Shift Structure and Cognitive Depletion: Evidence from Police Officers

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Abstract: Decision-making, risk-taking, and situational awareness are all important factors for effective and equitable policing. However, these factors can also be affected by fatigue, overwork, and cognitive stress, which can accumulate as police officers continue to work. This paper studies the evolution of police officer outcomes and activity over consecutive working days using rich data from the Chicago Police Department. To overcome the endogenous selection of working days, I take advantage of a unique shift structure where working days are predetermined and based on fixed groupings. This is combined with a two-way fixed effects design that leverages within-officer variation across different working days. I find that as officers work more consecutive days, they use more force, make more judgement-based discretionary arrests, and are more likely to be injured. These increases occur despite a decline in proactive policing activities. Officers make fewer arrests, conduct fewer stops, issue fewer citations and tickets, and spend less time actively patrolling as their workdays accumulate. The divergence between use-of-force and policing activity is not driven by changes in arrest types, shift assignments, or officer roles, instead, officers are changing their behavior as they work more days.

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1 Introduction

Professions of every kind encompass a unique blend of demands, from physical exertions and mental challenges to the need for attention, coordination, and the integration of new information. Each profession relies on workers facing these cognitive challenges, which can intensify and compound during extended work periods. How do these prolonged spells of consecutive workdays affect workers' performance, particularly in high-stakes professions such as law enforcement? This central question informs the need for optimal shift design and programs combating fatigue to maintain workplace effectiveness and safeguard the health and safety of workers and the public.

Police officers, in particular, face substantial physical and cognitive demands; their extended shifts necessitate making frequent split-second, life-and-death decisions. For instance, police officers must swiftly determine the appropriate level of force to use in potentially harmful situations, with choices ranging from discharging a firearm to opting to withdraw. These choices are frequently based on profiling or instinctive judgment, making them especially prone to being influenced by increased cognitive load. Prolonged work periods may significantly affect a police officer's decision-making, potentially leading to poorer judgment, more forceful interventions, or changes in productivity. However, this is complicated by the nature of public safety work, which requires 24-hour coverage. Unlike many professions where shifts can be adjusted or temporarily halted, public safety shifts are more rigid due to the constant need for protection and emergency response readiness. This rigidity poses challenges for shift managers, who must balance providing public safety while not overworking employees.

In this paper, I study the evolution of police officer work across consecutive days. I do this by leveraging rich administrative data on police officers, including daily officer shift assignments with detailed information on geographic location, roles, and timing; officer arrest data with types of arrests made and who is being arrested; use-of-force incidents with measures of intensity and injury reporting; investigatory stops with details about civilian characteristics;

and 911-call dispatches with their response time. These data come from the Chicago Police Department and are matched together to create a rich panel of officer shifts and daily outcomes from 2014 to 2019. Police officers in Chicago work 9-hour shifts, with 4 consecutive working days followed by 2 days off. In total, I observe 11,156 officers who work 5.3 million shifts.

Direct comparisons of police officer shifts are challenging due to potential selection of officers to working days. To circumvent this issue, I exploit a unique shift structure common among police officers, where working days are predetermined and based on fixed groupings. In this setting, officers are divided into one of six groups, each working the same set of days but on staggered schedules. As a result, each officer's schedule is entirely decided by this group assignment and the ability to deviate from this schedule is limited. This prevents officers from strategically working on days with higher or lower levels of crime, or working more or fewer days in a row based on their preferences or ability. I show empirically that this creates shift assignments that are uncorrelated with underlying crime patterns. This identification approach is combined with a two-way fixed effects design but, as expected, fixed effects do little to change the results as individual working days are not related to working conditions by design.

I find that police officers report using more force as the number of consecutive working days increase. In total, use-of-force incidents rise by a significant 10% between days one and three and remains elevated on the fourth day. Intuitively, one might anticipate that this rise in use-of-force would be accompanied by an overall increase in general police activities—such as arrests, investigatory stops, and the issuance of tickets or citations. However, I find the opposite to be true. Unlike the steady increase in use-of-force, I find that police activity, after an initial rise, declines over consecutive days. Additionally, this rise in use-of-force is also accompanied by an increase in officer injury, suggesting that the rise in use-of-force is not without consequence.

In addition to using more force, I provide evidence of frustration and irritation as working days increase. I do so by exploring the incidence of discretionary arrests, which are arrests that are judgment-based and are plausibly "unnecessary" for the maintenance of public safety. Examples of such arrests are charges such as *disobeying an officer* or *resisting an officer*. These arrests have been used in the past to explore frustration, irritation, and depletion of cognitive resources as discretionary arrests are often an emotional response from officers, rather than in response to a crime (Dube et al., 2023). I find a remarkably similar pattern between discretionary arrests and use-of-force. Discretionary arrests diverge from general police activity, such as non-discretionary arrests. This increase in discretionary arrests is consistent with the notion that officers become more frustrated and irritated as they continue to work consecutive days.

Additionally, I find evidence of officer shirking. Using GPS data from patrol cars, I find that officers spend more time stationary, evidence of reduced active patrolling. When dispatched for 911 calls, officers take longer to acknowledge and respond to calls as they work more days. These results further suggest that officers are less proactive in their policing efforts as they continue to work consecutive days.

Overall, I find a significant change in officer behavior over their assigned working days. Despite a decline in police activity, officers file more use-of-force reports after working four consecutive days. By itself, a rise in use-of-force is not necessarily a negative outcome. This is because use-of-force is a byproduct of many productive, and possibly necessary police activities. However, a rise in use-of-force without a corresponding rise in police interactions suggests excessive, unnecessary, and potentially inefficient use-of-force. This finding is consistent with the notion that as officers continue to work consecutive days, their judgment may become compromised, leading to a combination of over-reliance on force and reduced proactive policing efforts. Taken together, the threat to civilians through use-of-force and the increase risk of injury to officers suggests that the current shift structure may be suboptimal for both officers and the community.

I consider three alternative explanations for these findings. The first is that the findings are mechanical, simply because officers encounter more dangerous situations over consecutive days. However, I find robust evidence that the amount of crime on each day is unrelated to the number of consecutive days worked. Additionally, I find no evidence that officers make more or less violent arrests over consecutive days. This reinforces the central finding of the paper, police officers are using more force despite no increase in their day-to-day activities. The second explanation is that physical fatigue is the main driver of the results, either due to loss of sleep or physical exhaustion. While this explanation cannot be fully ruled out, an exploration into officer activity during the first three hours of their shift reveal large increases in use-of-force. These first three hours of an officer shift are presumably less likely to be affected by physical fatigue. The third explanation is that officer roles are changing over their working days. To address this, I utilize only patrol officers who have consistent roles over their working days. These officers are assigned to a small geographic region, known as a beat, and are consistently assigned to the same role for one year with little overlap in jurisdiction with other officers. Additionally, analysis based on officer roles within each arrest reveals no reductions from primary to assisting officer based on their working days.

Using these estimates, I construct comparisons involving alternative shift structures. I demonstrate that restructuring shifts to include more frequent breaks can lead to a reduction in use-of-force incidents and officer injuries. Importantly, these reductions are not achieved by decreasing total work time of individual officers. Instead, the restructured schedules involve more frequent, albeit shorter, periods of rest. As a result, some alternative structures are able to reduce adverse incidents while simultaneously increasing arrests and stops by taking advantage of performance gains at the beginning of officers' work spells. These results indicate that more frequent breaks can positively impact both officers and the public by increasing officers' capacity to perform safely and effectively.

These findings contribute to several areas of research, such as understanding how shift structures influence productivity and performance. Despite shift design being a critical determinant of workplace effectiveness, the optimal balance between workdays and breaks is often unclear. Work schedules vary greatly, both in their duration of shifts and their patterns of workdays and non-workdays. Prior work has explored non-law enforcement occupations and found that prolonged hours can reduce effort (Chan, 2018), increase mistakes (Brachet et al., 2012; Huffmyer et al., 2016), and reduce productivity (Pencavel, 2015; Collewet and Sauermann, 2017; Bavafa and Jónasson, 2023). While these studies predominately focus on the *negative* effects of working hours within a day, several studies suggest that consecutive working periods have *positive* returns to productivity in moderation due to learning on the job (Erosa et al., 2022; Eden, 2021). Importantly, the specific threshold at which work becomes "too much", triggering negative effects, is often undefined and varies by individual and context making shift design a difficult endeavor. In this study, I provide evidence in a new context of policing, where police officers are subject to unique demands and pressures. The results of this study show that even under the standard 9-hour shifts, officers do not fully "reset" after nightly breaks between shifts, an important consideration for shift managers.

Second, this paper contributes to understanding the role of cognitive load in the workplace by using insights from experimental work on cognition with empirical field data on workplace behavior. These prior studies show that depletion of cognitive endurance threatens the ability to maintain focus (Brown et al., 2022) and make high-quality decisions (Caplin and Martin, 2016). In addition to focus and attention, fatigue and overwork can contribute to errors in judgment (Schilbach, 2019), impatience (Kamstra et al., 2000), and increase preference for risk (Castillo et al., 2017). There have been several empirical studies that have explored these findings outside the lab. For example, high-pressure situations in sports, which demand increased mental effort, can deplete an individual's limited attention capacity (Archsmith et al., 2021), and long periods of grading lead professors to grade harsher and leave more rude comments (Wang et al., 2023). Most similar to the current study, Dube et al. (2023) implements a police officer training program aimed at enhancing officers' decision-making capabilities while under cognitive stress and finds a reduction use-of-force and discretionary arrests among training participants. The current study identifies a circumstance in which officers are placed under increased cognitive stress and shows how police officers respond to this stress through changes in their behavior.

Third, this paper contributes to work on the economics of policing by providing evidence of a powerful policy lever, shift structure, which has the potential to improve individual police officer quality. Generally, prior work has found a negative elasticity of crime with respect to police presence (Levitt, 1997; McCrary, 2002; Di Tella and Schargrodsky, 2004; Evans and Owens, 2007; Draca et al., 2011; Fu and Wolpin, 2018; Weisburst, 2019; Mello, 2019). However, these studies leverage changes in the quantity or distribution of officers and their effects on crime, but a less explored aspect of police presence is individual police officer quality (Owens and Ba, 2021; Chalfin and Goncalves, 2020). In this paper, I provide evidence that the quality of service that individual police officers provide is dynamic, and affected by shift structure. By providing evidence of a policy tool available to policing managers, this paper sheds light on how individual officers can be managed to improve the quality of policing services. This is especially important given that police departments have a wide range of shift structures with varying shift lengths, working days per week, and patterns of time off, prompting the question of which structure is most effective.

The rest of the paper proceeds as follows, Section 2 provides background on related literature and the shift structures of police officers in Chicago, Section 3 details the data and the empirical strategy, Section 4 gives the results on arrests, investigatory stops, and use-of-force reports, then conducts heterogeneity analysis, mechanism exploration, robustness, and a discussion on alternative shift structures. Section 5 concludes with potential areas for future work.

2 Prior Literature

2.1 Police Staffing

The total direct and indirect costs of crime are estimated to be $3 trillion per year in the United States (Anderson, 2021). The principal organization responsible for reduction and deterrence of crime, the police, are comprised of 800,000 sworn law enforcement officers spread over approximately 18,000 agencies (NLEOMF, 2023). Despite similar goals, police departments in the United States are decentralized with varying personnel structures, incentive schemes, and training. Little is known about how these differing personnel structures lead to differing effectiveness of police departments. This is especially important considering that in recent years, police forces have had trouble recruiting and retaining officers, as evidenced declines in total officers during 2022 in the three largest police departments in the United States: New York City, Chicago, and Los Angeles (NY DCJS, 2023; Federation, 2022; Times, 2021).

The complexity of police work and the varied shift structures make police officers an ideal subject for studying the impact of work schedules. Research on how shift structure affects police outcomes has left many unanswered questions and has been limited in its scope. This dearth of applied research is exacerbated by the highly decentralized nature of police forces leading to variation in how the shifts are assign, the number of hours worked in a day, and the organization of days worked within a week. Police shifts typically range from 3 to 5 days per week with shift lengths ranging from 8 to 12 hours. But this structure can be substantially altered by officer-initiated or administratively mandated overtime, leading to significant deviations from the norm.

Shift structures represent a critical policy lever within police departments, controlling the availability of officers on duty. This availability has the potential to deter criminal activity before occurring and to respond to incidents as they occur. Prior work on the elasticity of crime with respect to police presence has found a negative relationship between the two (Weisburst, 2019; Mello, 2019; Fu and Wolpin, 2018; Draca et al., 2011; Evans and Owens, 2007; Di Tella and Schargrodsky, 2004; McCrary, 2002; Levitt, 1997). However, these prior studies have focus on the quantity of officers and their effects on crime, but a less explored aspect of police presence is individual police quality. Both a change in quantity and quality of police officers can affect the effective number of officers on the street.

Working numerous consecutive shifts might impact the quality of individual police officers. Officers on successive days may improve their abilities in solving and preventing crimes due to increased understanding of local crime patterns and community dynamics. This knowledge enables more effective surveillance and swift action on investigative leads. However, the transition between personal and professional mindsets could introduce significant start-up costs, particularly in high-crime zones, potentially affecting the overall quality of an officer's work.

While there may be benefits to working consecutive shifts, the potential risks associated with such schedules could be quite costly. Prolonged periods of work without adequate rest can lead to fatigue and exhaustion among officers, diminishing their physical and mental health. Prior work in this area has suggested that police officer are often work long hours, report poor quality sleep, and score poorly on exams related to fatigue-induced impairment (Vila, 2000) In situations where empathy and patience are crucial, an overworked officer may be more prone to errors and resort to depersonalized policing, prioritizing swift resolutions over de-escalation tactics. The cumulative effect of fatigue can impair judgment and reduce the capacity for nuanced decision-making. This reduced sympathy and self-control is closely related to the concept of ego depletion, where individuals can expend their cognitive endurance through over-use (Baumeister and Vohs, 2007). Ensuring fatigue is not a factor in fair and equitable policing is pivotal in maintaining public trust and ensuring the safety of both officers and the communities they serve.

Police unions and municipal governments frequently debate how many hours officers should work. In Chicago, for example, the leader of the Chicago Fraternal Order of Police argued in 2022 that officers were being overworked, leading to burnout due to insufficient time off. He claimed that the lack of rest and support from city leadership endangered officers' well-being. However, this claim was contested by the then-Mayor Lightfoot, who stated, "This notion… 'They're being worked like mules' — it's just simply not correct," (Pratt, 2022). The controversy highlights the ongoing debate over optimal shift structures in high-stakes occupations like policing. But at the core of this issue is a lack of understanding of how shift structure affects policing outcomes.

2.2 Shift Structure and Productivity

Optimal shift design is a critical determinant of workplace effectiveness and a major consideration for managers across all occupations. The relationship between hours worked and productivity has long been a focus of research, with many studies examining how labor allocation affects overall output. Previous work in this area has primarily focused on hours worked within a day and their effect on productivity, usually within health-care, where long hours are the norm, or in manufacturing, where output can be easily quantified.

For instance, Pencavel (2015) explored this relationship with WWI munitions workers and found a linear relationship between productivity and hours worked up to a certain threshold. Specifically, after exceeding 48 hours worked within a week, worker productivity per hour began to decline. Similar to this finding, the current paper finds that the relationship between hours worked and productivity has a specific threshold beyond which productivity begins to decline. However, the current paper finds that police officers, initially, become more productive. This is consistent with the nature of police work, where officers can become more effective at solving and preventing crimes by working consecutive shifts, leading to increased understanding of local crime patterns and community dynamics.

However, one of the major challenges in assessing the effect of shift structure on productivity is the potential endogeneity in how shifts are assigned. More capable workers may be assigned more shifts, creating bias in the analysis. Additionally, for many workers who work primarily on weekdays, it is difficult to separate the effect of individual weekdays from the interactions between coworkers, whose schedules may be correlated.

To address these challenges, Collewet and Sauermann (2017) used data from call center workers who were scheduled independently of their preferences by a centralized personnel manager. They found that a 1% increase in working hours translated to a 0.9% increase in call volume, a measure of output. Interestingly, this was accompanied by an increase in call quality, suggesting that continuity of work could benefit the quality of output even if the quantity did not increase proportionally. This current study adopts a similar approach by leveraging centrally planned schedules and using individual-level data, though it explores a different setting.

It is possible that the high-stakes nature of police work could lead to different outcomes than those found in other settings. For example, in manufacturing fatigue and overwork can lead to reduced output, but in policing, the consequences of reduced performance can be much more severe. Most prior research in high-stakes settings has concentrated on variations in hours worked within a day, an intensive margin increase, particularly in settings like healthcare. Medical professionals, for instance, are frequently asked to work extended hours.

Brachet et al. (2012) examined emergency medical service (EMS) workers and found that extended shifts, such as 24-hour shifts, resulted in reduced performance, including slower response times, longer procedure times, and increased interventions per patient. Similar to police officers, EMS workers are 'forced' into situations. Even if fatigued, in most cases EMS units cannot pass off their responsibilities to other units due to the time sensitive nature of their work.

This differs from Chan (2018), which finds that doctors will reduce their effort at the end of long shifts. When possible, doctors will pass off patients to other doctors, thus reducing effort is potentially optimal a way to manage fatigue. This is not possible for police officers, who are geographically dispersed and dispatched to crime scenes by a centralized dispatcher who is unaware of the police officers individual capacity. Interestingly, if a doctor cannot reduce their effort, Chan (2018) find doctors will use expensive hospital resources to expedite their work.

This result has important implications for police work, particularly in how officers might manage the pressures of their shifts. If quick resolutions are prioritized, police officers may resort to using excessive force or making discretionary arrests to expedite their work, despite these actions high cost. When faced with argumentative or uncooperative individuals, police officers can use force to end the interaction, rather than using de-escalation techniques.

