RECREATIONAL MARIJUANA LEGALIZATION AND CRIME IN THE CONTEXT OF SOCIAL DISORGANIZATION THEORY IN DENVER, COLORADO

by

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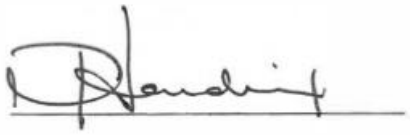

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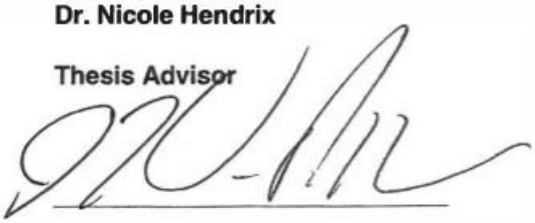

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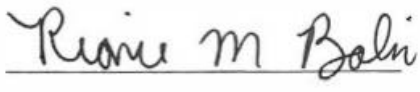

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ABSTRACT

Recreational marijuana legalization is a growing phenomenon in the United States. Currently, eight states and the District of Columbia permit the sale of recreational marijuana. Recreational use refers to ingestion of the drug without physician recommendation for the purposes of intoxication. A review of the literature indicates there is still much to be understood about the relationship between drug use and crime and recreational marijuana legalization itself.

Some fear that an increase in availability will result in direct harm to a community. The current study utilized an interrupted time series analysis and multiple linear regression to test the impact of recreational marijuana legalization on crime in Denver, Colorado in the context of social disorganization theory. Findings suggest that the introduction of recreational marijuana into a community may not significantly impact rates of reported crime per 100,000 residents. However, when covariates derived from concepts of social disorganization theory are accounted for, legalization has a significant impact on Part 1, violent, and disorder crime in Denver, Colorado. Several variable results were inverse of the hypothesized direction. The current study concludes with discussion of limitations and implications for continued research.

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Chapter One: Introduction

After the prohibition of alcohol failed, politicians and legislators of the United States turned their attention to a different substance that, at the time, was a common household product. The misplaced fear American citizens felt towards immigrants was foundational to marijuana criminalization in the United States (Hudak, 2016; Martin & Rashidian, 2014; Nicholson, Duncan, & White, 2002). Politicians in the 1920s and 1930s associated use of the drug with African Americans and the Mexican immigrants fleeing in from the south due to a civil war (Hudak, 2016; Martin & Rashidian, 2014). Officials at the time exploited the prejudice of Americans to criminalize marijuana as a way to exert control over minority populations (Adams, 2016). This influence, paired with propaganda in the form of books and movies at the time, established the negative connotation associated with marijuana use (Hudak, 2016). This historical context is essential to understand current perceptions of marijuana use in that it shows how marijuana criminalization was not about the drug itself or the effects of its use. The original founding of marijuana use as an unacceptable behavior may feed into a continued misunderstanding of the drug today and how it may influence a community. The current study aims to provide empirical evidence of how recreational marijuana impacts a community in the form of reported crime.

As of January 8, 2018, 30 states have legalized marijuana for medical use, or as a treatment for certain debilitating illnesses (Austin, 2017). Some argue that using marijuana for medicinal purposes is less harmful than current options available on the market (Reiman & Todd, 2014). This trend in legalization follows the idea that the harm from the prohibition of marijuana outweighs harms posed by permitting its use and increasing its availability in the United States. While legalization is currently controversial, it has occurred nonetheless. This is

most evident in the legalization of recreational marijuana in recent years. Currently, in the United States, recreational use[1] of marijuana is permitted in eight states and the District of Columbia (Robinson, 2017). The current study aims not to investigate either side of the controversy relevant to recreational marijuana legalization. Instead, its purpose is to analyze whether there is a measurable impact on reported crime in a community after the introduction of recreational marijuana legalization.

Research shows that legalization has altered the perception of marijuana use as risky behavior, especially among adolescents (Schuermeyer et al., 2014; Wall et al., 2012). Some may argue that this will result in a direct increase in use. However, studies have found that medical marijuana legalization has not led to an increased frequency of use in adolescents (Choo et al., 2014; Lynne-Landsman, Livingston, & Wagenaar, 2013). This is evidence that medical legalization in the United States has not behaved as some believed it would. This may also be the case with recreational marijuana legalization. As such, the current study aims to determine if there has been a measurable impact on crime in Denver when analyzing crime trends post-legalization.

The state of Colorado was the first in the country to legalize recreational use of marijuana. For this reason, the city of Denver, Colorado was selected for analysis. As an urban environment, social disorganization theory best applies as an explanation for existing crime in the community and serves as this study's theoretical foundation. Shaw and McKay (1942) first used social disorganization theory as an explanation for criminal behavior and delinquency in Chicago, Illinois. This theory holds that ethnic heterogeneity, economic status, and residential

[1] Recreational use refers to consumption of the drug for the purpose of intoxication outside of medical recommendation (Nicholson, Duncan, & White, 2002).

instability impact a community's ability to establish adequate social controls (Shaw & McKay, 1942). It also states that collective efficacy, or informal social controls, are essential in maintaining order within a community (Shaw & McKay, 1942). In turn, a community that lacks cohesiveness is one that encourages criminal and delinquent behavior. When tested, these findings have been supported (Kubrin, 2014; Veysey & Messner, 1999; Waring & Weisburd, 2002). Prior research has found that concepts of social disorganization are known to impact crime in the urban community (Cullen & Pratt, 2003; Shaw & McKay, 1944; Liska & Chamlin, 1984; Lowenkamp, Cullen, & Pratt, 2003; Sampson & Groves, 1989; Veysey & Messner, 1999; Waring & Weisburd, 2002). As such, the current study used both direct and indirect measures of concepts of social disorganization theory to account for real influences on crime in Denver. When these concepts were considered, recreational marijuana legalization may have caused additional changes in crime.

Residents of Colorado do not universally support recreational legalization. Approximately 45% of state voters indicated they did not want Amendment 64 added to the state constitution, permitting the recreational sale of marijuana in Colorado (Colorado Secretary of State, 2012). There have also been attempts to repeal Amendment 64 since 2013 (Roberts, 2013; Thomas, 2013). Social conflict to this degree may imply that recreational legalization has not led to an increase in use or an increase in crime. If findings from the current study did not find an increase in crime, recreational legalization may not directly harm a community in the form of reported crime, challenging some ill-informed assumptions individuals may be making about the impact of legalization. Conversely, if analysis returned an increase in crime post-legalization, this may be evidence that recreational marijuana legalization produces measurable harm to a community in the form of reported crime.

Recreational marijuana legalization is growing in the United States. First and foremost, the current study determined whether legalization of recreational marijuana had impacted crime in Denver. This study also expanded upon research related to concepts of social disorganization theory and how they influence crime in an urban community. Finally, the current study contributed to our understanding of how recreational marijuana legalization can impact a community and aimed to educate the future of recreational legalization in the United States. As legalization grows in the United States, it is essential that research continues to examine the impact it has on both individuals and communities.

Chapter Two: Review of the Literature and Background Data

The present study examined the effect of recreational marijuana legalization on crime in Denver, Colorado. The geographic distribution and trends of crime in Denver were analyzed within the context of social disorganization. Prior research has found that concepts of social disorganization (residential instability, economic disadvantage, and ethnic heterogeneity) considerably affect crime in urban communities (Kubrin & Weitzer, 2003; Sampson, Raudenbush & Earls, 1997; Tolsma & Van der Meer, 2017; Veysey & Messner, 1999; Waring & Weisburd, 2002). Previous research has failed to thoroughly examine the potential effect of recreational drug legalization on community-level crime outcomes. The current study will fill this gap in the literature and add to what is known about the relationship between crime and drug legalization.

Historical Context

Marijuana, a strain of the Cannabis Sativa plant bred for intoxication, was once broadly used in household and medicinal products in the United States (Hudak, 2016; Sawler et al., 2015). Prior to criminalization in the 1920s, marijuana was a widely produced agricultural product (Gerber, 2004; Hudak, 2016). A movement to criminalize marijuana began in the 1920s and 1930s as a political response to fear and prejudice that Americans felt towards Mexican immigrants and other minority populations in the United States (Hudak, 2016; Martin & Rashidian, 2014). At this time, these were the individuals predominately associated with using marijuana (Martin & Rashidian, 2014). Harry J. Anslinger, the original commissioner of the Bureau of Narcotics, laid the foundation of his political career as an advocate for the prohibition of alcohol (Gerber, 2004). After the prohibition of alcohol failed, Anslinger switched his focus to marijuana (Hudak, 2016). His speeches and other publications were heavy with rhetoric that

painted marijuana users as unpredictable and harmful to society (Anslinger & Cooper, 1937). At one point, Anslinger and Cooper (1937) wrote the following:

> No one can predict what may happen after the smoking of the weed. I am reminded of a Los Angeles case in which a boy of seventeen killed a policeman. They had been great friends. Patrolling his beat, the officer often stopped to talk to the young fellow, to advise him. But one day the boy surged toward the patrolman with a gun in his hand; there was a blaze of yellowish flame, and the officer fell dead. (p. 1)

Similar to this instance, many of Anslinger's publications included detailed descriptions of serious criminal events where heinous acts were committed under the influence of marijuana. Those publications expanded the negative public perceptions of the drug. Perceptions were further influenced by popular media, like the movie "Reefer Madness" (Meade, Hoerl, & Gasnier, 1936). This film showed images of men and women jumping from the seventh story of an apartment building while under the influence of marijuana (Meade, Hoerl, & Gasnier, 1936). To add to this portrayal of marijuana and those who used it, federal research at the time claimed that users were more likely to commit violent crimes (Bromberg, 1934; Stanley, 1931; Walton, 1940). All of this led to the passage of The Marihuana[2] Tax Act of 1937, which prohibited its use in the United States (Caulkins, Hawken, Kilmer, & Kleiman, 2012). Harry Anslinger died in 1975, but his legacy of combating drug use in the United States was continued by President Richard Nixon (Adams, 2016).

The passage of the Controlled Substances Act of 1970, encouraged by President Nixon and his War on Drugs, classified marijuana as a schedule I substance (Martin & Rashidian, 2014). Schedule I is the most severe classification and is assigned to drugs the federal

[2] "Marihuana" is the outdated spelling used for clarification purposes.

government believes are most often abused and have no accepted use as a medical treatment (Drug Enforcement Agency Drug Scheduling, 2017). Currently, the federal government continues to classify marijuana under the most severe schedule (Drug Enforcement Agency Drug Scheduling, 2017). This classification has created a unique conflict between federal law enforcement and states that have legalized marijuana for recreational and medical use. The present study investigated crime within the unique context of recreational marijuana legalization. The purpose of this study was not to argue whether marijuana should be legalized; that controversy exceeds the scope of this project. Instead, the current study aimed to examine the impact of recreational marijuana on crime in Denver, Colorado while also accounting for concepts of social disorganization and their continued influence on crime.

Trends in Marijuana Use

Marijuana is the most produced and used illicit substance in the world (United Nations Office on Drugs and Crime, 2011). Globally, marijuana use has been legalized in multiple countries including (but not limited to) Spain, Peru, the Netherlands, Jamaica, Israel, Mexico, Costa Rica, Cambodia, Argentina, Switzerland, Australia, Canada, and North Korea (Torres, 2017). In 2014, the United Nations Office on Drugs and Crime estimated that marijuana had been used at least once in the past year by 3.8% of the global population (UNODC, 2014).

According to the 2016 Gallup poll, 13% of adults in the United States use marijuana recreationally, an increase from the rate of 7% as recorded in the 2013 poll (McCarthy, 2016). Based on aggregated data from the 2013, 2015, and 2016 Gallup polls, more males smoke and experiment with marijuana in the United States than females (McCarthy, 2016). Additionally, adults with an annual income less than $30,000.00 indicated the highest rate of active use of recreational cannabis (McCarthy, 2016). Research completed by the National Institute of Drug

Abuse (2017) indicated that marijuana use is most prevalent among 12- to 25-year-olds. Nationally, it was estimated in 2015 that 7% of all adolescents 12 to 17 years of age were current marijuana users. This statistic equates to 1.8 million adolescents in that age range at time of estimation (SAMHSA, 2017). Additionally, findings have indicated that marijuana use is more frequent in adolescent males versus females of the same age (NIDA, 2017).

Marijuana use in the United States has increased over time (McCarthy, 2016; NIDA, 2017). An increase may be due to a shift in public perception of risk associated with use. This point is illustrated by the work of Schuermeyer and colleagues (2014). Schuermeyer et al. (2014) collected self-report data to compare perceptions of marijuana use and availability in Colorado to other non-medical marijuana states. Findings showed that Colorado residents were more likely to indicate that marijuana use was acceptable behavior when compared to residents of non-medical marijuana states (Schuermeyer et al., 2014). These findings suggest that commercialization of marijuana leads to an increase in availability in the community. This increase in availability may lead to a normalization of its use within a community. Schuermeyer and colleagues (2014) concluded that their finding is suggestive of increased risk of marijuana use and dependence, though it is yet to be seen if a normalization of the behavior leads to a definitive increase in use.

In an analysis of marijuana use post-legalization, Wall and colleagues (2011) found a higher rate of adolescent use in states with medical marijuana legalization. Consistent with the findings of Schuermeyer et al. (2014), Wall and colleagues (2011) found a lower perceived risk associated with engagement in marijuana use when compared to adolescents in states that had not legalized marijuana. It is unclear if this lower risk associated with the behavior was the initial cause of medical legalization or an effect of the legislation itself. Opponents of legalization argue this is evidence proving legalization increases dissemination to adolescents and young adults,

resulting in an increased rate of use. However, this may not be the case. Studies have found that marijuana legalization has not led to an increased frequency of use in adolescents (Choo et al., 2014, Lynne-Landsman, Livingston, & Wagenaar, 2013). While findings suggest adolescents are the highest population of marijuana users in the United States (NIDA, 2017), research has yet to conclusively state the effect of recreational legalization on the rate of adolescent use in the United States.

The long-term impact of legalization on rates of use is unknown (Lynne-Landsman, Livingston & Wagenaar, 2013; Schuermeyer et al., 2014). Decriminalization of marijuana in the United States gave way to medical legalization. Value was found in the use of the drug as a medicinal treatment for several illnesses and may have potentially led to a lowering of perceived risk associated with use of the drug and the beginning of its normalization into several American communities. Theoretically, this shift in perception associated with marijuana paired with an increase in availability due to recreational legalization may have led to an increase in use. While the current study did not measure changes in the use of marijuana, the effect of legalization on crime was analyzed in Denver, Colorado.

Marijuana Legalization in the United States

Legal marijuana has become more accessible in the past 24 years in the United States (Crombie, 2014). The path to legalization of recreational use of marijuana began with decriminalization and acknowledgment of its potential as a medical treatment. Decriminalization of marijuana in the United States began in 1993 (Room, Fischer, Hall, Lenton, & Reuter, 2010). Oregon became the first state to pass legislation making possession of small amounts of marijuana a minor ticket offense (Crombie, 2014). Within the following 5 years, nine more states joined the decriminalization movement, including Alaska, Maine, California, Colorado,

Mississippi, New York, Nebraska, North Carolina, and Ohio (Austin, 2017). From 1996 to 2012, 18 states legalized cannabis for medical use pending physician approval (Austin, 2017). Ailments such as HIV, multiple sclerosis, cancer, and glaucoma were accepted illnesses that could be treated with marijuana (Hill, 2015). Medical marijuana has also been utilized to treat neurodevelopmental-related conditions such as Tourette's and chronic seizures (Whiting et al., 2015). Medical marijuana is still heavily regulated, as patients have access only from certified medical providers (Austin, 2017). The impact of these changes on drug availability in the United States has been examined in research. Compton and colleagues (2016) found that in a survey of 565,500 adults in the United States, participation in medical marijuana use increased from 10.4% in 2002 to 13.3% in 2014. The state of Colorado legalized medical marijuana in 2000 (Kamin, 2012). In the 13-year span from 2001 to 2014, 115,467 approved licenses for patient medical marijuana use were issued (Colorado Department of Public Health & Environment, 2017).

After several states accepted the introduction of medical marijuana into their communities, several followed with permitting recreational marijuana. Recreational marijuana use refers to use of the drug without medical recommendation for the purpose of intoxication (Nicholson, Duncan, & White, 2002). Currently, eight states and the District of Columbia have passed laws allowing recreational use of marijuana (Robinson, 2017). Additional states considering recreational legalization include Illinois, New York, and Rhode Island (Cerdá, Wall, Keyes, Galea, & Hasin, 2012). This form of legalization is the least regulated marijuana has been in the United States since the Civil War (Hudak, 2016).

Recreational marijuana legalization was included on the ballot referendum in the state of Colorado in 2012. After a passing vote, recreational marijuana was available January 1, 2013 (Brohl, Kammerzell, & Koski, 2015). Protection for recreational use was added to the Colorado

State Constitution through Amendment 64, which calls for marijuana to be regulated and taxed similarly to alcohol (C.O. Const. amend. LXIV). Amendment 64 allows citizens and visitors aged 21 and up to use marijuana recreationally in the privacy of their homes (C.O. Const. amend. LXIV). Amendment 64 passed with 54.8% of voters in favor, while 45.1% voted against it (Colorado Secretary of State, 2012). These results demonstrate that the voting population of Colorado was highly conflicted about recreational legalization. While there are citizens of Denver, Colorado that oppose legalization (Roberts, 2013; Thomas, 2013), recreational ratification reflects a society that, for the most part, accepts this previously illegal behavior. Some might assume that if this recreational legalization trend continues, the United States may see a point where marijuana is federally legalized. Conflict within Colorado about the social acceptability of recreational marijuana use could mean that legalization has little effect on crime in Denver. Conflicted citizenry may reflect greater societal conflicts about the acceptability of recreational marijuana use.

While legalization has developed over time in the United States, those that oppose it are concerned it may result in a direct increase in crime (Trilling, 2016). However, this assumes there is a direct relationship between drug use and criminal behavior. The current study offers some insight into if this fear has come to fruition after recreational legalization has been introduced into a community, as well as fills an existing gap in drug-crime relationship research concerning recreational marijuana availability.

