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Three Essays on Structural Racism in US Law Enforcement

Author
McCall, Andrew James

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Three Essays on Structural Racism in US Law Enforcement

by

Andrew James McCall

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Committee in charge:

Professor Sean P. Gailmard, Chair
Professor Taeku Lee
Professor Amy E. Lerman
Professor Steven Raphael
Professor Eric Schickler

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Abstract

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Paper 1

While scholars have identified ways that racial conservatives exerted out-sized influence on criminal justice policies, little attention has been paid to whether police departments have incentives to learn about and adopt reforms that reduce racial disparity. I present a game of imperfect information between residents and a municipal police chief to show that a chief's inability to prevent officer behavior that residents perceive to be abusive, coupled with resident unwillingness to assist police in the aftermath of this behavior, creates an incentive for the chief to choose and learn about new policing strategies that rely less on resident assistance. This induces a bias in favor of aggressive over collaborative tactics in the police chiefs policy selection and learning decisions. Segregation and discrimination ensured that many Black Americans lived in conditions that produced this result in the later twentieth century; thus the model shows structural racism in local police policy making.

Paper 2

Scholarship on racial inequality in policing has largely focused on factors that would cause individual officers to rely on race when deciding whether to make an arrest. Extant explanations suggest that if officers chose not to discriminate and managed to eliminate the influence of stereotypes and implicit associations on their behavior, any remaining racial disparity would be statistical discrimination. I identify an additional source of officer bias: strategic limits on information transmission. I show that when dedicated officers are uncertain whether their police chief is independent of political pressures, a chief who cares about crime control cannot credibly communicate the reason for their policy choices. Therefore if

the chief is better informed than the officers about what arrest intensities would be optimal for reducing crime, chief policy choice will give officers exaggerated or understated posterior beliefs about the probability that individuals within a particular group should be arrested. Under certain conditions this would lead to the endogenous development of taste-based discrimination.

Paper 3

This paper examines the conditions under which municipal police chiefs in the latter half of the 20th century would have adopted policies that reduced the rate of arrests among Black residents. I use a two player game of incomplete information, in which the commonly valued outcome depends upon non-contractible effort from a less informed subordinate, to show that officer uncertainty about their chief's competence and skepticism of policies that reduce rates of arrest among Black people could have prevented chiefs from adopting such policies in equilibrium. This conservatism arises even when both chief and officer are not individually racist and the chief knows that the new policy would be more effective at controlling crime.

For my parents and grandparents

Contents

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Chapter 1

Introduction

A consensus that has emerged behind the push for criminal justice reform is the notion that the War on Drugs was responsible for a massive increase in the incarceration of Black people in the US (Western, 2006; Alexander, 2010). This has been used to advocate for policy changes from the legalization of marijuana to the creation of drug courts. A proposition often treated as a corollary of of this argument is that if the War on Drugs were wound down (or had never taken place), the racial inequality of the US criminal justice apparatus would be appreciably reduced.

I want to challenge this corollary. True, the war on drugs was responsible for a disproportionately large increase in the rate of incarceration among people identified as Black and Latino, but I contend that the war on drugs was not the origin of the racial dis proportionality in who is arrested and subsequently incarcerated. That is an older problem, that which is perpetuated in part by features of police departments that would exist with or without the war on drugs. I contend that to understand the causes of racial dis-proportionality in arrests, we have to examine the way US policing transitioned out of the Jim Crow era.

1.1 Drivers of Racial Disparity in Punishment

This dissertation is in conversation with six other works on the causes of racial disparity, although most of them focus on punishment or crime policy broadly. Each of their theories are relevant to policing even when that is not specifically addressed.

The first is Weaver (2007) who argued that racial conservatives strategically politicized crime in the 1960s in order to champion punitive crime policies that would preserve the US racial hierarchy. They put the issue of crime onto the agenda because it was one where they had a relative advantage over racial liberals, and could enact policies that would protect their preferred distribution of power by race.

Murakawa (2014) studies the evolution of federal criminal justice policy in order to show how relatively racially liberal political actors laid foundations necessary for mass incarceration. In particular, she notes how liberals pioneered the notion of using the criminal justice system to fix the nations ”race problem”, and did not challenge conservatives on the notion that Black people were more likely to violate the law than whites. Since liberals had first move to nationalize and professionalize criminal justice bureaucracies, conservatives had only to continue the work they had begun in order to build an apparatus capable of incarcerating so many.

Forman Jr (2017) examines criminal justice policy in Washington DC, in particular, to explain why large proportions of Black people supported punitive criminal justice policies that drove mass incarceration. He points to fears of criminal victimization that justified extreme measures in the minds of many Black people and advocacy organizations. This made DC city government, even after Black people occupied a majority of the seats on the city council, a willing participant in intensifying the surveilance, arrest, and incarceration of disproportionately large numbers of Black people.

Miller (2008) argues that the increasing shift of criminal justice policy to the state and federal levels has limited the influence available to the city residents who experience the greatest threat from crime, as well as the greatest surveillance from police. Because of the resources necessary to participate at those levels, the set of interests that hold sway over criminal justice policy is a distorted reflection of the people whose lives are effected by it.

With the exception of Miller, these scholars structure their work to help us understand why a political decision would be made to create a shift in policy. Why racial liberals were willing to support a policy change, why Black advocacy organizations supported a policy change, or how conservatives put crime on the agenda in order to gain strategic advantage in elections and policy making. They conceive of the thing to be explained as policy choice, rather than inaction. Since increasing incarceration required a vast increase in prison populations, it makes sense to look for new political decisions to explain the increase. But thinking about the racial disparity component alone, this restriction directs attention away from an important set of developments about how policing was designed to run itself.

Imagine a world where the criminal justice system is like a machine that runs itself. What if, in this hypothetical world, it was built to over-sanction and under-protect Black people before the civil rights movement, was not restructured in that respect during the civil rights movement, and was then given license to vastly expand its incarceration. In such a world, increasing disparity in incarceration becomes not a puzzle of why black people were locked up, so much as how white people were saved, and why Black people were not saved in the same ways.

Re-framing the question in this way makes Miller’s work stand out, because it offers an account of how the venue in which criminal justice policy has increasingly been decided creates structural disadvantages for relatively low income and demographically concentrated urban constituencies, such as Black people. So it could as well explain a decision as a non-decision. It also resonates with elements of the account in Elizabeth Hinton's (2016) history of the war on crime. In particular, she recounts how 1970s reforms to the juvenile justice system led to a marked increase in the number of juveniles sent to prison, and shortly thereafter the creation of diversion programs intended to keep troubled youth from being treated like hardened criminals. These programs were just not created in urban centers where the majority of Black people lived, and so they became safety nets for white youth (cite).

The big question is: why should we think of local policing as running independently of the political whims of those in power? The short answer is that it was not, but that unprecedented steps were taken in the mid 20th century to make it so, and I argue that the consequences of this effort on racial equality in policing have been profound.

Another major thread of explanations for racial inequality in policing that I will engage with only in conclusions, is quantitative empirical work that has come out recently and is based on data from the last decade or two. In this line of work, the question is some variant of: can we identify (or in the case of experiments involving body cameras, can we reduce) racial discrimination in the decision making of individual police officers. In the work of Jennifer Eberhardt and others, this discrimination is theorized to be consciously inaccessible to the officers who are engaging in it.

While substantively my argument bears directly on this line of work, a key divergence is that this starts from the premise that racial disparity is an aberration in the operation of police departments caused by the unplanned actions of individuals. At its core, it conceptualizes the set of possible explanations within a moral hazard framework, where the problem that needs to be solved is better monitoring of police decision making (or better selection of officers who would not make individually racist decisions).

The basic problem with this approach is that it fails to recognize the institutional context of racial inequality in policing. It is a question of bureaucratic performance, ultimately, so I borrow tools from the study of bureaucracy in this dissertation. Furthermore, it is a question of bureaucratic performance in the United States, which means that an explicit purpose of police departments for much of their history was to enforce a legal structure designed to preserve white supremacy.