For example, police officers can use physical contact, such as handcuffing, or choose to make a judgement-based arrest, such as ‘disobeying and officer’. Understanding why officers use these costly actions and in what environments they rely on them, provides insights in how to improve police officer policies, prioritize de-escalation, and reduce injuries.

Organizations and managers are not unaware of the risks associated with extended working hours. In 2011, the Accreditation Council for Graduate Medical Education implemented a cap on the number of hours medical interns could work, citing the dangers of unsafe working conditions when interns were required to work excessively long shifts (Nasca et al., 2010). Similarly, the Federal Aviation Administration (FAA) has restrictions limiting air traffic controllers to six consecutive days of work and no more than 10 consecutive hours, following reports of controllers working five 8-hour shifts over a 4-day period. The primary difficulty in reducing the number of hours worked by police officers is the constant demand for police services and emergency response readiness, which requires officers to be available at all hours of the day.

3 Data and Methodology

Data for this paper comes from multiple Freedom of Information Act (FOIA) requests filed with the City of Chicago and the Chicago Police Department. These data help to understand officer duty schedules and daily activities, providing insight into the operational behaviors of police personnel.

3.1 CPD Shift Logs and Shift Structure

The primary source of data for this study are the shifts worked by members of the Chicago Police Department (CPD) from 2014 through the end of 2019. This dataset includes detailed records of over 15,000 sworn officers and nearly 13 million shifts. For each officer, the data includes key demographic and professional information such as name, badge number, race, age, and tenure, as well as records of any work absences and their reasons. Additionally, the data specifies the watch (time of day) and beat (geographic location) to which officers were assigned. Beats in Chicago are geographic areas covering approximately one square mile. Officers that are explored in this paper will be tasked with patrolling their assigned beat and will typically not respond to calls for service outside of this assigned area. There also includes a rough measure of the specific assignment within each beat. There are over 9,000 unique combinations of beat, watch, and assignment recorded in the dataset, which together define the specific roles and responsibilities assigned to each officer.

Important to this analysis, officers will work the same watch and beat assignments day to day. This consistency between assignments is vital to identification, as it ensures that any observed changes in performance are attributable to the shift structure rather than varying responsibilities. These assignments are given out at the beginning of each year and are decided based on a seniority-based preference system (more tenured officers pick first) and the discretion of a watch commander. While assignments generally do not change, the watch commander has the power to move officers to new assignments based on the operational needs of their respective districts. Because these are set at the beginning of each year, officers have little power to manipulate their schedules on a day-to-day basis.

The structure of shifts for CPD officers is, in large part, structured based on 'day off groups', a scheduling system where officers are designated into 6 distinct groupings that dictate which days officer are assigned. All officers within the same 'day off group' are assigned to work on the same days. This structure leads officers to have their set of work-days and off-days predetermined and rotating. Officers in this study will work for 4 consecutive days followed by 2 days off. Because this is a 6-day schedule (rather than a typical 7-day schedule), officers will work weekdays in a rotating fashion. For example, an officer may work Monday to Thursday, followed by Sunday to Wednesday, followed by Saturday to Tuesday.

Importantly, each 'day off group' is staggered by one day. That is, on any given day each ‘day off group’ is at a different stage of their rotating schedule. An example of this structure is illustrated in Figure 1 for two of these day off groups. This structure assures that both weekend and weekdays are evenly distributed to officers, and that officers are evenly distributed between days of the year. This scheduling is advantageous to a researcher, since it removes some of the selection that workers have to choose their working days based on crime levels. While deviations from this schedule do occur, fewer than 2% of shifts fall outside an officer’s assigned schedule and results are robust to the removal of these shifts. Figure 1 depicts the temporal variation in these deviations for several day off groups, displaying that they are relatively rare. Figure 2 shows the raw counts of each shift’s consecutive day worked number, displaying a steep drop off after the 4th day worked.

Still, despite little control over shift assignment on a day-to-day basis, it is important for identification that officers cannot manipulate their schedules to work on days with lower levels of crime. I show in Appendix Table A.1 that individual officer work days are unrelated to two measures of crime at the district-level: counts of civilian-initiated 911 calls and counts of gunshots reported by ShotSpotter technologies. The second measure, counts of ShotSpotter gunshots, uses data from geographically-spaced microphones across the city of Chicago to detect gunfire. This measure has been used in previous literature as a measure of criminal activity that is not subject to police reporting bias (Carr and Doleac, 2016, 2018; Ang et al., 2021). This table shows that officers are not experiencing different levels of expected crime, conditional on how many consecutive days that they have worked. If officer could control their schedules, for example, taking off their last day if they expect higher crime levels, we would expect to see a relationship between officer work days and crime levels. This evidence supports the idea that officer schedules are relatively fixed.

3.2 Measures of Police Officer Activity

Arrests First, arrest records by officer are added for all non-juvenile arrests made between 2014 and 2019. This data includes the demographics of arestees (race, age), and suspected crime. This data also includes the role of each officer in each arrest from first officer, second officer, or assisting officer. Each arrest requires one first officer but may also contain one second officer as well as any number of assisting officers. The majority of analysis utilizes counts of arrests of any role. But the patterns in outcomes are consistent between alternative definitions and analysis using only specific roles are provided as robustness.

Investigatory Stops Second, investigatory stop records are included. These data record incidents where a CPD officer stops and questions a civilian based on suspicion that the civilian has committed a crime. For each stop, this data contains demographic information on the stopped individual (race, age) and information on at least one first officer and an optional second officer. Similar to arrests, the counts of stops that are used do not restrict to specific roles. Alternative analysis using only specific roles are provided as robustness. Investigatory stops that occurred between 2016 and 2019 are used. The shorter time frame is used to exclude a 2015 policy change that increased the documentation requirements for investigatory stops that essentially ended the practice of "stop and frisk".

Tickets and Citations Third, the number of parking tickets, traffic violations, and citations are included. Each of these measures has only one officer listed. This data measures a lower level of enforcement compared to arrests. The majority (83%) of tickets are related to parking violations, however, patrol officers make up only 16% of parking tickets issues by the CPD. These outcomes are summed together for the majority of analysis, but they are presented individually in Appendix Figure A.3.

911-Call Dispatches Officer 911 dispatch data is included for all 911 calls for service between 2014 and 2019. This data includes several time segments that measure each officer's daily response time to their assigned calls for service. All calls originate from a civilian and are entered into a centralized dispatch system. Once a dispatcher records the manner of emergency and the location of the call, they will assign an officer to be dispatched. In most cases calls for service are assigned to officers within their beat. In this paper, dispatch time is split into three separate time segments: (1) the time from the initial 911 call to when the dispatcher assigns an officer to respond, (2) the time from an officer is assigned to when they report being en route to the call location, and (3) the time from when an officer is en route to when they arrive on-scene. Each of these time segments measure a different aspect of call response. Segment (1) is a placebo test of sorts, as it measures dispatcher availability, not officer response. Segment (2) measures the availability and alertness of officers, while segment (3) measures officer's driving and proximity to call location.

Patrol Car GPS Pings Lastly, GPS data from patrol cars is included. Patrol cars register their location at least every 30 minutes but only if the car exceeds 15 mph. Consequently, a higher count of GPS pings indicates increased driving by officers, serving as a proxy for patrol activity.

Summary statistics for each of these measures of officer activity are presented in Table 1. Police officers are involved in 1 arrest approximately every 6 days. The vast majority of these arrests, 97%, are for non-discretionary charges. Investigatory stops are less frequently than arrests, occurring once every 10 days. This is in part because Chicago abolished their stop-and-frisk policy in 2015 increasing the threshold required for police officers to stop individuals.

3.3 TRR Use-of-Force Reports

Following an instance of force, CPD members will file a Tactical Response Reports (TRR) detailing the circumstances that resulted in force being used. According to CPD policy, a TRR must be filed if a civilian alleges injury due to officer actions or the civilian actively resists, flees, uses force against an officer, or physically obstructs an officer (CPD, 2020). The filing of a TRR automatically triggers a review and approval process by an officer's supervisor, a process that is usually completed within 20 minutes of the event. For this analysis, I use all TRR reports filed for over the years 2014 to 2019 for non-juvenile suspects. In total, there are 33,811 TRR reports filed during the sample period. For my analysis, I use total force reported, measured in the number of force actions recorded on a TRR report. On average there are 2.7 force actions recorded per TRR report. While this measure is preferred, as it captures the intensity of force, the results with each outcome are indistinguishable from one another and are shown in Appendix Figure **??**.

Summary statistics for use-of-force are presented in Table 1. An officer will file use-of-force report approximately once every 300 days. An injury is reported on 46% of all force reports.

3.4 Sample Restrictions

This paper makes three sample restrictions to obtain a subset of shifts where officers can be appropriately compared. Since the CPD is a large organization with many levels of ranks, tasks, and schedules, these restrictions reduce the amount of variation that arises from endogenous differences in officers and shift types to help isolate the treatment effect of consecutive days worked.

First, this paper uses officers who are assigned to work watch 1 (night), watch 2 (morning), or watch 3 (evening). These three watches make up 82% of officers and are the standard watches for beat officers. A 4th watch is reserved for special assignments that can start at any time of the day and is not used for this analysis.

Second, this paper uses police officers who are assigned to day off groups 61 through 66. These groups are the largest day off groups and entirely contain officers who work 9-hour shifts, the most common shift length for CPD officers. These 6 day off groups account for 86%

of all district-assigned officers who work watch 1 to 3 and represent the 'standard' groups for CPD patrol officers.

Third, shift spells (a string of consecutive workdays) that extend beyond 4 days are excluded from the analysis. Both these additional shifts and the shifts leading up to these extra days are excluded making all shift spells in this analysis 4 or fewer days. These removed shifts, which account for 4% of all shifts, are considered abnormal because they represent officers working outside their assigned days. This would lead to a different relationship between days worked and officer effort, as officers may reduce their effort over their entire shift spell when faced with additional scheduled days. These extra days often occur during periods of increased demand for officers and as a result, for the main analysis, should not be compared to when increased police presence is not needed. The temporal variation of these extra days are shown in Appendix Figure A.6, which shows that these extra days occur during high-crime summer months and are temporally concentrated.

3.5 Methodology

To explore the relationship between consecutive days works and police officer outcomes I estimate the following two-way fixed effects Poisson model:

$$\begin{aligned}\ln(y_{it}) = &\delta_2 \times \mathbb{I}(\text{DayWorkedNumber(2)}_{it}) \\ &+\delta_3 \times \mathbb{I}(\text{DayWorkedNumber(3)}_{it}) \\ &+\delta_4 \times \mathbb{I}(\text{DayWorkedNumber(4)}_{it}) + \theta_i + \tau_t + \beta_a + \varepsilon_{it}\end{aligned} \tag{1}$$

Where y_{it} are various outcomes for officer i on date t. Outcomes are counts of actions, such as total arrests, or stops conducted; all at the officer-date level. The main parameters of interest are δ_2, δ_3, and δ_4. These coefficients measure the relationship between the outcomes, y_{it}, and the set of indicators, $\mathbb{I}(\text{DayWorkedNumber(n)}_{it})$, which are indicator variables that are equal to 1 on an officer's n^{th} day worked. Due to the sample restrictions mentioned in Section 3.4, which restrict shifts spells of length 4 or less, the maximum value for $\text{DayWorkedNumber}_{it}$ is 4. The indicator for the first shift worked is omitted so that all estimates are relative to the first shift. This specification allows for a non-linear relationship between each of the consecutive days worked and various officer outcomes.

Also included are officer fixed effects (θ_i), date fixed effects (τ_t), and beat-assignment fixed effects (β_a). There are a total of 10,073 unique combinations of beat and assignment included. The addition of beat-assignment fixed effects, indexed by assignment a, helps to account for potential endogenous assignment of officers based on their shift history. However, there is little evidence that this occurs. In fact, the estimates of δ_2, δ_3, and δ_4 are not sensitive to the inclusion of beat-assignment fixed effects, further evidence that beat-assignments and the number of consecutive days worked are not correlated. Lastly, standard errors are clustered at the officer level.

The Poisson model is appropriate for this analysis because the outcome variable, y_{it}, consists of count data representing non-negative integers with many zeros. The Poisson distribution effectively models the probability of a given number of events occurring within a fixed interval. While the Poisson model assumes that the mean and variance of the outcome are equal, this assumption is not strictly necessary for the model to be consistent and can be relaxed if the conditional mean is correctly specified (Wooldridge, 2014). That said, I show robustness to two separate models in Section 4.9. The first is the negative binomial model, which does not require the assumption that the variance and mean are equal. The second is a linear model, which assumes that the relationship between consecutive days worked and outcomes is linear. Both of these alternative models produce nearly identical results to the Poisson model.

Identification

Identification in this model comes from the arbitrary assignment of shifts to officers through the centralized 'day off group' scheduling system discussed in Section 3.1. While the assignment of shifts is not strictly random, this system significantly constrains individual officers from manipulating which days that they work. Once an officer is given a beat (location) and watch (time of day) assignment, the officer will typically work that same post for one year or more. While an officer may have a preference for a day off group because it gives them a specific day off in the year (e.g. a birthday), they will be restricted to that day off group for the rest of the year.

I rule out that day off group preferences leads officers to be assigned to days with lower or higher levels of crime in two ways. First, in Appendix Table A.1 I show that individual officer work days are unrelated to two measures of crime, counts of civilian-initiated 911 calls and counts of gunshots reported by Shotspotter technologies. The second measure, counts of ShotSpotter gunshots, uses data from geographically-spaced microphones across the city of Chicago to detect gunfire. This measure has been used in previous literature as a measure of criminal activity that is not subject to police reporting bias (Carr and Doleac, 2016, 2018; Ang et al., 2021). Both of these measures of underlying crime trends are not correlated with officer work days, evidenced by the precise null estimates shown in Table A.2. Second, analysis can be conducted separately for each day off group, but results under this alternative specification produce similar results.

Due to this scheduling structure, DayWorkedNumber(n)$_{it}$ can be seen as exogenously assigned to officers and independent of daily-level trends in crime. Fixed effects for officer and date are included in Equation 1 to control for time-invariant officer characteristics, such as arrest propensity, and time-variant changes across Chicago, such as overall trends in crime and weather. And, as will be shown in Section 4.9, a model without fixed effects yields similar results to the model with fixed effects, bolstering the claim that individual shift assignments are not based on officer-specific or date-specific factors.

4 Results

4.1 Main Results

The main results of this paper focus on police use-of-force and three key measures of police activity: arrests made, stops conducted, and tickets or citations issued. These main results are presenting in Figure 3, which plots the estimated coefficients from Equation 1 for these outcomes, with each comparison made between an officer's first day and their subsequent second, third, or fourth day of consecutive work. Each coefficient estimate compares one of the main outcomes between an officer's first day and their second, third, or fourth day. The y-axis gives these point estimates and their associated 95% confidence intervals, derived from a Poisson regression. Summary statistics for each outcome variable can be found in Table 1.

Figure 3 shows that as officers continue to work, there is an increase in the amount of reported force used, shown in red. In total, use-of-force rises by 10% between days one and three and remains elevated on the fourth day. One might therefore expect that this rise in use-of-force would be accompanied by an increase in general police activity.

However, the remaining three measures of police activity, stops conducted (in blue), the total arrests made (in green), and tickets/citations issued (in turquoise), show a contrasting pattern. Unlike the steady increase in use-of-force, these activities follow an inverse U-shaped trajectory over consecutive days. While they initially rise, they start to decline by day three and continue to decrease through day four.

That is, despite police officers reporting fewer enforcement actions, they continue to use more force as they continue to work. The divergence in use-of-force and activity suggests that the increase in use-of-force is not driven by an increase in general police activity. It is important to recognize that an increase in reported use-of-force alone is not inherently problematic. Use-of-force is a byproduct of many often necessary, and often productive policing activities. However, an increase in use-of-force that is not accompanied by a similar increase in general police activity suggests that the increase in use-of-force is excessive. Such a shift may indicate a heightened use-of-force in response to similar incidents, which could potentially result in greater risks and injuries for both officers and civilians involved.

In Figure 4 I express these outcomes as a rate, rather than a daily count, to show that the divergence between use-of-force and police activity is consistently rising between days. To do so, I divide the one plus the percent change in force, by one plus the percent change in each of the other outcomes.[1] This gives the relative change in use-of-force, compared to each individual level of police activity. I use the delta method to calculate the standard error of the ratio of these two variables and estimate the covariance between force and each outcome by bootstrapping the procedure with 500 replications. While previously overall outcomes in Figure 3 exhibited an inverse-U shaped relationship, this rate of force per outcome in Figure 4 show that is a consistently increasing change for each additional day worked by approximately 4% per day.

These findings highlight the need to further investigate the underlying causes of this divergence. As the results indicate, officers may be employing unnecessary or preventable force, as they appear to be using more force per incident in pursuit of arrests. In Subsection 4.2, I address and rule out several potential mechanisms that could explain these patterns, including officers' selection of workdays or changes in the arresting behaviors of officers. Then, in Subsection 4.3, I explore the mechanism of stress, irritation, and frustration accumulating over working days as a possible factor contributing to these observed trends in officer activity. This exploration utilizes a measure of plausibly unnecessary discretionary arrests that arise from frustration, providing further insight into the motivations influencing officer behavior.

[1]The formula for each day t is $\frac{1+\%\Delta Force_t}{1+\%\Delta Outcome_t}$.

4.2 Ruling Out Potential Mechanisms

In this subsection I rule out several potential mechanisms that could explain the observed patterns in officer activity.