The Drug-Crime Relationship

An increase in availability of marijuana may lead to an increase in use. A potential growth in use is what some fear may lead to more crime. However, the relationship between drug use and crime is complex. Many studies have been completed in attempts to understand better

how crime and drug use interact with one another. Meta-analyses of existing literature have found a strong correlation between criminal offending and drug use. Gandossy, Williams, Cohen, & Harwood (1980) completed one of the earliest comprehensive analyses of studies in Canada, Europe, Australia, and the United States. After analyzing arrest records, the records of offenders in drug treatment, and personal testimonies of convicted offenders, Gandossy and colleagues (1980) concluded there was a high correlation between the use of drugs and committing crime. A second analysis done by McBride and McCoy (1993) concluded that there is a strong correlation between drug use and criminal behavior; however, the use of drugs cannot be concluded as a direct cause of crime. Furthermore, the researchers suggested that instead of "innocents" lured into criminal behavior through drug use, drug abuse and criminal activity are a part of a broader set of deviant behaviors or a criminal subculture (McBride & McCoy, 1993). Simply put, involvement in criminal activity does not cause drug use, just as drug use does not lead directly to crime; rather, acceptance into a deviant subculture could correlate to both behaviors.

Bennett, Halloway, and Farrington (2008) reviewed 30 studies and concluded that the risk of offending was at least three to four times greater for drug users when compared to non-drug users. Their findings held when compared against varying crime types and drugs used; the odds of offending were highest among crack cocaine users. When analyzing differences in intent behind drug use, the lowest risk of violent offending was among recreational drug users (Bennett, Halloway, & Farrington, 2008). These findings suggest that post-recreational legalization, there may not be an increase in violent crime, or crime in general.

Specific to marijuana use, Derzon and Lipsey (1999) completed another analysis of existing research. Derzon and Lipsey (1999) reviewed 30 independent studies using meta-analytic techniques. The studies used focused on the relationship between marijuana use and

juvenile delinquency. The authors found a positive and significant association between marijuana use and delinquency (Derzon & Lipsey, 1999). More specifically, correlations between marijuana use and property offenses, aggressive behavior, and delinquency were found (Derzon & Lipsey, 1999). However, based on variance in the pattern of their findings, it could not be determined if marijuana use led to crime and delinquency, or vice versa (Derzon & Lipsey, 1999). Instead, Derzon & Lipsey (1999) concluded that co-morbidity, or co-occurrence, may have caused the relationship between drug use and crime in adolescents. The present study will account for the role juveniles may play in predicting crime in Denver, Colorado.

While meta-analyses may lend some understanding of the drug-crime relationship, direct tests of the possible connection have also offered further insight. Using self-report data, Dorsey and Middleton (2017) analyzed a population of probationers to determine if there was a relationship between drug use and their current offenses. Nearly 70% of probationers in the United States reported a history of drug use, with 32% indicating they were using illegal drugs only a month before their last offense. Of these offenders, the drug with the highest reported rate of use was marijuana (Dorsey & Middleton, 2017). By contrast, another study conducted by White and Gorman (2000) analyzed national and city-level data sets. The data showed that crime trends vary by city; there was no black-and-white connection between any particular crime and drug. They also concluded that many pathways lead to participation in both drug use and criminal behavior (White & Gorman, 2000). The effect of medical marijuana legalization on Part I crime for all states that had allowed medicinal use of marijuana before 2006[3] were also examined. Findings suggested that there was no effect on Part I offenses. In fact, there was an indication of correlation between medical marijuana legalization and a reduction in assault and

[3] States include Alaska, California, Colorado, Hawaii, Maine, Montana, Nevada, Oregon, Rhode Island, Vermont, and Washington (Morris, TenEyck, Barnes & Kovandzic, 2014).

homicides (Morris, TenEyck, Barnes & Kovandzic, 2014). The present study analyzed several crime types to account for potential variance in a possible impact as a result of recreational marijuana legalization in Denver, Colorado.

Based on the literature, there are five potential causal models of the drug-crime relationship. Adapted from the work of Bennett and Holloway (2008), the first model holds that drug use is a direct cause of crime. An example of this model would be the drug-addicted individual who commits crime to feed a drug habit, as Gandossy, Williams, Cohen, and Harwood (1980) suggested. The second model is that crime causes drug use. Similar to the first model, this theory proposes that criminal behavior is the cause of drug use. These first two models propose a direct causal relationship between crime and drug use (Bennett, Holloway, & Farrington, 2008). Next is the reciprocal model. It states that drug use sometimes causes crime and vice versa, or that the relationship is bi-directional. The fourth model, the common-cause model, assumes that neither causes the another. Instead, both drug use and crime may be caused by another unaccounted-for variable. This model is reflected in conclusions drawn by McBride and McCoy (1993), who stated that drug use and crime are part of a deviant subculture. Finally, the last model states that the relationship between drugs and crime is a coincidence and not causally connected. Of all models, this is perhaps the least widely accepted (Bennett, Holloway, & Farrington, 2008). The variations in proposed models of the drug-crime relationship show its complexity. While there has been an abundance of research analyzing the relationship between drug use and criminal behavior, findings imply there are still many unanswered questions and areas that need to be further studied. The current study aims to help fill this gap in knowledge of how recreational drug legalization may impact crime.

A further exploration of the relationship between drug use and crime is necessary to determine if there is a direct causal relationship between recreational marijuana legalization and crime in Denver, Colorado. From previous research, it is known that drug use is prominent in populations of offenders, and while some researchers have stated that drugs have had a multiplying effect on crime (Gandossy, Williams, Cohen, & Harwood, 1980), a conclusion that one causes the other indefinitely cannot be drawn. This study analyzed crime after recreational legalization to offer some context on whether increased drug availability contributed to changes in crime in Denver, Colorado. The current study relied on a theoretical model built on the foundation of social disorganization theory to understand patterns and implications of crime. Understanding this helped explain the effect of legalization on crime within the city of Denver.

Social Disorganization Theory

The current study was informed by decades of research about concepts of social disorganization theory and how they can influence crime in an urban community. Clifford Shaw and Henry McKay are credited with creating this macro-level theory during the 1920s and 1930s at the University of Chicago (Akers & Sellers, 2013). Social disorganization is defined as the inability to realize universal values between members of a community who, as a result, are unable to maintain adequate social control, therefore increasing the likelihood of crime and delinquency (Kubrin, 2014; Shaw & McKay, 1942; Waring & Weisburd, 2002). Social influences on crime have been applied predominately to urban environments, though it was not created to exclusively explain crime in inner-city communities (Akers & Sellers, 2013).

With the foundation of social disorganization theory set by Shaw and McKay (1942), Sampson and Groves (1989) further examined application of the theory to urban communities. Similar to Shaw and McKay's findings (1942), Sampson and Groves (1989) suggested that low

economic status, ethnic heterogeneity, residential mobility, and family disruption contribute to social disorganization within a community. They proposed that higher levels of disorganization in a community lead to an increase in overall crime and delinquency (Lowenkamp, Cullen, & Pratt, 2003; Sampson & Groves, 1989; Veysey & Messner; 1999).

Within communities, two forms of social control are used to regulate behavior: formal and informal (Akers & Sellers, 2013). Formal controls are those exercised by institutions such as law enforcement agencies, churches, or schools that work to maintain stability (Sampson & Laub, 1999). Informal control, or social efficacy, is embodied in peer groups, families, and neighbors. These are individuals who show social cohesion in their willingness to interfere against deviance or undesirable behavior within the community and provide guardianship for other members (Sampson & Laub, 1999). Highly disorganized communities show positive correlations with arrest rates, alcohol use, and drug dependence (Liska & Chamlin, 1984). Research also suggests that creating stronger social control in a community can efficiently lower crime (Peterson, Krivo, & Harris, 2000).

In one of the earliest applications of social disorganization theory, Shaw and McKay (1942) argued that three structural features have the greatest impact on social controls in a community: ethnic heterogeneity (or cohesiveness), economic status, and residential instability. Their findings suggest that these factors weaken attachment to the community, thereby weakening social controls and creating greater potential for criminal or delinquent behavior (Boggess & Hipp, 2010; Shaw & McKay, 1942).

The diversity of ethnicity and race in a community, as mentioned in the work of Shaw and McKay (1942), has been found to reduce cohesiveness and collective efficacy (Sampson, Raudenbush, & Earls, 1997). Cohesion may encourage informal social control and, in turn, lower

crime. Literature suggests that higher racial heterogeneity may be positively correlated with all crime types, but more so to violent crime (Avison & Loring, 1986; Hipp, 2007). Racial and ethnic diversity may introduce some difficulty into a community process of developing social efficacy. Previous research suggests that communities with lower levels of collective efficacy are more prone to crime and deviant behavior (Kirk & Matsuda, 2011; Morenoff & Sampson, 1997; Sampson, Raudenbush, & Earls, 1997; Twigg, Taylor, & Mohan, 2010). The current study considered the potential impact that racial and ethnic diversity may have on crime in Denver, Colorado.

Like cohesion, residential stability implies citizens are invested in the community. Residential instability has been measured as property values, percentage of renters versus homeowners in a community, and homelessness. Findings show higher correlations of violent crime in communities with more residential instability (Boggess & Hipp, 2010; Sampson, Raudenbush, Earls, 1997; Tita & Greenbaum, 2009). Communities with higher rates of transience also have higher rates of property crime (Trickett, Osborn, & Ellingworth, 1995). This increase in property crime may be a result of fewer individuals invested financially in a community, which would lower informal social controls. The current study included a measure of transience to analyze a potential impact on reported crime in Denver.

Economic characteristics, as discussed by Shaw and McKay (1942), have been found to impact crime within communities greatly. Economic status has been measured by examining percentages of families on welfare in a community, unemployment rates, and mortgage foreclosures. Studies using these variables have consistently found that areas of concentrated disadvantage have higher rates of both property and violent crime (Hipp, 2007; Kubrin & Weitzer, 2003; Parker & Reckdenwald, 2008). Research findings also indicate that communities

with higher levels of disorganization have higher rates of drug use; although, as established in the previous section, it is a complicated relationship in which one cannot assume causation of one variable from another (Liska & Chamlin, 1984; Martinez, Rosenfeld, & Mares, 2009). The current study analyzed how economic status can influence crime by including a measure of the population in Denver, Colorado living in poverty.

The theoretical model of this study relied on past drug-crime relationship research and social disorganization theory to justify the inclusion of the theoretical concepts. The current study tested this relationship while informed by the context of social disorganization. The concepts of social disorganization theory have been found to influence crime in urban areas (Boggess & Hipp, 2010; Sampson, Raudenbush, & Earls, 1997; Tita & Greenbaum, 2009). Both direct and indirect measures of concepts of social disorganization were utilized by the current study to control for those effects on crime to gain a more transparent image of a possible relationship between crime and recreational legalization.

Current Gaps in the Literature

This study examined the effect of legalization of marijuana on crime in the city of Denver. It intended to contribute to what is known about the effects of the legalization of marijuana as gaps remain in the existing literature. Recreational marijuana legalization is a relatively new development. Studying the impact of recreational legalization on crime may offer more context for our understanding of the drug-crime relationship. If there is an increase in crime post-legalization, some support for the model suggesting that drug use leads to crime could be established. Conversely, if there is no crime increase identified, previous findings may be questioned claiming that marijuana use, theoretically encouraged through legalization, is directly harmful to society in terms of crime. It is also worth noting that recreational marijuana

legalization marks new territory for drug availability in the United States. Findings of the current study may challenge many assumptions made about the connection between drug use and criminal behavior if the study found no increase in crime post-legalization.

Social disorganization theory has been used to explain crime in urban communities since the 1940s (Akers & Sellers, 2013). This study replicated findings analyzing concepts of social disorganization theory and how they impact crime in an urban setting. This study investigated these topics in Denver, Colorado, a city with little known about the urban development of crime. It also expanded on what is known about the role of legalization of recreational marijuana on specific crime types. If there was no increase in violent crime, findings would be supportive of Bennett and colleagues' (2008) conclusion that recreational drug users were less likely to offend violently. If there was no increase in property crime, Derzon & Lipsey's (1999) findings suggesting that marijuana use and property offenses are positively correlated would not be supported.

The current study fills a gap in the literature surrounding potential implications of accepting a previously "deviant" labeled behavior. There may be unforeseen consequences of this trend. For example, the state of Nevada was the first to accept the deviant behavior of prostitution in the form of legalization. Prostitution is legalized in many counties of the state, which first began in 2004 (ProCon Historical Timeline, 2017). Some claim that the motivation to legalize prostitution was to lower the spread of diseases or improve the safety of those who engage in the act itself. However, an unanticipated effect of prostitution legalization was a dramatic increase in human trafficking (Farley, 2007). There are no precise estimations of how many people are trafficked into or out of Nevada. However, 107 children were recovered from sex traffickers in the state in 2016 (Laxalt, 2017). One can assume that if voters had known this

would be an effect of the legislation, the voting results might have gone the opposite direction. While this is not an attempt to compare recreational marijuana legalization to sex trafficking, it is still an important point to make about the unforeseen circumstances of accepting forms of deviance in the United States. This study aimed to examine if there have been unanticipated consequences of legalizing the recreational use of marijuana on crime.

The current study expands on existing research concerning the relationship between drug use and crime while filling a gap in research about recreational marijuana availability and crime in a community. Furthermore, it expands on a substantial body of research related to concepts of social disorganization theory and how they impact crime in the urban community of Denver, Colorado. Finally, the current study contributes to our understanding of how recreational marijuana legalization can impact a community and aims to educate the future of recreational legalization in the United States.

Chapter Three: Methodology

While a review of the literature shows there are some gaps in understanding of how recreational marijuana legalization may impact a community, there has been extensive research on the relationship between drug use and crime. Prior research informs that there are higher rates of drug use in offender populations (Dorsey & Middleton, 2017; White & Gorman, 2000). However, the relationship between drug use and crime is complex and difficult to understand despite many years of researching it (Bennett, Halloway, & Farrington, 2008; Derzon & Lipsey, 1999; Dorsey & Middleton, 2017; Gandossy, Williams, Cohen, & Harwood, 1980; McBride & McCoy, 1993; Morris, TenEyck, Barnes, & Kovandzic, 2014; White & Gorman, 2000). Marijuana use has been found to be associated with property offenses, aggressive behavior, and delinquency (Derzon & Lipsey 1999; Green et al., 2016), but it has never been concluded that marijuana use exclusively leads to crime and delinquency. Additionally, it has yet to be concluded how legalization influences rates of drug use (Lynne-Landsman, Livingston & Wagenaar, 2013; Schuermeyer et al., 2014), nor was that the focus of this study. There is some evidence that marijuana is an in-demand product in Denver, Colorado. After legalization of medical marijuana in Colorado in 2000 (Kamin, 2012), 115,467 patients, less than 3% of the state population, were legally permitted to use marijuana for therapeutic treatment (Colorado Department of Public Health & Environment, 2017; U.S. Census Bureau, 2017). In the first year of recreational legalization in Denver, the Colorado State Department of Revenue estimated that the product demand for marijuana equated to 130 metric tons (Light, Orens, Lewdanowski, & Pickton, 2014).

While it is not yet understood how legalization impacts rates of use, previous research supports that increased drug availability lowers the perceived risk associated with use (Compton

et al., 2016; Schurmeyer et al., 2014; Wall et al., 2012). The identification of the value of marijuana for therapeutic purposes may contribute to the change in perceived risks. This change in risk may result in an increase in use, though that investigation exceeds the scope of the current project. Some believe that an increase in use of the drug could translate into an increase in criminal or deviant behavior (Lopez, 2018). The current study examined the pattern of crime before and after recreational legalization of marijuana to determine the extent of any impact recreational legalization may have had on crime in Denver, Colorado.

Research Problem

The purpose of the current study was to analyze the impact of recreational marijuana legalization on reported crime within a community. Recreational legalization in the United States is likely to continue, but long-term effects of increased availability of marijuana on crime have yet to be seen. Addressing this research problem is relevant to the continuing trend of legalization in the United States. There is still much to understand about the drug-crime relationship, particularly concerning recreational legalization. As a developing movement, many states are considering adopting recreational legalization citing points such as increased tax revenue from sales, an increase in jobs and economic health, and lessening the strain on an already over-burdened criminal justice system (Forman, 2018). However, research has been unable to analyze long-term effects of recreational legalization as it has only been present in a few areas of the country for a short time (Robinson, 2017).

Denver, Colorado is the largest city in the United States where recreational marijuana has been available for the most prolonged period. Denver is an urban community. Prior criminological research has established concepts that directly impact crime within communities like Denver. One theory that has been tested in urban communities consistently is social

disorganization theory (Akers & Sellers, 2013). The current study relied upon social disorganization as a theoretical foundation to control for these known predictors of crime. Accounting for these known influences helped determine if further change in crime was due to recreational legalization. Previous research shows that concepts of social disorganization considerably impact crime in urban communities (Liska & Chamlin, 1984; Lowenkamp, Cullen, & Pratt, 2003; Sampson & Groves, 1989; Shaw & McKay, 1944; Veysey & Messner, 1999; Waring & Weisburd, 2002). The presence of transience, ethnic heterogeneity, and economic instability in a community weaken social controls (Shaw & McKay, 1942) and can encourage criminal and deviant behavior. This prior research is the justification for including covariates that reflect concepts of social disorganization in the methodology. Controlling for these impacts on urban crime ensures a coherent image of how recreational legalization may have impacted crime. This theoretical foundation is essential in analyzing the continued application of the theory as an explanation for urban crime. Using the conceptual framework of social disorganization theory also helps to isolate the effects of legalization on crime in Denver, Colorado.

This study utilized techniques that resulted in a temporal and community-based analysis of crime in Denver, Colorado. The current analysis will be a tool to predict how further recreational legalization may impact comparable communities in the United States. Specifically, this study examined changes in crime post-legalization, while accounting for the impact that economic status, transience, and ethnic heterogeneity have on crime. The subsequent sections outline how this study answers the following research question:

"What is the impact of recreational marijuana legalization on crime in the context of social disorganization theory in Denver, Colorado?"

Analytical Model

The current quasi-experimental design provided a robust image of changes in crime over an 8-year period in the city of Denver, Colorado. This 8-year period began in 2009 to reflect 4 years before recreational legalization and 4 years after its introduction into the community. Using this time frame allowed the examination of crime trends before the introduction of recreational marijuana into the community. It also gave 4 years of crime incidents after recreational legalization. A 4-year post-period ensured enough time to detect any immediate or delayed change in crime after legal recreational marijuana increased in availability within the community.

The outcome measure of crime is evaluated in four variables: by count of total part 1 crime, property crime (burglary, larceny-theft, motor vehicle theft, and arson), violent crime (murder, rape, robbery, & assault), and disorder crime (disturbing the peace, drug/narcotics violations, crimes against society, liquor law violations, curfew violations, criminal mischief, property damage, and trespassing). Present in the study is a segmented regression analysis of crime count by month. An Interrupted Time Series analysis ensures crime is analyzed over a period that reflects 4 years before recreational legalization and 4 years after. Additionally, this study uses a measure of crime bound by census tract. The dataset contains all reported crime in the city of Denver, Colorado at the incident level. However, crime data at the incident level lacks variability. Therefore, crime has been aggregated from the incident level to the geographic area of census tract. This aggregation allows a standard unit of analysis for the multivariate analytical procedure and introduces elements of a case control experimental design.