Without a precise accounting of how police departments transitioned out of the Jim Crow era, and how racial disparity was removed from their operation, it would be at best optimistic to assert that the purpose of police departments does not include maintaining racial disparity in punishment and protection. The chapters in this dissertation begin the work of providing such an account. An answer not to "why do we see racial inequality in policing?" but to "what would need to change in order for racial disparity in policing to be eliminated?”

Chapter 2

Resident Assistance, Police Chief Learning, and the Persistence of Aggressive Policing in Black Neighborhoods

Scholarship on the post-World War II trajectory of racial inequality in criminal justice has focused on reasons why criminal justice policy in the United States has been overly-responsive to the preferences of constituencies that wanted greater incarceration and more punitive policies (e.g. Weaver 2007). Hinton documents how federal policy makers began to intervene in local law enforcement in the 1960s with the specific intent of increasing and professionalizing the surveillance of urban Black populations (Hinton, 2016, chap. 4). Several scholars have examined why and under what circumstances Black political leaders and racial liberals supported punitive crime control policies that disproportionately impacted non-white populations, effectively removing all opposition to the demands of racial conservatives (Forman Jr, 2017; Fortner, 2015; Murakawa, 2014). Lacey and Soskice argue that local control over criminal justice policy in the United States has made it over-responsive to the preferences of wealthier Americans, leading to an over-reliance on punitive criminal justice policies in response to crime (Lacey and Soskice, 2015). Similarly, Miller argues that increasing federal and state influence over crime policy created a bias toward the representation of wealthy and well organized interests and excluded less well-resourced groups and racial minorities from the problem definition and agenda setting processes (Miller, 2008, 5-8).

An implication of prior scholarship is that, absent political interference or racial bias, municipal police departments in the US would have reduced the racial disparity in their practices since World War II. However, this research has focused on political and civil society actors outside of police departments, ignoring the bureaucrats formally empowered to make policy decisions within a police department: the Chief of Police (Hunt and Magenau, 1993, 4, 46-50). I remedy this by examining the incentives for police chiefs to learn about and adopt new policies, and identify a reason we might expect certain racialized outcomes of policing to continue even absent political pressure to preserve them. My analysis suggests that delegating police policy making to 'color-blind' police chiefs will, under certain circumstances, entrench particular dimensions of racial inequality in policing.

I consider a municipal police chief's incentives to learn about and implement collaborative rather than aggressive policing tactics in predominantly Black neighborhoods.[1] A collaborative approach is defined by relatively limited reliance on formal sanctions such as arrest, even in the presence of clear violation of the law, and officer intervention largely determined by resident complaints. Aggressive policing strategies, in contrast, prioritize the use of formal sanction against law violators for any infraction, and actively seek out violators rather than allocating their attention on the basis of resident complaints.[2] Perhaps the most famous contemporary example of aggressive policing tactics is the New York Police Department's "Stop, Question, and Frisk" program, which involved officers stopping and frisking pedestrians they deemed suspicious as part of their routine patrol activities (Gelman, Fagan and Kiss, 2007). The use of aggressive policing policies produces large numbers of arrests for minor offenses, and increases the exposure of all people within a neighborhood to police scrutiny with potentially violent consequences (Eckhouse 2018; Lerman and Weaver 2014, 36-41).

I argue that a police chief's inability to reliably prevent patrol officer behavior that residents perceive to be abusive, coupled with residents' unwillingness to assist the police following such events, lowers a police chief's expectations of assistance.[3] This gives even 'color-blind' chiefs a bias in favor of aggressive policing strategies because they rely less on resident assistance to be successful. Furthermore, this asymmetric reliance on resident assistance also reduces a chief's incentive to learn about new collaborative approaches.

I present a game of imperfect information between the residents of a neighborhood and their police chief. The chief must decide whether to pay a cost to learn how effective a new policy is and be able to implement it, before choosing whether to enact it or the *status quo*. In equilibrium, the chief will only invest in

[1] I focus on the treatment of Black residents because the historical sources I rely on allow me to characterize police chief beliefs about Black people as a group more precisely than other non-Anglo-White groups.

[2] This distinction relies heavily on the conceptualization in Wilson's *Varieties of Police Behavior* and descriptions in Skolnick's *Justice Without Trial* and the report of the National Advisory Commission on Civil Disorders.

[3] Throughout the paper I will refer to "abusive events", because the logic of the model is agnostic with respect to whether abuse actually occurred. The key factor is whether some event causes residents to bear a higher cost from assisting the police.

acquiring expertise about policies that have some chance of improving expected department performance. Greater reliance on resident cooperation lowers the department's expected performance on collaborative policies when the chief cannot prevent abusive events. As a result, the chief will hold a new collaborative policy to a higher threshold than a new aggressive policy when deciding whether to learn about or implement it.

This approach follows Volden, Ting and Carpenter (2008), who examine policy learning and experimentation across multiple jurisdictions with the potential to learn from one another. This model differs in that it focuses on the effect of jurisdiction-specific population cooperation dynamics that are inescapable for police policy makers, and identifies bias in what kinds of policies will be learned and implemented.

I articulate a local institutional cause of persisting aggressive police practices in predominantly Black areas of US cities that is independent of the racial preferences of police officers, police chiefs, or their political principals. I show how prior organizational development and practices could have prevented the interests of police administrators and Black residents from converging (Bell Jr, 1980). In so doing I show a mechanism through which, in an era when the practices, resources, and structure of local police departments changed rapidly, certain consequences of their operations in predominantly Black areas remained relatively constant. This is not an argument that racial preferences were inconsequential to the perpetuation of aggressive policing practices in predominantly Black areas. There is ample historical evidence that they were (see, for example, Muhammad 2010). Rather, I argue that even in the absence of individual level racism, the mechanism I articulate would have perpetuated racial disparity in the use of aggressive policing tactics.

A second contribution is to highlight the role of expertise acquisition incentives in the perpetuation of racial disparity in policing practices over time. I show that the incentives of police chiefs dissuaded learning new policies that would foster cooperation in predominantly Black neighborhoods, and so that we might expect racial inequality to have persisted in part through genuine ignorance of an alternative.

2.1 Police Chief Expectations of Resident Assistance

In this section I draw on the writings of several prominent, mid-twentieth century US police chiefs in order to characterize their perspective when considering whether to learn about and adopt new policing policies. In their writings, these chiefs expressed the belief that resident assistance improved department effectiveness, and that events garnering negative publicity reduced this assistance. In addition, they expressed the belief that their departments would receive less assistance if residents heard about officer behavior they disapproved of, and a particular concern that Black residents would not assist officers.

The importance of resident assistance is directly addressed in O.W. Wilson's 1950 textbook, *Police Administration*, where he writes:

> "Public cooperation is essential to the successful accomplishment of the police purpose. Public support assists in many ways; it is necessary in the enforcement of major laws as well as of minor regulations, and with it arrests are made and convictions obtained that otherwise would not be possible" (Wilson, 1950, 388).

Part of a chapter dedicated to public relations, this quote summarizes the view that resident assistance makes police officers more effective at doing their jobs.[4] According to Deakin's history of US police professionalization, Wilson's textbook became known as the "Bible of professionalism" and sold well enough to warrant a third edition in 1972 (Deakin, 1988, 216, 218). [5]

In addition to believing that resident assistance was an important determinant of department success, police chiefs expressed repeatedly that residents will not cooperate if they have a negative opinion of the police department, and that they see this opinion as sensitive to rumors, news coverage, and personal experience. The view was expressed concisely by the Chief of Police from Saint Louis, Missouri, in his address before a 1963 conference at the Southern Police Institute on "The Role of Police in Race Tension and Conflict":

> "Needless to say, whether or not we get the cooperation of our Negro residents and our white residents depends on what they think the Saint Louis Police Department is doing. If they think that St. Louis police are out to harass Negroes and "hoosiers," they are not going to help. If they are convinced the Department and its officers are dedicated to the impartial enforcement of the law, they will help" (Brostron, 1963, 40).