Daily Crime Exposure is Unrelated to Consecutive Working Days The 'day off group' scheduling design standardizes officers' schedules throughout the year, limiting their control over workdays on a week-to-week basis. Nevertheless, a skeptical reader might still question whether officers could choose specific workdays, perhaps by using personal days.[2] In Figure 5 I demonstrate that officers, on average, do not encounter differing levels of crime exposure based on the number of consecutive days worked.

This figure estimates Equation 1 using two measures of crime that are minimally influenced by individual officer enforcement decisions, yielding precise null results for both outcomes. These measures are the number of civilian-initiated 911 calls and the number of ShotSpotter gunshots detected. Both metrics are recorded at the district level to reflect overall crime trends. The first measure, civilian-initiated 911 calls, measures reports of crimes by civilians, such as domestic disturbances or injuries. The second measure, ShotSpotter gunshots detected, measures the number of gunshots detected by the ShotSpotter detection system, which is a network of microphones that detect and triangulate the location of gunshots. ShotSpotter was added to the CPD starting in 2017 and is only available for a subset of districts.

The precise null results in Figure 5 suggest that officers are not endogenously selecting into shifts based on the level of crime in their district.

Violent Arrests Are Not More Common on Day Four A potential concern is that officers might conduct more violent arrests as their consecutive workdays increase, potentially raising the likelihood of use-of-force incidents due to encounters with violent individuals. To investigate this, I estimate Equation 1 using the count of each arrest type as the outcome and show

[2] This concern is minimal, as officers receive only 4 to 6 personal days annually, depending on their tenure.

these results in Figure 6.

Figure 6 shows that across all arrest types, officers have a similar inverse U-shaped relationship between days worked and arrests made. While some variations exist, such as a spike in narcotics arrests on the third day, all arrest categories show a decline on the fourth day and follow a similar overall trajectory. This evidence supports the idea that officers are not changing their arrest patterns as they work more consecutive days.

No Arrest Redistribution Among Police Officers Making an arrest can be a significant administrative burden for officers. As a result, it is conceivable that officers might defer the responsibility to their peers to minimize their own workload. To investigate this possibility, I estimate Equation 1 using the count arrests by arresting officer role as the outcome and present those results in Figure 7.

Figure 7 shows that the roles of individual officers do not change as officers work more consecutive days. Across both the number of arrests made, in Panel (a), and the number of stops conducted, in Panel (b), the roles of officers remain consistent. This consistency supports the argument that officers are not making strategic adjustments in their enforcement roles based on their consecutive workdays.

4.3 Stress, Irritation, and Frustration

In this subsection I explore the mechanism of stress, irritation, and frustration accumulating over working days as a potential driver of the observed patterns in officer activity. To do this, I leverage discretionary arrests, a list of plausibly 'unnecessary' arrests, that stem from frustration and irritation that officers may experience. This definition of discretionary is defined following a pre-specified list from work by Dube et al. (2023). The most common arrest types to fall in this category are for obstructing an officer, disorderly conduct, or obstructing identification.[3]

[3]The specific definition of this variable is found in Dube et al. (2023) Table A2. In the current paper, 92% of discretionary arrests are for obstructing and officer, disorderly conduct, or obstructing identification. The full list of discretionary arrests and their frequencies for this analysis is provided in Appendix Table A.3.

Discretionary arrests are low level arrests that likely stem from frustration and irritation that officers may experience and are not seen as being made in the interest of public safety. The decision to arrest a civilian with a discretionary arrest, while based on real actions, is often left up to the officer. The perception of a civilian being disrespectful or disobedient is a key driver of discretionary arrests.

Figure 8 shows the results for estimating Equation 1 using the count of discretionary arrests or non-discretionary as the outcome. Both arrest types follow similar patters until day three, when they diverge. Discretionary arrests, similar to use-of-force, remain elevated on the fourth day. The consistency of results between discretionary arrests and use-of-force suggests that these outcomes are driven by similar mechanisms.

In the context of similar research, this result is consistent with Dube et al. (2023), who find that cognitive-based training that emphasizes thoughtful decision-making reduces officer discretionary arrests and use-of-force. The present paper finds a similar, but opposite, result: when officers are cognitively constrained (due to consecutive working days), these same outcomes are affected. This result is promising, as it suggests that changes in officer shift structures that prioritize officer well-being and cognitive health could lead to reductions in discretionary arrests and use-of-force.

4.4 Officer and Civilian Injury

If officers are using more force for the same incidents, it is natural to think that they are more likely to injure themselves and others. Civilian injuries resulting from police actions are significantly costly events, impacting both the individuals involved and the city, should the injury lead to legal action. Officer injuries can exacerbate issues related to under-staffing, as officers would need time to recover.

To investigate the impact of consecutive working days on injuries I estimate Equation 1 using the count of use-of-force reports that include a report of injury to officers or to civilians and present these results in Figure 9. Figure 9 shows officer injuries in red and civilian injuries in blue. I find no significant difference in injuries reported to officers for the first three consecutive days worked. However, by the fourth day, there is a significant increase in reported injuries. This surge in injury prevalence coincides with the observed divergence between use-of-force and the number of arrests made.

Civilian injury does not see a significant increase, yet there is suggestive evidence of an elevated threat. Given the imprecision of these estimates, ruling out effect sizes for civilian injuries is challenging. Additionally, injuries are officers-reported. Injuries reported by officers themselves may be more accurate, as they directly experience and document their own injuries. In contrast, civilian injuries may be under-reported due to situational pressures or perceptions.

4.5 Heterogeneity by Race/Ethnicity and Tenure

This section examines the impact of shift structure on outcomes differentiated by civilian race/ethnicity and officer tenure. Table 2 presents results based on the race/ethnicity of each civilian involved for three outcomes: Stops Conducted (Panel A), Arrests Made (Panel B), and Use-of-Force Reported (Panel C). The initial increase in stops is driven by changes in stops of Black and Hispanic civilians. Conversely, the number of stops involving White civilians remains relatively stable across different days. This difference in stop rates is important, as variations in police presence across racial and ethnic groups may lead to disproportionately higher arrest rates for more heavily policed communities, irrespective of the actual level of criminal activity (Chen et al., 2023).

Interestingly, while stops conducted are higher for Black and Hispanic civilians, this trend of increased activity involving Black and Hispanic civilians is not seen in arrests. For arrests, civilians of each race/ethnicity experience an initial increase followed by a decrease. One potential reason for this discrepancy is that investigatory stops could be motivated by racially-biased profiling. Investigatory stops are often based on cognitive factors such as intuition and deduction rather than objective evidence or first-hand observation, like many arrests. From a perspective of equity, reducing variability and uncertainty in the burden of policing of Black and Hispanic civilians is important.

Use-of-force incidents are categorized by the race or ethnicity of civilians in Panel C. These results indicates statistically significant increase in use-of-force with incidents involving Black civilians. However, this finding warrants cautious interpretation, as use-of-force incidents are relatively rare events, thereby limiting the statistical power to detect differences among other racial or ethnic groups. Specifically, since 77% of use-of-force incidents involve Black civilians, the comparatively low number of incidents involving other groups limit the ability to identify significant differences.

Lastly, Table 3 presents the results by officer tenure. The data are categorized into three tenure groups: the lowest tenure group constitutes 30% of the sample, the middle group comprises 50%, and the highest tenure group accounts for the remaining 20%. Overall, officers in the high tenure group (20 or more years) exhibit reduced variability in their outcomes. Specifically, aside from one significant estimate, there is no observable relationship between the number of days worked and daily outcomes among experienced officers. This suggests that experience may contribute to the stabilization of these outcomes, indicating that seasoned officers are more adept at providing consistent service. However, it is important to note that experienced officers make fewer arrests compared to their mid-career counterparts. These findings may represent an upper limit on the benefits of experience, potentially conflating the effects of both expertise and fatigue.

4.6 Within-Shift Changes

This section investigates within-shift changes in officer behavior by focusing on the first and last three hours of a standard nine-hour shift. The analysis includes only shifts lasting exactly nine hours, which constitute 98% of the shifts in the primary estimation sample. By segmenting these shifts into three-hour intervals and estimating the initial and final segments separately, we can compare patterns of activity and use-of-force during these critical periods across consecutive workdays.

The objective is to understand how officers' actions evolve at the beginning and end of their shifts, particularly as they work more consecutive days. The effects of accumulated stress or fatigue may manifest differently during these periods.

In the first three hours of their shifts, officers display a notable divergence between use-of-force incidents and general policing activities. Specifically, Figure 10(a) shows that as officers work more consecutive days, use-of-force incidents increase during these initial hours. Conversely, activities such as arrests made and stops conducted do not exhibit the same upward trend. This pattern is consistent with the main results.

In contrast, during the last three hours of their shifts, all measured outcomes follow a similar pattern. Figure 10(b) illustrates that these activities display an inverse U-shaped relationship with consecutive days worked: they initially rise but begin to decline by the third day and continue decreasing on the fourth day. This uniformity suggests that the compounded effects of consecutive workdays and within-shift fatigue impact all aspects of officer behavior similarly during the final hours. The consistent decline across all activities may reflect physical exhaustion or diminished engagement as officers near the end of both their shift and a series of consecutive workdays.

This result is interesting because it suggests that the cumulative effects of consecutive shifts manifest immediately at the beginning of each workday. Police officers do not seem to 'reset' their behavior at the start of each shift, but rather carry over the effects of consecutive workdays into their daily activities. This finding is significant because it highlights the need for interventions aimed at mitigating stress and fatigue that reduce the number of consecutive shifts worked rather than focusing only on hours within a single shift.

4.7 Dispatch and Patrolling Behavior

In this section I explore how working consecutive days affects officer dispatch and patrolling behavior. While arrest behavior reflects officer decision-making in the field, these decisions are influenced by prior activities such as patrolling and dispatching to calls for service. Given that police dispatches are one of the most frequent interactions between the police and the public, they are crucial for understanding effectiveness and public perception of police. Analyzing how officers change their patrolling and dispatch behavior can help provide insight into the types of crimes they observe and how capable they are to make arrests.

Dispatch time refers to the duration from when a civilian calls 911 to when an officer to arrives on-scene. This is split into three segments: (1) the time from the initial 911 call to when a centralized dispatcher assigns an officer to respond, (2) the time from an officer is assigned to when they report being en route to the call location, and (3) the time from when an officer is en route to when they arrive on-scene. In most circumstances, officers are only assigned to respond to 911 calls within their beat.

Table 4 examines the relationship between consecutive days worked and police officer dispatch time, revealing that while officers do not change their overall dispatch time, the take longer to respond to dispatch orders on their fourth day worked. Column (1) reports the full dispatch time while Columns (2) to (4) breaks down dispatch time into the three aforementioned segments. I find no significant change in overall dispatch time in Column (1). Column (2) serves as a placebo test, as it reflects dispatcher availability, which would only be affected if consecutive officer days were correlated with dispatcher availability, such as through low- or high-crime days. In Column (3), there is a small but significant increase in dispatch-to-enroute time for officers on their fourth day. This dispatch segment reflects and officer's response time to dispatch orders and can be delayed if an officer is unprepared or slow to respond to dispatch orders. Once an officer is enroute to a crime scene, I find not change in their response time, reported in Column (4).

Next I use data from CPD patrol car GPS pings, which record the longitude, latitude, and speed of CPD patrol cars when they exceed 15MPH. These pings will register at most once every 30 minutes. This data will help understand officer patrolling and mobility patterns by detecting how often officers are stationary versus active patrolling.

Figure 11 presents an analysis of the relationship between consecutive days worked and GPS ping data, revealing that officers exhibit fewer movements as they work more consecutive days. This can be seen on the left panel, where I find small, but significant reductions in total GPS pings, indicating decreased geographic activity from officers as they work more. Notably, on an officer's last day, GPS pings see the largest decline, which coincides with the drop in total arrests made and stops conducted, as seen in Section 4.1. These patterns suggest various potential mechanisms, such as reduced patrolling, substituting driving with walking, or spending more time with each arrest. However, without knowing the specific reasons for officer movements, pinpointing the exact mechanism of reduced patrolling is challenging. That said, even without pinpointing the specific mechanism, reduced patrolling is a potential reason for the decline in other policing activities, such as total arrests made.

Lastly, in the right panel, I find that officers only slightly increase their speed as their consecutive working days increase. This change is small and precise, totaling a 0.4% change over all working days and can be considered a null finding due to its small size.

4.8 Expanding to 5-day Analysis and the "Last Day" Effect

One potential mechanism for the observed reduction in officer actions on day four is a psychological "last day" effect that is unrelated to fatigue. To explore this hypothesis, I leverage day-off cancellations that occurred in 2021 and 2022. These cancellations affected all beat officers and resulted in the cancellation of their first day off after a specified date. For instance, a notice could be sent out on 01/01/2021 could cancel an officer's first assigned day off between 01/01/2021 and 01/04/2021, depending on an officer's assigned schedule. These notices were typically sent out several days in advance, requiring most officers to work five consecutive days. An example of one of these cancellation notices is provided in Appendix Figure A.4 and the temporal distribution of these notices are shown in Appendix Figure A.5. Unfortunately, due to data constraints, beat-assignment fixed effects are not available for these shifts.

While police officers frequently work overtime shifts outside this time frame, overtime is usually assigned endogenously, meaning it is strategically distributed to address rising crime levels or in response to idiosyncratic shocks. Using overtime shifts that are not uniformly assigned may introduce bias to estimates. By leveraging cancellations that uniformly affected all officers, I can mitigate much of the selection bias associated with who is assigned overtime. However, estimates need to be interpreted cautiously given that the circumstances of work may be different on day five. The primary objective of this analysis is to observe officer activity on the fourth day when they are required to work a fifth consecutive day, not activity levels on the fifth day.

Table 5 presents the results after incorporating shift spells that include a mandatory fifth day. This table is estimating by interacting each indicator variable in Equation 1 with an indicator equal to 1 if a shift spell is of length 5. Each shift spell analyzed here is exactly four or five days in length and shifts are restricted to 2021 and the beginning of 2022. Both shift spells of length four and five exhibit similar patters: an initial increase followed by a decrease on the fourth day. Estimates for four-day spells are attenuated, possibly because five-day spells occur during periods of high crime, which date fixed effects cannot fully account for. Nonetheless, the overall patterns between spells of length four and five are consistent. Interestingly, spells of length five have no detectable increase in use-of-force, however, since use-of-force is a rare event, these estimates are under-powered, and I cannot rule out large positive or negative changes.

The goal of this analysis is to rule out a “last day” effect, where officers might reduce their efforts on the fourth day simply because it is their final day. If this were not the case, we would expect to see elevated activity on day 4, rather than a consistent U-shaped relationship between days worked and activity. Estimates on day five should be interpreted with caution, as the assignments on day five may be substantially different from those on days one to four.

4.9 Additional Heterogeneity and Robustness

This section explores several other potential sources of heterogeneity and robustness checks with regard to the estimating equation. In Figure 12, I explore heterogeneity with respect to high and low crime areas, as measured by the mean daily arrests. In Panel (a), I show beats with above median arrests, and in Panel (b), I show beats with below median arrests.

I find that increases in use of force are driven by high arrest areas, as shown in Panel (a). Low arrest areas, in Panel (b), do not exhibit the same increase in use-of-force, and in fact, decrease similar to the other outcomes. Activity levels in both high and low arrest areas follow the same U-shaped pattern, with a decrease in activity on the fourth day. This result is consistent with the idea that police work has a cumulative effect on officer behavior, and that officers in high arrest areas accumulate this effect more quickly.

Next I show that officers have similar outcomes based on which weekday they start their shift spell. This is shown in Figure 13, where each indicator is interacted with the day of week of the shifts spells first day. There is no evidence that officers have different outcomes based on which day they start their shift spell. Stops conducted are also explored in Appendix Figure A.1.

I find no significant difference in outcomes made by day of week for and any starting day. Despite weekdays being evenly distributed to officers, one may think officers have different impacts of stress and performance based on which day that they work. For example, a four-day shift spell that starts on Thursday and contains Saturday and Sunday may lead to different outcomes than one that does not contain a weekend. This null finding reinforces the conclusion that consecutive shifts uniformly tax officers' capacities, independent of the weekly cycle.

Table 6 presents results for each of the main outcomes with various sample selection or econometric model changes. For each robustness check, Panel A gives the results for arrests made, Panel B for stops made, and Panel C for force reported. Column 1 gives the main results from the preferred specification (identical to the main results shown in Figure 3)

The main results are consistent with each robustness check. Column 2 of Table 6 incorporates district-specific linear time trends, this helps adjust for gradual shifts at the district level, such as evolving leadership dynamics. Column 3 of Table 6 removes beat-assignment fixed effects. The consistency of results between Column 1 and Column 4 provide evidence that officers are not being endogenously sorted to assignments based on their number of consecutive days worked. Column 4 of Table 6 fully interacts each individual officer fixed effect with each beat-assignment fixed effect. This adds over 40,000 fixed effects and leads to comparisons within-officer-assignment. This fully interacted model leverages within-officer-assignment variation comparing the same officer assigned to the same assignment across different days. While this specification removes a great deal of variation in outcomes, it remains consistent with the preferred model in Column 1, further evidence that officers are not endogenously sorted into assignments.

Columns 5 and 6 present different model specifications using alternative models to the Poisson. Column 5 of Table 6 reports the preferred specification from Column (1) estimated using negative binomial. In the presence of over dispersion (the conditional mean exceeds the conditional variance), the negative binomial model can better model the data. However, the results are consistent with the Poisson model suggesting that the Poisson model is sufficient. The Poisson model is standard in the literature and is used in the main results for consistency. Column 6 of Table 6 reports the preferred specification from Column (1) estimated using ordinary least squares. Once these estimates are scaled by their respective mean values, their effect sizes are equivalent to the Poisson model.