Three concepts identified within social disorganization theory (economic status, residential instability, and ethnic heterogeneity) have repeatedly been tested with results showing

a notable impact on crime in urban communities (Liska & Chamlin, 1984; Lowenkamp, Cullen, & Pratt, 2003; Sampson & Groves, 1989; Shaw & McKay, 1944; Veysey & Messner, 1999; Waring & Weisburd, 2002). The current study used both indirect and direct measures to analyze concepts of social disorganization theory and how they influence crime in Denver. These measures include average percent female-headed households per census tract, average percent juvenile population per census tract, average percent population living in poverty per census tract, average percent renter-occupied homes per census tract, and the Diversity Index score per census tract. Every census tract was appointed an average score for each covariate. These scores were derived from census data for each year in the period analyzed. Years falling after 2010 were based on census estimates, as 2010 was the last year an official census was completed. Data from 2009 has been excluded from the average scores for each covariate derived from social disorganization theory as census tracts in Denver, Colorado changed in 2010. Standardization of census estimates from 2009 is not possible. However, each crime incident present in the dataset has an X and Y coordinate that allows for the inclusion of 2009 crime incidents in the analysis.

The first variable selected in the context of social disorganization theory is the rate of female-headed households divided by population per census tract. This variable acts as an indirect measure of multiple concepts of social disorganization theory, including economic instability, family disruption, and supervision. Previous research has established that higher concentrations of single-parent families can result in weak informal social controls and increased rates of delinquency (Sampson, 1986; Wright & Cullen, 2001). Single-parent families are also more likely to be impoverished (Jackson, Brooks-Gun, Huang, & Glassman, 2000; McLanahan, 1985). This variable also acts as a measure of lower levels of parental supervision, which can encourage delinquency in communities that have lower levels of collective efficacy. Prior

research has found that single-parent families are more consistently associated with criminal and deviant behavior when compared to two-parent families (Farrington, 2011; Demuth & Brown, 2004; Sampson, 1986). This literature establishes that consideration of this measure will provide value to the current analysis of crime in Denver, Colorado.

The next measure of social disorganization is the rate of population that is juvenile in each census tract. Prior research indicates that communities with higher percentages of a juvenile population are positively correlated with increased rates of property crime (Brezina & Agnew, 2015; Ferro, 2003). Juveniles, defined as individuals aged 17 years or younger (U.S. Census Bureau, 2011), have not yet completely socialized into adulthood. Part of that socialization includes more knowledge of acceptable versus unacceptable behavior. Adulthood also brings an increase in responsibility that may deter individuals from committing crime or engaging in deviant behavior. The inclusion of this variable is an essential measure of disorganization as it heavily impacts property crime (Brezina & Agnew, 2015; Ferro, 2003). Accounting for that influence helps provide a further understanding of how recreational legalization has impacted property crime in Denver, Colorado.

Another important measure of disorganization is the percentage of the population of Denver living in poverty per census tract. This variable serves as a measure of economic status. In urban communities, the most impoverished areas are those more likely to have higher crime rates (Krivo & Peterson, 1996; Ludwig, Duncan, & Hirschfield, 2001). Similar to drug use and crime, poverty and crime also have a complicated relationship. Mental illness and stress are more prominent in impoverished communities (Belle, 1990; Wilton, 2004). This may lead to criminal behavior. Prior research has found that poverty is positively correlated with all crime types in an urban community (Avison & Loring, 1986; Hipp, 2007; Flang & Sherbenou, 1976).

Additionally, impoverished communities are associated with higher rates of illicit drug use (Ennett, Flewelling, Londrooth, & Northon, 1997; Hoffmann, 2002; Krivo & Peterson, 1996). The current poverty threshold for individuals in the United States is $12,488 (U.S. Census, 2017). This value changes depending on marital status and the number of individuals living in a household (U.S. Census, 2017). The current study measured the population of Denver, Colorado living in poverty per census tract to account for a possible influence on reported crime.

The current study next utilizes the percent of renter-occupied homes per census tract. This variable is an indirect measure of residential instability or transience, one of the main concepts of social disorganization theory (Shaw & McKay, 1942). Individuals that rent homes may be less likely to live in the area for an extended period versus individuals that buy homes and are financially invested in the community. Most renters in the United States are single, aged 39 and younger, are college students or just graduated, or are individuals with minimal education and meager incomes (Fernald, 2013). These individuals are likely to relocate for a variety of reasons, whether it be related to career opportunities, education, or out of necessity. Individuals who are more transient may be less likely to invest socially and financially into a community in which they will temporarily live. Social disorganization theory holds that communities that have a more substantial portion of these individuals may struggle to establish informal social controls, which in turn, can encourage crime and delinquency (Shaw & McKay, 1942). Previous research indicates that communities with less residential stability are positively associated with higher rates of both property and violent crime (Boggess & Hipp, 2010; Browning, Dietz, & Feinburg, 2004; Sampson, Raudenbush, & Earls, 1997; Rephann, 2008; Tita & Greenbaum, 2009).

The final measure of social disorganization the current study utilizes is the Diversity Index (DI). The DI measures ethnic heterogeneity, or the variance in race and ethnicity present in

a community population (Kubrin, 2014). The higher the DI value is, the more diverse the community is (Reese-Cassal, 2014). Simply put, this variable measures the probability that any two people in a community will be of different ethnicities. Social disorganization theory holds that communities with higher levels of racial and ethnic diversity struggle to establish informal social controls (Akers & Sellers, 2013). Communities with increased diversity have the potential for more hostile relations and issues with mutual distrust. In turn, this conflict could infringe upon the establishment of collective efficacy. Including this measure is important as Denver is among the more racially and ethnically diverse cities in the United States (Bernardo, 2017). This combination of covariates reflects the central concepts of social disorganization. The study utilizes these measures to investigate how they have continued to impact crime in Denver over an 8-year period.

Current Analysis

Two analytical techniques are present in the current exploratory environmental study to answer the research question posed in the introduction of this chapter. The combination of these techniques ensures a temporal and incident-based analysis of crime in the urban community of Denver, Colorado. The analytical technique also allows further prediction of what the continued impact of recreational marijuana legalization may have on crime in comparable cities considering adopting recreational legalization policy.

Interrupted Time Series Analysis

To identify how crime has changed over time, the current study utilized an Interrupted Time Series analysis (ITS). An ITS examines how an outcome variable has changed over a period of time by analyzing the trend before and after an inflection point. A significant change at the inflection point will be detected as a change in the slope of a trend, a change in level, or both.

Pre-intervention time points are important to establish crime trends before the change point, or intervention. Each ITS in the study used monthly crime counts as the unit of analysis. This measure resulted in a total of 96 months of crime incident data. This period equates to 48 months before and 48 months after the change point of January 1, 2013 (the date recreational use of marijuana became legal in Colorado). Four ITS models were run for each crime type measured. These included total crime, property crime, violent crime, and disorder crimes by count per month. Results of the ITS identified changes in both count and trend of each crime type post-legalization. The formal hypotheses are as follows:

$$H_0: R^2_{\text{time, prepost,time since}} = 0$$

$$H_A: R^2 \neq 0$$

alpha: 0.05

It was hypothesized that violent crime would not increase after recreational legalization had been introduced into the Denver community. It was also hypothesized that both property and disorder crime would increase post-recreational legalization in Denver, Colorado.

An ITS was selected as it is the best method to measure crime trends over an extended period. A segmented regression correlates changes in the outcome with the passage of time across an inflection point. However, many other concepts may have influenced crime in the urban community of Denver during this period. As such, the current study utilized a second analytical technique to investigate further any potential effect recreational marijuana legalization had on crime in Denver, Colorado during the study period.

Linear Regression

To test the relationship between concepts of social disorganization, recreational legalization, and crime in Denver, a general linear regression model was conducted. Regression

analyses can be used to determine the relationship between selected independent variables and an outcome variable. A linear model is the best method to establish further context into the relationship between recreational marijuana legalization, crime, and predictor covariates that are known to effect crime from prior social disorganization research efforts. Additionally, it allows for the prediction of crime over time at the census tract level post-recreational legalization. A total of four models were completed to measure the effect of legalization on total Part I crime and three specific types of crime including property, violent, and disorder over the 8-year period.

To offset the lack of standardization in crime data, crime rate per census tract was calculated as the outcome variable. This spatial measure reduces precision but ensures comparison across varying areas of the city. The current study used theoretically sound covariates including the DI, average percentage of renter-occupied homes, average percentage of juvenile population, average percentage of population living in poverty, and average percentage of female-headed households per census tract. These covariates were selected to measure concepts of social disorganization theory including diversity, family disruption, collective efficacy, economic status, and residential instability. Incidents of reported crime in the 8-year period were assigned a value for each covariate per year at the census tract level, apart from 2009 per the census changes implemented in 2010. Census estimates were used for those years that fall after the last census, which occurred in 2010 (U.S. Census Bureau, 2010).

An additional covariate was used to measure the impact of recreational marijuana legalization on crime directly. The proportion of crime calculated for each census tract reflects crime after legalization divided by crime before. This proportion shows the net change in crime after the introduction of recreational marijuana per census tract. Because some census tracts show lower crime when compared to other parts of Denver, there could be a theoretical existence

of zero, making crime a continuous variable. If this covariate returned a positive and significant value, it would show that recreational legalization did have an impact on crime in Denver, Colorado after the introduction of recreational marijuana legalization. If the returned value was not significant, there may have been no effect of recreational legalization on crime per census tract.

It was hypothesized for all linear models that the influence of covariates in a census tract would be directly reflected in increased reported crime. These results would show that the selected covariates that measure concepts of social disorganization continue to impact crime in the urban environment. This potential result would support the utility of social disorganization theory as a continued explanation of crime in the urban community. Based on previous literature, it was hypothesized that the only increases in crime post-legalization would be property and disorder crimes and that violent crime would not increase. This is due in part to the findings of marijuana use in urban communities and no significant relationship to increases in violent crime (Bennett, Halloway, & Farrington, 2008). The formal hypotheses are as follows:

$$H_0 : R^2_{\text{DI, R-OH, JP, Poverty, FHH, Crime Rate}} = 0$$

$$H_A : R^2_{\text{DI, R-OH, JP, Poverty, FHH, Crime Rate}} \neq 0$$

alpha: 0.05

The outcome of these techniques results in a thorough analysis of crime changes in Denver and the relation to recreational marijuana legalization. Investigating this research problem filled a gap in existing drug-crime relationship literature, analyzed how the introduction of recreational marijuana can change crime in an urban community, and studied how concepts of social disorganization continue to impact crime. While there were potential threats to validity and reliability, efforts were made to combat them and ensure that the model was sound. These

efforts helped to ensure that the model examined how recreational legalization may have changed crime in Denver, Colorado after its introduction into the community.

Chapter Four: Analytical Results

A temporal and community-based analysis of crime in Denver established context of changes in crime over the 8-year period. A segmented regression tested if changes in crime post-legalization were significant, while the linear regression tested covariates derived from concepts of social disorganization theory as an explanation of crime in Denver, Colorado. Findings from the analysis provided evidence of how reported crime may change after the introduction of recreational marijuana legalization into comparable communities.

Descriptive Statistics

Table 1 provides the descriptive statistics for the four crime classifications by count. The median count of reported crime for the analyzed period is 2,202 for the city of Denver. This value is close to the mean value returned of 2,189.84, which is evidence of a normal distribution of the data. A standard deviance value of 260.45 for Part 1 crimes in Denver, Colorado indicates how the data is spread around the mean value. There is a 68%likelihood that the true value for Part 1 crime by month falls between 1929.39 and 2449.99 reported incidents. A returned value of -0.23 for skew indicates a slight negative skew in the distribution of Part 1 offenses in the 8-year period analyzed. The kurtosis returned was -0.54, meaning the distribution of Part 1 crime count by month is platykurtic, or that the distribution has lower tails along the x-axis. This distribution suggests fewer and less extreme outliers. The Shapiro-Wilk test was used as a cross check of a normal distribution. A non-significant value of W = 0.99 (NS) returned suggests the values of Part 1 crime by count are not significantly different from a theoretical normal distribution.

Table 1. *Descriptive Statistics: Crime Count*

	Part 1	Property	Violent	Disorder
Median	2,202.00	1,893.5	302.50	813.00
Mean	2,189.84	1,887.35	302.49	872.50
Variance	67,834.24	50,162.65	2,178.02	34,581.60
Std. Dev.	260.45	223.97	46.70	185.96
Skewness	-0.23	-0.22	0.05	0.31
Kurtosis	-0.54	-0.61	-0.20	-1.231
Shapiro-Wilk	W= 0.99 (NS)	W= 0.99 (NS)	W= 0.99 (NS)	W= 0.93($p < .001$)

The median and mean values returned for property crime by count were 302.5 and 302.49, respectively. This suggests a normal distribution of the data. A standard deviation of 223.97 indicates that there is a 68%likelihood that the true value of reported property crime by month falls between 1663.38 and 2111.32. A returned value of -0.22 for skewness shows a slight negative skew in the distribution of property crime in the 8-year period. The kurtosis value of -0.61 returned for property crime indicates that the shape of the distribution of values has thinner tails, or that there are less extreme outliers in the distribution. The Shapiro-Wilk value returned was W = 0.99 (NS). This shows that the distribution of property crime count is not significantly different from a theoretical normal distribution.

The median and mean values returned for violent crime in Denver, Colorado for the analyzed period were 302.5 and 302.49, respectively. This suggests that extreme outliers are not distorting the distribution of the violent crime data. A standard deviation value of 46.7 means that 68%of all reported violent crime are likely to fall between 255.79 and 349.19 incidents per month in Denver, Colorado. A skew of 0.05 was returned, meaning that there is a slight positive skew in the distribution of violent crime data for the period analyzed. The kurtosis value returned for violent crime was -0.2, meaning that the distribution of violent crime has a flatter distribution. The Shapiro-Wilk value returned was W = 0.99 (NS), as was the case for both

property and Part 1 total crime. Like the previous crime types, these values returned show that violent crime count is not significantly different from a theoretical normal distribution.

Finally, the mean and median values returned for disorder crime in Denver were 813 and 872.5. As this crime type has the highest difference between the mean and median values, there may be an abnormal distribution of the data. This means there is a 68% likelihood that the true value of disorder crime in Denver falls between 686.54 and 1058.46 reported incidents a month. Disorder crime had the highest skew value returned of 0.31. Disorder crime has the highest positive skew of all crime types present in this study. The kurtosis for disorder crime was -1.23, resulting in a flatter than normal distribution of the data points. A Shapiro-Wilk value of $W = 0.93$ ($p < .001$) was returned, implying that the data is significantly different from a theoretically normal distribution. Further analysis will help determine if this is the case.

Table 2. *Descriptive Statistics: Crime Rate Per 100,000*

	Part 1	Property	Violent	Disorder
Median	345.07	297.08	47.03	130.44
Mean	339.72	292.88	46.85	134.43
Variance	1,565.94	1,203.92	43.52	551.44
Std. Dev.	39.57	34.69	6.59	23.48
Skewness	-0.22	-0.17	-0.10	0.19
Kurtosis	-0.46	-0.58	-0.21	-1.04
Shapiro-Wilk	W= 0.99 (NS)	W= 0.99 (NS)	W= 0.99 (NS)	W= 0.95 ($p < .05$)

Table 2 shows descriptive statistics for crime rate per 100,000 in the recorded population of Denver, Colorado from 2009 to 2016. The population was used as a flat value for each calendar year. The rate was calculated from the reported count total of each month. The first crime classification, Part 1 total, returned a median value of 345.07 incidents per 100,000 residents a month. The mean value was 339.72 incidents a month per 100,000 residents. The closeness of these values is evidence of a normal distribution. The standard deviation of Part 1 crime rate was 39.57. Therefore, there is a 68%likelihood that the true value for Part 1 total

crime is between 300.15 and 379.29 reported incidents per 100,000 residents per month. From a skew value of -0.22, we can infer that there is a slight negative skew in the data distribution of Part 1 crime in Denver. Part 1 kurtosis also returned a value of -0.46, meaning that the distribution has lower tails that stay close to the x-axis. Finally, the Shapiro-Wilk test value returned was W = 0.99 (NS). A non-significant return indicates that reported crime per 100,000 residents in Denver is not significantly different from a theoretical normal distribution.

Property crime by rate of 100,000 residents shows a median value of 297.08. A mean of the same crime type of 292.88 suggests a normal distribution of data points. With a standard deviation of 34.69, there is a 68%likelihood that the true value of monthly crime rate for property crime in the period analyzed is between 258.19 and 327.57 incidents per 100,000 residents per month. A skew of -0.17 shows a slight negative skew in the distribution of property crime rate, while the kurtosis returned was -0.58. The Shapiro-Wilk value was W = 0.99 (NS) indicating that the distribution is not significantly different from a theoretical normal distribution.

The violent crime rate in Denver, Colorado from 2013 to 2016 shows a median value of 47.03. The mean of the same crime type was 46.85. Similar to the previous crime types, the closeness of these two values suggests a normal distribution of the data. The standard deviation further demonstrates this lack of spread. A value of 6.59 means that there is a 68%likelihood that the true value of all violent crime rate per 100,000 residents per month falls between 40.56 and 53.44 reported incidents a month. A skew of -0.1 shows a very slight negative skew in the data and the kurtosis value returned was -0.21 for the violent crime rate in Denver, Colorado. The Shapiro-Wilk value returned was W = 0.99 (NS). This indicates that the distribution of violent crime rate is not significantly different from a theoretical normal distribution.

The rate of disorder crime rate per month shows a value of 130.44 for the median and 134.43 for the mean. The closeness of these values is evidence of a normal distribution. A standard deviance of 23.48 means that there is a 68%likelihood that the true value of disorder crime per 100,000 residents per month of the 8-year period falls between 110.95 and 157.91 incidents per month. Unlike the other crime categories, a skew value of 0.19 shows a slight positive skew in the distribution. Disorder crime rate in Denver returned a kurtosis of -1.04 while the Shapiro-Wilk result returned was $W = 0.95$ ($p < .001$). This indicates that the distribution may be significantly different than a theoretical normal distribution. Next, the descriptive statistics for the social disorganization theory covariates are presented.