In this address Brostron reports on the perceived success of the St. Louis Council on Police-Community Relations, established in 1955, and suggests it has been a worthwhile investment because of the increase in cooperation it caused.

In addition to their general concerns about resident assistance, police chiefs in some jurisdictions expressed particular uncertainty about the assistance their departments would receive from Black residents. Chiefs explained these concerns

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[4]While it is certainly the case that a department's public image could also make the police chief's position more secure, Wilson's justification is entirely on performance grounds. See historical appendix for further sources on this point.

[5]Wilson himself served as the chief of police in Fullerton California, Wichita Kansas, and Chicago Illinois, in addition to Dean of the school of Criminology at the University of California (Fogelson, 1977, 142-143).

as rooted in the editorial decisions of Black news organizations (Rudwick, 1961), a general tendency among Black residents to believe negative rumors about police (Curry and King, 1962, 55), and civil rights organizations attempting to incite anti-police feelings (Wilson, 1963). William Kephardt conducted a study of the Philadelphia Police Department between 1953 and 1956, in which he interviewed all of the police captains in the department, many administrators and officers, and surveyed over half of the department. Kephardt wrote:

> "[C]ommanders stated that the Negro press followed a standard policy of taking the side of the Negro offender, irrespective of the merits of the case; i.e., instances of "brutality" are exaggerated, distorted, or invented; the white policeman is depicted as "surely", "rude," and "prejudiced" " (Kephart, 1957, 147).

This had not been a specific line of inquiry, but complaints about Black newspapers were volunteered by about half of the Black officers he interviewed and three quarters of the commanders (Kephart, 1957, 146).

2.2 Model of Police Chief Learning and Policy Choice

I present a game of imperfect information between two sequentially rational and risk neutral players: the residents of an area (R) and a police chief (P). The model represents P's decision to learn about and potentially implement one new policing policy and R's subsequent decision to assist the police or not. I use the model to examine how effective P must expect a new policy to be in order to expend effort learning about it, and then how effective it must be in order for her to implement it.

The game begins with P choosing whether to learn a new policy, which either represents a new collaborative or a new aggressive approach to policing (x_c or x_g). Before learning, P is uncertain how effective the new policy would be. P then chooses to implement this new policy or remain with the *status quo* (x_s). If she does not learn the new policy P must implement the *status quo*. Nature then decides whether an abusive event occurs ($\eta \in \{0,1\}$, where $\Pr(\eta = 1) = \pi$). Finally, R chooses whether to assist the police or not ($a \in \{1,0\}$).

The outcome of the two players' choices is the police department's performance reducing crime, represented by $Y \in \mathbb{R}$. This depends upon the policy P selects and whether R chooses to assist.

$$y = \begin{cases} x_i - (1-a)\alpha_g & \text{if P chooses policy } i \in \{g, s\} \\ x_c - (1-a)\alpha_c - \rho & \text{if P chooses } x_c \end{cases}$$

where $x_i, x_c \in \mathbb{R}$ are the effectiveness of the policy P chooses to implement, and $\alpha_g, \alpha_c > 0$ are the policy-type specific reductions in performance when residents do not assist the police ($a = 0$).[6] For simplicity, I use two common knowledge parameters to represent the performance reductions for aggressive (α_g) and collaborative (α_c) policies, and assume the *status quo* policy is aggressive. Finally, $\rho \geq 0$ can be interpreted as patrol officer antipathy toward residents, to the extent that it makes patrol officers less effective when asked to cooperate with those residents. However, this same variable could be used to represent relatively lower effectiveness due to a lack of training or familiarity with residents.

R's utility is determined by police department performance, his decision to assist *P*, and whether an abusive event occurs.[7]

$$u_r = y - c_r \eta a$$

This formulation normalizes the cost of assistance absent an abusive event at 0, with the cost of assistance after an event as $c_r > 0$. The probability that an abusive event occurs, π, is the same regardless of policy type and is common knowledge *ex ante*.[8]

I represent *P* as motivated by department performance, the cost of learning new policies, and a possible taste for aggressive policing tactics.

$$u_p = \begin{cases} y - c_p n + \psi & \text{if P chooses } x_s \text{ or } x_g \\ y - c_p n & \text{if P chooses } x_c \end{cases}$$

Where $n = 1$ if P learns a new policy and $n = 0$ otherwise. Thus, I assume that learning nothing is costless, but learning an additional policy costs $c_p > 0$. The parameter $\psi \geq 0$ represents P's taste for an aggressive policy. This taste could come from the chief's antipathy toward residents, or careerist motivation to employ tactics that would please the mayor, generate positive media attention, or mollify criticism of the department.

At the start of the game *P* is uncertain about how effective the potential new policy is, but knows the new policy's effectiveness falls on the interval between $\underline{x}_i$ and $\bar{x}_i$. I assume the width of the interval is the same for both types of new policy, and that the true effect is distributed uniformly. Formally, $x_i \sim \mathbb{U}(\underline{x}_i, \bar{x}_i)$ and $\bar{x}_i - \underline{x}_i = \varepsilon$ for $i \in \{g, c\}$. If she learns the new policy, *P* observes its true effectiveness, x_g or x_c. *R* has the same prior beliefs about the effectiveness of the new policy. The

[6] This formulation assumes no policy has a chance of fully eliminating crime in the jurisdiction. The assumption is justified in the 1950s and 60s, at least, because historians have noted there is little evidence that policing strategies had an effect on the level of crime in a jurisdiction (Fogelson, 1977, 232-233), a fact noted by professionalization advocates at the time (Smith, 1940, 153).

[7] If residents had a preference for one policy or the other it would not change their sequentially rational behavior. See appendix.

[8] In the online appendix I consider the conditions required to sustain the substantive results if the probability of abuse varies by policy type.

effectiveness of the status quo policy (x_s) and the effectiveness reduction when residents do not cooperate (α_c and α_g) are common knowledge.

Sequence of Play

1. *P* chooses whether to learn the new policy.

2. If she learns, she observes the new policy's effectiveness and then chooses whether to implement the *status quo* or new policy. If she does not learn, she must implement the *status quo*.

3. Nature chooses whether an abusive event occurs.

4. *R* observes the policy chosen and whether an abusive event occurred and then chooses whether to assist the police.

The Cost of Assistance

The model assumes that residents respond to a common set of possible abusive events. This shared reaction could be the result of mobilization by organizations or arise without central coordination, if a collection of people shares a judgment that a particular police action was unacceptable. Michael Dawson's argument about the politicization of Black identity in the late-nineteenth and early-twentieth centuries, and the resulting reliance on the 'Black utility heuristic', suggests that Black Americans during the 1950s and 1960s would have been particularly likely to respond collectively (Dawson, 1994, 48-51, 56-61). The logic of the model could also be applied to Mexican-American, Chinese-American, or later Latino and Asian American residents of a jurisdiction, in addition to white ethnic groups (e.g. Irish-American) or socio-economic groups such as the homeless.

An Abusive Event

The variable η represents an event that causes members of the group to incur some cost from assisting the police. One example is an officer using force against a suspect in a way that is perceived to be abusive by residents, and knowledge of the officer's action disseminating through the neighborhood.[9] For simplicity I refer to this as an event, but it requires the actions of many people to spread information about its occurrence, or frame it as an event that should inspire anger at the police. By representing the occurrence of abuse as outside the chief's control, I assume either that the chief has done what they can to prevent such incidents, or that residents may respond to events outside the jurisdiction. In this way the model takes the chief's difficulty controlling public perceptions as given, and examines what effect it has on policy selection and learning.

The probability of an abusive event, π, could be influenced by at least three sets of factors. First, patrol officer treatment of residents could increase or decrease π. Scholars have found observational and experimental support for the theory

[9] The occurrence of an abusive event is similar to the option for sabotage in the extended principal agent model in Brehm and Gates (1997). This model differs from theirs because it takes as given some fixed limit to how well *P* can oversee her officers, and treats the occurrence of such abusive events as exogenous.

that population cooperation with police is increased by the perception that officers apply the law in a neutral fashion (e.g. Mazerolle et al. 2013; Tyler 2005; Tyler and Huo 2002). This suggests that a department whose officers behave in a procedurally just fashion would have a lower π. Second, news organizations and civic leaders, through their opinion leadership, could increase or decrease π. Third, residents themselves, by caring about police treatment of other residents to a greater or lesser extent, could increase or decrease π.