4.10 Alternative Policy Estimates

In this section I simulate alternative shift structures to demonstrate how policies that require fewer consecutive work days can lead to lower instances of force and fewer police officer injuries. To construct these estimates I create department-wide averages for first officer arrests, first officer investigatory stops, use-of-force reports, and officer injures. First-officer outcomes are used as to not inflate counts of arrests or stops due to arrests being repeatedly counted for each involved officer. First, the sum of each officer's outcomes are calculated on their first, second, third, and fourth consecutive work day. These sums are then combined using weighted average of these officer outcomes, with weights based on each officer's presence in the sample. That is, an officer who is present in my sample for two years will be twice weighted that of an officer who is present for one year.

This strategy creates single representative officer, whose schedule can be applied across the full 6-year period. By scaling this officer by the expected police force size between 2014 and 2019, I can obtain estimates of the total amount of these outcomes that we would expect to occur. Importantly, these estimates assume the officers' activity is not policy-dependent. For example, this approach assumes that an officer's day two activity will be the same if it occurs in a work spell of three days or four days.

The current policy, where officers work 4 consecutive days followed by 2 days off will be further referred to as Policy 1. I use these estimates of officer outcomes to simulate two alternative policies, Policy 2 and Policy 3, which maintain the same ratio working days and non-working days as the current schedule, Policy 1. Policy 2 has a structure 2/1, where an officer will work two days, followed by one day off. This structure has the same ratio of working days and non-working days as Policy 1, but has non-working days more frequent but in shorter stretches.

Policy 3 has a structure 3/2/3/1, where officers alternate between three days of work and breaks lasting one or two days. Similar to the previous policies, Policy 3 preserves the same ratio of working days and non-working days. Specifically, over a twelve-day cycle under each policy, officers work eight out of the twelve days, ensuring that the workload distribution remains balanced across these different scheduling structures.

Estimates under policies 1, 2, and 3 are presented in Table 7A and compared against each other in Table 7B. By removing an officer's fourth working day, both policies 2 and 3 reduce use-of-force incidents by 2.71% and 0.75% and reduce incidents of officer injuries by 2.45% and 1.73%, each respectively. The key differences between policies 2 and 3 are whether they include officer's third working day. As seen in Section 4.1, the third working day is a productive working day with high levels of arrests made and stops conducted when compared to an officer's first day. Since Policy 2 does not contain three consecutive working days, there is a decline in the total arrest made and investigatory stops conducted. On the other hand, Policy 3 is able to both increase productive policing measures (total arrests and stops) while decreasing use-of-force and officer injuries.

In summary, the simulations of alternative shift structures policies indicate that reducing the number of consecutive workdays can decrease the incidence of use-of-force events and officer injuries. The implementation of a 2/1 work-rest cycle (Policy 2) or a 3/2/3/1 cycle (Policy 3) both lower these outcomes compared to the current 4/2 structure (Policy 1). In fact, Policy 3 is able to reduce use-of-force incidents while simultaneously increase both total arrests made and stops conducted. These findings suggest that adjusting shift schedules could enhance officer safety and potentially improve community interactions, emphasizing the need for policy adjustments that consider both officer welfare and operational effectiveness. However, more research needs to be done with regard to officer preferences over shifts and the potential for changes in officer behavior under these new policies.

5 Conclusion

This study explores the relationship between shift structures and policing behaviors and finds that police officers use more force, make more plausibly 'unnecessary' discretionary arrests, and are more likely to be injured as they work more consecutive days. These increases are despite no difference in crime between days. In fact, proactive policing activities, such as arrests, investigatory stops, issuance of citations, patrolling, and timely 911 dispatch, decrease as officers work more days. The divergence in use-of-force from policing activity outcomes suggests that this use-of-force is excessive, unnecessary, and inefficient. Additionally, instead of a buildup of fatigue alone, the results suggest that officers accumulate frustration and irritation that leads to these unnecessary arrests These estimates suggest that the cumulative effects of consecutive working days contribute to a shift in policing behavior over time and do not fully reset after nightly breaks between shifts.

The significance of these results underscores the need for police departments to carefully evaluate shift schedules to enhance officer effectiveness and reduce the risks associated with extended duty periods. This paper provides new evidence that police officers are susceptible to cognitive depletion and may not provide consistent public safety if their endurance is affected. These dynamics call for a re-evaluation of current shift scheduling practices in policing to mitigate these adverse effects and enhance both officer well-being and public safety. Using alternative policy simulations, I show that a shift structure with more frequent breaks can lead to more effective policing and less use of force without reducing the number of officers on duty. Additionally, this line of research not only aids in enhancing police performance but also contributes to the broader discussion on workplace productivity and worker welfare across various sectors. Law enforcement, health care, and emergency services are all professions where prolonged work periods can have large potential costs. Ultimately, this paper paves the way for future investigations into the dynamic interplay of work patterns, cognitive stress, and performance outcomes, highlighting the importance of continuous assessment and adaptation of work structures to promote optimal productivity and well-being in the workplace.

However, any change in the shift structure of a police force needs to be considered holistically, from the perspective of an officer, the community, and the city before being implemented. While estimates of policy changes with more frequent breaks show evidence of more effective policing, it is important to consider how the preferences of officers factor in to personnel decisions. More work needs to be done to explore how shift lengths and rest intervals could offer insights into more sustainable work patterns. For instance, giving increased lengths of breaks, fewer but longer shifts, or giving assignments based on officer fatigue factors could have positive benefits for officers' physical and mental health and improve their relations with their communities. This paper highlights the need for consideration of factors such as police officers physical and mental health when making personnel decisions.

Some departments are already implementing changes to shift structures to improve officer health and performance. For example, a four-day work week has been implemented in Seattle, WA in 2022 (Sun, 2023), and a 32-hour work week in Golden, CO in 2023 with reports on increased officer morale and performance (Hayes, 2023). These changes are promising, but more research is needed to understand the effects of these changes on officer performance and community relations.

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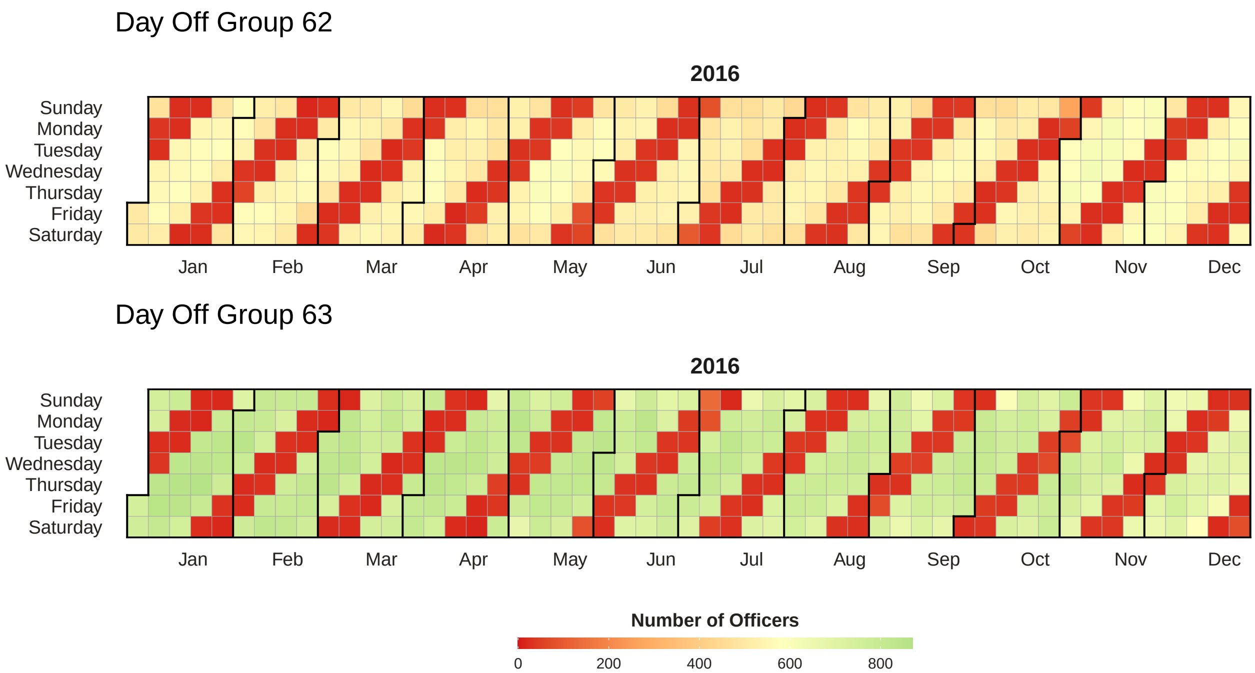
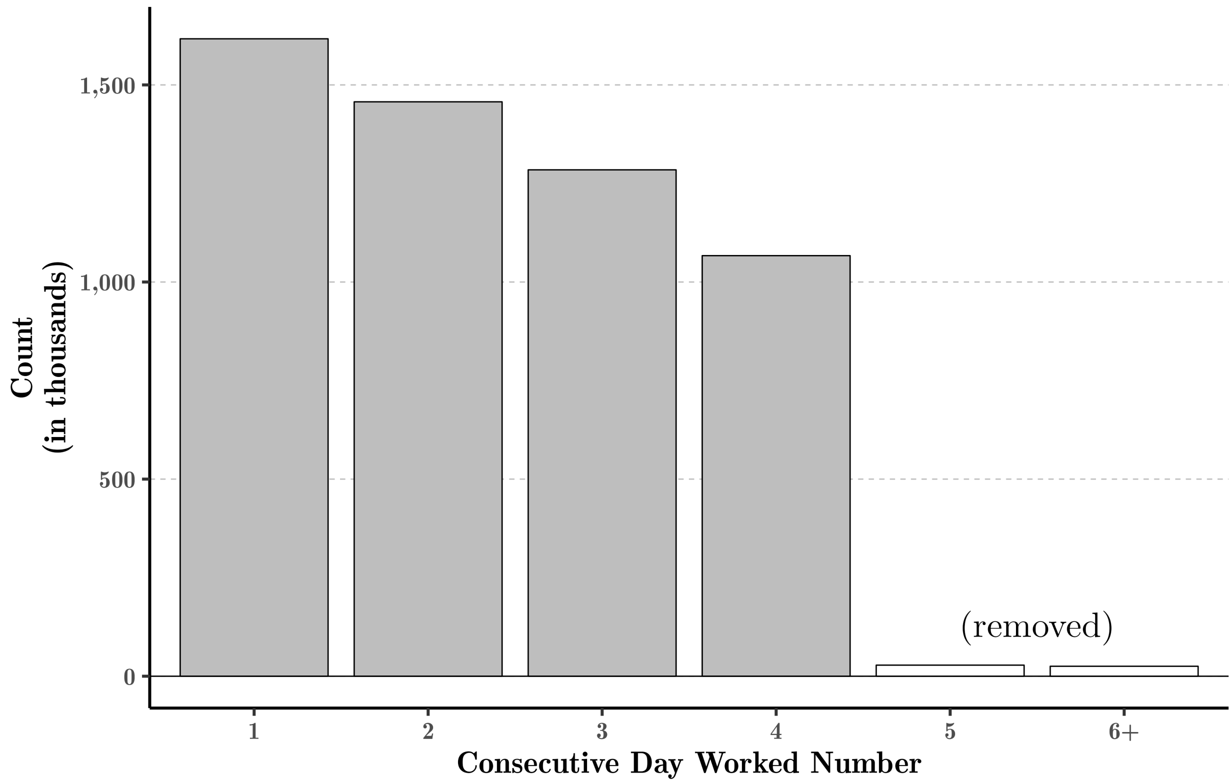
Figures

Figure 1: Day Off Group Scheduling Example, 2016



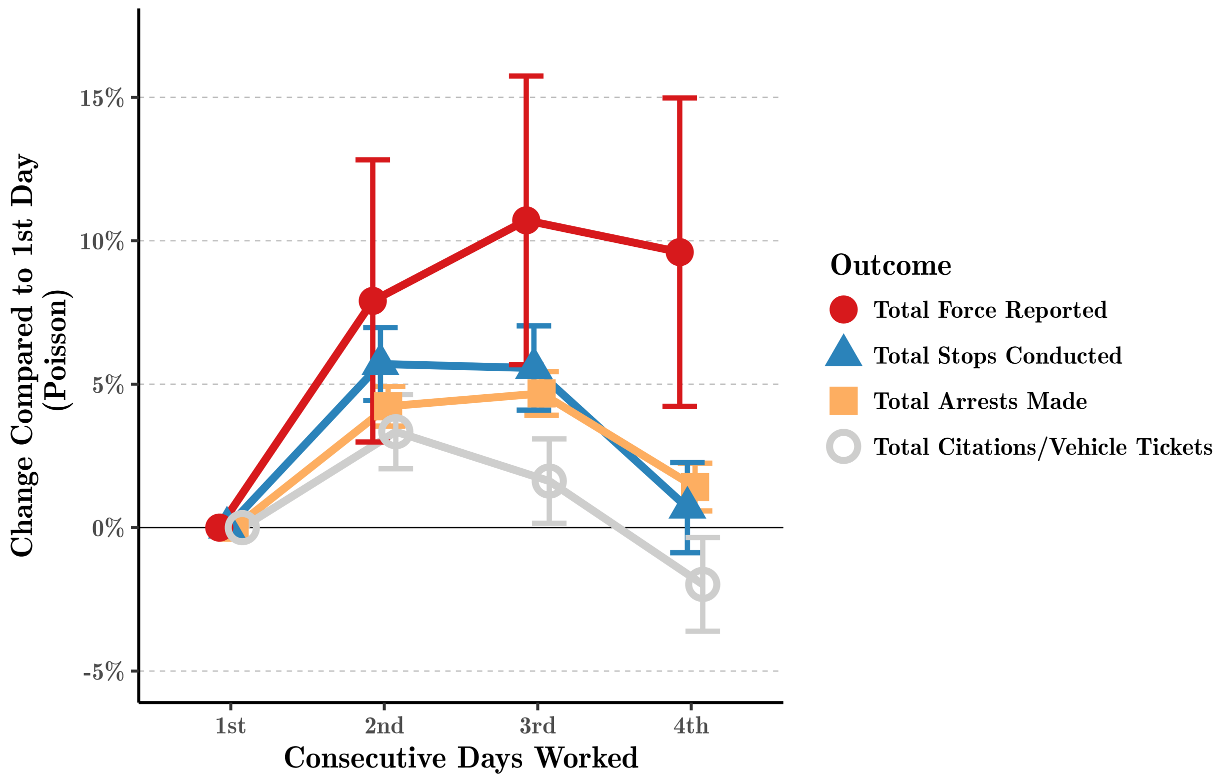
Note: This figure depicts the number of officers marked as present on a given day for two *day off groups*. There are 20 possible day off groups, but 6 groups (61 to 66), which correspond to the 4-2 9-hour structure, contain 86% of all officers. There are several notable days with variation, (1) July 2nd to 3rd was a music festival that required officers in DOG 62 and 63 to work on their off day, (2) October 30th marked the deadliest weekend of the year and officers in DOG 62 were called in, DOG 63 officers were already working.

Figure 2: Raw Counts of Consecutive Working Days



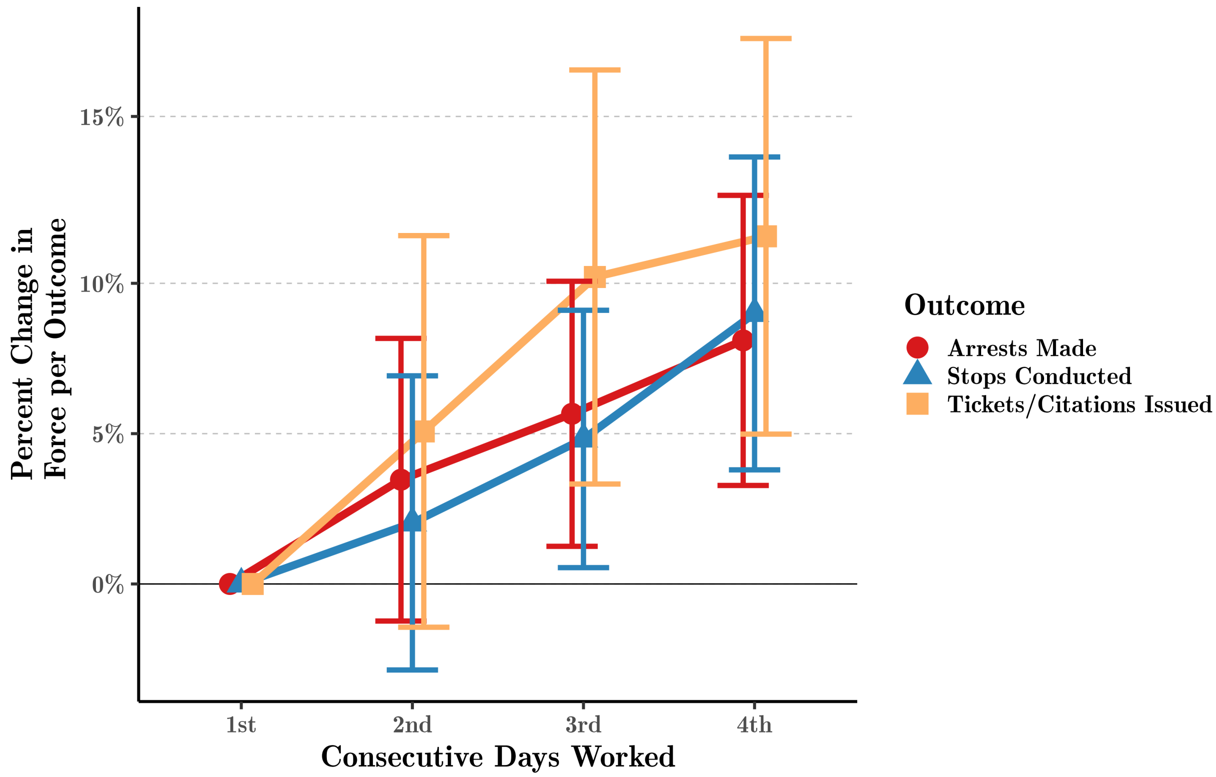
Note: This figures gives the count of each shift's *Consecutive Day Worked Number* for Chicago Police Officers between 2014 and 2019. *Consecutive Day Worked Number* is equal to 1 on the first day of a shift spell.

