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THE IMPACT OF BODY-WORN CAMERAS ON USE OF FORCE AND CITIZEN COMPLAINTS: A QUASI-EXPERIMENTAL STUDY AT THE NEWPORT NEWS POLICE DEPARTMENT

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THE IMPACT OF BODY-WORN CAMERAS ON USE OF FORCE AND CITIZEN COMPLAINTS: A QUASI-EXPERIMENTAL STUDY AT THE NEWPORT NEWS POLICE DEPARTMENT

by

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B.S., Missouri State University, 2010
M.S., Missouri State University, 2013

A Dissertation
Submitted in Partial Fulfillment of the Requirements for the
Doctor of Philosophy Degree

School of Justice and Public Safety
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DISSERTATION APPROVAL

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COMPLAINTS: A QUASI-EXPERIMENTAL STUDY AT THE NEWPORT NEWS POLICE
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Doctor of Philosophy

in the field of Criminology & Criminal Justice

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MAJOR PROFESSOR: Dr. Joseph Schafer

Several questionable officer involved shootings and perceived abuses of authority disproportionately involving minority citizens have resulted in public outcry, protests, and nationwide scrutiny of police in recent years. The resulting police legitimacy crisis has prompted agencies to rapidly equip officers with body-worn video cameras (BWCs). BWC advocates lauded the findings of an early study that attributed significant reductions in use of force incidents and citizen complaints to the devices and it is this and a handful of other short-term studies upon which the claims of these benefits are predicated. However, subsequent research has produced mixed findings and the sustainability of any reductions remains questionable. The limited knowledge concerning the impact of BWCs on the aforementioned outcomes is problematic considering the potential negative impact of unrealistic expectations and the expense of BWC program maintenance. The objective of this dissertation is to address gaps in the extant research by exploring the impact of an incremental deployment of the devices on the frequency and severity of use of force incidents and the frequency and outcome of citizen complaints while controlling for staffing, volume of officer-initiated enforcement contacts, and the Ferguson incident. Utilizing 86-months of secondary data collected from the Newport News, Virginia Police Department (NNPD) a vector autoregressive multivariate time series analysis indicates that BWCs were a significant factor in a substantial sustained reduction in use of force and a substantial sustained increase in exonerated complaint dispositions at the NNPD.

DEDICATION

I dedicate this dissertation to Barbara Kyle, who is not only my wife, but my soulmate. Your sacrifice and steadfast support over the years made me the man I am today and was the most impactful factor in the completion of this dissertation. You are my hero and I love you more than I can express in words. This is for you babe.

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CHAPTER 1

INTRODUCTION

> We know that on a daily basis, officers perform their jobs with distinction and provide great service. They risk their lives, and this does not always receive the attention it deserves. The good and hard work of police officers in America is being overshadowed by the occurrence of what have been referred to as 'lawful but awful' incidents.

> - Police Executive Research Forum, 2016, p. 119

Michael Brown, Tamir Rice, Eric Garner, Freddie Gray, Alton Sterling, and Philando Castile—well-known names of African American males killed in questionable police use of force incidents since 2014—are examples of high-profile "lawful but awful" incidents referred to in the epigraph above. These and many other questionable uses force (both lethal and non-lethal) and other abuses of authority disproportionately involving minority citizens have resulted in public outcry, protests, and nationwide scrutiny of police.[1] In response to the growing police legitimacy crisis, President Obama appointed the President's Task Force on 21st Century Policing to examine the issues and make recommendations for reform. In its final report the President's Task Force indicated that the legitimacy crisis is the most urgent issue facing policing in the U.S. today and recognized the potential of body-worn cameras (BWCs) to improve agency transparency and officer accountability (President's Task Force on 21st Century Policing, 2015). Based on these perceived benefits, in December 2014, President Obama committed $75 million in federal grant funding to help local law enforcement agencies equip their officers with BWCs (The White House, Office of the Press Secretary, 2014).

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[1] The terms police/police officer used hereinafter to refer to all law enforcement agencies/officers with general policing responsibilities and arrest powers (e.g., municipal police departments, sheriff's departments, state police/highway patrol agencies, special jurisdiction agencies such as transit police, etc.).

Following the 2014 shooting of Michael Brown by a Ferguson, Missouri, police officer (which was not captured on video), the benefits of BWCs received substantial media attention and entered public discourse. The dialogue has focused on the increased transparency and improved officer behavior that the devices are presumed to produce (Schneider, 2018). Body-worn camera advocates assert that improved officer behavior manifests in reduced use of force incidents and citizen complaints (White, 2014). Proponents and early implementers of BWCs lauded the findings of a few small studies demonstrating these positive effects, and it is these few studies on which the aforementioned claims are predicated (Farrar & Ariel, 2013; Mesa Police Department, 2013).

The first U.S. study to measure the impact of BWCs on use of force and citizen complaints was conducted at the Rialto, California, Police Department in 2012 and is frequently cited by BWC advocates (Ariel, 2017). Farrar (who was the Rialto Chief of Police at the time the study was conducted) and Ariel (2013) reported that BWCs reduced use of force incidents by more than 50 percent and citizen complaints by 90 percent. However, these rather impressive reductions represent relatively small raw counts in an agency of 115 sworn officers—a decrease from 60 use of force incidents in the 12 months preceding the study to 25 during the 12-month trial, and 28 complaints in the 12 months preceding the study to 3 during the 12-month trial period (Farrar & Ariel, 2013).

Since the Rialto study, scholars have investigated these claims with more rigorous research generating mixed results, but the U.S. studies that have been published are generally limited to the examination of use of force and citizen complaint frequency in randomized controlled trials of relatively short duration. Questions regarding sustainability of any reductions in these outcomes, potential changes in the level of force employed (frequency of suspect injury),

and potential changes in the proportion of exoneration and sustained complaint dispositions remain largely unaddressed. Furthermore, few studies have examined a potential reduction in officer-initiated activity, a "de-policing" effect, which some argue might occur when officers are equipped with the devices and could be a factor in use of force and citizen complaint reductions. Likewise, while police officer recruitment and retention difficulties have been widely reported in recent years (Morison, 2017), extant BWC studies have not controlled for potential patrol personnel shortages.

Despite the sparse evidence of their efficacy to reduce use of force and citizen complaints, law enforcement agencies across the country are rapidly implementing BWCs. According to a report generated by the Bureau of Justice Statistics, 32 percent of U.S. police departments had begun implementation of the devices by 2013, which was more than one year prior to shooting death of Michael Brown in Ferguson, Missouri (Reaves, 2015). Just two years later a survey of Major Cities Chiefs and Major County Sheriff's (2015) association member agencies indicated that 95 percent had adopted BWCs, were in the process of implementing them, or intended to implement them in the near future. The ramifications of unrealistic expectations concerning the impact of BWCs cannot be overstated. Such unmet expectations would likely exacerbate the current police legitimacy crisis. Therefore, more research is urgently needed to examine the impact of the devices.

The current study of the Newport News, Virginia, Police Department's implementation and four years of experience with BWCs seeks to contribute to the limited body of BWC literature in these areas, specifically, whether BWCs have a significant impact on the frequency of use of force incidents, level and severity of force employed, and the frequency and dispositions of citizen complaints when simultaneously considering staffing and volume of

officer-initiated enforcement activity.

Statement of the Problem

Police officers are the most visible agents of government who, under a theoretical social contract, are entrusted with the power to use coercive force—including physical force up to and including deadly force within lawful parameters—to keep order through the enforcement of law (Bittner, 1974). The controversy generated by the authority to coerce compliance with lawful orders, detain, and arrest, using physical force to do so, if necessary, is compounded by the ability of officers to exercise considerable discretion in the course of their enforcement activity (Walker, 1993). Moreover, police officers have a great deal of autonomy because they are frequently geographically separated from supervision (Weitzer, 2015). Police officers are expected to bring their coercive power to bear on myriad situations involving crime and/or disorder to achieve some sort of resolution (Bittner, 1974). They are expected to exercise sound judgment and make thoughtful and proper decisions concerning matters of life and liberty of citizens within the confines of a complex set of laws, often in rapidly evolving, stressful confrontations with offenders and other hostile persons, including split-second decisions to use physical force. Their decisions and actions are judged by police command staff and administrators through the lens of agency policy, the judiciary through the lenses of constitutional requirements, statutes, and case law, and most importantly, in the court of public opinion.

Public perceptions of use of force, abuse of authority, and the consequences.

While competence in addressing crime is one component in citizen satisfaction with the police, *how* officers perform their law enforcement duties is paramount. However, "regardless of what true crime trends exist or how officers are actually interacting with community members,

the citizens' perceptions are the basis of their satisfaction or dissatisfaction with police" (Kyle &

Schafer, 2016, p. 287). Gallagher and colleagues (2001) assert that public opinion of the police is

developed through a complex nexus of influences, but that process related factors are most

impactful. For more than a decade before the Ferguson incident, criminal justice scholars and

practitioners alike have observed that citizens' perceptions of police legitimacy in the U.S. were

less than ideal, particularly poor among minorities, and increasingly linked with the concept of

procedural justice (Mazerolle, Bennett, Davis, Sargeant, & Manning, 2013).

Extensive research has demonstrated that the theoretical construct of procedural justice is

a critical factor in citizens' perceptions of police legitimacy and explains both the source of the

problem and the solution (Mazerolle et al., 2013; Tyler, 2014). Procedural justice in the context

of policing is simply treating every individual in a fair and respectful manner and allowing

citizens to have a voice during interactions with officers. According to Tyler (2014), "Procedural

justice can be viewed as a means to attaining legitimacy (the belief that the police ought to be

allowed to exercise their authority to maintain social order, manage conflicts and solve problems

in their communities…)" (p. 9). Conversely, procedural injustices, even *perceived* injustices,

have a negative impact on police legitimacy. Whether actual or perceived, unnecessary or

excessive use of force and other forms of abuse of authority have serious consequences.

While use of force in police-citizen contacts is relatively rare, when such instances do

arise, they bring to the forefront what is arguably the most controversial aspect of the police role,

and citizens are rightfully concerned with why, how, and against whom police use force.

Although most use of force incidents are determined to be legally justified, as Brandl (2018)

aptly states, "[e]ven when it is necessary and justified, the use of force never photographs well"

(p. 245). In many instances when a use of force is ruled justified in accordance with agency

policy and legal parameters, many citizens do not share the same sentiment. This is especially true when deadly force is used against an unarmed subject, or a given non-lethal use of force appears to be unnecessary or excessive, hence the public outcry and civil unrest following the shooting death of Michael Brown in Ferguson, Missouri, and the subsequent clearance of the officer involved from any wrongdoing (Kahn & Martin, 2016), and the public outrage following police use of a Taser on an 86-year-old man in Kingstree, South Carolina (Wootson, 2017).

Likewise, citizens are concerned with other types of police abuse of authority, including "verbal/psychological abuse" and "legal abuse/violation of civil rights abuse" (Carter, 1985, p. 322). The 2009 arrest of Harvard Professor Henry Louis Gates Jr. for disorderly conduct by Cambridge, Massachusetts, police, which drew the comment "police acted stupidly" from President Obama, is one example of a perceived abuse of authority (Cooper, 2009). The arrest of an emergency room nurse in Salt Lake City, Utah, for obstruction when she refused an officer's order to draw blood from an unconscious suspect (an action prohibited by hospital policy without a search warrant) is another (Wang & Hawkins, 2017).

These are but a few examples of questionable uses of force and other possible abuses of authority that have received substantial negative attention from the public. Advancements in video recording technology that enable anyone with a cell phone to record any event and instantly disseminate or even stream those recordings through social media has exacerbated the police legitimacy problem. Citizen captured videos of perceived police mistreatment of citizens have produced public skepticism concerning police enforcement activities and justification for uses of force (Brucato, 2015). This skepticism and increased scrutiny are fueled in part by video recordings that capture only a fraction of an incident, which leaves viewers to speculate about the ethicality of, and justification for, an officer's actions. Yet, many videos capture behavior that

leaves little doubt about officer misconduct. Social media sites such as YouTube contain numerous citizen-captured video recordings of police officers engaging in questionable uses of physical force, making questionable arrests, and threatening and/or treating citizens disrespectfully. Furthermore, many minority citizens relate encounters with police that suggest the contact may have been the result of racial profiling (Epp, Maynard-Moody, & Haider-Markel, 2014). Actual physical abuses of authority (unnecessary and excessive force), non-physical abuses of authority (verbal/psychological abuse and legal abuse/violation of civil rights abuse), or public perception of either produce considerable negative consequences. Of course, humanitarian concerns are of utmost importance given that the lives and liberty of citizens are at stake, but there are two other serious ramifications, the fiscal impact and damage to police legitimacy.

First, citizen complaints concerning police abuses of authority can have a serious fiscal impact. For instance, of the six cases named at the outset, lawsuits filed against police agencies in five have resulted in large settlements or judgments: $1.5 million in the Michael Brown case (Patrick, 2017); $6 million in the Tamir Rice case, $5.9 million in the Eric Garner case, $6.4 million in the Freddie Gray case (Berman & Lowery, 2016); and $3 million in the Philando Castile case (Smith, 2017). According to Elinson and Frosch (2015):

> The 10 [U.S.] cities with the largest police departments paid out $248.7 million last year [2014] in settlements and court judgments in police misconduct cases, up 48% from $168.3 million in 2010… Those cities collectively paid out $1.02 billion over those five years in such cases, which include alleged beatings, shootings, and wrongful imprisonment.

According to Balko (2014), settlements and judgments stemming from police misconduct cases have cost the City of Chicago almost half a billion dollars in the last 10 years ($84.6 million in 2013 alone), and in the City of Baltimore:

Over the past four years, more than 100 people have won court judgments or settlements related to allegations of brutality and civil rights violations. Victims include a 15-year-old boy riding a dirt bike, a 26-year-old pregnant accountant who had witnessed a beating, a 50-year-old woman selling church raffle tickets, a 65-year-old church deacon rolling a cigarette and an 87-year-old grandmother aiding her wounded grandson. Those cases detail a frightful human toll. Officers have battered dozens of residents who suffered broken bones—jaws, noses, arms, legs, ankles—head trauma, organ failure, and even death, coming during questionable arrests. Some residents were beaten while handcuffed; others were thrown to the pavement. And in almost every case, prosecutors or judges dismissed the charges against the victims—if charges were filed at all.

In fact, the Cato Institute's (2012) National Police Misconduct Reporting Project calculated that settlements and judgments in police misconduct cases totaled $346,512,800 nationwide in 2010. Moreover, juries are increasingly more sympathetic to victims of police abuse of authority. On February 16, 2018 a Baltimore County, Maryland jury awarded $38 million to the family of a woman shot and killed by police (Stevens, 2018). While staggering, the fiscal impact is but one of the negative consequences.

Second, and of more concern, is the negative impact on police legitimacy, which is invaluable in a democratic society and difficult to restore when it is tarnished. A substantial and growing body of research demonstrates that perceptions of fairness and treating citizens with respect and dignity, the primary elements of procedural justice, are most impactful in terms of public opinion of the police. For example, while it is obvious that a citizen who is treated disrespectfully by an officer is highly likely to view such an interaction as unjust and leave the encounter with a negative opinion of the police, Epp and colleagues (2014) found that when an officer stops an African American citizen and he or she either fails to explain the reason for the stop, or cites a seemingly trivial reason, the citizen is likely to feel they are being victimized. Historically, the relationship between police and minorities, African Americans in particular, has been strained. However, the advances in technology and media exposure of perceived unnecessary or excessive force and other abuses of authority have increased this tension, which

largely constitutes the current legitimacy crisis (Kochel, 2019).

A 2016 poll conducted by Pew Research Center found that 75 percent of Whites believed that police treated racial and ethnic minorities equally, but 67 percent of African Americans did not believe that to be the case. Similarly, three-quarters of Whites believed that police were using the right amount of force in most situations while 67 percent of African Americans disagreed. Furthermore, the poll revealed that about two-thirds of African Americans believed police officers were not held accountable for misconduct while an equal proportion of Whites believed they were (Morin & Stepler, 2016). The Black Lives Matter movement and numerous public protests reflect these findings.

Procedural injustices, or even the perception thereof, erodes police legitimacy. Not only in terms of the individual who had the negative experience personally but will likely impact the opinions of others vicariously (Brunson, 2007). Negative perceptions of police legitimacy impact citizens' willingness to obey the law, report crimes, identify as witnesses, or otherwise cooperate and partner with police to address crime (Tyler, 2006). The fact that public opinion of police is very poor among African American citizens is especially problematic as many high crime areas are heavily minority populated, thus police effectiveness in addressing those crime problems is likely hindered. Thus, minimizing use of force and officer behaviors that generate citizen complaints is crucial.

Body-Worn Cameras, a Potential Solution?

BWCs are small, self-contained, digital video recording devices that attach to an officer's shirt, or are mounted on glasses, hats, or a headband and are a notable advancement from earlier forms of video recording technology utilized by police. In-car video systems, which have been in use by police since the 1980s, only capture activity immediately in front of a police vehicle,

seriously limiting their utility for recording police-citizen interactions in their entirety. The small size of BWCs, hands-free portability, and ability to operate and store video for full tours of duty overcome the limitations of in-car video systems. Video recording is initiated and ended by the officer manually activating/deactivating the camera; however, most BWCs on the market continuously record on a 15 second to 2-minute loop (depending on the product) in order to capture and preserve events immediately preceding camera activation (Hung, Babin, & Coberly, 2016). While BWCs allow officers to potentially record all police-citizen interactions, each agency sets forth its own policy regarding what types of police-citizen encounters officers are required to record, and conversely, what types they are prohibited from recording (The Leadership Conference on Civil and Human Rights & Upturn, 2017). The devices store all the captured video, which is typically downloaded into a server system or to a cloud-based storage service at the end of each shift by placing the camera in a dual-purpose cradle/port that also charges the BWC's battery. BWCs and their video data storage systems generally prevent editing, deleting, copying, or altering recorded video before or after download, except for redaction of copies by authorized persons to fulfill FOIA requests (Hung et al., 2016; Miller, Toliver, & Police Executive Research Forum, 2014).

While BWCs have received considerable attention in the U.S. recently, they were first piloted in the U.K. as early as 2005 (White, 2014). Although some pilot programs had already begun in the U.S., the devices first received attention in media coverage following the July 2013 Federal District Court decision in *Floyd v. City of New York*. In *Floyd,* the court ruled that the New York City Police Department engaged in a discriminatory pattern or practice in their "stop and frisk" program disproportionately targeting African American males. As a remedy, the court ordered NYPD to equip officers in the highest offending precincts with BWCs to enhance

oversight and prevent racial profiling (Goldstein, 2013).

Several high-profile police use of force incidents have occurred since the *Floyd* decision, in turn raising awareness of BWCs. The August 9, 2014 shooting death of Michael Brown in Ferguson, Missouri, was particularly pivotal. Brown, an unarmed African American teenager, was shot and killed by white Ferguson Police Officer Darren Wilson during an enforcement contact in which Brown was a suspect. The Michael Brown incident was not captured on video as the Ferguson Police Department was not so equipped, and the accounts of Officer Wilson and witnesses differed markedly (Fantz, 2014; United States Department of Justice, 2015). These conflicting reports, combined with the lack of video, raised public suspicions. The ruling of the U.S. Department of Justice (2015) that Officer Wilson's use of force was justified exacerbated this situation. The skepticism and suspicion surrounding the Michael Brown shooting and other questionable use of force incidents and perceived abuses of authority resulted in increased scrutiny of police by the public, civil rights advocacy organizations, and politicians. Demands for more transparency have prompted calls to equip police officers with BWCs (Lum, Koper, Merola, Scherer, & Reioux, 2015; President's Task Force on 21st Century Policing, 2015).

Presumably, the video captured by the devices would be made available to the public in order to increase transparency. The availability of video for public inspection in questionable cases of police enforcement activity (especially questionable use of force incidents) is increasingly important to public perceptions of police legitimacy (Stanley, 2014). Proponents of BWCs argue that if every police officer were equipped with a device that, with few exceptions (perhaps due to legitimate mechanical failure, or intentional sabotage by an officer), any police enforcement encounter with a citizen could be subject to review. Questions concerning the appropriateness or legality of any police officer action would no longer be answered based

primarily on official officer accounts of an incident but would be determined by the objective examination of the captured video; swifter investigations of complaints and more conclusive dispositions are anticipated as a result (Harris, 2010). BWC advocates assert that the new level of transparency generated by the devices would increase police accountability, which should elevate public perceptions of police legitimacy. However, many scholars and practitioners argue that the increased transparency and accountability generated by BWCs is the catalyst for a much more impactful benefit of the devices: improved police officer behavior consistent with the tenets of procedural justice, which is purportedly manifest in reduced use of force incidents and citizen complaints.

A theoretical framework has been proffered to explain this anticipated impact of BWCs, including theories that address the dynamics of coercive actions, deterrence theory, and objective self-awareness theory (Ariel, Farrar, & Sutherland, 2015). Ariel and colleagues (2015) contend that a combination of situational, psychological, and organizational factors influence a police officer's decision to use force, and potentially to abuse their authority. BWCs are anticipated to have an impact on all three. The devices are not only thought to deter officers from hastily using force or engaging in misconduct, but many claim that BWCs also serve as a stimulus to behave in a professional and courteous manner, which has been referred to as a "civilizing effect" (White, 2014), and described as procedurally just conduct (Hedberg, Katz, & Choate, 2017). This notion is derived from objective self-awareness theory. Ariel and colleagues (2015) assert that the devices produce a state of objective self-awareness that enhances the deterrent effect.

Based on this theoretical framework, which is supported by the results of the Rialto study and a few other small randomized controlled trials, some BWC advocates answer the question posed in this section's heading, *"are BWCs a potential solution?"* with a resounding "yes."

However, considering there have been a limited number of studies published that examined the impact of BWCs on use of force and/or citizen complaints, the majority of which have been randomized controlled trials of relatively short duration, and that they have produced mixed results, there is little evidence to date for the efficacy of BWCs to positively affect officer behavior. In contrast, one international study found that use of force incidents increased with the implementation of BWCs (Ariel et al., 2016). Noticeably missing from the literature are adequate controls for a potential de-policing effect and potential personnel shortages, both of which would likely impact use of force and citizen complaint rates. These gaps in the research are a salient issue due to the aforementioned importance of realistic expectations concerning BWC efficacy, and the substantial expense of BWC programs.

While the $75 million in grant funding that the Obama administration committed to equipping police officers with BWCs is a substantial investment, it is insignificant compared to the total expenditures required to establish and maintain BWC programs across the country. For example, the City of Duluth, Minnesota, equipped 110 officers with BWCs which are generating between 8,000 and 10,000 videos per month. They store most videos for 30 days and their 3-year contract for storage fees is $78,000 (Bakst & Foley, 2015). The City of Baltimore estimated video storage costs associated with full implementation of BWCs at the Baltimore Police Department of approximately $2.6 million per year (Newcombe, 2015). The five-year contract between Axon (a company formerly known as Taser and a major manufacturer of BWCs and provider of video storage and management services) and the City of San Diego alone included 1,000 cameras with a purchase price of $267,000 and $3.6 million for maintenance and video storage (Bakst & Foley, 2015). Moreover, these expenses do not include the human resource costs associated with managing the video recordings and redacting them as necessary to fulfill

FOIA requests, nor for the additional time required for officers to download and catalog the captured video (Major Cities Chiefs and Major County Sheriffs, 2015). For instance, according to Bakst and Foley (2015), storage fees for 150 BWCs at the Berkeley, California, Police Department are approximately $45,000 a year. In addition to those fees, the program will require assigning up to two full time employees to manage the video, and it will require officers to spend up to 30 minutes per shift dealing with recorded video. Bakst and Foley (2015) calculate the latter as the equivalent of the total hours worked by five full-time officers annually. The mixed empirical evidence is of concern considering the expense of BWC programs and limited police agency budgets. Although the initial purchase of the devices appears to be manageable, the associated program maintenance costs are a large recurring line item sure to draw resources away from other initiatives and endeavors, and these costs grow exponentially as the number of cameras increases.

The Purpose and Significance of the Study

The Newport News, Virginia, Police Department's (NNPD) experience with BWCs offers a unique opportunity to address the gap in the research identified above and granted the researcher unfettered access to their internal data necessary to make such a contribution to the literature. NNPD is a mid-size East coast police department of 440 sworn officers and 153 non-sworn personnel serving a population of approximately 180,000. The command staff of NNPD began implementation of BWCs in May 2013, more than one full year prior to the Ferguson incident and the intense nationwide scrutiny of police that followed, because they recognized that the devices would be beneficial in increasing transparency, resolving citizen complaints, and reducing liability. More importantly, the implementation of this innovative technology was well underway prior to the intense attention that BWCs have received and the pressure to equip police

officers with the devices. NNPD's deployment of BWCs to all 284 patrol personnel occurred incrementally in several waves spanning 3 years beginning with a 10 BWC pilot in May 2013 and an additional 44 of the devices by December of that year, another 30 by the end of 2014, 175 more during 2015, and the final 25 BWCs in the first half of 2016. This staggered rollout of the devices was due to budget constraints, which is not uncommon for larger agencies.

The objective of the study is to explore the impact of the devices on the frequency and severity of use of force incidents and the frequency and outcome of citizen complaints while controlling for staffing and volume of officer-initiated enforcement contacts. The current quasi-experimental study utilizes secondary data collected from the Newport News, Virginia Police Department for an 86-month period: May 2010 through June 2017; 36 months prior to the beginning of BWC implementation and the 50 months following, which includes 12 months post full implementation. The data includes computer assisted dispatch data, use of force data, citizen complaint data, and officer payroll data. A series of *t* tests, autoregressive, integrated, moving average (ARIMA) and vector autoregression (VAR/VARX) time series analyses are employed to address the following research questions:

Research Questions

1. What were the effects of BWCs on use of force?

    1a. If the frequency of use of force incidents was reduced, was the reduction sustained?

    1b. If the frequency of use of force incidents was reduced, was there an incremental decline with waves of BWC implementation, or did any decline plateau or decay over the course of implementation?

    1c. Was there a change in the severity of force used (citizen injuries)?

1d. Did BWCs have a significant impact on these outcomes when simultaneously considering staffing and volume of officer-initiated enforcement activity?

2. What were the effects of BWCs on citizen complaints?

2a. If the frequency of citizen complaints was reduced, was the reduction sustained?

2b. If the frequency of citizen complaints was reduced, was there an incremental decline with waves of BWC implementation, or did any decline plateau or decay over the course of implementation?

2c. Was there a change in the proportion of sustained complaints compared to those unfounded, unsubstantiated, or in which the officer was exonerated?

2d. Did BWCs have a significant impact on these outcomes when simultaneously considering staffing and volume of officer-initiated enforcement activity?

Overview of the Dissertation

The dissertation is presented as follows. Chapter 2 begins with an overview of use of force, abuse of authority, and citizen complaints, followed by a review of relevant literature regarding the theoretical framework offered by BWC advocates as the basis for their claims. The chapter continues with a review of extant research that has examined the impact of BWCs on use of force and citizen complaints and concludes with a review of the literature regarding a potential de-policing effect. Chapter 3 presents the research methods, including details regarding the study site, data collection, conceptualization and operationalization of the dependent, independent, and control variables, and a description of the statistical techniques utilized for the analysis. The results of the analysis are presented in Chapter 4, followed by a discussion of the conclusions, implications, and future research needs in Chapter 5.

CHAPTER 2

LITERATURE REVIEW

The focus of the current study is the presumed impact of BWCs on police officer

behavior, which in turn is believed to reduce use of force and citizen complaints. The anticipated

impact on officer behavior and subsequent outcomes is based on a theoretical framework that

includes social interactionist theory of coercive actions, deterrence, and objective self-awareness

theories. While this study is not a test of theory, a review of the applicable literature regarding

this framework is helpful to establish the basis for the claims made by BWC proponents

concerning the benefits of the devices (Farrar & Ariel, 2013; Ariel, Farrar & Sutherland, 2015).

Thus, this chapter begins with an overview of use of force, abuse of authority, and citizen

complaints, followed by a review of the theoretical framework, which, BWC proponents suggest,

supports the notion that equipping officers with the devices will deter them from escalating

enforcement encounters and increase their professionalism and courtesy. This anticipated

positive impact on officer behavior is presumed to manifest in reduced use of force incidents and

citizen complaints. Presentation of the extant published studies that examined the impact of

BWCs on use of force and citizen complaints follows, and the chapter concludes with a

discussion of a potential confounding factor, a possible de-policing effect.

Use of Force, Abuse of Authority, and Citizen Complaints

While most instances of police use of force are determined to be appropriate, and officers

are authorized to use force and expected to do so when it is justified to enforce the law and

maintain public safety, the legal parameters for the justification of use of force are vague. Even

legally justified uses of force can, and often are perceived by citizens as an abuse of authority

and can have a negative impact on police legitimacy. While unnecessary, inappropriate, and/or

excessive force are serious abuses of authority, there are other forms that are extremely harmful as well. Verbal and legal abuses can have a serious negative impact on the victim including psychological harm and unjust negative consequences in matters of life and liberty.

Identifying the correlates of use of force and abuse of authority and estimating the frequency of these phenomena accurately has been elusive. First, researchers have substantial methodological difficulty studying the behavior of police officers, especially unethical and/or illegal behaviors (Hickman & Poore, 2016; Son & Rome, 2004). Second, no consistent method of data collection on use of force incidents exists across law enforcement agencies, and although citizen complaints are often used as a proxy measure for police abuses of authority, there is good reason to believe that many such abuses go unreported (Lersch, 2002). Thus, police abuse of authority, especially the less serious forms, likely occurs much more frequently than the volume of citizen complaints indicates.

Regardless of whether a citizen subjected to a perceived unjust use of force or other abuse of authority files a complaint, their attitudes concerning police are negatively impacted as are those of others who witness and similarly perceive such an encounter and those with whom the encounter is communicated (Kochel, 2019; Son, Tsang, Rome, & Davis, 1997). Thus, any use of force incident or perceived abuse of authority, whether it generates a citizen complaint or not, is potentially damaging to police legitimacy. The sections that follow provide an overview of the relevant concepts, frequencies, and correlates of use of force, abuse of authority, and citizen complaints.

Use of force.

There is some ambiguity regarding what constitutes police use of force and a universal definition has been elusive. The International Association of Chiefs of Police (2001) defines use

of force as "that amount of effort required by police to compel compliance from an unwilling

subject" (p. 1). The Police Foundation (2016) defines it as "the means of compelling compliance

or overcoming resistance to an officer's commands in order to protect life or property or to take a

person into custody" (p. 1). Garner, Schade, Hepburn, and Buchanan (1995) asserted that police

use of force should be defined as "behaviors by individuals that intentionally threaten, attempt,

or inflict physical harm on others (Reiss & Roth, 1993, p. 2)," which is, in essence, the National

Academy of Sciences definition of "violence" (p. 152). Whether police use of force refers to the

application of physical force only, or includes other forms of non-physical coercion, varies

across the literature.

The Newport News Police Department's (2017) use of force policy, which is utilized for

the conceptualization of use of force in this study, defines force as follows:

> *Deadly Force*: Any use of force that is reasonably likely to cause death. *Non-Deadly Force*: Any use of force other than that which is considered deadly force. This includes any physical effort used to control or restrain another, or to overcome the resistance of another (p. 1).

While the NNPD (2017) use of force policy defines use of force in terms of physical contact, it

notes that verbal commands may legally constitute force:

> All officers who encounter a situation where the possibility of violence or resistance to lawful arrest is present should, if possible, attempt to defuse the situation through advice, warning, and verbal persuasion. NOTE: Verbal directions can legally qualify as use of force. In the event that a situation escalates beyond the effective use of verbal techniques to defuse the situation, officers are authorized to employ Department trained or approved compliance techniques…if resistance escalates, officers are authorized to respond in accordance with their training in reasonable force options (p. 2).

However, the NNPD (2017) policy requires officers to complete a use of force report only for

physical uses of force excluding low level control holds in which there is no complaint of injury

and the subject did not engage in "defensive or active resistance against the officer" (p. 8).

Official use of force reports are frequently used to measure use of force when it is conceptualized

as physical actions despite the obvious limitation of potential underreporting (Garner et al., 1995). This limitation, combined with the inconsistency in the conceptualization and measurement of use of force and issues associated with direct observation and survey methods, makes estimating the frequency of occurrence difficult.

Frequency of use of force.

At the outset it is important to note that no reliable national data collection method for police use of force exists, neither for deadly nor non-lethal, and studies conducted to estimate the frequency of police use of force have operationalized force differently utilizing a variety of metrics (Garner, Hickman, Malega, & Maxwell, 2018; Nix, Campbell, Byers, & Alpert, 2017). Nevertheless, extant research utilizing both citizen and police administrative surveys as methods of estimation indicates that the threat and/or use of non-lethal physical force is a relatively rare occurrence in police-citizen contacts overall (Adams et al., 1999; Eith & Durose, 2011; Garner et al, 2018). According to a 2015 Bureau of Justice Statistics report in which data from the 2002, 2005, 2008, and 2011 Police-Public Contact Surveys (PPCS) were examined, a little more than 1.5 percent of citizens surveyed reported that officers threatened to use force or actually used force on them during an encounter with police (Hyland, Langton, & Davis, 2015). However, estimations of the frequency of use of force can be misleading when comparing the occurrence to *all* police-citizen contacts, considering a substantial portion are not enforcement contacts and the majority do not involve arrest (Eith & Durose, 2011). In addition, citizen self-report surveys such as the PPCS exclude those incarcerated in local jails or prisons, a population likely to contain a substantial number who experienced police use of force (Hickman, Piquero, & Garner, 2008).