Police Learning

Learning is represented as paying for information about the effectiveness of a fixed new policy, along with the ability to implement it. This follows Volden, Ting and Carpenter (2008), who represent policy experimentation as an actor implementing a policy when they are uncertain about how effective it will be. The model presented here assumes certainty about a policy's effectiveness, after learning about it, in order to focus on how different dependence on cooperation influences the kinds of policies that will be learned. I represent learning in this way because, during the 1950s and '60s, police chiefs had access to a vast array of potential new policies through professional networks and publications.[10] In addition, the federal government attempted to influence local police departments beginning in the 1960s by demonstrating the effectiveness of policies in select jurisdictions, and disseminating the results (Hinton, 2016, chap. 4-5).

Individual Racism

Individual level racism on the part of patrol officers could influence three parameters: the probability of an abusive event (π), the effectiveness of a collaborative policy (x_c), and the effectiveness of the aggressive policy (x_g). In a department where officers harbor significant anti-black racism, officers might have a high likelihood of abusing residents.[11] In addition, such officers might not cooperate as effectively with Black residents, and so reduce the effectiveness of cooperative relative to aggressive tactics independent of resident assistance decisions. Finally, anti-Black racism could increase the effectiveness of the aggressive policy, if officers are particularly excited about pursuing criminals within the Black population.

The first of these three ways of representing individual level racism within the police department would not require any changes to the model, simply consideration of parameter combinations with high probabilities of an abusive event. The second two imply a difference in the department effectiveness at implementing collaborative policies, relative to aggressive ones.

Policy Type

In the following analysis I assume that $\alpha_c > \alpha_g$, or that the loss in a policy's

[10] Examples of nationally distributed professional publications include the *FBI Law Enforcement Bulletin*, the IACP's *Police Chief Magazine*, and *Police*. Journals with circulation at the state level include the *Michigan Police Journal* and the *Missouri Police Journal*.

[11] This could raise the probability of an abusive event conditional on both policies, or it could cause them to converge.

effectiveness when residents do not assist is higher for collaborative policies than for aggressive policies. This is because aggressive policies, by design, reallocate officer effort from responding to residents to seeking out arrests that could be made. Thus, resident assistance is less important to the success of aggressive policing tactics.[12]

Resident Assistance and Police Policy Choice without Racism

The central question in this paper is: how effective must a police chief believe a collaborative policy is, relative to an aggressive policy, in order to learn and implement it? To begin answering this I first characterize *R*'s equilibrium assistance choice and *P*'s optimal rule for policy selection after learning, assuming that officers and the chief are not individually racist ($\rho = 0$ and $\psi = 0$). Throughout the analysis I use the weak Perfect Bayesian Equilibrium solution concept.

R's equilibrium choice to assist the police will depend upon the cost of assisting after an abusive event occurs and whether such an event actually happens. When the cost of assisting police after an event is sufficiently high, *R* will assist police only when an event does not occur. When the cost is low, *R* will assist regardless.

It is sequentially rational for *R* to choose $\mathrm{a} = 1$ after P chooses $\mathrm{x_i}$ if and only if $\mathrm{x_i} - \mathrm{c_r}\eta \geq \mathrm{x_i} - \alpha_\mathrm{i}$, which requires: $\alpha_\mathrm{i} \geq \mathrm{c_r}\eta$. When $\eta = 0$, this inequality satisfied strictly because $\alpha > 0$ for all policies. When $\eta = 1$, this inequality is only satisfied in parameter regions where $\alpha_\mathrm{i} \geq \mathrm{c_r}$. This creates three cases in which R has a unique sequentially rational strategy. When $\mathrm{c_r} > \alpha_\mathrm{c}$, R will choose to assist the police unless an abusive event occurs. When $\mathrm{c_r} < \alpha_\mathrm{g}$, will assist regardless. I analyze the case when $\alpha_\mathrm{g} < \mathrm{c_r} < \alpha_\mathrm{c}$ in the online appendix.

These areas of the parameter space, defined by the relationship between $\mathrm{c_r}$, α_c, and α_g, can represent the circumstances in different jurisdictions or different areas of a single jurisdiction. When the cost is high ($\mathrm{c_r} > \alpha_\mathrm{c}$) the model captures the dynamics of areas or jurisdictions in which *P* is correct in her expectation that resident assistance can only be counted upon to the extent that abusive events can be prevented. When the chief cannot prevent abusive events, as seems to have been the case in many predominantly Black neighborhoods in the 1950s and '60s, assistance is therefore uncertain. When the cost is low ($\mathrm{c_r} < \alpha_\mathrm{g}$) the model more faithfully captures the circumstances in middle class white or wealthy precincts. In it the resident's assistance is assured, regardless of stochastic events beyond the chief's control.

After learning, the chief must choose policy before she knows whether an abusive event will occur. Therefore when she chooses policy knowing the cost of as-

[12] Note, although aggressive and collaborative approaches could be implemented in service of an overall reduction in crime or increase in safety, the actual perpetrators who will be punished might vary substantially between policing strategies.

sistance is high, her uncertainty concerning R's assistance reduces the department's expected effectiveness. When *R*'s strategy is to choose $a = 1$ only when an abusive event does not occur, *P*'s expected utility from choosing policy x_i is $EU_p(x_i) = x_i - nc_p - \pi\alpha_i$. Therefore after learning the new policy (x_i) in a learning equilibrium where $c_r > \alpha_c$, it is sequentially rational for *P* to choose x_i over the status quo, if $x_i > x_s + \pi(\alpha_i - \alpha_s)$. In the low cost case, R will assist no matter what, so $EU_p(x_j) = x_i - nc_p$. Therefore P's sequentially rational strategy is to choose x_i if $x_i > x_s$.

These policy selection rules show the minimum effectiveness a policy must have in order to be selected in equilibrium. In the high cost cast this depends both on how much the policy loses in the absence of resident assistance and the probability of an incident occurring. In effect, the non-zero probability of an abusive event causes a reduction in the expected performance of the department, so *P* will choose policy taking this into account.

Consider the difference between thresholds that a collaborative and aggressive policy must meet in order to be chosen over the *status quo* in the high cost case: $\pi(\alpha_c - \alpha_g)$. When the new policy's true effectiveness falls within this distance above the status quo, P would implement an aggressive policy but not a collaborative policy. Thus, under these conditions it is the selection disadvantage that collaborative approaches face relative to aggressive policies once *P* knows their true effectiveness.

The selection disadvantage for collaborative policies is increasing in the probability of an abusive event, the difference $\alpha_c - \alpha_g$, and will be positive so long as $\alpha_c > \alpha_g$ and $\pi > 0$. This captures the intuition that increasing differences in the chance of an abusive event magnify differences in the cost to effectiveness of non-assistance. Thus, in jurisdictions where police chiefs knew they had relatively low ability to prevent abusive events and Black residents had a high cost of assistance, new collaborative policing policies would have faced a disadvantage at the policy selection stage relative to aggressive ones.

In the low cost case, collaborative policies face no disadvantage in policy selection relative to aggressive policies. Since assistance is assured even if an abusive event occurs, the chief's expected performance does not depend on policy type. In this way the model illustrates how a police chiefs' racialized concerns about resident assistance would have induced racialized differences in their policy selection decisions.

Police Policy Learning without Racism

I discuss the conditions under which P will learn the new policy in equilibrium, first when the cost of assistance is high ($c_r > \alpha_c$) and then when the cost of assistance is low ($c_r < \alpha_g$). Throughout I assume no individual-level racism on the part of the police chief or officers. In both cases I identify the minimum expected effectiveness that a policy must have in order for P to learn it. I use this to show that high cost of assistance creates a higher expected effectiveness threshold for collaborative policies than aggressive.