Figure 3: Relationship Between Consecutive Days Worked and Main Outcomes



Note: Estimated via Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. Each color is a separate estimation of Equation (1) with a different outcome variable. Each estimation compares an officers outcomes between their first day of a shift spell and subsequent days. Officer, date, and beat-assignment fixed effects are included. The observation level is officer-day spans from 2014 to 2019, except for stops, which is only available from 2016 to 2019.

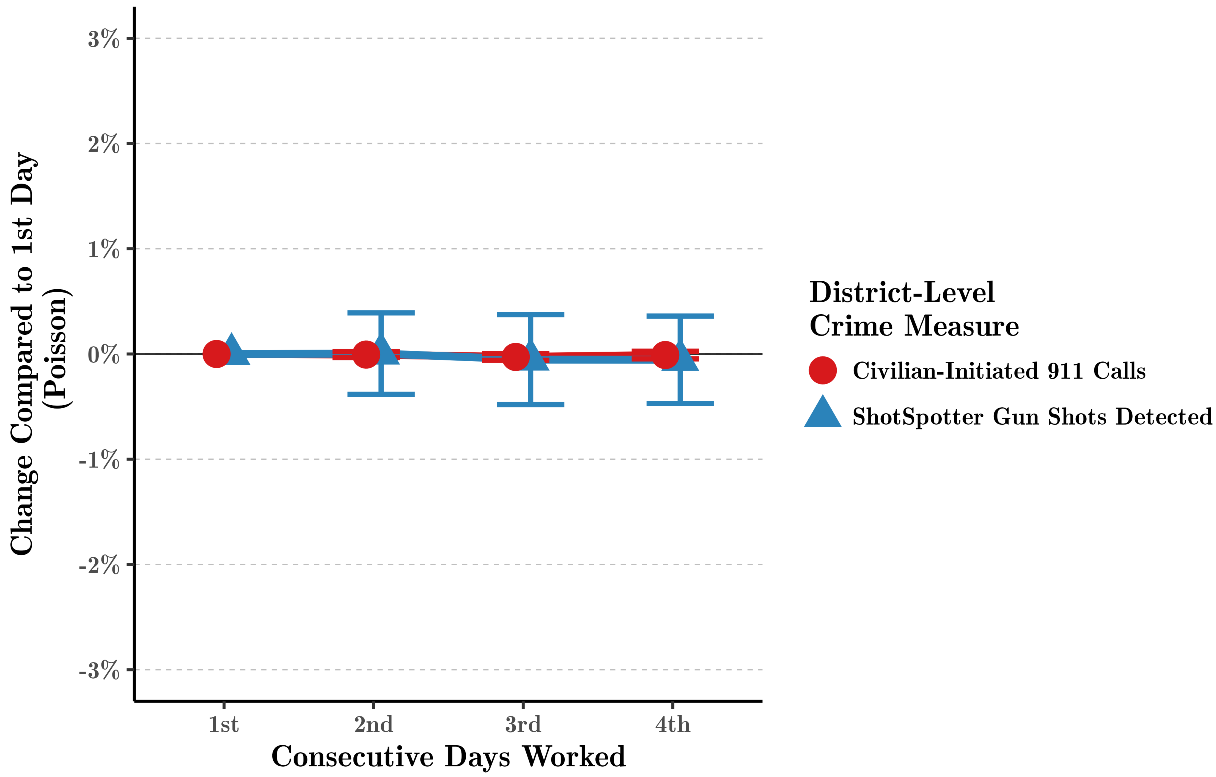
Figure 4: Rate of Use-of-Force Reports per Daily Outcome



Note: Estimated via Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. Each point estimate measures 1 plus the percent change for use-of-force, divided by 1 plus the percent change each outcome, this formula is given below. This results in a percent change in the rate of force per outcome. Standard errors are estimated via the delta method with the covariance between force and each outcome estimated via bootstrap with 500 replications. Officer, date, and beat-assignment fixed effects are included. The observation level is officer-day spans from 2014 to 2019, except for stops, which is only available from 2016 to 2019.

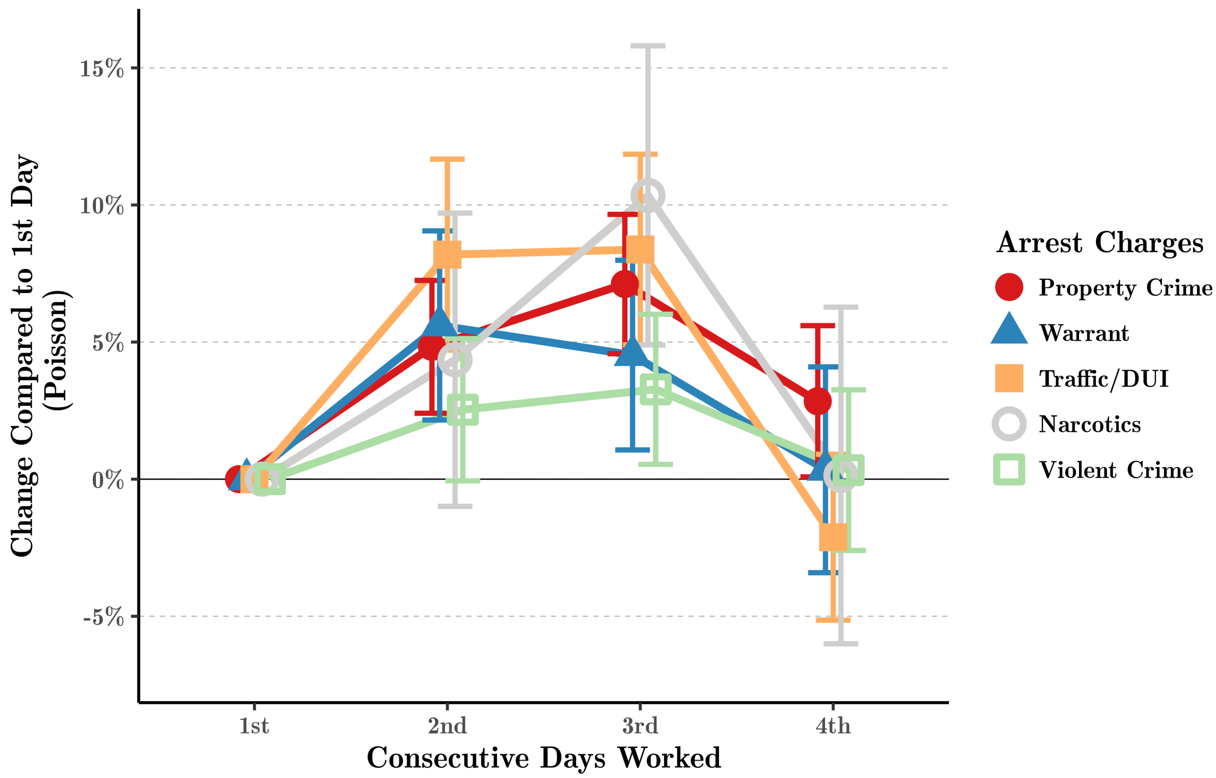
$$\text{Point Estimate on Day } t = \frac{1 + \%\Delta Force_t}{1 + \%\Delta Outcome_t}$$

Figure 5: Relationship Between Consecutive Days Worked and District-Level Crime Measures



Note: Estimated with Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. Each color is a separate estimation of Equation (1) with a different outcome variable. This figure displays the relationship between consecutive days worked and district-level measures of crime that are not directly related to officer enforcement actions. The precise null estimates of this figure suggest that in expectation, officers are not experiencing different levels of crime based on their number of consecutive days worked. *ShotSpotter Gun Shots Detected* measures the number of gunshots detected by ShotSpotter, a microphone-based gunshot detection system introduced to Chicago starting in 2017. Officer, date, and beat-assignment fixed effects are included. The observation level is officer-day spans from 2014 to 2019 for 911 Calls and 2017 to 2019 for ShotSpotter. These estimates are reported in table form in Appendix Table A.2.

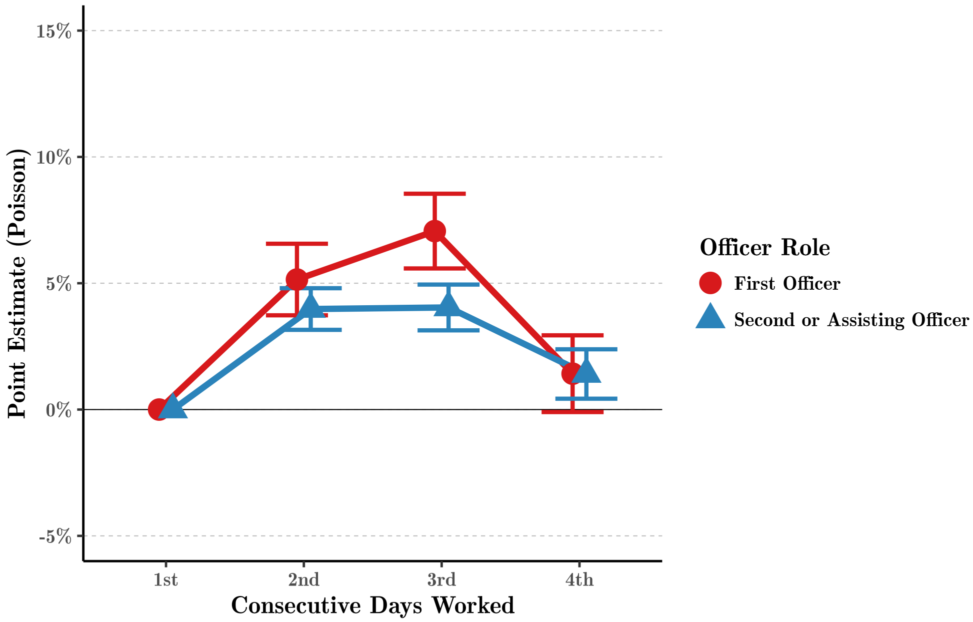
Figure 6: Poisson Estimates for Consecutive Days Worked and Arrest Types



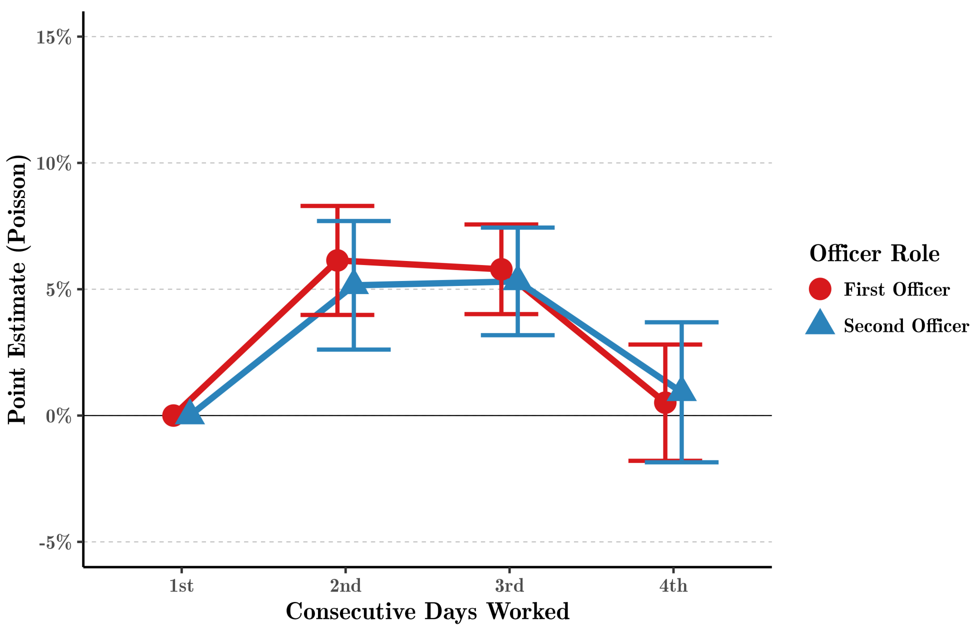
Note: Estimated with Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. Each color is a separate estimation of Equation (1) with a different outcome variable. Arrests in this figure include only first officer arrests to isolate individual officer arrest decisions. Officer, date, and beat-assignment fixed effects are included. The observation level is officer-day spans from 2014 to 2019. These results are shown in table form in Appendix Table A.4.

Figure 7: Exploring Officer Roles in Arrests and Stops

(a) **Role in Arrests**

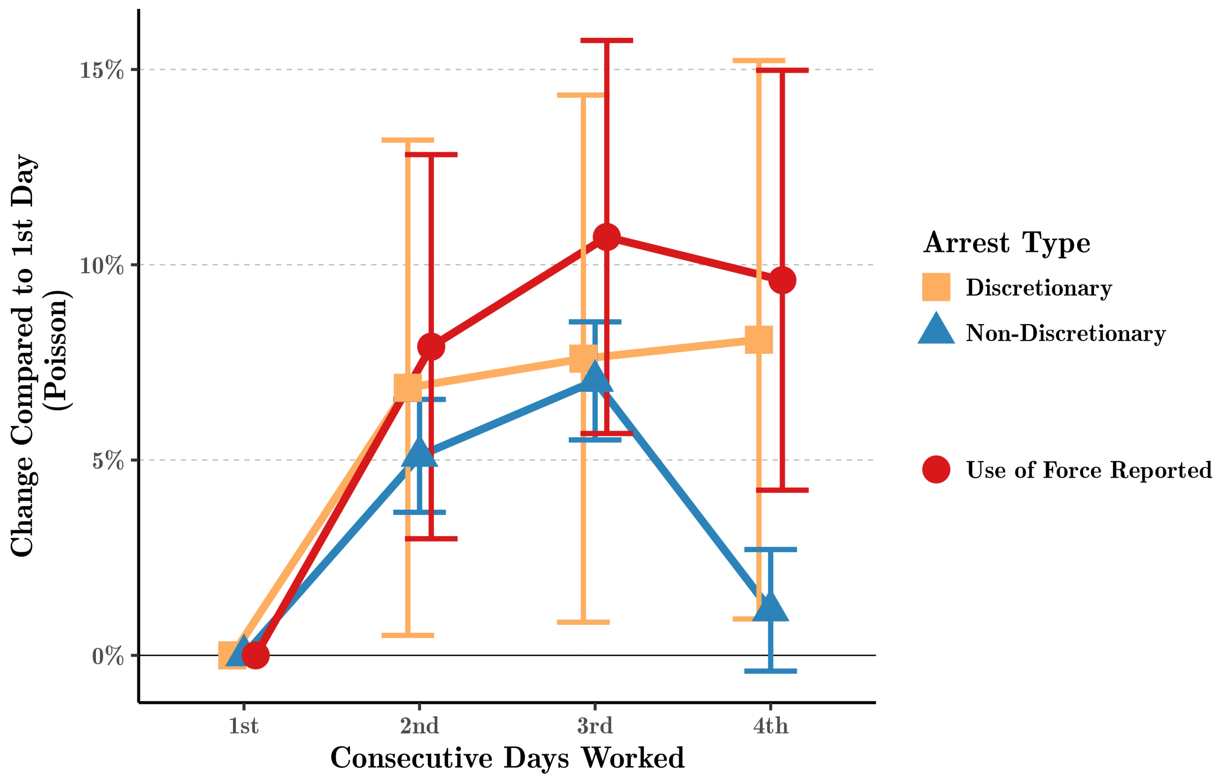


(b) **Role in Stops**



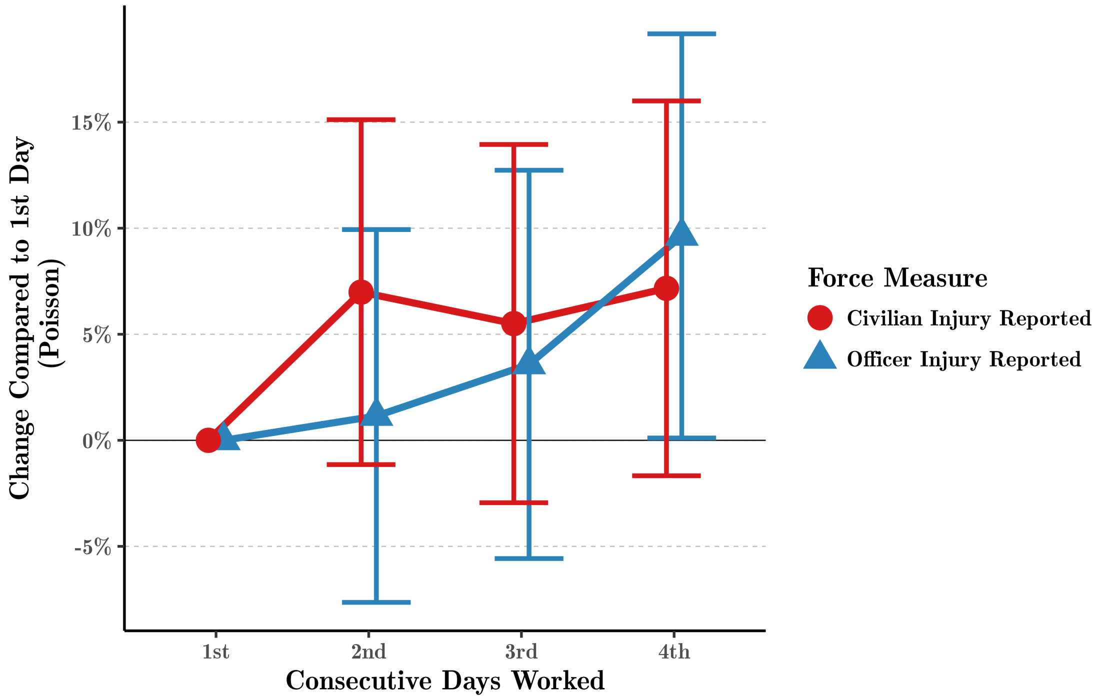
Note: Estimated with Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. Each color and panel are a separate estimation of Equation (1), this figure depicts 4 estimations. Each arrest has a primary officer (*First Officer*), up to one secondary officer (*Second Officer*), and any number of assisting officers (*Assisting Officer*). Stops have only one primary and optionally one secondary officer (the *First Officer* and *Second Officer*). Officer, date, and beat-assignment fixed effects are included. The observation level is officer-day spans from 2014 to 2019.

