2019

# Minimum Dropout Age and Juvenile Crime in the United States

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## ABSTRACT

# MINIMUM DROPOUT AGE AND JUVENILE CRIME IN THE UNITED STATES

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My dissertation examines how an increased minimum dropout age (MDA) affects juvenile crime not only in the community, but also in school. I first empirically estimate the magnitude of the impact of a higher MDA on high school enrollment. I then develop an economic model of crime that explains the relationship between an MDA and contemporaneous juvenile crime and empirically examine how a higher MDA affects juvenile crime both in the community and in school. I find that raising the MDA from 16 to 18 significantly increases school enrollment by 2.57%. Next, I find that raising the MDA to an age greater than 16 reduces crime in the community for individuals aged 16-to-18. Finally, I find that an MDA greater than 16 does not increase crime occurring in schools. These results indicate that increasing the MDA from 16 to 18 decreases community crime by 12% without affecting school crime. Although higher MDAs are primarily intended to increase the educational attainment for young adults, my findings highlight that a secondary impact is to reduce community crime.

NORTHERN ILLINOIS UNIVERSITY
DE KALB, ILLINOIS

MAY 2019

# MINIMUM DROPOUT AGE AND JUVENILE CRIME IN THE UNITED STATES

BY

MD. ABDUR RAHMAN FORHAD


A DISSERTATION SUBMITTED TO THE GRADUATE SCHOOL

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE

DOCTOR OF PHILOSOPHY

DEPARTMENT OF ECONOMICS

Dissertation Director:
Dr. Virginia Wilcox

# ACKNOWLEDGEMENTS

It would not be possible for me to accomplish the dissertation without the constant inspirations and moral supports from my mother, Mansura Begum. And most importantly, I am sincerely indebted to my advisor Dr. Virginia Wilcox for her consistent care during my doctoral research endeavor. I would like to express my sincere gratitude to my dissertation committee members Dr. Jeremy Groves and Dr. Maria Ponomareva for their valuable suggestions to improve my research. I highly appreciate their comments that helped me to establish a complete direction of my dissertation. I would also thank Dr. Anna Klis for her comments on my theoretical model.

I would like to sincerely thank my former advisors Dr. Kuan Xu and Dr. Talan İşcan at Dalhousie University, Canada who taught me how to start working on an interesting research question with a smile. Thanks to Dr. Philip Oreopoulos (University of Toronto, Canada), Dr. Clément de Chaisemartin (University of California, Santa Barbara, USA), Dr. Mark D. Anderson (Montana State University, USA), Dr. Brantly Callaway (Temple University, USA), Dr. Isaac M. Mbiti (University of Virginia, USA), Dr. Paolo Buonanno (University of Bergamo, Italy), and Dr. Syed Abu Hasnath (Boston University, USA) for their supports and directions at different stages of my dissertation. My research has also greatly benefited from the discussion of participants at various seminars.

Also, I would like to thank my Professors Dr. Mahbub Ullah, Dr. Muinul Islam, Dr. M. Abdul Mannan Chowdhury, Dr. Irshad Kamal Khan, Dr. Modabber Ahmed, Dr. Amirul Islam, Dr. Md. Alauddin Majumdar, Dr. Mohammad Tarequl Hasan Chowdhury, Professor Mohammad Ruhul Amin, and Dr. Mohammed A. Hossian at University of Chittagong,

Bangladesh for their insights and motivations to pursue higher studies. A special thanks to our most respected Professors Dr. Harendra Kanti Dey and Dr. Muhammad Sirajul Haque for their inspirations to become a member of academic arena.

The supports of my friends and colleagues through the PhD program are precious. I am grateful to my friends Rafi Hossain, Sheikh Touhidul Haque, Genuine Martin, Thomas Carr, Shakil Mahmud, Soroosh Azizi, Shawn Osell, Dr. Abraham Asfaw, Dr. Misbahul Islam, Dr. Md Rafayet Alam, and Dr. Mainul Islam Chowdhury for generously sharing your valuable time and knowledge at different stages in my life. You are awesome people who always have a significant impact on my professional and personal life. I feel equally privileged to be friends to Gail Jacky, Dr. Manahari Adhikari, Dr. Jeff Gard, Ashley Bartelt, Carson Shoupe, and Justin Ness at NIU. You guys always offer me a great opportunity to discuss education system in the United States and to blend it in my dissertation. A special thanks to the University Writing Center and its Director Gail Jacky for their consistent cares and supports with a smile. I also sincerely thank to my brother Anamul Kabir, my uncle Tabarak Ullah, and my father-in-law Dr. Md. Abdul Khaleque for their supports throughout the higher study.

As always, family is the keystone of my graduate study. I am highly indebted to my lovely wife, Taufica Nusrat, and everyone of my family for their continuous supports that always offer me more strength and motivation to accomplish my graduate study.

# DEDICATION

To the everlasting memory of my father Md. Abdur Rob and my mentor Dr. Muhammad Sirajul Haque, and to all my teachers at different stages of my life.

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# CHAPTER 1

# INTRODUCTION

In this introduction, I first describe why high school dropout is a problem for the individual, the community, and the United States as a whole. Second, I consider that increasing the minimum dropout age (MDA) can reduce the adverse consequences of dropping out. Third, I describe the relationship between the MDA and juvenile crime and emphasize the importance of addressing juvenile crime. Fourth, I briefly survey the previous literature and highlight the prevalence of juvenile crime in both the community and school. Finally, I report my findings that an MDA greater than 16 reduces community crime but not school crime.

Dropping out of high school poses a personal cost to individuals and affects the community and the nation. By dropping out, individuals significantly forgo the opportunity of higher earnings and more promising careers, since high school dropouts are nearly three times more likely to be unemployed than college graduates.[1] Around 16% of dropouts in the United States are unemployed, and 32% of them live below the poverty line. Most dropouts work in construction, truck transportation, landscaping, and food service industries with an average hourly wage of $12.75. Moreover, by the time dropouts are 50, their average hourly wage has only slightly increased to $16.50 (Messacar and Oreopoulos, 2012).

[1] See the U.S. Bureau of Labor Statistics (2014).

Increasing the high school graduation rate can reduce the economic disparity between graduates and dropouts, many of whom are minorities, such as African Americans, Latinos, and Native Americans. Stark and Noel (2015) find that African American and Latino students have a higher dropout rate than White students. If the graduation rate of Latino, African American, and Native American students matched the graduation rate of White American students by 2020, then the potential increase in their collective personal income would add more than $310 billion to the US economy.[2]

Many dropouts do not have health care and are dependent on state social assistance (Currie and Gruber, 1996; Cutler et al., 2008). Belfield and Levin (2007) find that dropouts have a lower life expectancy and higher rates of diabetes, heart disease, and other chronic illnesses. Dropouts older than 25 report having worse health than high school graduates of the same age, regardless of their income (Pleis et al., 2009).

The returns from schooling should not only be measured in terms of monetary benefits, but also the opportunities for self-accomplishment, social interaction, and independence (Oreopoulos and Salvanes, 2011). More schooling can reduce the cost of unemployment and help individuals make better decisions in the future. These attributes decrease criminal activity and other risky behaviors. For example, the United States could save around $18.5 billion in crime costs if the high school graduation rate increased by 5%. Over the course of their lifetimes, the dropouts in 2010 alone will cost the nation more than $337 billion in lost wages.[3]

Policy makers and researchers agree that the high school graduation rate needs to improve in the United States if we are to increase global competitiveness, alleviate polarization, and improve other adverse social conditions, such as lowering the incarceration rate.

[2]See, Alliance for Excellent Education (2006a).
[3]See, Alliance for Excellent Education (2006b).

However, there is no consensus about how to achieve this objective. Raising the MDA is a partial solution that may increase the high school graduation rate. The MDA refers to the maximum age at which a student is required to attend school or an equivalent educational program as defined by each state. If individuals stay in school longer, more of them will eventually graduate from school. Almost 25% of students who otherwise would have dropped out remain in school because of compulsory schooling laws in the United States (Angrist and Krueger, 1991). Oreopoulos (2007b) also suggests more restrictive compulsory schooling policies to reduce the dropout rates, arguing that such changes increase college enrollment and improve other social economic indicators.

What do we know about the young individuals who would be affected by a higher MDA? According to the Department of Education (2015), dropouts are students who were not enrolled in school and had not completed high school or an alternative program. High school dropouts are more likely to have a lower academic attainment, to have a lower academic expectation, to have a lower English language proficiency, to feel that schooling is boring, and to feel pressure to contribute to their families during teenage years. Also, some of them may fail to understand the future consequences of education. Dropouts are more likely to be African American or Hispanic and have lower socio-economic status.

More highly educated people may generate many positive spillover benefits, such as a law-abiding nation and civic participation in the community. However, few studies examine the relationship between education and crime. Lochner (2004), Buonanno and Leonida (2009), and Lochner (2011) explain the long-term effect that education has on crime in the community. Nonetheless, they do not address whether schooling through an increased MDA affects contemporaneous juvenile crime.

Higher crime rates negatively impact communities in terms of the expenses of law enforcement agencies. According to the US Department of Justice (2016), more than 22 million incidences of violent and property crimes were reported in 2015, resulting in approximately $16 billion in economic losses to the victims and $280 billion in government expenditures on police protection, judicial and legal activities, and corrections. Sum et al. (2009) argue that each high school dropout costs taxpayers an average of over $292,000 in lower tax revenues, higher cash and in-kind transfer costs, and imposed incarceration costs. If individuals work instead of committing crime for their livelihoods, communities would save some of the money that is used to address criminal activities. In addition, the per capita income of the communities would be higher. Also, if more individuals work instead of committing crime, then the country would receive taxes from their earnings.

To explain the theoretical relationship between crime and education, previous studies like Lochner (2004), Buonanno and Leonida (2009), and Lochner (2011) develop an economic model of crime. Using the human capital accumulation model, they argue that education improves an individual's human capital level by offering careers with a higher wage in adulthood. A higher wage implies a higher opportunity cost of committing crime in the community, which discourages an individual from committing crime in adulthood. These studies thus indicate that schooling reduces community crime in the long run. However, schooling might have an immediate impact on criminal activity. While individuals stay in school, they cannot commit crime in the community during school hours. This effect implies that schooling may reduce contemporaneous crime in the community. Consequently, this reduction would decrease the federal and state expenditures on crime-related incidences. For example, if California had reduced juvenile crime in 2007, the state would have saved up to $1.1 billion (Belfield and Levin, 2007).

While the literature on the relationship between an MDA and community juvenile crime is sparse, Anderson (2014) argues that there is an incapacitation effect of MDA on crime in a community. Comparing 16- to 18-year-olds' crime rates with 13- to 15-year-olds' crime rates, he finds that increasing the MDA from 16 to 18 reduces juvenile crime in the community. However, he does not compare juvenile crime in states with an MDA of 16 (MDA 16) to that in states with an MDA of greater than 16 (higher MDA).

States with an MDA greater than 16 allow their students more interactions with each other. Kang (2007) and Zimmerman (2003) argue that peer associations are significant determinants for a better academic environment. Conversely, some of the students who otherwise would have dropped out might be unmotivated. In addition, students who do not want to stay in school longer might become frustrated and resentful. Their suppressed anger and frustration might manifest in many ways, such as verbal abuse, larceny, bullying, use of illegal drugs, physical attacks, and sexual abuse. Also, younger students who share classes and other aspects of their learning environment with these unmotivated potential dropouts may exhibit similar inappropriate behaviors, which could lead to an increase in disciplinary problems in schools (Gaviria and Raphael, 2001). Overall, these interactions might deteriorate the academic environment (Bowen and Bowen, 1999; Ennett and Bauman, 1994; Hinduja and Patchin, 2013).

Individuals who are required to stay in school commit fewer crimes in the community, which implies that schooling has an incapacitation effect on community crime (Anderson, 2014; Jacob and Lefgren, 2003; Luallen, 2006; Machin et al., 2011). However, one of the potential consequences of schooling through an MDA greater than 16 would be a displacement of community crime to the school. An individual who drops out at the age of 16 is more likely than others at 16 to commit crime in the community. Because an MDA greater than 16 retains students in school who otherwise would have dropped out, some of them might bring

their criminal activities into school. An MDA greater than 16 thus might increase school crime. Gilpin and Pennig (2012) argue that an MDA 18 significantly increases criminal activities in school, but they do not address the neighborhood crime that can influence such activities. However, Willits et al. (2013) and Willits et al. (2015) have found that community crime can spill over into neighborhood schools.

When a student is exposed to other students' negative actions, this student can also be victimized (Olweus, 1997). This victimization might affects individuals' welfare. Eriksen et al. (2014) examine the potential effects of bullying on academic performance in elementary schools in Denmark. They argue that bullied students' grades suffer immediately and that the effects of victimization are likely to increase in severity with continued bullying. A higher MDA may not only have an impact on preventing juvenile crime in the community, but might also increase juvenile delinquent behavior in school. Similarly, using the Youth Risk Behavior Surveys (YRBS), Anderson et al. (2013) examine the relationship between an MDA and students' victimization in the United States. In their study, they examine the effect of an MDA greater than 16 on one of the five measures of student victimization, defined as binary outcomes: whether student was threatened or injured with a weapon on school property in the past 12 months; student was in a physical fight on school property in the past 12 months; student missed school for fear of his/her safety in the past 30 days; student was offered, sold, or given an illegal drug on school property in the past 12 months; student had property stolen or damaged on school property in the past 12 months. In their study, they control for students' gender, race, and age. Anderson et al. (2013) find strong evidence that students, especially younger and female students, fear increased violence and have more concerns about school safety. They argue that property crime in school increases with an increased MDA. However, they do not examine the effect of an MDA greater than 16 on overall school crime by considering school-crime-prevention resources, such as parental involvement,

security cameras, security guards with stun guns, drug-sniffing dogs, and student-to-teacher ratio.

Previous studies do not address the effect of a higher MDA on contemporaneous juvenile crime, focusing instead on long-term criminal activities during adulthood. In this study, I examine the effect of an MDA greater than 16 on contemporaneous crime both in the community and in school. To do so, I first develop an economic model of crime that shows a theoretical relationship between MDA and crime both in the community and in school. I then estimate the effect of an MDA greater than 16 on enrollment of students who otherwise would have dropped out (potential dropout). Finally, I empirically test whether an MDA greater than 16 affects juvenile crime both in the community and in school.[4]

My economic model of crime is a noteworthy contribution because this model can explain the theoretical relationship between an MDA and contemporaneous juvenile crime in the community. An MDA greater than 16 may not only immediately reduce juvenile crime in the community, but also it may increase juvenile crime in school. Previous studies have thus far focused on the long-term the effects of schooling on community crime. However, an MDA greater than 16 immediately reduces the time and opportunity for individuals aged 16-to-18 to commit community crime because they spend less time in the community. Conversely, MDA allows potential dropouts more time and opportunity to commit crime in school. Therefore, an MDA greater than 16 not only affects individuals' schooling decisions, but also affects their immediate time allocations on crime both in the community and in school. My economic model of crime explains that an MDA greater than 16 reduces contemporaneous juvenile crime in the community. The results of my model also implies that an MDA greater than 16 may increase crime in school.

[4]In my empirical analyses, I use data describing the juvenile arrest rate to represnt juvenile crime in the community.

I empirically examine the effects of an MDA greater than 16 on enrollment between the ages of 16 and 18. Unlike prior studies, I first empirically estimate the magnitude of the impact of an MDA greater than 16 on high school enrollment. Using the American Community Survey (ACS) dataset, I find that raising the MDA from 16 to 18 increases the probability of high school enrollment by 2.57%. This implies that increasing the MDA from 16 effectively retains potential dropouts in school.

Using the Uniform Crime Reporting (UCR) dataset, I find that an MDA greater than 16 reduces community crime. For example, states with an MDA of 18 have 4.76 fewer total juvenile crime incidences per 1,000 individuals between ages 16 to 18 than states with an MDA of 16. However, using the School Survey on Crime and Safety (SSOCS), I find that an MDA greater than 16 does not affect school crime. This implies that MDA greater than 16 decreases community crime without increasing school crime. These findings are significant to policy makers because this information helps them decide about raising the MDA to an age greater than 16.

In this study, I offer systematic evidence to explain the effects of an MDA greater than 16 on juvenile crime in the United States. Approximately 567,000 students were dropouts during 2013-14 academic year, which was almost 5.2% of the 10.9 million enrolled in grades 10 through 12 (McFarland et al., 2018). In 1999, according to the US Department of Justice (DOJ), a dropout nationally caused $1.7 to $2.3 million in crime and drug-related activities during their lifetime. According to the DOJ (2017), in 2016 residents aged 12 or older experienced an estimated 5.7 million violent victimizations, a rate of 21.1 victimizations per 1,000 persons in this age group, and households experienced an estimated 15.9 million property victimizations, a rate of 119.4 victimizations per 1,000 households. In addition, only 42% of total violent crimes and 36% of total property crimes were reported to the law enforcement agencies. To address these crime-related monetary and non-monetary incidents, the

estimated cost would range from $690 billion to $3.41 trillion; however, there are difficulties in calculating the non-monetary cost of crime.[5] Also, among the Organization for Economic Co-operation and Development (OECD) countries, the United States has the highest incarceration rate, which is almost three times that of the next country (World Prison Brief, 2016). Merlo and Wolpin (2015) argue that juvenile delinquency can be a starting point in the trajectory of adult criminality. According to the Office of Juvenile and Delinquency Prevention (2015), approximately 2,900 delinquencies are reported every day. To minimize the adverse consequences, this study recommends that states increase their MDA as an effective policy to prevent juvenile crime in their communities. For example, when states have increased their MDA from 16 to 18, they have experienced, on an average a 12% reduction in total juvenile crime. In other words, increasing the MDA not only prevents juvenile crime, but also offers a safer community.

The organization of my study is as follows: I first discuss the dropout scenarios in the United States and its adverse consequences of dropping outs and propose an MDA greater than 16 as a partial solution. In Chapter 2, I describe the policy background of MDA in the United States and review the relevant literature on the relationship between the MDA and criminal activity. In Chapter 3, I develop an economic model of crime to explain how an MDA greater than 16 influences contemporaneous crime both in the community and in school, and, in Chapter 4, I describe the data and empirical estimation methods used in this study. In Chapter 5, I report the empirical findings that an MDA greater than 16 effectively retains potential dropouts in school and reduces juvenile crime in the community. In Chapter 6, I conclude my results and offer policy recommendations to address juvenile crime in the United States.

[5]COSTS OF CRIME: Experts Report Challenges Estimating Costs and Suggest Improvements to Better Inform Policy Decisions GAO-17-732: Published: September 26, 2017. Publicly Released: September 26, 2017.

# CHAPTER 2

# POLICY BACKGROUND AND LITERATURE REVIEW

## 2.1 Background: State Laws Regulating the Minimum Dropout Age

Education is a fundamental human right and can help individuals become better citizens (Walsh, 1993; Holt and Holt, 2004). Education can help in the development process of a country in many ways. For example, education makes individuals independent, confident and aware individuals about their potentials. Education can offer individuals enough self-esteem to implement their well-informed judgments about their careers and morals, which eventually contribute to the country's well-being. Oreopoulos and Salvanes (2011) argue that educated citizens can better contribute to inclusive and egalitarian civic participation. For example, educated people tend to choose community representatives who prioritize wellbeing of the community as a whole. Education also empowers women to fight against poverty, helping them to make better choices for themselves and their families (Heward and Bunwaree, 1999; Abu-Ghaida and Klasen, 2004).

Eduction is often linked with individuals' abilities, particularly in the workforce. Spence (1973) argues that well-educated job applicants send a signal to the employers that they are more productive employees than job applicants with lower education levels. He claims that education increases a worker's productivity as it partially differentiates in their innate

abilities or human capital. Educational achievement can be good indication of motivation, persistence, and organizational capabilities for a future employee, and education can be a sorting device and to some extent a social discriminator (Wolf, 2002). Education can reduce crime (Lochner and Moretti, 2004), improve child health status (Currie and Moretti, 2003), and provide social benefits through enhanced civic participation (Milligan et al., 2004). Based on the monetary and non-monetary benefits, education is the key determinant for the socio-economic development in a country.

Like many other countries, the United States offers free educational programs that help citizens contribute to the country's development. Free-education age requirements refer to the age range at which a student can enroll in public school. For example, Massachusetts offers free education for the students between 3 and 22. Although free-education is available to all, some may drop out at their states' MDA, which is 16. MDA refers to the maximum age at which a student is required to attend school or some other equivalent education program as defined by states' laws. Students younger than 16 must stay in school if they have not graduated. In 1853, Massachusetts enacted the first MDA in the United States, and all other states had adopted similar laws by 1918. The objectives of introducing the MDA are to protect youths from entering the labor market too early and to make them more educated (Oreopoulos, 2006).

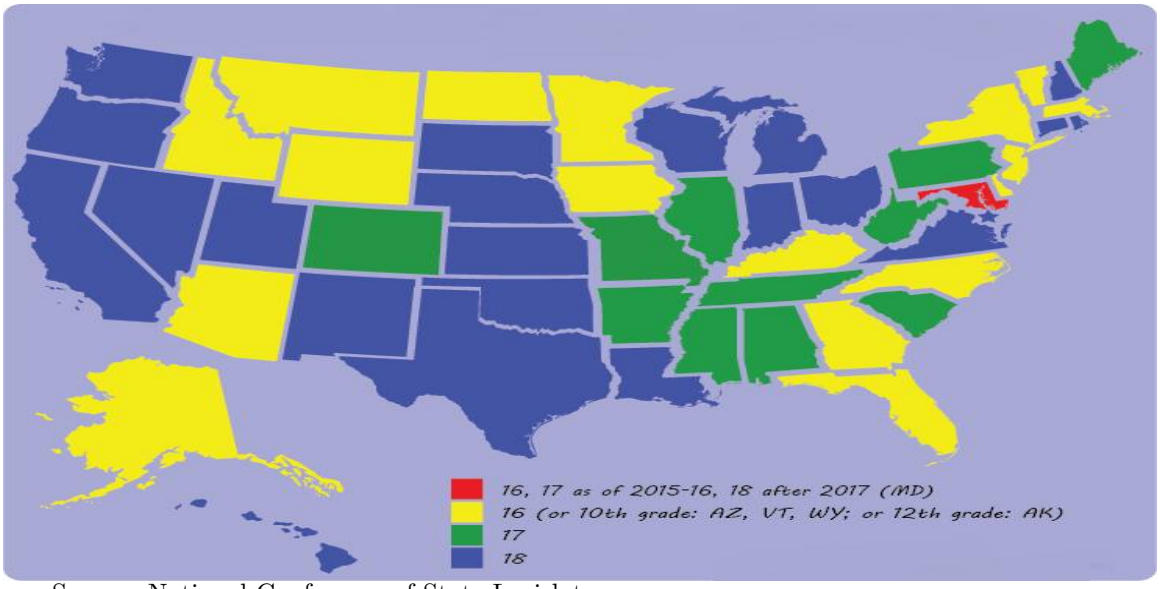
Table 2.1 shows the trends of minimum dropout ages across the states. The total number of states implementing an MDA grater than 16 is continually increasing. As of 2014, 25 states had an MDA of 18, 11 states had an MDA of 17, and 15 had an MDA of 16. Figure 2.1 shows the MDA of each state, which indicates that there is a variation of MDAs across the country. Most states are increasing their respective MDA to increase the high school graduation rate.

**Table 2.1.** Numbers of States by MDA, 1950 to 2014.

| MDA (Years) | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 | 2014 |
|---|---|---|---|---|---|---|---|---|
| less than 16 or 16 | 42 | 43 | 40 | 39 | 33 | 29 | 20 | 15 |
| 17 | 5 | 4 | 6 | 6 | 10 | 10 | 10 | 11 |
| 18 | 4 | 4 | 5 | 6 | 8 | 12 | 21 | 25 |

Source: National Center for Education Statistics.
Note: This Table shows the trends of total number states, including District of Columbia, with their MDAs.

**Figure 2.1.** The variation of MDAs in the United States




Source: National Conference of State Legislatures.
Note: This figure shows the state specific distribution of MDA in the United States.

An MDA is a legal mandate, which is monitored by local school attendance officers, superintendents, law enforcement officers, and municipal or juvenile domestic relations courts. In every state, parents or legal guardians are responsible for this mandatory attendance. If anyone fails to comply, it is considered a misdemeanor in most states. There are penalties, such as fines and jail sentences, for noncompliance. For example, the fine for the first offense ranges from $20 to $100, and it increases for subsequent offenses from $250 to $1,000, depending on the jurisdiction. Parents or legal guardians can receive a 30-day jail sentencing

in most states. Some states use alternative sentences, such as community service or counseling. If students violate their respective MDA, they are also subject to legal ramifications. For example, students can have their driving privileges revoked. These punishments are not usually imposed until administrative measures prove unsuccessful.

Each state has had an MDA of at least 16 since 1980. States with an MDA greater than 16 implies that potential dropouts are required to stay in school longer than their counterpart. In other words, potential dropout would have less time to stay in the community, which eventually allows them less opportunity to commit crime in the community. Similarly, MDA greater that 16 allows potential dropouts to stay longer in school, which allows more opportunity to commit delinquent behavior in school. In this study, I will examine whether there is a causal relationship between MDA and juvenile crime both in the community and in school.

## 2.2 Literature Review

There is a growing body of research explaining the relationship between education and juvenile crime. In economics, Becker (1968) first argues that criminals behave as rational agents by analyzing the cost-benefit framework. He argues that individuals consider whether to engage in legal or illegal activities by comparing the net value of earnings from crime to the loss of earnings from not working, taking into account the probability of apprehension. Freeman (1999) argues that there are three central concerns: the effects of incentives on criminal behavior, decision interaction within a market framework, and the use of cost-benefit analysis. These concerns are discussed in the economics of crime literature.

The posited reasons for committing crime vary with the disciplines of study. Previous studies argue that crime is influenced by a wide range of potential factors: the role of punishment (Becker, 1968; Ehrlich, 1973), conditions in prison (Katz et al., 2003), the role of police administration and incarceration procedures (Levitt, 1997, 1998; Di Tella and Schargrodsky, 2004; Levitt, 1996), the role of education (Lochner and Moretti, 2004; Lochner, 2011), social interactions and peer effects (Case and Katz, 1991; Glaeser et al., 1996b; Gaviria and Raphael, 2001; Kling et al., 2005; Jacob and Lefgren, 2003), and the role of family circumstances and structure (Glaeser and Sacerdote, 1999; Donohue III and Levitt, 2001). Other studies have also considered the impact of wages and unemployment rates on crime, such as Grogger (1998) and Raphael and Winter-Ebmer (2001); the impact of criminal histories on labor market outcomes, such as Grogger (1995) and Kling et al. (2004); the effect of incarceration on the supply of crime in the economy, such as Freeman (1996) and Freeman (1999); and the returns to education among recent prison releases, such as Western et al. (2001). Because so many factors influence crime, research needs to use a multidimensional approach to address crime and its consequences.