The intuition behind these results is that in order for learning to be worthwhile for P, the new policy must have sufficiently high chance of improving department performance *relative to the status quo*. Since improving upon department performance requires meeting different thresholds for collaborative and aggressive policies, the collaborative policy will have a higher bar to meet when the cost of assistance is high.

The threshold at which *P* will implement the new policy over the status quo makes it possible to characterize the probability that learning pays off for *P*. In this model learning is only valuable to P through its effect on department performance, so in the high cost case *P* benefits from learning x_i only if $x_i > x_s + \pi(\alpha_i - \alpha_g)$. Since the π and α parameters are known ahead of time, P knows the probability that she will want to implement a new policy x_i is zero if $\bar{x}_i < x_s + \pi(\alpha_i - \alpha_g)$ and one if $\underline{x}_i > x_s + \pi(\alpha_i - \alpha_g)$. When $\underline{x}_i < x_s + \pi(\alpha_i - \alpha_g) < \bar{x}_i$, the probability she will implement the new policy is $\frac{\bar{x}_i - (x_s + \pi(\alpha_i - \alpha_g))}{\varepsilon}$.

Mirroring the result from the chief's policy selection choice, in the high cost case a collaborative policy must be more effective than an aggressive policy in order for learning it to have some chance of paying off. This difference is not present in the low cost case.

Proposition 1. *When the cost of assistance is high* ($c_r > \alpha_c$) *and the chief and officers are not individually racist* ($\psi = 0$ *and* $\rho = 0$)*, the chief will only learn the new policy* i *in equilibrium if it satisfies:*

$$E(x_i) \geq \begin{cases} x_s + \pi(\alpha_i - \alpha_g) + c_p - \frac{\varepsilon}{2} & \text{if } c_p \geq \frac{\varepsilon}{2} \\ x_s + \pi(\alpha_i - \alpha_g) + \sqrt{2 c_p \varepsilon} - \frac{\varepsilon}{2} & \text{if } c_p < \frac{\varepsilon}{2} \end{cases}$$

Proof. See Appendix. □

Proposition 1 captures the intuition that *P* will only pay the cost of learning when she has high enough confidence that it will increase the department's performance. I call these minimum expectations *belief thresholds*. In parameter regions where the new policy does not meet its belief threshold, *P* will not learn in equilibrium.

When the cost of learning is sufficiently small relative to *P*'s *ex ante* uncertainty about the new policy's effectiveness, the belief threshold is low enough that the new policy may not actually improve upon the department's status quo performance. This allows for the existence of equilibria in which *P* learns but the status quo is enacted anyway. With a higher c_p, learning will only take place when the new policy will certainly increase the department performance by a large enough amount.

No matter the cost of learning, the belief thresholds when resident assistance is costly depend on the size of π and α_i. As a result, the collaborative policy faces the same disadvantage in P's learning decision as it does in P's policy selection decision. P's belief thresholds for a new collaborative policy are $\pi(\alpha_c - \alpha_g)$ higher than for a new aggressive policy.

Proposition 2. *When the cost of assistance is low* ($c_r < \alpha_g$) *and the chief and officers are not individually racist* ($\psi = 0$ *and* $\rho = 0$)*,* P *will only learn the new policy in equilibrium if it satisfies:*

$$E(x_i) \geq \begin{cases} x_s + c_p - \frac{\varepsilon}{2} & \textit{if } c_p \geq \frac{\varepsilon}{2} \\ x_s + \sqrt{2c_p\varepsilon} - \frac{\varepsilon}{2} & \textit{if } c_p < \frac{\varepsilon}{2} \end{cases}$$

Proof. See Appendix. □

Proposition 2 identifies the belief thresholds that a new policy must meet in order to be learned in an equilibrium when the cost of residents assisting the police is low. Unlike in the case with high cost of assistance, the belief threshold in proposition 2 does not depend upon the policy that is being learned. This is because when the cost of assistance is low, the residents will continue to assist after an abusive event. Therefore collaborative policies do not face a disadvantage in the chief's policy learning choices when the cost of assistance is low.

Figure 2.1 illustrates the parameter requirements for P to learn in equilibrium. The shaded region in the left panel is the range of parameters in which P would choose to learn a new aggressive policy, but not a new collaborative policy. There is no such region in the right panel, which represents the case when the cost of assistance is low. This is because the aggressive and collaborative policies must meet the same belief thresholds when the cost of assistance is low.

Taking Individual Racism into Account

I discuss how the previous results change when the chief and officers are individually racist ($\rho > 0$ and $\psi > 0$). Formal analyses can be found in the online appendix.

Individual racism by police officers or the chief raises the effectiveness threshold at which the chief will select a new collaborative policy in equilibrium. When the cost of assistance is low, a new aggressive policy must meet $x_g > x_s$ while a new collaborative policy must meet $x_c > x_s + \rho + \psi$. The collaborative policy faces a selection disadvantage in the low cost case because of P's preference for the aggressive policy and because of the department's relative incapacity at collaboration. The disadvantage is added to in the high cost case, through the same mechanism

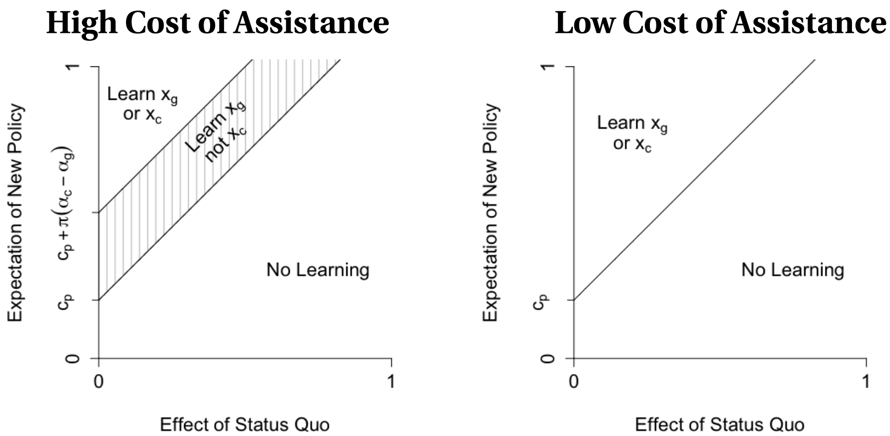

Figure 2.1: **Learning Choice with No Individual Racism**. Parameter regions where *P* will choose to learn the new policy, or not, when the cost of assistance is high (left) and low (right). The x-axis represents the effectiveness of the status quo policy, and the y-axis represents the expected effectiveness of the new policy (either aggressive or collaborative). The shaded region represents the space where a new aggressive policy would be learned, but not a new collaborative policy. The figure assumes no individual level racism ($\rho = 0$ and $\psi = 0$), and $c_p \geq \frac{\varepsilon}{2}$.

at work without racism: the chief's anticipation that residents may not assist. This illustrates that a high cost to assistance has the same kind of effect on P's policy selection decision as individual racism, but is driven by a different mechanism. Crucially, eradicating individual level racism at the chief and officer level does not eliminate this effect.

As in the model without individual racism, the selection disadvantage for a collaborative policy influences the chief's learning decisions. The belief thresholds for a new aggressive policy are identical to those in the model without racism, because a new aggressive policy does not require officers to learn a new skill, and satisfied P's preference for aggressive policies.

In the online appendix I show that the differences between belief thresholds for the collaborative and aggressive policies are $\psi + \rho + \pi(\alpha_c - \alpha_g)$ when the cost of assistance is high and $\psi + \rho$ when it is low. Comparing these two differences shows that individual racism at the officer or police chief level, as represented in this model, have the same effect on P's learning behavior as does a high cost to assisting the police following an abusive event. In the unhappy circumstance where both are combined, as was likely the case in many jurisdictions in the mid-twentieth century United States, the two effects compound.