Table 3. *Descriptive Statistics: Social Disorganization Covariates*

	FHH	Juvenile	Renter	Poverty	Diversity
Median	9.25	18.77	48.13	16.55	63.03
Mean	11.24	19.87	48.03	18.21	58.76
Variance	60.84	99.48	453.04	127.99	456.79
Std. Dev.	7.80	9.97	21.29	11.31	21.37
Skewness	3.99	0.22	0.14	1.32	-0.41
Kurtosis	5.73	-0.28	-0.71	4.34	-0.97
Shapiro-Wilk	W= 0.89 (p< .05)	W= 0.99 (NS)	W= 0.99 (NS)	W= 0.92 (p < .05)	W= 0.94 (p < .05)

Table 3 shows the descriptive statistics for the social disorganization theory covariates. The median value of average percentage of female-headed households was 9.25 and the mean value was 11.24 per census tract, giving evidence of a normal distribution. A variance of 60.84 returned for the female-headed households was the lowest variance returned. This indicates that the distribution of values is not spread very far. A standard deviation of 7.8 shows that there is a 68% likelihood that the true value of the average percentage of female-headed households per census tract falls between 3.44% and 19.04% per census tract. This variable had the highest amount of skew returned. A skew of 3.99 shows a positive skew in the distribution. Female-headed households also returned the highest kurtosis, meaning that it would have a taller peak on

a plot of distribution. The Shapiro-Wilk value returned was W = 0.89 ($p < .05$). A significant p-value suggests abnormality from a theoretical normal distribution.

The average percentage of juveniles per census tract variable returned a median value of 18.77 and a mean value of 19.87. The closeness of these values suggests a normal distribution of values. The variance returned was 99.48. This was the second lowest variance returned, meaning that the juvenile variable had the second lowest spread in value distribution. A standard deviation value of 9.97 means that there is a 68%likelihood that the true value for the juvenile covariate falls between 9.9% and 29.84% of the population per census tract. The juvenile variable returned a value of 0.22, implying that there is a slight positive skew in the distribution of data. The kurtosis returned was -0.28. The Shapiro-Wilk test returned the result of W = 0.99 (NS). A non-significant p-value indicates the distribution of values for the juvenile covariate is not significantly different from a theoretical normal distribution.

The average percentage of renter population per census tract variable shows a median value of 48.13 and a mean of 48.03. This variable has the closest mean and median values, which gives little evidence of an abnormal distribution. The variance value returned was 453.04. This was the second highest variance returned for variables in Table 3. A standard deviation of 21.29 means that there is a 68% chance that the true value of the renting population per census tract in Denver, Colorado lies between 26.74% and 69.32%. A skew of 0.14 and kurtosis value of -0.17 indicates that a trend line through the distribution of the renter variable would have a slight positive skew and favors values lower than the mean. The Shapiro-Wilk test returned a value of W = 0.99 (NS), indicating that the distribution of values for the renter population covariate is not significantly different from a theoretical normal distribution.

The poverty variable shows a mean value of 18.21 and median of 16.55. The closeness of these values gives evidence of a normal distribution. A variance of 127.99 was returned, showing that there is some spread of values in the distribution. The standard deviation returned was 11.31. This means that there is a 68% likelihood that the true value of the average population living in poverty per census tracts falls between 6.9% and 29.52%. The skew of poverty was 1.32, indicating a positive skew in the distribution. The kurtosis value of 4.34 is the second highest in the table. The Shapiro-Wilk value returned was $W = 0.92$ ($p < .05$). A significant p-value indicates an abnormal distribution in the data.

The final variable in the table, diversity, shows a median value 63.03 and a mean of 58.76. The variance for diversity was 127.99 while the standard deviation returned was 11.32. For the variable of diversity, there is a 68% likelihood that the true value falls between 37.39% and 80.13% per census tract. A skew of -0.41 means there is a slight negative skew in the distribution of diversity in Denver for the period analyzed. The kurtosis value for diversity was -0.97. A Shapiro-Wilk test returned a value of $W = 0.94$ ($p < 0.05$), indicating the data are significantly different from a theoretical normal distribution.

Table 4. *Descriptive Statistics: Ratio Covariate*

	Part 1	Property	Violent	Disorder
Median	1.16	0.50	1.02	1.25
Mean	1.19	0.50	1.07	1.27
Variance	0.05	0.003	0.12	0.21
Std. Dev.	0.23	0.06	0.35	0.46
Skewness	0.99	-3.23	1.48	0.44
Kurtosis	6.06	26.67	3.98	3.75
Shapiro-Wilk	W= 0.90 (NS)	W= 0.78 (NS)	W= 0.90 (NS)	W= 0.94 (NS)

*$p < .05$

Table 4 presents descriptive statistics for the ratio variable included in the multiple regression. This variable is the net change of crime in each census tract after the implementation of recreational legalization. The first crime type analyzed was Part 1. A mean value of 1.19 was

returned as well as 1.16 for the median. This is evidence of a normal distribution. A standard deviation of 0.23 indicates that there is a 68% chance that the true value of the net change in Part 1 total crime lies between 1.42 and 0.96 per census tract in the city of Denver. A skew value of 0.99 indicates a positive skew in the distribution of data. The kurtosis value was 6.06, while a non-significant p-value returned in the Shapiro-Wilk test indicates the skew is not significantly different from a theoretical normal distribution.

The next crime type for the ratio value is property crime per census tract. For the net change in property crime after legalization, both the mean and median value returned was 0.5. This crime type also had the lowest variance with a value of 0.003. A standard deviation of 0.06 indicates a 68% chance that the true value of net change in property crime lies between 0.56 and 0.44. Property crime returned a skewness of -3.23. This paired with a kurtosis value of 26-67 is evidence of an abnormal distribution. However, the results of the Shapiro-Wilk test, W = 0.78 (NS), indicates that property crime is not significantly different from a theoretical normal distribution.

The ratio of violent crime in Denver, Colorado returned a mean value of 1.07 and a median of 1.02. A variance of 0.12 was returned, while the standard deviation value was 0.35. This indicates a 68% chance that the true value of the net change in violent crime per census tract after the implementation of recreational legalization is between 1.42 and 0.72. The skew value for violent crime returned was 1.48. This is the highest positive skew returned for the ratio variable. The kurtosis value returned was 3.98. A Shapiro-Wilk test returned was W = 0.90 (NS), indicating that the values for the ratio variable of violent crime are not significantly different from a theoretical normal distribution.

The last crime type for the ratio variable was disorder crime. A median value of 1.25 was returned, while the mean was 1.27. The closeness of these two values is evidence of a normal distribution. A variance of 0.21 is the highest in the ratio value descriptive statistics. A standard deviation of 0.46 shows a 68% chance that the true value of the disorder crime ratio lies between 1.73 and 0.81. The skewness returned for disorder crime was 0.44, while the kurtosis was 3.75. The final Shapiro-Wilk test returned W = 0.94 (NS), showing that the distribution is not significantly different from a theoretical normal distribution.

The following plots show how values for variables derived from concepts of social disorganization have changed over a 7-year period in Denver, Colorado. It should be noted that while the crime incidents aggregated to census tract are from the years 2009 to 2016, the average values for measures of social disorganization are not. As census tracts changed in 2010, the census estimates for female-headed households, impoverished residents, juveniles, renters, and diversity were derived from census data from 2010 forward. While this may limit the scope of the measurement for these concepts, these values do not vary much in Denver as illustrated by the following plots.

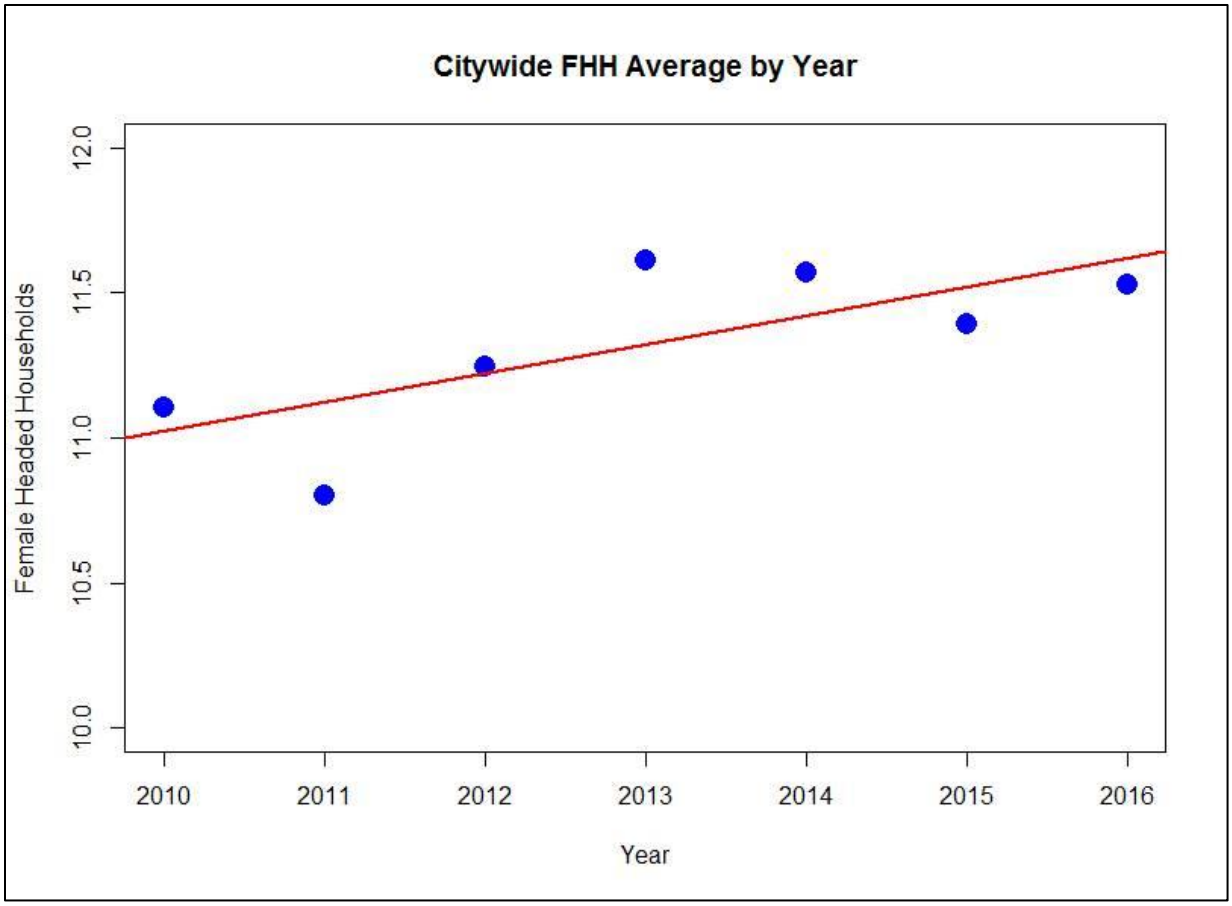

Figure 1. *Female Headed Households in Denver, Colorado by Year*

Figure 1 shows how the citywide percent of female-headed households has changed over time in Denver, Colorado. The fitted line shows an increasing trend, though the level varied for the 7 years of census data used. However, the difference between the highest and lowest citywide averages is only 0.8%, indicating that the citywide average of female-headed households in Denver, Colorado is static and has not varied much over time.

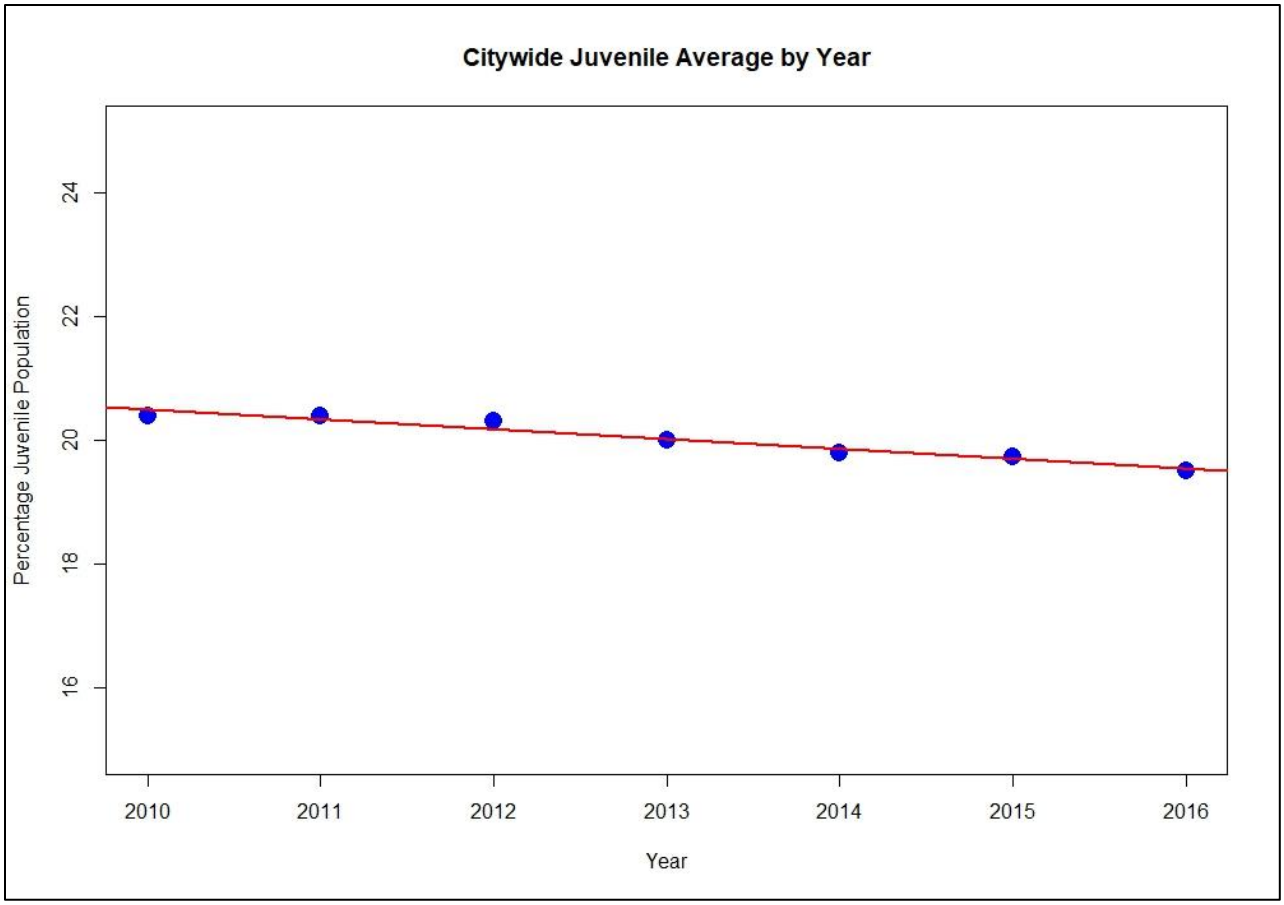

Figure 2. *Juvenile Population in Denver, Colorado by Year*

Figure 2 indicates how the citywide percent of the percentage of juvenile population per census tract has changed over time in Denver, Colorado. The fitted line indicates a slight but steady decrease in the citywide average. The difference between the highest and lowest yearly percentages is 0.9. Like the average of female-headed households, this citywide average per census tract has not varied much over the 7 years of census data utilized.

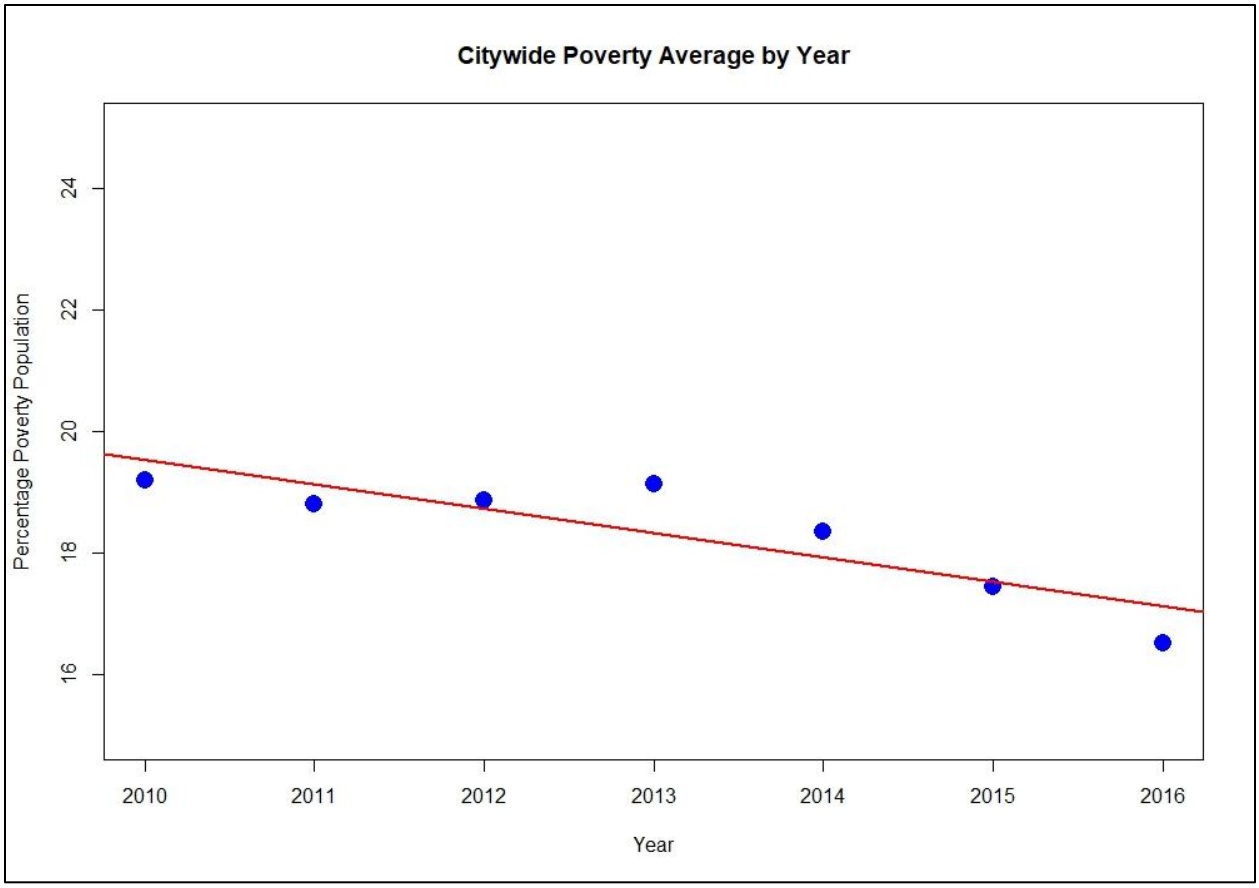

Figure 3. *Impoverished Population in Denver, Colorado by Year*

Figure 3 illustrates how the citywide percentage of the population living in poverty per census tract has varied over the 7-year period in Denver, Colorado. There was a slight increase in 2013, though the figure shows a steady decrease in the post period. The difference in value from the highest to the lowest year of citywide average is 2.7%. A variation of less than 3% illustrates that the average population living in poverty per census tract has not varied much in the 7 years of census data used.