Crime imposes many direct and indirect expenditures on the community and the country as a whole. States implement various public policies to reduce crime and its adverse consequences. For example, states might implement a stricter criminal justice system or increase the number of police resources (Levitt, 2004; Sherman, 1992; Durlauf and Nagin, 2010). Other approaches that try to prevent crime focus on education as a means of improving human capital (Lochner, 2004, 2010; Machin et al., 2011; Anderson, 2014; Meghir and Palme, 2005; Meghir et al., 2012).

Lochner (2004) argues that education plays a great role in human capital investment by increasing individuals' work opportunities in the labor market to earn higher pay. These opportunities eventually discourages individuals from committing crime. Education may

teach individuals to become more patient (Becker and Mulligan, 1997). Education also generates detail forward-looking thoughts, which make individuals more aware of crime and its potential costs. A forward-looking individual might put more value on punishment, which discourage them from committing crime.

Several studies examine the long-term effect of education on earnings in the long run. For example, more schooling leads to higher earnings (Mincer, 1974), which indicates that the opportunity cost of committing crime is higher. Grogger (1998) argues that a higher opportunity cost might be the main reasons individual do not commit crime. Linking crime to wages, Grogger (1998) shows that graduating from high school reduces the productivity of a crime. Using a natural experiment, Angrist and Krueger (1991) find that almost 25% of potential dropouts remain in school because of the MDA, which ultimately increases their educational attainment and future earnings.

Education also influences other behavior like self-awareness and long-term planning, which offer individuals promising careers opportunity. For example, individuals' earnings increase by an average of 10% (Acemoglu and Angrist, 2000) and their overall lifetime wealth increases by about 15% with an extra year of compulsory schooling (Oreopoulos, 2007a). Educational benefits might be augmented by early childhood interventions, such as Perry Preschool. This program began in 1962 to offer high-quality education for disadvantaged children aged 3-4 to improve their likelihood for future success Schweinhart et al. (2005) find that Perry Preschool provides a quality education to poor children and prepare them for school. This schooling program helps students in their subsequent educational programs and their economic stability. This also helps to reduce their tendency to commit crime in their adulthood. As an MDA greater than 16 requires students to stay in school, Cook and Ludwig (2011) recommend increasing the MDA to prevent community crime. However, they do not empirically test the effect of this policy. Oreopoulos (2007a) also argues that dropouts

tend to be more focused on immediate costs from schooling, such as stress from taking tests, uninteresting academic content. This short-term focus prevents them from considering their potential lifetime earnings if they graduate.

Previous studies examine the effects of education on community crime in the long run. However, Anderson (2014) argues that there might be short-term effects as well. The long-term relationship emphasizes the impact of additional schooling on adult criminal behavior. For example, parochial schooling has a significant impact on decreasing a crime in the community (Witte and Tauchen, 1994). However, more schooling may increase the opportunity to commit crime in school in the short-term. For example, an MDA requires an individual to stay longer in school, which will allow them more opportunity to commit school crime. In other words, MDA requires unmotivated dropouts to stay in school, which allows them more opportunity to commit crime in school. Therefore, an MDA greater than 16 affects not only crime in the community, but also crime in school.

In the following sections, I first review the previous theoretical literature and then explain how my economic model of crime shows the relationship between the MDA and juvenile crime. I then discuss the relevant empirical literature that covers the long- and short-term effects of an MDA greater than 16 in the following two categories: i) MDA and crime in the community and ii) MDA and crime in school.

### 2.2.1 MDA and Crime: Theoretical Perspectives

Since Becker (1968), economists have developed the economic models of crime that describe an individual's economic incentives for committing crime.[1] In this section, I briefly review the literature related to economic model of crime and explain how my proposed economic model of crime contributes to the literature. In the 1960s, studies - Becker (1968) and Ehrlich (1970) - focused on expected income analysis to explain why individuals commit crime and argued that punishment prevents individuals from committing crime within a static framework. However, they did not satisfactorily explain how harsh punishment deters individuals from committing crime. To address this gap, in the beginning of the 1970s, studies - Stigler (1970) - introduce the concept of marginal punishment. Later, studies- Block and Heineke (1975) - explained how individuals' attributes affect their tendencies to commit crime. Following the static framework, other studies focused on how a social network and societal structure affect individuals' behavior. Individuals' current behavior depends on their past behavior. In the 1980s, studies - Heckman (1979) and Flinn (1986) - showed the criminal behavior patterns within a dynamic framework. In the 2000s, studies - Lochner (2004) and Buonanno and Leonida (2009) - started exploring the relationship between human capital and crime, explaining how education can prevent community crime in the long run. However, none of these prior studies explain that there is an immediate effect of schooling on crime in both the community and in school.

Criminals behave as rational economic agents who want to maximize their well-being. Because the total outcome of criminal activities is uncertain, Becker (1968) argues that

[1] Although sociologists and criminologists view the reason for committing crime differently, they each emphasize biological development, establishment of social networks, poor family background, social cultural norms and values as reasons for committing crimes, but they do not propose a theoretical model to explain why individuals commit crime.

criminals want to maximize their expected utility. He assumes that individuals' expected utility is a function of income. If the expected utility from crime is higher than the expected utility from legitimate work, an individual tends toward crime rather than work in the labor market.

Punishment may prevent individuals from committing crime, but there is a debate over the degree of punishment and crime. Becker (1968) defines expected punishment as the probability of punishment times its severity. He argues that society defines some activities as crime and chooses justice policies that combine the probability and severity of punishment to minimize society's potential total loss from crime. To implement the societal justice policies, society has a cost. In addition, society cannot afford the 'complete' cost of implementation of the justice system, which implies that the level of implementation is considerably lower than the 'complete.' However, Stigler (1970) points out that Becker's model does not explain why harsh punishment cannot deter individuals from committing crime. Instead, Stigler (1970) argues that potential criminals make their decisions at the margin. If the same punishment is applied for a major crime and a minor crime, then harsh punishment might not be effective to prevent individuals from committing crime. For example, if the punishment for a theft of $5 is equivalent to the punishment for theft of $10,000, harsh punishment cannot deter individuals from committing crime. In addition, society requires more cost to implement a harsh punishment. Stigler (1970) argues that society should set a rational criteria of punishment through marginal adjustments by varying the resources for its implementation.

Becker (1968) and Stigler (1970) consider the effect of punishment alone on criminal behavior. Ehrlich (1970, 1973) argues that individuals allocate time to commit crime based on the costs and benefits from illegal activities rather than on the cost of punishment alone. He develops a more comprehensive model to explain the relationship between work and crime. For simplicity, he assumes that leisure time is fixed, which implies that leisure does

not affect individuals' optimal decisions. He argues that individuals, in deciding to commit crime, evaluate whether their expected net benefits from crime are higher than their expected net costs, including their opportunity cost of other activities. He also argues that individuals' respond to incentives with their specialization in choosing to commit different types of crime. Unlike previous studies, which offer a hypothetical relationship between crime and work in the labor market, Ehrlich (1970, 1973) empirically tests the model on seven types of crime in the US from 1940 to 1960. He finds that the probability of incarceration has a negative and significant effect on all types of crime except for murder.

Unlike the standard portfolio theory in investment analysis, Allingham and Sandmo (1972), Singh (1973) and Kolm (1973) develop an economic model of crime that explains why individuals avoid taxes from their earnings. Individuals may invest their wealth in risky or non-risky projects. Investing in risky projects implies that there is a possibility of losses from the investments. They argue that losses in portfolio theory are analogous to punishment in the economic model of crime. In their models, individuals always weigh the costs of reporting their whole income, not reporting their whole income and facing potential penalties if caught. In this way, these studies refer to tax evasion as crime. Analyzing the substitution and income effects of income, these studies argue that individuals will invest a larger amount of their income to avoids paying taxes on their total earnings if the benefits are higher than that of costs.

Individuals' optimal decisions on crime and work may not only depend on the expected cost-benefits of the crime, but also depend on their personal preferences. For example, the preference toward crime might be different between an honest and a dishonest person. Block and Heineke (1975) refer to these factors as psychic factors. In their economic model of crime, they argue that individuals use psychic factors to choose their activities, whether legal or illegal, that maximize their expected utility. Like Ehrlich (1970, 1973), Block and

Heineke (1975) assume that leisure time is fixed. In this model, they also show that with a given probability of conviction, severity of punishment, and employment opportunity, a risk-averse and honest individual will allocate less time to engage in illegal activities than a dishonest individual. However, they also acknowledge that increasing the punishment will unambiguously prevent crime.

Increasing the punishment for a particular type of crime affects the perceptions that individuals have on other types of crimes. For example, increasing the probability of being arrested for burglary may influence potential criminals to shift to mugging. In this case, the conventional cost-benefit analysis does not explain the effect that increasing the punishment for one crime has on other types of crime. By using the substitution effect, Heineke (1978) shows how punishment for a particular type of crime influences individuals' likelihood to commit other crimes. Heineke (1978) also argues that individuals' income comprises three components: non-earned income, the monetary and monetized benefits and costs of legal activities, and the monetary and monetized benefits and costs of illegal activities. When individuals are convicted, then their income will be decreased by a factor that represents the monetary and monetized costs of crime. Heineke (1978) also argues that a change in any of the three components, such as an increase in the probability of conviction, will affect an individual's optimal time allocation for legal and illegal activities.

The role of a social networks and social structure may affect criminal behavior. Calvó-Armengol and Zenou (2004) develop an economic model of crime to explain the effect of social network and societal structure on criminal behavior. They argue that criminals might receive either a positive or negative benefits from their friends or social network. For example, criminals may compete with each other, which might offer a reduction in the aggregate gains from crime. On the other hand, if they share their knowledge and skill about how to commit crime efficiently or how to avoid the law and enforcement agencies, then there would be an

increase in their aggregate gains. Following Becker (1968), Calvó-Armengol and Zenou (2004) assume that individuals choose alternatives between work and crime by considering the cost-benefit analysis. They examine a subgame-perfect Nash equilibria in which individuals decide first to work in the labor market or become criminals. They argue that there might be multiple equilibria that are driven by the geometry of criminal connection. This result implies that individuals with a strong social network more often commit multiple crime in their communities.

In static models, such as Becker (1968), Block and Heineke (1975), and Ehrlich (1970), individuals allocate their time to commit crime if they believe that expected benefits from crime are higher than the expected costs, the forgone income from in the labor market. However, this approach does not consider the dynamic effect of crime, which comes through various channels: habit formation, capital accumulation, addiction, and peer-group effects. Heckman (1979) argues that these current activities may depend on individuals' previous activities. For example, individuals' likelihood to commit crime in the current period may affect their tendency to commit crime in future.

In the human behavioral model, the effect of current choice on future consequences is significant. For example, individuals facing a one-year sentence might face a multiple-year sentence for committing crimes in the future. By extending the static economic model of crime, Flinn (1986) develops a behavioral model to explain individuals' optimal time allocation on criminal activities. In this model, he argues that human capital is accumulated through work and experience and that crime and work are interchangeable. Individuals allocating a more time to criminal activities have less time to allocate to work, which reduces their opportunities to invest in their human capital. This decreases their future earnings in the labor market, which may further motivate individuals to commit crime. This implies that there is a trade off between work and crime.

Criminal activities in the current period do not only have a direct impact on the victims, but also have socio-economic impacts on criminals' economic prospects (Freeman, 1999). Becker (1964) argues that workers and employee can play a cooperative role in investing in a firm-specific human capital, which offers an incentive for maintaining stable employment in the long run. Nagin and Waldfogel (1998) refer to this incentives as long-term stable employment opportunity. They also argue that individuals' conviction record influences their future income and potential careers. They argue that criminal participation increases monetary wage in the short-term, but conviction from illegal activity reduces access to future career opportunity. For example, a first-time crime might have a positive effect on the current income of an individual under age 25, but it has less likely to have a positive future income of an individual over age 30.

Individuals criminal decisions might also be influenced by social norms. Differences in individuals' social norms might affect their decisions to choose a legal career over an illegal one given a similar wage structure. Sickles and Williams (2006) argue that individuals' preferences and earnings depend on their social capital, which comes through their interaction with a law-abiding peer group. Following Ehrlich (1973), they develop a dynamic model of crime that how social norms and interaction influence crime in the community. They employ the Euler equation GMM approach to explain the effect of social capital on individuals' decisions to commit crime. They assume that social capital offers an opportunity to interact with a 'good people,' which encourages individuals not to commit crime. For example, criminal behavior of an individual associated with a university professor, who has social prestige, may be different than that of individual associated with gang member. However, Sickles and Williams (2006) do not show how criminals' behavior negatively affects labor market outcomes.

Individual's likelihood to engage in criminal activities is also influenced by their future employment opportunities in the labor market. For example, forward-looking individuals always consider the prospect of the future career opportunities that might prevent them from committing crime. Imai and Krishna (2004) call these consequences a 'dynamic deterrence.' They also develop a dynamic model of crime to show how criminal activities adversely affect labor market outcomes. They assume that individuals' criminal decisions depend not only on wages and employment at the current period, but also on the future wages and employment that are affected by outcomes in the current period. Using the maximum likelihood approach, they show that the threat of future adverse effects in the labor market would also be a strong deterrent to community crime. Their findings are also consistent with Kahan (1998), who argues that anti-crime policies influence individuals' anticipation of future punishment.

Discounting the future income or punishment may affect individuals' criminal behaviors differently based on their perceptions. Wilson and Herrnstein (1985) argue that individuals usually consider a high discounting rate while committing crime. If the discount rate is high, then extreme punishment might fail to prevent crime. However, an increased likelihood of getting caught might prevent individuals from committing crime. But, there might be a trade off between certainty and severity of punishment if the discount rate is very high. Lee and McCrary (2005) develop a dynamic version of Becker's (1968) approach to explain whether or not individuals choose to commit crime in each period throughout their lives. If potential criminals value their future as much as their current welfare, an increase in sentencing from 5 to 10 years would imply a double cost of crime with the same probability of punishment. Similarly, the same outcome can be obtained if law enforcement doubles their efficiency in catching criminals, holding the sentencing as fixed. This implies that criminals consider uncertainty and severity as substitutes for each other. In their model, Lee and McCrary (2005) consider young criminals as adult criminals so that young criminals would receive

longer sentencing compared to the juvenile offenders. This suggests that younger individuals are more impatient or myopic than their older individuals.

Criminal behavior typically increases until individuals' late teens after which it decreases (Grogger, 1998). Criminal behavior may also respond to the likelihood of employment in the labor market. An increased likelihood of employment implies a higher opportunity cost for committing crime, and individuals are highly susceptible at the beginning of the career. Grogger (1998) explains how individuals chooses optimal time allocation on crime and work by considering returns to crime and wage structure in the labor market. He argues that work in the labor market would be an alternative to committing crime in the community. Grogger (1998) also shows that individuals' social capital stock is associated with a good reputation, and social punishment that reduces the level of human capital. Criminal behavior is also associated with depreciation of human capital stock in the labor market. But, Grogger (1998) does not address that individuals may receive human capital with their age into the model through experience and education. Prior studies do not consider that other determinants, such as human capital, that may affect criminal activities.

Human capital may also affect individuals' criminal behavior. Human capital theory indicates that more schooling leads to higher earnings (Becker, 1994; Chiswick, 1983; Mincer, 1997). Therefore, the opportunity cost for a better-educated individual to commit crime is higher than that of an individual with less education (Lochner and Moretti, 2004; Lochner, 2004). The higher opportunity cost implies that rational individuals with more education are less likely to commit crime than their less-educated counterparts. In this way, education may discourage individuals from participating in criminal activities.

Human capital is a set of skills and knowledge embodied by an individual, and investing in human capital through education will improve these skills (Schultz, 1961). Following

Becker (1968) and Ben-Porath (1967), Lochner (2004) proposes an economic model of crime in a human capital framework. In this model, Lochner (2004) argues that individuals with higher human capital commit fewer crimes because they earn more income from legitimate work than they would from criminal activities. In this model, he assumes that there are random shocks in individual returns from both crime and the labor market. Oreopoulos and Salvanes (2011) argue that education may improve individuals' civic participation, which in turn, according to Usher (1997), promotes their level of honesty and dedication to the community. Usher (1997) argues that, in this way, crime in the community decreases. However, Lochner (2004) and Flinn (1986) focus not only civic participation, but also education can affect human capital in the labor market.

Individuals are endowed with legal and criminal human capital, and their earnings from crime and work depend on their level of relevant human capital. Mocan et al. (2005) argue that there are two types of human capital: legal human capital that affects expected income in the labor market and criminal human capital that affects expected income from the criminal activities. These human capitals can be enhanced through experience and investment in both of these sectors. In addition, human capital can also depreciate, such as through reputation, and it may also increase through interaction with a peer group. By developing a two-stage dynamic stochastic model, Mocan et al. (2005) explain how individuals first choose their optimal time allocation for crime and work to maximize lifetime income, and then decide on their consumption level in each period. They also show how the risk of incarceration and the loss of opportunity affect the criminal behavior at the current period.

Buonanno and Leonida (2009) also propose an economic model of crime for representative individuals, which explains how individuals allocate their available time within a given period to schooling, crime, and work to maximize their expected disposable income. They argue that individuals choose their optimal time allocation, where the net marginal returns

are equal to the marginal cost of each activity. Following a similar approach, Lochner (2011) proposes a dynamic time allocation model of crime, work, and education to maximize lifetime earnings. Lochner (2011) assumes that the returns from work and crime are certain within a life cycle model to explain the role of schooling in the working period. In contrast, Lochner (2004) assumes that there are random shocks to the returns from work and crime. Neither of these studies, though, explain how states' education policies affect individuals' schooling decisions and the time allocation for criminal activities in adulthood.

Education-based policies and early childhood intervention may improve individuals' human capital level. Lochner (2010) shows that state education policy affects individuals' decisions to commit crime in their subsequent working period within a human capital accumulation framework. He assumes that individuals have two periods: schooling and adulthood. Human capital can improve through education programs, such as Perry Preschool and the Head Start Program. These programs can improve individuals' social and emotional development. In this two-period model, Lochner (2010) explains how education policy encourages schooling, and thus improves the human capital accumulation. A higher level of human capital may increase future income and offer promising career opportunities, thereby discouraging individuals from committing crime in adulthood. Therefore, crime in the community decreases. In a similar way, schooling through an MDA affects individuals' criminal activities in the community in adulthood within a human capital framework.

Schooling may have an immediate effect on contemporaneous juvenile crime. A higher MDA requires potential dropouts to stay in school for at least one more year, which immediately reduces their opportunity to commit community crime. This implies that a higher MDA reduces contemporaneous juvenile crime in the community. In contrast, if these unmotivated potential dropouts stay in school longer, they may influence other students in negative ways, such as peer pressure to drink alcohol, use illegal drugs, and smoke (Gaviria and Raphael,

2001). This can create additional problems for the school administration (Ennett and Bauman, 1994; Hinduja and Patchin, 2013). Consequently, the academic environment in school might deteriorate. A higher MDA, then, not only reduces contemporaneous crime in the community, but also increases crime in school. Previous studies do not show the immediate effects of schooling on contemporaneous crime.

In Section 2.2.1, I summarize the literature on economic models of crime to explain the factors that influence individual's behavior of committing crime. These factors have included the rational behavior of an individual (Becker, 1968), punishment on crime (Stigler, 1970), individual's attributes (Block and Heineke, 1975), returns on crime (Ehrlich, 1970; Allingham and Sandmo, 1972; Willits et al., 2015), and cost and benefits of punishment on crime Ehrlich (1973). Additionally, Lochner (2004) and Buonanno and Leonida (2009) describe the role schooling on individual's criminal behavior in the community in subsequent periods through human capital accumulation. However, they do not show that schooling at current period may also influence individual's criminal behavior in the same period. For example, an increased MDA from 16 to 17 requires potential dropouts to stay in school at least one more year. This additional schooling requirement immediately reduces the time and opportunity for potential dropouts to commit community crime. Conversely, an increased MDA may allow potential dropouts more opportunity to commit crime in school. Therefore, an MDA greater than 16 may not only affect individuals' schooling decisions, but also affects their immediate time allocations on crime both in the community and in school. In my study, I will develop an economic model of crime that shows a hypothetical relationship between the MDA and contemporaneous juvenile crime in the community, and I then describe how an MDA greater than 16 may influence crime in school.

### 2.2.2 MDA and Crime: Empirical Perspectives

Education might have long- and short-term impact on crime (Anderson, 2014). Education improves human capital, which will offer individuals' promising career opportunities. In the long run, this may prevent juveniles from committing crime in adulthood (Lochner, 2004; Meghir and Palme, 2005; Oreopoulos, 2006). In the short term, staying in school may offer less opportunity to commit community crime, which implies a reduction in community crime (Anderson, 2014; Jacob and Lefgren, 2009; Lazear, 2001). However, staying longer in school and having more peer associations may allow unmotivated students to commit delinquent behavior in school (Calvó-Armengol and Zenou, 2004; Gaviria and Raphael, 2001; Anderson et al., 2013). Therefore, school crime increases with an increased MDA. In the following section, I will review the relevant empirical literature on crime and the implementation of MDAs.

#### 2.2.2.1 MDA and Crime in the Community

Education may have long-term effects on criminal behavior in the sense that it can influence the criminal activities of children whose parents are directly affected by educational policy reforms. In the 1950s and the mid-1970s, many European countries had a major educational reforms, such as an increase in compulsory schooling years and an introduction of nationally unified curricula. For example, Sweden initiated a major reform that extended the compulsory years of schooling from seven to nine years in the late 1940s. Meghir and Palme (2005) first show the effects on the final academic achievements and earnings for those assigned to the reform compared to those who were not. They show that the new educational

reform significantly increases earnings, specifically for those whose fathers were not highly educated. Expanding on this study, Meghir et al. (2012) use micro-data for everyone born in Sweden between 1945 and 1955 and for their children with regard to individual register data on all convictions between 1981 and 2008. They then examine how parental criminal behavior affect the behavior of their children. Meghir et al. (2012) find that the increase in compulsory schooling years not only reduces crime for men, but also effectively reduced their children's criminal activities. They argue that these intergenerational effects come through improved parenting and investments in children.

The short-term relationship between crime and education can be explained in terms of an incapacitation effect, which is giving an individual one activity so that they are incapable of performing other activities. For example, staying in school implies that juveniles are occupied, which allows them less opportunity to commit community crime. Witte and Tauchen (1994) argue that more time spent in school decreases criminal activities in general.

One policy prescription to reduce juvenile crime is to lengthen the school hours or engage young students while they are not in school. Jacob and Lefgren (2003) were the first to examine the effects of schooling on juvenile crime in the community. They explain the effects of single-day changes in school-wide attendance on juvenile crime and arrest rates in 29 US cities for the period from 1995 to 1999. They consider teacher in-service days as a source of variation in student attendance because the teaching professionals are required to attend work while students are not. They argue that an additional day of school reduces serious juvenile property crime by about 14%, but increases juvenile violent crime by 28% on the same day. Various youth programs show that juvenile violence peaks on non-school days and in the evening during after-school hours. These results are consistent with an incapacitation effect of school which deters juveniles from committing property crime in society. However, there is a possibility to increase the violence and other minor delinquent

activities as the students can interact for a longer period in school and students are more likely to commit crimes against each other than older individuals.

Luallen (2006) follows a similar approach to that of Jacob and Lefgren (2003) in which she examines the impact of teacher strikes lasting about five days that happened in Washington state between 1980 and 2001. She uses the teacher strikes days instead of in-service days. Luallen (2006) argues that because in-service school days are planned at the beginning of regular school year, parents or legal guardians have adequate time to make alternative arrangements for their children during these off-days. In contrast, parents may not be well informed about school closures due to potential teacher strikes as they are often reported in local media only a couple of days before the event. She finds that an additional day of schooling decreases arrest rates for property crime by about 29%. However, it increases arrest rates for violent crime by about 32% in urban areas. This result for property crime is consistent with Jacob and Lefgren (2003). Luallen (2006) also argue that the incapacitation effects in school can explain property crime in the community.

Economists usually examine the direct effect of education on monetary benefits, such as higher education offers a higher payment in the labor market. However, education may also have non-monetary benefits. For example, schooling raises individuals' productivity, which may affect the productivity of the people around them. A higher productivity in the labor market may increase the opportunity cost of committing crime. This might prevent individuals from committing crime, which implies a lower crime in the community. However, these types of social benefits might be different across race and gender. For example, men usually commit more crimes than women. Lochner and Moretti (2004) examine the relationship between education and crime by using three different data sets: individual-level data from the Census on incarceration, state-level data on arrests from the Uniform Crime Reports, and self-report data on crime and incarceration from the National Longitudinal

Survey of Youth. Based on these three different sources, their study finds that schooling significantly reduces long-term criminal activities in society. For example, the incarceration rate of black high school dropouts is 3% higher than that of black high school graduates.

Lochner and Moretti (2004) also estimate the short-term effects of additional schooling on various types of crime. For example, on average, one additional year of schooling reduces burglary and larceny rate by about 6%, motor vehicle theft by 20%, arson by 13%, and the murder and assault by 30%. They find that the effects of schooling beyond one addition year are negligible for robbery but are significant for rape. They use their estimates to calculate the social savings from crime reduction associated with high school graduation among men. They argue that a 1% increase in the high school completion rate of all men ages 20 to 60 would save the US as much as $1.4 billion per year. These positive externalities can raise from 14% to 26% of the private returns, such as earnings and savings rate; improve the private monetary benefits, including heath; increase awareness about fertility with a desired family size and change in family size preferences; and enhance enjoyment opportunities through consumer choice efficiency.

School does not only affect individuals' earnings, but also their other activities. Schooling helps individuals make better decisions. Schooling might also improve individuals' resilience to focus on a specific long-term goal, which discourages them from committing crime. Using the same specification of Lochner and Moretti (2004), Oreopoulos (2009) find that incarceration rates among black men are reduced by about 20% with an additional year of schooling. Similarly, Oreopoulos (2007a) argues that more schooling would offer individuals better health, employment, and happiness. Therefore, they are less likely to commit crime. He also argues that the stress from taking tests or from condescending attitudes of teachers or friends and peers may force a student to leave school early.

Social capital is associated with a good reputation, and societal punishment for deviant behavior is associated with a depreciation in the stock of human capital. Using the 1958 Philadelphia birth cohort study, Williams and Sickles (2002) empirically show how social norms affect individual's criminal behavior. They find that human capital, measured by years of schooling, has significant and negative relationship on criminal behavior in adulthood. They also find that peer influence on youth has a larger impact on individuals' adult criminal behavior. They argue that family structure is the key determinant to explain individuals' decisions to commit crime. They assume that social capital is positively associated with a good-reputed peer group and that societal punishment is negatively associated with individuals' capital stock. They find that peer influence from youth affects criminal activity in adulthood. For example, individuals affiliated with gang members, such as through marriage purpose, are more likely engage in criminal activities than those affiliated with university professors.