Use of force rates in relation to arrests are arguably a more informative indicator of frequency. According to Garner and colleagues (2002), prior research has indicated that force is

used in 0.8% to 58.1% of arrests, and this wide range is due to the variety of operational

definitions of use of force in the literature. However, utilizing officer completed reports in a

sample of 7,512 arrests at six different agencies they found that *physical force* (which included

only actual application of physical force, excluded light control holds, and did not include threat

of force – e.g., displaying/pointing a weapon) ranged from 12.7% to 22.9% of arrests (Garner,

Maxwell, & Heraux, 2002). Hickman and colleagues (2008) utilized both PPCS data and the

Survey of Inmates in Local Jails (SILJ) to estimate the frequency of nonlethal force used in

arrests. According to Hickman et al. (2008), "We estimate that the police use or threaten to use

force in 1.7% of all contacts and in 20.0% of all arrests" (p. 563). Consistent with previous

studies, they found that the largest proportion of use of force incidents were at the lowest levels

of severity. Hickman et al. (2008) also noted that "males, youths, and racial minorities report

greater rates of police use of force" (p. 563). Notwithstanding the measurement issues, a

considerable amount of literature has been published on the correlates of use of force, and these

variables have frequently emerged as significant predictors.

Correlates of use of force.

Comprehensive reviews of the extensive empirical research literature regarding the

correlates of use of force have been conducted by Sherman (1980), Riksheim and Chermak

(1993), National Research Council (2004), and Klam and Tillyer (2010). Five different factor

categories were utilized as an organizing framework in these reviews, which include

characteristics of the community and the organization, situational variables associated with the

encounter, and characteristics of both the individual officer and suspect. Bolger (2015)

conducted a meta-analysis of use of force studies published from 1995 to 2013 examining the

variables identified in the aforementioned reviews and found that while none of the community

characteristics were significant, "those variables that tap into what occurs during an encounter and characteristics of the potential target of force seem to have the greatest impact on the likelihood of force being used" (p. 483). Significant encounter related variables included the seriousness of the offense, whether an arrest was made, whether the suspect resisted arrest, whether there was conflict between citizens, the number of officers on scene, and whether the encounter was officer initiated; suspect characteristics that emerged as significant included race, sex, demeanor, socio-economic class, and intoxication (Bolger, 2015).

While offense seriousness, arrest, resisting arrest, and conflict between citizens can all be considered legal factors and appropriate considerations in the use of force calculus under certain circumstances, clearly the race, sex, socio-economic class, demeanor, and intoxicated state of the suspect, or the mere presence of more officers absent resistance or an eminent threat of physical harm to themselves, other officers, or citizens, are inappropriate extralegal factors and should not have any impact on an officer's decision to apply physical force. These findings add to the already problematic nature of determining the justification for a given use of force.

Justification for use of force.

Each use of force incident must be assessed according to its unique circumstances and through the lens of the objective reasonableness standard established by the U.S. Supreme Court in the 1989 *Graham v. Connor* decision, which states:

> The "reasonableness" of a particular use of force must be judged from the perspective of a reasonable officer on the scene, rather than with the 20/20 vision of hindsight… The calculus of reasonableness must embody allowance for the fact that police officers are often forced to make split-second judgments—in circumstances that are tense, uncertain, and rapidly evolving—about the amount of force that is necessary in a particular situation (p. 490).

It is important to note that the *Graham* decision sets the minimum standard or threshold for justification of use of force and it is vague. While most use of force incidents are determined to

be legally justified in accordance with the objective reasonableness standard, there is often disagreement about the 'reasonableness" of a given use of force (Alpert & Smith, 1994; Pew Research Center, 2014; Worden, 1995). The 20/20 hindsight prohibition creates ambiguity, which drives much of this disagreement, and it undoubtedly masks some abuses of authority.

Regarding the 20/20 hindsight prohibition, Lyle and Esmail (2016) note that policing "is the only occupation that provides such relief from remedy for actions that does not contemplate or provide for analysis of decision making under a postmortem review" (p. 179). For example, they point out that pilots must make split-second decisions as well, and mistakes can have catastrophic consequences. When an aviation accident or incident occurs, a thorough investigation is conducted to determine the causes. Pilots are not afforded immunity for errors. The same can be said of medical professionals and myriad other professions. Policing is of course unique in that enforcement of the law involves danger of physical harm from subjects who are compelled to avoid apprehension, and failure to make split-second decisions to defend oneself can cost an officer their life. However, through poor judgment and errors an officer can construct circumstances that require the use of force, a phenomenon that Fyfe (2005) termed *the split-second syndrome*.

According to Fyfe (2005), "unnecessary violence occurs when well-meaning officers prove incapable of dealing with the situations they encounter without needless or too hasty resort to force" (p. 207). He argues that when officers rush into situations and confront suspects without utilizing cover and concealment, they often place themselves in a situation that requires a rapid decision to use force with limited information. Fyfe further asserts that incompetence often leads to escalation rather than de-escalation of tense encounters. The 20/20 hindsight prohibition in the *Graham* decision reinforces the split-second syndrome; by ignoring an

officer's decisions and actions prior to the moment of the force decision, the actual necessity to use force in a given enforcement contact is not ascertained (Fyfe, 2005).

While the *Graham* decision requires the objective analysis of only the information available to the officer at the moment he or she decided to use force, there is an unavoidable subjective element in one's assessment. Alpert and Smith (1994) referred to it as "subjective objectivity," and it makes consensus on whether a given use of force is reasonable or unnecessary/excessive highly unlikely. They argue that such judgments are shaped by one's experiences and attitudes. Therefore, individual police officers may view the dynamics of an enforcement encounter and the necessity of a given use of force differently depending on their previous experience and training, and likewise, citizens may judge the reasonableness of the same incident entirely differently than police and disagree with one another (Alpert & Smith, 1994). This subjectivity is evident in the following example cited by Ariel and colleagues (2015):

> Adams (1996: 53) cites a famous disagreement between a team of field researchers led by Reiss (1968) and a panel of experts from the President's Commission on Law Enforcement and Administration of Justice (1976), which aptly describes the measurement problem. The two teams could not agree on what constitutes "improper use-of-force", even though they were both scrutinizing the same incidents. Though dated, the problem they encountered still persists today (p. 514).

In summation, the police are empowered to use non-negotiable coercion, including physical force when necessary, and ultimately there will always be some circumstances in which force is justified in police work (Bittner, 1990; Skolnick & Fyfe, 1993). However, as Adams (2005) points out, "the amount of force used should be proportional to the threat and limited to the least amount required to accomplish legitimate police action" (p. 451). Unfortunately, that is not always the case. Moreover, there is widespread public perception that biases often impact enforcement decisions, including the application of physical force, through consideration of

extralegal factors. As Weisburd, Greenspan, Hamilton, Bryant, and Williams (2001) asserted, "the potential abuse and actual abuse of such authority remain both a central problem for police agencies and a central public policy concern" (p. 12). This continues to be the case nearly two decades after that statement was made.

Abuse of authority.

The term "police brutality" has been and continues to be commonly used to describe officer misconduct involving inappropriate or unlawful exercise of police powers. According to Reiss (1968), "[w]hat citizens mean by police brutality covers the full range of police practices…" (p. 11). He listed behaviors ranging from the use of profanity to abuses of power including unlawful searches and unwarranted use of force. However, Carter (1985) argued that the term "brutality" is nebulous, failing to capture the different behaviors it is meant to represent, and that "abuse of authority" is more descriptive. Carter's (1985) abuse of authority typology includes three categories of abuse: Physical abuse/excessive force, verbal/psychological abuse, and legal abuse/violation of civil rights. According to Carter (1985), "The underlying construct in the typology is that a police officer has exercised power by virtue of his/her office in a manner that is not consistent with law or ethical cannons" (p. 323). Carter's typology provides a clearer conceptualization of the three forms of abuse, however, determining whether a police officer's behavior and actions in a given encounter are a legitimate exercise of his or her authority or are an abuse of their powers can be difficult. While the difficulty of determining the reasonableness of a given use of force has been addressed, determining whether an officer's behavior and actions constitute verbal/psychological abuse or legal abuse/violation of civil rights can be equally problematic. For example, while there is little doubt that a 2017 incident in which an Orlando, Florida officer threatened a man with bodily harm, and arrest, and challenged him to

physically resist in a profanity laced tirade constituted abuse of authority (Von Ancken, 2017), the 2013 arrest of a motorist by a University of Central Florida (UCF) police officer is questionable. In the latter case a white male UCF officer was citing an African American female for an inoperative brake light and she refused to roll her window down completely per the officer's request. The woman asked the officer to pass the citation through the partially rolled-down window instead. After a brief verbal exchange the officer ordered the woman to exit her vehicle using forceful verbal commands. Ultimately, when she failed to comply, the officer broke the window, forced the woman to the ground, and arrested her (Weiner, 2014). The woman filed a complaint against the officer alleging that the officer abused his authority and that she believed the incident was racially motivated. Although she was not required to sign a citation per Florida law, the officer was exonerated following an internal investigation. The UCF Police Department released the officer's body-worn camera captured video of the incident, which subsequently went viral on social media and became the subject of heated public controversy.

Brunson and Miller's (2005) research provides further examples of verbal/psychological and legal/violation of civil rights abuses of authority. Their qualitative study was based on interviews of 40 young African American men in St. Louis, Missouri regarding their personal and vicarious experiences with police officers. Most of the sample reported being subjected to harassment, disrespect, verbal abuse, and either experiencing unwarranted searches and physical force or witnessing such incidents (see also, Brunson, 2007; Gau & Brunson, 2010). While ridiculing, harassing, using profanity toward, or searching a citizen without legal justification are clearly abuses of authority, as indicated in the UCF incident above, determining whether aggressive verbal commands, threats, exigent circumstances for warrantless searches, and detention/arrests are reasonable can be problematic in many cases. Often, even when such

actions are determined to be in accordance with departmental policy and legally justified by authorities, they are viewed as an abuse of authority by citizens, and thus might be classified as "lawful but awful" incidents or practices. The potential for officers to engage in biased policing, and perception of many citizens that it likely occurs frequently, complicates these judgments.

Bias-based policing is a form of abuse of authority that may span all three categories of Carter's typology and has been defined as "practices by individual officers, supervisors, managerial practices, and departmental programs, both intentional and nonintentional, that incorporate prejudicial judgments based on sex, race, ethnicity, gender, sexual orientation, economic status, religious beliefs, or age that are inappropriately applied" (Ioimo, Tears, Meadows, Becton, & Charles, 2007, p. 271). However, this definition does not necessarily contain an exhaustive list. Factors such as political leanings, membership in an organization, and behavior or appearance that violates societal norms could be included as well (Kappeler, Sluder, & Alpert, 1998; National Research Council, 2004). In short, any such extralegal factors that an officer or agency inappropriately applies in making impactful discretionary choices, such as the decision to make an investigatory stop, constitutes bias-based policing.

Correlates & frequency of abuse of authority.

Carter (1994) asserted that any given abuse of authority is either intentional or reactive. As the term suggests, intentional abuse "is that which is overtly and consciously imposed by the officer. Conversely, reactive abuse exists in response to stimuli or conditions without any overt, conscious decision to inflict the abuse" (Carter, 1994, p. 275). He described intentional abuses of authority as retaliation for some perceived provocation or a punishment for a specific action or behavior, whereas a reactive abuse of authority is unintentional although it may be precipitated by similar stimuli. According to Carter a combination of stressors, which include life threatening

stressors, social isolation stressors, organizational stressors, functional stressors, personal

stressors, physiological stressors, and psychological stressors, can trigger either. One of these

major stressors is citizen disrespect toward officers and refusal to defer to their authority.

An extensive body of research examining the impact of citizen demeanor on police

officer behavior has consistently found that citizens who are disrespectful towards police are

treated more punitively (cf., Klinger, 1994). In fact, Engel, Tillyer, Klahm, and Frank (2012)

document 50 studies that linked citizen demeanor to police officer behavior, which they assert

was unchallenged until Klinger's (1994) study of police-citizen encounters in Miami-Dade,

Florida. Klinger argued that in previous studies citizen demeanor had been operationalized in

such a way that illegal behaviors were included (e.g., non-compliance with lawful orders,

disorderly conduct, resisting arrest, etc.), and when such behaviors were excluded, citizen

demeanor would not be a significant factor in officer decision making/conduct. The results of

Klinger's study supported his assertion. However, Engel and colleagues (2012) point out that

citizen demeanor was a significant predictor of police officer behavior in an additional seven

"post- Klinger" studies, which operationalized citizen demeanor per his suggestion (see Engel et

al., 2012). In addition, recent studies have demonstrated that citizen demeanor is a factor in

police officers' assessments of threat (Nix, Pickett, Wolfe, & Campbell, 2017), and decisions to

escalate to forceful verbal commands (James, James, & Vila, 2018).

The colloquialism "contempt of cop" refers to this type of demeanor—a display of

disrespect, hostile attitude, and or challenge to an officer's authority. Van Maanen (1978)

documented that officers referred to citizens who failed to defer to their authority in this way as

"assholes" and observed that they were often treated harshly. Natapoff (2017) argues that

citizens who commit "contempt of cop" are often arrested on charges of disorderly conduct,

obstructing an officer, or other types of vaguely defined violations for nothing more than failing to adhere to the officer's conception of proper comportment. Moreover, Holmes (2016) argues that these individuals are often charged with resisting arrest as well.

In terms of improper force (unnecessary or excessive), Harris (2009) conducted a systematic review of the research literature and concluded that "[w]hat research there is suggests that situational factors have the most substantive impact on police use of improper force within police-citizen encounters…" (p.25). Similar to the correlates of use of force in general, studies have found that citizens who are intoxicated, antagonistic toward officers, and/or of lower socio-economic class are significantly more likely to be subjected to improper force and those odds are increased with the presence of citizen onlookers or more officers (Friedrich, 1980; Reiss, 1968; Worden, 1995). Thus, the literature regarding improper use of force suggests that a suspect's demeanor could indeed trigger this type of abuse of authority, especially when combined with one or more of the other aforementioned factors.

These studies involving observation of police-citizen encounters all indicated that the use of improper force is relatively infrequent. Reiss (1968) reported the highest percentage of improper uses of force at 2.4% of the police-citizen encounters observed, while Friedrich (1980) and Worden (1995) reported 1.8% and 1.3% respectively. However, Harris (2009) points out that the accuracy of these results should be viewed with a fair amount of skepticism due to the rather low scientific rigor of these few studies. Moreover, although these studies are all dated, one cannot rule out the likelihood of officer reactivity to the observers, which raises questions concerning the validity of the results as well.

Several theoretical perspectives have been applied in an attempt to identify the correlates of other abuses of authority (verbal/psychological abuse and legal abuse/violation of civil rights).

Some of these involve the asymmetry of police-citizen interactions, which speaks to officer reactions to citizen demeanor and "contempt of cop," and other situational factors that might lead officers to pursue a "just" outcome through unethical or unlawful means (such as unlawful searches), which has been referred to as "noble cause corruption" (Klockars, 1980). Bias, either implicit or explicit, is also commonly proposed as a correlate.

The potential for prejudice or stereotypes and implicit bias to impact an officer's decisions is rooted in their power to engage in selective enforcement, which is to choose when, where, and how to enforce which laws and, according to Davis (1969), "such power goes to selection of parties against whom the law is enforced…" (p.163). Although all of the aforementioned extra-legal factors that an officer might consider in his or her selection of whom to engage in an enforcement contact and/or how they treat the subject of an enforcement encounter are of concern, race is clearly inappropriate and the most problematic. According to Epp and colleagues (2014):

> Whether their choices are biased by race depends on how they see the social world: who is seen as 'suspicious,' 'out of place,' or simply 'unusual' determines who is stopped, questioned, and pressed for consent to be searched. Unfortunately, a large body of research demonstrates that most people in the contemporary United States, police officers included, cannot help but assume that racial minorities are more likely to be dangerous or engaged in criminality (p. 40).

The stereotype described above is applied to African Americans in particular, and the practice of effecting investigatory traffic or pedestrian stops based on racial stereotypes is commonly referred to as "racial profiling."

Extensive research has shown that minority citizens (young African American males in particular) are disproportionately subjected to intrusive proactive enforcement contacts (Smith, Rojek, Petrocelli, & Withrow, 2017). For example, Faggan and Davies (2000) found that African Americans were subjected to stop and frisks at a rate five times higher than whites in New York

City. A considerable number of studies have found that African Americans are also

disproportionately subjected to investigatory traffic stops (see Smith et al., 2017; Epp et al., 2014

for review). According to Brunson and Miller (2005), "young black men are widely viewed as

'symbolic assailants' in the popular imagination (Quillian and Pager 2001), in the criminal

justice system broadly (Bridges and Steen 1998; Kennedy 1997) and among the police

specifically (Anderson 1990; Skolnick 1994)" (p. 615), and they argue that being

disproportionately targeted for proactive enforcement contacts has deleterious impact on

minority views concerning police legitimacy in general (see also Epp et al., 2014).

Verbal/psychological abuse and legal abuse/violation of civil rights are believed to be

more pervasive than physical abuse, however, the actual frequency is even more difficult to

accurately estimate. For example, Brunson and Miller (2005) found that:

> Complaints of persistent harassment and disrespectful treatment were the most
> widespread in our interviews, and came from *both* delinquent and non-delinquent young
> men. These youths described repeated instances of being verbally abused by officers' use
> of antagonistic language, name calling, profanity, and derogatory remarks; and also
> protested against the physically invasive nature of police stops, including public cavity
> and strip searches (p. 635).

Citizen complaints are most often used as a proxy measure of all forms of abuse of authority, but

have some serious limitations.

Citizen complaints.

While citizen complaints are often used as a proxy measure for inappropriate, unethical,

or unlawful behavior (officer abuse of authority), Terrill and McCluskey (2002) point out that

there are different perspectives regarding what they actually indicate. First, they are indicative of

the citizen's perceptions about what occurred and, in many cases, may not be a reliable source of

data about the appropriateness of an officer's behavior in a given encounter. Second, it may be a

means of retaliation for a sanction received by a citizen from an officer and contain

embellishments of the facts. Third, they may be an indicator of real or potentially problematic officer behavior. Lastly, citizen complaints may be an indicator of officer productivity.

Another methodological problem with using citizen complaints as a proxy measure for officer abuse of authority is the likelihood of under-reporting. There are several reasons why officer abuse of authority may go unreported via citizen complaint: The system for filing a complaint employed by a given department may be cumbersome and time consuming, some citizens might fear reprisal (e.g., if the evidence is weak perhaps a criminal charge of filing a false report), and some citizens may believe that officers protect one another and filing a complaint would be futile (Brandl, Stroshine, & Frank, 2001). In any event, citizen complaints are problematic in terms of police legitimacy (Terrill & Paoline, 2015) and each deserves prompt and authentic investigation.

Investigations of citizen complaints result in one of four dispositions: unfounded, unsubstantiated, sustained, or exonerated (Novak, Cordner, Smith, & Roberg, 2017). In the first case, unfounded, investigators determine that there is evidence that contradicts the allegations made by the citizen—that the complaint is inaccurate or fabricated. The second possible disposition, unsubstantiated, indicates that there is not sufficient evidence to corroborate the complainant's allegations. Complaints are sustained when investigators have discovered enough evidence to support the complainant's allegations. The fourth disposition, exoneration, is assigned when there is evidence that the allegations against the officer are true, but the officer's actions were justified, within department policy, and lawful.

The bulk of the research literature concerning citizen complaints has focused on an individual unit of analysis—complaint prone officer correlates. Much less attention has been given to macro-level analysis of complaint types, frequency, and dispositions. However, Novak

and colleagues (2017) summarized some relevant studies, which included Independent (Christopher) Commission (1991), Dugan and Breda (1991), Petterson (1991), Walker (1998), Wallace (1990), and Law Enforcement News (1989). The results of these studies indicate that while less than 1 percent of citizens actually file a complaint, between 10 and 15 percent believe that they have a legitimate complaint. Second, the rate of complaints and the proportion of complaints sustained varies widely by agency, but excessive force complaints are generally sustained at a lower frequency than other types. Third, a large proportion of complaints in a given agency are generally filed against a relatively small proportion of officers who are younger and have little experience (Novak et al., 2017). Research regarding individual correlates has also generated evidence indicating that officers who engage in more proactive (officer-initiated) and aggressive enforcement activities also receive more citizen complaints (Lersch, 2002; Lersch & Mieczkowski, 1996). A recent study of citizen complaints in eight cities conducted by Terrill and Ingram (2016) found that "improper force and discourtesy were the two most frequent complaints in six of the eight city departments" (p. 171), 20% and 22% respectively, and that 11% of all complaints were sustained across the eight departments. They also found that male and minority citizens were more likely to file complaints, but that complaints filed by African Americans were less likely to be sustained.

The notion that police officer behavior can influence citizen behavior and ultimately the outcome of an encounter is central to the potential efficacy of BWCs to reduce use of force incidents and citizen complaints. Citizens are much less likely to defer to police authority and more likely to resist when officers are disrespectful or overly aggressive at the onset of an encounter (Mastrofski, Reisig, & McCluskey, 2002; Terrill, 2003). For example, research has demonstrated that police officer use of profanity in encounters with citizens has a negative

impact on officer credibility (Baseheart & Cox, 1993), and can increase citizen perceptions of excessive force (Patton, Asken, Fremouw, & Bemis, 2017). Such behavior on the part of police officers may provoke resistance or even an assault in an enforcement encounter. The next section presents the theoretical framework that predicts the outcome of police-citizen transactions and how BWCs may alter those transactions and outcomes by increasing professionalism and courtesy and reducing use of force and abuses of authority.

Theoretical Underpinnings for BWC Impact on Officer Behavior

The theoretical framework that follows explains the transactional nature of police-citizen enforcement contacts and the dynamics that can result in the undesirable outcomes detailed in the previous section. Then the two theories which have been proffered to explain how and why the utilization of BWCs is expected to result in reduced use of force and citizen complaints are presented. This theoretical framework consists of social interactionist theory of coercive actions, deterrence, and objective self-awareness theories.

  Dynamics of the police-citizen encounter.

The assumption that officer conduct is often a significant factor in how a citizen reacts to an enforcement contact is foundational for the belief that equipping officers with BWCs should reduce use of force and citizen complaints. Worden (1995) asserted that "officers not only respond to situations but also help to create them; sometimes, officers' choices early in police-citizen encounters can contribute to the emergence of circumstances that require the use of force" (p. 39), and research supports this assertion. For example, Bayley's (1986) study of Denver patrol officers revealed that when officers initially listened to citizens and sought information by asking questions, that force was less likely than when they initiated encounters with more coercive tactics. Mastrofski, Snipes, and Supina's (1996) Richmond, Virginia study found that

citizens treated disrespectfully by officers were significantly less likely to comply with the officer's requests. In another study utilizing data obtained through systematic social observation of Indianapolis, Indiana and St. Petersburg, Florida patrol officers in the Project on Policing Neighborhoods, Terrill (2003) found that police-citizen encounters that began with a coercive approach increased the likelihood of suspect resistance and additional use of force. In the latter study Terrill employed a broad conceptualization of force that included not only physical actions, but verbal commands as well. Terrill (2005) argues that Tedeschi and Felson's (1994) social interactionist theory of coercive actions explains the aforementioned phenomena.

>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>> *Tedeschi and Felson's social interactionist theory of coercive actions.*

Tedeschi and Felson (1994) define coercive actions in broad terms; they state that "a coercive action is an action taken with the intent of imposing harm on another person or forcing compliance" (p. 348). The authors assert that there are three types of coercive actions, conveying threats, the use of physical force, and punishment, which are intended to force another to comply with the demands of the coercer through threatened or the actual inflicting of harm. Harm is categorized into three forms, physical, social, and deprivation of resources. Physical harm refers to the threat or actual application of physical use of force to inflict pain, social harm refers to damaging one's social identity, status, and/or self-esteem through insults, ridicule, use of derogatory language, or any other action to embarrass or humiliate the target person, and punishment includes any action taken with the intent to harm the target person in order to restore the coercer's vision of justice. The authors view the motivations to engage in coercive actions and the goals the actor hopes to achieve through a social interactionist lens. According to Tedeschi and Felson (1994), "a social interactionist perspective emphasizes social conflicts, power and influence, social identities, and retributive justice. Although this social psychological

approach emphasizes situational factors, it includes cognitions, preferences, and emotions as important features of social actions" (p. 160).

The theory posits four basic tenets: The first, that coercive actions are intended to accomplish one or more of three goals: "(a) to control the behavior of others, (b) to restore justice, and (c) to assert and protect identities" (Tedeschi & Felson, 1994, p. 348). The second, one or more of the three types of coercive actions will accomplish one of these goals. Third, the actor weighs costs and benefits of coercive actions, and while anticipated high costs may inhibit such actions, their values may tilt the scales in favor of coercive action to achieve the desired goal. Lastly, while the means to achieve each of the aforementioned goals may differ, many instances involve all three desired outcomes.

This theory provides a plausible explanation for the police-citizen encounter that escalates to the use of non-physical coercion, physical force, and potentially the abuse of authority. It offers an explanation for both the behavior of the police officer and that of the citizen during an interaction. First, in terms of police officer conduct, because of the asymmetrical power relationship, police expect deference from all citizens (Alpert & Dunham, 2004). Moreover, as the asymmetry increases (i.e., the lower the social capital of the citizen), the more deference and respect is expected by an officer. Thus, the theory proposes that a hostile and disrespectful citizen demeanor, "contempt of cop," would be received as an affront to not only the police officer's social identity, but his or her official position and societal expectations in general, which would warrant a response to re-establish their authority. The theory further asserts that the motivation to force compliance and save face is substantially increased with the presence of onlookers or peer officers. According to the theory, threats, physical force, and punishments are all coercive means that one might employ to compel compliance. However, the theory also

posits that coercion will be utilized for retribution when their social identity has been threatened. Consequently, a police officer engaged in an enforcement encounter with a recalcitrant and disrespectful citizen would be likely to engage in coercive tactics, and perhaps verbal/psychological and/or legal/civil rights abuse of authority. Tedeschi and Felson (1994) assert that noncontingent threats are often used for retribution in such cases. "A noncontingent threat is coercive action that is usually intended to frighten or humiliate the target person. Fear and humiliation are harms imposed on the target by the threatener; hence, noncontingent threats may be conceived as a form of punishment" (Tedeschi & Felson, 1994, p. 169). Furthermore, the theory predicts that "contempt of cop" situations have a high potential to escalate to use of physical force or even a physical abuse of authority.

Tedeschi and Felson's theory not only predicts the police officer's behavior in such interactions, but the citizen's as well. As indicated earlier, when officers begin encounters with an aggressive/coercive approach, the likelihood of suspect noncompliance and resistance increases (Terrill, 2003), and citizens treated disrespectfully by officers are significantly less likely to comply with the officer's requests (Mastrofski et al., 1996). The theory makes clear that these officer behaviors are going to be particularly problematic with poor young inner-city minorities, among whom social identities are of great importance. Anderson's (1994) *Code of the Streets* is highly informative in this regard. According to Anderson, central to this code of poor inner-city youth and young adults is respect. They value it highly and vigorously protect their reputation of being tough by demanding it and retaliating when they sense they have been disrespected. Standing up to authority figures is especially indicative of toughness. Therefore, the social interactionist theory of coercive actions predicts that police officers entering an encounter aggressively, coercively, or in a disrespectful manner with this element are likely to

face noncompliance, resistance, or perhaps even physical assault. Tedeschi and Felson (1994) assert that individuals perform somewhat of a cost benefit analysis in the decision-making process and that anticipated high costs (e.g., arrest, discipline, etc.) may inhibit one from engaging in a coercive action. However, they point out that the more the desired outcome or goal is valued, the more cost an individual is willing to endure and that often mental scripts will override any fear of costs.

While social interactionist theory of coercive actions offers an explanation of how the dynamics of the police-citizen enforcement encounter can lead to the outcomes of concern (use of force, abuse of authority, and citizen complaints), protection of social identities is a particularly problematic phenomenon for police officers, and becoming more so as American society is increasingly scrutinizing officer behavior. Although fighting words doctrine—the legal concept that prohibits the use of language that would likely offend another to the point it could cause a breach of peace and upon which disorderly conduct statutes and ordinances were based—was established in the U.S. Supreme Court 1942 *Chaplinsky v New Hampshire* decision, in *Lewis v. City of New Orleans* (1974), disorderly conduct ordinances that prohibit foul language against police were ruled unconstitutional (Egan, 1999; c.f., Epps, 2019).[2] The case law clearly states that citizens have a constitutional right to criticize and express displeasure with government and its representatives and police officers are required to have a "thicker skin" than members of the general public. Technology may be of assistance in deterring hasty use of force and abuse of authority by increasing tolerance, procedurally just behavior and use of de-escalation techniques. The ability to observe police officer-citizen encounters in what has been a

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[2] The 2019 U.S. Supreme Court *Nieves v Bartlett* decision limits First Amendment retaliation claims against police to those instances in which no probable cause for arrest existed.

low-visibility environment is thought to be key. Are BWCs a solution?

Effects of being observed.

Ariel and colleagues (2015) have proffered two theories to explain the anticipated positive impact of BWCs on officer behavior, deterrence and objective self-awareness, which they apply simultaneously. This theoretical framework is based upon the notion that the power to control the behavior of individuals lies in the ability to observe them—Foucault's (1980) social theory of panopticism (based on Jeremy Bentham's panopticon), which asserts that surveillance is key for that kind of power.

Deterrence theory.

The most basic explanation is that BWCs are a means of oversight and monitoring of officer behavior and performance serving as the source of surveillance power mentioned above. The concept of deterrence is central to classical criminological theory, and according to Akers and Sellers (2013):

> The basic premise in classical criminology is that actions are taken and decisions are made by persons in the rational exercise of free will. All individuals choose to obey or violate the law by a rational calculation of the risk of pain versus potential pleasure derived from an act (p. 15).

However, the theoretical perspective has been elaborated upon and expanded into a modern version known as rational choice theory, which asserts that deterrence from all kinds of deviant behaviors occurs as a result of more than just legal sanctions/punishments, but through myriad unpleasant consequences (Grasmick & Bursik, 1990; Paternoster, 2010). Furthermore, scholars have recognized that punishment avoidance, and even vicarious punishment avoidance can influence the decision to engage in deviant behavior (Stafford & Warr, 1993).

Ariel and colleagues (2015) contend that surveillance of officer behavior via BWC captured video deters officers from hastily using force, abusing their authority, or otherwise

engaging in unprofessional conduct. BWCs are anticipated to have a deterrent effect on these

behaviors as any use of force is generally considered an unfavorable outcome to be avoided

whenever possible, and any abuse of authority or unprofessional conduct is grounds for

disciplinary action. The authors assert that BWC captured video of an incident involving

unnecessary or excessive force, other abuses of authority, or unprofessional conduct meets the

three basic tenets of deterrence theory: (1) There is a level of *certainty* that misconduct captured

on video will be discovered should a citizen complaint be filed, supervisory audit take place, or

the video be subject of prosecutorial review for evidentiary purposes; (2) captured video

provides the means for *celerity* in an investigation, disposition of a complaint, and subsequent

disciplinary action; and (3) *severity* is addressed in that any disciplinary record adversely affects

a police officer's career, and, in cases of more serious misconduct (such as excessive force and

other civil rights violations), not only potential termination and revocation of their peace officer

license, but perhaps criminal prosecution. Katz and colleagues (2014, 2015) cited this likely

deterrent effect in a randomized controlled trial of BWCs at the Phoenix, Arizona Police

Department. However, the devices are not only thought to deter officers from engaging in

misconduct, but some assert that BWCs also serve as a stimulus to increase professionalism and

courtesy, which has been referred to as a "civilizing effect" (White, 2014), and procedurally just

behavior (Hedberg et al., 2017). This notion is derived from another related but unique

theoretical perspective, objective self-awareness theory. Ariel and colleagues (2015) assert that

the devices produce a state of objective self-awareness that enhances the deterrent effect.

Objective self-awareness theory.

The central assumption of Duval and Wicklund's (1972) objective self-awareness theory

is that one becomes keenly self-aware when he or she knows they are being observed and

subsequently tend to modify their behavior to conform to social expectations. The theory is

comprised of four concepts: (1) state of consciousness; (2) self-evaluation; (3) standards of

correctness; and (4) conformity. The first, state of consciousness, is dichotomous consisting of

subjective and objective states of awareness. Duvall and Wicklund (1972) posit:

> When attention is directed inward and the individual's consciousness is focused on himself, he is the object of his own consciousness—hence 'objective' self-awareness. When attention is directed away from himself he is the 'subject' of the consciousness that is directed toward external objects, thus the term 'subjective' self-awareness (p. 2).

The second concept, self-evaluation, refers to a process that takes place in the state of objective

self-awareness in which one examines their behavior critically in comparison with the third

concept, standards of correctness. According to Duvall and Wicklund (1972):

> The notion of self-evaluation is predicated on the existence of a psychological system of standards of correctness that is possessed by each person… A standard is defined as a mental representation of correct behavior, attitudes, and traits (p. 3).

Examples of standards of correctness include rules of etiquette such as table manners,

appropriate language for present company, and proper comportment at a funeral (Duvall &

Wicklund, 1972). The final concept is conformity, which Duvall and Wicklund (1972) define as,

"a change in the person's attitudes, beliefs, or behaviors in the direction of the differing attitudes,

beliefs, or behaviors of other people who are present in the same situation" (p. 57).

Duvall and Wicklund (1972) postulate the following propositions. First, the two

conscious states are mutually exclusive. One cannot simultaneously focus conscious attention on

him or herself and an external stimulus. However, the theory posits that one may "oscillate"

between the two conscious states. Second, that the subjective state of awareness is the primary

or default conscious state. According to Duvall and Wicklund (1972):

> the environment is normally a strong enough stimulus to draw attention toward it, which means the self is totally excluded from attention. In order that the person become objectively self aware, it is necessary to create conditions that remind him of his status as

an object in the world" (p. 7).

Third, Duvall and Wicklund (1972) assert that stimuli such as seeing oneself in a mirror can be sufficient to trigger objective self-awareness, but that being observed by another person is the strongest stimulus. Lastly, when one enters the state of objective self-awareness one automatically engages in self-assessment comparing behavior to the previously mentioned standard of correctness. If one discovers a discrepancy between the two, then he or she will either conform his or her behavior to the standard of correctness, or flee the situation causing the objective self-awareness state (Duvall & Wicklund, 1972). According to Duvall & Wicklund (1972), "awareness of the self as an object acts as a feedback system which forces the individual to alter aspects of himself in the direction of his conception of what a correct person should be" (p. ix).