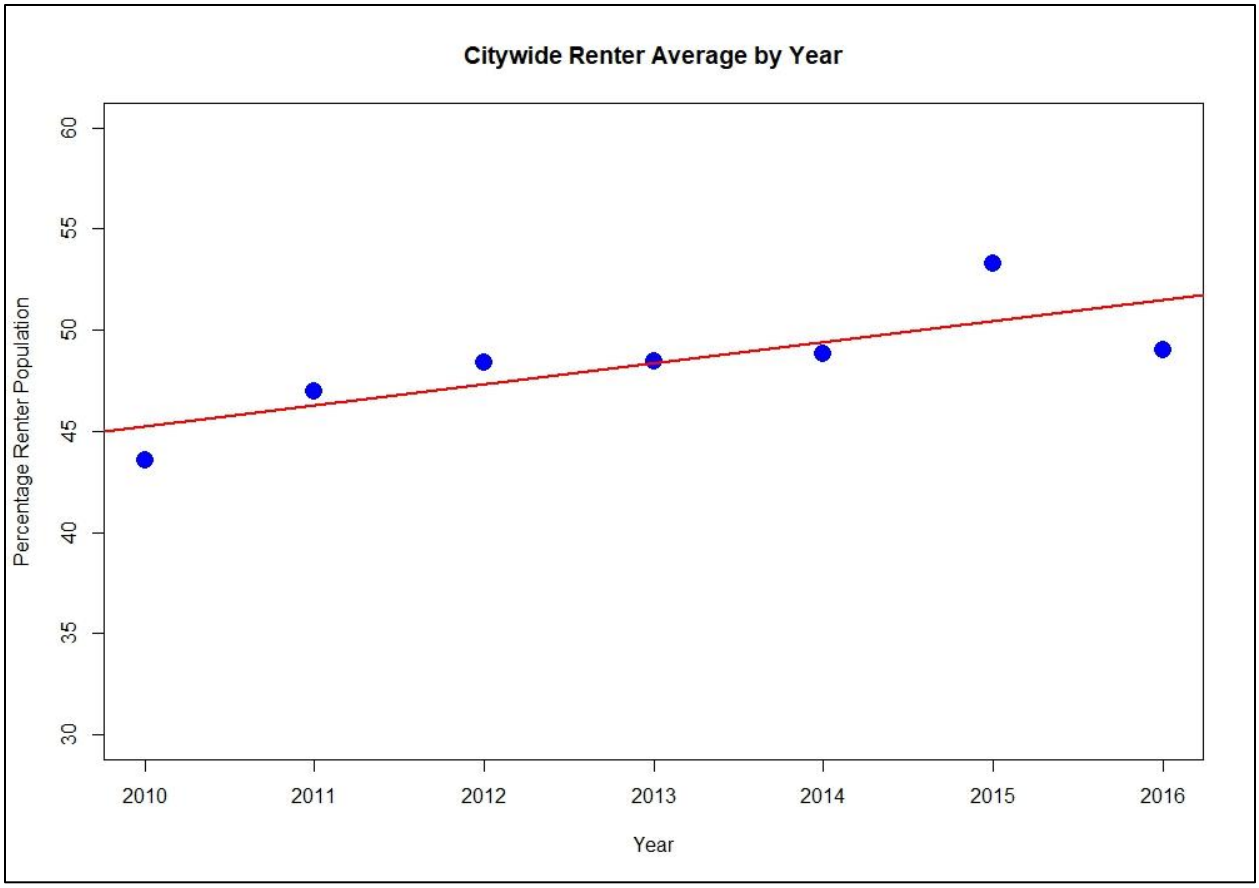

Figure 4. *Renter Population in Denver, Colorado by Year*

Figure 4 illustrates the change in yearly citywide percentages for renter population per census tract. The lowest point was 2010, while the highest is 2015. The difference in these values is 9.7%. As reflected in the descriptive statistics, this variable has high variance. While 2010 is the lowest point in the plot, the fitted line reflects a gradual increase.

The covariate of diversity index is the result of averaging census estimates from 2011 and 2016. These scores were derived according to the method described on the ESRI website (Reese-Cassal, 2014). The 2011 citywide average of diversity scores per census tract was 58.9. The 2016 citywide average was 58.6. This indicates that while it is a small change in the average score, the city of Denver was slightly less diverse by 0.3% per census tract in the 5-year period between. Similar to the other covariates measuring concepts of social disorganization theory, it did not

vary much over time. Further analysis of the relationship between variables in the current study will show significant correlations and further explore value distributions.

Table 5. *Correlation Matrix of All Variables (N = 144)*

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Disorder Rate	--												
2 Part One Rate	0.88	--											
3 Property Rate	0.84	0.99	--										
4 Violent Rate	0.86	0.71	0.62	--									
5 FHH	0.01	-0.20	-0.04	0.10	--								
6 Juvenile	-0.18*	-0.19*	-0.19*	-0.10	0.84	--							
7 Renter	0.38	0.32	0.28**	0.45	-0.02	-0.23	--						
8 Poverty	0.33	0.22**	0.16	0.47	0.64	0.44	0.54	--					
9 DI	0.10	0.03	-0.01	0.22	0.08	0.66	0.18*	0.65	--				
10 Disorder Ratio	0.57	0.48	0.44	0.59	0.01	-0.08	0.21*	0.22**	0.11	--			
11 Part 1 Ratio	0.01	0.12	0.14	0.01	-0.01	0.08	-0.05	-0.09	0.09	0.27	--		
12 Property Ratio	0.01	0.10	0.11	0.01	0.07	0.11	0.00	0.01	0.17	0.29	0.72	--	
13 Violent Ratio	0.19	0.21	0.19	0.21	0.05	0.09	0.03	0.05	0.17	0.36	0.40	0.12	--

*$p < .05$, **$p < .01$, ***$p < .001$***

Table 5 is the correlation matrix of all variables in the current study. The juvenile variable is significantly correlated to the rates of disorder, Part 1, and property crime. However, the values returned indicate a significant negative relationship, indicating that as the juvenile population decreases per census tract, the rate of reported Part 1, disorder, and property crime increases. These are the only negative correlations of significance. However, this finding is opposite of the anticipated direction. Prior studies inform us that the presence of juveniles is strongly correlated with increased rates of property crime (Brezina & Agnew, 2015; Ferro, 2003). This is not supported by the current findings.

Additional correlational significance was returned with the variable derived from the percent of renting population per census tract and the rate of property crime, the diversity variable, and the ratio of disorder crime. Positive significant values returned indicate that as the renting population per census tract increases in Denver, Colorado, the ratio of disorder crime, rate of reported property crime, and diversity per census tract also increase. Of the three significant correlational relationships, the highest correlation was returned with the rate of reported property crime. Significant correlations were returned with the poverty variable and the rate of Part 1 crime and the ratio variable for disorder crime. These values were also positive, indicating that as the population living in poverty increases, the rate of reported Part 1 crime and the ratio variable for reported disorder crimes also increases.

There were correlations returned that prior research informs us should be significantly associated but were not. For example, the female-headed household variable returned no significant correlations when prior research establishes that single-parent families are more likely to be impoverished and associated with criminal and deviant behavior (Demuth & Brown, 2004; Farrington, 2011; Jackson, Brooks-Gun, Huang, & Glassman, 2000; McLanahan, 1985; Sampson

1986). This is not supported by the current findings. Additionally, prior research informed the inclusion of the rate of violent crime. Prior research indicates that violent crime is correlated with residential instability (Boggess & Hipp, 2010; Browning, Dietz, & Feinburg, 2004; Tita & Greenbaum, 2009), though current findings did not return significance for the included measure in the current study.

Descriptive statistics show that there is some concern with the distribution of disorder crime. However, the public disorder crime is not correlated with any other outcome crime variable, indicating its inclusion is important. This indicates it will account for variance that the other crime types may not have by themselves. Further visual analysis of the distribution of data is necessary before exploring the use of the techniques and their findings. For this reason, quantile plots are included in this chapter.

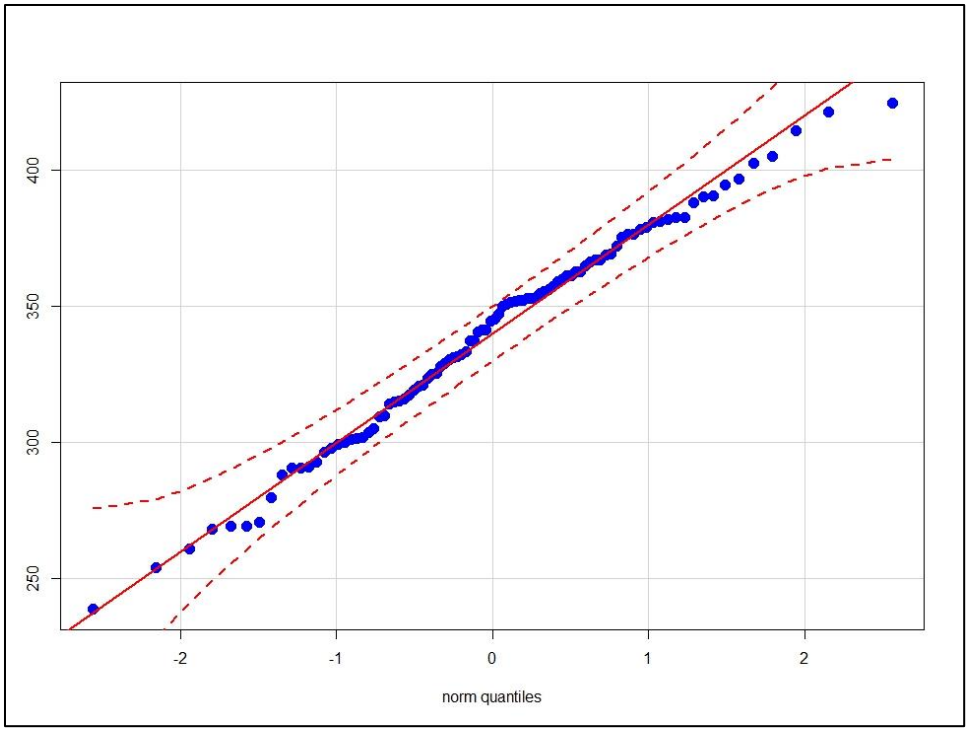

Figure 5. *Quantile Plot of Part 1 Crime by Count in Denver, Colorado*

Figure 5 shows visualization of Part 1 crime in Denver, Colorado over the analyzed period. The red trend lines indicate the outline of a normal distribution. The values on the x-axis refer to the quantiles of the normal distribution. The points are close to the fitted line, fall out in a linear fashion, and are within the 95% confidence interval for a theoretical normal distribution. This quantile plot shows that there is minimal to no concern about an abnormal distribution of total Part 1 crime in Denver, Colorado over the 8-year period analyzed.

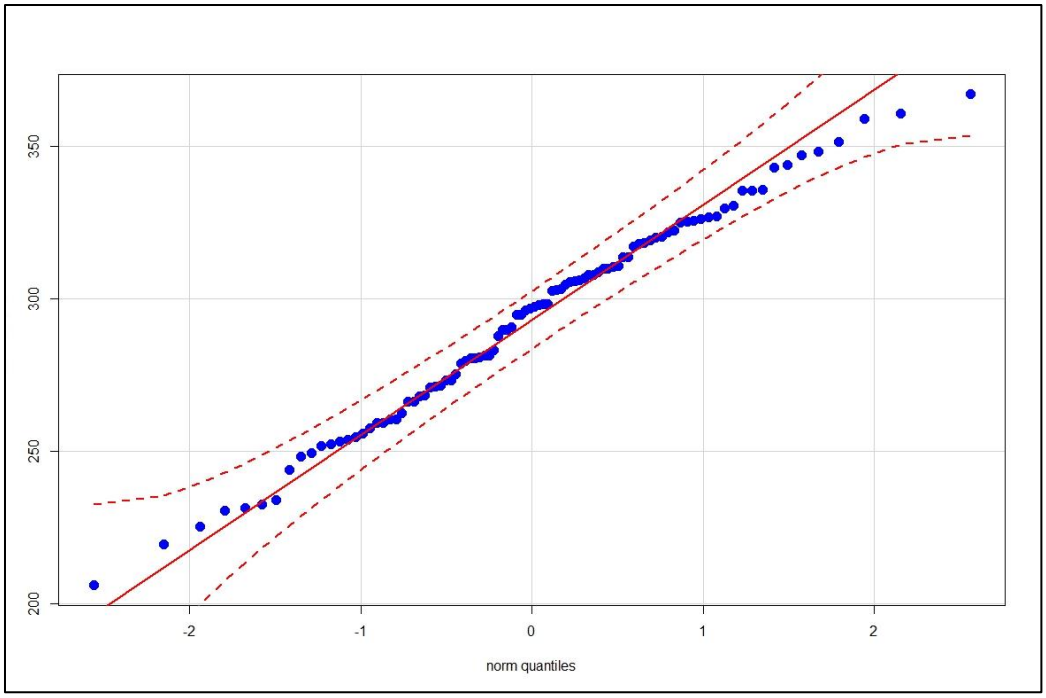

Figure 6. *Quantile Plot of Property Crime by Count in Denver, Colorado*

Figure 6 gives a visualization of property crime in Denver, Colorado from January 1, 2009 to end of year 2016. Data points around the first quantile area have the greatest stray from the middle trend line, but all points still fall within a normal distribution. There may be possible outliers at the highest and lowest points of distribution, but because they still fall within the confidence intervals of a normal distribution, the concern is minimal. From this plot, we can determine that the data points for the count of property crime by month are normally distributed as they fall out in a linear fashion and are within the 95% confidence interval. The next crime type analyzed was violent.

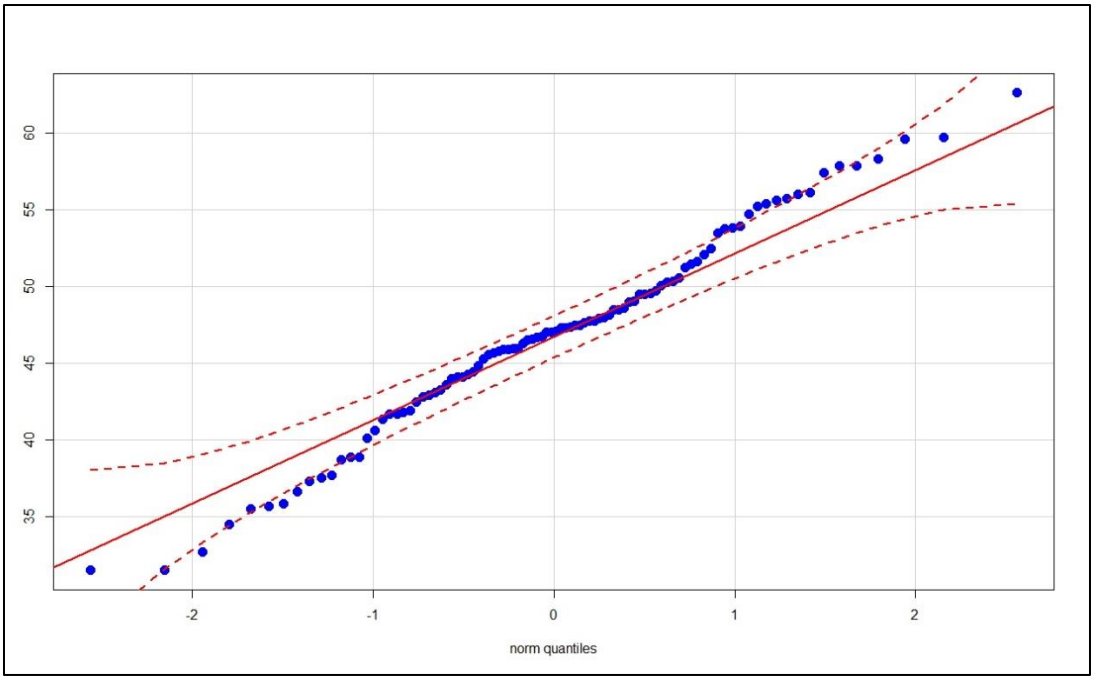

Figure 7. *Quantile Plot of Violent Crime by Count in Denver, Colorado*

As seen in Figure 7, the distribution of violent crime looks different from the others previously discussed. While the majority of points for the violent crime rate fall within the 95% confidence interval of a theoretical normal distribution, there are some points in the negative one quantile that dip below it. This suggests a spike of identical values in that point of the distribution. There are also points of the violent crime rate that fall above the normal distribution of data in the positive one quantile. Similar to the other abnormality in distribution, this again suggests the presence of a spike in identical values for violent crime rate by month. The highest and lowest points in the quantile plot are spaced further away from others in the distribution. However, both values still fall within the 95% confidence interval of a theoretical normal distribution.

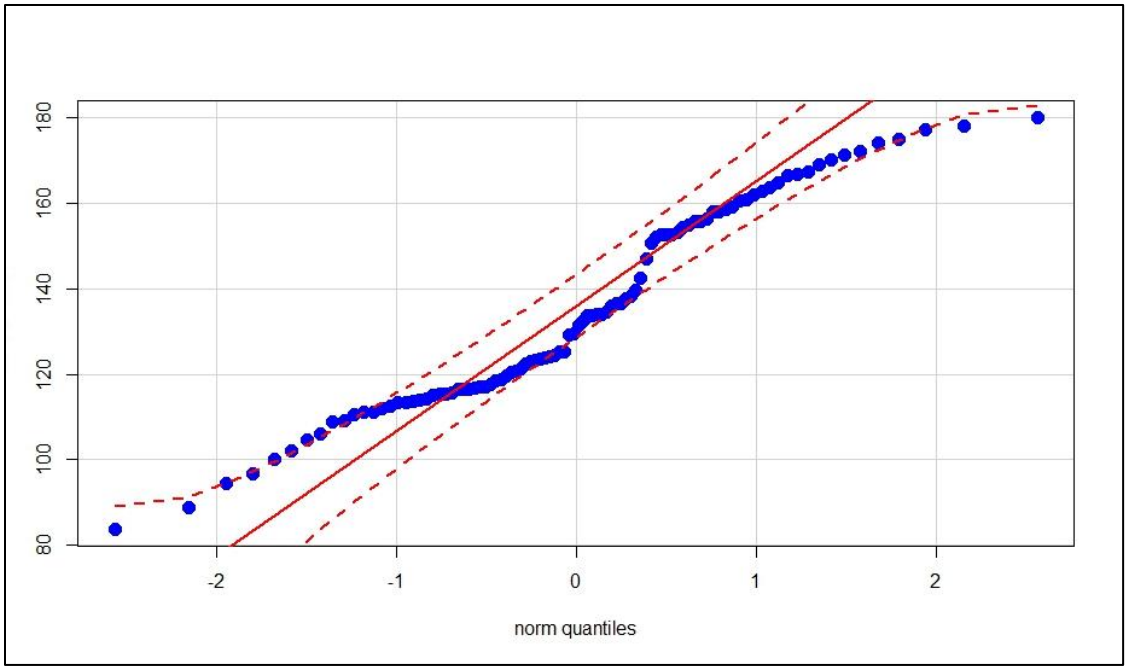

Figure 8. *Quantile Plot of Disorder Crime by Count in Denver, Colorado*

The final quantile plot seen in Figure 8 gives a visualization of the distribution of disorder crime in Denver, Colorado over the analyzed period. Of the four crime types, disorder has the most abnormal distribution. This is consistent with suggestions made by the descriptive statistics previously discussed. Some of the lower points slightly fall out of the normal distribution in the negative one quantile. There is also a slight deviation from a normal distribution at the median of the distribution. The final points of deviation are at the highest values in the distribution. Two points vary completely from the normal distribution, while the third highest value point slightly crosses out of the normal distribution. The distribution of disorder crime varies by month in Denver, Colorado, which is a conclusion echoed from the previous suggestions of the Shapiro-Wilk value from descriptive statistics.

