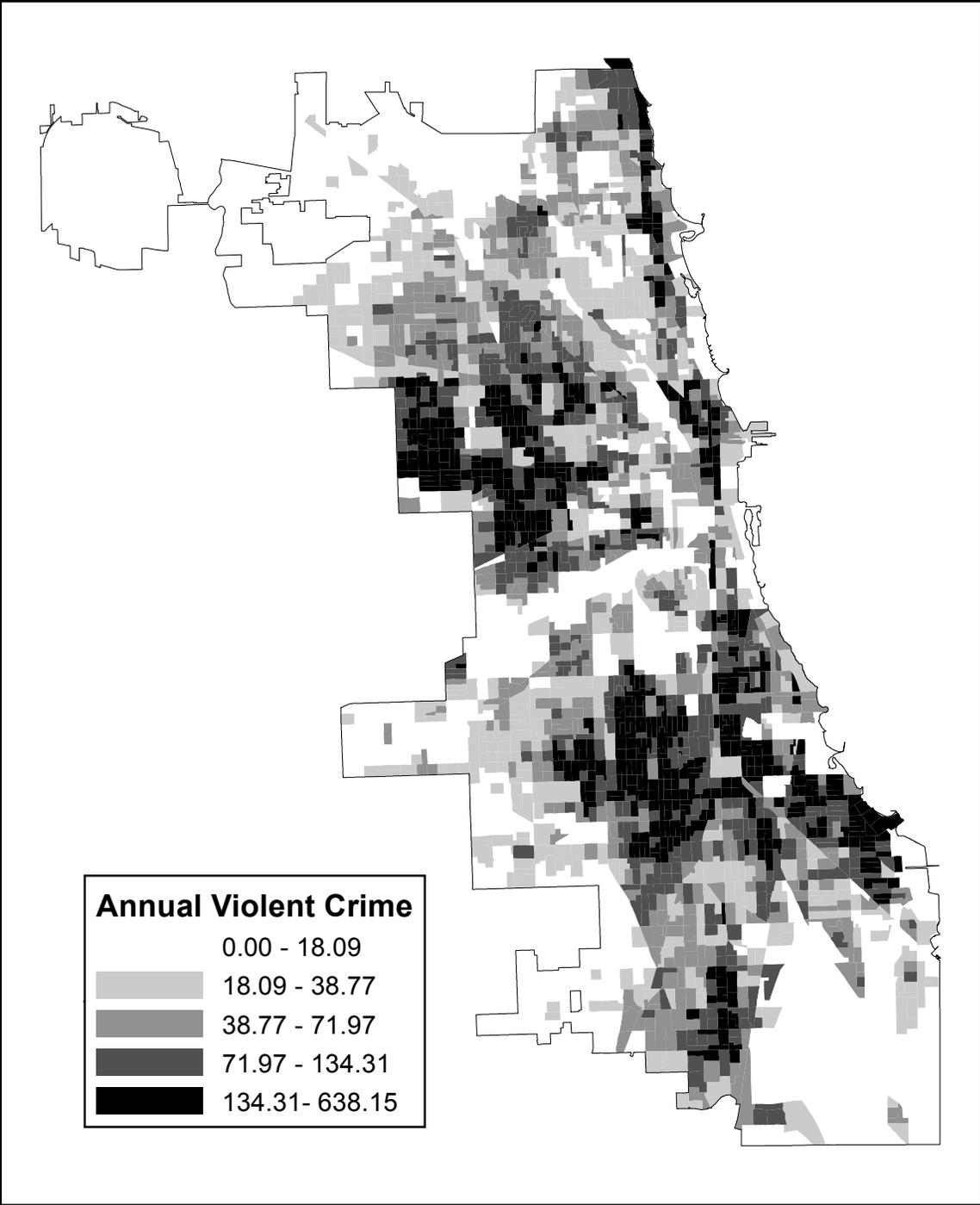
NOTE: \* p-value < 0.01, \*\* p-value < 0.001. All models include dummy variables for the calendar year and the number of semesters since each student started high school. <sup>a</sup> Standardized values. <sup>b</sup> Centered at age 16.