Figure 8: Comparison of Discretionary and Non-Discretionary Arrests



Note: Estimated with Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. Each color is a separate estimation of Equation (1) with a different outcome variable. This figure compares discretionary arrests to non-discretionary arrests with use of force being displayed in green for reference. Arrests in this figure include only first officer arrests to isolate individual officer arrest decisions. Officer, date, and beat-assignment fixed effects are included. The observation level is officer-day spans from 2014 to 2019. These results are shown in table form in Appendix Table A.4.

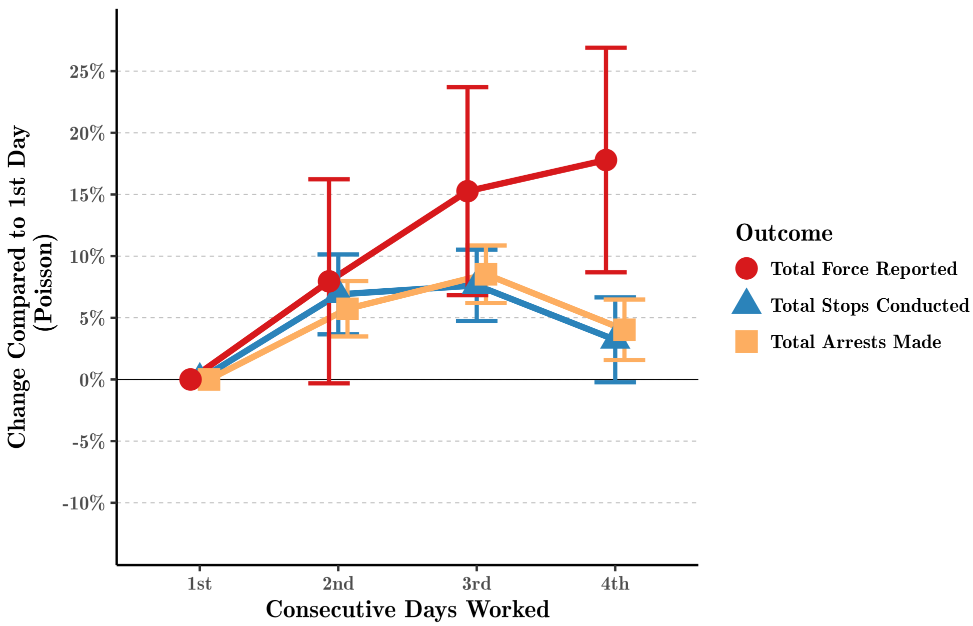
Figure 9: Relationship Between Consecutive Days Worked and Officer or Civilian Injury



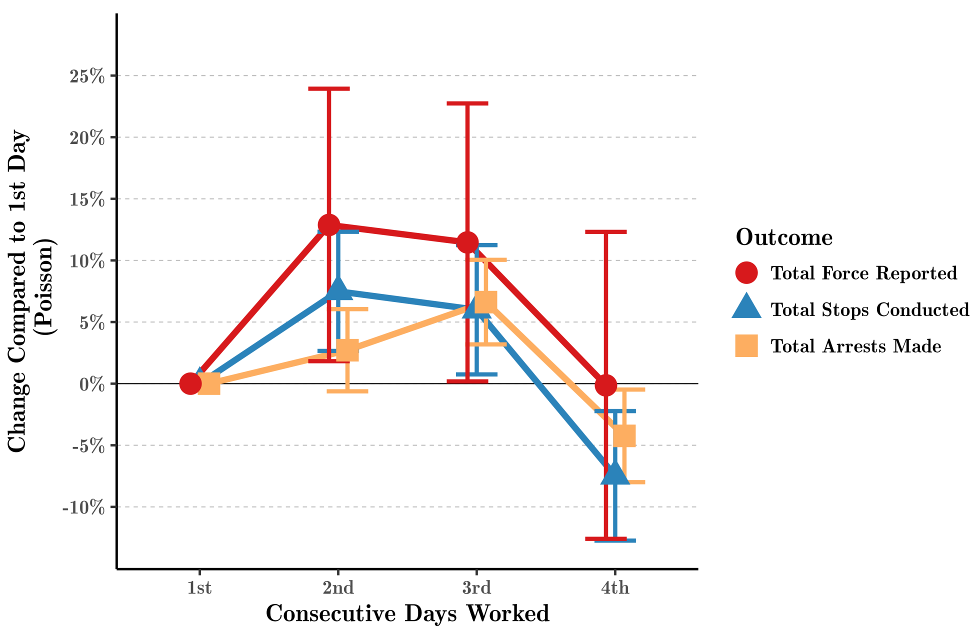
Note: Estimated with Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. Dependent variable is the count of reported injuries at the officer-day level. Officer, date, and beat-assignment fixed effects are included. The observation level is officer-day spans from 2014 to 2019.

Figure 10: Main Outcomes Split in First or Last 3 Hours of Shift

(a) **First 3 Hours of Shift**

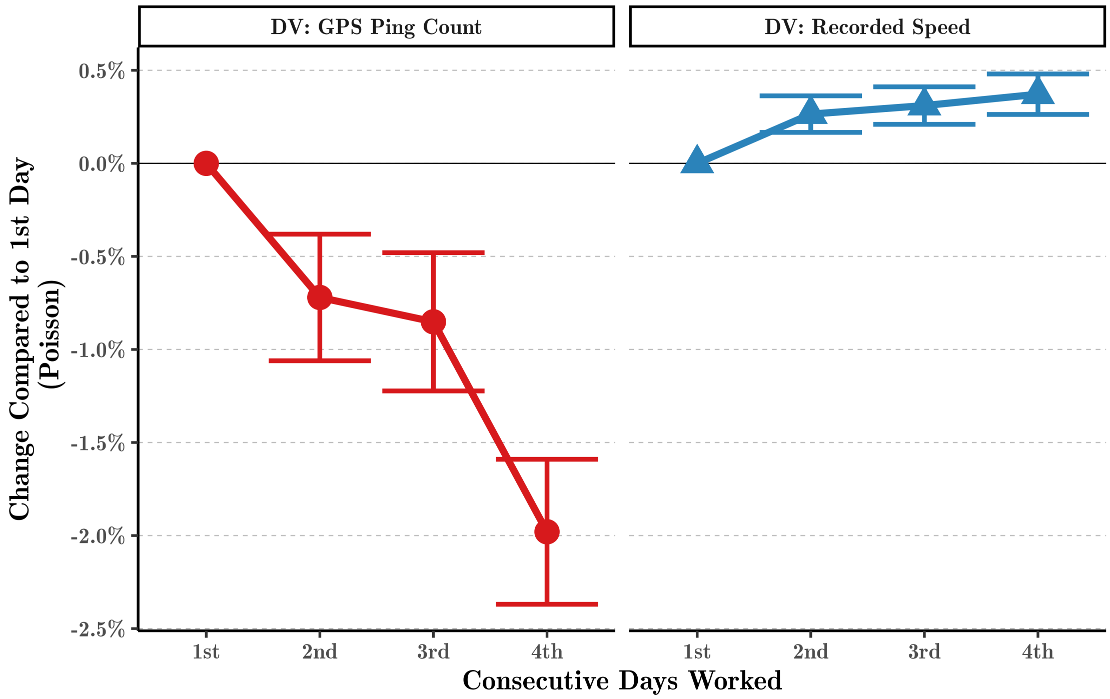


(b) **Last 3 Hours of Shift**



Note: Estimated with Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. Analysis restricts to shifts of exactly 9 hours, then divided into three hour bins. Each color and panel are a separate estimation of Equation (1) with a different outcome variable. Officer, date, and beat-assignment fixed effects are included. The observation level is officer-day spans from 2014 to 2019, except for stops, which is only available from 2016 to 2019. Tickets and Citations data cannot be included in this analysis because they are not time-stamped.

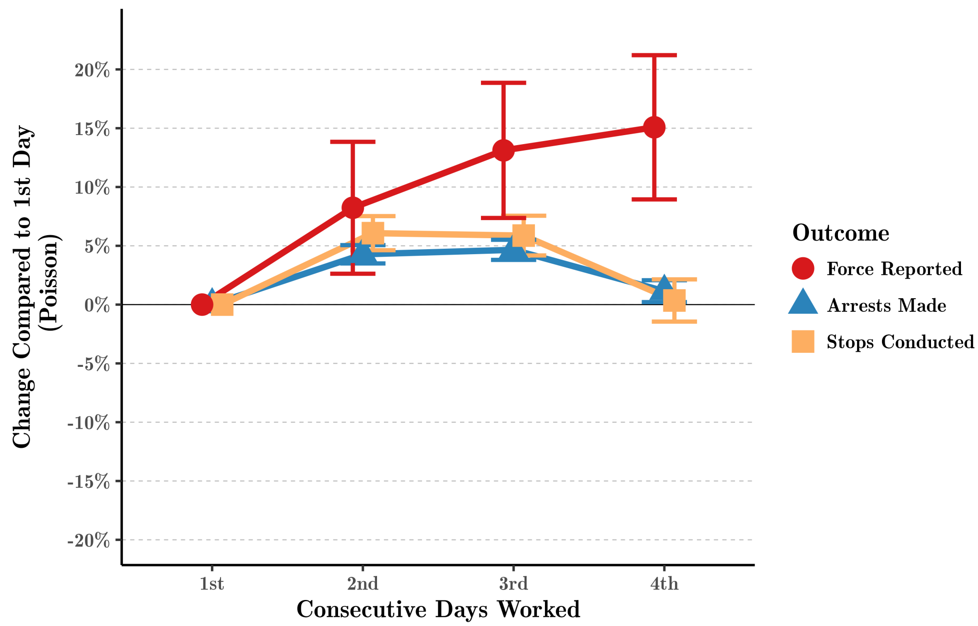
Figure 11: Relationship Between Consecutive Days Worked and GPS Pings



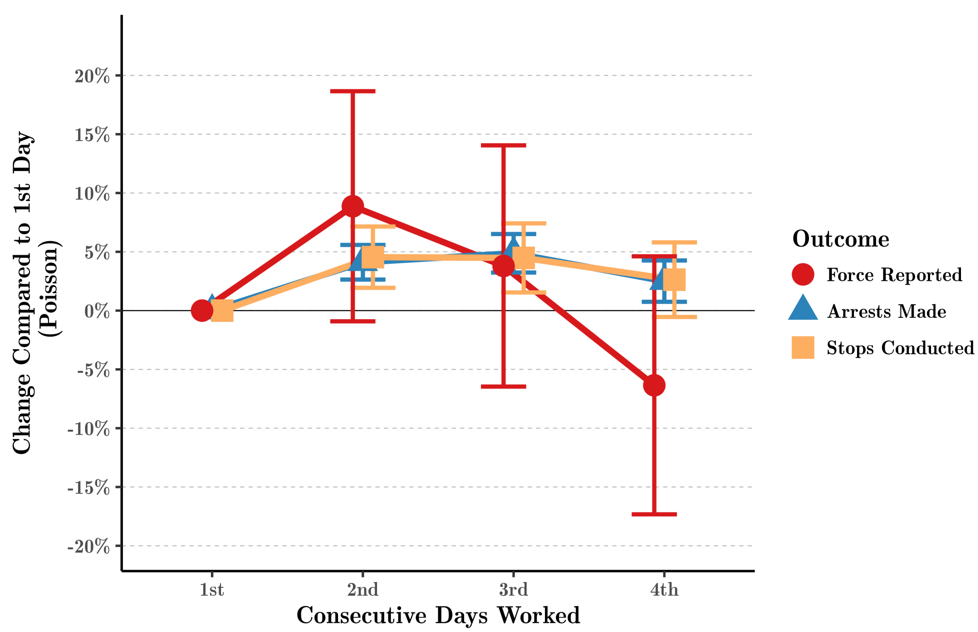
Note: Estimated with Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. Dependent variable is the count of GPS pings associated with an officers patrol car or the recorded speed at the time of a ping. Officer, date, and beat-assignment fixed effects are included. The observation level is officer-day spans from 2014 to 2019. Sample only includes officer-days that have at least one ping.

Figure 12: Main Outcomes Split in Above of Below Median Arrest Beats

(a) **High Arrest Beats**

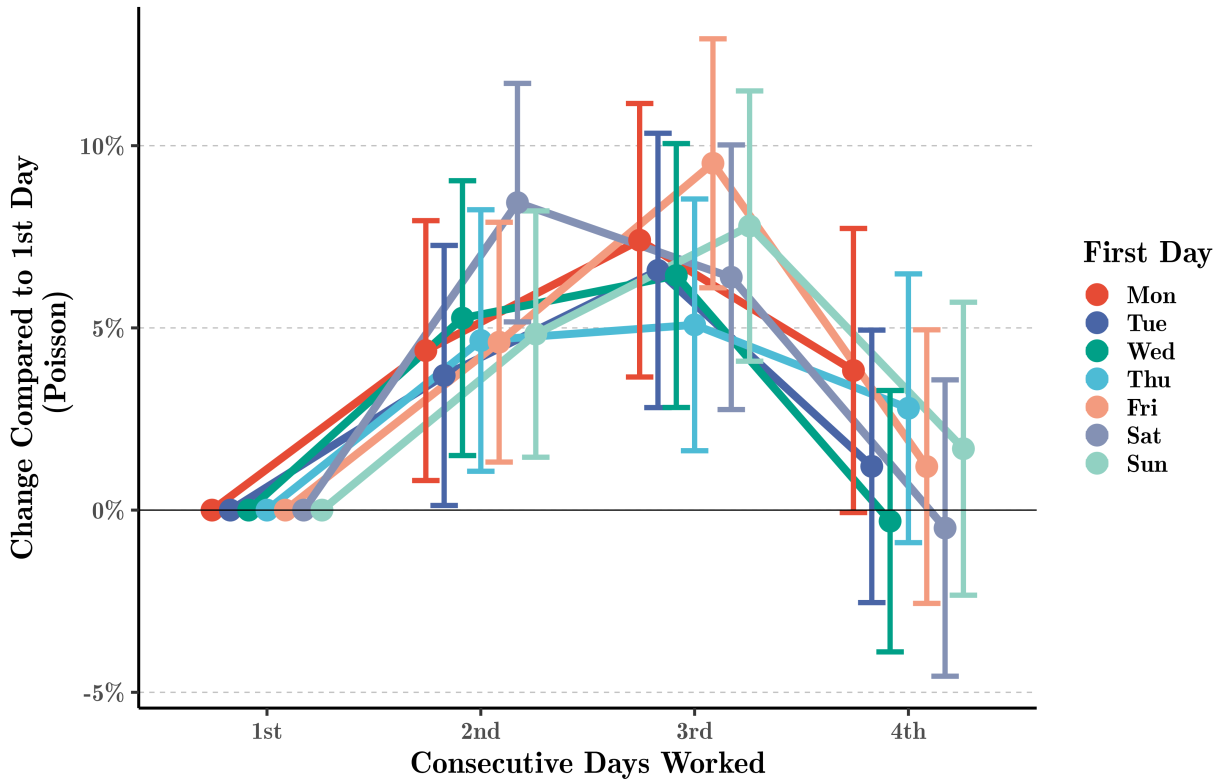


(b) **Low Arrest Beats**



Note: Estimated with Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. High and low arrest beats are defined as those above and below the median number of arrests per beat. Each color and panel are a separate estimation of Equation (1) with a different outcome variable. Officer, date, and beat-assignment fixed effects are included. The observation level is officer-day spans from 2014 to 2019, except for stops, which is only available from 2016 to 2019. Tickets and Citations data cannot be included in this analysis because they are not time-stamped.

Figure 13: Effect on Total Arrests, Split by Day of Week of First Shift



Note: Estimated with Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. This figure depicts a single regression where treatment effect for days 2 to 4 are interacted with an indicator variable based on the weekday of the first day of their shift spell. Also included is an un-interacted indicator variable for each day of the week that shift spell starts. That is, all estimates are relative to a shift spell's first day conditional on starting on the same weekday. Officer, date, and beat-assignment fixed effects are included. The observation level is officer-day spans from 2014 to 2019.