The effects of being observed (or even the perception of being observed) on compliance behaviors has been studied in a variety of contexts, such as productivity of industrial laborers (Landsberger, 1958), handwashing behaviors of public restroom users (Munger & Harris, 1989), employee handwashing in healthcare facilities (Bolton, Rivas, Prachar, & Jones, 2015), parent-child interactions (Gardner, 2000), doctor-patient interactions (Redman, Dickinson, Cockburn, Hennrikus, & Sanson-Fisher, 1989), patient care quality in nursing homes (Schnelle, Ouslander, & Simmons, 2006), littering (Ernest-Jones, Nettle, & Bateson, 2011), and honor system collection boxes for coffee (Bateson, Nettle, & Roberts, 2006) to name a few. While objective self-awareness theory has historically been applied and tested in direct observation situations (Wicklund, 1975; Silva & Duval, 2001), the notion among law enforcement practitioners and many academics alike is that video monitoring of officer activity would have essentially the same effect, and perhaps a greater impact due to the capturing of behavior via video recording

(Farrar & Ariel, 2013; Harris, 2010; Kassin, Kukucka, Lawson, & DeCarlo, 2014; Schellenberg, 2000; White, 2014).

As mentioned in Chapter 1, the desired behaviors that are anticipated as a result of objective self-awareness via BWCs define procedural justice, and the tenets of procedural justice and de-escalation techniques overlap. According to Todak and James (2018):

> The notion from procedural justice that citizens want to be treated by police with dignity and respect is echoed in the "respect" and "human" tactics which involve talking to citizens as people and minimizing the use of authoritative voice and "cop talk." Dignity and respect for citizens and their rights can also be shown through the "compromise" tactic. Sometimes, a small adjustment to charges can significantly improve a person's situation while still achieving justice. Demonstrating the fairness and neutrality components of procedural justice can be achieved using the "honesty" tactic. By providing a clear explanation for the decisions being made, officers demonstrate to citizens that they are applying the law fairly. Finally, the "listen" and "empower" tactics legitimize citizens' concerns and engage them as partners in the decision-making process (p. 517).

These are the very behaviors that the objectively self-aware police officer would arguably engage in which, in turn, should aid in de-escalation and result in fewer use of force incidents and citizen complaints. An anticipated result referred to by White (2014) as a "civilizing effect," which falls in line with the paradigm shift from a "warrior" to "guardian" mindset recommended by The President's Task Force on 21st Century Policing (2015) to address the current police legitimacy crisis.

In summation, the preceding theoretical framework established the behaviors that BWCs are anticipated to deter, those behaviors they are anticipated to promote, and the means by which these anticipated behavioral changes are believed to be achieved. Although BWCs have been implemented by U.S. police agencies on a large scale just in the last few years with very little evidence of their effectiveness, researchers have been quick to respond. Several randomized controlled trials and quasi-experimental studies have been conducted to test the impact of the

devices on use of force and citizen complaints, which have produced mixed results.

Extant BWC Research

A total of 14 studies examining the impact of BWCs on use of force and/or citizen complaints have been conducted in the United States, which include randomized controlled trials of the devices at the Rialto, CA Police Department, Mesa, AZ Police Department, Phoenix, AZ Police Department, Las Vegas, NV Police Department, Orlando, FL Police Department, Denver, CO Police Department, Spokane, WA Police Department, Washington, DC Police Department, Arlington, TX Police Department, Milwaukee, WI Police Department, Hallandale Beach, FL Police Department, and the Boston, MA Police Department. In addition, quasi-experimental evaluations of the impact of BWCs on use of force have been conducted at the Tampa, FL Police Department and an unnamed agency in the Northwest U.S. Eighteen publications have been generated from these studies, ten of which have been published in peer reviewed journals. Summaries of these studies and the associated publications are listed in Table 2.1.

Table 2.1: Extant Research Examining the Impact of BWCs on Use of Force & Citizen Complaints

DV - Use of Force Reports Only		
Jennings, Fridell, Lynch, Jetelina, & Gonzalez (2017)[1]	Tampa, FL	• **Research Design:** Quasi-experimental evaluation [3/2015 – 2/2016] • **Agency:** Tampa Police Department - large agency (1000 sworn) • **Unit of Analysis:** Individual officer and treatment vs. control groups • **Sample:** Treatment group BWC equipped (n = 60 officers) / control group (n = 60 officers) • **Measure:** Use of force reports • **Analysis:** PSM and t-test • **Results:** BWC equipped officers had significantly less use of force reports than control officers, both during the evaluation period and pre/post BWC implementation
Koslicki, Makin, & Willits (2019)[1]	Northwest, US	• **Research Design:** Quasi-experimental evaluation [pre BWC 1/2009 – 3/2013 / post BWC 4/2013 – 5/2016] • **Agency:** Unnamed – midsize or small agency (< 100 sworn) • **Unit of Analysis:** Aggregated monthly use of force reports • **Measure:** Monthly rate of use of force reports per 1,000 calls for service • **Analysis:** Interrupted time series • **Results:** Statistically significant increase in use of force reports in the 3 years following BWC implementation

DV - Citizen Complaints Only		
Goodison & Wilson (2017)	Arlington, TX	• **Research Design:** 6-month randomized controlled trial [10/2015 – 3/2016] • **Agency:** Arlington Police Department - large agency (635 sworn) • **Unit of Analysis:** Shift (12-hour) – all officers on shift BWC equipped • **Sample:** 9,730 shifts randomly assigned to treatment condition (4,893 treatment / 4,837 control) • **Measure:** Citizen complaints filed (rate per shift) • **Analysis:** Descriptive only • **Results:** BWC equipped officers had a 38% drop in citizen complaints compared to the same six months prior to BWC implementation
Hedberg, Katz, & Choate (2017)[1;] Katz, Choate, Ready, & Nŭno (2014)	Phoenix, AZ	• **Research Design:** 15 month randomized controlled trial [4/2013 – 7/2014] • **Agency:** Phoenix Police Department - large agency (3000 sworn) • **Unit of Analysis:** Incident • **Sample:** Patrol areas (1 experimental / 1 control) within 1 precinct • **Measure:** Citizen complaints filed (rate per incident) • **Analysis:** GLM regression • **Results:** BWC equipped officers significantly less likely to have citizen complaints filed against them

Mesa Police Department (2013)	Mesa, AZ	• **Research Design:** 12-month quasi-randomized controlled trial [10/2012 – 9/2013] • **Agency:** Mesa Police Department - large agency (800 sworn) • **Unit of Analysis:** Treatment and control groups (aggregated citizen complaints filed) • **Sample:** Treatment group BWC equipped (n = 50 officers) / control group (n = 50 officers) • **Measure:** Citizen complaints filed • **Analysis:** Descriptive only • **Results:** BWC equipped officers had 48% reduction in citizen complaints of misconduct and 75% reduction in use of force complaints filed against them
DV - Both Use of Force Reports & Citizen Complaints		
Ariel (2017)[1]	Denver, CO	• **Research Design:** 6-month randomized controlled trial [7/2014 – 12/2014] • **Agency:** Denver Police Department - large agency (1500 sworn) • **Unit of Analysis:** Patrol district • **Sample:** 1 treatment district (n = 119 officers) / 5 control districts (n = 513 officers) • **Measures:** Aggregated Use of force reports and citizen complaints filed • **Analysis:** Adjusted odds ratios • **Results:** Statistically significant lower odds of citizen complaints, no effect on use of force

Ariel, Farrar, & Sutherland (2015)[1]; Farrar & Ariel (2013); Sutherland, Ariel, Farrar, & De Anda (2017)[1]	Rialto, CA	• **Research Design:** 12-month randomized controlled trial [2/2012 – 1/2013] • **Agency:** Rialto Police Department - midsize agency (115 sworn) • **Unit of Analysis:** Shift (12-hour) – all officers on shift BWC equipped • **Sample:** 54 officers / 988 shifts randomly assigned to treatment condition (489 treatment /499 control) • **Measures:** Use of force reports and citizen complaints filed (rate per shift) • **Analysis:** Poisson and interrupted time series • **Results:** Statistically significant reductions in use of force and citizen complaints
Braga, Barao, McDevitt, & Zimmerman (2018)	Boston, MA	• **Research Design:** 12-month randomized controlled trial [9/2016 – 8/2017] • **Agency:** Boston Police Department - large agency (2000 sworn) • **Unit of Analysis:** Treatment and control groups (aggregated use of force reports and citizen complaints filed) • **Sample:** Treatment group BWC equipped (n = 140 officers) / control group (n = 141 officers) of gang unit • **Measures:** Aggregated use of force reports and citizen complaints filed • **Analysis:** Independent samples t-test and poisson

		• **Results:** No significant difference between BWC equipped/non-equipped officers in either use of force reports or citizen complaints
Braga, Sousa, Coldren, & Rodriguez (2018)[1]	Las Vegas, NV	• **Research Design:** 19-month randomized controlled trial [3/2014 – 9/2015] • **Agency:** Las Vegas Police Department - large agency (2600 sworn) • **Unit of Analysis:** Individual officers • **Sample:** Treatment group BWC equipped (n = 218 officers) / control group (n = 198 officers) • **Measures:** use of force reports and citizen complaints filed (binary 0 = no use of force/citizen complaint or 1 = 1 or more) • **Analysis:** z-test • **Results:** BWC equipped officers significantly less use of force reports and citizen complaints
Headley, Guerette, & Shariati (2017)[1]	Hallandale Beach, FL	• **Research Design:**12-month quasi-randomized controlled trial [1/2016 – 12/2016] • **Agency:** Hallandale Beach Police Department - midsize agency (60 sworn) • **Unit of Analysis:** Treatment and control groups (aggregated use of force reports and citizen complaints filed) • **Sample:** Treatment group BWC equipped (n = 26 officers) / control group (n = 25 officers) • **Measures:** use of force reports and citizen complaints filed (rate per shift)

		• **Analysis:** Independent samples t-test • **Results:** No significant difference between BWC equipped/non-equipped officers in either use of force reports or citizen complaints / no significant reductions in either measure pre/post BWC deployment
Jennings, Lynch, & Fridell (2015)[1]	Orlando, FL	• **Research Design:** 12-month randomized controlled trial [3/2014 – 2/2015] • **Agency:** Orlando Police Department - large agency (700 sworn) • **Unit of Analysis:** Treatment and control groups (aggregated use of force reports and citizen complaints filed) • **Sample:** Treatment group BWC equipped (n = 46 officers) / control group (n = 43 officers) • **Measures:** use of force reports and citizen complaints filed • **Analysis:** Independent samples t-test • **Results:** BWC equipped officers significantly less use of force reports and citizen complaints than control officer group and significant difference pre/post BWC implementation
Peterson, Yu, La Vigne, & Lawrence (2018)	Milwaukee, WI	• **Research Design:** 15-month randomized controlled trial [10/2015 – 12/2016] • **Agency:** Milwaukee Police Department - large agency (1800 sworn) • **Unit of Analysis:** Treatment and control groups (aggregated use of force reports and citizen complaints filed)

		• **Sample:** Treatment group BWC equipped (n = 252 officers) / control group (n = 252 officers) • **Measures:** Use of force reports and citizen complaints filed • **Analysis:** Poisson and logistic regression • **Results:** No significant reduction in use of force reports and citizen complaints pre/post BWC implementation / no significant difference between treatment and control officer groups
White, Gaub, & Todak (2017)[1]	Spokane, WA	• **Research Design:** 6-month randomized controlled trial [5/2015 – 10/2015] • **Agency:** Spokane Police Department - large agency (300 sworn) • **Unit of Analysis:** Treatment and control groups rate of use of force reports and citizen complaints filed per 1,000 calls for service per month • **Sample:** Treatment group BWC equipped (n = 82 officers) / control group (n = 67 officers) • **Measures:** Use of force reports and citizen complaints filed converted to monthly rate per 1,000 calls for service • **Analysis:** Independent and paired samples t-test • **Results:** No significant reduction in use of force reports and citizen complaints pre/post BWC implementation / no significant difference between treatment and control officer groups

Yokum, Ravishankar, & Coppock (2017)	Washington, DC	• **Research Design:** 6-month randomized controlled trial [5/2015 – 10/2015] • **Agency:** District of Columbia Police Department - large agency (3800 sworn) • **Unit of analysis:** Individual officer • **Sample:** Treatment group BWC equipped (n = 1,189 officers) / control group (n = 1,035 officers) • **Measures:** Use of force reports and citizen complaints filed • **Analysis:** WLS regression • **Results:** Null, no significant treatment effect on use of force reports or citizen complaints filed •

Notes: [1]Published in peer reviewed journal

Impact of BWCs on use of force.

The impact of BWCs on use of force has been examined in 11 of the 14 U.S. studies, showing mixed results. These include nine randomized controlled trials (Denver, CO – Ariel, 2017; Rialto, CA – Ariel et al., 2015, Farrar & Ariel, 2013, Sutherland et al., 2017; Boston, MA - Braga, Barao, et al., 2018; Las Vegas, NV - Braga, Sousa, et al., 2018; Hallandale Beach, FL - Headley et al., 2017; Orlando, FL – Jennings et al., 2015; Milwaukee, WI – Peterson et al., 2018; Spokane, WA – White et al., 2017; Washington, DC – Yokum et al., 2017) and two quasi-experimental evaluations (Tampa, FL - Jennings, et al., 2017; unnamed agency in Northwest, U.S. – Koslicki et al., 2019), all of which utilized officer completed use of force reports (official agency data) in the operationalization of the dependent variable. The first of these studies was conducted in Rialto, CA by Farrar and Ariel (2013) between February 2012 and January 2013. The statistically significant findings of this small RCT (reduced use of force incidents by more than 50 percent) are frequently cited in support of BWCs.

Since this first study, three others have found statistically significant reductions in use of force (Las Vegas, NV - Braga, Sousa, et al., 2018; Orlando, FL – Jennings et al., 2015; Tampa, FL - Jennings, et al., 2017). However, twice as many (six) have found no significant differences between BWC equipped officers and those in the control group and/or pre/post device implementation in terms of use of force (Denver, CO – Ariel, 2017; Boston, MA - Braga, Barao, et al., 2018; Hallandale Beach, FL - Headley et al., 2017; Milwaukee, WI – Peterson et al., 2018; Spokane, WA – White et al., 2017; Washington, DC – Yokum et al., 2017). Moreover, one study (Koslicki et al., 2019), the longest quasi-experimental evaluation to date (four years pre- and three years post-BWC deployment at an unnamed Northwest U.S. agency), found a statistically significant increase in use of force reports over the three years post BWC implementation.

Although the generalizability to U.S. policing is questionable, several international studies have examined the impact of BWCs on use of force as well. These include two conducted in Canada (Edmonton, AB - Edmonton Police Service, 2015; Toronto, ON - Toronto Police Service, 2016), one in the United Kingdom (Birmingham, UK - Henstock & Ariel, 2017) and one global/multi-site study (Ariel, Sutherland, Henstock, Young, Drover, Sykes, Megicks, & Henderson, 2016). Of these four studies, one reported statistically significant reductions in use of force (Henstock & Ariel, 2017) and two reported null results (Edmonton Police Service, 2015; Toronto Police Service, 2016). Ariel and colleagues (2016), however, reported a significant increase in use of force in their global/multi-site study, and found that this increase may be due to officer discretion in camera activation. Collectively, the U.S. and international studies fail to provide a definitive answer, thus the impact of BWCs on use of force remains unclear.

Impact of BWCs on citizen complaints.

The impact of BWCs on citizen complaints has been examined in 12 of the 14 U.S.

studies, which, like the research examining the impact of BWCs on use of force, have also produced mixed results. These include 10 randomized controlled trials (Arlington, TX – Goodison & Wilson, 2017; Phoenix, AZ – Hedberg et al., 2017, Katz, et al., 2014; Denver, CO – Ariel, 2017; Rialto, CA – Ariel et al., 2015, Farrar & Ariel, 2013, Sutherland et al., 2017; Boston, MA - Braga, Barao, et al., 2018; Las Vegas, NV - Braga, Sousa, et al., 2018; Orlando, FL – Jennings et al., 2015; Milwaukee, WI – Peterson et al., 2018; Spokane, WA – White et al., 2017; Washington, DC – Yokum et al., 2017) and two quasi-experimental evaluations (Mesa, AZ – Mesa Police Department, 2013; Hallandale Beach, FL – Headley et al., 2017), all of which utilized official agency data (citizen complaints filed) in the operationalization of the variable. Farrar and Ariel's (2013) Rialto study was again the first of these studies chronologically and found that BWC equipped officers experienced a 90% reduction in citizen complaints.

Since the Rialto study, six others have found statistically significant reductions in citizen complaints (Arlington, TX – Goodison & Wilson, 2017; Phoenix, AZ – Hedberg et al., 2017, Katz et al., 2014; Mesa, AZ – Mesa Police Department, 2013; Denver, CO – Ariel, 2017; Las Vegas, NV - Braga, Sousa, et al., 2018; Orlando, FL – Jennings et al., 2015). However, five studies found no significant differences in citizen complaint filings between BWC equipped officers and those in the control group and/or pre/post device implementation (Boston, MA - Braga, Barao, et al., 2018; Hallandale Beach, FL - Headley et al., 2017; Milwaukee, WI – Peterson et al., 2018; Spokane, WA – White et al., 2017; Washington, DC – Yokum et al., 2017).

The impact of BWCs on citizen complaints has been the subject of several international studies as well, two in Canada (Edmonton, AB – Edmonton Police Service, 2015; Toronto, ON – Toronto Police Service, 2016), three in the United Kingdom (Portsmouth, UK – Ellis, Jenkins, & Smith, 2015; London, UK – Goodall, 2007; London, UK – Grossmith, Owens, Finn, Mann,

Davies, & Baika, 2015), one in Uruguay (Mitchell, Ariel, Firpo, Fraiman, Castillio, Hyatt,

Weinborn, & Sabo, 2018), and one global/multisite study (Ariel, Sutherland, Henstock, Young,

Drover, Sykes, Megicks, & Henderson, 2017). Of these seven studies, all but two (Edmonton

Police Service, 2015; Toronto Police Service, 2016) reported statistically significant reductions

in citizen complaints. Notwithstanding the earlier caveat concerning the generalizability of the

international studies to U.S. policing, although the results are a little more consistent than those

of the use of force research, the impact of BWCs on citizen complaints is also inconclusive.

  Methodological issues and gaps in the extant BWC research.

  As indicated in the two preceding sections, the data sources for the measures of use of

force and citizen complaints have been consistent across the extant research (official agency

data), however, a number of different metrics have been utilized. Use of force and citizen

complaints have been examined as simple count variables in aggregate by month, by year, or the

length of the study for individual officers in a few instances, and for treatment and control

groups in most. Rates have been calculated and used in some studies, which include rate of use

of force reports and/or citizen complaints per shift (Ariel, et al., 2015; Goodison & Wilson,

2017; Headley et al., 2017; Hedberg et al., 2017), and per 1,000 calls for service (Koslicki et al.,

2019; White et al., 2017). One study coded use of force reports and citizen complaints as binary

variables (0 = no use of force reports/citizen complaints and 1 = 1 or more) (Braga, Sousa, et al.,

2018). However, while the rates that have been utilized standardize the measure, and in one case

controls for call volume, they do not control for staffing. Calculating a rate per patrol hours

worked for the dependent variables would arguably control for staffing, while including both

rates of externally generated calls for service and officer-initiated activity per patrol hours

worked would control for exposure to the possibility of being involved in a use of force incident

or named in a citizen complaint.

      Second, while the extant studies have examined the frequency of use of force incidents, the potential impact of BWCs on the level or severity of force utilized and frequency of citizen injuries has not been explored. Likewise, little attention has been given to potential changes in complaint dispositions. The only known study that has addressed the latter in any form is Braga and colleagues (2018) who found that BWC equipped officers were less likely than no-equipped officers to have complaints sustained, but the finding was not statistically significant. Lastly, the majority of the analyses have been descriptive and/or independent sample t-test comparisons of treatment and control groups. Only two of the U.S. studies employed time series analysis to examine a substantial period of time pre- and post-BWC deployment (Rialto, CA – Sutherland et al., 2017; Unnamed Northwest U.S. agency – Koslicki et al., 2019). Sutherland and colleagues (2017) examined four years post-BWC implementation at the Rialto, CA Police Department and found that the initial reductions in use of force and citizen complaints had been sustained. However, Koslicki and colleagues' (2019) analysis of four years pre and three years post BWC implementation data from an agency in the Northwest U.S. indicated a significant increase in use of force reports over the three years following device deployment. These are the only two known studies that have examined long-term impact of the devices and have conflicting results. A potential unintended consequence of equipping police officers with BWCs that is also scantly addressed in the research literature is the possibility of a de-policing effect.

Potential De-policing

      While several of the extant studies have demonstrated the potential positive effect of BWCs on officer behavior, concerns have been raised that the devices may negatively impact officer proactivity. Specifically, the devices may deter officers from engaging in proactive

enforcement contacts, such as stop and frisks of suspicious persons and traffic stops (particularly investigative traffic stops), a potential phenomenon that has been described as "camera-induced passivity" (Wallace, White, Gaub, & Todak, 2018, p. 481). However, concerns of de-policing first emerged post-Ferguson due to the increased scrutiny of police by the general public, government officials, and advocacy groups, a potential phenomenon commonly referred to as the "Ferguson effect."

A report published by the Federal Bureau of Investigation (2017) asserts that, as a result of the high-profile questionable deadly force incidents in recent years, law enforcement has felt a "chill wind" (Federal Bureau of Investigation, 2017). The report proposes that law enforcement officers have not only perceived that "national politicians stood against them, but also that the politicians' words and actions signified that disrespect was acceptable in the aftermath of the Brown shooting" (Federal Bureau of Investigation, 2017, p. 3). Furthermore, it asserts that the intense media coverage implying epidemic police misconduct and wrongdoing has led to a social movement to challenge and discredit law enforcement actions. The study asserts that police officers are demoralized and less proactive as a result—the de-policing phenomenon referred to as the Ferguson effect. De-policing, in terms of a Ferguson effect, in particular, has been identified as a form of dissent shirking. A concept found in the broader organizational behavior literature, it refers to a process in which reducing one's work activity serves as an emotionally-led form of silent protest (Chanin & Sheats, 2017). This concept is specifically applicable to policing due to the highly discretionary nature of policing (i.e., engagement in self-initiated enforcement activities).

A post-Ferguson de-policing phenomenon remains largely a matter of speculation, as most of the evidence presented thus far has been anecdotal. For example, 86 percent of surveyed

police officers in a Pew Research Center (2017) study indicated that the recent high-profile

police shootings of African American citizens has been problematic for policing, and 72 percent

reported being more reluctant to stop and question suspicious subjects (Morin, Parker, Stepler, &

Mercer, 2017). However, results of one empirical study that examined the issue has been

published in a peer reviewed journal. Shjarback, Pyrooz, Wolfe, and Decker (2017) analyzed

data from 118 Missouri law enforcement agencies (epicenter of the 2014 Ferguson incident) that

policed jurisdictions of 5,000 citizens or more using paired t-tests. According to Shjarback and

colleagues (2017):

> We found consistent evidence of a racialized de-policing effect. Departments made fewer
> vehicle/traffic stops, searches, and arrests in 2015 relative to 2014 in jurisdictions with
> larger African –American populations. Thus, a major finding of this study is that
> context—especially the racial compositions of cities—shapes de-policing behavior (p.
> 50).

There is widespread speculation that de-policing is responsible for recent increases in

violent crime (Mac-Donald, 2016). While the delay in the availability of data made it difficult to

address this question immediately, scholars have published some study results. Rosenfeld (2016)

conducted an analysis of de-policing effects and increased violent crime in a sample of large US

cities in a National Institute of Justice-sponsored study finding no connections between the two.

Similarly, Shjarback and colleagues (2017) found no significant impact on crime rates in their

study of Missouri agencies. However, due to the limited research this remains an open question

as well.

As mentioned, some have expressed concerns that BWCs could exacerbate de-policing

stemming from a Ferguson effect, or simply deter officers from engaging in self-initiated

enforcement encounters for fear of scrutiny. In either case, or both combined, Wallace and

colleagues (2018) suggest that this potential camera-induced passivity is due to the possibility of

both internal and external scrutiny of their actions resulting from the BWC captured video. They

further suggest that an officer's ability to limit his or her exposure to scrutiny is primarily limited

to discretionary activities, such as suspicious person (pedestrian) and traffic stops. As indicated

in a previous section of this chapter, enforcement contacts initiated by the officer is a correlate of

both use of force and citizen complaints. Thus, officers might become less proactive to protect

themselves. Although a handful of studies have examined the impact of BWCs on officer activity

in some form, only Wallace and colleagues (2018) have empirically examined de-policing and

BWCs specifically. Summaries of these studies and the associated publications are listed in

Table 2.2.

Table 2.2: Extant Research Examining the Impact of BWCs on Officer Proactivity

DV – Self Initiated Activity		
Headley, Guerette, & Shariati (2017)[1]	Hallandale Beach, FL	• **Research Design:** 12-month quasi-randomized controlled trial [1/2016 – 12/2016] • **Agency:** Hallandale Beach Police Department - midsize agency (60 sworn) • **Unit of Analysis:** Treatment and control groups (aggregated arrests, field contacts, and traffic citations. • **Sample:** Treatment group BWC equipped (n = 26 officers) / control group (n = 25 officers) • **Measures:** aggregated arrests, field contacts, and traffic citations (percent change for treatment and control groups pre and post BWC implementation) • **Analysis:** Independent samples t-tests • **Results:** Statistically significant reduction in arrests but increase in field contacts for BWC equipped officers compared to control group / no significant reductions/difference in traffic citations pre/post BWC deployment for either group
Peterson, Yu, La Vigne, & Lawrence (2018)	Milwaukee, WI	• **Research Design:** 15-month randomized controlled trial [10/2015 – 12/2016] • **Agency:** Milwaukee Police Department - large agency (1800 sworn) • **Unit of Analysis:** Treatment and control groups (aggregated arrests, traffic stops, and subject stops)

		• **Sample:** Treatment group BWC equipped (n = 252 officers) / control group (n = 252 officers) • **Measures:** Aggregated arrests, traffic stops, and subject stops for the nine months prior to BWC implementation and 9 months post implementation for treatment and control groups • **Analysis:** Poisson and logistic regression • **Results:** BWC equipped officers made 8% fewer subject stops than control group officers (statistically significant); no significant differences in number of arrests or traffic stops
Ready & Young (2015)[1]	Mesa, AZ	• **Research Design:** 12-month quasi-randomized controlled trial [10/2012 – 9/2013] • **Agency:** Mesa Police Department - large agency (800 sworn) • **Unit of Analysis:** Individual officer • **Sample:** Treatment group BWC equipped (n = 50 officers) / control group (n = 50 officers) • **Measure:** Officer completed field contact reports (binary 0/1: self-initiated; stop & frisk; warning; citation; arrest) • **Analysis:** HGLM logistic regression • **Results:** BWC equipped officers were significantly more likely to initiate encounters and issue citations, but significantly less likely to conduct stop & frisks than control group officers
Wallace, White, Gaub, & Todak (2018)[1]	Spokane, WA	• **Research Design:** 6-month randomized controlled trial [5/2015 – 10/2015]

		• **Agency:** Spokane Police Department - large agency (300 sworn) • **Unit of Analysis:** Individual officer • **Sample:** Treatment group BWC equipped (n = 82 officers) / control group (n = 67 officers) • **Measures:** Computer assisted dispatch recorded self-initiated calls and arrests • **Analysis:** HLM • **Results:** No evidence of statistically significant camera-induced passivity. Results showed an increase of proactivity for BWC equipped officers
White, Todak, & Gaub (2018)[1]	Tempe, AZ	• **Research Design:** 13-month randomized controlled trial [11/2015 – 12/2016] • **Agency:** Tempe Police Department - large agency (342 sworn) • **Unit of Analysis:** Treatment and control groups aggregated self-initiated calls • **Sample:** Treatment group BWC equipped (n = 101 officers) / control group (n = 99 officers) • **Measures:** Computer assisted dispatch recorded self-initiated calls converted to monthly rate per 1,000 self-initiated calls for treatment and control groups • **Analysis:** Independent a nd paired samples t-test • **Results:** No significant reduction in self-initiated calls / no significant difference between treatment and control officer groups

Notes: [1]Published in peer reviewed journal

As documented in Table 2.2 above, results are mixed. Of the five studies, all of which were randomized controlled trials, three found a statistically significant reduction in at least one officer activity measure, two found a statistically significant increase in at least one activity measure, and two had null findings. While Peterson et al. (2018) found a statistically significant reduction in pedestrian stops among BWC equipped officers and Ready and Young (2015) found that BWC equipped officers were significantly less likely to conduct stop and frisks, Headley et al. (2017) found an increase in field contacts for BWC equipped officers compared to the control group. Similarly, Headley et al. (2017) found a statistically significant reduction in arrests for BWC equipped officers, while Peterson et al. (2018) found no significant reduction or difference in arrests between that BWC equipped officers and those in the control group. Headley et al. (2017) found no significant reductions or difference between treatment and control groups in the issuance of citations pre/post BWC implementation and Peterson et al. (2018) found no significant differences in terms of traffic stops, but Ready and Young (2015) found that BWC equipped officers were significantly more likely to initiate encounters and issue citations. Finally, Wallace et al. (2018) and White et al. (2018) found no evidence of camera-induced passivity in Spokane, WA and no significant reduction in self-initiated activity in Tempe, AZ respectively.

Of these few studies, arguably the Spokane, WA research conducted by Wallace and colleagues (2018), which generated null findings, is the most comprehensive and focused on the potential link between BWCs and de-policing. However, considering the racialized de-policing effect found by Shjarback et al. (2017), it seems likely that Spokane's relative lack of diversity makes generalizability of these findings questionable. According to the U.S. Census Bureau (2010) the total population of Spokane (as of the last official census - 2010) is 208,916 and is

86.7 percent white, 2.3 percent African American, and 5 percent Hispanic. The second

methodological concern is the potential Hawthorne effect associated with a randomized

controlled trial, which is problematic in all five of these studies. While randomized controlled

trials are considered the "gold standard," Koslicki and colleagues (2019) call attention to this

issue that seems highly likely to occur in the unique context of policing. Regarding the mixed

results of the extant BWC literature and the possibility of a Hawthorne effect, Koslicki et al.

(2019) state:

> One explanation for these divergent results may relate to one of the greatest challenges presented to experimental researchers, which is to say 'that which we study, we influence. In the context of RCTs, this Hawthorne effect occurs through research subjects' awareness of being observed by the researcher (Merrett 2007), and – though there is some uncertainty as to the mechanisms and complexities behind the effect – remains a well-documented phenomenon across scientific fields (McCambridge et al. 2014, Chen et al. 2015). With many of the aforementioned findings on the efficacy of BWCs in changing police officer behaviour coming from RCTs, there is a likelihood that researcher presence on BWC research sites may affect the influence of BWCs through the duration of the trial (p. 5).

Although officers are being observed via the BWC video recordings, and, as set forth in the

theoretical framework, the devices are believed to alter officer behavior because of this

observation, Koslicki and colleagues argue the presence of researchers may introduce a

secondary Hawthorne effect due to the certainty that their activity is being monitored. They

argue that this potential problem could be avoided with a quasi-experimental research design.

De-policing, whether stemming from Ferguson effect dissent shirking, camera-induced

passivity for fear of public scrutiny, or a combination of the two, has generally been viewed in

negative terms. Accordingly, Wallace and colleagues (2018) state, "[t]he potential for BWCs to

alter police activity negatively is a serious concern that could short-circuit the primary benefits of

the technology" (p. 483). This negative connotation notwithstanding, some scholars suggest that

aggressive officer-initiated enforcement contacts negatively impact police legitimacy (Brunson,

2007; Brunson & Miller, 2005; Epp et al., 2014). Therefore, reductions in these types of contacts might serve to improve police-community relations (Sharback et al., 2017). Regardless of one's position on the issue, the extremely limited research examining the impact of BWCs on proactive enforcement contacts is insufficient to provide a conclusive answer.

Chapter Summary

This chapter began with an overview of use of force, abuse of authority and citizen complaints to further enlighten the problems on which BWCs are anticipated to have a positive impact. The theoretical underpinnings of the presumed positive impact of the devices followed. Tedeschi and Felson's social interactionist theory of coercive actions makes the transactional nature of the police officer-citizen enforcement encounter clear and explains how both the officer's and citizen's conduct from the onset of the contact can be problematic and lead to an undesirable outcome. Tedeschi and Felson's theory concerning the dynamics of the police-citizen enforcement encounter was followed by the theoretical framework on which the anticipated positive impact of BWCs on officer behavior is based. Deterrence and objective self-awareness theories were reviewed as they are the basis for BWC proponent claims that officers will be less likely to abuse their authority to protect their social identity and engage in procedurally just behaviors, including employing de-escalation techniques as a result of being observed via BWC captured video. Then, the extant research that has examined the impact of BWCs on officer behavior (use of force and citizen complaints specifically) was reviewed.