Interrupted Time Series

The use of an interrupted time series shows how crime count and trends have changed after the implementation of recreational legalization in January of 2013. The current interrupted time series analysis controls for population by using the crime rate of each month per 100,000 residents of the city over the 8-year period. The reported population for each of the 8 calendar years of the analytical period was used as a flat rate to calculate the rate of the four separate crime types per month. Denver, Colorado is among the fastest growing economies in the United States (Strauss, 2018). With that came an influx of individuals moving into the city. The standardization of using crime rate by month helps control for how an increased population may impact crime in Denver, Colorado. The period used in the segmented regression reflects 48 months before and 48 months after the implementation of recreational marijuana legalization in Denver, Colorado. The first crime type analyzed was total Part 1 crime.

Table 6. *GLM Regressions to Test Population Controlled ITS (N = 144)*

	Part One			**Property**			**Violent**			**Disorder**		
	b	*SE*	*β*	*b*	*SE*	*β*	*b*	*SE*	*β*	*b*	*SE*	*β*
(Intercept)	-7.480	1.3e-02***	-1.9e-04	-7.619	0.01***	-2.03e-04	-9.523	0.034***	-1.4e-03	-8.543	0.02***	3.9e-03
Legalization	-0.147	2.2e-02***	1.2e-06	-0.140	0.02***	-2.4e-06	-0.186	0.059**	1.3e-04	0.179	0.04***	-1.3e-05
Time	9.7e-05	3.9e-04	-1.03e-01	-1.6e-04	4.3-e04	-1.1e-01	0.002	0.001	-0.784	-5.9e-04	6.4e-04	0.001
Null dev:	588.42 on 95 Df			534.19 on 95 Df			94.99 on 95 Df			271.15 on 95 Df		
Residual dev:	424.44 on 93 Df			379.41 on 93 Df			80.78 on 93 Df			197.56 on 93 Df		
Fisher Scoring iterations:	4			4			4			4		

*$p < .05$, **$p < .01$, ***$p < .001$

Table 6 shows results of the general linear regression for the four separate ITS models run. The values reflected are logged values where legalization reflects the change in level of the reported crime rate and the time covariate represents a change in slope. Both of these covariates are representative of the post-period. The first model was Part 1 total crime. For this model, significant influence was returned for only the level of reported crime per 100,000 residents of

the city. After the implementation of recreational marijuana legalization, only the level of reported Part 1 crime significantly changed. The null deviance for the Part 1 model was 588.42 on 95 degrees of freedom, while the residual deviance value was 424.44 on 93 degrees of freedom. The deviance values help determine how well the linear model predicts the response variable. The null deviance shows the model without consideration of influence from the predictor variables. A decrease in the residual deviance value shows that inclusion of the predictor variables resulted in a better-fitted model to predict the outcome variable of crime rate per month. Of the four models run, this was the greatest decrease in residual value after inclusion of the covariates. While the level change was significant, the slope was not changed at a significant level. The rate of reported Part 1 crime was not significantly changed after the introduction of recreational marijuana legalization in Denver, Colorado.

The second linear regression model analyzed the rate of property crime. After recreational legalization, only the change in level was significant. The null deviance was 534.16 on 95 degrees of freedom, while the residual deviance was 379.41 on 93 degrees of freedom. Of the four models, this was the second greatest decrease in residual values after consideration of the impact of predictor covariates. Inclusion of the selected covariates increased the accuracy of prediction of the outcome variable of crime rate per month. Because only the change in level of reported property crime rate changed in the post period, one can see that the rate of reported property crime in Denver did not change significantly after the introduction of recreational marijuana legalization into the community.

The third regression model run evaluated the change in the rate of violent crime per month after the inflection point of recreational marijuana legalization. Like the previously discussed crime types, only the level of reported violent crime changed significantly. The slope

did not. The null deviance value was 94.99 on 95 degrees of freedom. The residual deviance value returned was 80.78 on 93 degrees of freedom. The accuracy of the model was improved with the inclusion of the covariates of slope and level. The third model indicates that like the prior ITS regression models, the rate of reported violent crime did not change significantly after the introduction of recreational marijuana legalization in the community of Denver, Colorado.

The final ITS regression model analyzed the change in reported disorder crimes in Denver, Colorado. When analyzing the change in slope and level of the rate of disorder crime, only the change in level was significant. The null deviance value returned was 271.15 on 95 degrees of freedom, while the residual deviance was 197.56 on 93 degrees of freedom. The accuracy of predicting the outcome variable was improved with the inclusion of the covariates of slope and level. These findings indicate that the change in reported disorder crimes in Denver, Colorado per month in the post period was not significant.

The ITS results indicate that recreational marijuana legalization did not significantly change reported crime after its introduction into the community of Denver, Colorado. While the level did significantly change, the slope did not. This indicates that the changes in slope were not statistically different from how reported crime was fluctuating before the introduction of recreational marijuana legalization. For all four models, inclusion of the covariates increases accuracy of the outcome variable prediction. However, several changes in trend were inverse of the hypothesized direction. Further visual analysis of these changes is discussed further in the following sections.

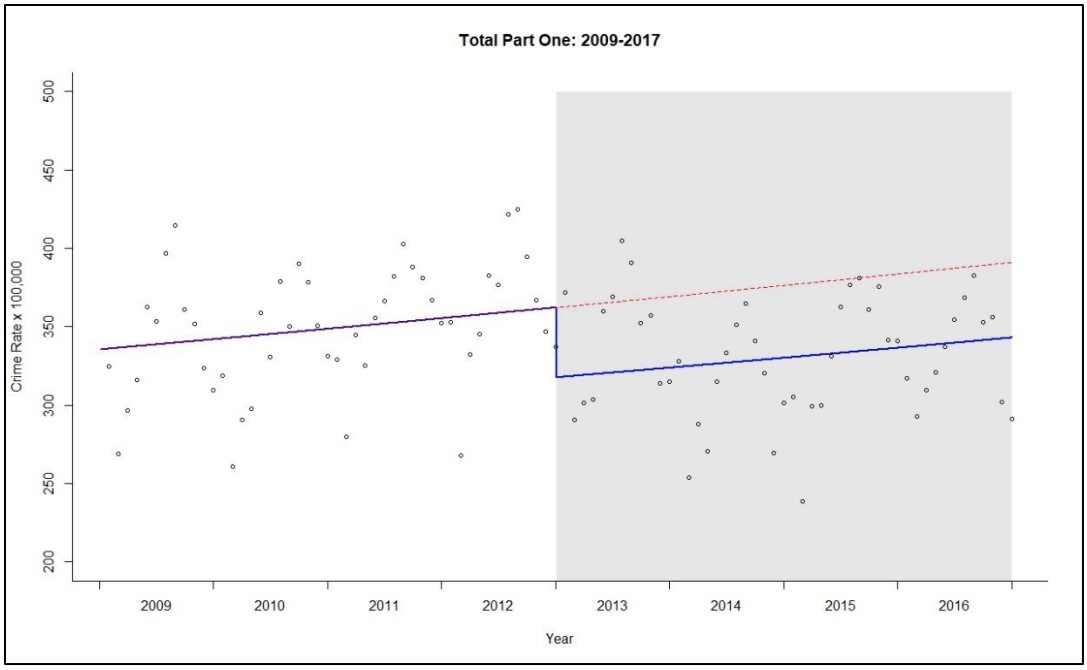

Figure 9. *Interrupted Time Series Plot of Part 1 Crime Rate in Denver, Colorado*

Figure 9 reflects Part 1 crime in Denver, Colorado over the period of 2009 to 2016. The points reflect Part 1 crime per 100,000 residents of the city. The blue trend line shows the crime trend through the entire analysis period. Before the inflection point, Part 1 crime in Denver was rising slightly but gradually. However, per the regression findings, there was a sharp decrease in both the trend and level of reported Part 1 crime per 100,000 residents post-recreational legalization. Part 1 crime continues to gradually increase as we move further from January of 2013, or when recreational marijuana became available within the community. The red trend line shows a projection of how Part 1 crime in Denver would have continued had the inflection point not occurred. While both the red and blue trend lines gradually increase over time past the inflection point, Part 1 crime in Denver decreased from where the red trend line continues. Visual analysis paired with findings from the regression indicate that while Part 1 crime changed inverse of the hypothesized direction, the change was not significant.

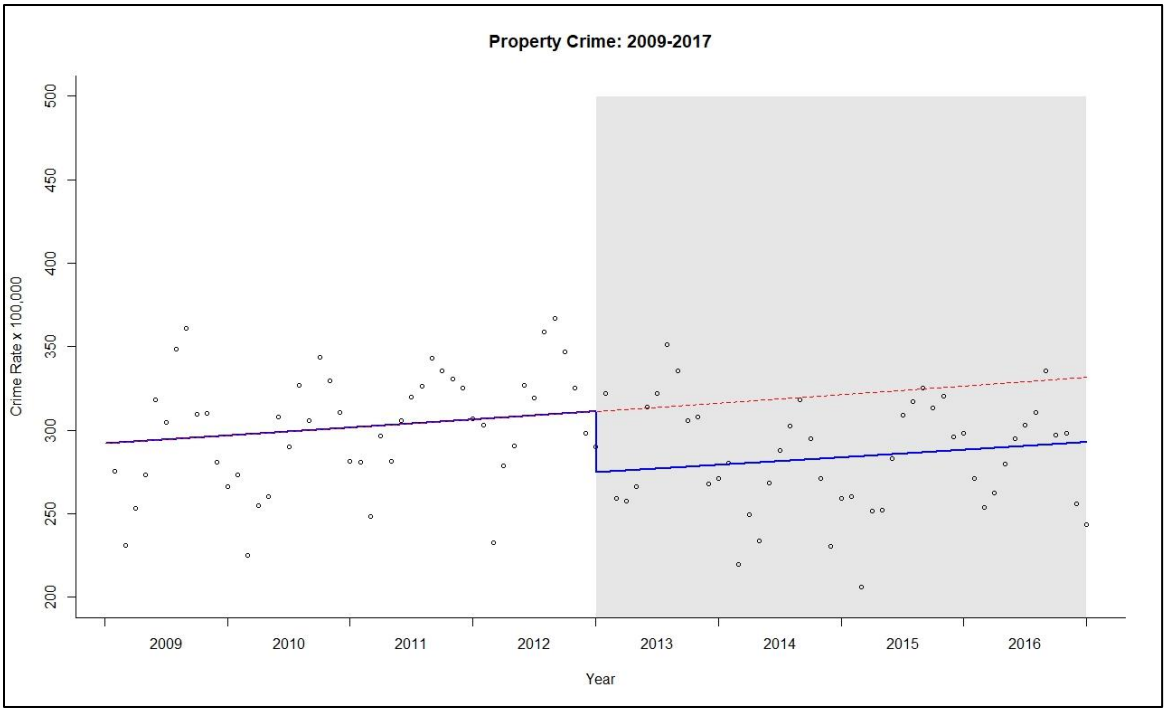

Figure 10. *Interrupted Time Series Plot of Property Crime Rate in Denver, Colorado*

The increasing trend of property crime in Denver, Colorado slowed after the introduction of recreational marijuana into the community in 2013. The rate of property crime per 100,000 in the population dropped with clear low points in 2014 and 2015. The trend of property crime rate was increasing at a faster pace before the inflection point. After the introduction of recreational marijuana legalization, the trend is still increasing, but at a slower pace. The increase in the 4-year post-period is not as high as total Part 1, which eludes to a sharper increase in violent crime after recreational legalization. The red trend line demonstrates how the trend would have continued had the inflection point not occurred. While the trend after the inflection point drops noticeably, the gradual increase appears to be slightly steeper than how the trend would have gradually increased had recreational marijuana legalization not occurred. This plot paired with the significant regression findings indicates that contrary to the hypothesized direction, property

crime significantly decreased after the introduction of recreational marijuana legalization. However, this change was not significant.

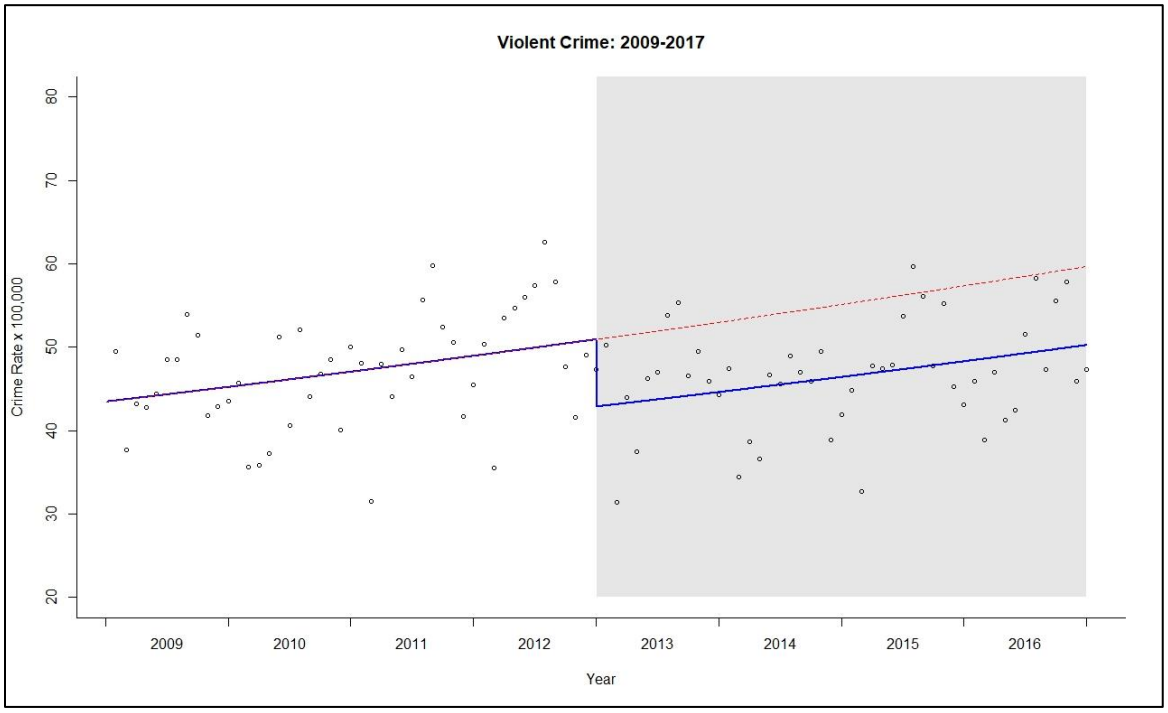

Figure 11. *Interrupted Time Series Plot of Violent Crime Rate in Denver, Colorado*

After the introduction of recreational marijuana into the community of Denver, the trend and level of violent crime per 100,000 citizens decreased, as seen in Figure 11. As with both previously discussed crime trends post-legalization, there is a slight increase in the trend as time elapses. The red trend line indicates that violent crime would have maintained a gradual increase if recreational legalization had not occurred. The regression findings indicate that the change in level of violent crime in the post period was significant. The change in slope was not. The rate of violent crime per 100,000 residents is still increasing in the post-period, just not a quickly as it was before the introduction of recreational marijuana legalization. This increase appears to be occurring at a slower rate if the inflection point had not occurred, as indicated by the red trend

line. Regression results paired with visual analysis show that while violent crime did not increase as it was hypothesized, the change was not significant.

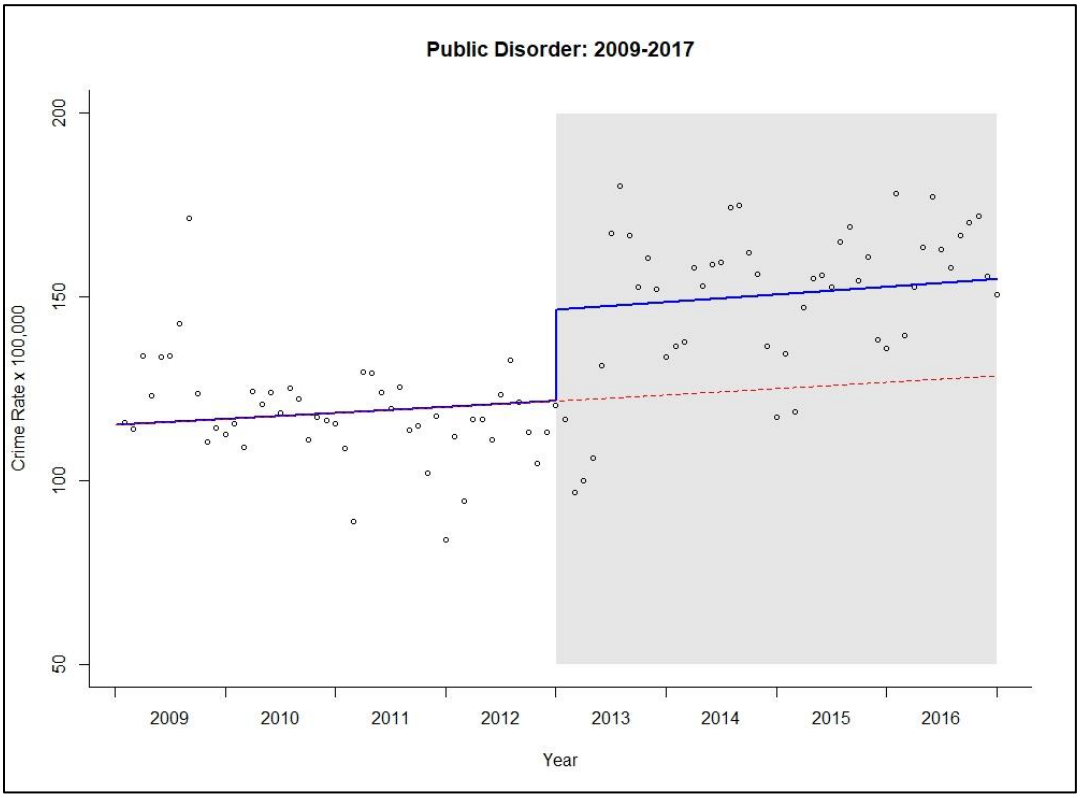

Figure 12. *Interrupted Time Series Plot of Disorder Crime Rate in Denver, Colorado*

Figure 12 shows that disorder crime in Denver increased after the inflection point of January 2013. While there was an initial decrease in reported crime in the first few months of 2013, there was a sharp increase in the middle of the year. Before legalization, the trend of disorder crime was increasing, but the level was much lower than what occurred in the post period. Regression findings indicate the change in slope and level of disorder crime was significant at the .001 level. The red trend line indicates that the gradual increase in disorder crime would have continued if legalization had not occurred. There is a current gradual increase in reported disorder crime per 100,000 residents, but the level is much higher than what may have occurred in the absence of the inflection point. Disorder crime in Denver, Colorado

significantly increased after the implementation of recreational marijuana legalization. Legalization had a higher influence on the trend change than just the influence of time alone. However, including these measures resulted in an accurate measure of the trend change in the rate of reported disorder crime per 100,000 residents of Denver, Colorado, as demonstrated by the regression findings.