2.3 Illustration: San Francisco, 1958

I illustrate the implications of this model by discussing the implementation of a new policy by the San Francisco Police department in 1958. Thomas Cahill served as Chief of Police in San Francisco from 1958 until 1970, and developed a national reputation as an effective reformer and expert on crime control (Agee, 2014, 200). During the 1960's he became known for creating San Francisco's Police Community Relations Unit; a group of officers dedicated to improving the relationship between police officers and minority residents in the city.

One of the first new programs Cahill introduced involved deploying a select group of officers to small areas of the city, with instructions to stop, question, and if possible arrest, anyone they encountered and thought suspicious. The program was the epitome of the aggressive policing tactics that several prominent police reformers advocated for at the time (Fogelson, 1977, 187-188). Although precise deployments varied, one of the regular targets was the Filmore district; one of two predominantly Black neighborhoods in San Francisco at the time (Agee, 2014, 36). In its first year the program's officers arrested 1,000 people and stopped 20,000, most of whom were either Black or juveniles (Fogelson, 1977, 188).

The model presented above provides a framework for thinking about what would have needed to be different for Cahill to choose a collaborative approach to policing in the Filmore. In particular, it suggests that the department's past relationship with Black residents might have influenced his expectation of how effective a collaborative approach would have been.

The California advisory Committee to the US Civil Rights Commission conducted a hearing in the San Francisco Bay Area in 1963, which included testimony that sheds some light on the assistance police expected from Black San Franciscans at the time. The police chiefs in attendance, including Cahill, "agreed that they are forced to deal with outspoken attitudes of hostility among many Negroes (California Advisory Committee to the US Commission on Civil Rights, 1963, 23). This was not disputed by representatives of the NAACP, CORE, and the Urban League, who reported that "[m]any Negroes in the area dislike and distrust the police, whom they view as the tangible symbol of white authority (California Advisory Committee to the US Commission on Civil Rights, 1963, 21). Finally, representatives of these groups also said that "many complaints leveled by Negroes charging physical violence [by the police] are untrue; nevertheless, these charges are believed by the Negro community (California Advisory Committee to the US Commission on Civil Rights, 1963, 22).

Given these conditions on the ground, a risk neutral and 'color-blind' police chief would have needed to believe that a collaborative approach was significantly more effective than the aggressive one, in order to learn about or enact it. Thus Cahill might have believed that a more collaborative policy could have been more effective, under different circumstances, but still chosen to crack down.

2.4 Conclusion

The analyses above show that a police chief learning about and adopting new collaborative policing approaches in place of aggressive ones can be prevented by a concern for the level of assistance the population will actually provide. Since the effectiveness of collaborative policies is more dependent upon whether the population assists the police, aggressive policies face an advantage in selection where resident assistance is uncertain. This disadvantage in policy selection also influences the police chief's learning decisions.

These results, coupled with doubts about Black assistance expressed by police chiefs, suggest that aggressive policing tactics might have persist in predominantly Black neighborhoods even with a police chief who cared exclusively about crime control and knew that a collaborative approach would be more effective. This result obtains without pressure from politicians or the public to enact punitive policies. This implication is not confined to concentrating disadvantage among Black residents; similar dynamics may help explain policing tactics in predominantly Latino areas, with troubling implications for the effects of local police participation in immigration enforcement. The model articulates how particular features of the historical relationship between Black Americans and local police likely made the group especially vulnerable to inefficient reliance on aggressive policing tactics with a significant human cost.

The argument has particular importance in understanding the trajectory of racial inequality in policing during the nineteen fifties, sixties, and seventies because this was a period of rapid investment in and expansion to local police capacity, and a time in which leading policing experts largely repudiated white supremacy as a goal of local police departments. It was, however, also the end of an era in which police departments had served more explicitly racialized goals, and had existing capacities that reflected that (Simon 2016). The model shows that the confluence of these historical trends could not have been more perfectly tailored to entrench racially disparate policing practice as the effect of 'color-blind' experts' decision making.

The applicability of the model is not unique to the mid-twentieth century. Aggressive tactics are still deployed by major police departments, and the racial consequences of their deployment has been a regular topic of criticism (see, for example, Gelman, Fagan and Kiss 2007). If highly racialized policing endeavors such as the War on Drugs created racial differences in the social or personal cost of assisting the police following abusive incidents, the model's intuition still applies. Further work is needed to identify the extent to which these dynamics might explain differences in arrest practices and racial disparity in arrests between jurisdictions.

This model makes a series of best-case assumptions about the functioning of police departments, including officers obeying the chief with certainty, no efficiency loss from policy change, and a fully a chief concerned exclusively with the true performance of the department. These optimistic assumptions about the chief and department limit the ability of the model to explain the historical experience of particular US cities with racist officers and police chiefs. However, they allow the model to demonstrate that achieving the ideal of a 'color-blind' and expert led police department will not eliminate racial disparity in policing, even under these optimistic assumptions. If racial equality in policing is to be achieved, given the history and institutions we have inherited, a new model of policing is needed.

2.5 Appendix

Proof for Proposition 1

P's expected utility from learning the new policy x_i is:

$$EU_p(n=1) = Pr(x_i \succ x_s)EU_p(x_i|x_i \succ x_s, n=1) + (1 - Pr(x_i \succ x_s))EU_p(x_s|n=1)$$

P will only learn if $EU_p(n=1) \geq EU_p(x_s|n=0)$. When *R*'s strategy is $a = 1$ iff $\eta = 0$ this requires:

$$\begin{cases} Pr(x_g \succ x_s)[E(x_g|x_g \succ x_s) - x_s] \geq c_p & \text{If } x_i = x_g \\ Pr(x_c \succ x_s)[E(x_c|x_c \succ x_s) - x_s - \pi(\alpha_c - \alpha_g) - \rho - \psi] \geq c_p & \text{If } x_i = x_c \end{cases} \tag{2.1}$$

When $c_p \geq \frac{\varepsilon}{2}$, inequality (2.1) cannot be satisfied unless $Pr(x_i \succ x_s) = 1$. Therefore the minimum value of $\bar{x}_i$ for which P will learn solves:

$$\begin{cases} E(x_g) - x_s \geq c_p & \text{If } x_i = x_g \\ E(x)_c - (x_s + \rho + \psi + \pi(\alpha_c - \alpha_g)) \geq c_p & \text{If } x_i = x_c \end{cases}$$

$$\implies \begin{cases} E(x_g) \geq x_s + c_p - \frac{\varepsilon}{2} & \text{If } x_i = x_g \\ E(x_c) \geq x_s + \rho + \psi + \pi(\alpha_c - \alpha_g) + c_p - \frac{\varepsilon}{2} & \text{If } x_i = x_c \end{cases}$$

When $c_p < \frac{\varepsilon}{2}$, learning can be sequentially rational with $Pr(x_i \succ x_s) < 1$, so the minimum value of $\bar{x}_i$ for which P will learn solves:

$$\begin{cases} \left(\frac{\bar{x}_g - x_s}{\varepsilon}\right)\left(\frac{\bar{x}_g - x_s}{2})\right) \geq c_p & \text{If } x_i = x_g \\ \left(\frac{\bar{x}_c - (x_s + \rho + \psi + \pi(\alpha_c - \alpha_g)}{\varepsilon}\right)\left(\frac{\bar{x}_c - (x_s + \pi(\alpha_c - \alpha_g) + \rho + \psi)}{2}\right) \geq c_p & \text{If } x_i = x_c \end{cases}$$

$$\implies \begin{cases} E(x_g) \geq x_s + \sqrt{2c_p\varepsilon} - \frac{\varepsilon}{2} & \text{If } x_i = x_g \\ E(x_c) \geq x_s + \rho + \psi + \pi(\alpha_c - \alpha_g) + \sqrt{2c_p\varepsilon} - \frac{\varepsilon}{2} & \text{If } x_i = x_c \end{cases}$$