The extant research literature examining the impact of BWCs on use of force and citizen complains has produced mixed results. While a few early randomized controlled trials indicated that equipping officers with BWCs substantially reduced use of force incidents and citizen complaints, several of the later studies found little or no impact on these outcomes. Of the 15

extant studies that have examined the impact of BWCs on use of force, five have found that

BWCs significantly reduced use of force incidents (Braga, Sousa, et al., 2018; Farrar & Ariel,

2013; Henstock & Ariel, 2017; Jennings et al., 2015; Jennings et al., 2017). However, eight of

the studies produced null findings (Ariel, 2017; Braga, Barao, et al., 2018; Edmonton Police

Service, 2015; Headley et al., 2017; Peterson, et al., 2018; Toronto Police Service, 2016; White

et al., 2017; Yokum et al, 2017), and two studies indicated significant increases in use of force

post BWC deployment (Ariel et al., 2016; Koslicki et al., 2019). Likewise, the studies examining

the impact of BWCs on citizen complaints have produced mixed results. Of the 19 extant studies,

12 found that BWC equipped officers had significant reductions in citizen complaints filed

against them (Ariel, 2017; Ariel et al., 2017; Braga, Sousa, et al., 2018; Ellis et al., 2015; Farrar

& Ariel, 2013; Goodall, 2007; Goodison & Wilson, 2017; Grossmith et al., 2015; Hedberg et al.,

2017; Jennings et al., 2015; Mesa Police Department, 2013; Mitchell et al., 2018). However,

seven of the studies produced null findings (Braga, Barao, et al., 2018; Edmonton Police Service,

2015; Headley et al., 2017; Peterson et al., 2018; Toronto Police Service, 2016; White et al.,

2017; Yokum et al., 2017).

The review of the extant research literature regarding the impact of BWCs on use of force

and citizen complaints revealed that while official agency records were consistently used as the

data source across studies, a variety of metrics were utilized in analyses. Six specific

methodological issues/gaps in the research were identified. First, the rates computed and utilized

in prior studies do not account for staffing levels, and this potential confounding variable has not

been otherwise controlled for. Second, although the theoretical framework suggests that officers

might employ lower level force options more frequently when BWC equipped, potential changes

in the severity of force (citizen injuries) has not been explored. Third, only one study has

examined changes in the frequency of complaint dispositions (Braga, Sousa, et al., 2018), which was during a 19-month randomized controlled trial. The long-term impact remains unknown. Fourth, only two studies have examined the impact of BWCs on use of force and citizen complaints for a period longer than the 12 to 19 month randomized controlled trials, and these two studies, which utilized time series analysis, generated conflicting results (Sutherland et al., 2017; Koslicki et al., 2019). Thus, reduction of use of force and citizen complaints, and the sustainability of any reductions in these outcomes post BWC implementation, remains undetermined. Fifth, although randomized controlled trials are considered the gold standard of research, Koslicki et al. (2019) aptly argues that there is an especially high potential for a Hawthorne effect among police officers due to the nature of the work, and this effect is likely exacerbated by the testing of a technology developed for the surveillance of officer behavior. All but one of the 14 studies conducted in the U.S. have been randomized controlled trials and arguably susceptible to a Hawthorne effect. As Koslicki et al. (2019) point out, this potential problem could be avoided with a quasi-experimental design. Lastly, the possibility that BWCs could contribute to de-policing has received scant attention from researchers.

Although the potential for BWCs to negatively impact officer proactivity is a commonly-cited concern, only five studies have examined officer activity in some form. Furthermore, only one of those examined the possible phenomenon referred to as camera induced passivity specifically (Wallace et al., 2018). Of these five studies (all of which were randomized controlled trials), three found a statistically significant reduction in at least one officer activity measure among the BWC equipped officers, which include: Pedestrian stops (Peterson et al., 2018); stop and frisk (Ready & Young, 2015); and arrests (Headley et al., 2017). However, two of them also found significant increases in at least one activity measure among the BWC

equipped officers, these include: Field contacts (Headley et al., 2017); and citations (Ready & Young, 2015). Two of the five studies generated null findings (Wallace et al., 2018; White et al., 2018). Thus, the results are inconclusive. Since all five of these studies were randomized controlled trials, the possibility of a Hawthorne effect cannot be ignored, especially in terms of officer activity.

BWC advocates lauded the findings of Farrar and Ariel's (2013) Rialto, California study and Mesa, Arizona Police Department's (2013) study, and the significant reductions in use of force incidents (Rialto) and citizen complaints (Rialto & Mesa) are frequently cited in support of claims that the devices improve police officer behavior. However, as the review of the extant literature revealed, subsequent research has produced mixed findings, which is problematic considering the potential negative impact of unrealistic expectations and the expense of BWC program maintenance outlined in Chapter 1. The dissertation seeks to advance the current body of research literature by addressing the six methodological issues and gaps listed above. Chapter 3 sets forth the methodology utilized for the study.

CHAPTER 3

METHODOLOGY

Utilizing 86 months of data (May 2010 through June 2017) the dissertation examines the impact of BWCs on use of force and citizen complaints at the Newport News, Virginia Police Department. This period includes 36 months pre-BWC implementation, 38 months of staggered BWC device deployment to all 284 patrol personnel, and 12 months post full BWC deployment to all patrol officers. As mentioned previously, NNPD deployed BWCs to patrol officers in waves due to budget constraints. The staggered deployment began with a 10-device pilot in May 2013, and the deployment of an additional 44 BWCs by December of that year. The staggered rollout continued with equipping another 30 patrol officers with BWCs by the end of 2014, and 175 more during 2015. The final 25 officers were BWC equipped in the first half of 2016 for a total of 284. The incremental deployment of BWCs among all 284 patrol personnel, combined with the fact that NNPD began implementation of BWCs more than one year prior to the Ferguson incident, the increased scrutiny of law enforcement, and the rush to equip officers with the devices that has followed, permits a unique examination of the impact of the devices.

The methodological design addresses the following research questions: (1a) Was the frequency of use of force incidents reduced post BWC implementation and, if so, was the reduction sustained? (1b) If the frequency of use of force incidents was reduced, was there an incremental decline with waves of BWC implementation, or did any decline plateau or decay over the course of implementation? (1c) Was there a change in the severity of force used (frequency of suspect injury)? (1d) Did BWCs have a significant impact on these outcomes when simultaneously considering staffing and volume of officer-initiated enforcement activity? (2a) Was the frequency of citizen complaints reduced post BWC implementation and, if so, was any

reduction sustained? (2b) If the frequency of citizen complaints was reduced, was there an

incremental decline with waves of BWC implementation, or did any decline plateau or decay

over the course of implementation? (2c) Was there a change in the proportion of sustained

complaints compared to those unfounded, unsubstantiated, or in which the officer was

exonerated? And (2d) did BWCs have a significant impact on these outcomes when

simultaneously considering staffing levels and volume of officer-initiated enforcement activity.

Sample & Data

Sample selection.

The current study utilizes a nonprobability purposive sample (Newport News, Virginia

Police Department) because of a confluence of three factors that allows for an important

contribution to the current body of knowledge concerning the efficacy of BWCs. First, BWC

implementation began at NNPD 15 months prior to the police legitimacy crisis that followed the

Ferguson incident and the subsequent rush to equip officers with BWCs. Second, implementation

of BWCs at NNPD occurred in several waves over the course of three years. Third, NNPD

granted the researcher unfettered access to the agency's internal data necessary to address the

current gaps in the extant research. While a nonprobability purposive sample of a single mid-

Atlantic agency imposes limitations in terms of generalizability, the Newport News Police

Department is representative of national averages in terms of diversity of sworn personnel.[3] The

2013 Law Enforcement Management and Administrative Statistics (LEMAS) Survey indicates

that 12.5% of sworn officers employed by local police departments are female, and

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[3] Although the proportion of NNPD officers who are racial minorities is larger than the national
average, African Americans are substantially under-represented in NNPD compared to the
proportion of the Newport News population.

approximately 27% are racial minorities (Reaves, 2015). Descriptive data of NNPD and its 440

sworn personnel for the period of the study are contained in Table 3.1.

Table 3.1: NNPD Descriptive Data (2010-2017)

Descriptive	M / %	S.D.	Range	2010-11 / 2016-17
Annual budget[1]	44.43	2.80	40.43 – 47.41	43.09 / 44.08
Authorized number of sworn personnel	430.00	8.66	420 - 440	420 / 440
Number of officers assigned to patrol	269.86	6.08	258 - 278	273 / 270
Proportion of sworn personnel female[2]	15.67%	-	-	-
Proportion of sworn personnel African American[2]	15.67%	-	-	-
Proportion of sworn personnel other racial minority[2]	13.33%	-	-	-
Citizen generated calls for service	152,661.86	9,218.70	145,020 - 163,226	163,226 / 142,826
Officer generated calls for service	63,300.17	15,160.82	41,791 - 85,241	85,241 / 41,791
Use of force incidents	117.71	32.71	67 - 155	155 / 67
Citizen complaints	181.29	52.85	123 - 256	212 / 111

Notes: [1]Millions of dollars; [2] Proportion of all sworn officers employed 2010 – 2017.

NNPD provides general law enforcement services to a diverse community of

approximately 180,000. The citizens of Newport News, Virginia are 49.0% white, 40.7% African

American, and 10.3% other races (U.S. Census Bureau, 2017). Additional descriptive data for

the City of Newport News are provided in Table 3.2.

Table 3.2: Newport News, Virginia, Descriptive Data (2010 – 2017)

Descriptive	M / %	S.D.	2010 / 2017
Population[1]	180,935.86	416.02	180,719 / 180,775
Proportion of population white[1]	50.38%	0.66	49.00% / 49.00%
Proportion of population African American[1]	40.40%	0.18	40.70% / 40.70%
Proportion of population with a bachelor's degree or higher[1]	23.89%	0.61	22.80% / 24.90%
Proportion of population unemployed[1]	5.61%	0.55	4.70% / 6.30%
Proportion of population below poverty level[1]	15.13%	0.90	13.50% / 16.40%
Median household income[1]	50,565.38	537.92	49,562.00 / 51,082.00
Violent crime rate[2]	454.13	27.81	488.15 / 499.07
Property crime rate[2]	3,136.88	118.02	3,359.20 / 3,041.74

Notes: [1]U.S. Census Bureau (2019): *American Fact Finder;* [2]Federal Bureau of Investigation (2019) – UCR Publications: *Crime in the United States.*

The descriptive data provided in Table 3.1 (NNPD) shows that while the annual budget, authorized number of sworn personnel, and number of officers assigned to patrol all remained relatively stable, substantial changes in the volume of citizen- and officer-generated calls for service, use of force incidents, and citizen complaints occurred. Between 2010 and 2017 citizen generated calls for service decreased modestly (12.50 percent), but officer-generated calls for service decreased by more than half (50.97 percent). During the same period NNPD experienced major reductions in use of force incidents and citizen complaints, 56.77 and 47.64 percent respectively. Regarding the City of Newport News, Table 3.2 shows that the population, proportion of white and African American residents, median household income, and violent

crime rate all remained relatively stable, but changes occurred in education level, unemployment, proportion of the population below poverty level, and the property crime rate between 2010 and 2017. While the proportion of the population that held a bachelor's degree or higher increased by 9.21 percent, the proportion of Newport News residents unemployed and below the poverty level increased by 34.04 and 21.48 percent respectively. However, the property crime rate decreased by 9.45 percent during the same period.

Data collection.

The researcher collected internal NNPD data from four sources for the period of May 1, 2010 through June 30, 2017, 86 months total: 36 months pre-BWC implementation (May 2010 – April 2013), 38 months of staggered BWC device deployment to all 284 patrol personnel (May 2013 – June 2016), and 12 months post full BWC deployment (July 2016 – June 2017). These data include: (1) NNPD computer assisted dispatch (CAD) data; (2) internal affairs data; (3); City of Newport News Human Resources Department payroll and personnel data; and (4) NNPD Training Division records of BWC assignments.

The CAD data is a log of all calls for service and self-initiated activity, which contains the date, day of week, time, officer identification, how the activity was generated (officer initiated or dispatched), description of the call/activity, location (street address, beat, and precinct), and disposition of every call and reported activity/contact. The CAD data was provided to the researcher by the NNPD Information Technology Department. NNPD utilizes *IA Pro* software to record use of force incidents and formal citizen complaints. The following information is extracted from officer completed and filed use of force reports and recorded in *IA Pro*: Officer IDs; the types of force used; citizen resistance and assaults on officers; arrests following use of force; citizens injured as a result of use of force; officers injured in use of force

incidents; the reason for the use of force; and the type of service being rendered at the time force was used.

IA Pro is also utilized for recording and tracking formal citizen complaints. Formal complaints are classified as those that could result in punitive disciplinary action should they be sustained. These complaints receive a full investigation. Conversely, informal complaints are of a less serious nature that are handled at the precinct level but are documented in a log maintained by the NNPD Internal Affairs Section of the Professional Standards Division. The citizen complaint information contained in both the *IA Pro* database of formal complaints and the informal complaint log includes: The date the incident occurred; the date the complaint was received; the complainant; the officer against whom the complaint is filed; the offense type; the IA investigator; the disposition; and conclusion date. The *IA Pro* database is also maintained by the NNPD Internal Affairs Section of the Professional Standards Division, which provided the researcher with reports containing use of force information and formal citizen complaint information aggregated by month for the 86-month period being studied. The researcher was also provided with a copy of the informal complaint log for the same period.

The City of Newport News Human Resources Department provided the researcher with payroll and personnel records, which included detailed reports of hours worked by patrol officers aggregated by month and a commissioned personnel record containing hire date, current assignment, current rank, promotion date, date of termination/resignation/retirement (if applicable), and demographic information (race and sex) for all officers employed during the 86 month period of interest. Lastly, the NNPD Training Division is responsible for maintaining the NNPD BWC program including training officers in the use of the devices and detailed record keeping of BWC assignments. The researcher was provided with the BWC assignment record

beginning with the ten-device pilot in May 2013 through the achievement of full deployment to all 284 commissioned officers assigned to the patrol division in June 2016.

Measures

Basis for calculated rates.

The use of force and citizen complaint frequency dependent variables and the officer self-initiated enforcement activity and call for service control variables are calculated as rates per regular patrol hours worked in each month. In addition to standardizing the measurements, regular patrol hours worked reflects the staffing level and controls for personnel shortages. Staffing levels are of importance because personnel shortages are likely to impact officer ability to engage in self-initiated enforcement contacts, which, as indicated in Chapter 2, increase the likelihood of use of force and citizen complaints. Conversely, staffing shortages may also limit the amount of time an officer may dedicate to a call for service and also produce citizen complaints. The mean number of regular patrol hours worked in a month during the period under examination is 35,764.78 ($sd = 1,702.85$). Thus, rates are calculated per 1,000 regular patrol hours worked.

Dependent variables.

Use of force.

The current study utilizes data extracted from internal NNPD use of force reports filed by officers. Use of force is conceptualized according to the definition of reportable use of force found in the *Newport News Police Department Operational Manual.* According to NNPD (2017) policy OPS-110 – Use of Force:

> *A Use of Force Report (NNPD Form #83) will be prepared by the primary officer employing the force while on-duty, acting in an official capacity or in the event that a Departmental issued weapon/device is utilized in the following situations:*

a. *Whenever an officer discharges a firearm or less-lethal munitions…* (Exceptions to this procedure are discharging a firearm at, or as part of the following: organized shooting matches; authorized range training; legal, personal practice and hunting).

b. *When the use of force results in a visible injury or death of any person, including officers.*

c. *When a subject complains that an injury has been inflicted as the result of an application of force by an officer.*

d. *Whenever O.C.* [oleoresin capsicum – commonly referred to as "pepper spray" or popular brand name "Mace"] *or CS/CN gas* [commonly referred to as "tear gas"] *is employed.*

e. *In those situations where defensive or active resistance is employed against an officer.*

f. *Whenever an impact weapon is employed in an offensive manner.*

g. *Whenever an ECD* [electronic control device, commonly referred to by popular brand name "Taser"] *is employed in a police encounter with a suspect.* (p. 8).

NNPD departmental policy requires the primary officer in a use of force incident to file the use of force report and list only those other officers directly involved in the application of force. In the current study use of force is operationalized by counting the number of use of force reports filed in a given month (from the *IA Pro* database), regardless of the number of officers involved in each incident. A separate use of force report is required for each subject when force is used on more than one subject in the same incident. Therefore, the frequency of use of force variable reflects the number of subjects upon whom force was used. The use of force frequency variable is calculated as a rate per 1,000 regular patrol hours worked by month as follows:

$$\frac{\text{Number of Use of Force Incidents Month x}}{\text{Total Number of Patrol Hours Worked Month x}} (1,000)$$

Severity of force.

The severity of force variable is represented by the number of use of force incidents resulting in injuries to the citizen requiring medical attention (transported to a hospital for treatment). Severity of force is extracted from the *IA Pro* reports and calculated as a proportion of the total number of use of force incidents in a given month as follows:

$$\text{Severity of Force} = \frac{\text{Number of Citizens Injured (Requiring Medical Attention)Month x}}{\text{Total Number of Use of Force Incidents Month x}}$$

Citizen complaints.

The current study utilizes Farrar and Ariel's (2013) definition of citizen complaints, "incidents where the reporting party has filed a grievance… against [an officer for] alleged misconduct or what they perceive as poor performance" (p. 7), which is consistent with NNPD's classification. NNPD receives citizen complaints via request for a supervisor on scene, walk-ins to a precinct or headquarters, by telephone, email, website portal, or by U.S. mail. While clerks at any of the precinct stations or headquarters building may take complaints from walk-ins via a citizen complaint form or letter, and any officer, supervisor, or command staff member may receive a complaint in person (which are then forwarded to the Internal Affairs Unit of the Professional Standards Section), the latter means of filing are received directly by the Internal Affairs Unit. Each complaint is entered in a log and after a preliminary investigation and evaluation is recorded as either an informal or formal complaint. Informal complaints consist of minor policy violations while formal complaints are more serious in nature and receive full investigations. The latter are then entered into a database and tracked utilizing *IA Pro* software.

Both formal and informal citizen complaints are included in the current study's operationalization of the variable. However, citizen complaints often contain more than one allegation against one or more officers. Such cases are counted as a single complaint when the allegations are the same for each officer listed. Different allegations made against different officers contained in the same complaint are counted as an individual complaint. The citizen complaint frequency variable is calculated as a rate per 1,000 patrol hours worked by month as follows:

$$\frac{\text{Number of Citizen Complaints Month x}}{\text{Total Number of Patrol Hours Worked Month x}} \, (1{,}000)$$

Citizen complaint dispositions.

NNPD records the disposition of citizen complaints in one of 5 categories as follows: substantiated, not substantiated, unfounded, exonerated, or complainant refused to cooperate/complaint withdrawn. However, citizen complaints may, and often do, contain more than one allegation. Furthermore, as indicated in the previous chapters, BWC captured video is expected to provide evidence for swifter and more accurate investigations of citizen complaints. Thus, one would anticipate that there would be an increase in more conclusive dispositions (i.e., exonerated and substantiated). The frequencies of substantiated, not substantiated, unfounded, and exonerated proportions during the pre-BWC period compared to the deployment and post full implementation periods are examined.

Intervention/independent variable.

BWCs.

As previously mentioned, following the initial ten device pilot, NNPD deployed BWCs incrementally over a 38-month period (May 2013 – June 2016) to achieve 100% implementation (all 284 patrol officers equipped with the devices). Therefore, the BWC variable is computed both as a binary (0 = pre-BWC implementation, May 2010 – April 2013; 1 = post-BWCs, May 2013 – June 2017) for ARIMA analysis, as well as a proportion of the 284 total for a given month for VAR analysis as follows:

$$\text{BWC Deployment} = \frac{\text{Number of Officers BWC Equipped}}{\text{Total Number of Officers to be Equipped (284)}}$$

Control variables.

Officer Self-initiated enforcement activity.

Concerns have been raised that BWCs may have a de-policing effect through camera induced passivity, and that reduced proactive enforcement activity might mediate a relationship between BWCs and reduced use of force incidents and citizen complaints. Like Wallace and colleagues (2018), the current study includes traffic stops, suspicious vehicle checks, and suspicious person (pedestrian) stops/field interviews in the discretionary pro-active investigative/enforcement activity measure. The CAD data was filtered to extract only the aforementioned officer-initiated activities and officer assists are excluded. The self-initiated enforcement activity variable is calculated as a rate per 1,000 patrol hours worked by month as follows:

$$\frac{\text{Number of Self} - \text{Initiated Enforcement Contacts Month x}}{\text{Total Number of Patrol Hours Worked Month x}} (1,000)$$

Calls for service.

Call for service volume (those calls dispatched to officers, not self-initiated) can have an impact on the dependent variables through increased exposure to risk and impacts officer ability to engage in self-initiated enforcement contacts. Thus, calls for service should be controlled for. Calls for service in the current study are generated by any means other than officer initiated. Only the original call was extracted from the CAD data. Duplicate dispatch assigned call numbers are eliminated, as are calls cancelled by communications before an officer logs arrival. Call for service volume is calculated as a rate per 1,000 patrol hours worked by month as follows:

$$\frac{\text{Number of Calls for Service (Dispatched)Month x}}{\text{Total Number of Patrol Hours Worked Month x}} (1,000)$$

Ferguson incident.

As related in Chapter 2, there is wide-spread speculation that the increased public scrutiny of police following the August 2014 shooting of Michael Brown by a Ferguson, Missouri police officer deterred officers across the U.S. from engaging in proactive enforcement activities, a de-policing phenomenon dubbed the "Ferguson effect." As time series analysis is sensitive to historical events, the Ferguson incident is controlled for with the variable coded as follows: Pre-Ferguson (prior to August 2014) = 0; post Ferguson (August 2014 and after) = 1.

Seasonality.

As crime, calls for service, and proactive activities are subject to seasonal increases (generally higher in volume during the warmest months), seasonality will be controlled for utilizing monthly average temperatures for the period under examination[4], or the use of a seasonal statistical model as described in the analytic strategy section below.

Analytic Strategy

The impact of BWCs on each of the dependent variables is assessed with a series of t tests and two different time series techniques, autoregressive integrated moving average time series analysis (ARIMA, SARIMA if the data fits a seasonal model) and vector autoregression analysis (VAR) using STATA/IC 16.0. Time series analysis is the appropriate statistical technique to test the impact of an intervention and additional explanatory variables over time as the modeling produces a valid and reliable result by distinguishing the impact of the intervention from other factors on the dependent variable (McDowall, McCleary, Meidinger, & Hay, 1980).

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[4] Average monthly temperatures for the 86-months examined were obtained from historical weather records collected by the Newport News/Williamsburg International Airport Weather Station made available on the Weather Underground website: https://www.wunderground.com/history/daily/us/va/newport-news/KPHF

This is of importance because time series data is "serially dependent," meaning that each time point measurement is impacted by those that came before (McDowall et al., 1980; Ostrom, 1978). As McDowall and colleagues (1980) point out, ordinary least square regression assumes that "adjacent error terms are uncorrelated… this assumption is seldom satisfied by time series data, however, and when error terms are correlated, the standard errors of ordinary least squares parameter estimates are *biased*" (p. 12). In short, the authors warn that erroneous statistically significant results are common when time series data is analyzed using OLS regression.

ARIMA time series analysis has been utilized to assess the impact of several interventions in the criminology and criminal justice field. For example, it has been used to assess the impact of reducing the legal blood alcohol concentration (BAC) to .08 on traffic fatalities in New Jersey (Chamlin, 2016), to evaluate the effects of the New York Juvenile offender law that certifies violent offenders to be tried in criminal court (Singer & McDowall, 1988), and to assess the impact of New York's sex offender registration law (Sandler, Freeman, & Socia, 2008). In terms of BWC research, it has been utilized in the Rialto, California study (Sutherland et al., 2017) and in a study of an unnamed Northwest U.S. agency (Koslicki et al., 2019), the former evaluating the impact of the devices on use of force and citizen complaints, the latter on use of force only. VAR, a multivariate time series technique that allows for examination of how several endogenous variables impact one another over time, has been utilized extensively in financial policy analysis, but less so in other fields. Corman, Joyce, and Lovitch's (1987) examination of crime, deterrence, and unemployment, Enders and Sandler's (1993) study of the effectiveness of antiterrorism policies, and Witt and Witte's (2000) research on crime, incarceration, and the labor supply are three examples of the utilization of VAR analysis in criminological research.

ARIMA requires a series of diagnostic tests prior to the actual analysis to assess the fitness of the data and make necessary adjustments to address any pre-intervention trends, autocorrelation, moving average, and/or seasonality. The assumption is that the pre-intervention time series reflects only 'white noise' (no pattern or 'signal'), and the goal of the aforementioned diagnostics is to identify and correct for violations of that assumption before proceeding with the analysis (Andrews, Dean, Swain, & Cole, 2013).

The process of specifying the model is comprised of the series of the following diagnostic tests. First, a plot of the time series must be examined to reveal any trends in the dependent variables pre-intervention. Then a correlogram is generated and examined for a slow decay to zero, which also indicates a trend. However, an augmented Dickey-Fuller test is utilized to confirm whether or not a trend exists. The null hypothesis of the Dickey-Fuller test is that a trend, or unit root, exists. Therefore, a significant result indicates no trend. If the test result is not significant, indicating the existence of a trend, the data is differenced (d) = 1, and a subsequent Dickey-Fuller test of the differenced variable is performed to ensure the trend is resolved.

Assessment of the pre-intervention series for auto regression, AR (p), and moving average, MA (q) follows. To diagnose AR, a partial autocorrelation (PAC) graph is generated and inspected for spikes outside of the 95% confidence level in early lags. A lack of such spikes indicates an AR of 0, however, if such spikes exist, an issue with auto regression is indicated, which requires specification, AR (p) = 1, 2, etc. To diagnose MA, an autocorrelation (AC) plot is generated and examined for spikes outside of the 95% confidence level in early lags and a correlogram is generated to reveal any significant q statistics. If neither are detected, an MA of 0 is indicated, but spikes on the AC plot and significant q statistics require a q specification in the

model, MA (q) = 1, 2, etc. Lastly, the series are examined for seasonality.[5] The current study's

monthly observations require examination for 12-month seasonality, which would manifest in

spikes at lags 12, 24, 36, etc. in the series. ARIMA models with an annual seasonal pattern (12-

month) are specified (p, d, q) (P, D, Q)$_{12}$, where "P" symbolizes auto regression (AR) of the

seasonal component, "D" symbolizes differencing of the seasonal component, "Q" symbolizes

moving average (MA) of the seasonal component, and "12" indicates the number of lags for

seasonal differencing.

Following diagnosis and specification, an ARIMA (or SARIMA if indicated) model of

each dependent variable and BWCs coded simply as 0 for pre-implementation (May 2010 –

April 2013), and 1 for all months after the beginning of BWC implementation (May 2013 – June

2017) is analyzed.

The second analytic technique, VAR, is the ideal multivariate time series analysis when

data contains variables that are expected to impact one another in a "system" (Sims, 1980).

Essentially, these variables are all treated as endogenous in the system, which reflects a vector of

two or more, it is autoregressive in that it contains lagged values of the variables, and the

stochastic error terms are referred to as impulses or shocks (Lutkepohl, 2007; Sims, 1980). The

basic premise of VAR modeling is that "the dependent variable is a function of its lagged values

and the lagged values of the other variables in the model" (Adeleye, 2018). VAR is particularly

ideal for the current study as it also allows for the inclusion of independent exogenous variables

in what is referred to as VARX modeling. This allows for the examination of the impact of the

staggered deployment of BWCs on the focal variables. The VAR/VARX analyses consist of two

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[5] Diagnoses of seasonality were confirmed utilizing the auto-ARIMA function in R 3.6.1
statistical software.

models. First, the five focal dependent variables (use of force rate, severity of force, citizen

complaint rate, substantiated complaint dispositions, and exonerated complaint dispositions) and

the two other system variables (calls for service rate, and self-initiated enforcement activity rate)

are examined as an endogenous system in a VAR (model 1). Second, the exogenous variables

(BWC proportion, Ferguson incident, and monthly average temperature) are added in a full

VARX model (model 2).

Utilization of VAR is contingent upon certain requirements. First, the variables contained

in the endogenous system must be cointegrated and stationary by the first difference. Second, all

the variables included in the model must have equivalent lags. Third, it is crucial that the optimal

lag length is examined. Lastly, the ordering of the endogenous system is important. Ensuring that

these requirements are met is crucial because, first, if the variables in the endogenous system are

nonstationary, the regression estimates may be spurious (c.f. Fanchon & Wendel, 1992; Sims,

1980). Second, inclusion of variables with different numbers of lags, and/or specifying too few

or too many lags may also produce erroneous regression estimates. Too many lags results in a

loss of degrees of freedom and multicollinearity, while too few lags may produce specification

errors (Adeleye, 2018). Third, the proper ordering of the endogenous variables in the system is

important as different ordering likely generates different results. Thus, like ARIMA modeling,

VAR requires a series of diagnostic tests and ordering determination per the prescribed schema.

First, testing for cointegration and stationarity of the variables to be included in the

endogenous "system" is required. In the current study cointegration of the endogenous system

variables is determined utilizing the Stata/IC 16.0 Johansen test for cointegration and the

augmented Dickey-Fuller test is utilized to confirm stationarity. Second, a vector autoregression

specification optimization test must be performed to select the optimal lag length for the analysis

by choosing the lowest appropriate information criterion value. The Stata/IC 16.0 vector autoregression specification optimization test (varsoc) generates four information criterion values, final prediction error (FPE), Akaike's information criterion (AIC), Hannan-Quinn information criterion (HQIC), and Schwartz-Bayesian information criterion (SBIC). According to a study conducted by Hacker and Abdulnasser (2008), the most reliable information criterion for optimal lag-length selection for VAR analyses is the Schwartz-Bayesian information criterion (SBIC). Thus, the SBIC values are used in the current study. Third, the correct ordering of the variables to be included in the endogenous system must be determined utilizing the Cholesky ordering method.

The Cholesky ordering method requires the analyst to identify the first and last variables listed in the system as follows. The first variable is the contemporaneous exogenous variable. It does not respond contemporaneously to impulses or shocks in any of the other variables, however, changes in the contemporaneous exogenous variable impacts every other variable in the system contemporaneously. The variable ordered last, referred to as the contemporaneous endogenous variable, reacts to all the other variables at time t, but the impact of changes in the contemporaneous endogenous variable is not manifest in the other system variables until t_1.

The current study includes the following five dependent variables: Use of force rate; severity of force (use of force incidents resulting in citizen injury); citizen complaint rate; substantiated complaint proportion; and exonerated complaint proportion, each of which are included in a VAR endogenous system along with calls for service rate and self-initiated enforcement activity rate. Calls for service rate is the obvious contemporaneous exogenous variable. It does not likely respond contemporaneously to impulses or shocks in the self-initiated enforcement activity rate, or any of the dependent variables to be included in the models. At the

other end of the spectrum, each of the dependent variables are the obvious contemporaneous

endogenous variable. Use of force rate, severity of force, citizen complaint rate, substantiated

complaint proportion, and exonerated complaint proportion are all likely to be impacted by the

endogenous system variables at time t, but the impact of changes in these dependent variables are

not likely to impact the other system variables until t_1. Thus, the Cholesky ordering of the

endogenous system in both the model 1 VAR and model 2 VARX analyses is as follows: First,

calls for service rate, second, self-initiated enforcement activity rate, and third, dependent

variable $y_{1,2,3,4,5}$. The exogenous regressor variables to be examined in the VARX analyses

include BWC proportion, the Ferguson incident, and the average monthly temperature.

Three post estimation tests are recommended for VAR analysis (Adeleye, 2018). First, a

Breusch–Godfrey serial correlation LM test should be conducted to ensure there is no

autocorrelation in the residual errors. Second, a Jarque-Bera test should be conducted to ensure

the errors are normally distributed, and lastly, a check of the stability of the VAR estimates

should be conducted ensuring the modulus of each eigenvalue is less than one.

In addition, the statistically significant b coefficients generated by the VAR/VARX

analyses are converted to Cohen' d to determine effect size utilizing Apel and Hsu's (2017)

formula as follows:

$$d = \beta \times \frac{1}{\sqrt{\dfrac{(T_{Pre} - 1) \cdot S^2_{YPre} + (T_{Post} - 1) \cdot S^2_{YPost}}{T_{Pre} + T_{Post} - 2}}}$$

In summary, the analysis is comprised of the examination of the descriptive statistics, the

diagnosis, specification, and estimation of the ARIMA models, and the specification, estimation,

and interpretation of the VAR/VARX models for each of the following dependent variables: use

of force rate, severity of force, citizen complaint rate, substantiated complaint proportion, and

exonerated complaint proportion. The results are reported in Chapter 4.

CHAPTER 4

RESULTS

Descriptive Statistics

Basis for calculated rates—regular patrol hours worked.

The regular patrol hours worked in a month ranged from 32,584.16 to 39,690.28 ($m =$ 35,764.78, $sd = 1,712.83$) and decreased 7.30% from the pre-BWC period to the post-BWC period. The descriptive statistics for the pre-BWC, BWC deployment, and post full BWC deployment periods of the study are contained in Table 4.1, and the time series is graphed in Figure 4.1. The time series graph shows the beginning of the downward trend coinciding with the beginning of BWC implementation.

Table 4.1: NNPD Monthly Regular Patrol Hours Descriptive Statistics (May 2010 – June 2017)

Period	*M*	*SD*	*Range*
Pre-BWC (May 2010 – April 2013)	36,741.14	1,003.77	34,750.66 – 38,737.02
BWC Deployment (May 2013 – June 2016)	35,378.04	1,803.41	32,584.16 – 39,690.28
Post-BWC (July 2016 – June 2017)	34,060.40	1,105.06	33,104.12 – 36,310.54

Notes: $n = 86$ months; $M =$ mean number of regular patrol hours worked in a month during corresponding period.