Figure 1: Annual Trend in Neighborhood Violence Crime and Achievement



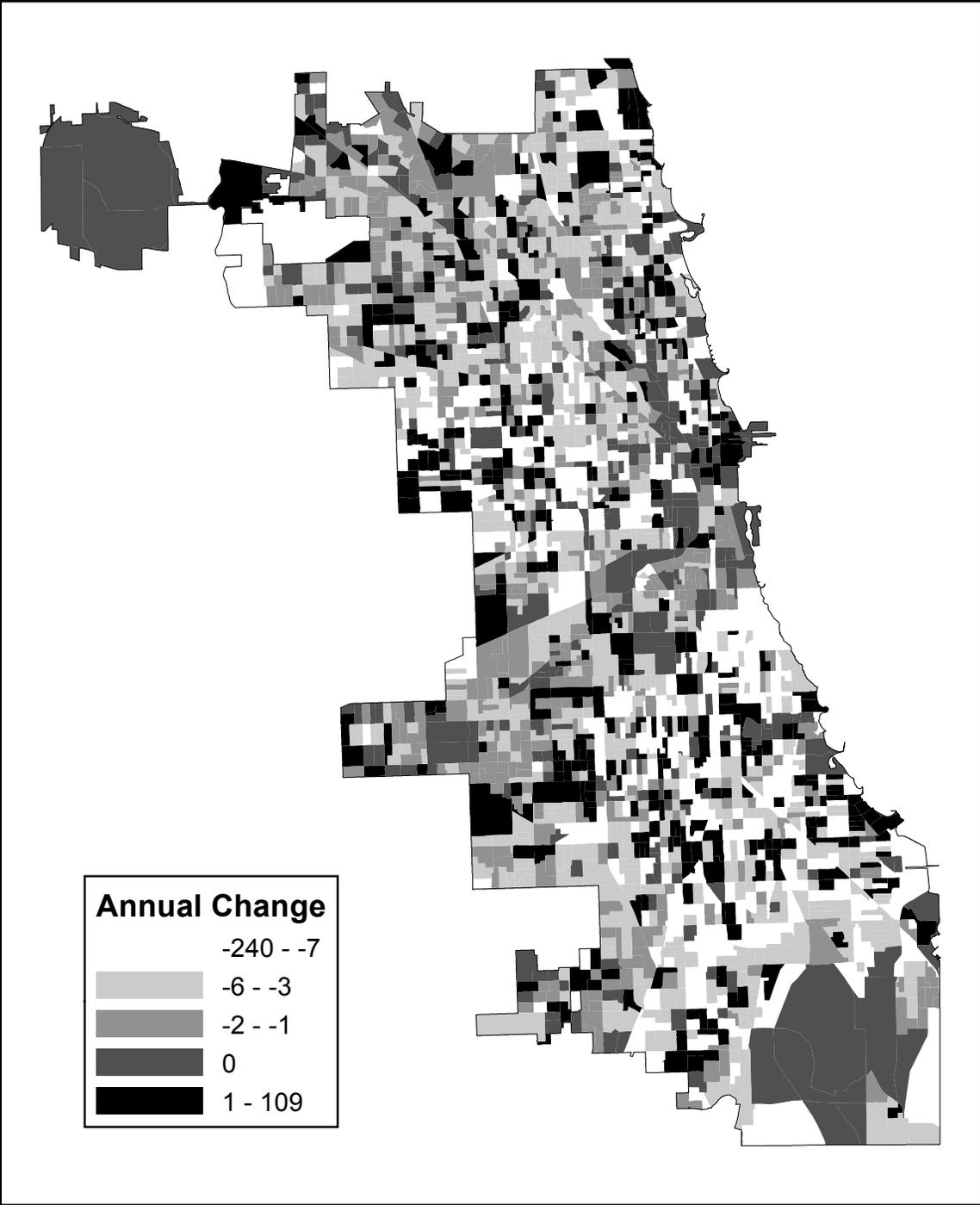
SOURCE: Author's calculations based on Chicago Police Department data.