The interrupted time series analysis shows the rate of Part 1 and property crime decreased after the introduction of recreational marijuana legalization. The rate of public disorder crime per 100,000 residents increased in the post-period. However, none of these changes were at a significant level. These crime types are further explored in the following multiple regression while introducing covariates derived from concepts of social disorganization theory to test their influence on crime and the utility of the theory as an explanation for crime in Denver, Colorado.

Ordinary Least Squares Multiple Regression

Multiple regression was used to test for both the influence of legalization and covariates measuring the effect of social disorganization on crime in Denver, Colorado over the 8-year period analyzed. Covariates derived from concepts of social disorganization were averaged by census tract for each year of the present study. This average includes census data from 2010 forward as the tracts changed for the 2010 census data. Data from 2009 was excluded from these averages as the census tracts changed from 2009 to 2010. Standardization for census estimates from 2009 exceeds the scope of this project. However, crime incidents from 2009 were still included as incidents were issued an X and Y coordinate. This makes the aggregation to the current census tracts possible.

The outcome variable of crime rate per census tract was based on 2016 crime and the recorded 2016 population of 693,060 residents in the city of Denver. This is to ensure the

relevancy of the model as averaging the population for the 8-year period would decrease the generalizability as the population of Denver, Colorado continues to increase greatly. Findings from the multiple regression are presented below in Table 7.

Table 7. *OLS Regression (N = 144)*

	Part One			**Property**			**Violent**			**Disorder**		
	b	*SE*	*β*	*b*	*SE*	*β*	*b*	*SE*	*β*	*b*	*SE*	*β*
(Intercept)	--	2133.60	795.05	--	2880.52	-422.09	--	225.92	-6.11	--	954.64	-1,568.6
FHH	0.27	100.20	154.01	0.27	92.88	135.07	0.09	13.23	7.35	0.21	54.89	78.90
Juvenile	-0.50	71.41**	-220.45	-0.45	66.11**	-178.21	-0.50	9.40***	-33.37	-0.40	39.32**	-118.4
Renter	0.09	24.22	17.60	0.10	22.51	18.54	0.01	3.20	0.44	0.07	13.29	9.60
Poverty	0.26	57.16	101.06	0.17	52.92	61.25	0.54	7.48***	31.50	0.22	31.56	57.98
DI	-0.04	26.06	-9.07	-0.06	24.31	-11.45	0.12	3.41	3.64	0.00	14.20	-0.02
Ratio	0.20	1493.80*	3,708.22	0.15	5565.46	10,310.08	0.21	129.07***	404.14	0.48	422.98***	3,023.90
R2		0.19			0.15			0.38			0.451	
Adjusted R2		0.16			0.11			0.36			0.43	
F		5.616***			4.053***			14.35***			18.76***	

$p < .05$*, $p < .01$**, $p < .001$***

For Part 1 crime in Denver, Colorado, the female-headed households covariate did not have a significant p-value, indicating it did not have a significant impact on the outcome variable of crime rate per census tract. The unstandardized coefficient returned was 0.27, while the standardized coefficient returned was 154.01. This shows that the rate of Part 1 crime per census tract is associated with a .27 increase for every one-unit increase in the average percentage of female-headed households per census tract. This change in the dependent variable is equivalent to 154.01 standard deviations increase. The juvenile covariate did return an impact significant at the 0.01 level. The value returned was negative, showing that as the population of juveniles decreases, the rate of Part 1 crime per census tract increases. The unstandardized coefficient for juveniles was -0.5 and the standardized coefficient value returned was -220.45, indicating that the outcome variable is associated with a 0.5 decrease in the rate of Part 1 crime per census tract per one-unit increase of the average percentage of juvenile population per census tract.

The renter covariate in the Part 1 crime rate did not show a significant impact and returned an unstandardized coefficient of 0.09. This value indicates an increase of 0.09 in the rate of Part 1 crime per census tract for every one-unit increase in the population of renters per census tract. The standardized coefficient returned for the same covariate was 17.6, showing that there is an increase in the Part 1 crime rate of 17.6 standard deviations for every one-unit increase of a standard deviation in the renter covariate.

Within the same model, the poverty covariate did not have a significant impact on the outcome variable. The unstandardized coefficient was 0.26, while the standardized coefficient was 101.06. For every one-unit increase of the average population of impoverished residents per census tract, there is a 0.26 increase associated with Part 1 crime rate per census tract. When testing the Part 1 total crime model, the diversity index covariate did not return a significant impact on the outcome variable. Additionally, the unstandardized coefficient was -0.04. This indicates a 0.04 decrease in the rate of Part 1 crime per census tract for every one-unit increase of the diversity of residents per tract. The standardized coefficient returned for diversity was -9.07. A change of one standard deviation in diversity results in 9.07 standard deviations decrease in Part 1 rate of reported crime per census tract.

For the final covariate of the ratio of Part 1 crime that occurred after legalization over crime that occurred before, there was a significant impact. This temporal influence of legalization included in the regression was significant at the 0.05 level. The unstandardized coefficient was 0.2, while the standardized coefficient returned was 3,708.22. This indicates that there is a 0.2 increase in the outcome variable for every one-unit increase in the ratio covariate. For every one standard deviation increase in the ratio covariate, there is an increase in 3,708.22 standard deviations for the Part 1 crime rate per census tracts.

For the rate of reported Part 1 total crime per census tract in Denver, Colorado, the presence of female-headed households, renter population, impoverished residents, and diversity of the population per census tract are not significant predictors. Both the presence of juveniles and the temporal influence of the net change in Part 1 crime after recreational legalization per census tract are significant. However, they do not have the same direction of influence on the outcome variable. A decrease in the percentage of juveniles is associated with an increase in the rate of property crime. However, the ratio variable shows a positive relationship, indicating that the temporal inclusion of legalization significantly impacted reported property crime rate per census tract in Denver, Colorado.

In sum, the first model shows legalization had a significant influence on Part 1 total crime, but the only influence of social disorganization concepts returned was for the juvenile population covariate. Of the two significant covariates, legalization had the greater influence on Part 1 crime. This model was significant, $F (4,404, 137) = 5.62$, $p < .001$, and accounted for approximately 19% ($R^2 = .19$) of the variance in Part 1 crime rate per census tract. This suggests the null hypothesis can be rejected in that that there is no effect of the combined covariates on the outcome variable of Part 1 total crime.

Property Crime Rate

The second model tested property crime. The female-headed households covariate did not have a significant p-value. The unstandardized coefficient was 0.27, while the standardized coefficient returned was 135.07. This indicates that for every one-unit increase in female-headed households, there is an increase of 0.27 associated with the rate of property crime per census tract. The standardized coefficient indicates that for every one increase in the standard deviation

for the female-headed households covariate, there is an increase in the rate of property crime per census tract of 135.07 standard deviations.

The only significant impact returned on the second model was the juvenile covariate, which was significant at the 0.01 level. Because the value returned is negative, one can see that as the population of juveniles decreases per census tract, the rate of property crime per 100,000 residents increases. The standardized coefficient for the juvenile coefficient was -178.21, indicating a decrease of 178.21 standard deviations in the rate of property crime per one standard deviation change of the juvenile covariate. The unstandardized coefficient for the juvenile covariate was -0.45. From these values, it can be determined that the rate of property crime decreases by 0.45 for every one-unit increase of the juvenile population per census tract. For the renter population covariate, the unstandardized coefficient was 0.1, while the standardized coefficient was 18.54. For every one-unit increase in the population of renters per census tract, there is a 0.1 increase in the rate of property crime associated. A standard deviation increase in the renter covariate results in 18.54 standard deviations increase in the rate of property crime per census tract. The poverty covariate returned an unstandardized coefficient of 0.17 and a standardized coefficient of 61.25, indicating an increase of 0.17 in the rate of property crime for a one-unit increase in the percent of impoverished population per tract.

The diversity index covariate in the second model returned an unstandardized coefficient of -0.06. A decrease of 0.06 in the rate of property crime per 100,000 per census tract is associated with a one-unit increase in the diversity of a tracts population. The standardized coefficient returned was -11.45, showing that a change of one standard deviation in diversity results in a decrease of 11.45 standard deviations for the rate of property crime. The final covariate in the property crime model was the temporal consideration for the impact of

legalization on property crime per census tract. The unstandardized coefficient returned was 0.15, while the standardized coefficient was 10,310.08. This indicates that a one-unit change in the ratio coefficient results in a 0.15 increase in the rate of property crime per census tract. It also shows that for one standard deviation change in the ratio covariate, a change of 10,310.08 standard deviations is associated with the rate of reported property crime per census tract. This model was significant, $F(3{,}733, 137) = 4.05$, $p < .001$, and accounts for approximately 15% ($R^2 = 0.15$) of the variance in the rate of property crime per census tract. Like the first model, this indicates the null hypothesis can be rejected of no change in the outcome variable when accounting for recreational marijuana legalization and measures of social disorganization theory.

Violent Crime Rate

For violent crime in Denver, the female-headed household had an unstandardized coefficient of 0.09 and a standardized coefficient of 7.35. This indicates that a 0.09 increase in the violent crime rate per census tract for every one-unit increase in female-headed households. The standardized coefficient indicates that a one standard deviation change in this covariate results in 7.35 standard deviations change of violent crime rate per census tract. A non-significant impact was returned for the female-headed households covariate, indicating that this covariate was not a significant predictor of the outcome.

The covariate for juvenile population per census tract returned a significance at the 0.001 level. Like the previous models, this value also reflects a negative relationship with the percentage of juvenile population per census tract. The unstandardized coefficient for the juvenile covariate was -0.5 and the standardized coefficient was -33.57. This indicates a decrease of 0.5 in the outcome variable per one-unit increase of the percentage of juvenile population per census tract in Denver. The standardized coefficient shows a decrease of 33.37 standard

deviations of the outcome variable for every one standard deviation change in the juvenile covariate.

The next covariate of renter population did not have a significant impact. The renter covariate returned an unstandardized coefficient of 0.01 and a standardized coefficient of 0.44, meaning that this coefficient had the smallest influence on the outcome variable. The poverty covariate had an impact significant at the 0.001 level. The presence of impoverished individuals is a significant predictor of the rate of violent crime per census tract. An unstandardized coefficient of 0.12 was returned, as well as a standardized coefficient of 31.5. For every one-unit increase in poverty, there is a .12 increase associated with the rate of violent crime per census tract.

The diversity index covariate did not have a significant impact. An unstandardized coefficient of 0.12 was returned for the diversity covariate, and the standardized coefficient was 3.64. These values indicate an increase of 0.12 in the outcome variable for every one-unit increase in diversity per census tract. It indicates that a one standard deviation change in the covariate causes 3.64 standard deviations change in the outcome.

The final covariate in the violent crime regression model was the temporal consideration for the impact of recreational legalization on violent crime. This covariate did return an impact significant at the 0.001 level, indicating that legalization had a significant impact on the outcome of violent crime rate per census tract. The unstandardized coefficient for the ratio covariate was 0.21, while the standardized coefficient was 404.14. A one-unit change in the ratio results in a .21 increase in the outcome, while a one standard deviation change in the ratio predictor variable results in 404.14 standard deviations change in the outcome. This model was significant, $F(531.2, 137) = 14.35$, $p < .001$, and accounts for approximately 38% ($R^2 = 0.38$) of the variance

in the rate of violent crime rate per census tract in the period analyzed. A significant p-value indicates the null hypothesis for this model was rejected.

Disorder Crime Rate

The fourth model tested disorder crime in Denver, Colorado. The first covariate, derived from the average percent of female-headed households per census tract, did not return a significant impact on the outcome variable. The unstandardized coefficient was 0.211, while the standardized coefficient was 78.9. A one-unit increase in the female-headed household covariate is associated with an increase of 0.211 for the monthly reported disorder crime rate per 100,000 people. The juvenile covariate returned an impact significant at the 0.01 level, indicating that the presence of juveniles is a significant predictor of the rate of disorder crime per census tract. However, like the other models, this is a negative relationship. As the population of juveniles per census tract decreases, the rate of property crime per census tract increases. The unstandardized coefficient was -0.4, while the standardized coefficient was -118.4. For every one-unit increase in juvenile population, there is a decrease of 0.04 in the rate of reported disorder crime per census tract. The standardized coefficient indicates that for every standard deviation increase in juvenile population, there is a change in 118.4 standard deviations associated with the rate of disorder crime per census tract.

The renter covariate did not have a significant impact on the outcome variable of rate per census tract. The unstandardized coefficient of 0.07 and standardized coefficient of 9.6 returned for the renter covariate. For the population of renters per census tract in Denver, Colorado, there is an increase of 0.07 associated with the rate of disorder crime. Poverty showed an unstandardized coefficient of 0.22 and a standardized coefficient of 57.98 but did not have a significant impact on the outcome variable. The diversity covariate had a non-significant

influence on the outcome variable, while the ratio covariate for this model returned an impact significant at the 0.001 level. The unstandardized coefficient was 0.48, and the standardized coefficient was 3,023.9. This indicates an increase of 0.48 in the rate of disorder crime is associated with a one-unit increase in the ratio covariate. The standardized covariate value shows that for the rate of disorder crime, this covariate had the greatest influence. This model was significant, $F(2{,}208, 137) = 18.76$, $p < .001$, and accounts for approximately 45% ($R^2 = 45.1$) of the variance in the rate of disorder crime per census tract. The null hypothesis of no change in the rate of reported disorder crime per census tract in Denver, Colorado was rejected when both recreational marijuana legalization and various measures of social disorganization theory are considered.

Model Diagnostics

A variance inflation function test was done on the covariates used in the multiple regression to test for the issue of multicollinearity, or the issue of overlap in the explanation of variance in the dependent variable. Table 8 shows the results of the test.

Table 8. *Variance Inflation Function Values*

	Part 1	Property	Violent	Disorder
FHH	5.42	5.39	5.4	5.38
Juvenile	4.5	4.46	4.49	4.51
Renter	2.36	2.36	2.35	2.35
Poverty	3.7	3.68	3.63	3.74
Disorder	2.77	2.77	2.69	2.7
Ratio	1.07	1.06	1.01	1.1

For all four ordinary least squares regression models, the covariates with concern for multicollinearity are female-headed households and the percent juveniles per census tract. Because a variance inflation function value greater than five was returned, we know that female-headed households may be linearly predicted from the other covariates present with some degree of accuracy. This implies that multiple regression may be a more accurate test of the outcome

variable if female-headed households were removed. However, running reduced models exceeded the scope of the current study. The covariate of juvenile population is approaching concern with multicollinearity with the values returned for each model approaching five. This is discussed further in the following chapter.

The final test of model diagnostic was that of a Breusch-Pagan test. Findings are presented in Table 9.

Table 9. *Breusch-Pagan Test Results*

	BP	Df	p-value
Part 1	6.87	6	0.33
Property	4.65	6	0.59
Violent	28.29	6	8.296e-05*
Disorder	16.78	6	0.01*

*$p < .05$

The Breusch-Pagan test returned significant p-value for the violent crime and disorder crime rate models of the multiple regression. This indicates a lack of homoscedasticity, or the normalization of variance of data points around the regression line. The issue appears to be more prominent in the violent crime rate model than the regression model for disorder crime rate in Denver, Colorado. These findings suggest that for future research, a logarithmic transformation should be applied to the skewed variables, or that a weighted least squares regression would be a better fit in determining the influence of the selected covariates for both the rate of violent and disorder crime in Denver, Colorado.

Conclusion

Findings from the segmented regression show that after the implementation of recreational marijuana legalization, Part 1 crime rate, property crime, and violent crime decreased. The rate of disorder crime per 100,000 residents of the city increased. A general linear regression to evaluate the population-controlled model shows significance in the change in level of reported crime after the inflection point, but no significant change in the slope. Therefore, the

conclusion is that all four crime types analyzed showed no significant changes after the introduction of recreational marijuana legalization. Instead, the rate of change for all crime types in the post period was not significant from the normal rate of change before recreational marijuana legalization was introduced. Part 1 and property crime changed inverse in the hypothesized direction, a phenomenon further explained in the following chapter.

The multiple regression showed that a number of the social disorganization covariates were found to be significant predictors. The covariate derived from the juvenile population per census tract was a significant predictor for all four crime types, though not in the direction hypothesized. Poverty was a significant predictor for violent crime with findings showing a positive relationship between the two variables. The covariate derived from the ratio of crime after legalization over crime that occurred before was a positive significant predictor for Part 1 total, violent, and property crime. These findings pose implications for recreational marijuana legalization in Denver, Colorado. Additionally, there are several limitations of the current study that should be addressed. Lastly, the current study gives groundwork for future research on the topic to assess how recreational marijuana legalization can impact comparable cities to Denver, Colorado.

Chapter Five: Conclusions, Limitations, and Implications

This study attempted to investigate how recreational marijuana legalization has impacted crime in Denver, Colorado in the context of social disorganization theory. Chapter four presented findings from the current analysis. An interrupted time series analysis and multiple regression explored how recreational marijuana legalization impacted reported crime over an 8-year period. It also tested covariates measuring concepts of social disorganization theory and their relationship with the rate of crime per 100,000 residents per census tract.