Tables

Table 1: Summary Statistics at the Officer-Day Level

	Mean	SD	Min	Max
Total Arrests Made	0.160	0.513	0	42
As First Officer	0.034	0.202	0	13
As Assisting Officer	0.094	0.413	0	42
As Second Officer	0.032	0.196	0	13
Nondiscretionary	0.032	0.198	0	13
Discretionary	0.001	0.038	0	5
Total Stops Conducted	0.097	0.487	0	19
As First Officer	0.054	0.332	0	19
As Second Officer	0.043	0.297	0	19
Total Tickets and Citations	0.769	2.112	0	173
Total Force Reported	0.008	0.173	0	19
Total Force Reports Filed	0.003	0.058	0	8
With Officer Injured	0.001	0.027	0	8
With Civilian Injured	0.001	0.029	0	7
Entry to Dispatch Time	6.911	8.107	0	99
Dispatch to Enroute Time	2.649	5.309	0	69
Enroute to Onscene Time	7.986	8.178	0	78

Note: Observation level is officer-day and spans 2014 to 2019. Dispatch time is measured in minutes. The top 1% of each dispatch time is removed for data quality, these cutoffs are given equal to the *Max* of each variable. *Total Force Reported* counts the number of actions recorded on a TRR force report. Discretionary arrests follow the pre-specified definition found in Dube et al. (2023).

Table 2: Poisson Estimates for *Day Worked Number* and Race of Civilian

	Race of Civilian		
	Black	*Hispanic*	*White*
	(1)	(2)	(3)
	Panel A: Stops Conducted		
Day Worked Number			
× Day 2	0.061***	0.068***	0.040
	(0.011)	(0.023)	(0.028)
× Day 3	0.068***	0.034*	0.032
	(0.011)	(0.018)	(0.025)
× Day 4	0.005	0.019	-0.031
	(0.012)	(0.024)	(0.031)
Mean of Dependent Variable	0.035	0.013	0.005
Observations	3205286	2310539	2086526
	Panel B: Arrests Made		
Day Worked Number			
× Day 2	0.043***	0.071***	0.086***
	(0.009)	(0.019)	(0.021)
× Day 3	0.065***	0.076***	0.090***
	(0.009)	(0.019)	(0.023)
× Day 4	0.015	-0.022	0.054**
	(0.010)	(0.018)	(0.024)
Mean of Dependent Variable	0.018	0.006	0.003
Observations	2511798	1788240	1477905
	Panel C: Force Reported		
Day Worked Number			
× Day 2	0.094***	0.095*	0.084
	(0.025)	(0.054)	(0.074)
× Day 3	0.120***	0.031	0.075
	(0.026)	(0.059)	(0.077)
× Day 4	0.114***	0.092	0.083
	(0.028)	(0.061)	(0.081)
Mean of Dependent Variable	0.002	0.001	0.000
Observations	2454472	474106	189310

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The observation level is officer-day spans from 2014 to 2019. The dependent variable is a count of outcomes that an officer is involved in with a civilian of the specified race/ethnicity. Estimated via Poisson with standard errors are clustered at the individual level. Fixed effects are included for officer, date, and beat-assignment.

Table 3: Poisson Estimates for *Day Worked Number* and Officer Tenure (Years)

	Years of Tenure		
	0 to 5	*5 to 20*	*20 or More*
	(1)	(2)	(3)
	Panel A: Arrests Made		
Day Worked Number			
× Day 2	0.048***	0.063***	0.024
	(0.010)	(0.012)	(0.025)
× Day 3	0.065***	0.089***	0.030
	(0.010)	(0.012)	(0.024)
× Day 4	0.026**	0.005	0.016
	(0.012)	(0.012)	(0.026)
Mean of Dependent Variable	0.053	0.031	0.015
Observations	1114445	1698169	520833
	Panel B: Stops Conducted		
Day Worked Number			
× Day 2	0.053***	0.093***	0.025
	(0.011)	(0.029)	(0.030)
× Day 3	0.048***	0.084***	0.070**
	(0.011)	(0.017)	(0.031)
× Day 4	0.002	0.024	0.016
	(0.012)	(0.031)	(0.036)
Mean of Dependent Variable	0.097	0.037	0.019
Observations	1201594	1056377	352125
	Panel C: Force Reported		
Day Worked Number			
× Day 2	0.091**	0.114***	-0.068
	(0.036)	(0.038)	(0.091)
× Day 3	0.114***	0.134***	-0.050
	(0.038)	(0.039)	(0.092)
× Day 4	0.128***	0.096**	-0.011
	(0.040)	(0.043)	(0.091)
Mean of Dependent Variable	0.012	0.008	0.003
Observations	816909	1292231	142831

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The observation level is officer-day spans from 2014 to 2019. The dependent variable is a count of outcomes that an officer is involved in. The sample consists of three tenure groups: the lowest tenure group comprises 30% of the total, the middle group 50%, and the highest tenure group the remaining 20%. Estimated via Poisson with standard errors are clustered at the individual level. Fixed effects are included for officer, date, and beat-assignment.

Table 4: Poisson Estimates for *Day Worked Number* and Priority 1 Dispatch Time

	Total Time	*Time Segments*		
	Call Entry to Onscene	*Call Entry to Officer Dispatch*	*Officer Dispatch to Officer Enroute*	*Officer Enroute to Officer Onscene*
	(1)	(2)	(3)	(4)
Day Worked Number				
× Day 1	-	-	-	-
× Day 2	0.000	0.002	0.005	0.001
	(0.002)	(0.003)	(0.005)	(0.003)
× Day 3	0.002	0.005	0.004	0.003
	(0.002)	(0.003)	(0.005)	(0.003)
× Day 4	0.003	0.000	0.012**	0.004
	(0.003)	(0.003)	(0.006)	(0.003)
Mean of Dependent Variable	17.546	6.911	2.649	7.986
Observations	1218421	1536812	1535162	1149491

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Observation level is officer-day and spans 2014 to 2019. The dependent variable is mean time (minutes) of 911 call dispatches per day. Column (1) represents the total time of a 911 dispatch from the initial call to the officer arriving on the scene. Columns (2) through (4) represent the time spent in each segment of the dispatch. Estimated via Poisson with standard errors are clustered at the individual level. Fixed effects are included for officer, date, and beat-assignment.

Table 5: Poisson Estimates for *Day Worked Number* using Cancelled Off Days

	Total Arrests Given	*Total Stops Conducted*	*Total Force Reported*
	(1)	(2)	(3)
Day Worked Number			
$\times$ Spell Length 4			
$\times$ Day 2	0.053***	0.042**	0.114
	(0.019)	(0.016)	(0.076)
$\times$ Day 3	0.054***	0.061***	0.165**
	(0.018)	(0.014)	(0.072)
$\times$ Day 4	-0.042**	-0.061***	0.151**
	(0.019)	(0.017)	(0.073)
$\times$ Spell Length 5			
$\times$ Day 2	0.079	0.146***	0.219
	(0.053)	(0.041)	(0.231)
$\times$ Day 3	0.100**	0.142***	0.030
	(0.050)	(0.038)	(0.246)
$\times$ Day 4	0.001	0.000	-0.133
	(0.057)	(0.043)	(0.246)
$\times$ Day 5	-0.930***	-0.804***	-0.683**
	(0.079)	(0.060)	(0.328)
Mean of Dependent Variable	0.022	0.059	0.004
Observations	630020	786285	289960

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is a count of outcomes that an officer is involved in. Sample is restricted to 2021 and 2022 and contains only shift spells of 4 or 5 days. Shift spells of 5 days contain 4 consecutive regular days followed by 1 involuntary overtime day. Estimated via Poisson with standard errors are clustered at the individual level. Fixed effects are included for officer, date, and beat-assignment.

Table 6: Robustness Table

	Preferred Model (1)	*No Beat-Assignment FE* (2)	*Unit Linear Trends* (3)	*Officer-Beat-Assignment FE* (4)	*Negative Binomial* (5)	*OLS* (6)
			Panel A: Arrests Made			
Day Worked Number						
× Day 2	0.051***	0.054***	0.052***	0.048***	0.042***	0.0018***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.004)	(0.0002)
× Day 3	0.071***	0.071***	0.071***	0.072***	0.046***	0.0024***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.004)	(0.0003)
× Day 4	0.014*	0.010	0.014*	0.011	0.015***	0.0002*
	(0.008)	(0.008)	(0.008)	(0.008)	(0.004)	(0.0003)
Mean of D.V.	0.034	0.034	0.034	0.034	0.034	0.0337
Observations	3480251	3612392	3480251	2284322	4,003,851	5323345
			Panel B: Stops Conducted			
Day Worked Number						
× Day 2	0.057***	0.066***	0.062***	0.060***	0.058***	0.0034***
	(0.006)	(0.011)	(0.011)	(0.012)	(0.007)	(0.0006)
× Day 3	0.056***	0.066***	0.057***	0.052***	0.057***	0.0032***
	(0.007)	(0.009)	(0.009)	(0.010)	(0.008)	(0.0005)
× Day 4	0.007	0.010	0.005	0.004	0.021**	0.0002
	(0.008)	(0.012)	(0.012)	(0.013)	(0.008)	(0.0006)
Mean of D.V.	0.054	0.054	0.054	0.054	0.054	0.0538
Observations	2998927	2880755	2755257	1631366	2,998,927	3542261
			Panel C: Force Reported			
Day Worked Number						
× Day 2	0.079***	0.077***	0.079***	0.070***	0.108***	0.0006***
	(0.025)	(0.025)	(0.025)	(0.026)	(0.035)	(0.0002)
× Day 3	0.107***	0.099***	0.107***	0.104***	0.119***	0.0008***
	(0.026)	(0.026)	(0.026)	(0.027)	(0.037)	(0.0002)
× Day 4	0.096***	0.084***	0.096***	0.109***	0.126***	0.0008***
	(0.027)	(0.027)	(0.027)	(0.029)	(0.038)	(0.0002)
Mean of D.V.	0.008	0.008	0.008	0.008	0.008	0.0081
Observations	3007717	3229640	3007717	1309220	3,007,717	5323345

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Observation level is officer-day and spans 2014 to 2019. The dependent variable is a count of outcomes that an officer is involved and is estimated via Poisson, Negative Binomial in Column (5), or OLS in Column (6). Standard errors are clustered at the individual level. Fixed effects are included for officer, date, and beat-assignment in all columns except for Column (2) which includes only officer and date fixed effects.

Three compared policies:

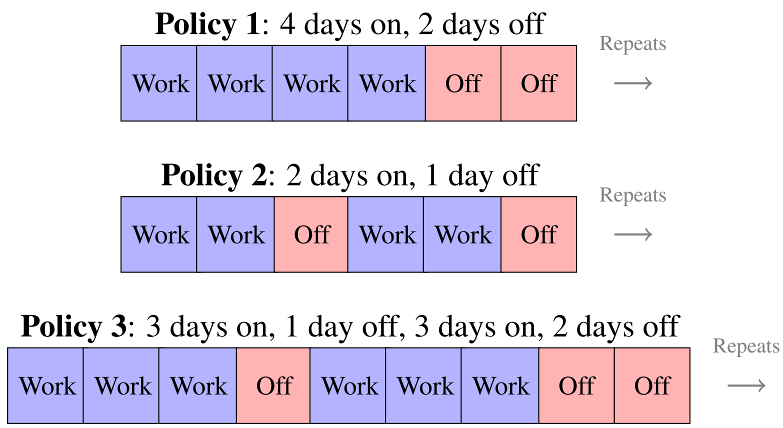


Table 7A: Total Outcomes Under Alternative Work Schedules, 2014-2019

	Policy 1	*Policy 2*	*Policy 3*
Arrests	179,756	178,033	180,698
Stops	246,837	244,441	247,698
Use-of-Force	43,163	41,993	42,840
Officer Injuries	3,756	3,664	3,691

Table 7B: Comparisons Between Alternative Work Schedules, 2014-2019

	Change from Policy 1 to 2		*Change from Policy 1 to 3*	
	Net Change	*Percent*	*Net Change*	*Percent*
Arrests	-1,723	-0.96%	942	0.52%
Stops	-2,396	-0.97%	861	0.35%
Use-of-Force	-1,170	-2.71%	-323	-0.75%
Officer Injuries	-92	-2.45%	-65	-1.73%

Note: This analysis assumes that officer behavior is not policy-dependent and their outcomes are not dependent on their shift spell length. Outcomes for each officer are summed by *Day Worked Number* and then weighted each by officers frequency to construct a representative officer. These daily averages are then summed over the six-year study period from 2014 to 2019 to simulate a full police force of representative officers working for the full sample.

Please see my website for the full Appendix: `https://ferrazares.github.io/`

Appendix

Table A.1: Comparison of District Activity by *Day Worked Number*

	Civilian-Initiated 911 Calls		*ShotSpotter Gunshot Detections*	
	Mean	*SD*	*Mean*	*SD*
Day 1	165.81	51.5	4.55	3.80
Day 2	165.62	51.5	4.52	3.81
Day 3	165.86	51.6	4.52	3.77
Day 4	166.13	51.8	4.54	3.78

Note:
This table shows the mean of civilian-initiated calls for service and ShotSpotter alerts by *Day Worked Number*. This comparison is meant to illustrate that individual officer working days are not related to underlying levels of crime. That is, officers are not experiencing differences in expected crime levels conditional on how many consecutive days they have worked.

Table A.2: Poisson Estimates for *Day Worked Number* and District Activity

	District-Level Crime Measure	
	ShotSpotter Alerts	*Civilian-Initiated Calls for Service*
	(1)	(2)
Day Worked Number		
× Day 1	-	
× Day 2	-0.0001	0.0000
	(0.0001)	(0.0020)
× Day 3	-0.0003*	-0.0005
	(0.0002)	(0.0022)
× Day 4	-0.0001	-0.0006
	(0.0002)	(0.0021)
Mean of Dependent Variable	165.55	4.69
Observations	3244829	524631

Note:
* p < 0.1, ** p < 0.05, *** p < 0.01. The dependent variable is a count of the listed variable at the district-date level which is regressed on the officer-level *Day Worked Number* and fixed effects for beat-assignment, date, and officer. Each outcome measures district-level activity that is unrelated to an officer's own activity. Civilian-Initiated Calls for Service uses data from 2014 to 2019 while Shotspotter Alerts uses data from 2018 and 2019 due to Shotspotter adoption starting in 2017. Standard errors are clustered at the individual level.

Table A.3: Definition and Frequency of Discretionary Arrests

Charge Description	n	%
RESISTING/OBSTRUCT/PC OFF/CORR EMP/FRFTR	18,632	55.39%
OBSTRUCTING IDENTIFICATION	8,616	25.62%
DISORDERLY CONDUCT	3,996	11.88%
RESIST/OBSTRUCT OFFICER	1,731	5.15%
OBSTRUCTING AN OFFICER	463	1.38%
RESISTANCE TO OFFICER	104	0.31%
IVC - OBEDIENCE TO POLICE OFFICERS	71	0.21%
DISOBEY POLICE, FIRE OR TRAFFIC AID	23	0.07%
Total	33,636	100%

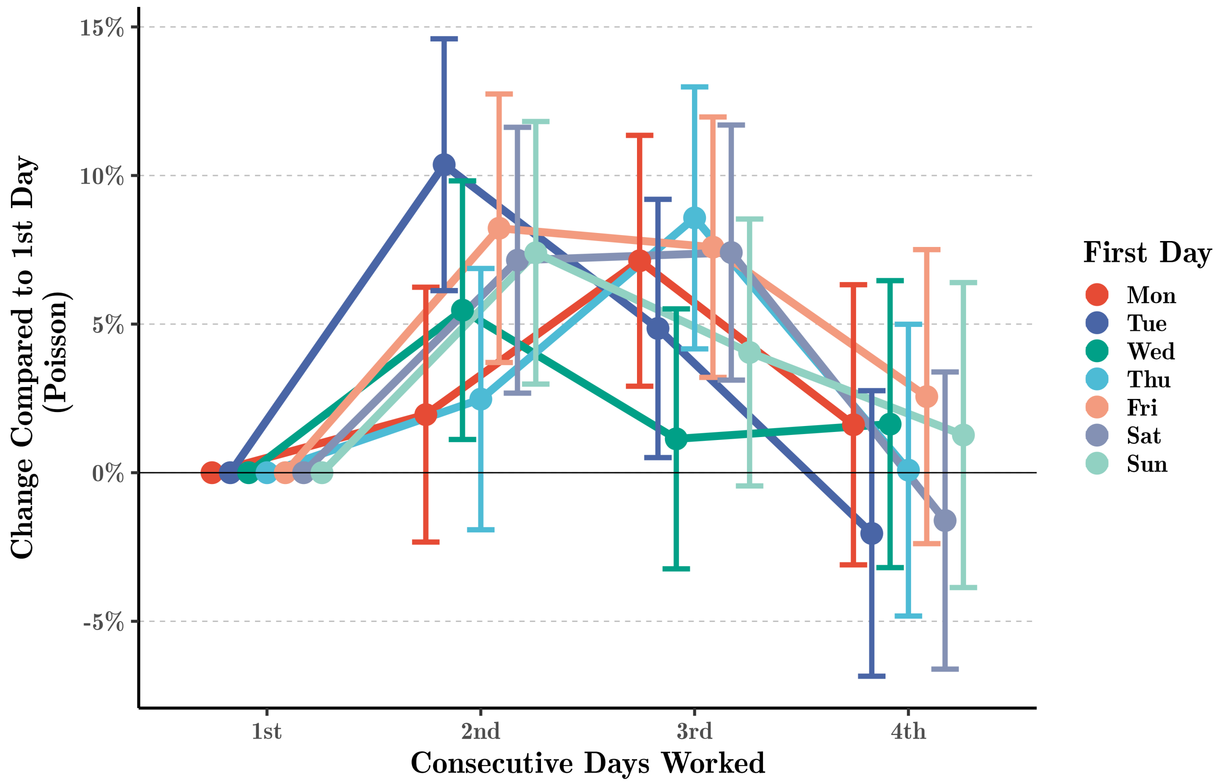
Note:
This figure gives the frequency of discretionary arrests by charge description. Discretionary arrests follow a definition from Dube et al. (2023).