An individual's combined decision on school and work affect their future criminal behaviors. Merlo and Wolpin (2015) show how youths allocate their time to studying and working as an alternative to committing crime with a possibility of being punished. Using the NLSY97 data on black male youths, they estimated a five-variate discrete-outcome vector autoregression (VAR) in which the variables are school attendance, employment, criminal activity, arrest, and incarceration. They assess the data on black males from age 14 to the time they either graduate from high school or reach age 22 without a high school diploma. Using the estimates from the VAR model, they simulate the effects of schooling at 16-year-old adolescents' on subsequent criminal activities. They find that youths at 16 who are not enrolled in school will have a higher probability of committing crime by 42.2% at the ages of 19 to 22 and will more likely be arrested by 22.5% and to be incarcerated by 19.5%.

Different education statuses may have different effects on individuals' behaviors. Buonanno and Leonida (2009) investigate the effect of education on crime in Italy. In their study, they use four schooling measures, such as percentage with a high school diploma, percentage with a university degree, average years of schooling and percentage enrolled in high school and university. They find that a 10% increase in high school graduation rates reduces property crime rates. However, they argue this result does not imply that there is a reduction in total crime.

Increasing the MDA increases individuals' level of education. Machin et al. (2011) argue that individuals are affected by an increased MDA, which generates a sharp increase in education compared to those who do not. Following Lochner and Moretti (2004), Machin et al. (2011) examine the effect of one additional year of compulsory schooling in England and Wales in 1973. They used a regression-discontinuity model to look at birth cohorts just before and after the MDA changed. They find that an additional year of schooling reduces the incarceration rate for property crime by about 30%, which is more than double the reduction in the United States found by Lochner and Moretti (2004). They also calculate the net social benefits after increasing the MDAs were implemented as within the range of £23-30 million, which is less than the amount Lochner and Moretti (2004) found. These studies argue that subsidized education policies can improve human capital and that an increased human capital can reduce crime in the long run.

Higher education through lengthening the school day may also have an impact on criminal activities in the community. Berthelon and Kruger (2011) examine the effect of a school reform policy in Chile, which lengthened school hours from half to full days, on contemporaneous juvenile crime in the community. They find that extending the school days decreases property crime by 24%, violent crime by 11%, and total crime by 19%. They argue

that imposing longer school days similar to imposing more school days has an incapacitation effects on crime in the community.

Recent studies-such as Bedard and Dhuey (2006), Puhani and Weber (2008), Black et al. (2011), and Clay et al. (2012)- argue that older students are more likely to be mature than are their younger cohorts, which makes the older students better prepared to learn new material and build relationships with adults and other students. This result can encourage policy makers to increase the average school starting age (SSA) at the state level (Deming and Dynarski, 2008). A decreased SSA would allow students to stay longer in school even with an unchanged MDA. Studies like Landersø et al. (2017) and Cook and Kang (2016) argue that school starting age (SSA) may affect individual criminal behavior. Landersø et al. (2017) find that lower SSA decreases the tendency of an individual under 18 to commit crime in the community. Landersø et al. (2017) refer to this effect as an incapacitation effect as lower SSA requires dropouts to be in school longer than they currently are. In addition, Cook and Kang (2016) examine the effects of socioeconomic statuses, such as a single mother with poor neighborhood or without a high school diploma, on crime in the community. They find that individuals with lower socioeconomic status have lower academic achievement and a higher tendency to commit crime.

As a requirement of school accountability, school districts implement a standard test-based promotion system that may also incapacitate students' ability from committing crime to commit crime in the community. This policy requires students to demonstrate a minimum level of proficiency in various subjects through standardized tests. Students who fail are required to retake the tests during summer. Jacob and Lefgren (2009) argue that such types of policy may help students to improve their grades and to increase overall graduation rates in school. Eren et al. (2017) find that such types of summer school require potential students who fail to stay in school, which allows them less opportunity to commit crime

in the community. Using administrative data on crime and education in Louisiana, Eren et al. (2017) find that test-based promotion policy decreases the tendency of committing community crime.

Increasing the MDA requires potential dropouts to stay in school for at least one more year, which allows them less opportunity to commit community crime. Anderson (2014) examines how a higher MDA affects juvenile crime in the community. He considers the 16-18 age group of students as potential dropouts and examines the effects of a higher MDA on these potential dropouts compared to the 13-15 age group. He finds that an MDA 18 decreases a significant amount of property, violent, and drug crime rate. In the case of counties with a higher proportion of African American individuals, he finds that a higher MDA has a greater impact. Following Jacob and Lefgren (2003), he argues that the increase in MDA may be effective to reduce the crime in general. This indicates that an MDA has an incapacitation effect in school as it keeps the students in school and decreases the opportunity to commit a crime in the community. However, previous studies do not compare the effect of an MDA greater than 16 on crime between individuals ages 16 to 18 in states with an MDA greater than 16 and individuals ages 16 to 18 in states with an MDA 16. In this study, I will examine the effect of an MDA greater than 16 on juvenile crime for the same age group.

#### 2.2.2.2 MDA and Crime in School

A higher MDA requires potential dropouts to stay longer in school, which offers them more opportunity to engage in school crime. A higher MDA improves enrollment in the upper secondary school, where most of the students can be at the late-teenage or early adulthood stage. Grogger (1998) argues that individuals' criminal behavior typically increases until

their late teens and then decreases. Interaction among students can improve their academic performance or increase delinquent behavior in school. For example, peer interaction may cause a risk of young delinquents influencing and abusing other students (Anderson et al., 2013).

An economic model of crime emphasizes the economic incentives of criminal activities, which can be empirically tested through observable datasets; however, other behavioral characteristics, such as psychological attitudes and peer-group influence, may also affect criminal behavior. In this case, increasing the MDA requires potential dropouts to stay longer in school. This implies that younger students must share their learning environment with older students. Thus, students' behavioral effects may manifest through two possible ways: peer interaction and emotional motivation. These effects depend on social norms, peer influence, neighborhood effect, conformity, contagion, social interaction, and their interdependence. Students might not like to stay in school longer, which might cause frustration and anger. These emotions may manifest in negative ways, such as attacking other students, causing this types of school crime to increase.

An individual's behavior in school is highly influenced by the school environment and their peer-group interactions. More specifically, an individual's behavior in school depends on their reference group (Manski, 1993). The potential mechanism for committing crime comes through disruptions in the classroom (Lazear, 2001), network formation (Bayer et al., 2009), change in the norm (Silverman, 2004), and learning about the crime opportunity (Calvó-Armengol and Zenou, 2004; Sah, 1991).

An individual who commits crime typically does not require formal schooling to acquire their skills and knowledge. Criminals act together based on their connections and ability to network with others. As a result, social network and peer interaction likely play an extensive

role in proliferating criminal activities. For example, Bayer et al. (2009) analyze the likelihood that incarceration would influence juveniles to commit more crimes as adults. Using data on a juvenile correction center in Florida, they find a strong peer effect on burglary, violence, larceny, and drug-related crime. This result implies that peer influences reinforce individual's subsequent likelihood to engage in crime with improved skill and knowledge.

An individual's socioeconomic success is influenced by family and community characteristics, such as church attendance, drug use, and criminal history. Using the dataset from a National Bureau of Economic Research (NBER) survey of youth living in a low-income Boston neighborhood area, Case and Katz (1991) examine the effect of family background and neighborhood peers on disadvantaged youths' criminal behaviors. They find that family background strongly influences the socioeconomic outcomes of the disadvantaged youth. For example, youths with family members associated with drug use are more likely to use drugs and youths with educated family members are likely to be more educated. They also find that youths from a high-crime neighborhood are more likely to engage in criminal activities. This result implies that family and neighborhood have a significant influence on criminal behavior.

Social interaction might also affect neighborhood crime. For example, crimes committed by younger individuals typically involve more social components (Glaeser et al., 1996a). Fergusson et al. (2002) refer to this interaction as a socialization effect, which might encourage young students affiliated with delinquent peers to engage in criminal activities in school. This effect might come through imitation, social learning, peer group influence, social facilitation. Billings et al. (2013), Deming (2011), and Bayer et al. (2009) argue that peer pressure in criminal activities exists within neighborhoods, schools, and juvenile corrections facilities. However, the mechanism of such effects is multidimensional.

Family problems, such as domestic violence, might impact students who do not have family problems. Carrell and Hoekstra (2010) examine how children from troubled families affect overall misbehavior in the classroom. They consider children who are from troubled families as exogenous to their peers who do not experience violence at home. They find that children linked with home violence significantly increase misbehavior in other students. They also argue that students with classmates from violent homes significantly experience a lower academic achievement. This result implies that the social cost of troubled families extends the problem beyond the private cost born by the children at home.

School can offer either a positive or a negative environment that might affect individual behavior. For example, there is a high likelihood of hiring the least-qualified teachers in urban schools in low-income neighborhoods (Lankford et al., 2002). Thus, the low-income, low-achieving, and non-white students in these urban areas find themselves in classes with many of the least-skilled teachers. As a result, Lankford et al. (2002) argue that low-income neighborhoods may have a higher rate of violence and a higher dropout rate. Conversely, a quality school may be an effective tool to prevent crime. Deming (2011) examines the long-term effects of attending a first-choice middle school on juveniles' criminal activities. Using public school choice lotteries to admit students in Charlotte-Mecklenburg School (CMS), North Carolina, he argues that winning these lotteries secures admission in a better school and reduces crime during adulthood. He claims that the high school intervention can prevent crime in the community.

Levitt and Lochner (2001) find that criminal activities rise sharply during adolescence, peak in the late-teenage years, and then fall steadily. They argue that an 18-year-old in the United States is five times more likely to be arrested than a 35-year-old for the case of property crime and two times more likely for violent crime. This result implies that the juvenile crime rate is larger than the overall crime rate in the United States.

There is growing literature in economics using the psychological approaches to emotion. Economists pay attention to the anticipated emotion in maximizing wellbeing, such as disappointment and regret. Loomes and Sugden (1982) argue that these emotions are not experienced at the time of decision making, but are experienced in the future. In contrast, psychologists pay attention to immediate emotions that are experienced at the decision-making time. Loewenstein (2000) first argues that immediate emotions, such as anger and fear, play an important role when individuals make their economic decisions. A higher MDA requires potential dropouts to stay in school longer. Some of them will not like to do so, which might cause frustration and anger. The anger and frustrations can manifest in many ways, such as sexual abuse, bullying, larceny, verbal abuse, violence, and lack of motivation. Eventually, these negative externalities of an MDA greater than 16 can lead to a deterioration of the academic environment, which further cause a lower attendance at and a decreased attachment to school (Bowen and Bowen, 1999). Anderson et al. (2013) find that this policy has a negative and a greater impact on female students' attendance than on male students.

Manski (1999) argues that spurious effects may rise when individuals staying in the same reference group behave in a similar fashion because they have a common set of unobservable characteristics. Gaviria and Raphael (2001) argue that school-based peer influence is important to determine youth behavior. Using a sample of tenth-grade students in the United States, they examine peer-group influence in the following five activities: drug use, alcohol consumption, cigarette use, and dropping out of school as well as church attendance. They find that there is a strong evidence of peer-group effects in high school in the United States. Using survey data, Kremer and Levy (2008) examine peer effects in the context of housing on a large state university arguing that males with roommates who drank alcohol prior to college obtained on average a lower grade point average than those with non-drinking

roommates. However, they find no effect of roommates' academic or socioeconomic background on grade point averages.

A higher MDA requires unmotivated students, who otherwise would drop out without graduating, to remain in school. Oreopoulos (2007a) argues that unmotivated students are more likely to ignore the future consequences of dropping out or are more likely to engage in criminal activities. If unmotivated individuals stay in school longer, they may exhibit disruptive behavior and influence other students in negative ways, such as through peer pressure. This can create additional problems for the school administration (Ennett and Bauman, 1994; Hinduja and Patchin, 2013). In addition, schooling has an incapacitation effects that reduce community crime (Anderson, 2014; Jacob and Lefgren, 2003; Luallen, 2006; Machin et al., 2011). Therefore, a higher MDA may increase crime in school. Gilpin and Pennig (2012) argue that an MDA 18 increases criminal activities in school. However, they do not consider the neighborhood crime that can influence criminal activities in school. Willits et al. (2013) and Willits et al. (2015) argue that crime in the community can spill over into neighborhood schools.

Students might be exposed to other students' negative actions. This victimization might have an immediate and long-term consequences on individuals' welfare. Eriksen et al. (2014) examine the actual and potential effects of bullying on educational performance and find that bullied students' grades suffer and that the effects of victimization are likely to increase in severity. Similarly, Anderson et al. (2013) examine the possible negative consequences of an MDA greater than 16, such as increased bullying, threats, and gang activity or simply a decrease in the perception of school safety. Using the national Youth Risk Behavior Surveys (YBRS), they argue that property crime in school increases as the MDA increases. They also find that there is a stronger evidence that younger and female student fear increased violence and have more concerns about school safety than do male students.

However, they do not examine the effect of an MDA greater than 16 on overall school crime by incorporating school-crime-prevention resources, which this study addresses.

In Section 2.2, I briefly summarized the relevant literature on community crime and schooling. Previous studies examine the effects of education on community crime in subsequent periods. However, schooling may have an immediate impact on both in the community crime and in school. For example, an increased MDA from 16 to 17 requires potential dropouts to stay in school at least one more year. This additional schooling requirement immediately reduces the opportunity for potential dropouts to commit community crime. Conversely, an increased MDA may allow potential dropouts more opportunity to commit crime in school. In the following, I will develop an economic model of crime that shows a hypothetical relationship between the MDA and contemporaneous juvenile crime both in the community and in school. I then empirically estimate the magnitudes of the enrollment increase due to an increased MDA. Finally, I provide a comprehensive empirical analysis of the effect of increasing the MDA on juvenile crime both in the community and in school. The findings of my study can help policymakers set priorities and take necessary measures for the most affected states and schools.

# CHAPTER 3

# THEORETICAL MODEL

An MDA greater than 16 requires potential dropouts to stay in school for at least one more year, which immediately reduces their available time and opportunities to commit crime in the community. This means that a higher MDA may immediately reduce juvenile crime in the community. In contrast, if these potential dropouts stay in school longer, they have the potential to influence other students in negative ways, such as through peer pressure to drink alcohol, use illegal drugs, and smoke (Gaviria and Raphael, 2001). This may create additional problems for the school administration (Ennett and Bauman, 1994; Hinduja and Patchin, 2013) and deteriorate the academic environment. Therefore, an MDA greater than 16 may not only reduce contemporaneous crime in the community, but also, it may increase crime in school.

In this chapter, I develop an economic model of crime that shows how an MDA greater than 16 affects contemporaneous juvenile crime in the community. I then describe how an MDA greater than 16 influences crime in school. Previous studies focus on the theoretical relationship between schooling and the crime an individual commits in the community; in these cases, the individual's schooling is completed. In my study, I focus on the relationship between schooling through an increased MDA and the crime an individual commits in both the community and school during adolescence. An adolescent's choices are more complicated because he or she must consider future earnings gained from more schooling versus the current utility from engaging in criminal activity. To illustrate this, following Buonanno and

Leonida (2009), I first explain the circumstances, such as human capital accumulation and time endowment, in states with an MDA of 16, and I describe how individuals aged 16 in these states allocate their optimal time for work, school, and community crime. In this case, schooling is not mandatory.

Second, I describe how individuals aged 16 in states with an MDA greater than 16 allocate their optimal time for community crime, school, and work. An MDA greater than 16 requires individuals aged 16 to stay in school for at least one more year, indicating that schooling is mandatory. This reduces an individual's time availability to commit crime in the community and to work in the labor market. Therefore, individuals with an MDA greater than 16 choose their optimal time allocation for work and crime in the community after allowing time for mandatory schooling. In this case, I also consider similar circumstances, such as human capital accumulation and individuals' earnings.

Third, by using the numerical solutions of the income maximization problems, I compare an individual's optimal time allocation for community crime in states with an MDA of 16 to the time allocation for community crime in the schooling stage in states with an MDA greater than 16. I then describe how an MDA greater than 16 reduces crime in the community. This result implies that schooling resulting from an MDA greater than 16 has an incapacitation effect on community crime. One of the potential consequences of increasing the MDA to an age greater than 16 would be the displacement of community crime to the school. An MDA greater than 16 retains students in school who otherwise would have dropped out. This schooling requirement allows potential dropouts more time and opportunity to commit crime in school or some of them might bring their criminal activities into school. Finally, I describe how an MDA greater than 16 might increase crime in school.

## 3.1 Economic Model of Crime for States with an MDA of 16

I first consider an individual who is 16 years old because every state has an MDA of at least 16. Individuals want to maximize their lifetime income by choosing an optimal time allocation for the following three activities: school ($s_t$), work ($l_t$), and community crime ($c_{ct}$) in period $t$. I assume that an individual's leisure time is fixed.[1] In this section, I first illustrate the circumstances that individuals in this study might have considered, and I then describe the individuals' optimal time allocations to maximize their lifetime income.[2]

The total time endowment in each period is normalized to 1, which implies $c_{ct}+s_t+l_t = 1$. I assume that the time allocated to crime is comprised of planning and carrying out the activity as well as of avoiding incarceration or punishment. The time allocation for school is the time spent in classes or other required school activities as well as traveling to and from school. I assume that the time allocation for schooling in states with an MDA of 16 ($s_t$) should not be greater than the time allocation to schooling in states with an MDA of 17 ($s_{1mda}$), that is $0 < s_1 \leq s_{1mda}$. The time allocation for work includes all time spent obtaining and maintaining a job. The time allocation for other activities is assumed as leisure.

Following Ben-Porath (1967), Lochner (2004), and Buonanno and Leonida (2009), I assume that individuals are endowed with an initial level of human capital ($h_{t-1}$). Therefore,

[1] Following previous studies on crime and education - such as Block and Heineke (1975), Buonanno and Leonida (2009), Ehrlich (1973), and Lochner (2011) - I assume that leisure is fixed. Thus, leisure does not affect an individual's time allocation in this simple model as this study examines the effect of an MDA on contemporaneous crime in the community.

[2] While some individuals who are ages 16 to 18 may not behave rationally, my model follows that of Becker (1968) in assuming economic rationality.

considering the human capital resulting from only legal activities, human capital accumulation in period $t$ can be defined as:

$$h_t = h_{t-1} + f(s_{t-1}), \tag{3.1}$$

where $s_{t-1}$ is the time allocation for schooling in period $t-1$, and $h_{t-1}$ is the human capital level in period $t-1$. I assume that $f(.)$ increases with respect to $s$ at a decreasing rate; that is, $f(.)$ is concave with respect to $s$. This implies that $f_s > 0$, $f_{ss} < 0$. A higher level of human capital will offer a better career opportunity in the labor market.

When individuals work $l_t$ unit of time in the labor market, they earn $w_t h_t$ per unit of $l_t$, where $w_t$ is the rental rate on human capital ($h_t$) in period $t$. Therefore, individuals earn $w_t h_t l_t$ from legitimate work in period $t$. I assume that schooling does not have an immediate payoff in period $t$, but that schooling, $s_t$ in period $t$, yields a payoff in the $t+1$ period because human capital has increased. For simplicity, I also assume that there is no human capital depreciation. Additionally, the wage rate in period $t+1$ is assumed at least greater than the wage rate in period $t$. This implies that $h_{t+1} > h_t$, and $w_{t+1} \geq w_t$; so earnings in period $t+1$ are $(w_{t+1}h_{t+1}) > (w_t h_t)$.

Individuals may also allocate time to committing crime. If an individual commits a crime, s/he earns a return $R$ with a probability $(1-\pi)$. Witte and Tauchen (1993) argue that criminal jurisdictions and punishments depend on the severity of offenses and the probability that an individual would be arrested. The probability of being arrested or punished depends on an individual's ability to avoid apprehension and on the efficiency of police and logistics infrastructures. For simplicity, I assume that the probability of being arrested ($\pi$) is constant for all individuals.

Returns from community crime, $R_t(c_{ct}, h_t)$ depend on the time allocated to crime and human capital level in period $t$. Individuals with a higher level of human capital are assumed to be more skilled criminals, which implies that $R_h \geq 0$. I assume that returns to community crime increase at a diminishing rate with the time allocated to crime. This implies that $R(c_{ct}, h_t)$ is concave in $c_{ct}$ for criminals ($R_c > 0$ and $R_{cc} < 0$). Punishment or incarceration restricts individuals from allocating their time for the crime to their normal activities.[3] Individuals receive a punishment of $P(c_{ct})$, which increases in $c_{ct}$ at a constant rate. This implies that $P_c > 0$ and $P_{cc} = 0$.

Similar to community crime at period $t$, an individual earns return $R_{t+1}(c_{ct+1}, h_{t+1})$ from community crime in period $t+1$. Following Lochner (2004) and Buonanno and Leonida (2009), I assume that schooling in period $t$ offers returns in period $t+1$ through human capital accumulation. Therefore, $R_{t+1}(c_{ct+1}, h_{t+1})$ depends on schooling in period $t$. For example, returns from community crime in the second period would be $R_2(c_{c2}, h_2)$, where $h_2 = h_1 + f(s_1)$. Also, more schooling implies a higher human capital accumulation and higher returns in the labor market in the subsequent period. More earnings thus discourage individuals from committing a crime in the community in subsequent periods, which implies that $R_{2c2s1} < 0$. In addition, I assume that human capital can only be improved by schooling, training, and legal activities.[4]

Based on these above assumptions, I consider a simple two-period model to explain the income maximization problem of individuals aged 16. In this case, $t = 1, 2$. I define the first period to be the *schooling stage* and the second period to be the *working stage*. Therefore,

[3] In the United States, incarcerated individuals may take the General Educational Development (GED) test. However, because access to the GED is not equally provided in the US prison system, I do not incorporate incarcerated individuals into the model.

[4] Crime at period $t$ may increase an individual's experience in their subsequent periods, regardless of the type of experience. This implies that individuals have increased human capital for criminal activities in subsequent periods, which implies $R_{c2c1} \geq 0$. Comparing the effects of crime and schooling in period $t$ on human capital in period $t+1$ is a question for future research.

an individual's total income is the sum of income in the schooling stage and the discounted income in the working stage. I assume that the discount rate is $\beta$, where $0 < \beta < 1$. I also assume that individuals are not going to high school in the working stage, which implies $s_2 = 0$. The time constraint in the schooling stage is $c_{c1} + s_1 + l_1 = 1$, and the time constraint in the working stage is $c_{c2} + l_2 = 1$. Therefore, an individual's income maximization problem is as follows:

$$\max_{c_{c1},s_1,l_1,c_{c2},l_2} \Big\{ \begin{aligned} & w_1 h_1 l_1 + (1-\pi) R_1(c_{c1}, h_1) - \pi P(c_{c1}) \\ & + \beta[w_2 h_2 l_2 + (1-\pi) R_2(c_{c2}, h_2) - \pi P(c_{c2})] \Big\} \end{aligned} \tag{3.2}$$

subject to the time endowments and human capital constraints

$$\begin{aligned} & c_{c1} + s_1 + l_1 = 1 \\ & c_{c2} + l_2 = 1 \\ & h_2 = h_1 + f(s_1) \\ & c_{c1}, s_1, l_1, c_{c2}, l_2 \geq 0 \\ & 0 < s_1 \leq s_{1mda}. \end{aligned}$$

Substituting time and human capital constraints into Equation 3.2 yields:

$$\max_{s_1,c_{c1},c_{c2}} \quad \Big\{ \begin{aligned} & w_1 h_1 (1 - s_1 - c_{c1}) + (1-\pi) R_1(c_{c1}, h_1) - \pi P(c_{c1}) \\ & + \beta[w_2 (h_1 + f(s_1))(1 - c_{c2}) + (1-\pi) R_2(c_{c2}, (h_1 + f(s_1))) - \pi P(c_{c2})] \Big\} \end{aligned} \tag{3.3}$$

The first order conditions with respect to $c_{c1}, s_1$, and $c_{c2}$ for interior solution are:

$$c_{c1}: \qquad w_1 h_1 = (1-\pi) R_{1c1}(c_{c1}, h_1) - \pi P_{c1}(c_{c1}) \tag{3.4}$$

$$s_1: \qquad w_1 h_1 = \beta[w_2(1-c_{c2}) f_{s1} + (1-\pi) R_{2s1}(c_2, (h_1 + f(s_1))) f_{s1}] \tag{3.5}$$

$$c_{c2}: \qquad \beta w_2 h_2 = (1-\pi)\beta R_{2c2}(c_2, (h_1 + f(s_1))) - \pi\beta P_{c2}(c_{c2}) \tag{3.6}$$

Equations 3.4 to 3.6 represent the conditions that describe the individual's optimal time allocation for committing community crime and schooling during schooling stage, and time allocation for committing community crime in the working stage. Each equation shows that marginal benefits equal to marginal costs of each activity. These optimal values also determine the individual's time allocation for work in the labor market. In this case, the schooling for an individual aged 16 is not mandatory as there was an MDA of 16. In the next section, I will describe the optimal time allocations for an individual aged 16 in states with an MDA of 17; in which case, the schooling is mandatory. I assume that the time allocation for schooling in states with an MDA of 16 is less or equal to the required time allocation for a potential dropouts in states with an MDA of 17.

## 3.2 Economic Model of Crime for States with a Higher MDA

When a state implements an MDA greater than 16, a higher MDA, the impact on students' choices will vary depending on the trade-off between future benefits of education and the benefits of current alternative activities. For many students, raising the MDA will have no impact on their schooling attainment because they would have completed high school anyway. However, for students with lower returns to high school education, dropping out

may be a viable alternative. For these individuals, an MDA greater than 16 forces them to remain in school for at least one more year. This requirement decreases an individual's time availability for committing crime and work in the schooling period, which implies that an individual's time endowment for working and committing crime becomes $c_{c1}+l_1 = 1-s_{1mda}$, where $s_{1mda}$ is the mandatory schooling. It is assumed that $s_{1mda}$ is positive, and thus the total time endowment for work and crime in states with an MDA of 17 is lower than the time endowment for work, schooling, and crime in states with an MDA of 16. Similar to Section 3.1, I assume that individuals do not go to high school in the working stage, which implies $s_2 = 0$. In this case, individuals choose their optimal time allocation for work and community crime both in the schooling and working stages. I also assume that individuals living in states with a higher MDA have similar human capital accumulation, earnings from the labor market, returns to crime, and punishment scenarios. Therefore, an individual's income maximization problem is as follows:

$$\max_{c_{c1},l_1,c_{c2},l_2} \Big\{ \begin{aligned} &[w_1 h_1 l_1 + (1-\pi) R_1(c_{c1}, h_1)] - \pi P(c_{c1}) \\ &+ \beta\{[w_2 h_2 l_2 + (1-\pi) R_2(c_{c2}, h_2)] - \pi P(c_{c2})\} \Big\} \end{aligned} \tag{3.7}$$

subject to the time and human capital constraints

$$\begin{aligned} c_{c1} + l_1 &= 1 - s_{1mda} \\ c_{c2} + l_2 &= 1 \\ h_2 &= h_1 + f(s_{1mda}) \\ c_{c1}, l_1, c_{c2}, l_2 &\geq 0. \end{aligned}$$

Using the similar approach used in Section 3.1, the optimal conditions for work, schooling, and community crime can be obtained. In Section 3.1, the schooling is not required.