There were three hypotheses of the present study. The first was that violent crime would not increase post-legalization. There was some support for this hypothesis as the ITS showed a decrease in the rate of violent crime after the implementation of recreational marijuana legalization. However, this decrease was not at a significant level, nor was the change in slope in the post period significant. It was further hypothesized that property crime would increase post-legalization. However, the results of the ITS indicated a significant decrease in the rate of reported property crime per 100,000 residents per census tract after the introduction of recreational marijuana legalization. This finding is opposite the hypothesized direction and is discussed further in the following section.

An additional hypothesis of the current study concerns the covariates derived from social disorganization theory. It was hypothesized that the presence of all concepts of social disorganization theory would influence the four crime types analyzed. Findings of the multiple regression only partially support this hypothesis. Of the five predictors included, the only consistent influence on all crime in Denver, Colorado was from the presence of juveniles. Similar to results of the ITS, this direction was also inverse of the hypothesized direction. Findings of the multiple regression showed that in the context of this study, the lower the

percentage of juvenile population per census tract, the higher the rate of reported crime was. An additional significance was returned for the percentage of the population living in poverty per census tract covariate, but only for violent crime.

The last hypothesis of the current study was that the rates of reported Part 1 and property crime would increase after the introduction of recreational marijuana legalization in Denver, Colorado. Findings of the ITS instead showed that both crime types decreased. While the changes in both were non-significant, this was an inverse direction of that hypothesized.

To summarize, some findings of the current study were as hypothesized. However, several were not. There are several limitations of the current study as well as theoretical implications for future research, all of which are discussed in the following sections.

Overview of the Findings

The findings of this study show that the rates of Part 1 crime and property crime decreased after the recreational marijuana legalization. Part 1 crime is derived from the combination of property and violent crime. Findings of the regression indicate that between the two, violent crime decreased at a greater but non-significant level, though both decreased overall. The combination of these two crime types drove the decrease of reported Part 1 crime.

The rate of property crime did not behave as anticipated. While the original hypothesis stated property crime would increase, findings of the ITS showed a significant decrease in the level of reported rate per month. This finding indicates that increasing the availability of marijuana does not increase property rates, but may instead result in a decrease. Findings additionally suggest that recreational marijuana legalization may result in a decrease in reported property crime, though in the current study, this decrease was non-significant. The original hypothesis of an increase in property crime after recreational legalization is derived from

research relevant to recreational drugs, their users, and crime. Specifically, prior research gives evidence that marijuana use is positively associated with property offenses (Derzon & Lipsey, 1999) and research indicating that drug use is more often associated with violent crime (McBride & McCoy, 1993), as previously discussed. However, findings of the current study do not support some of these previously discussed studies. For example, these findings contradict those of Derzon and Lipsey (1999), who concluded that marijuana use is positively correlated with reported property offenses. This was not supported, evident in the current findings. However, the current study did not measure marijuana use, only the increase in availability, which theoretically leads to an increase in use. This concept is discussed further in the following section.

An additional theoretical explanation of the property crime findings concerns the black market value of marijuana after the introduction of recreational marijuana legalization. As the availability of marijuana increased, its street value decreased. A parallel could be drawn to the example of moonshine and the United States experience with its prices after prohibition. During prohibition, street value of moonshine increased as demand for the product did. The price decreased after prohibition ended and alcohol became widely available again, decreasing demand for the product (Grabianowski, 2004). This may be the case with marijuana in Denver, Colorado. This increase in availability resulted in less demand for the product. A reduction in demand may have driven down the black market price of marijuana, lowering the need to commit property crime to fuel a drug habit. Additionally, recreational legalization presents an opportunity for increased product regulation. Consumers may be more likely to buy from a dispensary with wider variety, increased security, and a regulated product compared to a common drug dealer on the street.

As the current study hypothesized, violent crime did not increase post-recreational legalization. This hypothesis was informed by prior research indicating that recreational drug users are less likely to commit violent offenses, and that medical marijuana legalization was correlated with a reduction in assaults and homicides (Morris, TenEyck, Barnes & Kovandzic, 2008; White & Gorman, 2000). The decrease in the trend of reported violent crime was significant, but the slope was not. This is evidence that increasing the availability of marijuana in a community for recreational use does not increase the rate of reported violent crime per 100,000 residents. In fact, the introduction of recreational marijuana into a community may decrease the rate, as shown in the current study. Assuming that recreational legalization leads to an increase in use, these findings directly contradict Harry Anslinger's claims about marijuana use and the biased findings stated by federal government research in the 1930s and 1940s (Anslinger & Cooper, 1937; Bromberg, 1934; Stanley, 1931; Walton, 1940). Specific to the relationship between drug use and crime, the decrease in violent crime supports findings of Morris, TenEyck, Barnes, and Kovandzic (2014), who found that increasing the availability of marijuana in a community was correlated with a reduction in assault and homicides. Current findings also support the conclusions of Bennett and colleagues (2008), who concluded that recreational drug users were less likely to violently offend.

The current study hypothesized that disorder crime would increase post-legalization. This hypothesis was educated from prior drug-crime relationship research finding correlations between marijuana use and higher crime in general, as well as studies indicating that communities with higher drug use are associated with disorganization in a community (Bennett, Holloway, & Farrington, 2008; Liska & Chamlin, 1984; Martinez, Rosenfeld, & Mares, 2009). The ITS findings showed that the rate of disorder crime per month increased after the

introduction of recreational marijuana legalization in Denver, Colorado, though only the level significantly changed. Descriptive statistics indicated that disorder crime had the highest level of variance. The crimes included in the measure of public disorder varied considerably, which explains this variance. However, the outcome variable of the rate of disorder crime per census tract was not correlated with another crime type. Additionally, the R^2 value returned for the disorder multiple regression model shows the highest percentage of variance explained by the covariates included. The inclusion of disorder crime was valuable to the current study. However, it does present some limitations, discussed further in the next section.

A review of the descriptive statistics indicated that values for covariates derived from concepts of social disorganization theory were static and did not vary much over the 7-year period used to derive city-wide averages in Denver, Colorado. The only covariate derived from concepts of social disorganization theory that was a significant predictor for all four multiple regression models was the average percentage of the juvenile population per census tract. However, the direction of the relationship was inverse of that hypothesized. For each crime type analyzed, the higher the percentage of juvenile population per census tract, the lower the crime rate was. This may be due to the fact that many of the crimes analyzed are felonies. In the United States, adults are much more likely to commit and get convicted of a felony offense than juveniles (Bureau of Justice Statistics, 2004). This may answer why the relationship of the juvenile covariate to the output variables was inverse of the hypothesized relationship.

An additional theoretical explanation of the directional relationship between the percentage of juvenile population per census tract and reported crime rate in Denver, Colorado is gentrification. As previously stated, Denver, Colorado is among the fastest growing economies in the United States (Strauss, 2018). As the city grows and displaces residential areas, the

juvenile population has been pushed outwards as well. Additionally, the city has seen large growth in the homeless population. This population of offenders is not accounted for in the reported population rates used in the current analysis. If transients in the city are responsible for crime, but not considered in the population of offenders, it may further explain why findings of the current study showed that as the population of juveniles decreases, the rate of reported crime increases.

An additional significant predictor covariate measuring social disorganization theory was poverty. This covariate was a significant predictor of the rate of violent crime per census tract. Social disorganization theory holds that an impoverished community is more likely to have higher rates of all crime, but violent crime particularly (Hipp, 2007; Parker & Reckdenwald, 2008). The current study supports that. However, the average percentage of impoverished population per census tract was not a significant predictor for Part 1, property, and disorder crimes. Future research should expand to look at other measures of economic disadvantage, such as population receiving welfare or government assistance per census tract or section eight housing in the city, to compare reported crime rates to investigate social disorganization in Denver, Colorado further.

The last significant covariate in the multiple regression was the ratio of crime post-legalization over crime that occurred before. This variable was the net change in reported crime incidents per census tract. It returned a significant impact on Part 1 crime, violent crime, and disorder crime, indicating that when concepts of social disorganization are included, recreational marijuana legalization did have a significant impact on these crime types. Regression does not account for temporal changes very well, and the introduction of the ratio covariate was an attempt to force an adjustment and consideration of recreational legalization.

Findings of the current study challenge some concerns of adopting recreational marijuana legalization and its impact on reported crime (Trillings, 2016). Recreational marijuana legalization did not result in significant changes in reported crime per 100,000 residents of the city. Additionally, some crime and one social disorganization theory variable went opposite of the hypothesized direction. This demonstrates a need for additional research. However, the current study and its findings do present some limitations that need to be addressed.

Limitations

There are several limitations in the current study. The first limitation is that of the timeframe used. A longer post-period would allow for further understanding of the impact of recreational legalization on a community. Additionally, an extended post-period would result in more data available for use, which would only enhance analysis. This was not feasible for the current study as the official dataset used concluded in 2016. More time in the period analyzed would also help account for how community growth has further impacted legalization and crime in Denver, Colorado. For this reason, research on this topic should continue. Four years may not be enough time to determine conclusively what impact recreational marijuana legalization has on a community, particularly with one like Denver, Colorado, where growth has increased greatly in recent years.

The second limitation of the present study lies in the data used. First, the use of reported crime presents a constraint. Reported crime only accounts for a small percentage of total criminal activity that occurs within a community. Underreporting may also be an issue for some subgroups and populations within the city of Denver. While community outreach has shown success in relationships with the Denver Police Department and its residents, populations like transients or undocumented immigrants may be hesitant to report victimization. This

underrepresentation of populations introduces some error in the current study. It is also likely that drug-related crime is underreported. The National Crime Victimization Survey estimates that from 2006 to 2010, over three million violent crimes per year went unreported (Langton, Berzofsky, Krebs, & Smiley-McDonald, 2012). This estimate would only be greater with the inclusion of drug-related offenses. Future research should expand to include data sources from individuals in the community. While self-report data presents its own set of limitations, furthering a qualitative approach may be a more accurate measure of crime and victimization within a community. Additional exploration of qualitative methods into the community of Denver would also be beneficial. However, investigation at a personal level with individuals of the Denver community was not viable for the current study.

Another limitation of the data used in the present study is with the census data. While data are derived from an official source, the use of estimates presents some measure of error. Using data derived from the future census in 2020 would show more accurate measures of how Denver, Colorado has changed in both reported crime and the context of social disorganization theory concepts. The method by which the current study utilized census data should also be considered a limitation. An issue of multicollinearity was detected between the female-headed households and juvenile population variables. Homes included in the female-headed households census measure are those that have dependent and related children under the age of 18. This conceptualization, along with the inclusion of the juvenile population per census tract, resulted in an issue with multicollinearity. Theoretically, the inclusion of the female-headed households was intended to be an indirect measure of economic instability, family disruption, and supervision as discussed by Shaw and McKay (1924). However, there may be more effective census measures that could have been used to measure those in the place of female-headed households. The

census also gathers information of male or female householders with no spouses present. This measure also includes children. A combination of these census measures perhaps would result in a better measure of the social disorganization theory concepts. Expanding this measure and dropping the juvenile variable may offset some overlap in these measures while still returning a valuable analysis of social disorganization theory. Running reduced regression models exceeded the timeframe of the current study. Future research may result in a more thorough investigation of social disorganization concepts and their impact on reported crime Denver, Colorado if reduced regression models are utilized.

A third limitation present in the current study is in variable conceptualization. The current study uses a nuanced definition of disorder crime. The crimes included in the disorder classification were all "crimes against society" in the city of Denver, and offenses such as criminal mischief, liquor law violations, disturbing the peace, and trespassing. While the disorder multiple regression explained a more significant amount of variance when compared to other models in the present study, a more precise definition and conceptualization of disorder crime may increase the accuracy of the measure.

Selection of the city of Denver, Colorado may also be considered a limitation of this study. There is a possibility that the city of Denver and its culture is an anomaly. This would make findings generalizability limited. Its growth of industry and economy paired with political atmosphere and higher tolerance for diversity may restrict generalizability (Bernardo, 2018; Martin, 2016). Much of this growth has occurred after the implementation of recreational legalization, making the generalization of findings that much more difficult. There may be larger cities in the United States that compare to Denver, but none have had recreational marijuana available for sale as long as Denver, Colorado. Additionally, the juvenile covariate, Part 1 crime,

and property crime variables all behaved inverse of the proposed direction, indicating a need for further research.

Current findings and limitations present some potential implications for the future of recreational marijuana legalization in the United States as well as continued research in Denver, Colorado.

Implications

Communities considering legalizing recreational marijuana should anticipate its potential impact on reported crime, as identified by the current study. While there were some abnormalities in the Part 1 and property crime rates per month, they were not at a significant level. This is evidence that if there is any harm introduced in the form of reported crime after implementation of recreational legalization, its impact would not be significant. Contrary to Harry Anslinger's (1937) belief, the community of Denver did not descend into chaos in the context of reported crime after the availability of recreational marijuana increased. While disorder crimes did increase after recreational legalization, it was also at a non-significant level. Assuming generalizability of the current findings, potential communities may see potential increases in disorder crime, and decreases in Part 1, property, and violent crime, though none of these changes will be statistically significant. The costs versus benefits should be weighted before pursuing recreational marijuana legalization. In the context of reported crime, the risk of implementing recreational marijuana legalization is minimal. However, there are several other aspects of community health that should be considered prior to recreational legalization adoption. These are discussed further in this section.

The most substantial implications provided in the current study are those for the direction of future research. A major focus of a further investigation into the impact of recreational

marijuana legalization should be on the rate of use. The current study did not investigate the increase of availability of marijuana on rates of use in the community, though the investigation of this topic would benefit the field and community of Denver, Colorado greatly. Findings of the current study may challenge some estimates made by the National Institute of Drug Abuse (NIDA) on the age of users in the United States. Specifically, NIDA estimates that marijuana use is more frequent in adolescent males aged 12 to 17 years (NIDA, 2017). If this were the case, and assuming that legalization leads to an increase in use and use leads to crime, the negative relationship between the percentage of juvenile population per census tract and rate of all four crime types per census tract would be a positive one. This example only further illustrates the need for continued research into rates of use post-legalization.

As the recreational legalization of marijuana continues in the United States, research should continue to determine the extent of its impact on a community. Investigation of the impact of recreational marijuana legalization should come from many perspectives and fields. Research should also expand further than analyzing crime to determine the impact of recreational legalization on a community. There are other methods of determining the "health" of a community and its individuals, such as studies of the physical environment, income and social status, health services, and social support networks. Researching the impact of recreational marijuana at the interpersonal level exceeded the scope of the current project, but findings from studies of these topics would further understanding of recreational marijuana legalization.

Research endeavors should also investigate implications that recreational marijuana legalization may have on the criminal justice system. For example, examining probation and parole violations after recreational marijuana legalization would offer some insight into further implications for the criminal justice system. One potential consequence may exist in parole and

probation violations. If a condition of probation is abstinence from marijuana use, but an increase in availability leads to an increase in consumption, does recreational marijuana legalization result in an increase in probation and parole violations? An increase in these violations would introduce more strain on an already overburdened criminal justice system. Probation violations would also introduce more disorganization into the local community as able-bodied family members are incarcerated and unable to provide for families. Would that potential increase in imprisoned family members increase the need for government resources such as welfare and section eight housing? Further research should be done to determine the extent of these criminal justice system issues and potential strain and disorganization they may introduce into a community. Criminal justice system implication research also presents an opportunity to investigate the relationship between drug use and crime further, as we know from prior research that drug use is reported at a higher rate in offender populations (Gandossy, Williams, Cohen, & Harwood, 1980; McBride & McCoy, 1993). As recreational legalization grows in the United States, having a condition in probation or parole to remain drug-free would still exist. Increasing the availability of the drug within communities may result in higher recidivism rates and increased costs to courts and corrections in the United States.

Further crime-related research endeavors should expand at a more granular level. While analyzing crime by broad definitions set by the FBI increases the generalizability of findings, there may be one or two specific crimes driving the rate of the total category. For example, there is some evidence that post recreational legalization, commercial burglaries increased in the city of Denver (Rogers & Moss, 2016). Future crime should also investigate how much seasonality impacts reported crime rates in Denver. All visual analysis plots of the ITS indicated lower crime rates reported in colder months of the year with February consistently having the lowest amount

of reported crime. This is consistent with all four crime types analyzed. Prior research has established that reported crime changes on the impact of seasonality (Baumer & Wright, 1996; Hird & Ruparel, 2007).

The current findings pose more research topics in the city of Denver related to the impact of recreational marijuana. First, research in general needs to be continued in the city as several variables did not result in anticipated findings. This is first evident in the correlation matrix discussed in the previous chapter. Several variables were not correlated as prior research implies they might be, such as female-headed households, or were associated in the opposite direction, as was the case for the juvenile population variable in both the correlation matrix and regression output.

Second, further research could be completed to explore how concepts of social disorganization continue to impact crime. While the covariates accounted for a moderate amount of variance for violent and disorder crime, this was not the case for Part 1 and property crime. Research could be furthered to determine if there are other influences of social disorganization that impact these two crime types, such as more accurate measures of racial and ethnic diversity or percentage of welfare recipients per census tract. Additionally, this research should continue in the context of the city of Denver, where a quickly evolving residential community holds potential for many sociological and criminological findings.

Future research should also focus on who is committing these crimes in the city of Denver. Specifically, researchers should investigate whether residents or visitors of the state are committing these offenses. Tourism in the city of Denver exploded post-legalization (Barber, 2016; Belvins, 2016). In 2016, the state of Colorado broke its own tourism record for the fifth year in a row with visitors spending over $19 billion in the state for the year (Belvins, 2016).

This trend in tourism growth continued into 2017, with Denver welcoming 30 million visitors into the city (McGhee, 2017). The current study had a control for population, though this does not account for the potential impact that visitors of the city are having on reported crime post-recreational marijuana legalization. Visitors drawn to the city because of recreational marijuana legalization but harming the community by offending many be an unanticipated negative impact on the community of Denver after the introduction of recreational marijuana legalization. Further investigation would better inform policy and police activity during peak tourism months of the year.

The current study provided further evidence of a continued need for social science research into Denver, Colorado as there were several variables that behaved opposite of the hypothesized direction. Research should continue to determine if Denver is an anomaly, or if many of the assumptions made about recreational marijuana legalization are unfounded. As previously stated, the current study does not argue whether or not recreational marijuana legalization should occur. Instead, the focus is on the impact of its introduction on reported crime in a community. Findings of the current study show that recreational marijuana legalization did not have a significant impact on the rate of reported crime by month in Denver, Colorado after its introduction. Additionally, concepts of social disorganization theory only partially predicted the rate of crime per census tract in Denver, Colorado. These findings may challenge some assumptions about marijuana and how it can impact crime in a community. As recreational marijuana legalization continues in the United States, research should continue to determine the extent of its impact.

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