Notes: The solid horizontal line is the overall time series.
The red horizontal straight line is the overall trend.
The dashed horizontal lines are the pre- and post-BWC trend.
The horizontal green line is the number of BWCs deployed.
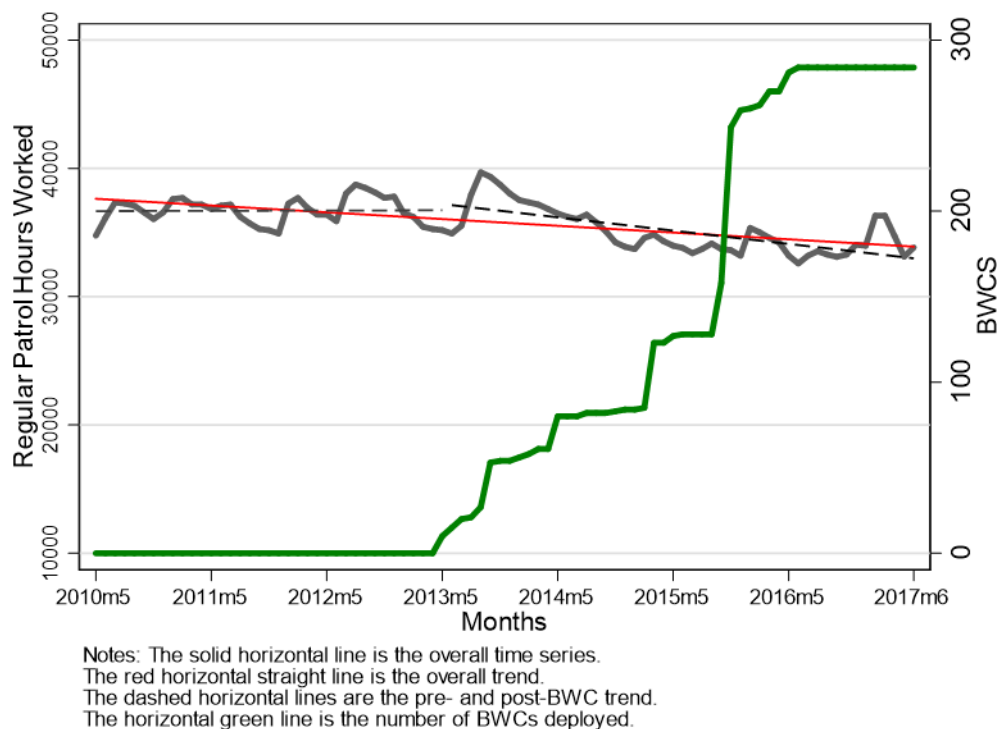
Figure 4.1: NNPD Monthly Regular Patrol Hours Worked (May 2010 – June 2017)

Dependent variable—use of force rate.

The monthly use of force rate ranged between 0.030 and 0.589 per 1,000 regular patrol hours worked ($m = 0.266$, $sd = 0.118$) and the pre-BWC and post-BWC period means reflect a decrease of 58.01%. The descriptive statistics for the pre-BWC, BWC deployment, and post full BWC deployment periods of the study are contained in Table 4.2, and the time series is graphed in Figure 4.2. The time series graph indicates an overall downward trend during the 86-month period under examination, however, a clear decline is observed in the BWC implementation and post BWC period trend line compared to that of the pre-BWC period.

Table 4.2: NNPD Monthly Use of Force Rate per 1,000 Regular Patrol Hours Worked Descriptive Statistics (May 2010 – June 2017)

Period	*#UOF*	*M*	*SD*	*Range*
Pre-BWC (May 2010 – April 2013)	437	0.331	0.090	0.159 – 0.518
BWC Deployment (May 2013 – June 2016)	330	0.243	0.115	0.030 – 0.589
Post BWC (July 2016 – June 2017)	57	0.139	0.048	0.059 – 0.211

Notes: *n* = 86 months; *#UOF* is the number of use of force incidents that occurred during the corresponding period; *M, SD, and Range* = rate per 1,000 regular patrol hours worked in a month during the corresponding period.

Notes: The solid horizontal line is the overall time series.
The red horizontal straight line is the overall trend.
The dashed horizontal lines are the pre- and post-BWC trend.
The horizontal green line is the number of BWCs deployed.
*Rate per 1,000 regular patrol hours worked.

Figure 4.2: NNPD Monthly Use of Force Rate per 1,000 Regular Patrol Hours Worked (May 2010 – June 2017)

Dependent variable—severity of force (citizen injuries).

The monthly severity of force measure (monthly proportion of use of force incidents resulting in citizen injury requiring medical attention) ranged from 0.000 to 1.000 ($m = 0.473$, $sd = 0.194$) and the data indicates a nominal decrease of 0.62% between the pre-BWC and post-BWC periods. The descriptive statistics for the pre-BWC, BWC deployment, and post full BWC deployment periods of the study are contained in Table 4.3, and the time series is graphed in Figure 4.3. The overall trend line shows the proportion of use of force incidents resulting in citizen injury remained relatively stable; however, a downward trend is observed in the pre-BWC period, and conversely, an upward trend beginning with BWC implementation.

Table 4.3: NNPD Monthly Proportion of Use of Force Incidents Resulting in Citizen Injury Descriptive Statistics (May 2010 – June 2017)

Period	#UOF	#Injured	M	SD	Range
Pre-BWC (May 2010 – April 2013)	437	207	0.482	0.160	0.154 – 0.857
BWC Deployment (May 2013 – June 2016)	330	156	0.463	0.216	0.000 – 1.000
Post-BWC (July 2016 – June 2017)	57	25	0.479	0.209	0.250 – 1.000

Notes: $n = 86$ months; *#UOF* is the number of use of force incidents that occurred during the corresponding period; *#Injured* is the number of citizens injured as a result of use of force incidents during the corresponding period. *M, SD, and Range* = proportion of use of force incidents resulting in citizen injuries that required medical attention during the corresponding period.
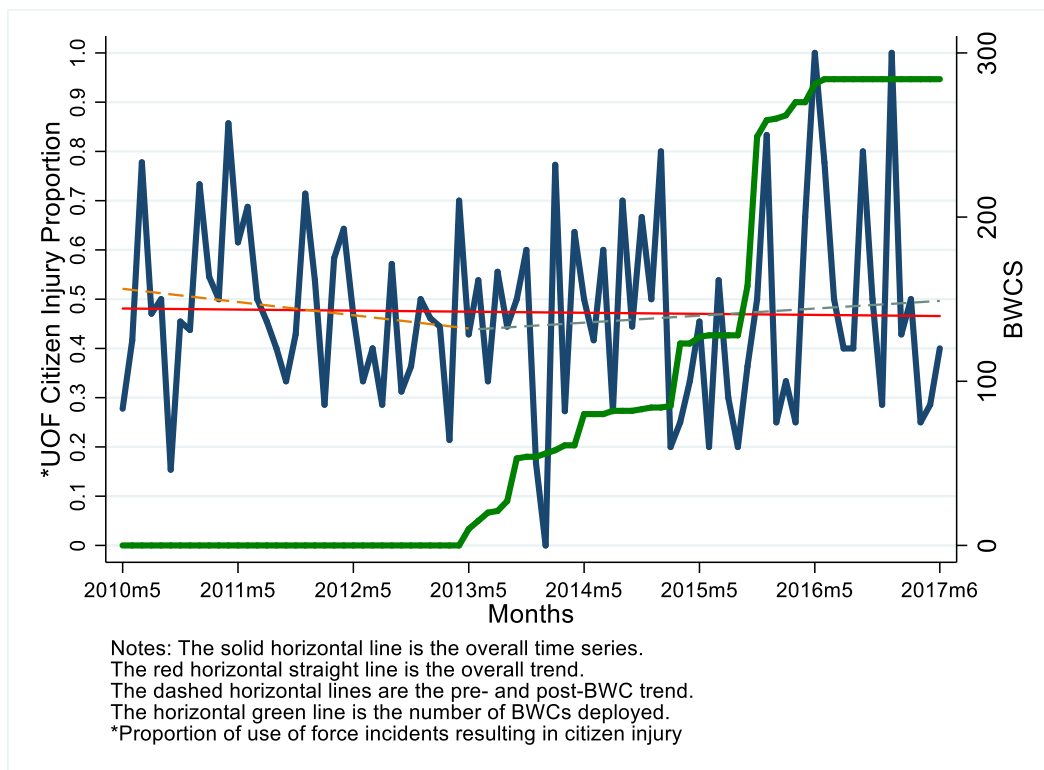
Figure 4.3: NNPD Monthly Proportion of Use of Force Incidents Resulting in Citizen Injury (May 2010 – June 2017)

Dependent variable—citizen complaint rate.

The monthly citizen complaint rate ranged between 0.000 and 0.944 per 1,000 regular patrol hours worked (*m* = 0.408, *sd* = 0.198) and the pre-BWC and post-BWC period means reflect a decrease of 47.39%. The descriptive statistics for the pre-BWC, BWC deployment, and post full BWC deployment periods of the study are contained in Table 4.4, and the time series is graphed in Figure 4.4. While the graph indicates an overall downward trend, a stark contrast is observed between the pre-BWC period and after BWC implementation began. The graph indicates a marked trend of increasing citizen complaints during the pre-BWC period, followed by a notable decreasing trend during the BWC implantation and post-BWC periods.

Table 4.4: NNPD Monthly Citizen Complaint Rate per 1,000 Regular Patrol Hours Worked Descriptive Statistics (May 2010 – June 2017)

Period	# of Complaints	# of Allegations	M	SD	Range
Pre-BWC (May 2010 – April 2013)	660	821	0.498	0.172	0.109 – 0.944
BWC Deployment (May 2013 – June 2016)	502	588	0.368	0.203	0.000 – 0.907
Post-BWC (July 2016 – June 2017)	107	167	0.262	0.088	0.120 – 0.361

Notes: *n* = 86 months; *# of Complaints* is the number of citizen complaints that were filed against officers during the corresponding period; *# of Allegations* is the number of allegations contained in the filed complaints during the corresponding period; *M, SD,* and *Range* = rate per 1,000 regular patrol hours worked in a month during the corresponding period.

Notes: The solid horizontal line is the overall time series.
The red horizontal straight line is the overall trend.
The dashed horizontal lines are the pre- and post-BWC trend.
The horizontal green line is the number of BWCs deployed.
*Rate per 1,000 regular patrol hours worked.
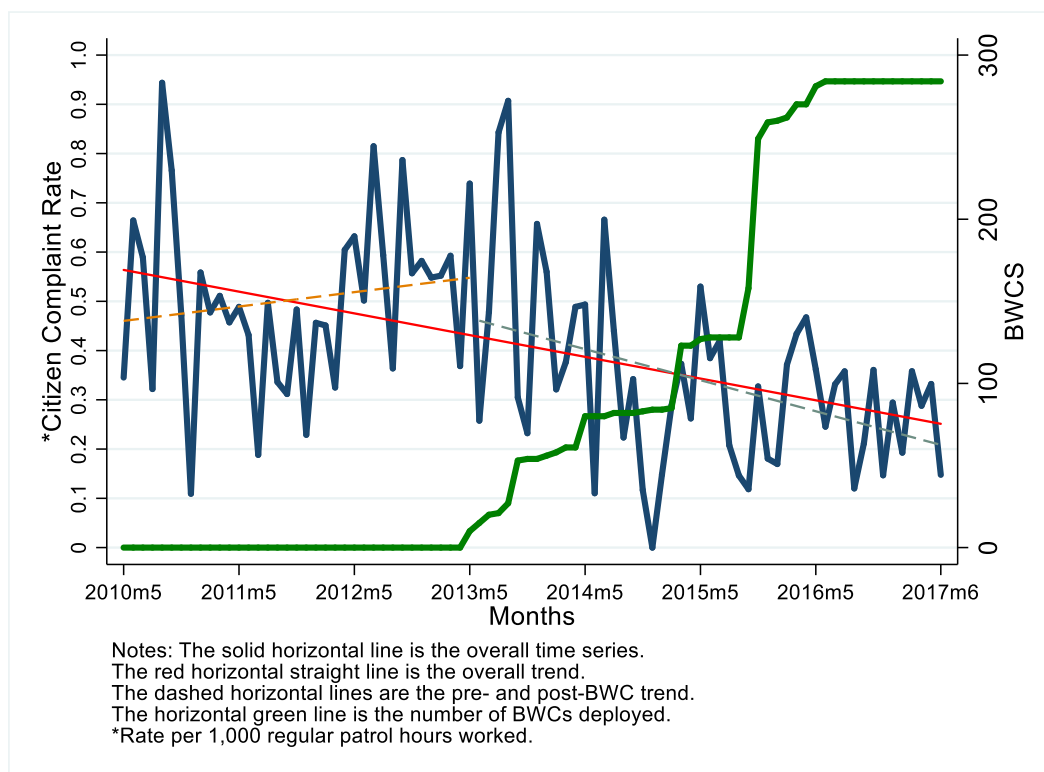
Figure 4.4: NNPD Monthly Citizen Complaint Rate per 1,000 Regular Patrol Hours Worked (May 2010 – June 2017)

Dependent variable—citizen complaint disposition proportions.

The monthly proportion ranges, means, and standard deviations for each of the four

citizen complaint dispositions for the 86-month period under examination are as follows:

Unfounded allegations ranged between 0.000 and 1.000 (m =0.504, sd = 0.233), decreasing by

19.20% between the pre-BWC and post-BWC periods; not substantiated allegations ranged

between 0.000 and 0.692 (m =0.162, sd = 0.156), decreasing by 40.00% between the pre-BWC

and post-BWC periods; substantiated allegations ranged between 0.000 and 0.700 (m =0.122, sd

= 0.142), increasing by 40.35% between the pre-BWC and post-BWC periods; and exonerated

allegations ranged between 0.000 and 0.500 (m =0.101, sd = 0.111), increasing by 115.38%

between the pre-BWC and post-BWC periods. The descriptive statistics for the pre-BWC, BWC

deployment, and post full BWC deployment periods of the study are contained in Table 4.5, and

the time series are graphed in Figures 4.5, 4.6, 4.7, and 4.8 respectively. The graphs show an

overall downward trend in unfounded dispositions, not substantiated dispositions remained

relatively stable, and increasing trends in substantiated and exonerated dispositions.

Table 4.5: NNPD Monthly Citizen Complaint Disposition Proportion Descriptive Statistics (May 2010 – June 2017)

Period	*Unfounded*	*Not Substantiated*	*Substantiated*	*Exonerated*
Pre-BWC (May 2010 – April 2013)	0.526	0.150	0.171	0.078
BWC Deployment (May 2013 – June 2016)	0.504	0.109	0.156	0.106
Post-BWC (July 2016 – June 2017)	0.425	0.090	0.240	0.168

Notes: n = 86 months; *Unfounded, Not Substantiated, Substantiated,* and *Exonerated* are the proportions of citizen complaint allegations that received the respective disposition during the corresponding period; Rows may not total 1.000 due to citizen complaints withdrawn or dismissed due to a complainant's failure to cooperate.
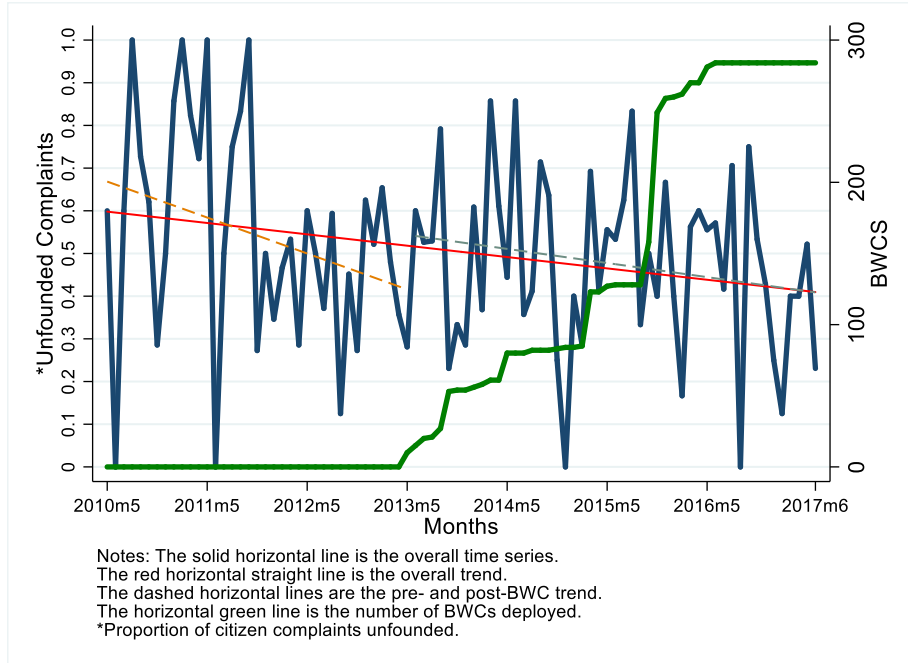
Figure 4.5: NNPD Monthly Proportion of Unfounded Citizen Complaints (May 2010 – June 2017)
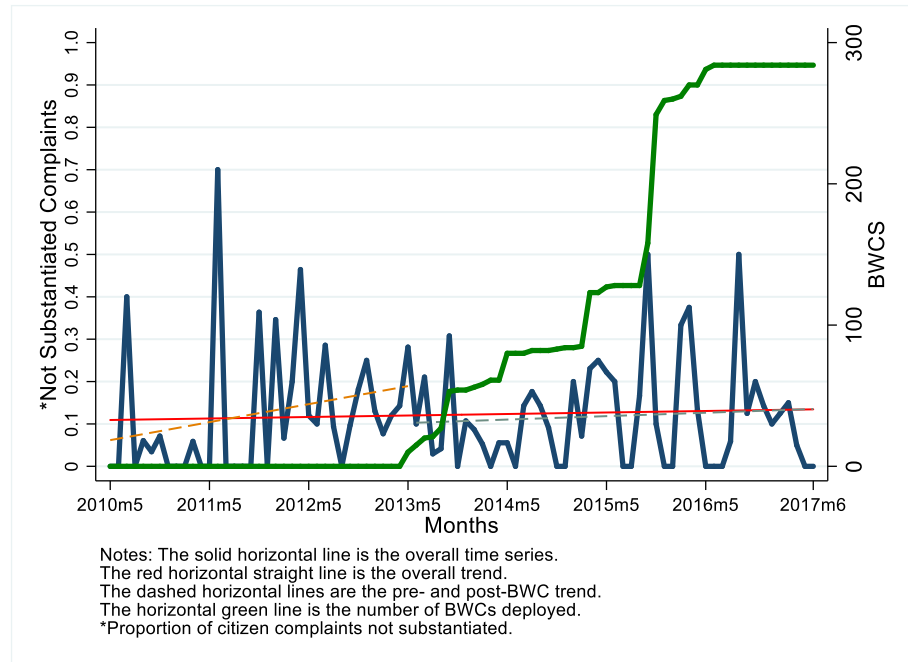
Figure 4.6: NNPD Monthly Proportion of Not Substantiated Citizen Complaints (May 2010 – June 2017)

Notes: The solid horizontal line is the overall time series.
The red horizontal straight line is the overall trend.
The dashed horizontal lines are the pre- and post-BWC trend.
The horizontal green line is the number of BWCs deployed.
*Proportion of citizen complaints substantiated.
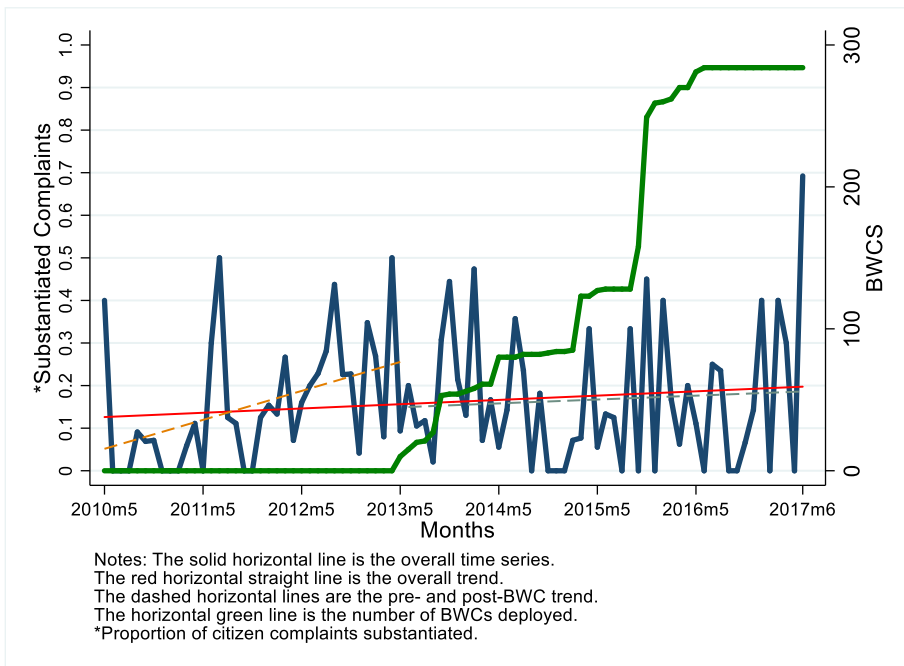
Figure 4.7: NNPD Monthly Proportion of Substantiated Citizen Complaints (May 2010 – June 2017)

Notes: The solid horizontal line is the overall time series.
The red horizontal straight line is the overall trend.
The dashed horizontal lines are the pre- and post-BWC trend.
The horizontal green line is the number of BWCs deployed.
*Proportion of citizen complaints exonerated.
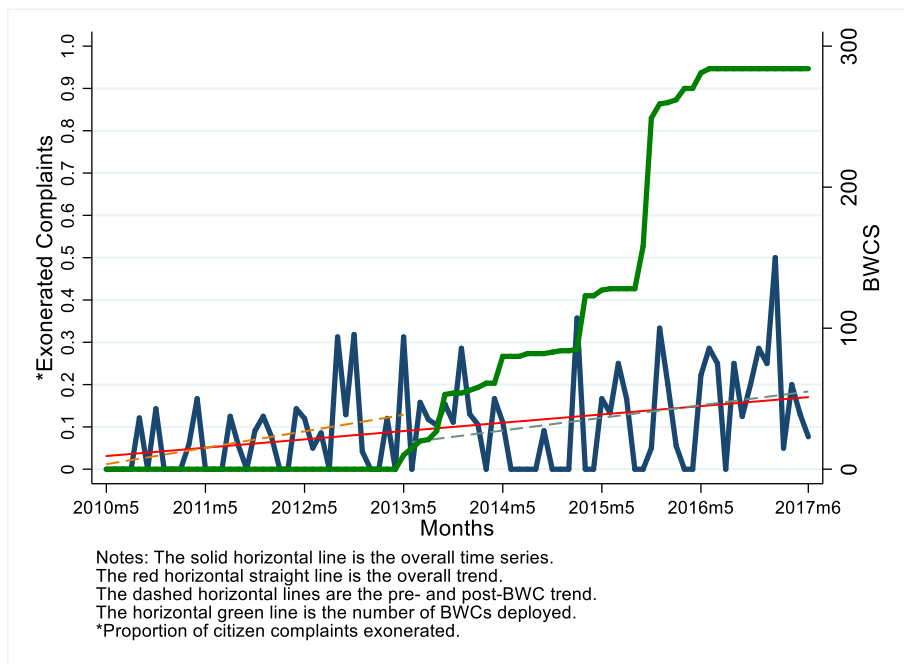
Figure 4.8: NNPD Monthly Proportion of Exonerated Citizen Complaints (May 2010 – June 2017)

Independent variable—BWCs.

The descriptive statistics of NNPD's 38-month staggered deployment of 284 BWCs

(May 2013 – Jun 2016) to all patrol personnel are contained in Table 4.6.

Table 4.6: NNPD BWC Deployment Descriptive Statistics (May 2010 – June 2017)

Period/Month	# of Additional Officers BWC Equipped	Total BWCs Deployed	Proportion of Full Deployment (284)
May 2010 – Apr 2013	0	0	0.000
May 2013	10	10	0.035
Jun 2013	5	15	0.053
Jul 2013	15	20	0.070
Aug 2013	1	21	0.074
Sep 2013	6	27	0.095
Oct 2013	26	53	0.187
Nov 2013	1	54	0.190
Dec 2013	0	54	0.190
Jan 2014	2	56	0.197
Feb 2014	2	58	0.204
Mar 2014	3	61	0.215
May 2014	19	80	0.282
Aug 2014	2	82	0.289
Sep 2014	0	82	0.289
Oct 2014	0	82	0.289
Nov 2014	1	83	0.292

Period/Month	# of Additional Officers BWC Equipped	Total BWCs Deployed	Proportion of Full Deployment (284)
Dec 2014	1	84	0.296
Jan 2015	0	84	0.296
Feb 2015	1	85	0.299
Mar 2015	38	123	0.433
Apr 2015	0	123	0.433
May 2015	4	127	0.447
Jun 2015	1	128	0.451
Jul 2015	0	128	0.451
Aug 2015	0	128	0.451
Sep 2015	0	128	0.451
Oct 2015	30	158	0.556
Nov 2015	91	249	0.877
Dec 2015	10	259	0.912
Jan 2016	1	260	0.915
Feb 2016	2	262	0.923
Mar 2016	8	270	0.951
Apr 2016	0	270	0.951
May 2016	11	281	0.989
Jun 16	3	284	1.000
Jul 2016 – Jun 2017	0	284	1.000

Notes: n = 86 months: 36-months pre-BWC (May 2010 – April 2013); 38-month incremental BWC deployment period (May 2013 – June 2016); 12-month post-BWC period (July 2016 - June 2017).

Control variable—self-initiated enforcement activity rate.

The monthly self-initiated enforcement activity rate ranged between 85.717 and 223.033

per 1,000 regular patrol hours worked ($m = 148.395$, $sd = 35.920$) and the pre-BWC and post-

BWC period means reflect a decrease of 43.83%. The descriptive statistics for the pre-BWC,

BWC deployment, and post full BWC deployment periods of the study are contained in Table

4.7, and the time series is graphed in Figure 4.9. The latter shows a slight downward trend during

the pre-BWC period, which became more pronounced at the beginning of BWC implementation.

Table 4.7: NNPD Monthly Self-Initiated Enforcement Activity Rate per 1,000 Regular Patrol Hours Worked Descriptive Statistics (May 2010 – June 2017)

Period	*M*	*SD*	*Range*
Pre-BWC (May 2010 – April 2013)	181.032	16.742	153.526 – 223.033
BWC Deployment (May 2013 – Jun 2016)	132.224	25.157	95.579 – 191.043
Post-BWC (Jul 2016 – June 2017)	101.693	9.470	85.717 – 120.383

Notes: $n = 86$ months; *M, SD,* and *Range* = rate per 1,000 regular patrol hours worked in a month during the corresponding period.

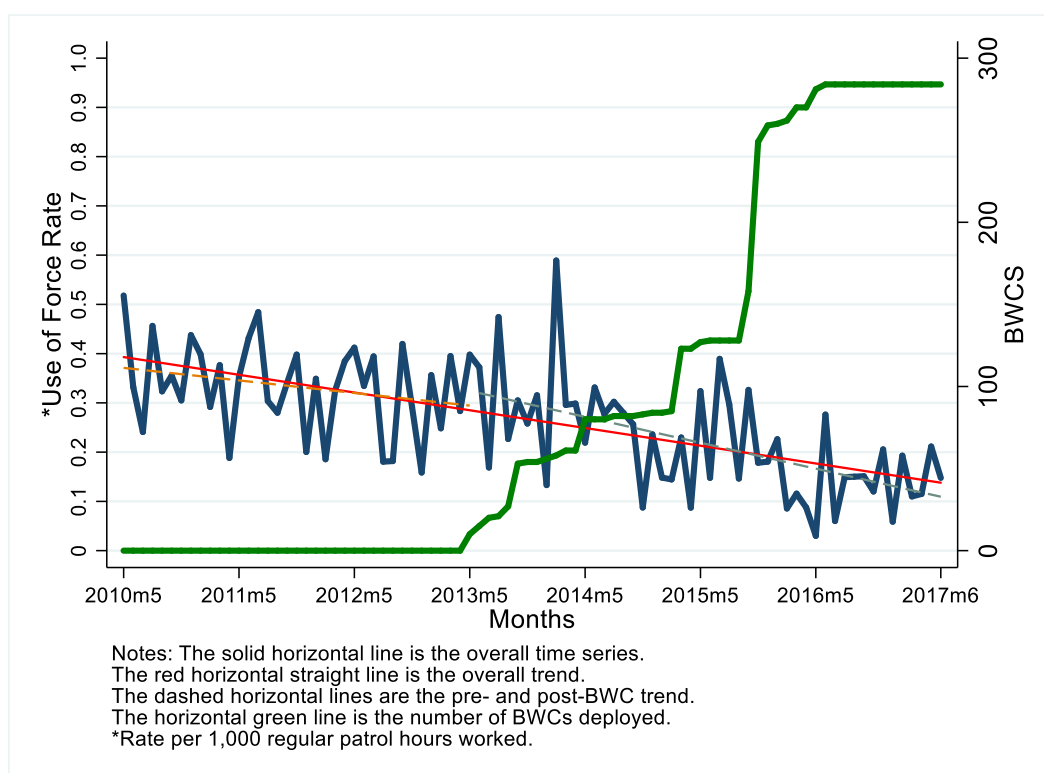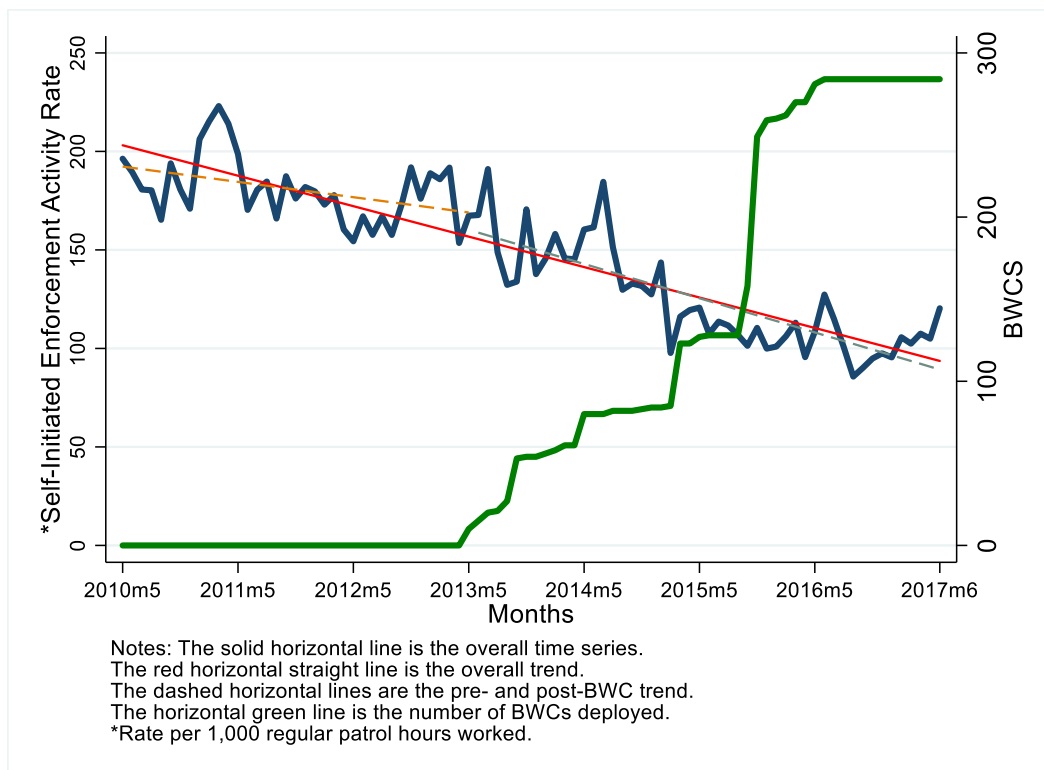**Figure 4.9: NNPD Monthly Self-Initiated Enforcement Activity Rate per 1,000 Regular Patrol Hours Worked (May 2010 – June 2017)**

Control variable—calls for service rate.

The monthly calls for service rate ranged between 269.653 and 517.487 per 1,000 regular patrol hours worked ($m = 355.734$, $sd = 39.272$) and the pre-BWC and post-BWC period means reflect a decrease of 5.70%. The descriptive statistics for the pre-BWC, BWC deployment, and post full BWC deployment periods of the study are contained in Table 4.8, and the time series is graphed in Figure 4.10. The graph indicates a slight downward trend overall.

Table 4.8: NNPD Monthly Calls for Service Rate per 1,000 Regular Patrol Hours Worked Descriptive Statistics (May 2010 – June 2017)

Period	M	SD	Range
Pre-BWC (May 2010 – April 2013)	366.835	44.129	285.585 – 517.487
BWC Deployment (May 2013 – Jun 2016)	348.313	33.110	278.604 – 406.424
Post-BWC (Jul 2016 – June 2017)	345.930	31.152	269.653 – 389.235

Notes: $n = 86$ months; *M, SD,* and *Range* = rate per 1,000 regular patrol hours worked in a month during the corresponding period.

Notes: The solid horizontal line is the overall time series.
The red horizontal straight line is the overall trend.
The dashed horizontal lines are the pre- and post-BWC trend.
The horizontal green line is the number of BWCs deployed.
*Rate per 1,000 regular patrol hours worked.
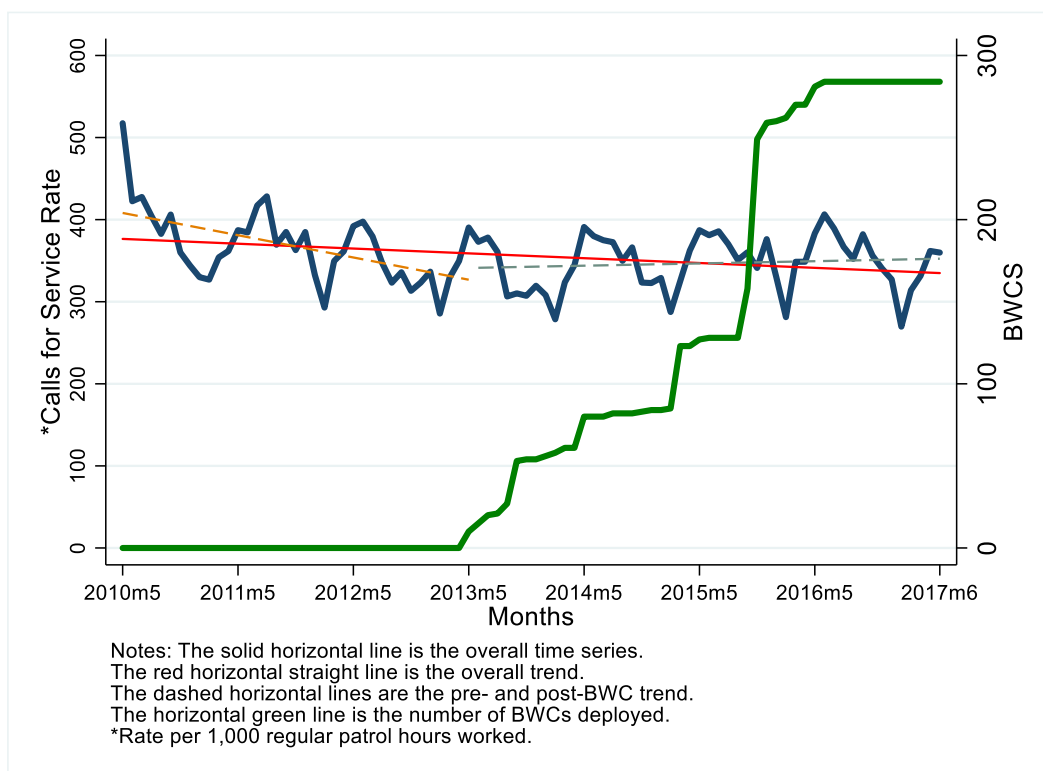
Figure 4.10: NNPD Monthly Calls for Service Rate per 1,000 Regular Patrol Hours Worked (May 2010 – June 2017)

Control variable—average monthly temperature.