In contrast, schooling is required for potential dropouts described in Section 3.2. But, the total time available for work and community crime in states with an MDA of 17, described in Section 3.2, is less or equal to the available time in states with an MDA of 16, described in Section 3.2. In other words, as $0 < s_1 \leq s_{1mda}$, individuals have less time available to commit crime and work in states with an MDA of 17 than in states with an MDA of 16. In the next section, I will describe how an MDA of 17 influences community crime in the schooling stage.

## 3.3 MDA and Crime both in the Community and in School

An MDA greater than 16 requires potential dropouts to stay in school longer, which reduces their time availability to choose between work and crime in the community compared to those potential dropouts in states with an MDA of 16. In other words, individuals in states with a higher MDA have less time available to commit crime in the community. In Section 3.1, I describe the optimal conditions for time allocation to committing crime, working, and schooling in states with an MDA of 16, in which case schooling is not mandatory. In contrast, states with an MDA greater than 16 require potential dropouts to stay in school longer, making schooling mandatory. In Section 3.2, I describe the optimal conditions for time allocation for work and crime by using the individual's remaining time endowment after allowing for mandatory schooling. In both cases, individuals' optimal conditions for time allocation to each activity are in functional forms of multiple arguments, and it would thus be difficult to find analytical solutions for each activity.

In this section, I therefore numerically calibrate the optimal time allocations for each activity in both cases. The optimal conditions in Sections 3.1 and 3.2 allow the possibility

of many combinations of time allocation. In this numerical example, I consider an interior solution in which individuals allocate their time for work, schooling, and community crime during the schooling stage and for work and community crime during the working stage. I then compare the optimal time allocation to community crime in the schooling stage in states with an MDA of 16 to states with an MDA greater than 16. Finally, I describe how an MDA greater than 16 might influence crime in school.

Following the assumptions in Section 3.1, the functional form of an individual's income maximization problem in Equation 3.3 for states with an MDA of 16 would become

$$\max_{c_{c1},s_1,l_1,c_{c2},l_2} \Big\{ \begin{aligned} &[w_1 h_1 l_1 + (1-\pi) c_{c1}^{\alpha_c} h_1 - \pi \psi c_{c1} \\ &+ \beta\{[w_2(h_1 + s_1^{\sigma_s})l_2) + (1-\pi) c_{c2}^{\alpha_c}(h_1 + s_1^{\sigma_s})] - \pi \psi c_{c2}\} \Big\} \end{aligned} \tag{3.8}$$

subject to the time endowments

$$c_{c1} + s_1 + l_1 = 1$$

$$c_{c2} + l_2 = 1$$

$$c_{c1}, s_1, l_1, c_{c2}, l_2 \geq 0$$

$$0 < s_1 \leq s_{1mda}.$$

Using the approach discussed in Section 3.1, I can numerically solve the optimal time allocation for work ($l_1^*$), schooling ($s_1^*$), and community crime ($c_{c1}^*$) in states with an MDA of 16.

A state-mandated higher MDA, such as an MDA of 17, implies that potential dropouts stay in school for at least one more year. Now, they are required to stay in school. For example, they must allocate a given amount of their total time for schooling $s_{1mda}$, where

$0 < s_{1mda} < 1$. In the case of an MDA of 17, a potential dropout's time endowment will be lower than in states with an MDA of 16. For simplicity, I assume that individuals allocate 75% of their total time endowment for required schooling because of an MDA of 17, that is $s_{1mda} = 0.75$. I consider the total time endowment is 12 hours, which is normalized to 1, after allowing 12 hours for leisure and other activities every day. I assume that a student allocates 9 hours required time on traveling to and from school and other academic activities, which implies that $s_{1mda} = 0.75$. Thus, the time endowment, $c_1 + s_{1mda} + l_1 = 1$, for potential dropouts in states with an MDA of 17 becomes

$$c_1 + l_1 = 0.25. \tag{3.9}$$

Similar to the income maximization problem in Equation 3.8, an individual's income maximization problem in Equation 3.7 for states with an MDA of 17 would become

$$\max_{c_{c1}, l_1, c_{c2}, l_2} \Big\{ [w_1 h_1 l_1 + (1-\pi) c_{c1}^{\alpha_c} h_1 - \pi \psi c_{c1} + \beta\{[w_2(h_1 + s_1^{\sigma_s}) l_2) + (1-\pi) c_{c2}^{\alpha_c} (h_1 + s_1^{\sigma_s})] - \pi \psi c_{c2}\} \Big\} \tag{3.10}$$

subject to the time constraints

$$c_{c1} + l_1 = 0.25$$

$$c_{c2} + l_2 = 1$$

$$c_{c1}, l_1, c_{c2}, l_2 \geq 0.$$

Using a hypothetical numerical example, I solve income maximization problems in Equations 3.8 and 3.10 following the optimal conditions in Sections 3.1 and 3.2, respectively. I then report the optimal time allocation for each activity, and I compare an individual's

time allocation between states with an MDA of 16 and states with an MDA greater than 16. In this case, I consider states with an MDA of 17.

In this example, I consider a potential dropout, an individual aged 16 without a high school diploma, who has two time periods: schooling and working. The parameter values used in the simulated economic model of crime are given in Table 3.1. Using the federal funds rate of 2.25% from the Federal Reserve Bank of St. Louis (2018), I consider that the discount factor $\beta$ is 0.0978. Following Munyo (2015), I assume a 10% probability of

**Table 3.1.** Parameter Values for Economic Model of Crime

| Parameter | Value | Sources |
|---|---|---|
| $\pi$ | 0.10000 | Munyo (2015) |
| $w_1$ | 5.08000 | Bureau of Labor Statistics |
| $h1$ | 10.0000 | indexed between 1 and 100 |
| $\psi$ | 0.50000 | Munyo (2015) |
| $\alpha_c$ | 0.14000 | calibrated |
| $\beta$ | 0.97800 | Federal Reserve Bank of St. Louis (2018) |
| $w_2$ | 5.19430 | Bureau of Labor Statistics |
| $\sigma_s$ | 0.08000 | Collin et al. (2018) |

Note: This table shows parameter values used in the numerical example. The federal funds rate of 2.25% is used to calculate the discount factor $\beta$ and to calculate the future values in the working stage.

apprehension. Punishment may depend on the severity of the crime. Additionally, using the high school graduation rate in a state with an MDA of 16 and the required time allocation on schooling in states with an MDA of 17 ($s_{1mda} = 0.75$), I calibrate these values and assume that there are same in both periods. For simplicity, I also assume that more time allocated to crime implies more severe crime in the community, and the punishment increases with the

time allocated to crime at a constant rate, the average length of punishment $\psi$. Following Munyo (2015), I also consider the monetary values of punishment as the average length of sentencing multiplied by the time allocation to commit crime. Following Munyo (2015), I assume that this constant rate $\psi$ is the average length of punishment for juveniles is 180 days in a year, and it is 0.50 from a normalized scale between 0 to 1; however, there is a wide range of punishment depending on the types of crime. For simplicity, I assume that $\psi$s are fixed over time. I assume that an individual's initial capital level in the schooling stage is indexed from 1 to 100. In this case, I assign individuals with an initial capital index of 10. I consider the average of the states minimum wage from 1982 to 2008 as individual's wage rate is 5.08 per unit of time in the labor market. I use the adjusted the states' minimum wages to year-2000 dollar by using the Consumer Price Index (CPI) from the Bureau of Labor Statistics. According to the Bureau of Labor Statistics (2019), 415,000 individuals aged 16 or older without a high school diploma earn the minimum wage or below. For simplicity, I also consider that the wage rate in the working stage is at least higher than the future value of the wage rate in the schooling stage because individuals have received more education.

To show the effect of an MDA greater than 16 on community crime in the schooling stage, I report my results in Table 3.2. Column (1) shows the optimal time allocation for potential dropouts in states with an MDA of 16, and Column (2) shows the same for potential dropouts in states with an MDA of 17. Table 3.2 shows that time allocation for committing community crime is 0.06058717, which implies that potential dropouts in states with an MDA of 16 allocate 6.06% of their total time endowment to community crime in the schooling stage. Similarly, Column (2) shows that potential dropouts in states with an MDA of 17 allocate 5.17% of their total time endowment to committing community crime. This implies that potential dropouts in states with an MDA of 17 allocate less time for

**Table 3.2.** Time Allocation for Work, Schooling, and Crime in the Community

| Time Allocation | (1) States with an MDA of 16 | (2) States with an MDA greater than 16 |
|---|---|---|
| schooling stage | | |
| community crime | 0.06058717 | 0.05168525 |
| schooling | 0.57163660 | 0.75000000 |
| work | 0.36777623 | 0.19831475 |
| working stage | | |
| community crime | 0.27816360 | 0.17365640 |
| work | 0.72183640 | 0.82634360 |

Note: This table shows the time allocation for work, school, and crime in the community.

committing community crime in schooling stage than potential dropouts in states with an MDA of 16.

Table 3.2 also shows that the time allocation to schooling in states with an MDA greater than 16 is higher than in states with an MDA of 16. These results imply that individuals who are required to stay in school commit fewer crimes in the community, indicating that schooling has an incapacitation effect on community crime. As an MDA greater than 16 requires potential dropouts to stay in school longer, one of the potential consequences of this required schooling would be a displacement of community crime to the school. Therefore, my economic model of crime suggests that an MDA greater than 16 decreases crime in the community, and has the potential to increase crime in school. Additionally, Grogger (1998) argues that individuals' criminal behaviors typically increase until their late teens and then decrease. An MDA greater than 16 mostly influences this group of individuals. An MDA greater than 16 requires potential dropouts to stay in school longer, creating an opportunity to interact with each other. These interactions can improve students' academic performance

or increase delinquent behavior in school. For example, peer interaction may cause a risk of young delinquents influencing or abusing other students (Anderson et al., 2013). Therefore, an MDA greater than 16 may increase crime in school.

In this chapter, I developed an economic model of crime that shows a potential dropout's optimal conditions for work, schooling, and community crime in states with an MDA of 16 and states with an MDA of 17. Using a hypothetical numerical example, I show how an MDA greater than 16 reduces crime in the community. I then describe how an MDA greater than 16 may displace community crime to the school. Because a higher MDA allows potential dropouts more time availability and opportunity to commit crime in school, it may increase crime in school. In this chapter, I have developed two hypotheses: first, an increased MDA reduces crime in the community; second, a higher MDA may increase crime in school. These hypotheses will be empirically tested in the following chapter, where I describe the data used for my empirical research.

# CHAPTER 4

# DATA AND EMPIRICAL MODEL

In this chapter, I first describe the potential data sources and give a brief explanation of the variables used in the study. Second, I will describe the empirical model and how I use it to estimate the impact of an MDA greater than 16 on enrollment in high school. Finally, I will describe the empirical model and how I use it to examine whether an MDA greater than 16 affects juvenile crime in the community and in school.

## 4.1 Data

### 4.1.1 Data for a Higher MDA and Enrollment

To identify high school enrollment status, I use the American Community Survey (ACS) data for the period of 2000-2015 to examine the effect of a higher MDA on high school enrollment. The ACS is an ongoing survey that provides anonymous micro-level information about US citizens. The ACS is a part of the US Census Bureau's Decennial Census Program, which collects data from all the counties, school districts, and other small geographic districts. I use the ACS data because it includes nation-wide data relevant to high school enrollment along with other demographic and economic characteristics. The ACS survey

provides individual-level data on the ages of individuals enrolled in high school. The dependent variable of this section is a binary indicator whether individuals ages 16 to 18 enroll in high school. The explanatory variables are individuals' respective states' MDA and other economic and demographic variables.

I collect the state-wide MDA data from the National Center for Education Statistics' (NCES) Digest of Education Statistics, and various reports and policy briefs published in the Department of Education. Table 2.1 shows that there is a tendency across the states, not considering the District of Columbia, to increase their MDAs. Table 4.1 shows the group

**Table 4.1.** States with different level of MDA from 1982 to 2016

| Level of MDA | States |
|---|---|
| States with an MDA of 16 | Alaska, Arizona, Delaware, Florida, Georgia, Idaho, Iowa, Massachusetts, Montana, New Jersey, New York, North Carolina, North Dakota, Vermont, Wyoming |
| States with an MDA of 17 | Alabama (2009), Colorado (2008), Illinois (2004), Maine, Minnesota (2014), Mississippi (1999), Missouri (2009), Pennsylvania, South Carolina, Tennessee, West Virgina (2011) |
| States with an MDA of 18 | Arkansas (2010), California (1993), Connecticut (2002), Hawaii, Indiana (2005), Kansas (2000), Kentucky (2015), Louisiana (2001), Maryland (2012), Michigan (2010), New Hampshire (2011), Nebraska (2005), Nevada (2007), New Mexico (1983), Ohio, Oklahoma, Oregon, Rhode Island (2011), South Dakota (2011), Texas*, Utah, Virgina (1991), Washington, Wisconsin |

Source: Department of Education.
Note: District of Columbia is not included.
The sample periods for Sections 4.1.1, 4.1.2, and 4.1.3 are 2000-2015, 1982-2008, and 2004-2016, respectively. The year in the parenthesis indicates when a higher MDA is implemented. In other words, it is the Fall semester of the relevant year. For example, 2000 = the 2000-2001 school year. States without parenthesis indicate that they already in the mentioned MDA group, and they do not change in their MDA during the sample period.
* Recently, Tennessee increased its MDA from 17 to 18, and Texas increased its MDA from 18 to 19.

of states with different level of MDAs. I do not incorporate the District of Columbia in my empirical analysis because of low number of samples and different nature of the state. As every state has at least an MDA of 16 years, I consider this as my benchmark.

### 4.1.2 Data for Juvenile Crime in the Community

To examine the causal relationship between an MDA and juvenile crime in the community, I use the Uniform Crime Reports: Arrests by Age, Sex, and Race data for the period of 1982-2008. The Uniform Crime Reporting (UCR) Program defines individuals under 18 as juveniles. The UCR, which reports all crime known to the police, provides the number of arrests based on characteristics, such as age, sex, and county. Because of unavailability of individual-level crime data, I use the county-level dataset, which includes the number of county-level arrests each year. Using the number of annual arrests in each county of a state every year, I calculate a county-level arrest rate per 1,000 individuals aged 16 to 18.

Following the UCR definition of crime, I divide total juvenile crime into three categories: property crime, violent crime, and drug-related crime. I use the arrest rate as a proxy for juvenile criminal behavior. I calculate the arrest rates per 1,000 of the specified age group population as a representation for the juvenile crime rates in a particular county. The data are aggregated by the age of the offender and by the types of crime. Below I briefly describe the crime categories. Full definitions of each category of crime are provided in Appendix B.

*Property crimes* are crime in which an individual takes money or property without force. Examples of property crime includes burglary, larceny, theft, motor vehicle theft, arson, shoplifting, and vandalism.

*Violent Crimes* are the crimes in which an individual uses force or the threat of force to harm another individual physically. Examples of violent crime are simple assault, aggravated assault, robbery, and murder. *Aggravated assault* is an unlawful attack by one person upon another for the purpose of inflicting severe or aggravated injury. This type of assault usually occurs through the use of a weapon or by means likely to result in severe injuries or death. Conversely, simple assaults include assaults and attempted assaults in which no weapon is used that do not result in serious or aggravated injury to the victim.

*Drug-related crimes* are those in which an individual produces, distributes, and/or uses banned/illegal substances. Examples of the drug-related crimes are the unlawful cultivation, manufacture, distribution, sale, purchase, use, possession, transportation, and importation of any illegal drugs or illicit substances.

In Table 4.2, I show the descriptive statistics for the rates of different types of crime. Column (1) shows the average crime rates for all states. Columns (2), (3), and (4) show the average crime rates of states with an MDA of 16, 17, and 18, respectively. The total juvenile crime rate for all states is 39.03 per 1,000 population at the 16-18 age group. The average total crime rates for states with an MDA of 16, 17, and 18 are 37.22, 40.52, and 42.38, respectively, indicating that the average total crime rates for all states is slightly higher than states with an MDA 16. Table 4.2 also shows that the difference in average crime rates between states with an MDA of 16 and states with an MDA of 17 or 18 are statistically significant at 5% level of significance. This statistics imply that states with an MDA of 16 could also have a lower crime rate. For example, according to the UCR, Vermont with an MDA of 16 have lowest juvenile crime rate across the states because most of students go for farming after finishing their school everyday. In contrast, states with an MDA greater than 16, such as Tennessee with a large metropolitan area like Memphis and with an MDA of 17,

could have a higher crime rate. Also, states - Louisiana and Arkansas ranked at the top in crime incidents across the country although they have an MDA of 18.

Table 4.2 shows the descriptive statistics for each crime category listed. It shows that property crime rates for each group of states are higher than violent crime rate and drug-related crime rate. For example, the total property crime rate in states with an MDA 16 is 20.41, where violent and drug-related crime rates are 9.31 and 7.50, respectively. The average property crime rates for states with an MDA 16 is lower than the property crime rates in states with an MDA of 17, but it is higher than those states with an MDA of 18. Table 4.2 also shows that violent crime rate and drug-related crime rate in states with an MDA greater than 16 have a higher crime rates than in states with an MDA 16. For example, according to the UCR, St. Louis, Missouri has the highest violent crime rate across the major cities in 2017; however, Missouri has an MDA of 17.

In Table B.1 in Appendix B, I also report the detail summary statistics for individual constituents of each broad crime category. For example, the average larceny crime rate is slightly higher in states with an MDA of 16 than in states with an MDA of 17 or 18; however, the aggravated assault rates in states with an MDA greater than 16 are higher than in states with an MDA of 16. In case of burglary crime rate, it is higher in states with an MDA of 16 than those in states with an MDA 17 or 18. These descriptive statistics shown in Tables 4.2 and B.1 indicate that states with an MDA greater 16 do not necessarily have a lower crime rate. In this study, I control for county, state, and time fixed to capture the fixed characteristics that may influence crime rate.

I collect other control variables, such as county-level demographic information from the U.S. Census Bureau. I also collect the data on state-level minimum wage from the Bureau of Economic Analysis. I adjust the states' minimum wages to year-2000 dollar by using the

**Table 4.2.** Summary Statistics for Community Crime Rates and Control Variables

| | (1) All States (MDA 16 and above) | (2) States with MDA16 | (3) States with MDA17 | (4) States with MDA18 |
|---|---|---|---|---|
| **Dependent Variables** | | | | |
| total crime rate | 39.03 | $37.22^{ab}$ | $40.52^{a}$ | $42.38^{b}$ |
| | (45.36) | (43.05) | (50.99) | (24.97) |
| property crime rate | 20.46 | $20.41^{ab}$ | $21.32^{a}$ | $19.85^{b}$ |
| | (24.77) | (24.66) | (24.82) | (24.97) |
| violent crime rate | 10.06 | $9.31^{ab}$ | $10.94^{a}$ | $11.25^{b}$ |
| | (14.2) | (13.13) | (17.41) | (13.68) |
| drug-related crime rate | 8.50 | $7.50^{ab}$ | $8.24^{a}$ | $11.26^{b}$ |
| | (16.37) | (14.31) | (17.72) | (19.47) |
| **Control Variables** | | | | |
| minimum wage rate | 5.08 | 5.18 | 5.02 | 5.01 |
| | (0.44) | (0.42) | (0.40) | (0.51) |
| African-American | 0.10 | 0.08 | 0.15 | 0.07 |
| ratio | (1.50) | (1.04) | (1.40) | (1.10) |
| popratio1618 | 0.05 | 0.05 | 0.05 | 0.05 |
| | (0.01) | (0.01) | (0.01) | 0.01 |
| unemployment rate | 5.45 | 6.05 | 5.50 | 4.79 |
| | (2.12) | (2.17) | (2.32) | (1.42) |
| male ratio | 0.49 | 0.49 | 0.49 | 0.49 |
| | (0.18) | (0.17) | (0.18) | (0.20) |
| $N$ | 130043 | 75426 | 24887 | 29730 |

Note: Standard deviations are shown in parentheses.
This Table shows the summary statistics of broad categories of crime rate. The summary statistics for constituents crime rate of each category is given in Table B.1 in Appendix B.
[a] indicates the 5% level of significance for a two-tailed t-test of difference between crime rates in states with MDA 16 and that of 17.
[b] indicates the 5% level of significance for a two-tailed t-test of difference between crime rates in states with MDA 16 and that of 18.
The minimum wage is adjusted in 2000 US dollars.
The popratio1618 is the ratio between population of 16-to-18 year olds and the total number of population in the county.
African-American ratio indicates the ratio between black population to the total number of population in a county.

Consumer Price Index (CPI) from the Bureau of Labor Statistics. Table 4.2 also shows the summary statistics for control variables used in this study. The average minimum wage is 5.08 for all states, and there is not a huge variation in average minimum wage rates across the group of MDA states. On average, the African-Americans ratio is 10% of total population in the county for all states.[1] The population density for individuals aged 16-to-18 is represented by the ratio of population aged 16-to-18 and the total population in the county. The average of population aged 16-to-18 ratio is 0.05, which is 5% of total population in the county for all states. I also collect the unemployment rate from the Federal Reserve Economic Data (FRED). The average unemployment rate is 5.45% for all states, and it is higher in states with an MDA of 16 than in states with an MDA of 17 or 18.

### 4.1.3 Data for School Crime

To examine the effect of an MDA greater than 16 on school crime, I use a restricted-access version of the Department of Education's School Survey on Crime and Safety (SSOCS) from 2004 to 2016. Following the UCR definition, I classify the total school crime recorded in SSOCS into three broad categories: property crime, violent crime, and drug-related crime. Below I briefly describe the crime categories. Full definitions of each category of crime are provided in Appendix B.

According to the SSOCS, *property crime* includes theft/larceny and vandalism. *Theft* is taking someone else's personal property worth $10 or more without consent. Common examples of theft in school are pick-pocketing, purse snatching, stealing motor vehicle parts and

[1]The African-American ratio is assumed to proxy for community or cultural factors.

accessories from school. *Vandalism* at school often involves destruction of school property, bombing, computer hacking, and other activities that cause property damages.

The categories of *violent crime* recorded in SSOCS are threats, robberies, physical assaults with a weapon, and sexual assaults. A *threat* is a communication of potential or verbal attack to individuals or a property. Unlike the threat, a *robbery* is the taking or attempt to take an individual's property by force. A *physical attack* with weapon is the use of an object to strike an individual with the intend of causing physical harm. The SSOCS does not consider physical attack without a weapon as violent crime. A *sexual crime* is the violence committed against someone because of their sex. Examples of sexual crime is sexual harassment and rape.

According to the SSOCS, a *drug-related* crime consists of the use and/or possession of illegal or non-prescribed drugs and the provision of alcohol to minors. *Drug use* consists of the number of recorded incidents of students distributing, possessing, or using prescription drugs inappropriately. These instances occur when individuals use and distribute drugs without a prescription. *Alcohol use* data consists of the number of recorded incidents of students distributing, possessing, or using alcohol.

In the SSOCS, survey respondents, such as principals in each school, report the total number of incidents from each survey every year. The number of incidents refer to the specific crime, such as the number of physical attacks, not the number of victims or offenders. In addition, respondents also report the total number of incidences brought to police administrations. However, respondents do not report all types of incidences to police administrations. For example, in the 2016 SSOCS, on average, respondents only reported 30% of the total crime incidences that occurred during the school year. As this study examines the effect of a higher MDA on school crime, I consider total number of incidences for each crime

category, including the number of incidences reported to the police or other law enforcement agencies. I then calculate the crime rate per 1,000 students in each school. For example, the average total crime rate is 52.80, which implies that the number of total crime incidents per 1,000 students in a school every year is about 53.

In Table 4.3, I show the descriptive statistics of broad types of crime rate in school. Columns (1), (2), (3), and (4) show the average crime rates for all states and for states with an MDA of 16, 17, and 18, respectively. Violent crime happens more frequently than does any other type of crime. For example, an average 35 of violent crimes per 1,000 students are reported each school year, whereas property crime and drug-related crime reported 13 and 5 times, respectively, per 1,000 students each school year.

In Table 4.3, column (1) shows the average crime rates for schools in all states. Columns (2), (3), and (4) show that the descriptive statistics of different types of crime in schools in states with an MDA 16, 17, and 18, respectively. The average total crime rate per 1,000 in states with an MDA 18 is 57.75, and the rates in states with an MDA 16 and 17 are 49.50 and 47.44, respectively. Also, the difference in average crime rates between states with an MDA of 16 and states with an MDA of 17 or 18 are statistically significant at 5% level of significance. The average rate of property crime in states with an MDA of 16 is 11.68, which is greater than in states with an MDA of 17 but is lower than in states with an MDA of 18.

I also report the detailed summary statistics for individual constituents of each broad crime category in Table B.3 in Appendix B. In the 2016 SSOCS, only 30% of the total number of violent crime are reported to law enforcement agencies. In the case of property crime rate for all states, theft and larceny rates are higher than vandalism rates. On average, 7.87 theft and larceny incidences per 1,000 students in all states occur every school year. In the case of violent crime rates for all states, physical attacks with a weapon are the most prevalent

**Table 4.3.** Summary Statistics for School Crime Rates and Control Variables

| Crime Rate | (1) All States (MDA 16 and above) | (2) States with MDA16 | (3) States with MDA17 | (4) States with MDA18 |
|---|---|---|---|---|
| **Dependent Variables** | | | | |
| total crime rate | 52.80 | $49.50^{ab}$ | $47.44^{a}$ | $57.75^{b}$ |
| | (178.51) | (153.7) | (69.9) | (222.97) |
| property crime rate | 13.16 | $11.68^{ab}$ | $10.26^{a}$ | $15.57^{b}$ |
| | (44.75) | (21.94) | (16.46) | (63.52) |
| violent crime rate | 34.69 | $33.75^{ab}$ | $33.05^{a}$ | $36.21^{b}$ |
| | (128.77) | (147.81) | (57.71) | (130.24) |
| drug-related crime rate | 4.95 | $4.08^{ab}$ | $4.13^{a}$ | $5.96^{b}$ |
| | (30.29) | (10.24) | (13.37) | (44.00) |
| **Control Variables** | | | | |
| security camera | 0.65 | 0.62 | 0.68 | 0.65 |
| | (0.48) | (0.48) | (0.41) | (0.49) |
| parental involvement | 0.58 | 0.56 | 0.60 | 0.58 |
| | (0.02) | (0.02) | (0.02) | (0.02) |
| neighborhood crime | 0.06 | $0.05^{b}$ | 0.05 | $0.08^{b}$ |
| | (0.23) | (0.22) | (0.22) | (0.25) |
| student-teacher | 14.97 | $13.74^{ab}$ | $14.59^{a}$ | $16.18^{b}$ |
| ratio | (14.50) | (7.02) | (18.88) | (17.27) |
| recreational facilities | 0.85 | 0.87 | 0.85 | 0.84 |
| | (0.35) | (0.34) | (0.35) | (0.36) |
| African-American student | 14.78 | $14.80^{ab}$ | $19.71^{a}$ | $11.06^{b}$ |
| ratio | ( 22.84) | (22.84) | (28.01) | (18.88) |
| male-student ratio | 49.49 | 49.45 | 49.53 | 49.60 |
| | ( 9.19) | (9.19) | (8.87) | (9.30) |
| city | 0.26 | 0.28 | 0.20 | 0.30 |
| | (0.41) | (0.44) | (0.40) | ((0.45)) |
| dog-sniffing | 0.39 | 0.34 | 0.41 | 0.42 |
| program | (0.48) | (0.48) | (0.49) | (0.49) |
| *N* | 7932 | 3132 | 1335 | 3465 |

Note: Standard deviations are shown in parentheses.
This Table shows the summary statistics of broad categories of crime rate. The summary statistics for constituents crime rate of each broad category is given in Table B.3 in Appendix B.
[a] indicates the 5% level of significance for a two-tailed t-test of difference between crime rates in states with MDA 16 and that of 17.
[b] indicates the 5% level of significance for a two-tailed t-test of difference between crime rates in states with MDA 16 and that of 18.

and threats are the second most prevalent crime in school, and sexual crimes are the least common violent crime. On average, there are 20.44 physical attacks with a weapon and 13.41 threat incidences per 1,000 students; and 1.5 sexual crime rates per 10,000 students, instead of 1,000 students, reported to school administrations every year. In the case of drug-related crime, the drug-use rate, 3.68 per 1,000 students, is higher than the alcohol rate, 1.26 per 1,000 students. However, this does not imply that a higher MDA increases school crime.