Figure 2: Quintiles of Average Annual Violent Crime by Census Block Group in Chicago, 2002–2010



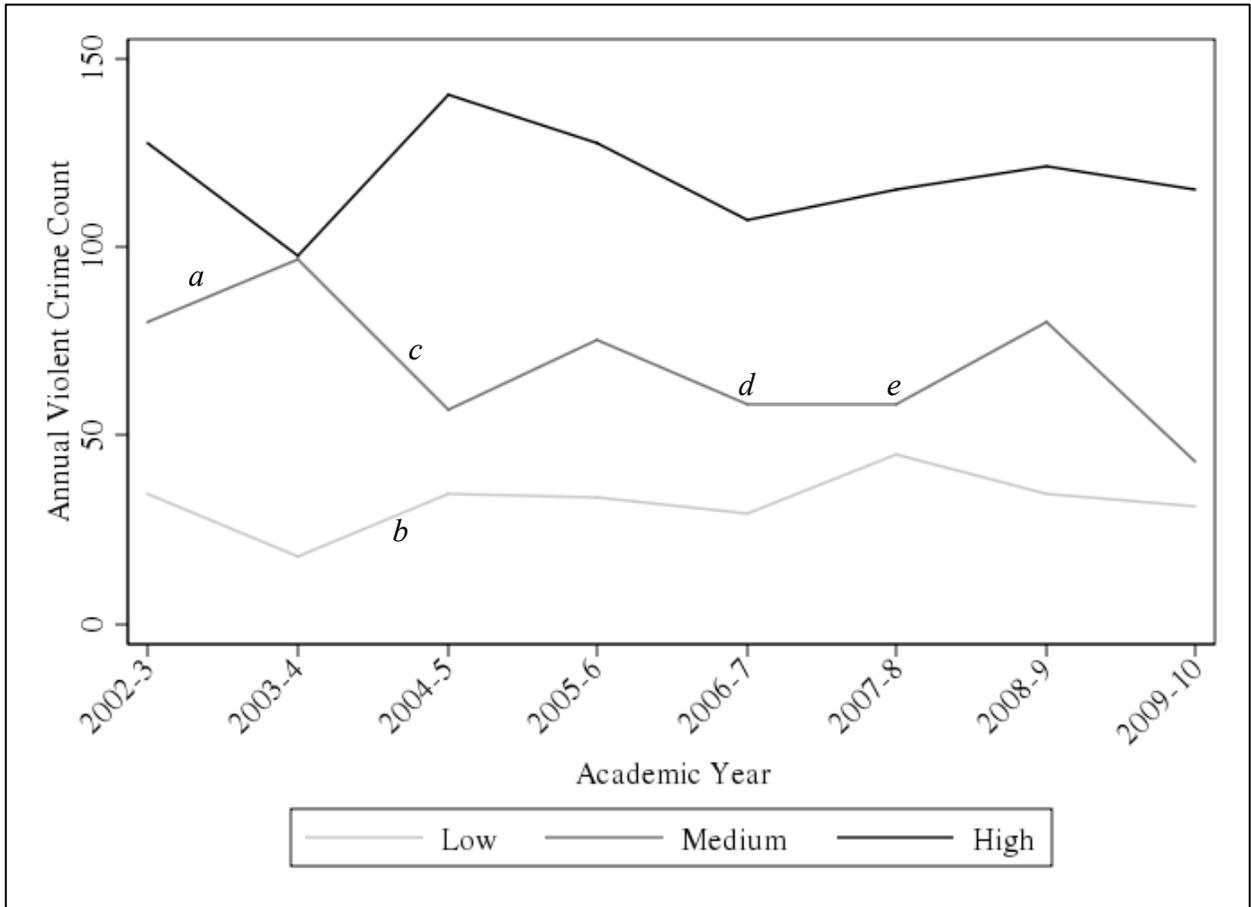
SOURCE: Author’s calculations based on Chicago Police Department data.

Figure 3: Quintiles of Average Change in Violent Crime by Census Block Group in Chicago, 2002–2010