Table A.4: Poisson Estimates for *Day Worked Number* and Arrest Types

	Discretionary?		*Charge Category for Arrest*					
	No	*Yes*	*Violent*	*Property*	*Narcotics*	*Warrant*	*Traffic*	*Other*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Day Worked Number								
× Day 1	-	-	-	-	-	-	-	-
× Day 2	0.051***	0.069**	0.025*	0.048***	0.044	0.056***	0.082***	0.092***
	(0.007)	(0.032)	(0.013)	(0.012)	(0.027)	(0.018)	(0.018)	(0.022)
× Day 3	0.070***	0.076**	0.033**	0.071***	0.103***	0.045**	0.084***	0.152***
	(0.008)	(0.034)	(0.014)	(0.013)	(0.028)	(0.018)	(0.018)	(0.024)
× Day 4	0.012***	0.081**	0.003	0.028**	0.001	0.003	-0.021	0.093***
	(0.008)	(0.036)	(0.015)	(0.014)	(0.031)	(0.019)	(0.015)	(0.024)
Mean of Dependent Variable	0.032	0.001	0.008	0.010	0.002	0.005	0.007	0.003
Observations	3460697	1426522	3038467	3060152	1189337	2522066	2130608	2039006

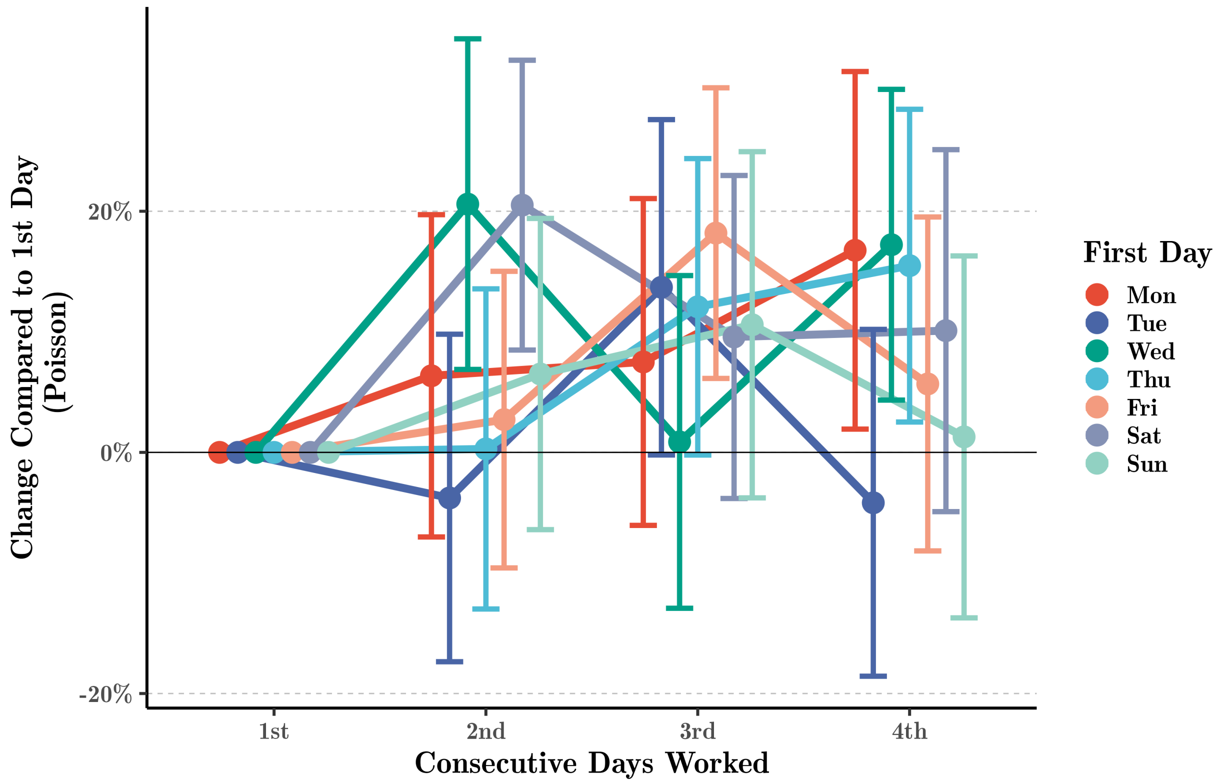
Note:
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Observation level is officer-day and spans 01/2014 to 12/2019. The dependent variable is a count of outcomes that an officer is involved and is estimated via Poisson. Arrests in this table include only first officer arrests to isolate individual officer arrest decisions. Columns (1) and (2) define *Discretionary* using Dube et al. (2023) and a full list of the included charge categories is available in Dube et al. (2023) Table A2. Standard errors are clustered at the individual level.

Figure A.1: Effect on Stops Conducted, Split by Day of Week of First Shift



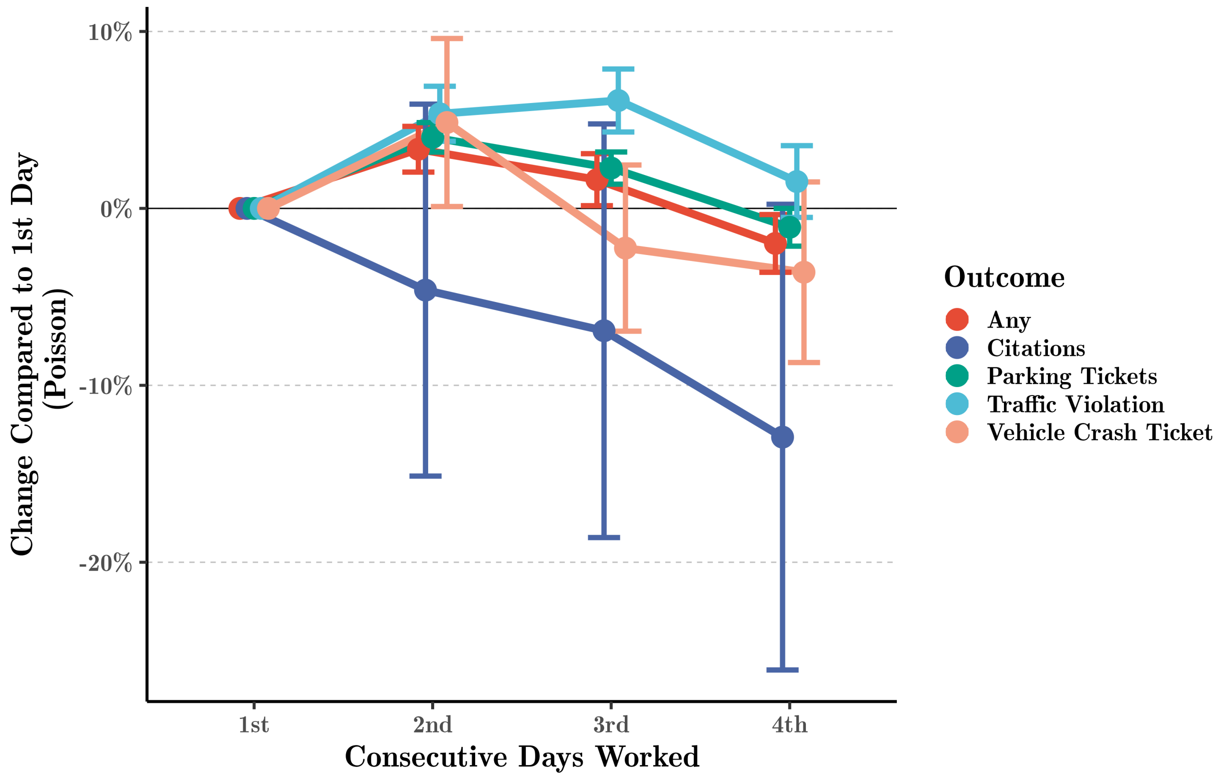
Note(s): This figure depicts a single regression where treatment effect for days 2 to 4 are interacted with an indicator variable based on the weekday of the first day of their shift spell. Also included is an un-interacted indicator variable for each day of the week that shift spell starts. That is, all estimates are relative to a shift spells first day conditional on starting on the same weekday.

Figure A.2: Effect on Force Reported, Split by Day of Week of First Shift



Note(s): This figure depicts a single regression where treatment effect for days 2 to 4 are interacted with an indicator variable based on the weekday of the first day of their shift spell. Also included is an un-interacted indicator variable for each day of the week that shift spell starts. That is, all estimates are relative to a shift spells first day conditional on starting on the same weekday.

Figure A.3: Relationship Between Days Worked and Citations, Tickets, and Other Violations



Note(s): Estimated with Poisson with standard errors clustered at the officer level and 95% confidence intervals shown. Officer, date, and beat-assignment fixed effects are included. The outcome variable is the count of outcomes at the officer-day level.

Table A.5: Poisson Estimates for *Day Worked Number* and Being Assigned Police Car

	Indicator For 'Assigned Vehicle'
	(1)
Day Worked Number	
× Day 1	-
× Day 2	0.001***
	(0.000)
× Day 3	0.001***
	(0.000)
× Day 4	0.001**
	(0.000)
Mean of Dependent Variable	0.839
Observations	5460576

Note:
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Observation level is officer-day and spans 01/2014 to 12/2019. The dependent variable is an indicator variable equal to 1 if an officer is assigned a vehicle. Standard errors are clustered at the individual level.

Figure A.4: Cancellation Notice Sent on 12/06/2021

THIS MESSAGE PROVIDES CORRECTIONS OR ADDITIONS TO MESSAGE #274782.

REFERENCE # 274783

RDO CANCELLATION

06-DEC-2021 17:32

GENERAL MESSAGE

Distribution Method:
- [x] Archive
- [x] CPD Intranet Home Page
- [x] Unit Inbox
- [ ] Faxed
- [ ] Email

Select distribution list

To: ALL UNITS

From: MARZULLO, VICTORIA J
SERGEANT OF POLICE
140 - OFFICE OF THE FIRST DEPUTY SUPERINTENDENT (OFDS)

Telephone No.:312-745-6200

On Behalf Of: ERIC M. CARTER
FIRST DEPUTY SUPERINTENDENT
140 - OFFICE OF THE FIRST DEPUTY SUPERINTENDENT (OFDS)
312-745-6200

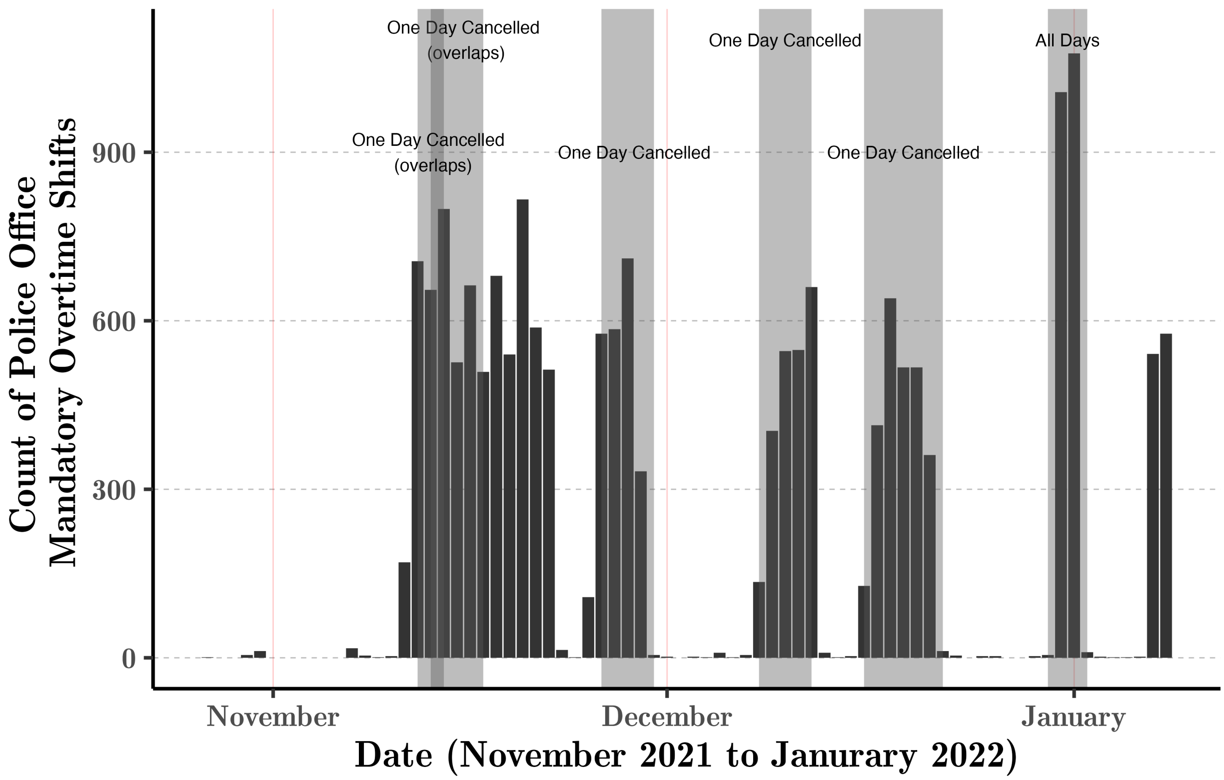
Message: Beginning 1st Watch 09-DEC-21 (Wednesday night for Thursday) all sworn, full duty members will have ONE RDO cancelled; the Department will return to normal operations with regular days off effective 2nd watch 13-DEC-21. The member's first RDO will be cancelled. PSHQ and Training Support Group (TSG) personnel will have one of their two days off cancelled, assignment rosters are forthcoming for which RDO will be cancelled. Sworn CPD members are further reminded the use of elective time remains restricted. The use of elective time will require prior approval from a Deputy Chief or above within the requesting member's chain of command. Members should continue to watch the Administrative Message Center for updates.

Attachments:

WARNING: This message is intended only for the use of the individual or agency to which it is addressed and may contain information that is confidential and/or exempt from disclosure under applicable law. If you have received this communication in error, please notify us immediately by telephone and destroy the original. Any unauthorized copying or dissemination of this communication is prohibited.

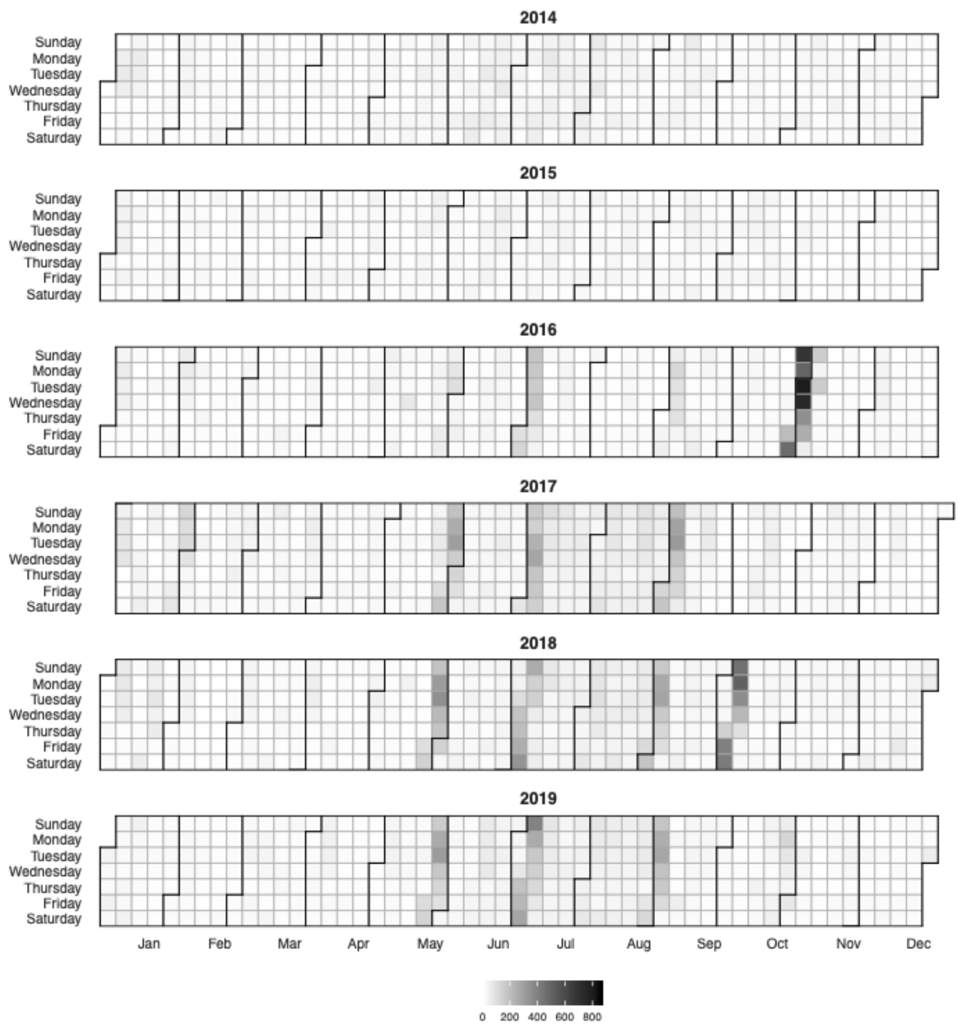
CITY OF CHICAGO / DEPARTMENT OF POLICE 3510 SOUTH MICHIGAN AVENUE CHICAGO, IL 60653

Figure A.5: Count of Mandatory Overtime, 12/2021



Note(s): This figure depicts the count of mandatory overtime shifts worked by beat officers between November and December of 2021. The shaded regions indicate the time period that days off were cancelled, and the text indicates the number of days off that were cancelled per officer.

Figure A.6: Frequency of Shifts with *Day Worked Number* > 4



Note(s): This figure plots the frequency of 'extra' shifts for officers. Any shift that is worked outside of an officer 4-day schedule is counted.