Following the literature on school crime, I use the school-crime-prevention resources as control variables: security cameras in use, security guards with stun guns, drug-sniffing dogs, student-to-teacher ratio, and recreational facilities. Following the SSOCS, I measure these school-crime-prevention resources, except the student-teacher ratio, as binary indicators. To address the crime and safety in school, an average of 65% schools use security camera, 39% practice random drug-dog sniffing, 51% have security guards with guns, and 85% organize students' enrichment and recreational programs. Although schools have part-time teachers as well as full-time teachers, in this study, I only use the full-time teachers. The average student-to-teacher ratio is approximately 15:1.

Community and parental involvement to prevent crime as well as the criminal tendencies of a neighborhood also influence crime in school. Following the SSOCS, community crime in the neighborhood in which the school is located is termed as 'school neighborhood crime.' This represents all crime that occur near the school, not the crime occured in school. School neighborhood crime is classified according to three levels of crime: high, moderate, and low. In this case, the SSOCS considers the neighborhood where a school is located. According to the SSOCS, 6% of schools are located in neighborhood with a high-level crime, and 19% are located in neighborhood with a moderate-level crime. In this study, I use a binary indicator whether schools are located in neighborhoods with high-level crime. To capture the parental involvement in preventing school crime, I also use parental involvement

as a binary indicator that represents whether a school has a formal process or policy either to inform parents about their children's behavior or to encourage parents to be more involved in addressing crime and safety issues in school. On average, only 58% of schools have a formal process to engage parents in addressing crime and safety in school.

## 4.2 Empirical Models

### 4.2.1 Effects of a Higher MDA on High School Enrollment

I assume an MDA of 16 as my benchmark. As every state has at least an MDA of 16, I will refer to an MDA greater than 16 as 'higher MDA.' States with a higher MDA require individuals to stay in school for at least one more year than does state with an MDA of 16. To examine the effect of a higher MDA on the probability that an individual enrolls in school, I employ a probit model given as follows:

$$Prob(y_{kst} = 1) = \Phi(\delta_0 + \delta_{17}\, MDA17_{st} + \delta_{18}\, MDA18_{st} + \delta_3 T_s + \beta X_{kst}), \qquad (4.1)$$

where $y_{kts} = 1$ if individual $k$, aged 16-to-18, enrolls in school in $s$ state at time $t$, otherwise 0. $MDA17_{st}$ is a binary variable for an MDA of 17, where $MDA17_{st} = 1$ if state $s$ of individual $k$ has an MDA of 17 at time $t$, otherwise 0. Similarly, $MDA18_{st}$ is a binary variable for an MDA of 18, where $MDA18_{st} = 1$ if state $s$ of individual $k$ has an MDA 18 at time $t$, otherwise 0. The variable $T_s$ represents the time trends to capture the time series variation within each state. $X_{kst}$ is a set of control variables that represent other characteristics for individual $k$ in state $s$ at time $t$. An individual's high school enrollment decision might be

affected by parental education, family income, and demographic characteristics. In this case, I control for family income as a control variable. $\delta_{17}$ and $\delta_{18}$ indicate the effects of an MDA of 17 and an MDA of 18 on the probability that an individual enrolls in high school. Because an MDA of 17 requires students to stay in school for at least one more year, it is expected that the $\delta_{17}$ and $\delta_{18}$ are to be positive and statistically significant. This implies that an MDA greater than 16 increases the probability that an individual enrolls in school. In this case, I consider the individuals aged 16-to-18 as potential dropouts.

High school enrollment might also be different in different group of individuals. Therefore, I show the effect of an MDA greater than 16 on the likelihood to enroll in high school for individuals aged 16-to-18 with different demographic characteristics. To examine this, using an interaction term, I extend the baseline equation 4.1 as follows:

$$\begin{aligned} Prob(y_{kst} = 1) = \Phi(&\delta_0 + \delta_{17}\, MDA17_{st} + \delta_{18}\, MDA18_{st} + \delta_{17}^{int}\, Interact17_{kst} \\ &+ \delta_{18}^{int}\, Interact18_{kst} + \delta_3 T_s + \beta X_{kst}), \end{aligned} \tag{4.2}$$

where $Interact17_{kst}$ is the vector of interactions between an MDA of 17 and the individual's demographic characteristics (male and African-American status). Similarly, $Interact18_{kst}$ is vector of interactions between an MDA of 18 and the individual's demographic characteristics. For any demographic status, the coefficients of interest for an MDA of 17 are $\delta_{17}$ and $\delta_{17}^{int}$, and the coefficients of interest for an MDA of 18 are $\delta_{18}$ and $\delta_{18}^{int}$. If the interaction term is between an MDA of 17 and individual's male-demographic status, the $\delta_{17} + \delta_{17}^{int} \times male$ measures the impact of increasing the MDA from 16 to 17 on high school enrollment for male individuals. As the coefficients in probit models have little economic meaning, I report average partial effects after estimating the Equation 4.1. Robust standard errors are reported in this empirical strategy.

### 4.2.2 Effects of a Higher MDA on Juvenile Crime in the Community

To examine the effect of a higher MDA on juvenile crime in the community, I employ the following empirical strategy:

$$Y_{ist} = \alpha_i + \lambda_s + \lambda_t + \tau_{17}\, MDA17_{st} + \tau_{18}\, MDA18_{st} + \beta X_{ist} + u_{ist}, \tag{4.3}$$

where $Y_{ist}$ is the juvenile crime rate of county $i$ in state $s$ at time $t$, $MDA17_{st} = 1$ for the states with an MDA of 17 at time $t$, otherwise 0; also $MDA18_{st} = 1$ for the states with an MDA of 18 at time $t$, otherwise 0. $\alpha_i$, $\lambda_s$, $\lambda_t$ are the county, state, and time fixed effects respectively. These effects can capture the potential biases from the county, state, and time fixed effects. The crime rate may be affected by the implementation of other state laws, and fixed effects can capture these effects. For example, state fixed effects control for the differences in states' reporting standard, such as efficiency of law enforcement agency and states' tolerance policy to crime, causing some states to have a higher number of crime incidents. The variable $X_{ist}$ is a set of control variables: the minimum wage rate, African-American population ratio, population aged 16-to-18 ratio, and the unemployment rate. As Equation 4.3 incorporates county fixed effects, a consistent estimator obtained from this equation is a Difference in Difference (DID)-type estimator. Section 3.3 suggests that a higher MDA reduces juvenile crime in the community, that is, $\tau_{17}$ and $\tau_{18}$ are expected to be negative and statistically significant for juvenile crime in the community. For example, an estimated $\tau_{17}$ implies how an MDA of 17 decreases crime rate in the community per 1,000 individuals aged 16-to-18.

When examining the effect of a higher MDA on crime in the community, it would be great to examine whether increasing the MDA has a homogeneous effects across different group of populations. For example, high school dropout rates in counties with a higher proportion of African-Americans in the population are greater than those in counties with a higher proportion of Whites (Heckman and LaFontaine, 2010; Lee et al., 2011), indicating that the effect might be different to the racial composition. Studies, such as Anderson (2014), also show that the average male juvenile crime rate is greater than the average female juvenile crime rate. This analysis might help policy makers who are interested in a specific population. Therefore, I examine the effect of a higher MDA on community crime with different community characteristics. To examine this, using interaction terms, I extend the baseline specification in Equation 4.3 as follows:

$$\begin{aligned} Y_{ist} = \quad & \alpha_i + \lambda_s + \lambda_t + \tau_{17}\, MDA17_{st} + \tau_{18}\, MDA18_{st} + \tau_{17}^{int}\, Interact17_{ist} \\ & + \tau_{18}^{int}\, Interact18_{ist} + \beta X_{ist} + u_{ist}, \end{aligned} \tag{4.4}$$

where $Interact17_{ist}$ is the vector of interactions between an MDA of 17 and community characteristics (male ratio and African-American ratio) of county $i$ in state $s$ at time $t$. Similarly, $Interact18_{ist}$ is vector of interactions between an MDA of 18 and community characteristics (male ratio and African-American ratio) of county $i$ in state $s$ at time $t$. The coefficients of interests are $\tau_{17}$ and $\tau_{17}^{int}$ for an MDA of 17 and $\tau_{18}$ and $\tau_{18}^{int}$ for an MDA of 18. For example, if the interaction term is between an MDA of 17 and African-American population ratio (AA), $\tau_{17} + \tau_{17}^{int} \times AA$ measures the impact of increasing the MDA from 16 to 17 on the crime in communities with a larger proportion of African-Americans. Standard errors in these specifications are clustered at the state level. Clustering standard errors at the state level is done to control for potential correlation across counties in a particular state.

### 4.2.3 Effects of a Higher MDA on Juvenile Crime in School

To examine the effect of a higher MDA on juvenile crime in school, I estimate the following regression:

$$Y_{jst} = \alpha_j + \lambda_s + \lambda_t + \tau^s_{17} MDA17_{st} + \tau^s_{18} MDA18_{st} + \beta X_{jst} + u_{jst}, \tag{4.5}$$

where $Y_{jst}$ is crime rate of school $j$ in state $s$ at time $t$, $MDA17_{st} = 1$ for the states $s$ of school $j$ with an MDA of 17 at time $t$, otherwise 0; also $MDA18_{st} = 1$ for the states with an MDA of 18 at time $t$, otherwise 0. The reference category includes states with an MDA of 16. $\alpha_j$, $\lambda_s$, and $\lambda_t$ are the school, state, and time fixed effects, respectively. These fixed effects capture school, state, and time characteristics not represented in the other explanatory variables that affect school crime. The variable $X_{jst}$ represent the set of control variables: the security camera use in school, location of schools: city and suburb, male-student ratio, African-American student ratio, parental involvement program to address the delinquency behavior, school neighborhood crime, recreational programs, student-teacher ratio, and dog-sniffing program for the drug-related crime. As $\alpha_j$ control for school fixed effects, Equation 4.5 yields a consistent DID-type estimator. As Section 3.3 suggests that a higher MDA increases juvenile crime in school, I expect $\tau^s_{17}$ and $\tau^s_{18}$ to be positive and statistically significant. For example, an estimated $\tau^s_{17}$ implies how an MDA of 17 increases school crime rate per 1,000 students.

To examine the effect of a higher MDA on schools with interaction terms, I extend the baseline specification in Equation 4.5 as follows:

$$\begin{aligned} Y_{jst} = \quad & \alpha_j + \lambda_s + \lambda_t + \tau_{17}^{s} MDA17_{st} + \tau_{18}^{s} MDA18_{st} + \tau_{17}^{sint} Interact17_{jst} \\ & + \tau_{18}^{sint} Interact18_{jst} + \beta X_{jst} + u_{jst}, \end{aligned} \tag{4.6}$$

where $Interact17_{jst}$ is the vector of interactions between an MDA of 17 and the school's demographic characteristics. Similarly, $Interact18_{jst}$ is vector of interactions between an MDA of 18 and school-demographic characteristics. The coefficients of interests are $\tau_{17}^{s}$ and $\tau_{17}^{sint}$ for an MDA of 17 and $\tau_{18}^{s}$ and $\tau_{18}^{sint}$ for an MDA of 18. For example, if the interaction term is between an MDA of 17 and urban location, the $\tau_{17}^{s} + \tau_{17}^{sint} \times urban$ measures the impact of increasing the MDA from 16 to 17 on crime in schools located in urban areas compared to those in rural areas. In this case, standard errors in are clustered at the state level. Clustering standard errors at the state level is done to control for potential correlation across schools in a particular state.

In the following chapter, I report the empirical results of how an MDA greater than 16 influences the likelihood to enroll high school, and how a higher MDA affects juvenile crime both in the community and in school.

# CHAPTER 5

# RESULTS OF THE EMPIRICAL ANALYSIS

In this chapter, I will describe my estimates of the magnitude of a higher MDA on high school enrollment. I call an MDA greater than 16 a 'higher MDA.' Second, I will present my estimation of the relationship between a higher MDA and juvenile crime in the community and in school. Finally, I will present my results of the effect of an MDA on juvenile crime for different groups of individual.

## 5.1 Effects of a Higher MDA on High School Enrollment

Since 1980, most of the states have had an MDA at least 16 years. In this study, I assume that the MDA of 16 years is the benchmark. Some states have increased their MDA from 16 to 17 or 18. There are some other states that have not changed their MDA. An MDA greater than 16 implies that potential dropouts are required to stay in school for at least one more year. Following Equation 4.1, I use a probit model to estimate the magnitude of the effect of a higher MDA on high school enrollment. In Table 5.1, I report average partial effects (APE) of higher MDAs on enrollment.

The dependent variable in Equation 4.1 is a binary indicator whether individuals enroll in high school. High school enrollment depends on states' MDA, as well as on the family,

**Table 5.1.** Average Partial Effect of a Higher MDA on Enrollment

| | *Dependent Variable: Enrollment* | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| mda17 | $0.0075^{***}$ | $0.0094^{***}$ | $0.0058^{*}$ |
| | (0.0029) | (0.0008) | (0.0025) |
| mda18 | $0.0257^{***}$ | $0.0124^{***}$ | $0.0130^{***}$ |
| | (0.0030) | (0.0006) | (0.0005 ) |
| mda17× male | | $0.0193^{***}$ | |
| | | (0.0011) | |
| mda18 ×male | | $0.0159^{***}$ | |
| | | (0.0005) | |
| mda17× non-white | | | $0.0247^{*}$ |
| | | | (0.0114) |
| mda18 × non-white | | | $0.0198^{*}$ |
| | | | (0.0088) |
| Control Variables | Yes | Yes | Yes |
| Time Trends | Yes | Yes | Yes |
| Pseudo $R^2$ | 0.045 | 0.050 | 0.053 |
| $N$ | 1813950 | 1813950 | 1813950 |

Note: Robust Standard Errors are shown in parentheses.
*. **, *** indicate $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively.
Male indicates that individuals are male.
Non-white indicates that individuals are not white students.

socio-economic, and demographic characteristics. For example, it may be that a higher MDA will affect male students differently than female students. For this reason, I estimate the specification in Equation 4.2 by interacting the MDAs and individual's demographic characteristics in the baseline model. In this case, I consider male and non-white category. The 'male' category includes the male students, and the 'non-white ' category includes Hispanic, African-American, and Asian students. In Table 5.1, I report the APE of MDA on high school enrollment without interaction with demographic variables in Column (1) and with interactions in Columns through (2) to (3). As other characteristics, such as family

income may influence the decision to enroll in high school, I use family income as a control variable. For example, a family with higher income is more likely to invest in education for the next generation (Bowen and Bok, 2016; Hanushek, 1986; Taubman, 1989).

In Table 5.1, the estimates of higher MDA show the APE of increasing MDA from 16 to 17 or 18 on the probability of individual's enrollment in high school for individuals between the ages of 16 and 18. Column (1) shows that APE of an MDA greater than 16 on enrollment in the baseline model in Equation 4.1, and these are positive and statistically significant. For example, the estimated effect of increasing the MDA from 16 to 17 in Column (1) is 0.0075, which is positive and statistically significant at a 5% significance level. These estimates imply that the requirement that a student stays in school for an additional year increases the probability that those individuals stay in school. More important, this implies that an MDA of 17 increases individual's probability of enrollment by approximately 1%. Similarly, an MDA of 18 increases the probability of overall enrollment by approximately 2.57%.

Columns (2) and (3) show the APE of a higher MDA on enrollment with an interaction. The estimates of category 'male' and 'non-white' students are positive and statistically significant. For example, Column (2) shows that the estimated APE of an MDA of 17 is $0.0094 + (0.0193 \times male)$. Table 4.2 shows that on average 49% of the total population are males. Therefore, the total effect of an MDA of 17 on male-students' enrollment is $0.0094 + (0.0193 \times 0.49) = 0.018857$, whereas the average effect of an MDA of 17 is 0.0075 shown in Column (1). This implies that an MDA of 17 has a larger effect on enrollment for male students compared to the average effect shown in the baseline model. Similarly, an MDA of 18 has a larger effect than the baseline model on enrollment in high school. Column (3) also shows a larger effect of a higher MDA for non-white students than the average effect. As a higher MDA has positive effects on enrollment for male and African-American students,

I also estimate a full interaction model by interacting individual's status of their state MDA, non-white, and male. The results are similar to those reported in Table 5.1. This implies that a higher MDA also increases the probability of high school enrollment.

To summarize these results, an MDA greater than 16 has positive impact on overall enrollment in high school. According to the Department of Education (2018), approximately 80.70% students in Florida, with an MDA of 16, graduated from high school during 2015-16 academic year, indicating that approximately 19% students were dropped out. The over all estimated effect of increasing the MDA in Florida from 16 to 18 implies that approximately 13.32% of potential dropouts would stay in school.

## 5.2 MDA and Juvenile Crime in the Community

In Section 5.1, I report the estimated magnitudes of a higher MDA on high school enrollment. Now I consider the impact of a higher MDA on juvenile crime in the community. If individuals stay longer in school, they would have less opportunity to commit a crime in the community. In this section, I report my estimates of how an MDA greater than 16 affects juvenile crime in the community. I include county, state, and year fixed effects. County fixed effects can capture the effects county-specific characteristics, such as rural and urban settings. State fixed effect can capture state-specific characteristics that can influence crime rate in the community. The year fixed effects capture differences across time that are common to all counties. I consider 16 as the benchmark MDA.

### 5.2.1 Effects of a Higher MDA on Juvenile Crime in the Community

I use county-level arrest rate as a measure of crime rate per 1,000 individuals aged 16 to 18. I control for the year, county, and state fixed effects as I use county-level panel dataset. Following Equation 4.3, I report the effects of an MDA greater than 16 on crime rates in Table 5.2, where each column presents the results from a separate regression model. Following the UCR definition of crime, I categorize total crime rate into three broad categories: property crime rate, violent crime rate, and drug-related crime rate. Column (1) presents the effects of a higher MDA on total crime rate. Column (2) shows the effect of a higher MDA on property crime rate, where property crime includes burglary, larceny, and motor vehicle theft. Column (3) shows the effects of a higher MDA on violent crime rate, where violent crime includes simple assault, aggravated assault, robbery, rape, and murder-related crime. Column (4) shows the effects of a higher MDA on drug-related crime rate, where the drug-related crime includes drug selling and drug possession.

In Table 5.2, I report the estimated effects of a higher MDA on the total crime rate, which are negative and statistically significant. For example, the estimate of an MDA of 17 is -5.146, which implies that states with an MDA17 have 5.15 fewer total juvenile crime incidents per 1,000 individuals aged 16-to-18 than do states with an MDA of 16. Table 4.2 shows that the average total crime rate in states with an MDA of 16 is 37.22. My result implies that increasing the MDA from 16 to 17 reduces approximately five incidents per 1,000 individuals aged 16-to-18. Similarly, states with an MDA18 have 4.76 fewer total juvenile crime incidents per 1,000 individuals, ages 16-to-18, than do states with an MDA of 16. States raising their MDA from 16 to 18 have experienced an average of 4.76 fewer incarceration

**Table 5.2.** Higher MDA and Juvenile Crime in the Community, Broad Categories

| | (1) total crime rate | (2) property rate | (3) violent rate | (4) drug-related rate |
|---|---|---|---|---|
| mda17 | -5.146*** | -2.388*** | -0.974*** | -1.784*** |
| | (0.594) | (0.333) | (0.183) | (0.226) |
| mda18 | -4.758*** | -4.689*** | -0.358* | -0.289** |
| | (0.553) | (0.310) | (0.171) | (0.110) |
| real_min_wage | -7.321*** | -4.599*** | -1.531*** | -1.191*** |
| | (0.470) | (0.263) | (0.145) | (0.178) |
| popratio1618 | 17.563*** | 9.408*** | 4.172*** | 3.983*** |
| | (0.2003) | (0.112) | (0.062) | (0.0761) |
| African-American ratio | 0.165* | 0.169*** | 0.160 | 0.174*** |
| | (0.084) | (0.047) | (0.127) | (0.032) |
| unemployment rate | 0.930*** | 0.391*** | 0.306*** | 0.234*** |
| | (0.099) | (0.055) | (0.031) | (0.038) |
| popratio_male | 0.001 | 0.015 | 0.010 | 0.148** |
| | (0.143) | (0.080) | (0.044) | (0.054) |
| County Fixed Effects | Yes | Yes | Yes | Yes |
| State Fixed Effects | Yes | Yes | Yes | Yes |
| Time Fixed Effects | Yes | Yes | Yes | Yes |
| $R^2$ | 0.178 | 0.177 | 0.191 | 0.187 |
| $N$ | 130043 | 130043 | 130043 | 130043 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, and *** indicate $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively.
Each column is taken from a separate regression by using Equation 4.3.
The minimum wage is adjusted in 2000 US dollars.
The popratio1618 is the ratio between total population of 16-to-18 year olds and the total number of population.
The African-American ratio indicates the ratio between the total number of African-Americans to the total number of population.
The popratio_male indicates the ratio between the total number of males to the total number of population.

incidents per 1,000 individuals (aged 16-to-18), which is an approximately 12% reduction of the total average juvenile crime rate in the community. Additionally, the estimated effect of a higher minimum wage is negative and statistically significant, which implies that increasing the minimum wage reduces total juvenile crime rate in the community. The estimated effect

of African-Americans on each crime category is positive and statistically, except the violent crime rate.

In Table 5.2, Column (2) shows the effects of a higher MDA on the property crime rate in the community. The estimates of higher MDAs are negative and statistically significant. For example, the estimate of an MDA of 17 is -2.388, which implies that states with an MDA of 17 have 2.39 fewer property crime incidents per 1,000 individuals aged 16-to-18 than do states with an MDA of 16. Table 4.2 shows that the property crime rate in states with an MDA of 16 is 20.41. My results imply that increasing the MDA from 16 to 17 reduces approximately two incidents of property crime per 1,000 individuals aged 16-to-18 in the community. Similarly, states with an MDA of 18 have significantly fewer property crime incidents in the community than do states with an MDA of 16. Similar to the effect of an MDA greater than 16 on total crime rate, increasing the minimum wage decreases property crime rate in the community. The estimate of unemployment rate on property crime rate is positive and statistically significant, indicating that a higher unemployment rate increases property crime rate. Columns (3) and (4) also show that states with an MDA greater than 16 have less violent crime and drug-related crime incidents per 1,000 individuals aged 16-to-18 than do states with an MDA of 16. Although the estimated effect of a higher minimum wage is negative and significant for all the crime categories, male-population ratio rate significantly increases only drug-related crime rate.

I also check the joint significant test for an MDA of 17 and an MDA of 18 on each crime category. Using the F-statistic, I find that an MDA of 17 and an MDA of 18 are jointly significant at 5% level of significance on the total crime rate. These results are consistent for property crime rate, violent crime rate, and drug-related crime rate, indicating that an MDA of 17 and an MDA of 18 are jointly significant to reduce the juvenile crime rate in the community.

Further following the UCR definition, in Table 5.3, I break each broad category into its constituent crime categories and examine how a higher MDA affects each. Column (1) shows the effects of higher MDA on the larceny crime rate. For example, the estimates of an MDA of 17 is -1.501, which is negative and statistically significant. Table B.1 shows that the average larceny crime rate in states with an MDA of 16 is 12.90. My result implies that increasing the MDA from 16 to 17 reduces larceny crime incidents in the community by 1.50 per 1,000 individuals aged 16-to-18. Similarly, increasing the MDA from 16 to 18 decreases larceny incidents in the community by 1.73 per 1,000 individuals aged 16-to-18. This implies that an MDA of 18 has a larger effect to reduce larceny crime rate than that of an MDA of 17.

Similar to the larceny crime rate, an MDA greater than 16 reduces burglary rate and motor vehicle theft rate. However, the arson rate is not found statistically significant at 5% level of significance. The estimated effect of an MDA of 18 on burglary rate is -2.094, which is negative and statistically significant. I also check the joint significant test for an MDA of 17 and an MDA of 18 on constituent broad crime category. Using the F-statistic, I find that an MDA of 17 and MDA of 18 are jointly significant at 5% level of significance on the larceny crime rate. These results are consistent for burglary rate and motor vehicle theft rate.