The monthly average temperature ranged between 33.10° Fahrenheit and 81.64° Fahrenheit during the 86-month period under examination ($m = 60.76$, $sd = 14.17$). The descriptive statistics are contained in Table 4.9.

Table 4.9: Monthly Average Temperatures in Newport News, Virginia (May 2010 – June 2017)

Month	Temp	Month	Temp	Month	Temp	Month	Temp
05/2010	69.91	03/2012	56.67	01/2014	38.04	11/2015	54.42
06/2010	79.17	04/2012	57.63	02/2014	42.13	12/2015	53.81
07/2010	81.02	05/2012	68.35	03/2014	47.32	01/2016	38.51
08/2010	77.82	06/2012	72.50	04/2014	60.15	02/2016	42.94
09/2010	73.57	07/2012	80.94	05/2014	70.20	03/2016	53.97
10/2010	61.05	08/2012	76.82	06/2014	77.93	04/2016	56.584
11/2010	49.22	09/2012	69.77	07/2014	80.18	05/2016	64.02
12/2010	33.10	10/2012	60.71	08/2014	78.06	06/2016	73.64
01/2011	33.84	11/2012	46.73	09/2014	74.67	07/2016	80.38
02/2011	43.95	12/2012	48.62	10/2014	65.26	08/2016	80.01
03/2011	47.91	01/2013	43.45	11/2014	49.60	09/2016	74.51
04/2011	61.22	02/2013	43.34	12/2014	46.00	10/2016	62.47
05/2011	67.32	03/2013	45.53	01/2015	40.21	11/2016	49.49
06/2011	75.38	04/2013	60.52	02/2015	34.06	12/2016	43.07
07/2011	79.70	05/2013	68.55	03/2015	48.43	01/2017	43.28
08/2011	77.34	06/2013	74.58	04/2015	61.21	02/2017	49.03
09/2011	72.03	07/2013	81.64	05/2015	72.73	03/2017	48.60
10/2011	58.72	08/2013	77.38	06/2015	80.49	04/2017	64.32
11/2011	52.65	09/2013	71.49	07/2015	78.65	05/2017	65.85
12/2011	47.22	10/2013	64.34	08/2015	76.24	06/2017	75.25
01/2012	43.73	11/2013	50.87	09/2015	72.57		
02/2012	44.61	12/2013	46.94	10/2015	59.50		

Notes: n = 86 months; Source: Weather Underground website: https://www.wunderground. com/ history/daily/us/va/newport-news/KPHF

t **Tests**

The first stage of the analysis consisted of *t* tests to examine each of the dependent variables for significant differences between the pre-BWC, BWC deployment, and post-BWC period means. Cohen's *d* was then calculated for each t test result to examine the effect sizes. The results of the t tests and corresponding Cohen's *d* are presented in Table 4.10.

Table 4.10: Dependent Variable *t* Test Results and Effect Sizes for pre-BWC vs. BWC Deployment vs. Post-BWC Periods

Variable	Period	*M*	Mean Difference	*t*	Cohen's *d*
Use of Force Rate	Pre-BWC (May 2010 – April 2013)	0.331			
	vs.		0.088	3.585**	0.84
	BWC Deployment (May 2013 – June 2016)	0.243			
	BWC Deployment (May 2013 – June 2016)	0.243			
	vs.		0.104	4.369***	1.16
	Post-BWC (July 2016 – June 2017)	0.139			
	Pre-BWC (May 2010 – April 2013)	0.331			
	vs.		0.192	9.149***	2.61
	Post-BWC (July 2016 – June 2017)	0.139			
Severity of Force	Pre-BWC (May 2010 – April 2013)	0.482			
	vs.		0.019	0.425	0.10
	BWC Deployment (May 2013 – June 2016)	0.463			
	BWC Deployment (May 2013 – June 2016)	0.463			
	vs.		-0.016	-0.221	0.07
	Post-BWC (July 2016 – June 2017)	0.479			

Variable	Period	*M*	Mean Difference	*t*	Cohen's *d*
	Pre-BWC (May 2010 – April 2013)	0.482			
	vs.		0.003	0.053	0.02
	Post-BWC (July 2016 – June 2017)	0.479			
Citizen Complaint Rate	Pre-BWC (May 2010 – April 2013)	0.498			
	vs.		0.129	2.903**	0.68
	BWC Deployment (May 2013 – June 2016)	0.368			
	BWC Deployment (May 2013 – June 2016)	0.368			
	vs.		0.106	2.493*	0.67
	Post-BWC (July 2016 – June 2017)	0.262			
	Pre-BWC (May 2010 – April 2013)	0.498			
	vs.		0.236	4.452***	1.69
	Post-BWC (July 2016 – June 2017)	0.262			
Substantiated Complaint Dispositions	Pre-BWC (May 2010 – April 2013)	0.171			
	vs.		0.002	0.046	0.01
	BWC Deployment (May 2013 – June 2016)	0.156			
	BWC Deployment (May 2013 – June 2016)	0.156			
	vs.		-0.054	-0.999	0.29
	Post-BWC (July 2016 – June 2017)	0.240			
	Pre-BWC (May 2010 – April 2013)	0.171			
	vs.		-0.052	-0.934	0.28
	Post-BWC (July 2016 – June 2017)	0.240			

Variable	Period	M	Mean Difference	t	Cohen's d
Exonerated Complaint Dispositions	Pre-BWC (May 2010 – April 2013)	0.078			
	vs.		-0.044	-1.912	0.44
	BWC Deployment (May 2013 – June 2016)	0.106			
	BWC Deployment (May 2013 – June 2016)	0.106			
	vs.		-0.086	-2.236*	0.71
	Post-BWC (July 2016 – June 2017)	0.168			
	Pre-BWC (May 2010 – April 2013)	0.078			
	vs.		-0.130	-3.986***	1.17
	Post-BWC (July 2016 – June 2017)	0.168			
Calls for Service Rate	Pre-BWC (May 2010 – April 2013)	366.835			
	vs.		18.522	2.021*	0.47
	BWC Deployment (May 2013 – June 2016)	348.313			
	BWC Deployment (May 2013 – June 2016)	348.313			
	vs.		2.382	0.216	0.07
	Post-BWC (July 2016 – June 2017)	345.930			
	Pre-BWC (May 2010 – April 2013)	366.835			
	vs.		20.904	1.488	0.53
	Post-BWC (July 2016 – June 2017)	345.930			
Self-Initiated Enforcement Activity Rate	Pre-BWC (May 2010 – April 2013)	181.032			
	vs.		48.808	9.637***	2.25
	BWC Deployment (May 2013 – June 2016)	132.224			

Variable	Period	M	Mean Difference	t	Cohen's d
	BWC Deployment (May 2013 – June 2016)	132.224			
	vs.		30.531	6.075***	1.58
	Post-BWC (July 2016 – June 2017)	101.693			
	Pre-BWC (May 2010 – April 2013)	181.032			
	vs.		79.339	15.276***	5.71
	Post-BWC (July 2016 – June 2017)	101.693			

Notes: $*p < 0.05$; $**p < 0.01$; $***p < 0.001$

The *t* test results reported in Table 4.10 indicate statistically significant reductions in the pre-BWC vs. BWC deployment and the BWC deployment vs. post-BWC period use of force rate means. The corresponding Cohen's *d* values of 0.837 and 1.158 indicate large and very large effect sizes respectively.[6] The calculated Cohen's *d* of 2.606 for the statistically significant pre-BWC vs. Post-BWC *t* test result indicates a huge effect size associated with the overall 58 percent reduction in the use of force rate between the pre-BWC and post-BWC periods. While the *t* tests indicated no statistically significant changes in the pre-BWC, deployment, and post-BWC period severity of force means, the increase in the proportion of use of force incidents resulting in citizen injury between the BWC deployment and post-BWC periods is noteworthy.

In terms of citizen complaint measures, the t test results indicate statistically significant reductions in the pre-BWC vs. BWC deployment, and the BWC deployment vs. Post-BWC period citizen complaint rate means. The corresponding Cohen's *d* values of 0.677 and 0.667 respectively indicate a medium effect size. Like the use of force rate pre-BWC vs. post-BWC *t*

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[6] Cohen (1988) defined a small effect size as $d = 0.20$ or less, medium effect size as $d > .20$ and < 0.80, and large effect size as $d \geq 0.80$. Sawilowsky (2009) expanded Cohen's scale to include very large as $d \geq 1.20$ and huge ≥ 2.00.

test result, the calculated Cohen's *d* of 1.688 for the statistically significant pre-BWC vs. post-BWC citizen complaint rate indicates a huge effect size associated with the overall reduction of more than 47 percent. While the *t* tests indicated no statistically significant differences in the pre-BWC, BWC deployment, post-BWC, or the pre-BWC vs. post-BWC means of substantiated complaint dispositions, nor in the difference between the pre-BWC and BWC deployment means of exonerated complaint dispositions, there was a statistically significant increase between the BWC deployment and post-BWC periods for the latter, and the calculated Cohen's *d* of 0.705 indicates a medium effect size. Furthermore, the calculated Cohen's d of 1.172 for the statistically significant pre-BWC vs. post-BWC exonerated complaint disposition reflects a very large effect size associated with the overall increase in exonerations of more than 115 percent.

Lastly, *t* tests were conducted on the two additional variables included in the VAR/VARX endogenous system, calls for service rate and self-initiated enforcement activity rate. The *t* test results indicated a statistically significant reduction in the calls for service rate between the pre-BWC and BWC deployment periods. However, the results showed no statistically significant differences between the BWC deployment period and the post-BWC period, nor between the pre-BWC and post-BWC periods, which suggests that calls for service remained relatively stable over the entire 86-month period under examination. The *t* test results for the self-initiated enforcement activity rate indicated statistically significant reductions between all three periods with huge effect size of 2.25 and very large effect size of 1.58 respectively. The statistically significant *t* test result for the nearly 44 percent decrease in the self-initiated enforcement activity rate between the pre-BWC and post-BWC periods generated a Cohen's *d* of 5.71, also indicating a huge effect size.

ARIMA Diagnostics of Dependent Variables

    Use of force rate.

    A downward trend is observed in the plot of the pre-intervention series (Figure 4.2) and the autocorrelation (AC) plot reflects a slow decay to zero (Appendix A). However, the significant result of an augmented Dickey-Fuller test (Appendix A) indicates no unit root. The spikes outside the 95% confidence level of early lags in the autocorrelation (AC) plot indicates potential specification of MA (q) = 1 or 2 and a partial autocorrelation (PAC) plot (Appendix A) reveals both spikes outside of the 95% confidence level in early lags indicating the potential need for an AR (p) = 1 or 2 specification. No indication of a seasonal pattern was observed in the plots of the lags.

    Notwithstanding the significant augmented Dickey-Fuller test, the correlogram indicated a slow decay to zero in the AC plot and differencing was required to achieve white-noise in the pre-series (d = 1 eliminated the trend). L1 of the MA (q) specification was significant and retained (q = 1), however, L1 of the AR (p) was not significant therefore not retained (p = 0). A check for a SARIMA model found no fit for the data to a seasonal component. Thus, the final ARIMA model for use of force rate was specified (0, 1, 1). A correlogram (Appendix A) confirmed this specification produces a stationary pre-series (white noise) and insignificant q statistics.

    Severity of force.

    Figure 4.3 shows a downward trend in the severity of force variable (monthly proportion of use of force incidents resulting in citizen injury). However, the autocorrelation (AC) plot does not reflect a slow decay to zero (Appendix A), and the significant result of an augmented Dickey-Fuller test (Appendix A) indicates no unit root. The lack of significant spikes in early

lags of the autocorrelation (AC) plot suggests an MA (q) = 0, while a partial autocorrelation (PAC) plot (Appendix A) reveals 2 spikes outside of the 95% confidence level at lags 12, 16, and 24, indicating the potential need for an AR (p) specification, and/or for a seasonal pattern.

Neither the L1 of the AR (p), nor the L1 of the MA (q) specifications were significant. Therefore, neither were retained (p = 0 and q = 0 respectively). A check for a SARIMA model found no fit for the data to a seasonal component. Thus, the final ARIMA model for citizen complaint rate was specified (0, 0, 0). A correlogram (Appendix A) confirmed this specification produces a stationary pre-series (white noise) and insignificant q statistics.

Citizen complaint rate.

An upward trend is observed in the plot of the pre-intervention series of the citizen complaint rate (Figure 4.4), and the autocorrelation (AC) plot (Appendix A) shows a slow decay to zero indicating a trend. The result of an augmented Dickey-Fuller test (Appendix A) also indicates that there is a unit root requiring differencing (d = 1). The autocorrelation (AC) plot indicates spikes above the 95% confidence level in early lags, as does the partial auto correlation (PAC) (Appendix A), indicating the potential need for specification of MA (q) = 1 or 2 and AR (p) = 1 or 2 respectively. No seasonal pattern was detected in the plots of the lags.

The differencing (d = 1) eliminated the trend and both L1 and L2 of the AR (p) specification were significant and retained. (p = 2). An MA (q) = 1 specification was not significant and, therefore, was specified as q = 0. A check for a SARIMA model found no fit for the data to a seasonal component. Thus, the final ARIMA model for citizen complaint rate was specified (2, 1, 0). A correlogram (Appendix A) confirmed this specification produces a stationary pre-series (white noise) and insignificant q statistics.

Substantiated complaint disposition.

Figure 4.7 shows an upward trend in substantiated complaints. However, the autocorrelation (AC) plot does not reflect a slow decay to zero (Appendix A), and the significant result of an augmented Dickey-Fuller test (Appendix A) indicates no unit root and therefore no need for differencing (d = 0). The lack of significant spikes in early lags of the autocorrelation (AC) plot suggests an MA (q) = 0, while a partial autocorrelation (PAC) plot (Appendix A) reveals 2 spikes outside of the 95% confidence level at lags 14 and 20, indicating the potential need for an AR (p) specification, and/or for a seasonal pattern.

L1 of the AR (p) specification was insignificant and therefore not retained (p = 0). A check for a SARIMA model found no fit for the data to a seasonal component. Thus, the final ARIMA model for substantiated complaint disposition proportion was specified (0, 0, 0). A correlogram (Appendix A) confirmed this specification produces a stationary pre-series (white noise) and insignificant q statistics.

Exonerated complaint disposition.

While an upward trend was indicated in the plot of the pre-intervention series by the pre-intervention trend line (Figure 4.8), the AC plot (Appendix A) does not reflect a slow decay to zero and the results of an augmented Dickey-Fuller test (Appendix A) were significant, indicating that the pre-series was stationary (no unit root) and that differencing was not required (d = 0). The significant spike at lag 5 in the AC plot indicates the potential need for an MA (q) specification of 1, and the PAC plot (Appendix A) reveals 2 spikes outside of the 95% confidence level at lags 5, 13, 14, 19, and 24 indicating the potential need for an AR (p) specification, and/or for a seasonal pattern.

Notwithstanding the significant augmented Dickey-Fuller test, a correlogram indicated a slow decay to zero in the AC plot and differencing was required to achieve white-noise in the pre-series (d = 1 eliminated the trend). L1 of the MA (q) specification was significant and retained (q = 1), however, L1 of the AR (p) was not significant therefore not retained (p = 0). A check for a SARIMA model found no fit for the data to a seasonal component. Thus, the final ARIMA model for exonerated complaint disposition proportion was specified (0, 1, 1). A correlogram (Appendix A) confirmed this specification produces a stationary pre-series (white noise) and insignificant q statistics.

ARIMA Results

The results of the ARIMA models for each of the outcome variables are presented in Table 4.10. The results demonstrate a poor fit of the data to ARIMA models with insignificant Wald statistics for all but the citizen complaint rate and substantiated complaint proportion. As shown in Table 4.10, BWCs failed to emerge as a significant predictor of any of the dependent variables notwithstanding the 50 months following the beginning of BWC implementation. This is likely due to the failure to capture the impact of the incremental deployment of BWCs, for which VAR analysis is ideal.

Table 4.11: ARIMA Model 1 Results

Dependent Variable	Wald X^2	Independent Variable	b	SE
Use of Force Rate ARIMA (0, 1, 1)	2.69 ($p = 0.261$)	BWCs	0.061	0.044
Severity of Force ARIMA (0, 0, 0)	0.11 ($p = 0.741$)	BWCs	-0.015	0.047
Citizen Complaint Rate ARIMA (2, 1, 0)	65.51 ($p < 0.000$)	BWCs	0.079	0.122
Substantiated Complaints ARIMA (0, 0, 0)	67.31 ($p < 0.000$)	BWCs	0.011	0.035
Exonerated Complaints ARIMA (0, 1, 1)	0.320 ($p = 0.854$)	BWCs	-0.023	0.041

Notes: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

VAR/VARX Diagnostics and Results

As described in the analytic plan presented in Chapter 3, the VAR/VARX analyses consist of two models. First, the five focal dependent variables (use of force rate, severity of force, citizen complaint rate, substantiated complaint dispositions, and exonerated complaint dispositions) and the two other system variables (calls for service rate, and self-initiated enforcement activity rate) are examined as an endogenous system in a VAR (model 1). Second, the exogenous variables (BWC proportion, Ferguson incident, and monthly average temperature) are added in a full VARX model (model 2). A Johansen test for cointegration was conducted on all seven endogenous variables to be included in system, which indicated six cointegrating equations. Second, augmented Dickey-Fuller tests were conducted on each of the endogenous variables to ensure they were stationary by the first difference (see Appendix B). The diagnostics for each of the models are documented followed by the results of each analysis.

Model 1 – VAR analysis of endogenous system.

Model specification.

Cholesky ordering sequence = calls for service rate, self-initiated enforcement activity rate, use of force rate, severity of force, citizen complaint rate, substantiated complaint disposition, and exonerated complaint disposition.

Vector autoregression specification optimization.

A vector autoregression specification optimization test (results presented in Appendix B) indicated an optimal lag of 1 (lowest SBIC value of 14.306) for the specified endogenous variable system.

VAR results.

The results of the model 1 VAR are presented in Table 4.12.

Model 2 – full model VARX analysis.

VARX model specification.

Cholesky ordering sequence = calls for service rate, self-initiated enforcement activity rate, use of force rate, severity of force, citizen complaint rate, substantiated complaint disposition, and exonerated complaint disposition; exogenous variables = BWC proportion, Ferguson incident, and monthly average temperature.

Vector autoregression specification optimization.

A vector autoregression specification optimization test indicated an optimal lag of 1 (lowest SBIC value of 11.335) for the specified severity of force target variable system (Appendix B).

VARX results.

The results of model 2 (full VARX model) are presented in Table 4.13.

Table 4.12: Model 1 –VAR Results

Dependent Variable	Regressor	b	SE	95% Conf. Interval		Cohen's d
Calls for Service Rate	Self-Initiated Activity Rate	-0.256	0.175	-0.599	0.086	-
	Use of Force Rate	-3.640	26.171	-54.935	47.655	-
	Severity of Force	7.451	14.592	-21.149	36.051	-
	Citizen Complaint Rate	-0.249	14.983	-29.616	29.118	-
	Substantiated Complaints	5.337	19.853	-33.574	44.249	-
	Exonerated Complaints	-33.329	25.583	-83.471	16.814	-
Self-Initiated Activity Rate	Calls for Service Rate	-0.640	0.050	-0.162	0.034	-
	Use of Force Rate	8.156	15.438	-22.102	38.414	-
	Severity of Force	0.617	8.608	-16.253	17.488	-
	Citizen Complaint Rate	-7.971	8.838	-25.294	9.352	-
	Substantiated Complaints	-0.681	11.711	-23.634	22.272	-
	Exonerated Complaints	5.245	15.091	-24.334	34.823	-
Use of Force Rate	Calls for Service Rate	0.000	0.000	-0.000	0.001	-
	Self-Initiated Activity Rate	-0.000	0.001	-0.002	0.001	-
	Severity of Force	0.027	0.061	-0.093	0.147	-
	Citizen Complaint Rate	0.129*	0.063	0.006	0.252	0.39
	Substantiated Complaints	0.049	0.083	-0.114	0.213	-
	Exonerated Complaints	-0.169	0.107	-0.379	0.042	-
Severity of Force	Calls for Service Rate	0.000	0.001	-0.001	0.002	-
	Self-Initiated Activity Rate	-0.000	0.001	-0.003	0.002	-
	Use of Force Rate	-0.138	0.191	-0.513	0.238	-
	Citizen Complaint Rate	-0.118	0.110	-0.333	0.097	-
	Substantiated Complaints	-0.282	0.145	-0.567	0.003	-
	Exonerated Complaints	-0.303	0.187	-0.670	0.064	-

Dependent Variable	Regressor	b	SE	95% Conf. Interval		Cohen's d
Citizen Complaint Rate	Calls for Service Rate	-0.000	0.001	-0.001	0.001	-
	Self-Initiated Activity Rate	0.000	0.001	-0.002	0.002	-
	Use of Force Rate	0.460*	0.180	0.106	0.814	2.50
	Severity of Force	0.001	0.101	-0.196	0.198	-
	Substantiated Complaints	0.213	0.137	-0.056	0.481	-
	Exonerated Complaints	-0.075	0.176	-0.420	0.271	-
Substantiated Complaints	Calls for Service Rate	-0.000	0.000	-0.001	0.001	-
	Self-Initiated Activity Rate	0.000	0.001	-0.001	0.002	-
	Use of Force Rate	0.099	0.152	-0.198	0.396	-
	Severity of Force	-0.178*	0.845	-0.344	-0.013	1.15
	Citizen Complaint Rate	0.002	0.087	-0.169	0.169	-
	Exonerated Complaints	0.178	0.148	-0.112	0.469	-
Exonerated Complaints	Calls for Service Rate	0.000	0.000	-0.000	0.001	-
	Self-Initiated Activity Rate	0.001	0.001	-0.001	0.002	-
	Use of Force Rate	-0.272**	0.100	-0.468	-0.076	2.47
	Severity of Force	0.134*	0.056	0.025	0.243	1.22
	Citizen Complaint Rate	0.007	0.057	-0.106	0.119	-
	Substantiated Complaints	0.208**	0.076	0.059	0.357	1.89

Notes: * $p<0.05$; **$p<0.01$; *** $p<0.001$

Table 4.13: Model 2 –VARX Results

Dependent Variable	Regressor	b	SE	95% Conf. Interval		Cohen's d
Calls for Service Rate	Self-Initiated Activity Rate	-0.140	0.151	-0.437	0.157	-
	Use of Force Rate	-3.502	27.296	-57.001	49.997	-
	Severity of Force	11.208	12.521	-13.334	35.749	-
	Citizen Complaint Rate	-19.168	14.732	-48.042	9.707	-
	Substantiated Complaints	-21.712	17.652	-56.309	12.885	-
	Exonerated Complaints	-30.622	23.564	-76.808	15.563	-
	BWC Proportion	4.511	12.848	-20.670	29.692	-
	Ferguson Incident	-9.919	9.722	-28.974	9.137	-
	Monthly Avg. Temp.	1.253***	0.225	0.811	1.694	0.03
Self-Initiated Activity Rate	Calls for Service Rate	-0.030	0.062	-0.152	0.092	-
	Use of Force Rate	4.089	18.272	-31.724	39.903	-
	Severity of Force	-1.410	8.382	-17.838	15.019	-
	Citizen Complaint Rate	-11.101	9.862	-30.431	8.228	-
	Substantiated Complaints	-1.709	11.816	-24.868	21.451	-
	Exonerated Complaints	-1.935	15.774	-32.852	28.982	-
	BWC Proportion	16.098	8.601	-0.759	32.955	-
	Ferguson Incident	-14.632*	6.508	-27.388	-1.876	0.64
	Monthly Avg. Temp.	-0.106	0.151	-0.402	0.190	-
Use of Force Rate	Calls for Service Rate	0.000	0.000	-0.000	0.001	-
	Self-Initiated Activity Rate	-0.000	0.001	-0.002	0.001	-
	Severity of Force	0.008	0.047	-0.085	0.101	-
	Citizen Complaint Rate	-0.060	0.056	-0.169	0.049	-
	Substantiated Complaints	0.046	0.067	-0.085	0.177	-
	Exonerated Complaints	0.030	0.089	-0.144	0.205	-
	BWC Proportion	-0.168**	0.049	-0.263	-0.073	0.51
	Ferguson Incident	-0.085*	0.037	-0.157	-0.013	0.26
	Monthly Avg. Temp.	0.000	0.001	-0.001	0.002	-

Dependent Variable	Regressor	*b*	SE	95% Conf. Interval		Cohen's *d*
Severity of Force	Calls for Service Rate	0.000	0.001	-0.001	0.002	-
	Self-Initiated Activity Rate	-0.000	0.001	-0.003	0.002	-
	Use of Force Rate	-0.183	0.229	-0.632	0.265	-
	Citizen Complaint Rate	-0.174	0.123	-0.416	0.068	-
	Substantiated Complaints	-0.324*	0.148	-0.614	-0.034	1.65
	Exonerated Complaints	-0.374	0.197	-0.760	0.013	-
	BWC Proportion	0.172	0.108	-0.039	0.383	-
	Ferguson Incident	-0.165*	0.081	-0.325	-0.006	0.84
	Monthly Avg. Temp.	0.000	0.002	-0.003	0.004	-
Citizen Complaint Rate	Calls for Service Rate	-0.000	0.001	-0.002	0.001	-
	Self-Initiated Activity Rate	0.000	0.001	-0.002	0.002	-
	Use of Force Rate	0.069	0.202	-0.327	0.465	-
	Severity of Force	-0.020	0.093	-0.201	0.162	-
	Substantiated Complaints	0.141	0.131	-0.115	0.397	-
	Exonerated Complaints	0.039	0.174	-0.302	0.381	-
	BWC Proportion	-0.009	0.095	-0.196	0.177	-
	Ferguson Incident	-0.195**	0.072	-0.336	-0.054	1.06
	Monthly Avg. Temp.	0.002	0.002	-0.001	0.006	-
Substantiated Complaints	Calls for Service Rate	-0.001*	0.001	-0.002	-0.000	0.01
	Self-Initiated Activity Rate	0.001	0.001	-0.001	0.003	-
	Use of Force Rate	0.171	0.176	-0.174	0.516	-
	Severity of Force	-0.177*	0.081	-0.336	-0.019	1.14
	Citizen Complaint Rate	-0.037	0.095	-0.224	0.149	-
	Exonerated Complaints	0.091	0.152	-0.207	0.389	-
	BWC Proportion	0.167*	0.083	0.004	0.329	1.08
	Ferguson Incident	-0.117	0.063	-0.240	0.006	-
	Monthly Avg. Temp.	0.003	0.001	0.000	0.006	-

Dependent Variable	Regressor	b	SE	95% Conf. Interval		Cohen's d
Exonerated Complaints	Calls for Service Rate	0.000	0.000	-0.000	0.001	-
	Self-Initiated Activity Rate	0.001	0.001	-0.001	0.002	-
	Use of Force Rate	-0.157	0.118	-0.387	0.074	-
	Severity of Force	0.129*	0.540	0.023	0.235	1.17
	Citizen Complaint Rate	0.058	0.064	-0.067	0.183	-
	Substantiated Complaints	0.218**	0.076	0.069	0.368	1.98
	BWC Proportion	0.119*	0.055	0.010	0.227	1.08
	Ferguson Incident	-0.035	0.042	-0.117	0.047	-
	Monthly Avg. Temp.	-0.001	0.001	-0.003	0.001	-

Notes: * $p<0.05$; **$p<0.01$; *** $p<0.001$

VAR results.

The VAR analysis (model 1) examined the impact of each of the variables in the endogenous system on one another absent exogenous variables. Table 4.13 lists each of the system variables in the Cholesky ordering schema in the first column, calls for service rate, self-initiated activity rate, use of force rate, severity of force, citizen complaint rate, substantiated complaints, and exonerated complaints. The endogenous system regressors and exogenous variables are listed in the second column, and the corresponding b coefficients, standard errors, 95 percent confidence intervals, and Cohen's d values of effect size in the columns that follow. The results of the post estimation Breusch–Godfrey serial correlation LM, Jarque-Bera, and VAR estimate stability tests indicated no autocorrelation in the residual errors, that the errors are normally distributed, and that the modulus of each eigenvalue was less than one respectively.

Neither the first variable in the endogenous system, calls for service rate (the contemporaneously exogenous variable), nor the second variable, self-initiated enforcement activity rate, were significantly impacted by any of the other system variables. However, the negative impacts of the calls for service rate ($b = -0.640$), citizen complaint rate ($b = -7.971$), and substantiated complaint disposition proportion ($b = -0.681$) and the positive impact of exonerated complaint disposition proportion ($b = 5.245$) on the self-initiated enforcement activity rate are noteworthy.

In terms of the focal dependent variables, citizen complaint rate emerged as having a statically significant impact on the use of force rate ($b = 0.129$, $p = 0.040$) with a Cohen's d of 0.39 indicating a small effect size. While none of the other variables in the endogenous system had a statistically significant impact on severity of force, of interest are the negative impacts of the citizen complaint rate ($b = -0.118$), substantiated complaint dispositions ($b = -0.282$) and

exonerated complaint dispositions (b = -0.303). Use of force rate emerged as the only variable in the endogenous system having a statistically significant impact on the citizen complaint rate (b = 0.460, p = 0.011) with the Cohen's d of 2.50 indicating a huge effect size. However, the positive impact of substantiated complaint dispositions (b = 0.213) and negative impact of exonerated complaint dispositions (b = -0.075) are also noteworthy. Of the endogenous system variables, perhaps contrary to logic, severity of force had a statistically significant negative impact on substantiated complaints (b = -0.178, p = 0.035) with a Cohen's d of 1.15 indicating a very large effect size, and though not statistically significant, exonerated complaint dispositions had a positive impact on substantiated complaint dispositions (b = 0.178). Conversely, severity of force had a statistically significant positive impact on exonerated complaint dispositions (b = 0.134, p = 0.016) with a Cohen's d of 1.22 also indicating a very large effect size. While substantiated complaint dispositions had a statistically significant positive impact on exonerated complaints (b = 0.208, p = 0.006) with a Cohen's d of 1.89 indicating a very large effect size, use of force rate had a statistically significant negative impact (b = -0.272, p = 0.006) with a Cohen's d of 2.47 indicating a huge effect size.

VARX results.

The VARX analysis (model 2) examined the impact of each of the variables in the endogenous system on one another and the impact of the exogenous variables on each in the endogenous system. The format of Table 4.14 is consistent with that of 4.13 for model 1 except for the inclusion of the exogenous variables in the regressor column. The results of the post estimation Breusch–Godfrey serial correlation LM, Jarque-Bera, and VAR estimate stability tests indicated no autocorrelation in the residual errors, that the errors are normally distributed, and that the modulus of each eigenvalue was less than one respectively.

Consistent with the model 1 VAR analysis, neither the first variable in the endogenous system, calls for service rate (the contemporaneously exogenous variable), nor the second variable, self-initiated enforcement activity rate, were significantly impacted by any of the other system variables. However, of the exogenous variables, monthly average temperature had a positive impact on calls for service rate ($b = 1.253$, $p = 0.000$) with a Cohen's d of 0.03 indicating a small effect size, and the Ferguson incident had a statistically significant negative impact on the self-initiated enforcement activity rate ($b = -14.632$, $p = 0.025$) with a Cohen's d of 0.64 indicating a medium effect size. Although not statistically significant, the negative impact of the Ferguson incident on the calls for service rate ($b = -9.919$) and the negative impact of severity of force ($b = -1.410$), citizen complaint rate ($b = -11.101$), and both substantiated ($b = -1.709$) and exonerated ($b = -1.935$) complaint dispositions is of interest. Likewise, the positive impact of BWC proportion on the self-initiated enforcement activity rate, though not statistically significant, is noteworthy.

While none of the endogenous system variables had a statistically significant impact on the use of force rate, two of the exogenous variables emerged as significant. BWC proportion had a negative impact on the use of force rate ($b = -0.168$, $p = 0.001$) with a Cohen's d of 0.51 indicating a medium effect size, as did the Ferguson incident ($b = -0.085$, $p = 0.020$) with a Cohen's d of 0.26 indicating a small effect size. Of the endogenous system variables substantiated complaint dispositions had a statistically significant negative impact on severity of force ($b = -0.324$, $p = 0.028$) with a Cohen's d of 1.65 indicating a very large effect size. Of the exogenous variables, the Ferguson incident emerged as statistically significant having a negative impact ($b = 0.165$, $p = 0.042$) with a Cohen's d of 0.84 indicating a large effect size. While not statistically significant, the negative impacts of the use of force rate ($b = -0.183$), citizen

complaint rate ($b = -0.174$), and exonerated complaint dispositions ($b = -0.374$) are of interest as well.