□

Proof for Proposition 2

When $c_r < \alpha_g$, *R* will choose $a = 1$ no matter what, $EU_p(n = 1) \geq EU_p(x_s|n = 0)$ requires:

$$\begin{cases} Pr(x_g \succ x_s)[E(x_g|x_g \succ x_s) - x_s] \geq c_p & \text{If } x_i = x_g \\ Pr(x_c \succ x_s)[E(x_c|x_c \succ x_s) - x_s - \rho - \psi] \geq c_p & \text{If } x_i = x_c \end{cases} \tag{2.2}$$

When the new policy is aggressive, satisfying inequality (2.2) is the same as a new aggressive policy in the proof for Proposition 1. When $c_p \geq \frac{\varepsilon}{2}$, satisfying inequality (2.2) requires:

$$E(x_c) - (x_s + \rho + \psi) \geq c_p \qquad \Longrightarrow E(x_c) \geq x_s + \rho + \psi - \frac{\varepsilon}{2} + c_p$$

When $c_p < \frac{\varepsilon}{2}$, satisfying inequality (2.2) requires:

$$\left(\frac{\bar{x}_c - x_s - \rho - \psi}{\varepsilon}\right)\left(\frac{\bar{x}_i - (x_s + \rho + \psi)}{2}\right) \geq c_p \quad \Longrightarrow E(x_c) \geq x_s + \rho + \psi + \sqrt{2c_p\varepsilon} - \frac{\varepsilon}{2}$$

□

Policy-Specific Probability of Inciting Events

In the main analysis, I simplify the model by assuming that the probability of an abusive event is the same for both types of policies. However, the *Report of the National Advisory Commission on Civil Disorders* suggested that aggressive tactics would increase the risk of abusive events occurring (United States 1967, 158-160). Therefore, consider a revised version of the model in which the probability of an abusive event after a collaborative policy (π_c)is less than the probability of an abusive event after an aggressive policy (π_g).

In this model, R's optimal strategy would be unchanged. Similarly, when $c_r < \alpha_g$, P's expected utility and optimal decision rules are the same, so Proposition 2 from the print article holds. When $c_r > \alpha_c$, her expected utility from x_c is $x_c - \pi_c\alpha_c - c_p n$, and her expected utility from an aggressive policy x_i is $x_i - \pi_g\alpha_g - c_p n$. Therefore she will choose the new aggressive policy if $x_g > x_s$, and the new collaborative policy if $x_c > x_s + \pi_c\alpha_c - \pi_g\alpha_g$. Thus, the substantive conclusion that the collaborative policy faces a selection disadvantage remains so long as $\pi_c\alpha_c - \pi_g\alpha_g > 0$, or:

$$\pi_c > \pi_g\frac{\alpha_g}{\alpha_c}$$

where $\alpha_c > \alpha_g$. This indicates that if the difference $\pi_g - \pi_c$ grows too large, the advantage for the aggressive policy is replaced by a relative disadvantage.

Chief Policy Choice and Learning with Individual Racism

When $\rho > 0$ and $\psi > 0$, *R*'s optimal decision rule for whether to choose $\mathrm{a} = 1$ is the same as if $\rho = 0$ and $\psi = 0$. Since P has already made her choice of policy when R decides whether or not to assist, R could have a preference for one policy or the other and his greater or lesser utility from their preferred policy being chosen or not is the same regardless of his choice. Therefore it is not sequentially rational for R to behave any differently if he were to have preferences over the policy-type chosen. This is because of the sequence of decisions, where R makes his choice after P has already decided, so there is no way for P to punish him.

Proposition 3. *When* $\mathrm{c_r} > \alpha_\mathrm{c}$, $\rho > 0$, *and* $\psi > 0$, *P will choose the new policy after learning if it satisfies:*

$$\begin{cases} \mathrm{x_g} > \mathrm{x_s} & \textit{if the new policy is aggressive} \\ \mathrm{x_c} > \mathrm{x_s} + \psi + \rho + \pi(\alpha_\mathrm{c} - \alpha_\mathrm{g}) & \textit{if the new policy is collaborative} \end{cases}$$

Proof. When $\mathrm{c_r} > \alpha_\mathrm{c}$, R will choose $\mathrm{a} = 1$ if $\eta = 0$ and $\mathrm{a} = 0$ if $\eta = 1$, therefore $\mathrm{EU_p(x_s)} = \mathrm{x_s} - \pi\mathrm{x_g} + \psi - \mathrm{c_p n}$. If the new policy is aggressive, $\mathrm{EU_p(x_g)} = \mathrm{x_g} - \pi\alpha_\mathrm{g} + \psi - \mathrm{c_p n}$, so P will choose $\mathrm{x_g}$ iff $\mathrm{x_g} > \mathrm{x_s}$. If the new policy is collaborative, $\mathrm{EU_p(x_c)} = \mathrm{x_c} - \pi\alpha_\mathrm{c} - \rho - \mathrm{c_p n}$, so P will choose $\mathrm{x_c}$ iff $\mathrm{x_c} - \pi\alpha_\mathrm{c} - \rho > \mathrm{x_s} - \pi\alpha_\mathrm{g} + \psi \implies \mathrm{x_c} > \mathrm{x_s} + \psi + \rho + \pi(\alpha_\mathrm{c} - \alpha_\mathrm{g})$. □

The department's relative inefficiency at collaborative policies, and the P's preference for the aggressive strategy, simply add to the threshold that a collaborative policy must meet in order to be chosen. These two new factors (ψ and ρ) also create a difference in the low cost case.

Proposition 4. *When* $\mathrm{c_r} < \alpha_\mathrm{g}$, $\rho > 0$, *and* $\psi > 0$, *P will choose the new policy after learning if it satisfies:*

$$\begin{cases} \mathrm{x_g} > \mathrm{x_s} & \textit{when the new policy is aggressive} \\ \mathrm{x_c} > \mathrm{x_s} + \psi + \rho & \textit{when the new policy is collaborative} \end{cases}$$

Proof. When $\mathrm{c_r} > \alpha_\mathrm{c}$, R will choose $\mathrm{a} = 1$ with certainty, therefore $\mathrm{EU_p(x_s)} = \mathrm{x_s} + \psi - \mathrm{c_p n}$. If the new policy is aggressive, $\mathrm{EU_p(x_g)} = \mathrm{x_g} + \psi - \mathrm{c_p n}$, so P will choose $\mathrm{x_g}$ iff $\mathrm{x_g} > \mathrm{x_s}$. If the new policy is collaborative, $\mathrm{EU_p(x_c)} = \mathrm{x_c} - \rho - \mathrm{c_p n}$, so P will choose $\mathrm{x_c}$ iff $\mathrm{x_c} - \rho > \mathrm{x_s} + \psi \implies \mathrm{x_c} > \mathrm{x_s} + \psi + \rho$. □

As with policy selection, individual racism has an effect parallel to that of moving from low to high cost of resident assistance. In other words, both individual racism and a relatively high cost of assistance produce a disadvantage for collaborative policies relative to aggressive policies.

Proposition 5. P *will only learn a new aggressive policy in equilibrium if:*

$$E(x_g) \geq \begin{cases} x_s + c_p & \textit{if}\, c_p \geq \frac{\varepsilon}{2} \\ x_s + \sqrt{2\varepsilon c_p} - \frac{\varepsilon}{2} & \textit{if}\, c_p < \frac{\varepsilon}{2} \end{cases}$$

When the cost of assistance is high ($c_r > \alpha_c$*),* P *will only learn a new collaborative policy in equilibrium if:*

$$E(x_c) \geq \begin{cases} x_s + \psi + \rho + \pi(\alpha_c - \alpha_g) + c_p & \textit{if}\, c_p \geq \frac{\varepsilon}{2} \textit{ and } c_r > \alpha_c \\ x_s + \psi + \rho + \pi(\alpha_c - \alpha_g) + \sqrt{2\varepsilon c_p} - \frac{\varepsilon}{2} & \textit{if}\, c_p < \frac{\varepsilon}{2} \textit{ and } c_r > \alpha_c \end{cases}$$

When the cost of assistance is low ($c_r < \alpha_g$*),* P *will only learn a new collaborative policy if:*

$$E(x_c) \geq \begin{cases} x_s + \psi + \rho + c_p & \textit{if}\, c_p \geq \frac{\varepsilon}{2} \textit{ and } \alpha_g > c_r \\ x_s + \psi + \rho + \sqrt{2\varepsilon c_p} - \frac{\varepsilon}{2} & \textit{if}\, c_p < \frac{\varepsilon}{2} \textit{ and } \alpha_g > c_r \end{cases}$$

Proof. See Print Appendix for proof □

When The Cost of Assistance is Neither High Nor Low

In the analysis in the paper, I examine two regions of the parameter space in which $c_r > \alpha_c$ or $c_r < \alpha_g$, to represent the dynamics of policy selection and learning in communities with a good relationship or very bad relationship to the police department. In this section I examine the intermediate parameter space in which $\alpha_c > c_r > \alpha_g$.