Overall, an MDA greater than 16 reduces property crime incidents in the community. According to the UCR, the estimated property crime rate is 29.42 per 1,000 individuals in 2010, which causes an estimated of $15.7 billion of economic losses. In this study, I find that an MDA of 18 reduces property crime incidents by 4.69 per 1,000 individuals, which is approximately 16% of the UCR estimated property crime rate. This crime reduction implies that an increased MDA from 16 to 18 reduces an estimated $2.50 billion losses resulting from property crime. Table 5.3 also shows that the estimated effects of an MDA greater than 16

**Table 5.3.** Higher MDA and Crime in the Community, Individual Categories

| | (1) larceny | (2) burglary | (3) motor vehicle theft | (4) arson | (5) aggravated assault | (6) simple assault | (7) robbery | (8) murder | (9) rape | (10) drug possession | (11) drug sale |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mda17 | -1.501*** | -0.528*** | -0.336*** | -0.022 | -0.096 | -0.669*** | -0.174*** | -0.004 | -0.030 | -1.109*** | -0.506*** |
| | (0.202) | (0.151) | (0.068) | (0.016) | (0.064) | (0.121) | (0.046) | (0.011) | (0.018) | (0.193) | (0.066) |
| mda18 | -1.733*** | -2.094*** | -0.843*** | -0.019 | -0.239*** | 0.135 | -0.179*** | -0.053*** | -0.022 | -0.741*** | -0.372*** |
| | (0.187) | (0.141) | (0.063) | (0.015) | (0.060) | (0.113) | (0.043) | (0.010) | (0.017) | (0.180) | (0.062) |
| real_min_wage | -2.599*** | -1.414*** | -0.562*** | -0.024 | -0.328*** | -0.860*** | -0.256*** | -0.027** | -0.059*** | -0.729*** | -0.471*** |
| | (0.159) | (0.120) | (0.054) | (0.013) | (0.051) | (0.096) | (0.036) | (0.008) | (0.014) | (0.153) | (0.053) |
| popratio1618 | 4.058*** | 4.226*** | 1.019*** | 0.104*** | 1.204*** | 2.197*** | 0.513*** | 0.568*** | 0.201*** | 3.069*** | 0.793*** |
| | (0.067) | (0.051) | (0.023) | (0.005) | (0.020) | (0.041) | (0.015) | (0.004) | (0.006) | (0.065) | (0.022) |
| popratio_AA | 0.063* | 0.109*** | 0.023** | 0.003 | 0.042*** | 0.069*** | 0.051*** | 0.003 | 0.055* | 0.093*** | 0.091*** |
| | (0.028) | (0.021) | (0.009) | (0.002) | (0.009) | (0.017) | (0.006) | (0.002) | (0.003) | (0.027) | (0.009) |
| unemployment | 0.247*** | 0.108*** | 0.034** | 0.002 | 0.062*** | 0.188*** | 0.047*** | 0.002 | 0.006* | 0.197*** | 0.047*** |
| | (0.034) | (0.025) | (0.011) | (0.003) | (0.011) | (0.020) | (0.008) | (0.002) | (0.003) | (0.032) | (0.011) |
| popratio_male | 0.021 | 0.044 | 0.032* | 0.004 | 0.002 | 0.038 | 0.029** | 0.003 | 0.002 | 0.105* | 0.040* |
| | (0.049) | (0.036) | (0.016) | (0.004) | (0.016) | (0.029) | (0.011) | (0.003) | (0.004) | (4.663) | (1.602) |
| County FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| State FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.115 | 0.167 | 0.130 | 0.113 | 0.140 | 0.201 | 0.113 | 0.015 | 0.019 | 0.188 | 0.123 |
| $N$ | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, and *** indicate $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively.
Each column is taken from a separate regression by using Equation 4.3.
The minimum wage is adjusted in 2000 US dollars.
The popratio1618 is the ratio between total population of 16-to-18 year olds and the total number of population.
The popratio_AA ratio indicates the ratio between the total number of African-Americans to the total number of population.
The popratio_male indicates the ratio between the total number of males to the total number of population.

on each constituent of violent crime rate and drug-related crime rate, and these are negative and statistically significant, indicating that an MDA greater than 16 reduces juvenile crime in the community. In addition, Table 5.3 shows that an MDA of 18 has larger effects to reduce each constituent of property crime rate than that of MDA17, and an MDA of 17 has

greater effects reducing each constituent of drug-related crime rate than that of an MDA of 18.

Now, I consider interaction terms to examine whether a higher MDA has homogeneous effect on different group of individuals. Using the specification 4.4, I estimate the effect of a higher MDA on each crime category in the community and report the estimates in Table 5.4. Column (1) shows the estimated effect of a higher MDA on the total crime rate. The estimates of an MDA greater than 16 on the total crime rate are negative and statistically significant. For example, the estimate of an MDA of 17 on the total crime rate for the African-American population ratio (AA) is $-9.590 - 0.352 \times AA$. Table 4.2 shows that on average 10% of the total population are African-Americans. Therefore, the total effect of an MDA of 17 on the total crime rate is $-9.590 - 0.352 \times 0.10$, that is -9.6252. This estimated effect is even larger than the average effect of an MDA of 17, -5.146, from the baseline estimation showed in Table 5.2. This indicates that an MDA of 17 decreases the total crime rate more in communities with larger proportions of African-Americans. The negative effects of variables representing the male and African-American population ratios indicate that communities would benefit by developing interventions targeted at these groups.

Table 5.4 also shows that the effects of an MDA of 17 are negative and statistically significant on property crime rate and violent crime rate; however, it is not statistically significant on the drug-related crime rate. These results are consistent to the effect of an MDA of 18 on juvenile crime in the community. Additionally, Table 5.4 shows that increasing the MDA to an age greater than 16 reduces crime incidents, except the drug-related crime rate, in counties with a higher proportion of males in the population. Using specification 4.4, I also examine the effect of a higher MDA on constituents of each broad crime category, which is given in Table B.2 in Appendix B. These results are consistent for most of the constituent crime category. As a higher MDA significantly decreases crime in communities with larger

**Table 5.4.** Interaction Terms and Crime in the Community, Broad Category

| | (1) total crime rate | (2) property rate | (3) violent rate | (4) drug-related rate |
|---|---|---|---|---|
| mda17 | -9.590** | -0.805*** | -7.693* | -11.092 |
| | (4.009) | (0.226) | (2.706) | (6.562) |
| mda18 | -25.899*** | -17.255* | -12.086** | -3.443 |
| | (8.893) | (7.101) | (3.362) | (4.138) |
| mda17×AA | -0.352*** | -0.179** | -0.083** | 0.089 |
| | (0.037) | (0.040) | (0.011) | (0.641) |
| mda18×AA | -0.466*** | -0.233*** | -0.144*** | 0.089 |
| | (0.041) | (0.023) | (0.012) | (0.055) |
| mda17×male | -0.227*** | -0.066* | -0.125* | 0.169 |
| | (0.042) | (0.032) | (0.055) | (9.195) |
| mda18×male | -0.687** | -0.477*** | -0.272*** | 0.061 |
| | (0.219) | (0.122) | (0.067) | (0.083) |
| Control Variables | Yes | Yes | Yes | Yes |
| County Fixed Effects | Yes | Yes | Yes | Yes |
| State Fixed Effects | Yes | Yes | Yes | Yes |
| Time Fixed Effects | Yes | Yes | Yes | Yes |
| $R^2$ | 0.180 | 0.181 | 0.199 | 0.190 |
| $N$ | 130043 | 130043 | 130043 | 130043 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, *** indicate $p < 0.05$, $p < 0.01$, $p < 0.001$, respectively.
Each column is taken from a separate regression by using Equation 4.4.
The $mda17 \times AA$ indicates the interaction between an MDA of 17 and African-American ratio to the total population.
The $mda18 \times AA$ indicates the interaction between an MDA of 18 and African-American ratio to the total population.
The $mda17 \times male$ indicates the interaction between an MDA of 17 and male ratio to the total population.
The $mda18 \times male$ indicates the interaction between an MDA of 18 and male ratio to the total population.

proportions of African-Americans as well as with larger proportions of males (Tables 5.4 and B.2), I estimate a full interaction model with higher MDAs, African-American ratio, and male-ratio. The results are similar to those reported in Tables 5.4 and B.2. This indicates that a higher MDA is more effective in preventing community crime among African-American and male individuals.

The empirical findings imply that increasing the MDA to an age greater than 16 reduces juvenile crime incidents in the community. A higher MDA requires potential dropouts to stay in school for one more year, which allows them less time and opportunity to commit crime in the community. Anderson (2014) refers to this effect as an incapacitation effect. Although the results of my study are consistent with those in the literature, the magnitude of the effects differ. For example, Anderson (2014) finds that an MDA of 18 reduces total crime incidents by 10.27 per 1,000 individuals in the 16-to-18 age group to the 13-to-15 age group in the same years. One notable difference between our studies is that I compare juveniles aged 16-to-18 in states with an MDA greater than 16 to juveniles aged 16-to-18 in states with an MDA of 16, whereas Anderson (2014) compares the 16 to 18 group of population to the contemporaneous 13-to-15 age group. As every states has an MDA of 16, an increased MDA affects potential dropouts aged 16 and older. My results represent the effect better than Anderson (2014) because the effects of an MDA greater than 16 will impact the older group of students on which I focus. For example, younger individuals may be influenced to commit more or less crime in the presence of older individuals. Comparing the same age-group for control and treatment group overcomes this issue. I find that states raising their MDA from 16 to 18 have experienced an average of 4.76 fewer incarceration incidents per 1,000 individuals aged 16-to-18, which is an approximately 12% reduction of the total average juvenile crime rate in the community.

## 5.3 Effects of a Higher MDA and Juvenile Crime in School

### 5.3.1 Higher MDA and Crime in School

In this section, I show the effect of a higher MDA on school crime rate. Following the UCR definition, I classify total crime rate into three categories: property crime rate, violent crime rate, and drug-related crime rate. In Table 5.5, column (1) shows the effect of a higher MDA on the total crime rate in school. Column (2) shows the effect of a higher MDA on property crime rate, which includes theft/larceny and vandalism. Column (3) shows the effect of a higher MDA on the violent crime rate, which includes sexual misconduct, robbery, threats, and physical attacks with weapons. Column (4) shows the effects of a higher MDA on the drug-related crime rate, which consists of drug use, alcohol consumption, and possession of either drugs or alcohol by a minor.

In this analysis, the dependent variable is the crime rate per 1,000 students in each school. In column (1), the estimate of an MDA of 17 on total crime rate is 1.863, which is not statistically significant. The estimate of an MDA of 18 on the total crime rate is 28.725, which is also not statistically significant. I also check the joint significant test for an MDA of 17 and an MDA of 18 on total crime rate. Using the F-statistic, I find that an MDA of 17 and an MDA of 18 are not jointly significant at 5% level of significance on the total crime rate. This implies that an MDA greater than 16 does not have a significant impact on the total school crime rate. The estimate of security camera use on total crime rate is -4.983, which is not statistically significant. This implies that security cameras effectively do not reduce total crime rate in school. The estimate of parental involvement on the total crime rate is

**Table 5.5.** Higher MDA and Crime in School, Broad Categories

| | (1) total crime rate | (2) property crime rate | (3) violent crime rate | (4) drug-related crime rate |
|---|---|---|---|---|
| mda17 | 1.863 | 0.323 | 1.948 | 0.120 |
| | (4.531) | (1.037) | (3.507) | (0.452) |
| mda18 | 28.725 | 4.772 | 22.088 | 2.791 |
| | (18.896) | (4.325) | (14.623) | (1.891) |
| security | -4.983 | -1.039 | -5.139 | 0.708 |
| camera | (5.386) | (1.232) | (4.169) | (0.545) |
| parental | -21.473*** | -5.688*** | -12.871** | -2.250*** |
| involvement | (5.080) | (1.163) | (3.932) | (0.520) |
| neighborhood | 17.724* | 5.398* | 10.784* | 1.852** |
| crime | (8.596) | (2.425) | (4.201) | (0.059) |
| recreational | -8.457 | -1.504 | -6.524 | 0.023 |
| program | (6.720) | (1.538) | (5.201) | (0.671) |
| student-teacher | 0.967*** | 0.528*** | 0.327* | 0.108*** |
| ratio | (0.165) | (0.038) | (0.128) | (0.016) |
| African-American | 0.563*** | 0.027 | 0.537*** | 0.012 |
| student ratio | (0.123) | (0.028) | (0.095) | (0.013) |
| male-student ratio | 1.152*** | 0.220*** | 0.859*** | 0.080** |
| | (0.256) | (0.059) | (0.198) | (0.026) |
| city | 11.526 | 0.433 | 0.529 | 0.009 |
| | (6.496) | (1.710) | (4.603) | (1.166) |
| suburb | 7.245 | -2.647 | 3.593 | 0.700 |
| | (5.832) | (1.536) | (4.132) | (1.041) |
| Dog-sniffing | | | | -3.821*** |
| | | | | (0.538) |
| School FE | Yes | Yes | Yes | Yes |
| State FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| $R^2$ | 0.121 | 0.137 | 0.117 | 0.127 |
| $N$ | 7932 | 7932 | 7932 | 7932 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, and *** indicate $p < 0.05$, $p < 0.01$, $p < 0.001$, respectively.
Each column is taken from a separate regression by using Equation 4.5. The dependent variable is the crime rate per 1,000 students.

-21.473, which is negative and highly significant. This implies that parental involvement in high school significantly reduces the crime rate. The estimate of the student-teacher ratio is 0.967, which is positive and statistically significant. This implies that a larger student-teacher ratio leads to increase total crime incidents in school. The estimate of neighborhood crime on the total crime rate in school is 17.724, which is positive and statistically significant. These results imply that a school with a higher neighborhood crime rate is more likely to have more crime incidents. School location, such as city, is not statistically significant to influence the total crime rate. For example, the estimate of city location on the total crime rate is 11.526, and it is not statistically significant. This implies that the city location does not affect the total crime rate in school. The estimate of male-student ratio is positive and statistically significant. Additionally, the estimate of recreational facilities on the school crime is not significant. For example, the estimate of recreational facilities is -8.457, which is not statistically significant. This suggests that recreational facilities in school do not influence the total crime rate.

In addition to showing the effect on the total crime rate, Table 5.5 shows the effect of MDA greater than 16 on broad crime categories: property crime rate, violent crime rate, and drug-related crime rate. Column (2) shows the effects of a higher MDA on property crime rate in school. The estimate of an MDA of 17 is not statistically significant, which implies that an MDA of 17 does not affect property crime rate in school. Similarly, the estimate of an MDA of 18 is not statistically significant. The estimate of parental involvements on the property crime rate are negative and statistically significant, which implies that these are also useful for preventing property crime in school. Also, neighborhood crime significantly affects property the crime rate. Columns (3) and (4) show the effects of a higher MDA on the violent crime rate and drug-related crime rate, respectively. In both cases, the estimates of a higher MDA are not statistically significant, which suggests that a higher MDA does

not affect the violent crime rate or drug-related crime rate in school. The estimate of dog-sniffing on drug-related crime rate is negative and statistically significant, which implies that dog-sniffing effectively reduces drug-related crime in school.

Following the SSOCS definition of crime, I also break each broad category into its constituent crime categories. In Table 5.6, I report my results of how a higher MDA affects the constituent crime rate. For example, property crime includes theft/larceny and vandalism. Column (1) shows the effects of a higher MDA on theft/larceny crime rate. The estimate of an MDA 17 is not statistically significant. This implies that increasing the MDA from 16 to 17 does not affect theft/larceny rate in school. The estimate of an MDA of 18 is also not statistically significant on the theft/larceny crime rate. Therefore, an MDA greater than 16 does not increase the school crime rate. However, parental involvement significantly reduces theft/larceny crime rate in school. In addition, student-teacher ratio significantly increases the rates of theft/larceny, which in turns implies that hiring more teachers decreases theft/larceny incidents.

Violent crime includes sexual harassment, robbery, threats, and physical attacks with a weapon. In each case, Table 5.6 shows that an MDA greater than 16 does not have any significant impact on the school violence rate. Similarly, for the drug-related crime rate, an MDA greater than 16 does not have any significant impact on the drug use rate or the alcohol use rate. In summary, an MDA greater than 16 does not significantly influence the crime rate in school for any of the crime measures.

Now, I consider interaction terms to examine whether a higher MDA has homogeneous effect on the crime rate in schools with different characteristics. Using the specification 4.6, I estimate the effect of a higher MDA on each crime category in school and report the estimates in Table 5.7. In this case, I consider an interaction between a higher MDA

**Table 5.6.** Higher MDA and School Crime, Individual Categories

| | (1) theft rate | (2) vandalism rate | (3) robbery rate | (4) phy_attacks rate | (5) threat rate | (6) sexual rate | (7) drug use rate | (8) alcohol rate |
|---|---|---|---|---|---|---|---|---|
| mda17 | 0.123 | 0.217 | 0.007 | 0.537 | 1.128 | 0.003 | 0.251 | 0.089 |
| | (0.675) | (0.471) | (0.267) | (1.596) | (2.086) | (0.032) | (0.437) | (0.095) |
| mda18 | 4.177 | 0.705 | 0.024 | 12.322 | 9.883 | 0.031 | 2.801 | 0.014 |
| | (2.816) | (1.969) | (1.118) | (6.653) | (8.702) | (0.133) | (1.828) | (0.397) |
| security camera | -0.067 | 1.007 | -0.324 | -1.514 | -3.336 | -0.042 | 0.134 | -0.590*** |
| | (0.803) | (0.560) | (0.318) | (1.897) | (2.479) | (0.038) | (0.527) | (0.115) |
| parental involvement | -4.216*** | -1.459** | 0.133 | -6.914*** | -5.988* | -0.058 | -1.151* | -1.090*** |
| | (0.757) | (0.529) | (0.300) | (1.790) | (2.339) | (0.036) | (0.503) | (0.109) |
| neighborhood crime | 1.301* | 3.918*** | 1.180* | 5.222*** | 4.209*** | 0.073 | 1.551*** | 0.281 |
| | (0.579) | (1.102) | (0.525) | (0.732) | (0.878) | (0.074) | (0.024) | (0.223) |
| recreational program | -0.883 | -0.517 | -0.375 | -4.906* | -1.084 | -0.017 | 0.026 | -0.064 |
| | (1.001) | (0.699) | (0.397) | (2.367) | (3.094) | (0.047) | (0.649) | (0.141) |
| student-teacher ratio | 0.247*** | 0.277*** | 0.014 | 0.160** | 0.150* | 0.001 | 0.071*** | 0.037*** |
| | (0.025) | (0.017) | (0.010) | (0.058) | (0.076) | (0.001) | (0.016) | (0.003) |
| African-American student ratio | 0.014 | 0.013 | 0.008 | 0.340*** | 0.186** | 0.001 | 0.013 | -0.001 |
| | (0.018) | (0.013) | (0.007) | (0.043) | (0.057) | (0.001) | (0.012) | (0.003) |
| male-student ratio | 0.101** | 0.119*** | 0.043** | 0.308*** | 0.506*** | 0.005** | 0.082*** | -0.003 |
| | (0.038) | (0.027) | (0.015) | (0.090) | (0.118) | (0.002) | (0.025) | (0.005) |
| city | 0.949 | 0.405 | 0.327 | 2.146 | 5.616 | 0.063 | 0.539 | 0.039 |
| | (0.913) | (0.985) | (0.701) | (1.758) | (2.924) | (0.075) | (1.146) | (0.124) |
| suburb | 0.639 | 0.858 | 0.388 | 0.377 | 2.003 | 0.092 | 0.815 | 0.108 |
| | (0.824) | (0.884) | (0.629) | (1.588) | (2.623) | (0.067) | (1.028) | (0.111) |
| dog-sniffing | | | | | | | -2.716*** | -1.091*** |
| | | | | | | | (0.520) | (0..113) |
| School FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| State FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.122 | 0.144 | 0.114 | 0.112 | 0.112 | 0.111 | 0.120 | 0.213 |
| $N$ | 7932 | 7932 | 7932 | 7932 | 7932 | 7932 | 7932 | 7932 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, and *** indicate $p < 0.05$, $p < 0.01$, and $p < 0.001$ respectively˙
Each column is taken from a separate regression by using Equation 4.5.
The dependent variable is the crime rate per 1,000 students.

**Table 5.7.** Interaction
Terms and Crime in School, Broad Category for Male and African-American Student Ratio

| | (1) total crime rate | (2) property crime rate | (3) violent crime rate | (4) drug-related crime rate |
|---|---|---|---|---|
| mda17 | 21.687 | 0.922 | 21.530 | 0.471 |
| | (18.954) | (4.340) | (14.665) | (1.905) |
| mda18 | 40.524 | 8.253 | 55.184 | 4.767 |
| | (32.542) | (7.442) | (35.190) | (3.246) |
| mda17×AA | 0.015 | 0.029 | 0.031 | 0.012 |
| | (0.211) | (0.048) | (0.163) | (0.021) |
| mda18×AA | 0.205 | 0.080 | 0.125 | 0.003 |
| | (0.268) | (0.061) | (0.208) | (0.027) |
| mda17×male | 0.396 | 0.017 | 0.396 | 0.009 |
| | (0.366) | (0.084) | (0.283) | (0.037) |
| mda18×male | 0.294 | 0.244 | 0.704 | 0.155 |
| | (0.532) | (0.142) | (0.412) | (0.153) |
| Control Variables | Yes | Yes | Yes | Yes |
| School FE | Yes | Yes | Yes | Yes |
| State FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| $R^2$ | 0.132 | 0.140 | 0.121 | 0.128 |
| N | 7932 | 7932 | 7932 | 7932 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, and *** indicate $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively.
Each column is taken from a separate regression by using Equation 4.6.
The $mda17 \times AA$ indicates the interaction between an MDA of 17 and African-American student ratio to the total students.
The $mda18 \times AA$ indicates the interaction between an MDA of 18 and African-American student ratio to the total students.
The $mda17 \times male$ indicates the interaction between an MDA of 17 and male-student ratio to the total students.
The $mda18 \times male$ indicates the interaction between an MDA of 18 and male-student ratio to the total students.

and other school characteristics: African-American student ratio, male student ratio, and location of the school. In Table 5.7, Column (1) shows the the effects of a higher MDA on the total crime rate with interaction terms for African-American student ratio and higher MDAs as well as for male student ratio and higher MDAs. Similar to the findings in Tables 5.5 and 5.6, the estimates indicate that an MDA of 17 and an MDA of 18 do not significantly impact school crime rates. In Table B.4 in Appendix B, I also report the effects of higher MDAs on

component crime rates, and again the findings are not statistically significant. Additionally, I estimate a full interaction model with higher MDAs, African-American student ratio, and male-student ratio. The results are similar to those reported in Tables 5.7 and B.4.

Studies, such as Glaeser and Sacerdote (1999), find that schools with higher levels of crime are usually located in urban areas. According to the Department of Education (2016), schools with 1,000 or more students have higher crime if they are located in urban areas than in rural areas. Following the SSOCS definition of school location, I classify the location of schools into three categories: city, suburb, and town or rural. Using specification 4.6, I then estimate the effect of an MDA greater than 16 on each crime category with an interaction between the school location and their states' MDAs. In this case, my reference group is schools located in town or rural areas. Table B.5 in Appendix B shows that a higher MDA does not statistically significant on the school crime rate while interacting MDAs and with school location.

### 5.3.2 MDA and School Disciplinary Actions

While I consider all types of crime reported in schools, some crime incidents are very serious. School administrators often use stricter disciplinary actions, such as suspension and expulsion, to address delinquent behavior in school. Administrators may use these tools primarily to punish the offenders and secondarily to convey a message to other students that these activities will not be tolerated. As a higher MDA requires potential dropouts to stay in school longer, and as some of these potential dropouts may not like to do so, they may commit crime, and some of these crimes may be serious. To address more serious behaviors, school administrators may implement stricter disciplinary actions. As a result, a

higher MDA may increase the number of severe disciplinary actions that are enforced. In this section, I examine whether a higher MDA increases the disciplinary action rate, such as the suspension rate.

The SSOCS uses five categories of strict disciplinary actions: expulsion, suspension, transfer, probation, and detention. Expulsion refers to a procedural removal of a student with no continuing school services for at least the remainder of the academic year. Suspension refers to removal from school for less than the remainder of the academic year. The SSOCS classifies suspension into two categories: out-of-school and in-school suspension, which I refer to as *outside suspension* and *inside suspension*, respectively. Outside suspension implies removal from school lasting five or more days but less than remainder of the academic year. Inside suspension implies removal from the classroom setting for a specific number of days or for the remainder of the academic year. Transfer means that students are sent to a specialized school. Probation is the conditional situation that does not issue an immediate punishment, but instead issues punishment if further incidents occur. Detention refers to students' staying at school for a certain amount of time in a non-school hours. For example, if they are required to stay in school on Saturday; it is called Saturday detention.

Following the SSOCS, I consider school disciplinary action as a representation of the most severe crime. Using Equation 4.5, I also show whether an MDA greater than 16 affects the school disciplinary action rate, such as the expulsion rate. Table 5.8 shows the estimated effects of a higher MDA on the school disciplinary action rate. For example, Column (1) shows that the estimated effect of an MDA of 18 on the expulsion rate is 0.078, which is not statistically significant at 5% significance level. These results indicate that an MDA greater than 16 does not increase the expulsion rate in school. Similar to this, Table 5.8 shows that the estimate of an MDA greater than 16 are not statistically significant on disciplinary action. I also examine the effect of a higher MDA on school-disciplinary-action rates by

**Table 5.8.** Higher MDA and School Disciplinary Actions

| | (1) expulsion rate | (2) outside-suspension rate | (3) inside-suspension rate | (4) transfer rate | (5) detention rate | (6) probation rate |
|---|---|---|---|---|---|---|
| mda17 | 0.034 | 0.727 | 0.475 | 0.169 | -0.331 | -0.285 |
| | (0.179) | (1.087) | (0.664) | (0.416) | (0.322) | (0.500) |
| mda18 | 0.078 | 4.547 | 7.32 | 1.718 | -0.395 | -0.326 |
| | (0.750) | (4.541) | (4.773) | (1.740) | (1.345) | (2.090) |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| School FE | Yes | Yes | Yes | Yes | Yes | Yes |
| State FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.131 | 0.150 | 0.163 | 0.145 | 0.189 | 0.113 |
| $N$ | 7932 | 7932 | 7932 | 7932 | 7932 | 7932 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, *** indicate $p < 0.05$, $p < 0.01$, $p < 0.001$ respectively.
Each column is taken from a separate regression by using Equation 4.5.

using interaction terms between higher MDAs and the school's demographic characteristics. Tables B.6 and B.7 in Appendix B indicate that an MDA greater than 16 does not affect the school disciplinary action rate while considering the interaction between MDAs and school's demographic characteristics. This indicates that a higher MDA does not influence any of stricter disciplinary actions enforced in school.

The empirical findings of the effect of a higher MDA on crime in school imply that increasing the MDA to an age greater than 16 does not influence crime in school. A higher MDA requires potential dropouts to stay in school for one more year, which may allow them more time and opportunity to commit crime in the community. By using the individuals' victimization data, Anderson et al. (2013) finds that a higher MDA affects students' victimization. In contrast, my study examine the effect of a higher MDA on overall crime rate in school after controlling for the school characteristics, such as student-teacher ratio

and parental involvement. The results of my study indicate that a higher MDA does not influence the crime rate in school.

# CHAPTER 6

# DISCUSSION AND CONCLUSION

Education provides long-term benefits to individuals. However, some students choose to leave high school prior to graduation. An MDA greater than 16 requires potential dropouts to stay in school for at least one more year. While this provides them less opportunity to commit crime in the community, it allows potential dropouts more opportunity to commit crime in school. In this study, I examine the effect of an MDA greater than 16 on juvenile crime both in the community and in school.

I first empirically estimate the magnitudes of increased enrollment due to an MDA greater than 16. I find that raising the MDA to an age greater than 16 increases high school enrollment by 2.57%. Further results imply that raising the MDA to an age greater than 16 reduces community crime for individuals aged 16-to-18. I find that states with an MDA of 18 have 4.76 fewer incidents per 1,000 individuals aged 16-to-18 than do states with an MDA of 16. These results provide more accurate estimates for the relevant age group than prior studies. I also find that a higher MDA does not affect school crime. States raising their MDA from 16 to 18 have experienced an average of 4.76 fewer incarceration incidents per 1,000 individuals aged 16-to-18, which is an approximately 12% reduction of the total average juvenile crime rate in the community. According to the Council of Economic Advisers (2016), the estimated annual cost of juvenile incarceration for a single individual is $112,555, which is about 3.5 times the average tuition and fees at a four-year non-profit private university ($32,405) and almost 5 times the average cost of tuition and fees at a

four-year public university for an out-of-state student ($23,893). A lower crime rate will benefit the community in the form of a reduction in criminal justice system-related costs and incarceration. My results imply that states raising the MDA from 16 to 18 would have saved $537,337 per 1,000 individuals that states could have used on education or other public assistance programs. In other words, increasing the MDA not only prevents juvenile crime, but also improves the community overall.