The Ferguson incident was the sole variable to emerge as statistically significant in regard to the citizen complaint rate, curiously having a negative impact ($b = -0.195$, $p = 0.007$) with the Cohen's d of 1.06 indicating a large effect size. Like the use of force rate, the citizen complaint rate was not significantly impacted by any of the other endogenous system variables. However, though not statistically significant and minimal, the negative impact of BWC proportion ($b = -0.009$) and severity of force ($b = -0.020$) are noteworthy, as are the positive impacts of the use of force rate ($b = 0.069$), substantiated complaint dispositions ($b = 0.141$), and exonerated complaint dispositions ($b = 0.039$).

In terms of the complaint disposition variables, calls for service had a minimal but statistically significant negative impact on substantiated complaint dispositions ($b = -0.001$, $p = 0.044$) with a Cohen's d of 0.01 indicating a very small effect size, but negligible on exonerated complaint dispositions. Neither the self-initiated enforcement activity rate, nor the use of force rate had a statistically significant impact on either disposition. However, the positive impact of the use of force rate on substantiated complaint dispositions ($b = 0.171$) and, conversely, the negative impact on exonerated complaint dispositions ($b = -0.157$) is also of interest. Severity of force emerged as statistically significant for both dispositions, but curiously having a negative impact on substantiated complaint dispositions ($b = -0.177$, $p = 0.028$) with a Cohen's d of 1.14 indicating a large effect size and a positive impact on exonerated complaint dispositions ($b = 0.129$, $p = 0.017$) with a Cohen's d of 1.17 also indicating a large effect size. Although not statistically significant, interestingly, the citizen complaint rate had a negative impact on substantiated complaint dispositions ($b = -0.037$), but a positive impact on exonerated complaint

dispositions ($b = 0.058$). Substantiated complaints emerged as statistically significant having a positive impact on exonerated complaint dispositions ($b = 0.218$, $p = 0.004$) with a Cohen's d of 1.98 indicating a very large effect size, while exonerated complaint dispositions did not have a statistically significant impact on substantiated complaint dispositions ($b = 0.091$). Of the exogenous variables, BWC proportion had a statistically significant positive impact on both substantiated complaint dispositions ($b = 0.167$, $p = 0.045$) with a Cohen's d of 1.08 indicating a large effect size, and exonerated complaint dispositions ($b = 0.119$, $p = 0.032$) with a Cohen's d of 1.08 indicating a large effect size as well. While the Ferguson incident did not have a significant impact on either disposition, the direction was negative for both but more impactful for substantiated complaint dispositions ($b = -0.117$) than exonerated complaint dispositions ($b = -0.117$). The results of the post estimation Breusch–Godfrey serial correlation LM, Jarque-Bera, and VAR estimate stability tests indicated no autocorrelation in the residual errors, that the errors are normally distributed, and that the modulus of each eigenvalue was less than one respectively. These results, limitations of the study, conclusions, implications, and future research needs are discussed in Chapter 5.

CHAPTER 5

DISCUSSION & CONCLUSIONS

While several randomized controlled trials have examined the impact of BWCs on use of force in the past few years, the results are mixed. Only a handful of studies have examined these impacts over a substantial period of time. Sutherland and colleagues (2017) examined four years post BWC implementation at the Rialto, CA Police Department and found that the initial reductions in use of force and citizen complaints had been sustained. Conversely, Koslicki and colleagues' (2019) analysis of four years pre- and three years post-BWC implementation data from an unnamed agency in the Northwest U.S. indicated a significant increase in use of force reports over the three years following device deployment. Furthermore, adequate controls for officer-initiated enforcement activity and staffing have not been included in the extant research, and the potential impact on citizen complaint dispositions have received scant attention. The Newport News, Virginia Police Department's experience with BWCs offered a unique opportunity to address these gaps in the research.

The objective of this dissertation was to explore the impact of a staggered rollout of BWCs with multiple deployments on the frequency and severity of use of force and the frequency and outcomes of citizen complaints while controlling for staffing and officer-initiated enforcement activity. This overarching objective was broken down into ten research questions, which were posed in Chapter 1. This chapter begins by addressing each of those research questions in turn, followed by a discussion of the results, how the findings build on the extant body of knowledge, and the implications of the findings. The chapter concludes with the limitations of the study, suggestions for future research, and final conclusions.

Answers to the Research Questions

1. What were the effects of BWCs on use of force?

The descriptive statistics indicated that the mean use of force rate decreased by 58.01% between the pre-BWC period (May 2010 through April 2013) and the post-BWC period (July 2016 – June 2017). Similar to the Rialto, CA (Farrar & Ariel, 2013), Orlando, FL, (Jennings et al., 2015), Tampa, FL (Jennings et al., 2017), and Las Vegas, NV (Braga et al., 2018) studies, the findings in the current study indicated that BWCs were a significant factor in the notable decrease in use of force.

1a. If the frequency of use of force incidents was reduced, was the reduction

sustained?

Similar to Sutherland and colleagues' (2017) follow-up study of the Rialto, CA results, but in stark contrast to Koslicki and colleagues' (2019) results, the reduced use of force rate in the current study appears to remain stable during the 12-month (July 2016 through June 2017) post-BWC period (see Table 4.2 and Figure 4.2).

1b. If the frequency of use of force incidents was reduced, was there an incremental

decline with waves of BWC implementation, or did any decline plateau or decay

over the course of implementation?

A relatively continuous decline is observed during the BWC implementation period, which appears to flatten during the post-BWC (full deployment) period (see Figure 4.2).

1c. Was there a change in the severity of force used (monthly proportion of use of

force incidents resulting in citizen injuries)?

The monthly proportion of use of force incidents resulting in citizen injuries decreased nominally between the pre-BWC and post-BWC periods overall. However, distinct spikes of

1.00 proportions occurred in the post-BWC period and none of that magnitude occurred prior to BWC implementation (see Figure 4.3). The analysis results indicated that BWCs were not a significant factor in severity of force.

1d. Did BWCs have a significant impact on these outcomes when simultaneously considering staffing and volume of officer-initiated enforcement activity?

The proportion of BWCs was statistically significant factor in the reduced use of force rate while controlling for officer-initiated enforcement activity rate, calls for service rate, neither of which were statistically significant.

2. What were the effects of BWCs on the frequency of citizen complaints?

The descriptive statistics indicated that the mean citizen complaint rate decreased by 47.39% between the pre-BWC period (May 2010 through April 2013) and the post-BWC period (July 2016 – June 2017). Contrary to the Rialto, CA (Farrar & Ariel, 2013), Mesa, AZ (Mesa Police Department, 2013), Phoenix, AZ (Katz et al., 2014), Orlando, FL, (Jennings et al., 2015), Denver, CO (Ariel, 2017), Arlington, TX (Goodison & Wilson, 2017), and Las Vegas, NV (Braga et al., 2018) studies, the proportion of BWCs was not statistically significant in the notable reduction in the citizen complaint rate. However, the results of the analysis indicated that the Ferguson incident was a significant factor in that reduction.

2a. If the frequency of citizen complaints was reduced, was the reduction sustained?

Notwithstanding the findings above, the reduced citizen complaint rate in the current study appears to remain stable.

2b. If the frequency of citizen complaints was reduced, was there an incremental decline with waves of BWC implementation, or did any decline plateau or decay over the course of implementation?

A relatively continuous decline is observed during the BWC implementation period, which, like the use of force rate, appears to flatten during the post-BWC (full deployment) period (see Figure 4.4).

2c. Was there a change in the proportion of sustained complaints compared to those unfounded, not substantiated, or in which the officer was exonerated?

Both unfounded and not substantiated complaint disposition proportions decreased (by 19.20% and 40.00% respectively) while proportions of substantiated and exonerated complaint dispositions increased (40.35% and 115.38% respectively). While BWC proportion did not emerge as a statistically significant factor in the substantiated complaint disposition increase (as noted just beyond statistical significance), it had a statistically significant impact in the exonerated disposition increase.

2d. Did BWCs have a significant impact on these outcomes when simultaneously considering staffing and volume of officer-initiated enforcement activity?

While BWC proportion was the sole statistically significant factor in the exonerated complaint proportion model, calls for service rate emerged as significant in the substantiated complaint proportion model.

Discussion

The theoretical framework first proposed by Farrar and Ariel (2013) to predict the impact of BWCs on officer behavior was reviewed in Chapter 2. First, Tedeschi and Felson's (1994) social interactionist theory of coercive actions explains how the dynamics of police-citizen interactions can lead to the outcomes of concern (use of force, abuse of authority, and citizen complaints) and verbal/psychological, legal/civil rights, or physical abuse of authority. In summary, police and citizens have an asymmetrical power relationship in which officers expect

deference from all citizens (Alpert & Dunham, 2004). Moreover, the lower the social capital of the citizen, the more deference and respect is expected by an officer. Thus, the theory proposes that a hostile and disrespectful citizen demeanor, "contempt of cop," would likely be met with coercive means to compel compliance, such as threats, physical force, or punishments. The theory also posits that coercion will be utilized for retribution when the officer's social identity has been threatened. In short, a police officer engaged in an enforcement encounter with a recalcitrant and disrespectful citizen would be likely to engage in coercive tactics, and perhaps verbal/psychological, legal/civil rights, and/or physical abuse of authority. However, Farrar and Ariel (2013) assert that BWCs deter officers from acting on these impulses through what Duvall and Wicklund (1972) termed objective self-awareness.

According to Duvall and Wicklund (1972), one becomes keenly self-aware when he or she knows they are being observed and subsequently tend to modify their behavior to conform to social expectations. This state of objective self-awareness, produced by having their actions recorded by a BWC, would not only result in deterring officers from engaging in the aforementioned retaliatory coercive actions, but likely increase procedurally just professional behavior. Specifically, this phenomenon is expected to result in officer attentiveness to treating all citizens fairly, with dignity and respect, and attempting to deescalate before utilizing force when possible. This impact on officer behavior is, in turn, is expected to decrease use of force incidents and citizen complaints.

The review of applicable literature in Chapter 2 also generated several expectations that, in turn, guided the inclusion of several variables in addition to BWCs thought to impact the focal outcomes in the current study. While the results demonstrated a poor fit of the data to ARIMA models (likely due to the failure to capture the impact of the incremental deployment of BWCs),

VAR/VARX was ideal with post-estimation tests demonstrating good fit and reliable results. VAR/VARX analysis, which has rarely been employed in criminology and criminal justice research, allowed for a unique examination of the impacts of those variables included in the endogenous system. Utilizing the VARX results, the impacts of those variables on the focal variables, and on one another, is examined in comparison to previous findings in the research and support for the related theoretical frameworks is assessed. First, for the ease of reference, Table 4.14 presents the relationships between variables as negative or positive regardless of statistical significance.

Table 5.1 – VARX Analysis - Variable Relationships

Regressor Variable ↓	Use of Force	Severity of Force	Citizen Complaints	Substantiated Complaints	Exonerated Complaints	Calls for Service	Self-Initiated Activity
Use of Force		-	+	+	-	-	+
Severity of Force	+		-	- *	+	+	-
Citizen Complaints	-	-		-	+	-	-
Substantiated Complaints	+	- *	+		+ *	-	-
Exonerated Complaints	+	-	+	+		-	-
Calls for Service	+	+	-	- *	+		-
Self-Initiated Activity	-	-	+	+	+	-	
Ferguson Incident	- *	- *	- *	-	-	-	- *
Monthly Avg. Temp.	+	+	+	+ *	-	+ *	-
BWCs	- *	+	-	+ *	+ *	+	+

Notes: * indicates statistically significant relationship.

Use of force frequency.

The results of the VARX analysis indicated that both BWCs and the Ferguson incident were statistically significant contributors to the 58 percent decrease in the use of force rate between the pre-BWC period and the post full implementation of BWCs, and Cohen's *d* calculations indicated a medium effect size for both. However, contrary to previous research regarding the correlates of police use of force, self-initiated activity was not a significant

predictor of the use of force rate (see Bolger, 2015). This finding is interesting considering the nearly 44 percent decrease in the officer-initiated activity rate between the pre-BWC and post full BWC deployment periods. Likewise, although thought to be impactful, none of the other variables included in the VARX endogenous system (calls for service rate, severity of force, citizen complaint rate, substantiated complaint dispositions, or exonerated complaint dispositions), nor the other exogenous variable (monthly average temperature) had a significant impact on the use of force rate.

While the current study's findings are similar to those previous studies listed in the answer to research question 1 above as to the positive impact of BWCs on a notable decrease in use of force, they are in stark contrast to Koslicki and colleague's (2019) finding of an increase in use of force over 3 years post-BWC deployment. Furthermore, the current study's finding of the concurrent Ferguson incident's significance in the use of force reduction (which has not been previously controlled for) is noteworthy. Collectively, these findings may suggest that the combined effects of increased public scrutiny of police use of force incidents following the Ferguson incident, and the implementation of BWCs not only decreased use of force frequency at NNPD overall, but that officers may have been particularly careful in how they handled interactions that they had initiated, even prior to the Ferguson incident.

The VARX results indicated that severity of force, substantiated complaint dispositions, exonerated complaint dispositions, calls for service rate, and monthly average temperature all had a positive impact on the use of force rate. While the positive relationship of exonerated complaints, calls for service, and monthly average temperature are consistent with previous research reviewed in Chapter 2, at first glance the positive impact of severity of force and substantiated complaints seems to defy logic. However, the positive impact of substantiated

complaint dispositions suggests that fewer of these complaints were related to force after BWC implementation began, which is supported by the negative impact of the overall citizen complaint rate. This remains a matter of speculation, however, as the types of allegations were not examined in the current study. The self-initiated activity rate and the Ferguson incident had a negative impact as well. While, as mentioned above, the negative impact of the self-initiated activity rate on the use of force is incongruent with previous research (see Bolger, 2015), the negative impact of the Ferguson incident is to be expected considering the increased public scrutiny of use of force in general across the country. These results concerning the influence of BWCs and the Ferguson incident seem to support the theoretical framework.

Severity of force.

The current study is the first known to examine the impact of BWCs on severity of force and, as such, was exploratory in nature. The finding that the proportion of use of force incidents resulting in citizen injury spiked post BWC implementation is curious. As an anticipated benefit of BWCs is reduced use of force incidents, and the current study found that was the case at NNPD, one might expect that the severity of force would be reduced as well. However, substantiated complaint disposition proportion and the Ferguson Incident did have statistically significant negative impacts on severity of force with Cohen's *d* calculations indicating a very large effect size and large effect size respectively. In addition, although not statistically significant, BWCs had a positive impact.

These findings seem to be contradictory at first glance, however, they may be reconcilable. The negative impact of substantiated complaint dispositions and the Ferguson incident are intuitive. It seems logical that officers would not only avoid use of physical force when possible but also endeavor to use minimal force when it is required in light of the public

scrutiny of any use of force post-Ferguson. The finding that BWCs increase severity of force, on the other hand, is counterintuitive. However, it seems likely that two factors may be in play that would potentially explain this finding. First, perhaps a large proportion of the use of force reduction was at the lower end of the force continuum and more of the force that is used following the implementation of BWCs is in response to serious resistance. Second, having evidence of citizen resistance captured on BWC recorded video may make officers less inclined to attempt to negotiate for cooperation. In any event, this remains a matter of speculation as neither the types of force nor citizen resistance were examined in the current study.

In addition to substantiated complaint dispositions and the Ferguson incident, the use of force rate, citizen complaint rate, exonerated complaint dispositions, and self-initiated activity rate all had a negative impact on severity of force. While one would intuitively predict the negative impacts of the citizen complaint rate, substantiated complaint dispositions, and the Ferguson incident, and these impacts fall in line with the abuse of authority literature, the similar impacts of exonerated complaint dispositions and self-initiated activity are puzzling. Lacking additional data, including surveys of officers, one can only speculate as to the sources of these impacts. Perhaps officers avoid receiving a complaint, especially an allegation of unnecessary or excessive force regardless of the outcome, such that even exonerations negatively impact severity of force. In terms of the negative impact of self-initiated activity, it is plausible that officers react more quickly utilizing lower levels of force to control a subject when they have initiated a contact. But again, this remains a matter of speculation as the types of force were not examined in the current study.

Citizen complaint frequency.

While BWCs did have a negative impact on the citizen complaint rate, they were not a

statistically significant factor in the model. Based on the findings of Lersch (2002) and Lersch and Mieczkowski (1996) that officers who engage in more proactive (officer-initiated) and aggressive enforcement activities receive more citizen complaints, one would think that this reduction is also likely a function of the nearly 44 percent decrease in the officer-initiated activity rate. However, while the officer-initiated activity rate had a positive impact on the citizen complaint rate, it was not a statistically significant factor in the model either. However, the Ferguson incident's statistically significant negative impact with a Cohen's d calculation indicating a large effect size is notable.

As stated earlier, these findings suggest that NNPD officers may have been particularly careful in how they handled interactions that they initiated, even prior to BWC implementation and the Ferguson incident. This seems to be supported by Terrill and Ingram's (2016) findings that discourtesy makes up a substantial proportion of citizen complaints. However, the Ferguson incident's statistical significance with a Cohen's d calculation indicating a large effect size suggests that officers were more courteous and professional overall following the event. Perhaps officers are more concerned about citizen captured video of their actions and potential public scrutiny than BWC captured video.

The use of force rate, substantiated complaint dispositions, exonerated complaint dispositions, and monthly average temperature also had positive impacts on the citizen complaint rate. The positive impact of the use of force rate on the citizen complaint rate is predictable based on Terrill and Ingram's (2016) finding that a large proportion of citizen complaints are allegations of improper force. Likewise, the findings of Brandl and colleagues (2001), that some citizens may believe that officers protect one another and filing a complaint would be futile, supports the notion that when citizens see complaints substantiated, that they may be encouraged

to report perceived misconduct. With increased contacts between officers and citizens, as well as increased use of force incidents, the positive impact of the monthly average temperature on the citizen complaint rate is also logical. However, the positive impact of exonerated citizen complaints on the overall citizen complaint rate seems counterintuitive, especially in light of Brandl and colleague's (2001) findings. Although a matter of speculation, perhaps exonerations motivated Newport News citizens to file complaints rather than simply feeling defeated. Particularly in the post-Ferguson era. With more than 40 percent of the Newport News population African American, perhaps movements such as Black Lives Matter influenced citizens in such a way that exonerations were questioned and angered citizens, and ultimately generated more citizen complaints.

Severity of force had a negative relationship with the citizen complaint rate. While counterintuitive as well, this finding might suggest that the more severe force incidents were justified and produced fewer citizen complaints. Collectively, the results concerning the citizen complaint rate do not offer much support for the theoretical framework as it applies to BWCs. However, findings pertaining to the impact of the Ferguson incident seem applicable to the support of the theoretical concepts.

Substantiated and Exonerated complaint dispositions.

As related in Chapter 1, BWC advocates have anticipated that the captured video would aid in complaint investigations by providing an objective record of an encounter (While, 2014). A logical extension of this notion is that the two dispositions that reflect a high level of uncertainty about allegations of misconduct (unfounded and not substantiated) should be reduced and the more definitive dispositions (substantiated and exonerated) should increase. The current study's findings reflect exactly that.

Exonerations more than doubled and BWC proportion was a statistically significant factor with the inclusion of the other explanatory variables. The proportion of substantiated complaints and severity of force also had a significant impact on exonerations. The latter significant positive relationship between severity of force and exonerated complaints supports the earlier suggestion that more severe force incidents were justified and not only produced fewer citizen complaints, but also more exonerations when complaints were filed in these instances. In addition, the calls for service rate, and the self-initiated activity rate had a positive impact on exonerations while the Ferguson incident had a negative impact. These first findings further suggest that officers were more professional overall, but the latter suggests that citizen complaints may have been investigated more thoroughly or officer actions were subjected to greater scrutiny post-Ferguson.

BWCs were a statistically significant factor in the 40 percent increase in substantiated complaints as well, as were severity of force, calls for service rate, and monthly average temperature. As in the case of exonerations, BWC captured video likely provided evidence enhancing internal investigators' ability to determine what occurred, and thus producing these more definitive dispositions. The negative impact of severity of force on substantiated complaint dispositions further supports the suggestion that the more severe force incidents were justified in many cases. The calls for service rate had a negative impact on substantiated complaints, meaning the higher the call volume, the fewer substantiated complaints. This suggests that perhaps when officer have more time to engage in an interaction, the greater the possibility of engaging in some form of misconduct, perhaps an abuse of authority. The positive relationship between average monthly temperature and substantiated complaints is not surprising as warmer temperatures coincide with more outdoor contacts with higher potential for more aggressive

policing of disorder.

Calls for service rate.

The calls for service rate remained fairly stable during the study period and the results indicated that the only statistically significant factor was the monthly average temperature. The seasonality of crime and calls for service is well documented, and therefore this is to be expected. However, although not statistically significant, the negative impact of the Ferguson incident on the calls for service rate is noteworthy. It suggests that citizens were less likely to call for police services post Ferguson. Based on the findings of Kochel (2019) regarding the impact of the events on African American attitudes regarding police in particular, this impact might be explained by the proportion of Newport News citizens who are African Americans, more than 40 percent.

Self-initiated activity rate.

The only statistically significant variable that impacted the self-initiated activity rate in the VARX model was the Ferguson incident with a negative relationship. The results indicated that the Ferguson incident was the sole significant factor among the variables in the nearly 40 percent reduction in self-initiated activity. This finding falls in line with those of the Pew Research Center (2017), Morin and colleagues (2017), and Shjarback and colleagues (2017), all of whom indicated a de-policing effect related to the Ferguson incident. The results of these studies indicated that the reduction in self-initiated activities is tied to officer fears of public scrutiny of aggressive policing techniques.

Although not statistically significant, two other findings are notable. First, BWCs were positively related to the self-initiated activity rate which is important to the ongoing potential BWC induced passivity debate. Like Headley and colleagues (2017), Ready and Young (2015),

Wallace and colleagues (2018) and White and colleagues (2018), all of whom found either a

positive impact or null findings, the dissertation found no evidence of BWC induced passivity.

Second, the citizen complaint rate had a negative impact on self-initiated activity but, as

indicated earlier, self-initiated activity had a nominal impact on citizen complaints. This suggests

that officers might believe that self-initiated activities produce more complaints even though the

findings indicate that is not the case at NNPD during this 86-month period.

Discussion summary.

In summary, the results indicated that BWCs were a statistically significant factor in the

substantial reduction of use of force (58 percent) and increases in both substantiated (40 percent)

and exonerated (115 percent) citizen complaint dispositions, but not in the 47 percent reduction

in citizen complaints. In addition, there was no plateau in these outcomes during the staggered

BWC implementation period, but rather continuous trends that seemed to level off after full

implementation was achieved. While the results offer some support for the theoretical framework

proposed by Farrar and Ariel (2013) and subsequently embraced by BWC advocates, as

discussed, inclusion of the Ferguson incident control variable complicates application of the

theories to the impact of BWCs on use of force and citizen complaints. These results suggest

some important implications and future research needs, but several limitations must be

acknowledged first.

Limitations

While the dissertation contributes to the current body of knowledge as outlined above,

there are several limitations that must be noted. Although likely not an exhaustive list, foremost,

the study utilizes a nonprobability purposive sample, a single large mid-Atlantic municipal

police department purposively selected based on the length of experience with BWCs and

officers were not randomly selected to be equipped with BWCs through the staggered deployment of the devices. Supervisors and command staff assigned the devices to officers as they deemed appropriate. These facts alone may limit the generalizability of the results. Second, the study utilizes secondary data, internal agency records that were not collected with the purposes of the researcher in mind. That fact, combined with the "low visibility" nature of police work, means that some omissions in the CAD data and use of force reporting are likely. However, the latter may be less likely post-BWC implementation due to video documentation. Nevertheless, the researcher had to rely on the data collection and recording techniques utilized by the agency, which had been gathered for the internal purposes of NNPD, not for the purposes for which the investigator intended to utilize it.

Third, there are methodological issues related to time series analysis which must be noted. While time-series analysis is a quasi-experimental design which suffers relatively few threats to the validity of the results, there are a few specific potential threats that must be considered. First, that of history. According to Cook and Campbell (1979), 'history' refers to "the possibility that forces other than the treatment under investigation came to influence the dependent variable immediately after [the treatment was introduced]" (p. 211). Another potential threat to validity is in regard to changes in policy or procedures during the post 'interruption' period, a threat that Cook and Campbell (1979) refer to as "instrumentation." In addition, the possibility of seasonal variations must be considered, and such patterns accounted for (Cook & Campbell, 1979). While no major changes in policy were discovered and seasonality is controlled for, as with any law enforcement agency of similar size, promotions, retirements, resignations, and shifts in responsibilities resulted in various changes in supervisory and command staff assignments over the 86-month period of the study. The possibility that such

changes may have impacted department culture and contributed to the results of the study must be considered. In addition, time series-based models require a minimum of 50 observations as a rule of thumb (Box & Tiao, 1975). While the current study includes 86, the study would have been more robust with an increased number of observations, particularly post-BWC.

Fourth, the Ferguson incident was utilized as a proxy measure for a potential de-policing effect. While, as stated earlier, it was arguably a watershed moment in the current police legitimacy crisis, there have been several high-profile incidents both before and after. Therefore, it might not capture the cumulative effects of these incidents. And fifth, while the results seem to offer support for the proposed theoretical framework regarding the anticipated impact of BWCs on use of force and citizen complaints, the actual testing of theory was a delimitation of the dissertation. Thus, the mechanism of the BWC impacts remains an open question. As suggested by White (2014) and others, it is possible that BWCs have an impact on citizen behavior as well.

Implications

Notwithstanding the aforementioned limitations, there are five specific implications derived from the results of this study. First, a handful of extant studies have sought to identify correlates of officer acceptance (buy-in) of BWCs. The most salient issue identified to date has been that of organizational justice (see Ariel et al. 2014; Gaub, et al., 2016; Jennings et al., 2014; Katz et al., 2014; Kyle & White, 2016; Pelfrey & Keener, 2016; Smykla, Crow, Crichlow, & Snyder, 2015; Young & Ready, 2015), which has generally been discovered through surveys of officer attitudes. Recommendations that law enforcement leadership executives ensure high levels of organizational justice in their agency prior to BWC implementation abound based on these findings. However, empirical evidence of direct benefits of BWCs for the officer has been lacking. The importance of the current study's finding that exonerations more than doubled

(115.38% increase), and that BWCs were a significant factor in that increase cannot be overstated. Law enforcement leadership should utilize this information to relieve officers' apprehensions about the devices and bolster buy-in.

Second, the significant impact on both of the more conclusive complaint dispositions (substantiated and exonerated) and coinciding decreases in the less conclusive complaint dispositions indicates that BWC captured video does indeed aid in complaint investigations. This is an anticipated benefit of BWCs that has received little empirical support (see Lum et al., 2015). Third, there is a dearth of knowledge regarding staggered rollouts of BWCs, which is not uncommon due to budget constraints. The results of the current study indicate that the impact of BWCs on use of force frequency and complaint resolution begin to manifest with the start of implementation. Moreover, the benefits increased sequentially with implementation and were sustained long term. Law enforcement leadership should consider staggered implementation if their budgets do not allow a full deployment.

Fourth, notwithstanding the specific limitation concerning utilizing the Ferguson incident as a proxy measure noted above, the results of the current study indicate that the Ferguson incident was a significant factor in a substantial (nearly 40 percent) reduction in the officer self-initiated activity rate. However, there was no indication of camera induced passivity. While some law enforcement leaders may view this as problematic, as mentioned in Chapter 2, Brunson (2007) and Epp and colleagues (2014), among others, suggest that aggressive officer-initiated enforcement contacts negatively impact police legitimacy and Sharback and colleagues (2017) suggest that reductions in these types of contacts might serve to improve police-community relations.

Lastly, the finding regarding the impact of BWCs on severity of force must be fully

understood as this is likely counter to expectations of the public. While the increased proportion of use of force incidents resulting in citizen injury can be disturbing at first glance. Understanding the underlying fact that some use of force will always be necessary due to resistance and issues of safety is paramount. The reductions in use of force are likely attributable to those that could have been avoided through de-escalation or were unnecessary, but this remains a matter of speculation and will be addressed in the concluding future research needs section below.

Future Research Needs

The mixed results of the extant research regarding the impact of BWCs on use of force and citizen complaints—the two anticipated benefits of the devices most important for improving police legitimacy—are problematic. The lack of studies that examine those impacts long term is even more problematic given the continuing rapid implementation of BWC programs at substantial expense and with the high expectations of the public concerning their effectiveness. Although the current study produced some results consistent with the anticipated benefits and in line with the proposed theoretical framework. The inclusion of additional variables in a multivariate time series analysis demonstrated that there are other relevant factors that must be considered, and which may guide future research.

The current study examined the impact of BWCs on severity of force and complaint dispositions. The importance of the findings cannot be overstated but also reveal more questions to be answered. Future studies should examine specific types of force in order to investigate the impact of BWCs on severity of force further. Regarding the latter, the significant increases in both substantiated complaints and officer exonerations support this anticipated benefit of BWCs, which until now has received little empirical support. However, specific types of allegations

were not examined, and as stated in the discussion, there may be important nuances in terms of dispositions still to be discovered. While these results provide further evidence of the value of BWCs, considering this is a single study of a single agency, more research in this area is crucial.

Perhaps most important, while the theoretical framework first proposed by Farrar and Ariel (2013) has been reiterated in several of the studies that followed (including this one), it has not been tested. The data available to the investigator did not allow a test of the theory in this study, although the results seem to support it. Such research is a crucial need as the relationship between BWCs and reductions in use of force and citizen complaints is not fully understood. While a test of the theoretical framework would likely require direct observation of officer behavior prior to BWC implementation (thus time consuming and expensive), post-BWC observation could feasibly be conducted by coding BWC captured video, which might make such a study possible.

Conversely, null and negative results of several studies indicate that additional explanatory variables need to be explored. Research to identify variables that differentiate agencies that experience reductions from those that do not is the next logical step. Without further research to both understand how the devices can produce the desired benefits, and establish realistic expectations regarding their effectiveness, BWCs could ultimately further erode police legitimacy.

Final Conclusions

Law enforcement agencies continue to adopt BWCs at a rapid rate. While BWC research initially trailed introduction of the devices in large numbers, scholars have employed aggressive research agendas generating results from several studies in just a few years' time. Although this dissertation contributes to that rapidly developing body of knowledge, it also reveals additional

gaps in need of empirical research. As technological advances continue and occur more quickly, it is increasingly important for research to keep pace. May the information contained in this dissertation aid in that emerging research.