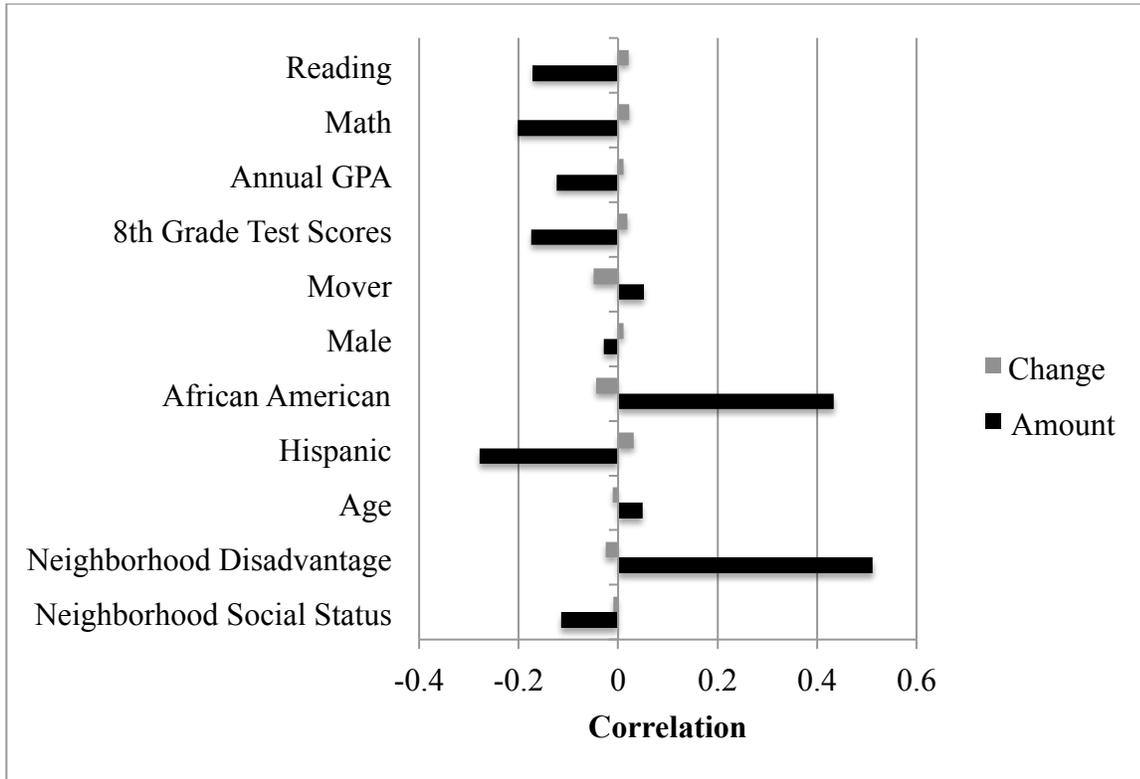
SOURCE: Author’s calculations based on Chicago Police Department data.

Figure 4: Typical Variation in Annual Violent Crime Count



SOURCE: Author's calculations based on Chicago Police Department data.

Figure 5: Correlations with Amount of Violence and Annual Change in Violence



SOURCE: Author's calculation based on data from the Chicago Police Department, and the Chicago Public Schools stored at the Consortium on Chicago School Research.

## ENDNOTES

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- i Eighth grade test scores are the only control variable used in the analysis with a more than a trivial amount of missing data. Approximately 7 percent of first time freshmen in these cohorts do not have an eighth grade test score. The probability that each student would be missing an eighth grade test score was calculated using all other available variables. The results were then weighted by the inverse probability that each student was included in the final sample. Results were almost identical with and without the weights. For the sake of simplicity the final results shown here do not include these weights.
- ii The full scoring range of these tests is 1 to 36. However, less than one percent of students in the sample score below 5 or higher than 28. The vast majority of students have scores in the middle of the range with substantial room for reductions and/or improvement. This suggests that the analysis is not susceptible to floor and ceiling effects based on the scale of the test.
- iii Homicides are the one type of crime that is almost always reported with a high level of geographic accuracy. Factor analysis (not shown) indicates that the block group homicide rates follow the same pattern and therefore form only one factor with the rates of other types of crimes. This suggests that the block group rates of other types of crimes are not systematically under or over reported.
- iv Student fixed-effects models were estimated in STATA using *xtreg, fe*. Hybrid models along the lines of those proposed by Allison (2005) and Raudenbush (2009) and estimated in R using *lmer* yield very similar results.
- v Multi-level difference-in-difference models were estimated in R using *lmer*. Interestingly, the coefficients for annual change in violent crime do not change substantially when  $V_{ikt-1}$ ,  $M_{it}$ , and  $N_k$  are left out of the models. The only difference is that the standard errors on the main

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linear coefficient are small enough for it to be statistically significant. Despite this lack of influence, these parameters are left in the model due to their theoretical importance.