My findings support an MDA policy greater than 16 to reduce juvenile crime because this policy reduces community crime without affecting school crime. However, this study is subject to the following limitations. First, the causal relationship between an MDA and juvenile crime, the time of day at which a crime occurs would be a key determinant. In this study, I do not consider this because of the lack of data. Incorporating this factor into the analysis would examine how an increased MDA affects juvenile crime during and outside school hours. Second, my research relies on administrative data for studying school crime. It may be useful in the future to analyze crime incidents as reported by students. Finally, because a higher MDA requires potential dropouts to stay longer in school than they would otherwise choose, students may not focus on their studies. Therefore, a future research question is how a higher MDA influences the academic achievement of these potential dropouts as well as their peers.

# REFERENCES


Abu-Ghaida, D. and Klasen, S. (2004). The costs of missing the millennium development goal on gender equity. *World Development*, 32(7):1075–1107.

Acemoglu, D. and Angrist, J. (2000). How large are human-capital externalities? evidence from compulsory-schooling laws. In *NBER Macroeconomics Annual 2000, Volume 15*, pages 9–74. MIT Press.

Alliance for Excellent Education (2006a). Demography as Destiny: How America Can Build a Better Future. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.173.7029&rep=rep1&type=pdf.

Alliance for Excellent Education (2006b). Saving futures, saving dollars: The impact of education on crime reduction and earnings. http://all4ed.org/wp-content/uploads/HighSchoolDropouts.pdf.

Allingham, M. G. and Sandmo, A. (1972). Income tax evasion: A theoretical analysis. *Journal of public economics*, 1(3-4):323–338.

Anderson, D. M. (2014). In School and Out of Trouble? The Minimum Dropout Age and Juvenile Crime. *The Review of Economics and Statistics*, 96(2):318–331.

Anderson, D. M., Hansen, B., and Walker, M. B. (2013). The minimum dropout age and student victimization. *Economics of Education Review*, 35:66–74.

Angrist, J. D. and Krueger, A. B. (1991). Does Compulsory School Attendance Affect Schooling and Earnings? *The Quarterly Journal of Economics*, 106(4):979–1014.

Bayer, P., Hjalmarsson, R., and Pozen, D. (2009). Building criminal capital behind bars: Peer effects in juvenile corrections. *The Quarterly Journal of Economics*, 124(1):105–147.

Becker, G. S. (1964). 1993. human capital.

Becker, G. S. (1968). Crime and Punishment: An Economic Approach. *Journal of Political Economy*, 76:526–536.

Becker, G. S. (1994). Human capital revisited. In *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education (3rd Edition)*, pages 15–28. The university of Chicago press.

Becker, G. S. and Mulligan, C. B. (1997). The endogenous determination of time preference. *The Quarterly Journal of Economics*, pages 729–758.

Bedard, K. and Dhuey, E. (2006). The persistence of early childhood maturity: International evidence of long-run age effects. *The Quarterly Journal of Economics*, 121(4):1437–1472.

Belfield, C. R. and Levin, H. M. (2007). *The economic losses from high school dropouts in California*. University of California, Santa Barbara.

Ben-Porath, Y. (1967). The production of human capital and the life cycle of earnings. *The Journal of Political Economy*, pages 352–365.

Berthelon, M. E. and Kruger, D. I. (2011). Risky behavior among youth: Incapacitation effects of school on adolescent motherhood and crime in chile. *Journal of public economics*, 95(1):41–53.

Billings, S. B., Deming, D. J., and Rockoff, J. (2013). School segregation, educational attainment, and crime: Evidence from the end of busing in charlotte-mecklenburg. *The Quarterly Journal of Economics*, 129(1):435–476.

Black, S. E., Devereux, P. J., and Salvanes, K. G. (2011). Too young to leave the nest? the effects of school starting age. *The Review of Economics and Statistics*, 93(2):455–467.

Block, M. K. and Heineke, J. M. (1975). A labor theoretic analysis of the criminal choice. *The American Economic Review*, 65(3):314–325.

Bowen, N. K. and Bowen, G. L. (1999). Effects of crime and violence in neighborhoods and schools on the school behavior and performance of adolescents. *Journal of Adolescent Research*, 14(3):319–342.

Bowen, W. G. and Bok, D. (2016). *The shape of the river: Long-term consequences of considering race in college and university admissions*. Princeton University Press.

Buonanno, P. and Leonida, L. (2009). Non-market effects of education on crime: Evidence from italian regions. *Economics of Education Review*, 28(1):11–17.

Calvó-Armengol, A. and Zenou, Y. (2004). Social networks and crime decisions: The role of social structure in facilitating delinquent behavior. *International Economic Review*, 45(3):939–958.

Carrell, S. E. and Hoekstra, M. L. (2010). Externalities in the classroom: How children exposed to domestic violence affect everyone's kids. *American Economic Journal: Applied Economics*, 2(1):211–28.

Case, A. C. and Katz, L. F. (1991). The company you keep: The effects of family and neighborhood on disadvantaged youths. Working Paper 3705, National Bureau of Economic Research.

Chiswick, B. R. (1983). The earnings and human capital of american jews. *Journal of Human Resources*, pages 313–336.

Clay, K., Lingwall, J., and Stephens Jr, M. (2012). Do schooling laws matter? evidence from the introduction of compulsory attendance laws in the united states. Technical report, National Bureau of Economic Research.

Collin, M. E., Weil, D. N., et al. (2018). The effect of increasing human capital investment on economic growth and poverty: A simulation exercise. Technical report, The World Bank.

Cook, P. J. and Kang, S. (2016). Birthdays, schooling, and crime: regression-discontinuity analysis of school performance, delinquency, dropout, and crime initiation. *American Economic Journal:*

*Applied Economics*, 8(1):33–57.

Cook, P. J. and Ludwig, J. (2011). *More Prisoners Versus More Crime is the Wrong Question*. Brookings Institution.

Council of Economic Advisers (2016). Economic reports of the president with annual report of the council of economic advisers.

Currie, J. and Gruber, J. (1996). Health insurance eligibility, utilization of medical care, and child health. *The Quarterly Journal of Economics*, 111(2):431–466.

Currie, J. and Moretti, E. (2003). Mother's education and the intergenerational transmission of human capital: Evidence from college openings. *The Quarterly Journal of Economics*, pages 1495–1532.

Cutler, D., Lleras-Muney, A., House, J., Schoeni, R., Kaplan, G., and Pollack, H. (2008). Education and health: Evaluating theories and evidence. *Making Americans Healthier: Social and Economic Policy as HealthPolicy*.

Deming, D. and Dynarski, S. (2008). The lengthening of childhood. *Journal of Economic Perspectives*, 22(3):71–92.

Deming, D. J. (2011). Better Schools, Less Crime? *The Quarterly Journal of Economics*, 126(4):2063–2115.

Di Tella, R. and Schargrodsky, E. (2004). Do police reduce crime? estimates using the allocation of police forces after a terrorist attack. *American Economic Review*, 94(1):115–133.

Donohue III, J. J. and Levitt, S. D. (2001). The impact of legalized abortion on crime. *The Quarterly Journal of Economics*, 116(2):379–420.

Durlauf, S. N. and Nagin, D. S. (2010). The deterrent effect of imprisonment. In *Controlling crime: Strategies and tradeoffs*, pages 43–94. University of Chicago Press.

Ehrlich, I. (1970). *Participation in illegitimate activities: an economic analysis*. PhD thesis, Dissertation, Department of Economics, Columbia Univer-sity.

Ehrlich, I. (1973). Participation in illegitimate activities: A theoretical and empirical investigation. *Journal of political Economy*, 81(3):521–565.

Ennett, S. T. and Bauman, K. E. (1994). The contribution of influence and selection to adolescent peer group homogeneity: the case of adolescent cigarette smoking. *Journal of personality and social psychology*, 67(4):653.

Eren, O., Depew, B., and Barnes, S. (2017). Test-based promotion policies, dropping out, and juvenile crime. *Journal of Public Economics*, 153:9–31.

Eriksen, T. L. M., Nielsen, H. S., and Simonsen, M. (2014). Bullying in elementary school. *Journal of Human Resources*, 49(4):839–871.

Fergusson, D. M., Swain-Campbell, N. R., and Horwood, L. J. (2002). Deviant peer affiliations, crime and substance use: A fixed effects regression analysis. *Journal of abnormal child psychology*, 30(4):419–430.

Flinn, C. (1986). *Dynamic Models of Criminal Careers*, chapter 9, pages 356–379. National Academy Press, Washington, D.C.

Freeman, R. B. (1996). Why do so many young american men commit crimes and what might we do about it? *Journal of Economic perspectives*, 10(1):25–42.

Freeman, R. B. (1999). The economics of crime. *Handbook of labor economics*, 3:3529–3571.

Gaviria, A. and Raphael, S. (2001). School-based peer effects and juvenile behavior. *Review of Economics and Statistics*, 83(2):257–268.

Gilpin, G. and Pennig, L. (2012). Compulsory schooling laws and school crime: Are delinquents incapacitated? *Available at SSRN 2037842*.

Glaeser, E. L. and Sacerdote, B. (1999). Why is there more crime in cities? *Journal of political economy*, 107(S6):S225–S258.

Glaeser, E. L., Sacerdote, B., and Scheinkman, J. (1996a). Crime and social interactions. *The Quarterly Journal of Economics*, 111(2):507–548.

Glaeser, E. L., Sacerdote, B., and Scheinkman, J. A. (1996b). Crime and social interactions. *The Quarterly Journal of Economics*, 111(2):507–548.

Grogger, J. (1995). The effect of arrests on the employment and earnings of young men. *The Quarterly Journal of Economics*, 110(1):51–71.

Grogger, J. (1998). Market Wages and Youth Crime. *Journal of Labor Economics*, 16(4):756–91.

Hanushek, E. A. (1986). The economics of schooling: Production and efficiency in public schools. *Journal of economic literature*, 24(3):1141–1177.

Heckman, J. J. (1979). *Statistical models for discrete panel data*. Department of Economics and Graduate School of Business, University of Chicago Chicago, IL.

Heckman, J. J. and LaFontaine, P. A. (2010). The american high school graduation rate: Trends and levels. *The review of economics and statistics*, 92(2):244–262.

Heineke, J. (1978). Economic models of criminal behavior: An overview. In Heineke, J. M., editor, *Economic Models of Criminal Behavior*. Amsterdam: North-Holland Publishing.

Heward, C. and Bunwaree, S. (1999). *Gender, education and development: Beyond access to empowerment*. Palgrave Macmillan.

Hinduja, S. and Patchin, J. W. (2013). Social influences on cyberbullying behaviors among middle and high school students. *Journal of Youth and Adolescence*, 42(5):711–722.

Holt, J. and Holt, J. C. (2004). *Instead of education: Ways to help people do things better*. Sentient Publications.

Imai, S. and Krishna, K. (2004). Employment, deterrence, and crime in a dynamic model. *International Economic Review*, 45(3):845–872.

Jacob, B. A. and Lefgren, L. (2003). Are idle hands the devil's workshop? incapacitation, concentration, and juvenile crime. *American Economic Review*, 93(5):1560–1577.

Jacob, B. A. and Lefgren, L. (2009). The effect of grade retention on high school completion. *American Economic Journal: Applied Economics*, 1(3):33–58.

Kahan, D. M. (1998). Social meaning and the economic analysis of crime. *The Journal of Legal Studies*, 27(S2):609–622.

Kang, C. (2007). Classroom peer effects and academic achievement: Quasi-randomization evidence from south korea. *Journal of Urban Economics*, 61(3):458–495.

Katz, L., Levitt, S. D., and Shustorovich, E. (2003). Prison conditions, capital punishment, and deterrence. *American Law and Economics Review*, 5(2):318–343.

Kling, J. R., Ludwig, J., and Katz, L. F. (2004). Neighborhood effects on crime for female and male youth: Evidence from a randomized housing voucher experiment. *Quarterly Journal of Economics*.

Kling, J. R., Ludwig, J., and Katz, L. F. (2005). Neighborhood effects on crime for female and male youth: Evidence from a randomized housing voucher experiment. *The Quarterly Journal of Economics*, 120(1):87–130.

Kolm, S.-C. (1973). A note on optimum tax evasion. *Journal of Public Economics*, 2(3):265–270.

Kremer, M. and Levy, D. (2008). Peer effects and alcohol use among college students. *Journal of Economic perspectives*, 22(3):189–206.

Landersø, R., Nielsen, H. S., and Simonsen, M. (2017). School starting age and the crime-age profile. *The Economic Journal*, 127(602):1096–1118.

Lankford, H., Loeb, S., and Wyckoff, J. (2002). Teacher sorting and the plight of urban schools: A descriptive analysis. *Educational evaluation and policy analysis*, 24(1):37–62.

Lazear, E. P. (2001). Educational production. *The Quarterly Journal of Economics*, 116(3):777–803.

Lee, D. S. and McCrary, J. (2005). Crime, punishment, and myopia. Working Paper 11491, National Bureau of Economic Research.

Lee, T., Cornell, D., Gregory, A., and Fan, X. (2011). High suspension schools and dropout rates for black and white students. *Education and Treatment of Children*, 34(2):167–192.

Levitt, S. and Lochner, L. (2001). The determinants of juvenile crime. In *Risky Behavior among Youths: An Economic Analysis*, pages 327–374. National Bureau of Economic Research, Inc.

Levitt, S. D. (1996). The effect of prison population size on crime rates: Evidence from prison overcrowding litigation. *The quarterly journal of economics*, 111(2):319–351.

Levitt, S. D. (1997). Using electoral cycles in police hiring to estimate the effect of police on crime. *The American Economic Review*, 87(3):270–290.

Levitt, S. D. (1998). Juvenile crime and punishment. *Journal of political Economy*, 106(6):1156–1185.

Levitt, S. D. (2004). Understanding why crime fell in the 1990s: Four factors that explain the decline and six that do not. *Journal of Economic perspectives*, 18(1):163–190.

Lochner, L. (2004). Education, work, and crime: A human capital approach*. *International Economic Review*, 45(3):811–843.

Lochner, L. (2010). Education policy and crime. In *Controlling crime: strategies and tradeoffs*, pages 465–515. University of Chicago Press.

Lochner, L. (2011). Nonproduction benefits of education: Crime, health, and good citizenship. In *in Handbook of the Economics of Education*. Citeseer.

Lochner, L. and Moretti, E. (2004). The effect of education on crime: Evidence from prison inmates, arrests, and self-reports. *American Economic Review*, 94(1):155–189.

Loewenstein, G. (2000). Emotions in economic theory and economic behavior. *American economic review*, 90(2):426–432.

Loomes, G. and Sugden, R. (1982). Regret theory: An alternative theory of rational choice under uncertainty. *The economic journal*, 92(368):805–824.

Luallen, J. (2006). School's out... forever: A study of juvenile crime, at-risk youths and teacher strikes. *Journal of Urban Economics*, 59(1):75–103.

Machin, S., Marie, O., and Vujić, S. (2011). The crime reducing effect of education*. *The Economic Journal*, 121(552):463–484.

Manski, C. F. (1993). Identification of endogenous social effects: The reflection problem. *The review of economic studies*, 60(3):531–542.

Manski, C. F. (1999). *Identification problems in the social sciences*. Harvard University Press, MA.

McFarland, J., Cui, J., and Stark, P. (2018). Trends in high school dropout and completion rates in the united states: 2014. nces 2018-117. *National Center for Education Statistics*.

Meghir, C. and Palme, M. (2005). Educational reform, ability, and family background. *The American Economic Review*, 95(1):414–424.

Meghir, C., Palme, M., and Schnabel, M. (2012). The effect of education policy on crime: an intergenerational perspective. Technical report, National Bureau of Economic Research.

Merlo, A. and Wolpin, K. I. (2015). The transition from school to jail: Youth crime and high school completion among black males. *European Economic Review*, 79:234–251.

Messacar, D. and Oreopoulos, P. (2012). Staying in school: A proposal to raise high school graduation rates. *Hamilton Project, Brookings Institution. http://www. brookings. edu/˜/media/research/files/papers/2012/9/27% 20compulsory% 20school-*

*ing/thp_messacaroreopoulos_compschool_discpaper. pdf.*

Milligan, K., Moretti, E., and Oreopoulos, P. (2004). Does education improve citizenship? evidence from the united states and the united kingdom. *Journal of public Economics*, 88(9):1667–1695.

Mincer, J. (1974). Introduction to "schooling, experience, and earnings". In *Schooling, Experience, and Earnings*, pages 1–4. National Bureau of Economic Research, Inc.

Mincer, J. (1997). The production of human capital and the life cycle of earnings: Variations on a theme. *Journal of labor economics*, 15(1, Part 2):S26–S47.

Mocan, H. N., Billups, S. C., and Overland, J. (2005). A dynamic model of differential human capital and criminal activity. *Economica*, 72(288):655–681.

Munyo, I. (2015). The juvenile crime dilemma. *Review of Economic Dynamics*, 18(2):201–211.

Nagin, D. and Waldfogel, J. (1998). The effect of conviction on income through the life cycle. *International Review of Law and Economics*, 18(1):25–40.

Olweus, D. (1997). Bully/victim problems in school: Facts and intervention. *European journal of psychology of education*, 12(4):495.

Oreopoulos, P. (2006). The compelling effects of compulsory schooling: Evidence from canada. *Canadian Journal of Economics/Revue canadienne d'économique*, 39(1):22–52.

Oreopoulos, P. (2007a). Do dropouts drop out too soon? wealth, health and happiness from compulsory schooling. *Journal of Public Economics*, 91(11–12):2213 – 2229.

Oreopoulos, P. (2007b). Would more compulsory schooling help disadvantaged youth? evidence from recent changes to school-leaving laws. In *The problems of disadvantaged youth: An economic perspective*, pages 85–112. University of Chicago Press.

Oreopoulos, P. (2009). Would more compulsory schooling help disadvantaged youth? *The Problems of Disadvantaged Youth: An Economic Perspective*, 85.

Oreopoulos, P. and Salvanes, K. G. (2011). Priceless: The nonpecuniary benefits of schooling. *The journal of economic perspectives*, 25(1):159–184.

Pleis, J. R., Lucas, J. W., and Ward, B. W. (2009). Summary health statistics for us adults: National health interview survey, 2008. *Vital and health statistics. Series 10, Data from the National Health Survey*, (242):1–157.

Puhani, P. A. and Weber, A. M. (2008). Does the early bird catch the worm? In *The economics of education and training*, pages 105–132. Springer.

Raphael, S. and Winter-Ebmer, R. (2001). Identifying the effect of unemployment on crime. *The Journal of Law and Economics*, 44(1):259–283.

Sah, R. K. (1991). Social osmosis and patterns of crime. *Journal of political Economy*, 99(6):1272–1295.

Schultz, T. W. (1961). Investment in human capital. *The American economic review*, 51(1):1–17.

Schweinhart, L. J., Monti, J., Xiang, Z., Barnett, W. S., Belfield, C., and Nores, M. (2005). *The High/Scope Perry Preschool Study Through Age 40: Summary, conclusions, and frequently asked questions*. High/Scope Educational Research Foundation.

Sherman, L. W. (1992). Attacking crime: Police and crime control. *Crime and justice*, 15:159–230.

Sickles, R. C. and Williams, J. (2006). An intertemporal model of rational criminal choice. *Contributions to Economic Analysis*, 274:135–165.

Silverman, D. (2004). Street crime and street culture. *International Economic Review*, 45(3):761–786.

Singh, B. (1973). Making honesty the best policy. *Journal of Public Economics*, 2(3):257–263.

Spence, M. (1973). Job market signaling. *The quarterly journal of Economics*, pages 355–374.

Stark, P. and Noel, A. (2015). Trends in high school dropout and completion rates in the united states: 1972-2012 (NCES 2015– 015). U.S. Department of Education. Washington, DC: National

Center for Education Statistics.

Stigler, G. J. (1970). The optimum enforcement of laws. *Journal of Political Economy*, 78(3):526–536.

Sum, A., Khatiwada, I., McLaughlin, J., and Palma, S. (2009). The consequences of dropping out of high school. *Center for Labor Market Studies Publications*, 23.

Taubman, P. (1989). Role of parental income in educational attainment. *American Economic Review*, 79(2):57–61.

Usher, D. (1997). Education as a deterrent to crime. *Canadian Journal of Economics*, pages 367–384.

Walsh, T. J. (1993). Education as a fundamental right under the united states constitution. *Willamette L. Rev.*, 29:279.

Western, B., Kling, J. R., and Weiman, D. F. (2001). The labor market consequences of incarceration. *Crime & delinquency*, 47(3):410–427.

Williams, J. and Sickles, R. (2002). An analysis of the crime as work model: Evidence from the 1958 philadelphia birth cohort study. *Journal of Human Resources*, 37(3):479–509.

Willits, D., Broidy, L., and Denman, K. (2013). Schools, neighborhood risk factors, and crime. *Crime & Delinquency*, 59(2):292–315.

Willits, D., Broidy, L. M., and Denman, K. (2015). Schools and drug markets: examining the relationship between schools and neighborhood drug crime. *Youth & Society*, 47(5):634–658.

Wilson, J. Q. and Herrnstein, J. Q. (1985). *Crime and human nature*. New York, NY, US: Simon & Schuster.

Witte, A. D. and Tauchen, H. (1993). Work and crime: An exploration using panel data. In *The Economic Dimensions of Crime*, pages 176–191. Springer.

Witte, A. D. and Tauchen, H. (1994). Work and Crime: An Exploration Using Panel Data. *Public Finance = Finances publiques*, 49:155–67.

Wolf, A. (2002). *Does Education Matter?: Myths About Education and Economic Growth*. Penguin Books. Penguin Books Limited.

Zimmerman, D. J. (2003). Peer effects in academic outcomes: Evidence from a natural experiment. *The Review of Economics and statistics*, 85(1):9–23.

# APPENDIX A

# LIST OF MDA IN THE UNITED STATES

**Table A.1.** MDA, Minimum and Maximum Age Limits for Free Schooling, by State: 2016

| State | Age Limit | Minimum | Maximum | State | Age Limit | Minimum | Max |
|---|---|---|---|---|---|---|---|
| Alabama | 6 to 17 | 5 | 17 | Nevada | 7 to 18 | 5 | * |
| Alaska | 7 to 16 | 5 | 20 | New Hampshire | 6 to 18 | ** | 21 |
| Arizona | 6 to 16 | 5 | 21 | New Jersey | 6 to 16 | 5 | 20 |
| Arkansas | 5 to 18 | 5 | 21 | New Mexico | 5 to 18 | 5 | ** |
| California | 6 to 18 | 5 | 21 | New York | 6 to 16 | 5 | 21 |
| Colorado | 6 to 17 | 5 | 21 | North Carolina | 7 to 16 | 5 | 21 |
| Connecticut | 5 to 18 | 5 | 21 | North Dakota | 7 to 16 | 5 | 21 |
| Delaware | 5 to 16 | 5 | 21 | Ohio | 6 to 18 | 5 | 22 |
| District of Columbia | 5 to 18 | 5 | + | Oklahoma | 5 to 18 | 5 | 21 |
| Florida | 6 to 16 | 4 | | Oregon | 7 to 18 | 5 | 19 |
| Georgia | 6 to 16 | 5 | 20 | Pennsylvania | 8 to 17 | 6 | 21 |
| Hawaii | 5 to 18 | 5 | 20 | Rhode Island | 6 to 18 | 5 | 21 |
| Idaho | 7 to 16 | 5 | 21 | South Carolina | 5 to 17 | 5 | 22 |
| Illinois | 6 to 17 | 4 | 21 | South Dakota | 6 to 18 | 5 | 21 |
| Indiana | 7 to 18 | 5 | 22 | Tennessee | 6 to 18 | 5 | * |
| | | | | Texas | 6 to 18 | 5 | 26 |
| Iowa | 6 to 16 | 5 | 21 | Utah | 6 to 18 | 5 | ** |
| Kansas | 7 to 18 | 5 | * | Vermont | 6 to 16 | 5 | ** |
| Kentucky | 6 to 18 | 5 | 21 | Virginia | 5 to 18 | 5 | 20 |
| Louisiana | 7 to 18 | 5 | 20 | Washington | 8 to 18 | 5 | 21 |
| Maine | 7 to 17 | 5 | 20 | West Virginia | 6 to 17 | 5 | 22 |
| Massachusetts | 6 to 16 | 3 | 22 | Wyoming | 7 to 16 | 5 | 21 |
| Michigan | 6 to 18 | 5 | 20 | Vermont | 6 to 16 | 5 | |
| Minnesota | 7 to 17 | 5 | 21 | Virginia | 5 to 18 | 5 | 20 |
| Mississippi | 6 to 17 | 5 | 21 | Washington | 8 to 18 | 5 | 21 |
| Missouri | 7 to 17 | 5 | 21 | West Virginia | 6 to 17 | 5 | 22 |
| Montana | 7 to 16 | 5 | 19 | Wisconsin | 6 to 18 | 4 | 20 |
| Nebraska | 6 to 18 | 5 | 21 | | | | |

Source: Education Commission of the States, Free and Compulsory School Age Requirements in the United States, retrieved June 15, 2017, from http://www.ecs.org/clearinghouse/01/18/68/11868.pdf.
Age limit implies that the age of required school attendance.
Minimum means that minimum age limit to which free education must be offered.
Maximum means that maximum age limit to which free education must be offered.
* means that Not applicable. State has not set a maximum age limit
** means that Not applicable. State has not set a maximum age limit
+ An adult student who is a resident of the District of Columbia is eligible for free instruction in the school.

# APPENDIX B

# MDA AND JUVENILE CRIME IN THE UNITED STATES

## B.1 UCR Crime Definitions

The Uniform Crime Reporting (UCR) reports all crime known to the police, provides the number of arrests based on characteristics, such as age, sex, and county. This section is retrieved from the UCR definition available at https://www.fbi.gov/services/cjis/ucr. The data presented in Crime in the United States reflect the Hierarchy Rule, which requires that only the most serious offense in a multiple-offense criminal incident be counted.

### B.1.1 Property Crime

Property crime includes the offenses of burglary, larceny-theft, motor vehicle theft, and arson. The object of the theft-type offenses is the taking of money or property, but there is no force or threat of force against the victims. The property crime category includes arson because the offense involves the destruction of property; however, arson victims may be subjected to force. Because of limited participation and varying collection procedures by local law enforcement agencies, only limited data are available for arson. Arson statistics are included in trend, clearance, and arrest tables throughout Crime in the United States, but they are not included in any estimated volume data. The arson section in this report provides more information on that offense.