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APPENDIX A

ARIMA DIAGNOSTICS

Use of Force Rate ARIMA Diagnostics

Autocorrelation (AC) Plot of Use of Force Rate Pre-Series

Bartlett's formula for MA(q) 95% confidence bands
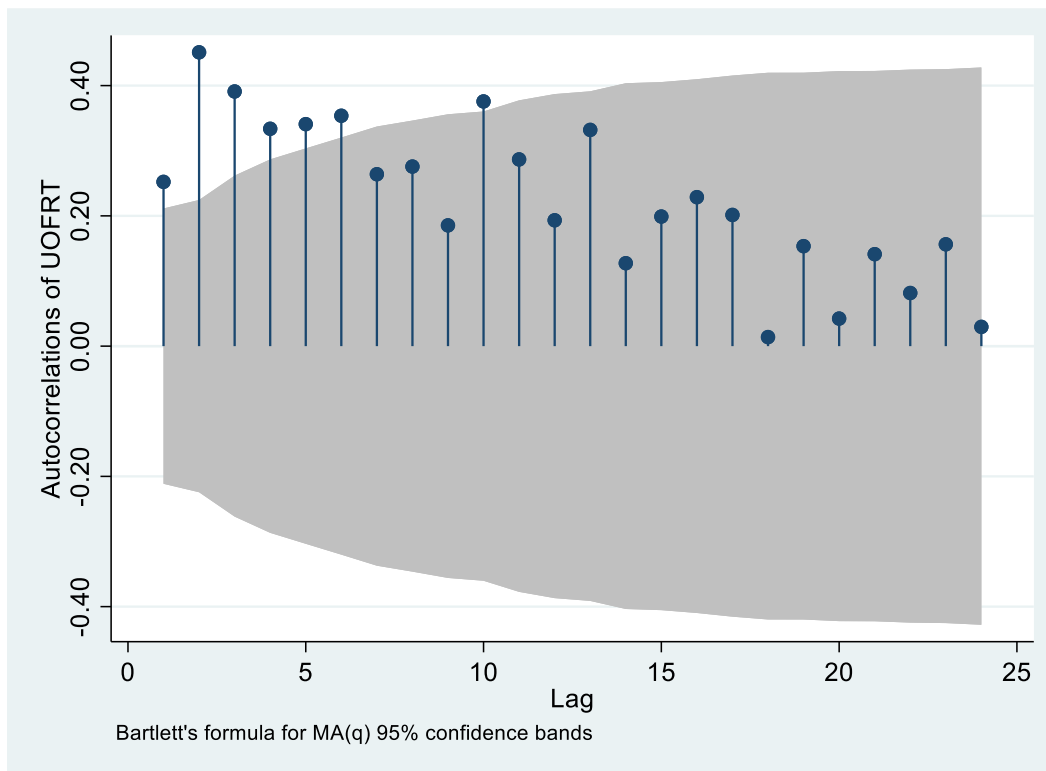
Augmented Dickey-Fuller Test of Use of Force Rate Pre-Series

```
Augmented Dickey-Fuller test for unit root          Number of obs   =        33

                        ———————— Interpolated Dickey-Fuller ————————
                   Test        1% Critical       5% Critical      10% Critical
               Statistic          Value             Value             Value
─────────────────────────────────────────────────────────────────────────────
 Z(t)            -3.477           -3.696            -2.978            -2.620
─────────────────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0086
```

Partial Autocorrelation (PAC) Plot of Use of Force Rate Pre-Series

95% Confidence bands [se = 1/sqrt(n)]
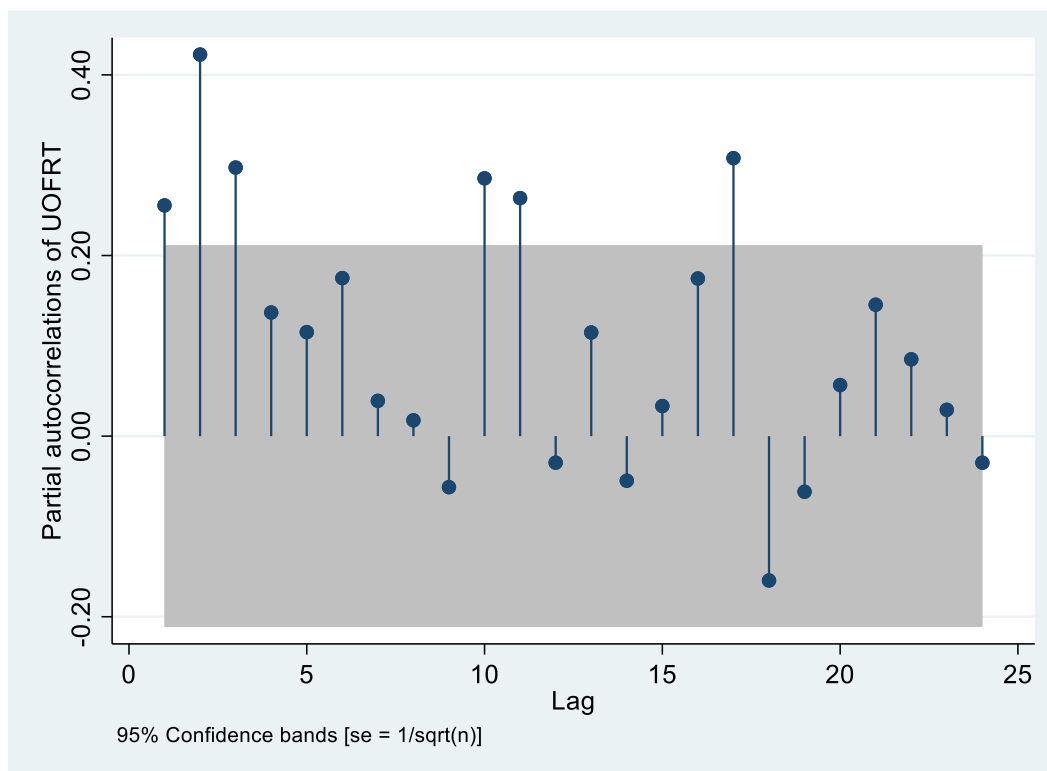
Correlogram of Use of Force Rate Pre-Series – ARIMA (0, 1, 1)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.0134	0.0134	.01577	0.9001		
2	0.1243	0.1256	1.3927	0.4984		
3	0.0509	0.0502	1.6261	0.6535		
4	0.0050	-0.0152	1.6284	0.8037		
5	0.0197	0.0061	1.6642	0.8934		
6	0.0391	0.0404	1.8071	0.9366		
7	-0.0991	-0.1090	2.7379	0.9081		
8	-0.0675	-0.0908	3.1754	0.9229		
9	-0.1090	-0.0879	4.3313	0.8883		
10	0.2021	0.2584	8.3603	0.5937		
11	0.1063	0.1663	9.4884	0.5769		
12	-0.0760	-0.1657	10.074	0.6095		
13	0.0709	-0.0160	10.591	0.6451		
14	-0.1249	-0.1488	12.215	0.5891		
15	0.0634	0.0668	12.639	0.6301		
16	0.1567	0.2106	15.27	0.5049		
17	0.0979	0.1940	16.312	0.5018		
18	-0.1526	-0.2712	18.883	0.3991		
19	0.0644	0.0222	19.347	0.4348		
20	-0.0578	0.0694	19.728	0.4751		
21	0.0648	0.0490	20.212	0.5079		
22	-0.0224	-0.1180	20.271	0.5661		
23	0.0425	-0.1018	20.486	0.6124		
24	-0.1499	-0.0526	23.21	0.5074		
25	-0.1028	0.0175	24.513	0.4899		
26	0.1318	0.1996	26.69	0.4257		
27	0.0090	-0.0302	26.7	0.4801		
28	0.0001	0.0022	26.7	0.5346		
29	0.0238	0.0232	26.775	0.5838		
30	-0.1429	-0.3443	29.52	0.4904		
31	-0.0067	-0.0621	29.526	0.5419		
32	-0.0349	-0.1616	29.696	0.5836		
33	-0.0578	-0.2048	30.172	0.6087		
34	-0.1078	-0.0101	31.858	0.5730		
35	-0.2447	-0.0754	40.712	0.2335		
36	0.0201	0.0619	40.773	0.2685		
37	-0.0500	0.0897	41.158	0.2935		
38	0.0188	-0.0832	41.214	0.3319		
39	0.0498	-0.1695	41.613	0.3577		
40	-0.0348	0.0546	41.812	0.3920		

Severity of Force ARIMA Diagnostics

Autocorrelation (AC) Plot of Citizen Injury Proportion Pre-Series

Bartlett's formula for MA(q) 95% confidence bands
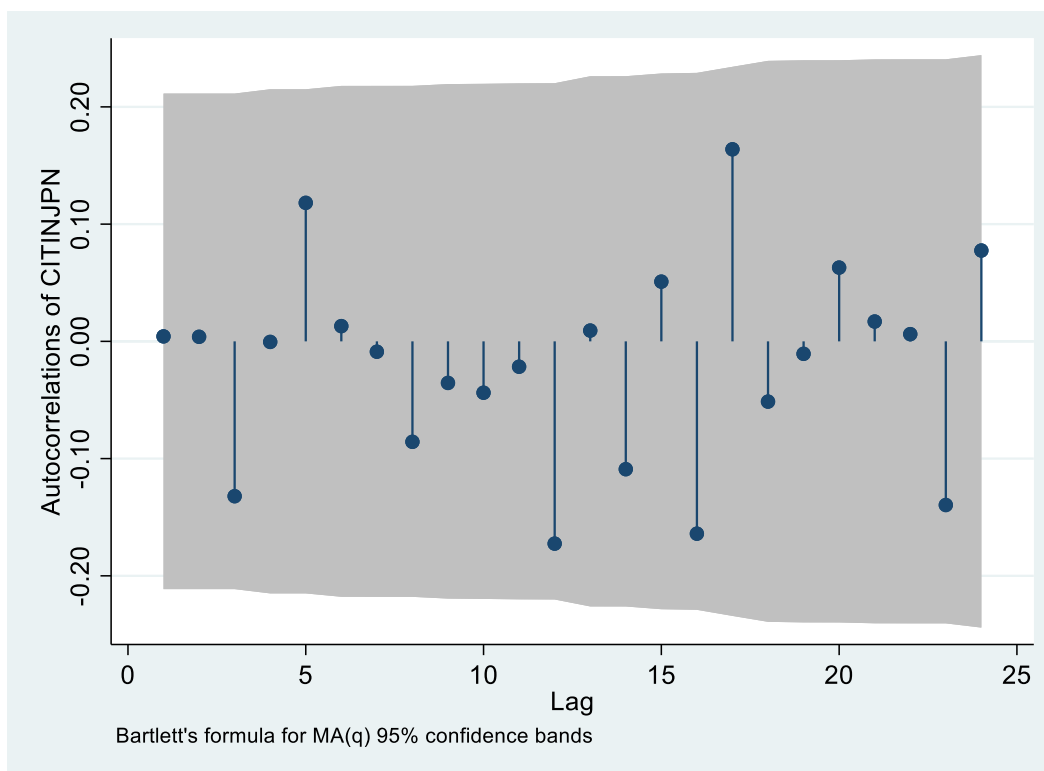
Augmented Dickey-Fuller Test of Citizen Injury Proportion Pre-Series

```
Augmented Dickey-Fuller test for unit root          Number of obs   =        33

                             ———————— Interpolated Dickey-Fuller ————————
                Test          1% Critical        5% Critical       10% Critical
             Statistic          Value              Value              Value
───────────────────────────────────────────────────────────────────────────────
Z(t)          -3.311            -3.696             -2.978             -2.620

MacKinnon approximate p-value for Z(t) = 0.0144
```

Partial Autocorrelation (PAC) Plot of Citizen Injury Proportion Pre-Series

95% Confidence bands [se = 1/sqrt(n)]
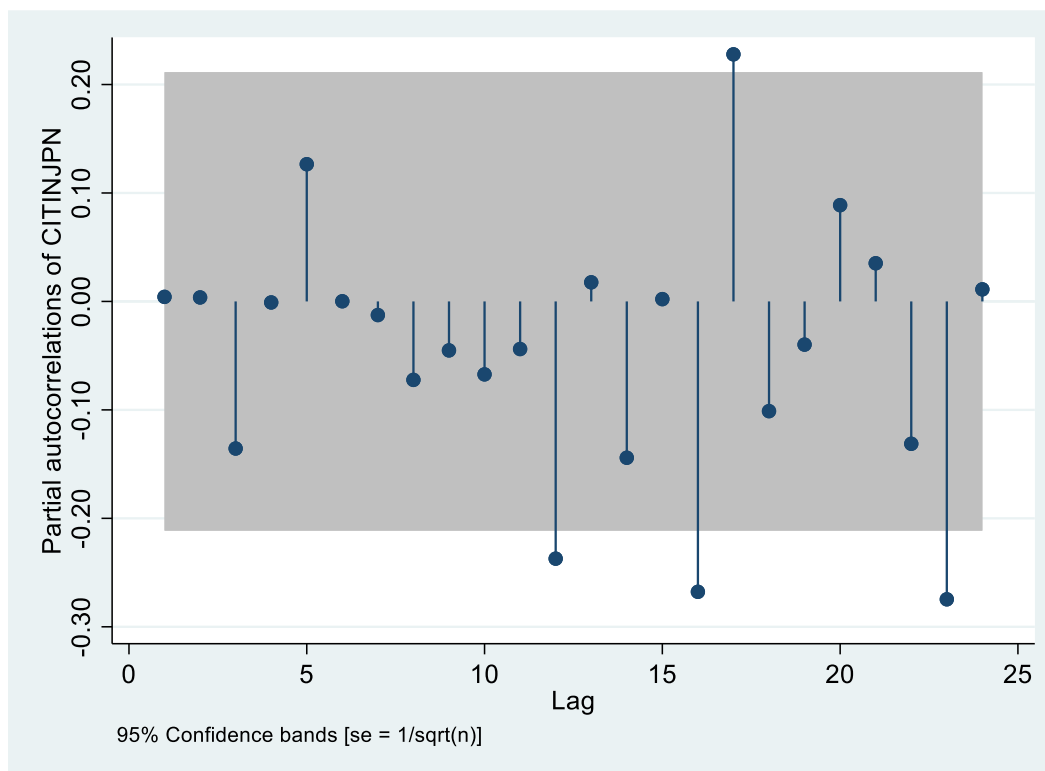
Correlogram of Citizen Injury Proportion Pre-Series – ARIMA (0, 0, 0)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.0043	0.0042	.00161	0.9680		
2	0.0039	0.0037	.00298	0.9985		
3	-0.1321	-0.1356	1.5937	0.6608		
4	-0.0005	-0.0009	1.5937	0.8099		
5	0.1181	0.1265	2.8978	0.7157		
6	0.0130	0.0002	2.9139	0.8196		
7	-0.0088	-0.0125	2.9214	0.8922		
8	-0.0857	-0.0723	3.6339	0.8886		
9	-0.0354	-0.0451	3.7574	0.9266		
10	-0.0438	-0.0673	3.9486	0.9496		
11	-0.0216	-0.0439	3.9958	0.9700		
12	-0.1725	-0.2372	7.04	0.8550		
13	0.0092	0.0176	7.0488	0.8996		
14	-0.1090	-0.1441	8.2983	0.8732		
15	0.0509	0.0021	8.5749	0.8987		
16	-0.1641	-0.2677	11.485	0.7786		
17	0.1638	0.2279	14.429	0.6365		
18	-0.0514	-0.1011	14.723	0.6809		
19	-0.0106	-0.0398	14.736	0.7392		
20	0.0629	0.0888	15.19	0.7654		
21	0.0169	0.0352	15.224	0.8116		
22	0.0062	-0.1313	15.228	0.8523		
23	-0.1396	-0.2747	17.569	0.7804		
24	0.0775	0.0111	18.302	0.7881		
25	0.0555	0.0798	18.684	0.8120		
26	0.1050	0.1070	20.074	0.7880		
27	0.0211	0.1210	20.131	0.8252		
28	-0.0220	-0.0116	20.194	0.8573		
29	-0.1466	-0.1416	23.049	0.7743		
30	0.0252	-0.0832	23.134	0.8097		
31	-0.0386	-0.0797	23.339	0.8365		
32	0.0455	-0.0383	23.629	0.8575		
33	-0.0331	0.1440	23.786	0.8804		
34	-0.0160	-0.1175	23.823	0.9034		
35	0.0133	0.0241	23.849	0.9231		
36	-0.0464	-0.1398	24.175	0.9336		
37	0.0193	-0.0970	24.232	0.9474		
38	-0.0279	-0.1392	24.355	0.9578		
39	0.0586	0.0517	24.907	0.9612		
40	-0.0066	0.0205	24.914	0.9703		

Citizen Complaint Rate ARIMA Diagnostics

Autocorrelation (AC) Plot of Citizen Complaint Rate Pre-Series

Bartlett's formula for MA(q) 95% confidence bands
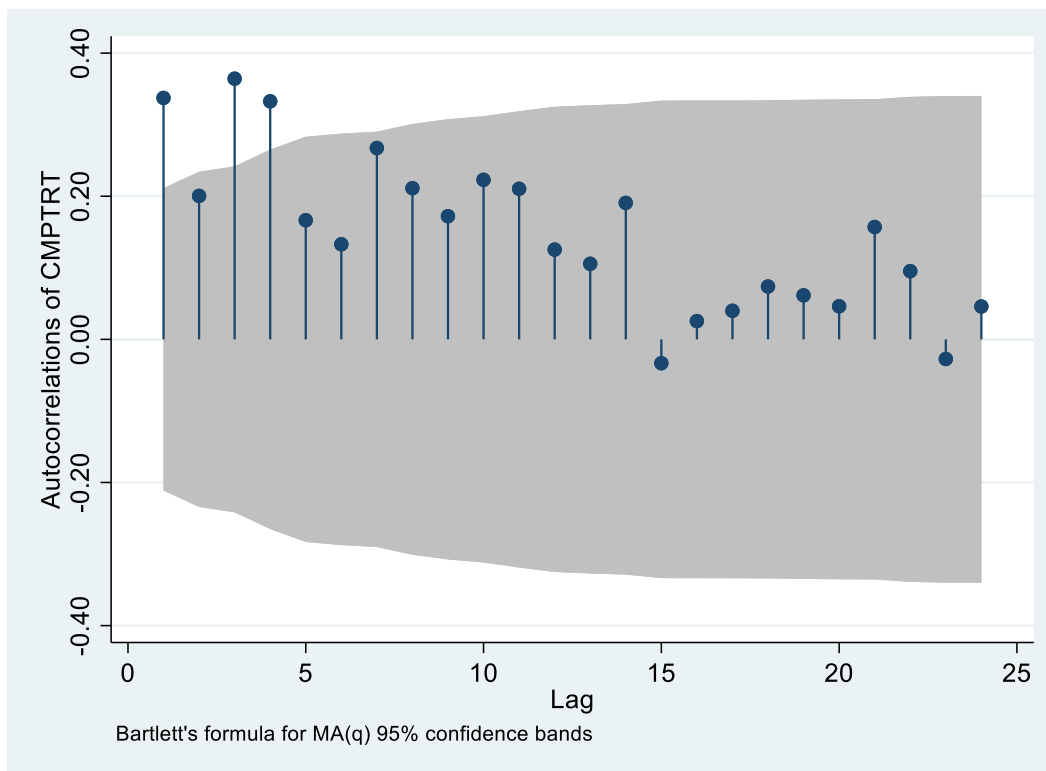
Augmented Dickey-Fuller Test of Citizen Complaint Rate Pre-Series

Augmented Dickey-Fuller test for unit root   Number of obs   =   33

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		───────────	Interpolated Dickey-Fuller	───────────
Z(t)	-2.293	-3.696	-2.978	-2.620

MacKinnon approximate p-value for Z(t) = 0.1742

Partial Autocorrelation (PAC) Plot of Citizen Complaint Rate Pre-Series

95% Confidence bands [se = 1/sqrt(n)]
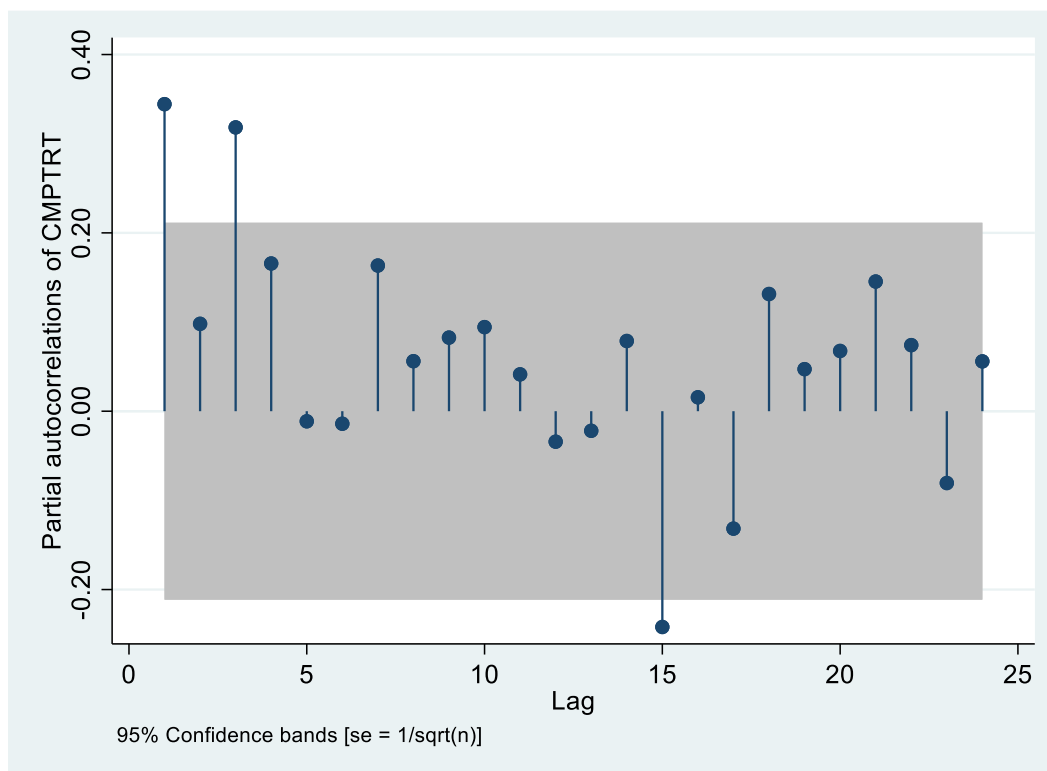
Correlogram of Citizen Complaint Rate Pre-Series – ARIMA (2, 1, 0)

					-1 0 1	-1 0 1
LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	-0.0120	-0.0119	.01269	0.9103		
2	-0.1526	-0.1548	2.0888	0.3519		
3	-0.1797	-0.1909	5.0018	0.1717		
4	0.0669	0.0378	5.4101	0.2477		
5	-0.0676	-0.1405	5.8326	0.3228		
6	-0.2143	-0.2796	10.13	0.1193		
7	0.0213	-0.0226	10.173	0.1790		
8	0.0165	-0.0988	10.199	0.2513		
9	0.0358	-0.0699	10.324	0.3249		
10	0.0656	0.0565	10.748	0.3775		
11	0.0335	-0.0339	10.861	0.4550		
12	0.0590	0.0333	11.213	0.5108		
13	-0.0374	0.0062	11.356	0.5810		
14	0.1453	0.1946	13.555	0.4834		
15	-0.2086	-0.1910	18.152	0.2547		
16	-0.0792	0.0075	18.825	0.2778		
17	-0.1079	-0.1450	20.091	0.2696		
18	0.0095	-0.1021	20.101	0.3272		
19	-0.0064	-0.0794	20.106	0.3883		
20	0.0149	-0.0496	20.131	0.4498		
21	0.1525	0.0272	22.817	0.3538		
22	0.1080	0.0844	24.187	0.3375		
23	-0.0320	-0.0444	24.309	0.3869		
24	-0.0150	-0.0033	24.336	0.4425		
25	-0.0750	-0.0600	25.03	0.4607		
26	-0.0166	-0.1003	25.065	0.5153		
27	0.0085	0.1256	25.074	0.5703		
28	0.0252	-0.0683	25.156	0.6193		
29	-0.1718	-0.2250	29.053	0.4623		
30	0.1404	0.2659	31.702	0.3815		
31	0.0034	-0.3022	31.704	0.4312		
32	-0.0027	-0.1270	31.705	0.4814		
33	-0.2063	-0.3388	37.757	0.2608		
34	0.0803	-0.4496	38.691	0.2661		
35	0.2631	0.1388	48.926	0.0592		
36	-0.0126	-0.3394	48.95	0.0735		
37	-0.1463	-0.0030	52.248	0.0495		
38	0.0131	0.5762	52.275	0.0615		
39	0.0982	-0.0267	53.826	0.0574		
40	0.0051	0.1953	53.83	0.0708		

Substantiated Citizen Complaint Disposition ARIMA Diagnostics

Autocorrelation (AC) Plot of Substantiated Complaint Disposition Proportion Pre-Series

Augmented Dickey-Fuller Test of Substantiated Complaint Disposition Proportion Pre-Series

```
Dickey-Fuller test for unit root                  Number of obs   =        35

                           ──────────── Interpolated Dickey-Fuller ────────────
                  Test         1% Critical        5% Critical       10% Critical
              Statistic           Value              Value              Value
─────────────────────────────────────────────────────────────────────────────
 Z(t)            -4.043            -3.682             -2.972             -2.618
─────────────────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0012
```

Partial Autocorrelation (AC) Plot of Substantiated Complaint Disposition Proportion Pre-Series

95% Confidence bands [se = 1/sqrt(n)]

Correlogram of Substantiated Complaint Disposition Proportion Pre-Series – ARIMA (0, 0, 0)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	-0.0471	-0.0555	.1974	0.6568		
2	0.1521	0.1785	2.2824	0.3194		
3	0.1043	0.1332	3.2737	0.3513		
4	-0.1021	-0.1534	4.2362	0.3750		
5	0.0667	0.0448	4.6525	0.4597		
6	0.0283	0.0738	4.7284	0.5791		
7	0.0280	0.0438	4.8038	0.6839		
8	0.0717	0.0752	5.3027	0.7248		
9	-0.0101	-0.0151	5.3128	0.8062		
10	-0.0539	-0.1033	5.6016	0.8476		
11	-0.0810	-0.1481	6.2641	0.8552		
12	-0.1523	-0.1963	8.6366	0.7336		
13	-0.0287	0.0173	8.7222	0.7936		
14	0.1780	0.3451	12.053	0.6020		
15	0.0344	0.1017	12.179	0.6654		
16	0.0849	-0.0040	12.958	0.6758		
17	0.0364	-0.0066	13.104	0.7292		
18	-0.0727	-0.1229	13.691	0.7490		
19	0.0489	0.1355	13.961	0.7859		
20	-0.2269	-0.3205	19.867	0.4663		
21	0.1423	0.1484	22.225	0.3866		
22	-0.0901	-0.1638	23.186	0.3913		
23	-0.0268	-0.1421	23.272	0.4450		
24	-0.0383	-0.1593	23.451	0.4933		
25	-0.1791	-0.1320	27.432	0.3347		
26	-0.1220	-0.0879	29.308	0.2973		
27	-0.1074	-0.1707	30.787	0.2800		
28	-0.1565	-0.2181	33.985	0.2014		
29	0.0398	0.0916	34.195	0.2322		
30	-0.1317	-0.1112	36.538	0.1910		
31	-0.0102	-0.0718	36.552	0.2265		
32	-0.0365	-0.2290	36.739	0.2585		
33	-0.0618	-0.0726	37.285	0.2784		
34	-0.1052	-0.4432	38.895	0.2587		
35	-0.0040	-0.3385	38.897	0.2985		
36	0.0105	-0.4274	38.914	0.3399		
37	0.0417	-0.1511	39.182	0.3722		
38	0.0295	-0.1348	39.32	0.4106		
39	-0.0333	-0.2732	39.499	0.4476		
40	0.0614	-0.0688	40.119	0.4650		

Exonerated Citizen Complaint Disposition ARIMA Diagnostics

Autocorrelation (AC) Plot of Exonerated Complaint Disposition Proportion Pre-Series

Bartlett's formula for MA(q) 95% confidence bands

Augmented Dickey-Fuller Test of Exonerated Complaint Disposition Proportion Pre-Series

```
Dickey-Fuller test for unit root                   Number of obs   =        35

                         ——————— Interpolated Dickey-Fuller ———————
                Test         1% Critical         5% Critical        10% Critical
            Statistic             Value               Value               Value
 ————————————————————————————————————————————————————————————————————————————
 Z(t)          -5.492              -3.682              -2.972              -2.618
 ————————————————————————————————————————————————————————————————————————————
 MacKinnon approximate p-value for Z(t) = 0.0000
```

Partial Autocorrelation (AC) Plot of Exonerated Complaint Disposition Proportion Pre-Series

95% Confidence bands [se = 1/sqrt(n)]

Correlogram of Exonerated Complaint Disposition Proportion Pre-Series – ARIMA (0, 1, 1)

					-1 0 1 -1 0 1
LAG	AC	PAC	Q	Prob>Q	[Autocorrelation] [Partial Autocor]
1	0.0252	0.0255	.05586	0.8132	
2	0.0459	0.0463	.24365	0.8853	
3	-0.1904	-0.1963	3.5126	0.3191	
4	0.0064	0.0175	3.5164	0.4754	
5	0.2348	0.3066	8.6139	0.1255	
6	0.0928	0.0428	9.4206	0.1513	
7	0.0445	0.0339	9.6085	0.2119	
8	-0.0994	-0.0082	10.556	0.2281	
9	-0.0777	-0.1007	11.144	0.2660	
10	0.0350	-0.0106	11.265	0.3373	
11	-0.0393	-0.1706	11.419	0.4089	
12	-0.0106	-0.0733	11.43	0.4925	
13	0.0780	0.2197	12.055	0.5231	
14	0.0915	0.2097	12.927	0.5323	
15	0.0117	-0.0173	12.941	0.6068	
16	-0.0668	-0.0614	13.419	0.6419	
17	0.0402	0.1098	13.595	0.6955	
18	-0.0577	-0.2052	13.963	0.7315	
19	0.2261	0.2445	19.692	0.4133	
20	-0.0071	-0.0388	19.698	0.4770	
21	-0.0087	-0.0814	19.707	0.5399	
22	-0.1983	-0.2796	24.32	0.3307	
23	-0.0987	-0.1939	25.482	0.3259	
24	0.1274	0.2453	27.449	0.2840	
25	-0.0935	-0.2460	28.527	0.2842	
26	-0.0651	-0.1410	29.058	0.3085	
27	-0.0803	0.0834	29.879	0.3196	
28	-0.1492	-0.1276	32.765	0.2445	
29	-0.0289	-0.1544	32.876	0.2828	
30	-0.0974	-0.1827	34.152	0.2748	
31	-0.0542	-0.2404	34.554	0.3018	
32	0.0658	0.2702	35.158	0.3209	
33	0.0705	0.3532	35.865	0.3356	
34	0.0173	-0.3839	35.909	0.3791	
35	-0.1596	-0.1547	39.678	0.2693	
36	-0.0506	0.1012	40.064	0.2946	
37	0.1067	0.4221	41.819	0.2695	
38	0.1603	0.4214	45.863	0.1784	
39	0.0052	0.0107	45.867	0.2088	
40	-0.0629	0.4138	46.518	0.2218	

APPENDIX B

VAR/VARX DIAGNOSTICS

Johansen Test for Cointegration

```
                      Johansen tests for cointegration
Trend: constant                                  Number of obs =     85
Sample:  2010m6 - 2017m6                                    Lags =      1
───────────────────────────────────────────────────────────────────────
                                                      5%
maximum                                   trace   critical
  rank     parms        LL     eigenvalue statistic  value
    0         7    -661.1019        .      369.5280  124.24
    1        20    -609.11343   0.70573    265.5511   94.15
    2        31    -568.24782   0.61770    183.8199   68.52
    3        40    -534.81071   0.54468    116.9457   47.21
    4        47    -507.89821   0.46913     63.1207   29.68
    5        52    -490.16267   0.34118     27.6496   15.41
    6        55    -478.26805   0.24412      3.8603    3.76
    7        56    -476.33788   0.04440
───────────────────────────────────────────────────────────────────────
```

Augmented Dickey-Fuller Tests for Stationarity

Augmented Dickey-Fuller Test of Calls for Service Rate

```
Augmented Dickey-Fuller test for unit root      Number of obs   =      84

                         ─────── Interpolated Dickey-Fuller ───────
              Test           1% Critical    5% Critical   10% Critical
           Statistic            Value          Value          Value
──────────────────────────────────────────────────────────────────────
 Z(t)        -4.248            -3.532         -2.903         -2.586
──────────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0005
```

Augmented Dickey-Fuller Test of Self-Initiated Enforcement Activity Rate – 1st Difference

```
Augmented Dickey-Fuller test for unit root      Number of obs   =      83

                         ─────── Interpolated Dickey-Fuller ───────
              Test           1% Critical    5% Critical   10% Critical
           Statistic            Value          Value          Value
──────────────────────────────────────────────────────────────────────
 Z(t)        -8.737            -3.534         -2.904         -2.587
──────────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0000
```

Augmented Dickey-Fuller Test of Use of Force Rate

```
Augmented Dickey-Fuller test for unit root          Number of obs   =        84

                                ————————— Interpolated Dickey-Fuller —————————
                     Test         1% Critical        5% Critical       10% Critical
                   Statistic         Value              Value              Value
─────────────────────────────────────────────────────────────────────────────────
 Z(t)               -3.590           -3.532            -2.903            -2.586
─────────────────────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0060
```

Augmented Dickey-Fuller Test of Severity of Force

```
Augmented Dickey-Fuller test for unit root          Number of obs   =        84

                                ————————— Interpolated Dickey-Fuller —————————
                     Test         1% Critical        5% Critical       10% Critical
                   Statistic         Value              Value              Value
─────────────────────────────────────────────────────────────────────────────────
 Z(t)               -6.335           -3.532            -2.903            -2.586
─────────────────────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0000
```

Augmented Dickey-Fuller Test of Citizen Complaint Rate

```
Augmented Dickey-Fuller test for unit root          Number of obs   =        84

                                ————————— Interpolated Dickey-Fuller —————————
                     Test         1% Critical        5% Critical       10% Critical
                   Statistic         Value              Value              Value
─────────────────────────────────────────────────────────────────────────────────
 Z(t)               -4.619           -3.532            -2.903            -2.586
─────────────────────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0001
```

Augmented Dickey-Fuller Test of Substantiated Complaint Proportion

```
Augmented Dickey-Fuller test for unit root          Number of obs   =        84

                                ————————— Interpolated Dickey-Fuller —————————
                     Test         1% Critical        5% Critical       10% Critical
                   Statistic         Value              Value              Value
─────────────────────────────────────────────────────────────────────────────────
 Z(t)               -5.145           -3.532            -2.903            -2.586
─────────────────────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0000
```

Augmented Dickey-Fuller Test of Exonerated Complaint Proportion

```
Augmented Dickey-Fuller test for unit root          Number of obs   =        84

                         ──────────── Interpolated Dickey-Fuller ────────────
                Test          1% Critical      5% Critical     10% Critical
             Statistic           Value           Value            Value
─────────────────────────────────────────────────────────────────────────────
  Z(t)        -5.185            -3.532          -2.903           -2.586
─────────────────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0000
```

Vector Autoregression Specification Optimization for Model 1 – VAR Analysis

```
Selection-order criteria
Sample:  2010m9 - 2017m6                        Number of obs      =        82
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-578.534				.003758	14.2813	14.3638	14.4868
1	-463.161	230.75	49	0.000	.000748*	12.6625*	13.3223*	14.3061*
2	-426.97	72.382	49	0.017	.001048	12.9749	14.2122	16.0566
3	-388.9	76.14	49	0.008	.00146	13.2415	15.0561	17.7614
4	-352.892	72.015*	49	0.018	.002281	13.5583	15.9504	19.5164

Notes: Endogenous system variables included = calls for service rate, self-initiated enforcement activity rate, use of force rate, severity of force, citizen complaint rate, substantiated complaint disposition, and exonerated complaint disposition.

Vector Autoregression Specification Optimization for Model 2 – VARX Analysis

```
Selection-order criteria
Sample:  2010m10 - 2017m6                       Number of obs      =        81
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-538.548				.0001	13.495	13.5899	13.7315
1	-300.869	475.36	64	0.000	1.4e-06*	9.20665*	10.0606*	11.335*
2	-252.038	97.663	64	0.004	2.1e-06	9.58118	11.1942	13.6015
3	-207.549	88.978	64	0.021	3.8e-06	10.0629	12.435	15.9752
4	-165.563	83.972*	64	0.048	8.3e-06	10.6065	13.7376	18.4106

Notes: Endogenous system variables included = calls for service rate, self-initiated enforcement activity rate, use of force rate, severity of force, citizen complaint rate, substantiated complaint disposition, and exonerated complaint disposition; exogenous variables = BWC proportion, Ferguson incident, and monthly average temperature.

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Major Professor: Joseph Schafer

Publications:

Kyle, M. J. & White, D. R. (2017). The impact of law enforcement officer perceptions of organizational justice on their attitudes regarding body-worn cameras. *Journal of Crime and Justice, 40*(1), 68-83. doi: 10.1080/0735648X.2016.1208885
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