Burglary is defined as the unlawful entry of a structure to commit a felony or theft. To classify an offense as a burglary, the use of force to gain entry need not have occurred. The UCR Program has three subclassifications for burglary: forcible entry, unlawful entry where no force is used, and attempted forcible entry. The UCR definition of structure includes

an apartment, barn, house trailer or houseboat when used as a permanent dwelling, office, railroad car (but not automobile), stable, and vessel (i.e., ship).

Larceny-theft is defined as the unlawful taking, carrying, leading, or riding away of property from the possession or constructive possession of another. Examples are thefts of bicycles, thefts of motor vehicle parts and accessories, shoplifting, pocket-picking, or the stealing of any property or article that is not taken by force and violence or by fraud. Attempted larcenies are included. Embezzlement, confidence games, forgery, check fraud, etc., are excluded.

Motor vehicle theft is defined as the theft or attempted theft of a motor vehicle. A motor vehicle is defined in the UCR Program as a self-propelled vehicle that runs on land surfaces and not on rails. Examples of motor vehicles include sport utility vehicles, automobiles, trucks, buses, motorcycles, motor scooters, all-terrain vehicles, and snowmobiles. Motor vehicle theft does not include farm equipment, bulldozers, airplanes, construction equipment, or water craft such as motorboats, sailboats, houseboats, or jet skis. The taking of a motor vehicle for temporary use by persons having lawful access is excluded from this definition.

Arson is defined as any willful or malicious burning or attempting to burn, with or without intent to defraud, a dwelling house, public building, motor vehicle or aircraft, personal property of another, etc. Only the fires that investigation determined to have been willfully set are included in this arson data collection. Fires labeled as suspicious or of unknown origin are excluded from these data.

### B.1.2 Violent Crime

Violent crime is composed of four offenses: murder and nonnegligent manslaughter, forcible rape, robbery, and aggravated assault. Violent crimes are defined as those offenses which involve force or threat of force. The data presented in Crime in the United States reflect the Hierarchy Rule, which requires that only the most serious offense in a multiple-offense criminal incident be counted. The descending order of UCR violent crimes are murder and nonnegligent manslaughter, rape, robbery, and aggravated assault, followed by the property crimes of burglary, larceny-theft, and motor vehicle theft. Although arson is also a property crime, the Hierarchy Rule does not apply to the offense of arson. In cases in which an arson occurs in conjunction with another violent or property crime, both the arson and the additional crime are reported.

Murder and nonnegligent manslaughter are defined as an willful (nonnegligent) killing of one human being by another. The classification of this offense is based solely on police investigation as opposed to the determination of a court, medical examiner, coroner, jury, or other judicial body. The UCR Program does not include the following situations in this offense classification: deaths caused by negligence, suicide, or accident; justifiable homicides; and attempts to murder or assaults to murder, which are classified as aggravated assaults. In addition to the number of murder offenses known, the UCR Program also encourages law enforcement agencies to report supplementary homicide data as well as information about justifiable homicides that may have occurred within their jurisdictions.

Rape is defined as offense for each victim of a rape, attempted rape, or assault with intent to rape, regardless of the victims age. In 2013, the FBI UCR Program began collecting rape data under a revised definition within the Summary Reporting System. Previously,

offense data for forcible rape were collected under the legacy UCR definition: the carnal knowledge of a female forcibly and against her will. Beginning with the 2013 data year, the term forcible was removed from the offense title, and the definition was changed. The revised UCR definition of rape is: penetration, no matter how slight, of the vagina or anus with any body part or object, or oral penetration by a sex organ of another person, without the consent of the victim. Attempts or assaults to commit rape are also included in the statistics presented here; however, statutory rape and incest are excluded. All rape data submitted in 2015 - whether collected under the revised definition or the legacy definitionare presented in this publication. However, because only three years of rape data have been collected under the revised definition, the overview presented here discusses only legacy definition rape data.

### B.1.3 Drug-related Crime

Drug-related crime is the violation of laws prohibiting the production, distribution, and/or use of certain controlled substances and the equipment or devices utilized in their preparation and/or use. The unlawful cultivation, manufacture, distribution, sale, purchase, use, possession, transportation, or importation of any controlled drug or narcotic substance. Arrests for violations of state and local laws, specifically those relating to the unlawful possession, sale, use, growing, manufacturing, and making of narcotic drugs. The UCR Program collects information on arrests for drug abuse violations based on the narcotics involved. Agencies must include all arrests for violations, including attempts, and subdivide the arrests by differentiating between sale/manufacturing and possession including opium or cocaine and their derivatives (morphine, heroin, codeine), marijuana, synthetic narcotics, and Dangerous nonnarcotic drugs (barbiturates, benzedrine).

## B.2 A Higher MDA and Juvenile Crime in Community

**Table B.1.** Summary Statistics for Community Crime, Individual Category

| crime rate | All States (MDA 16 and above) | States with MDA16 | States with MDA17 | States with MDA18 |
|---|---|---|---|---|
| total crime rate | 39.03 | $37.22^{ab}$ | $40.52^{a}$ | $42.38^{b}$ |
| | (45.36) | (43.08) | (50.99) | (45.75) |
| property crime rate | 20.46 | $20.41^{ab}$ | $21.33^{a}$ | $19.86^{b}$ |
| | (24.77) | (24.67)* | (24.82) | (24.98) |
| larceny rate | 12.85 | $12.90^{ab}$ | $12.82^{a}$ | $12.74^{b}$ |
| | (16.13) | (15.92) | (14.83) | (17.62) |
| burglary rate | 5.66 | $5.67^{ab}$ | $6.38^{a}$ | $5.04^{b}$ |
| | (10.05) | (10.17) | (10.70) | (9.12) |
| motor vehicle theft rate | 1.79 | $1.69^{ab}$ | $1.96^{a}$ | $1.89^{b}$ |
| | (4.5) | (4.25) | (5.00) | (4.71) |
| arson rate | 0.17 | $0.15^{ab}$ | $0.18^{a}$ | $0.19^{b}$ |
| | (0.98) | (0.85) | (0.89) | (1.28) |
| violent crime rate | 10.07 | $9.31^{ab}$ | $10.95^{a}$ | $11.26^{b}$ |
| | (14.2) | (13.14) | (17.41) | (13.69) |
| simple assault rate | 6.69 | $6.14^{ab}$ | $7.00^{a}$ | 7.85 |
| | (9.36) | (9.15) | (9.10) | (9.96) |
| aggravated assault rate | 2.29 | $2.20^{ab}$ | $2.54^{a}$ | 2.35 |
| | (4.51) | (4.22) | (5.31) | (4.49) |
| robbery rate | 0.75 | $0.67^{ab}$ | $1.01^{a}$ | $0.73^{b}$ |
| | (3.46) | (2.04) | (6.67) | (2.13) |
| rape rate | 0.29 | $0.21^{ab}$ | $0.26^{a}$ | $0.24^{b}$ |
| | (1.10) | (0.89) | (1.02) | (1.57) |
| murder rate | 0.09 | $0.09^{ab}$ | $0.14^{a}$ | $0.09^{b}$ |
| | (0.66) | (0.57) | (0.83) | (0.72) |
| drug-related crime rate | 8.50 | $7.50^{ab}$ | $8.24^{a}$ | $11.27^{b}$ |
| | (16.37) | (14.32) | (17.72) | (19.47) |
| drug sale rate | 1.41 | $1.35^{ab}$ | $1.61^{a}$ | $1.41^{b}$ |
| | (4.72) | (4.17) | (6.70) | (3.99) |
| drug possession rate | 6.92 | $6.01^{ab}$ | $6.39^{a}$ | $9.69^{b}$ |
| | (13.89) | (12.06) | (12.72) | (18.14) |
| *N* | 130043 | 75426 | 24887 | 29730 |

Note: Standard deviations are shown in parentheses.
This Table shows the summary statistics for constituent of broad categories of crime rate.
[a] indicates the 5% level of significance for a two-tailed t-test of difference between crime rates in states with MDA 16 and that of 17.
[b] indicates the 5% level of significance for a two-tailed t-test of difference between crime rates in states with MDA 16 and that of 18.

**Table B.2.** Interaction Terms and Crime in the Community, Individual Category

| | (1) larceny | (2) burglary | (3) motor vehicle theft | (4) arson | (5) aggravated assault | (6) simple assault | (7) robbery | (8) murder | (9) rape | (10) drug possession | (11) drug sale |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mda17 | -12.021** | -3.980** | -6.073*** | -1.162 | -2.196 | -5.269* | -0.149*** | 0.386 | -0.464 | -6.688 | -3.419* |
| | (4.074) | (1.061) | (1.368) | (1.320) | (1.302) | (0.051) | (0.929) | (0.214) | (0.360) | (3.911) | (1.343) |
| mda18 | -6.400** | -3.473** | -7.132*** | 0.251 | -2.878* | -6.253** | -2.112* | -0.392* | 0.451 | -3.168 | 0.090 |
| | (2.695) | (1.476) | (1.241) | (0.290) | (1.181) | (2.223) | (0.843) | (0.194) | (0.327) | (3.548) | (1.219) |
| mda17×AA | -0.108* | -0.054** | -0.151** | 0.002 | -0.012* | -0.052 | -0.015** | 0.006 | -0.003 | 0.073 | 0.005 |
| | (0.053) | (0.025) | (0.004) | (0.061) | (0.006) | (0.038) | (0.007) | (0.006) | (0.002) | (4.208) | (0.415) |
| mda18×AA | -0.076*** | -0.027* | -0.045*** | 0.005 | -0.012** | -0.094** | -0.024* | 0.003 | 0.002 | -0.057 | 0.096 |
| | (0.014) | (0.011) | (0.005) | (0.005) | (0.001) | (0.008) | (0.013) | (0.002) | (0.00) | (0.033) | (0.035) |
| mda17×male | -0.186*** | -0.098* | -0.061*** | -0.002 | 0.001 | -0.087* | -0.053** | -0.008 | 0.008 | 0.095 | 0.057* |
| | (0.010) | (0.041) | (0.027) | (0.007) | (0.026) | (0.039) | (0.019) | (0.005) | (0.007) | (0.084) | (0.0271) |
| mda18×male | -0.175* | -0.128* | -0.167*** | -0.006 | -0.066** | -0.137** | -0.049** | -0.009* | -0.009 | 0.069 | 0.013 |
| | (0.074) | (0.055) | (0.024) | (0.005) | (0.003) | (0.045) | (0.017) | (0.004) | (0.007) | (0.072) | (2.446) |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| County FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| State FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.149 | 0.168 | 0.132 | 0.114 | 0.144 | 0.202 | 0.114 | 0.015 | 0.019 | 0.190 | 0.125 |
| $N$ | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 | 130043 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, and *** indicate $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively.
Each column is taken from a separate regression by using Equation 4.4.
The $mda17 \times AA$ indicates the interaction between an MDA of 17 and African-American ratio to the total population.
The $mda18 \times AA$ indicates the interaction between an MDA of 18 and African-American ratio to the total population.
The $mda17 \times male$ indicates the interaction between an MDA of 17 and male ratio to the total population.
The $mda18 \times male$ indicates the interaction between an MDA of 18 and male ratio to the total population.

## B.3 Definitions of SSOCS Crime

SSOCS defines school activities as activities happening in school buildings, on school grounds, on school buses, and at places that hold school-sponsored events or activities. Unless otherwise specified, this refers to normal school hours or to times when school activities/events were in session. SSOCS provides information on a variety of topics related to crime and safety, including: school practices and programs, parent and community involvement at school, school security, staff training, limitations on crime prevention, frequency of crime and violence at school, frequency of incidents reported to police or law enforcement, frequency of hate crimes, gang-related crimes, and gang-related hate crimes, disciplinary problems and disciplinary actions, and other school characteristics related to school crime. Following the UCR definition, I classify the total school crime recorded in SSOCS into three broad categories: property crime, violent crime, and drug-related crime. A detail definitions of SSOCS crime is given below, which is retrieved from https://nces.ed.gov/surveys/ssocs/pdf/SSOCS_2016_Questionnaire.pdf.

### B.3.1 Property Crime

Property crime includes theft/larceny and vandalism. *Theft/larceny* is taking things worth over $10 without personal confrontation. In other words, theft/larceny means the unlawful taking of another persons property without personal confrontation, threat, violence, or bodily harm. This includes pocket picking, stealing a purse or backpack (if left unattended or no force was used to take it from owner), theft from a building, theft from a motor vehicle

or motor vehicle parts or accessories, theft of a bicycle, theft from a vending machine, and all other types of thefts.

*Vandalism* indicates the willful damage or destruction of school property including bombing, arson, graffiti, and other acts that cause property damage. This includes damage caused by computer hacking.

### B.3.2 Violent Crime

Violent crime recorded in SSOCS includes threats, robberies, physical attacks with a weapon, and sexual crime. A *threat* is a communication of potential or verbal attack to individuals or a property. *Threats with weapon* implies the threat of an actual and intentional touching or striking of another person against his or her will, or the intentional causing of bodily harm to an individual.

*Robbery* is the taking things by force, which implies the taking or attempting to take anything of value that is owned by another person or organization, under confrontational circumstances by force or threat of force or violence and/or by putting the victim in fear. A key difference between robbery and theft/larceny is that robbery involves a threat or battery.

*Physical attack or fight with a weapon* is an actual and intentional touching or striking of another person against his or her will, or the intentional causing of bodily harm to an individual.

A *sexual crime* is the violence committed against someone because of their sex. This types of incident includes sexual assault, rape, sexual harassment, sexual orientation. Sex-

ual assault is an incident that includes threatened rape, fondling, indecent liberties, or child molestation. Both male and female students can be victims of sexual assault. Classification of these incidents should take into consideration the age and developmentally appropriate behavior of the offender(s). Sexual harassment  conduct that is unwelcome, sexual in nature, and denies or limits a student's ability to participate in or benefit from a school's education program. The conduct can be carried out by school employees, other students, and non-employee third parties. Both male and female students can be victims of sexual harassment, and the harasser and the victim can be of the same sex. The conduct can be verbal, nonverbal, or physical. Sexual orientation means one's emotional or physical attraction to the same and/or opposite sex. Rape is a forced sexual intercourse (vaginal, anal, or oral penetration). This includes sodomy and penetration with a foreign object. Both male and female students can be victims of rape

### B.3.3 Drug-related Crime

According to the SSOCS, a *drug-related* crime consists of the use and/or possession of illegal or non-prescribed drugs and the provision of alcohol to minors. *Drug use* consists of the number of recorded incidents of students distributing, possessing, or using prescription drugs inappropriately. These instances occur when individuals use and distribute drugs without a prescription. *Alcohol use* data consists of the number of recorded incidents of students distributing, possessing, or using alcohol.

## B.4 MDA and Juvenile Crime in School

**Table B.3.** Summary Statistics for School Crime, Individual Category

| crime rate | All States (MDA 16 and above) | States with MDA16 | States with MDA17 | States with MDA18 |
|---|---|---|---|---|
| total crime rate | 52.80 | $49.50^{ab}$ | $47.44^{a}$ | $57.75^{b}$ |
| | (178.51) | (153.7) | (69.9) | (222.97) |
| property crime rate | 13.16 | $11.68^{ab}$ | $10.26^{a}$ | $15.57^{b}$ |
| | (44.75) | (21.94) | (16.46) | (63.52) |
| theft rate | 7.86 | $7.09^{ab}$ | $6.48^{a}$ | $9.07^{b}$ |
| | (29.89) | (13.43) | (10.47) | (42.86) |
| vandalism rate | 5.30 | $4.58^{ab}$ | $3.78^{a}$ | $6.50^{b}$ |
| | (23.48) | (14.47) | (11.62) | (31.93) |
| violent rate | 34.69 | $33.75^{ab}$ | $33.05^{a}$ | $36.21^{b}$ |
| | (128.77) | (147.81) | (57.71) | (130.24) |
| physical attacks | 20.44 | $19.70^{ab}$ | $21.04^{a}$ | $20.89^{b}$ |
| with weapon | (61.36) | (48.73) | (43.05) | (76.02) |
| threat rate | 13.41 | $13.40^{ab}$ | $11.57^{a}$ | $14.16^{b}$ |
| | (80.74) | (107.49) | (27.62) | (64.78) |
| robbery rate | 0.69 | $0.51^{ab}$ | $0.36^{a}$ | $0.98^{b}$ |
| | (18.93) | (3.41) | (2.11) | (28.43) |
| sexual crime rate | 0.15 | $0.13^{ab}$ | $0.08^{a}$ | $0.19^{b}$ |
| | (2.06) | (0.92) | (0.63) | (2.95) |
| drug-related crime rate | 4.95 | $4.08^{ab}$ | $4.13^{a}$ | $5.96^{b}$ |
| | (30.29) | (10.24) | (13.37) | (44.00) |
| drug use rate | 3.69 | $2.86^{ab}$ | $3.06^{a}$ | $4.60^{b}$ |
| | (29.6) | (7.87) | (11.72) | (43.57) |
| alcohol rate | 1.26 | $1.21^{ab}$ | $1.07^{a}$ | $1.36^{b}$ |
| | (4.52) | (5.26) | (4.08) | (3.92) |
| $N$ | 7932 | 3132 | 1335 | 3465 |

Note: Standard deviations are shown in parentheses.
This Table shows the summary statistics of constituent crime for broad categories.
$^{a}$ indicates the 5% level of significance for a two-tailed t-test of difference between crime rates in states with MDA 16 and that of 17.
$^{b}$ indicates the 5% level of significance for a two-tailed t-test of difference between crime rates in states with MDA 16 and that of 18.

**Table B.4.** Interaction
Terms and Crime in School, Individual Categories for Male and African-American Students

| | (1) theft rate | (2) vandalism rate | (3) robbery rate | (4) phy_attacks rate | (5) threat rate | (6) sexual rate | (7) drug use rate | (8) alcohol rate |
|---|---|---|---|---|---|---|---|---|
| mda17 | 1.541 | 0.263 | 0.143 | 4.524 | 16.757 | 0.183 | 0.555 | 0.033 |
| | (2.825) | (1.981) | (1.126) | (6.667) | (8.738) | (0.134) | (1.841) | (0.400) |
| mda18 | 3.126 | 5.069 | 4.333 | 22.352 | 37.673 | 0.491 | 4.733 | 0.144 |
| | (4.849) | (3.383) | (4.920) | (11.467) | (24.975) | (0.328) | (3.138) | (0.683) |
| mda17×AA | 0.005 | 0.023 | 0.005 | 0.063 | 0.029 | 0.000 | 0.004 | 0.007 |
| | (0.031) | (0.022) | (0.012) | (0.074) | (0.097) | (0.001) | (0.020) | (0.004) |
| mda18×AA | 0.043 | 0.040 | 0.004 | 0.075 | 0.055 | 0.000 | 0.008 | 0.005 |
| | (0.040) | (0.028) | (0.016) | (0.095) | (0.124) | (0.002) | (0.026) | (0.006) |
| mda17×male | 0.029 | 0.006 | 0.003 | 0.089 | 0.309 | 0.004 | 0.007 | 0.002 |
| | (0.055) | (0.038) | (0.022) | (0.129) | (0.169) | (0.003) | (0.036) | (0.008) |
| mda18× male | 0.138 | 0.108 | 0.090 | 0.223 | 0.577 | 0.011 | 0.155 | 0.002 |
| | (0.179) | (0.055) | (0.031) | (0.187) | (0.345) | (0.014) | (0.111) | (0.011) |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| School FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| State FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.125 | 0.148 | 0.116 | 0.114 | 0.117 | 0.110 | 0.125 | 0.203 |
| N | 7932 | 7932 | 7932 | 7932 | 7932 | 7932 | 7932 | 7932 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, and *** indicate $p < 0.05$, $p < 0.01$, and $p < 0.001$ respectively.
Each column is taken from a separate regression by using Equation 4.6.
The $mda17 \times AA$ indicates the interaction between an MDA of 17 and African-American student ratio to the total students.
The $mda18 \times AA$ indicates the interaction between an MDA of 18 and African-American student ratio to the total students.
The $mda17 \times male$ indicates the interaction between an MDA of 17 and male-student ratio to the total students.
The $mda18 \times male$ indicates the interaction between an MDA of 18 and male-student ratio to the total students.

**Table B.5.** Interaction Terms and Crime in School, Broad Categories for City and Suburb

| | (1) total crime rate | (2) property crime rate | (3) violent crime rate | (4) drug-related crime rate |
|---|---|---|---|---|
| mda17 | 5.854 | 1.594 | 4.191 | 0.246 |
| | (18.060) | (4.753) | (12.802) | (3.217) |
| mda18 | 24.754 | 2.927 | 18.403 | 4.176 |
| | (19.651) | (5.176) | (13.929) | (3.497) |
| mda17×city | 2.782 | 0.613 | 1.720 | 0.395 |
| | (4.275) | (1.126) | (3.030) | (0.760) |
| mda18×city | 3.433 | 1.016 | 4.470 | 0.096 |
| | (7.814) | (2.057) | (5.539) | (1.391) |
| mda17×suburb | 0.825 | 0.060 | 0.382 | 0.511 |
| | (5.357) | (1.410) | (3.798) | (0.955) |
| mda18×suburb | 8.290 | 4.683 | 11.645 | 2.023 |
| | (8.555) | (3.252) | (6.065) | (1.525) |
| Control Variables | Yes | Yes | Yes | Yes |
| School FE | Yes | Yes | Yes | Yes |
| State FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| $R^2$ | 0.122 | 0.128 | 0.120 | 0.131 |
| N | 7932 | 7932 | 7932 | 7932 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, and *** indicate $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively.
Each column is taken from a separate regression by using Equation 4.6.
The dependent variable is the crime rate per 1,000 students.
The $mda17 \times city$ indicates the interaction between an MDA of 17 and a binary indicator for city if schools are located in a city area.
The $mda18 \times city$ indicates the interaction between an MDA of 18 and a binary indicator for city if schools are located in a city area.
The $mda17 \times suburb$ indicates the interaction between an MDA of 17 and a binary indicator for suburb if schools are located in a suburb area.
The $mda17 \times suburb$ indicates the interaction between an MDA of 18 and a binary indicator for suburb if schools are located in a suburb area.
The reference group is schools located in town or rural areas.

**Table B.6.** Interaction Term and School Disciplinary Actions for African-American and Male Student Ratio

| | (1) expulsion rate | (2) outside-suspension rate | (3) inside-suspension rate | (4) transfer rate | (5) detention rate | (6) probation rate |
|---|---|---|---|---|---|---|
| mda17 | 0.616 | 3.216 | 4.247 | 0.517 | -6.226 | -5.715 |
| | (0.755) | (4.568) | (2.787) | (1.752) | (7.353) | (8.105) |
| mda18 | 3.465 | 15.117 | 1.137 | 2.840 | -6.299 | -0.092 |
| | (3.287) | (7.799) | (4.764) | (2.986) | (5.307) | (3.589) |
| mda17 ×male | 0.013 | 0.061 | 0.090 | 0.008 | 0.116 | 0.106 |
| | (0.015) | (0.088) | (0.054) | (0.034) | (0.126) | (0.141) |
| mda18×male | 0.070 | 0.353 | 0.143 | 0.083 | 0.121 | 0.007 |
| | (0.121) | (0.227) | (0.078) | (0.049) | (0.138) | (0.059) |
| mda17×AA | 0.007 | 0.073 | 0.091 | 0.004 | 0.017 | 0.020 |
| | (0.008) | (0.051) | (0.031) | (0.019) | (0.015) | (0.023) |
| mda18×AA | 0.004 | 0.188 | 0.117 | 0.040 | 0.004 | 0.004 |
| | (0.011) | (0.164) | (0.039) | (0.025) | (0.019) | (0.030) |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| School FE | Yes | Yes | Yes | Yes | Yes | Yes |
| State FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.130 | 0.147 | 0.160 | 0.133 | 0.188 | 0.117 |
| $N$ | 7932 | 7932 | 7932 | 7932 | 7932 | 7932 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, *** indicate $p < 0.05$, $p < 0.01$, $p < 0.001$ respectively.
Each column is taken from a separate regression by using Equation 4.6.
The dependent variable is the crime rate per 1,000 students
The $mda17 \times AA$ indicates the interaction between an MDA of 17 and African-American student ratio to the total students.
The $mda18 \times AA$ indicates the interaction between an MDA of 18 and African-American student ratio to the total students.
The $mda17 \times male$ indicates the interaction between an MDA of 17 and male-student ratio to the total students.
The $mda18 \times male$ indicates the interaction between an MDA of 18 and male-student ratio to the total students.

**Table B.7.** Interaction Term and School Disciplinary Actions for City and Suburb

| | (1) expulsion rate | (2) outside-suspension rate | (3) inside-suspension rate | (4) transfer rate | (5) detention rate | (6) probation rate |
|---|---|---|---|---|---|---|
| mda17 | 0.171 | 3.094 | 2.607 | -0.916 | -1.086 | 1.573 |
| | (0.858) | (5.030) | (2.549) | (2.372) | (1.603) | (2.984) |
| mda18 | 0.770 | 0.251 | 7.454 | 2.642 | -0.343 | -1.556 |
| | (0.945) | (5.539) | (5.806) | (2.611) | (1.772) | (3.300) |
| mda17×city | 0.073 | 1.292 | 0.757 | 0.102 | 0.371 | 0.341 |
| | (0.232) | (1.358) | (0.688) | (0.641) | (0.435) | (0.811) |
| mda18×city | 0.109 | 0.512 | 1.099 | 0.668 | 2.781 | 2.022 |
| | (0.418) | (2.451) | (1.242) | (1.156) | (1.784) | (1.460) |
| mda17×suburb | 0.021 | 0.190 | 0.071 | 0.035 | 0.226 | 0.304 |
| | (0.253) | (1.484) | (0.752) | (0.700) | (0.473) | (0.881) |
| mda18×suburb | 0.146 | 2.360 | 1.354 | 0.788 | 2.425 | 1.205 |
| | (0.404) | (2.371) | (1.201) | (1.118) | (2.757) | (1.409) |
| Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| School FE | Yes | Yes | Yes | Yes | Yes | Yes |
| State FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.150 | 0.149 | 0.190 | 0.150 | 0.139 | 0.136 |
| $N$ | 7932 | 7932 | 7932 | 7932 | 7932 | 7932 |

Note: Standard errors are in parentheses and are clustered at the state level.
*. **, and *** indicate $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively.
Each column is taken from a separate regression by using Equation 4.6.
The dependent variable is the crime rate per 1,000 students.
The $mda17 \times city$ indicates the interaction between an MDA of 17 and a binary indicator for city if schools are located in a city area.
The $mda18 \times city$ indicates the interaction between an MDA of 18 and a binary indicator for city if schools are located in a city area.
The $mda17 \times suburb$ indicates the interaction between an MDA of 17 and a binary indicator for suburb if schools are located in a suburb area.
The $mda17 \times suburb$ indicates the interaction between an MDA of 18 and a binary indicator for suburb if schools are located in a suburb area.
The reference group is schools located in town or rural areas.