When the cost of cooperating after an abusive event is intermediate ($\alpha_c > c_r > \alpha_g$), the level of effectiveness at which *P* will choose a collaborative policy is lower than that for an aggressive policy. $EU_p(x_g) = x_g - \pi\alpha_g - nc_p$ while $EU_p(x_c) = x_c - nc_p$, so if the new policy isu collaborative P will choose it after learning iff: $x_c > x_s - \pi\alpha_g + \psi + \rho$. If the new policy is aggressive, she will choose it if: $x_g > x_s$. Thus, the new collaborative policy faces a selection *advantage*.

The logic behind this reversal is that R will refuse to assist the police following an abusive event if the aggressive policy has been chosen. However, the cost of reducing the department performance by α_c is too great, and so they will assist following an abusive event if a collaborative policy is chosen. In effect, the greater dependence on his assistance gives R too great a stake in his assistance choice to withdraw it following an incident.

This relative advantage for a collaborative policy carries through the learning decision (as in Proposition 1).

Proposition 6. *When the cost of assistance is intermediate ($\alpha_c > c_r > \alpha_g$),* P *will only learn a new aggressive policy in equilibrium if it satisfies:*

$$E(x_i) \geq \begin{cases} x_s + c_p & \text{if } c_p \geq \frac{\varepsilon}{2} \\ x_s + \sqrt{2c_p\varepsilon} - \frac{\varepsilon}{2} & \text{if } c_p < \frac{\varepsilon}{2} \end{cases}$$

When the cost of assistance is intermediate ($\alpha_c > c_r > \alpha_g$), P *will only learn a new collaborative policy in equilibrium if it satisfies:*

$$E(x_i) \geq \begin{cases} x_s - \pi\alpha_g + \rho + \psi + c_p & \text{if } c_p \geq \frac{\varepsilon}{2} \\ x_s - \pi\alpha_g + \rho + \psi + \sqrt{2c_p\varepsilon} - \frac{\varepsilon}{2} & \text{if } c_p < \frac{\varepsilon}{2} \end{cases}$$

Proof. When $\alpha_c > c_r > \alpha_g$ and the new policy is aggressive, the reasoning and expressions are identical to the print appendix proof for proposition 1.

When $\alpha_c > c_r > \alpha_g$ and the new policy is collaborative, R will assist with certainty if P chooses x_c. Therefore P's expected utility from choosing a collaborative policy, once she has learned it, is $EU_p(x_c|n = 1) = E(x_c) - c_p$. Equilibria exist in which P will choose to learn iff $EU_p(n = 1) \geq EU_p(n = 0)$, which requires $E(x_c)$ that solves:

$$\Pr(x_c \succ x_s)[E(x_c|x_c \succ x_s) - \rho - x_s + \pi\alpha_g - \psi] \geq c_p \tag{2.3}$$

In order for inequality (2.3) to be satisfied when $c_p \geq \frac{\varepsilon}{2}$ requires that $\Pr(x_c \succ x_s) = 1$, so the condition reduces to:

$$E(x_c|x_c \succ x_s) - \rho - x_s + \pi\alpha_g - \psi \geq c_p \qquad \Longrightarrow E(x_c) \geq x_s - \pi\alpha_g + \rho + \psi$$

When $c_p < \frac{\varepsilon}{2}$, inequality (2.3) requires:

$$\left(\frac{\bar{x}_c - (x_s - \pi\alpha_g + \rho + \psi)}{\varepsilon}\right)\left(\frac{\bar{x}_c + (x_s - \pi\alpha_g + \rho + \psi)}{2} - (x_s - \pi\alpha_g + \rho + \psi)\right) \geq c_p$$
$$\Longrightarrow E(x_c) \geq x_s - \pi\alpha_g + \rho + \psi + \sqrt{2c_p\varepsilon} - \frac{\varepsilon}{2}$$

□

Chapter 3

What Police Chiefs Show Officers About Race and Arrest Decisions

In many US jurisdictions, people racialized as Black make up a disproportionately large share of those arrested by the police. Often this disproportionality is large enough that the probability of being arrested, conditional on committing a given crime, is significantly higher for people racialized as Black (Gelman, Fagan and Kiss, 2007; Beckett et al., 2005). This over-exposure to the criminal justice system has negative economic and political consequences for Black residents in the United States (Western, 2006; Lerman and Weaver, 2014; White, 2018). The deleterious impacts of this criminal justice contact beg the question: why it is happening? Scholars have devoted significant attention to the potential role of decisions by individual police officers.

A long standing explanation is that some police officers are more likely to arrest someone they racialize as Black than someone they racialize differently, even if the two individuals were engaged in identical behavior (Smith, Visher and Davidson, 1984; Weitzer, 1996). For simplicity, I will refer to this as explicit discrimination. Racial disparity driven by this mechanism would be eliminated only if officers choose not to engage in explicit discrimination.

A second explanation advanced by social scientists is that people racialized as Black are more likely to be involved in criminal activity than members of other racial categories, and therefore the most effective policing strategy for officers it to devote greater scrutiny to people they racialize as Black (e.g. Knowles, Persico and Todd, 2001; Anwar and Fang, 2006; Antonovics and Knight, 2009). Thus, differences in the rates of offending by race cause statistical discrimination by police officers who are exclusively motivated to maximize arrests. Racial disparity driven by this mechanism would be eliminated only if the rates of offending were equal across racial groups.

A rival set of explanations is that police officers' decisions are influenced by beliefs and psychological associations that officers are not aware of or which do not respond rationally to stimuli (for an excellent synthesis of these findings, see Glaser, 2014, chapter 4). For example, Eberhardt et al. (2004) report a series of experiments that show that the association between Blackness and criminality changes the way people process visual stimuli. In particular, subjects rated more stereotypically Black faces as looking more criminal, and directed their attention to Black faces when primed to think about crime. Racial disparity driven by these mechanisms would be eliminated only if officers eliminated the influence of these irrational cognitive processes on their behavior.

The collective implication of these theories of racial disparity is that if police officers refrain from explicit discrimination and behave fully rationally, racial disparity in arrests that is caused by the decisions of individual officers would be exclusively due to statistical discrimination. In this paper, I show that this is not generally true.

I argue that even if officers were to reason perfectly, they could develop inaccurate beliefs about the correlation between race and criminality because of unresolved tensions between the political responsiveness and professional independence of police departments in the United States. If police chiefs were independent experts committed to crime control, they would make policy choices that reflected their insights into what arrest intensity would best control crime. However, if police chiefs were to choose policies in order to satisfy political demands, officers could not learn the most effective arrest intensity from their decisions. When officers are uncertain whether police chief directives about arrests are made on the basis of independent expertise or political responsiveness, officers will learn from those decisions but develop inaccurate beliefs about the most effective approach to controlling crime. If the chief must decide between more or less intense arrests of a particular racial group, officers will have inaccurate posterior beliefs about the probability they need to arrest someone by race.

To do so I present a game of imperfect information between a police chief and representative patrol officer, in which the chief has private information about the optimal intensity of arrest for members of a group. The officer cares about controlling crime and the chief cares either about controlling crime or satisfying political demands. The chief chooses an arrest intensity, sends a message to the officer about why, and then selects his effort on the basis of how effective he expects the policy to be. The possibility that the chief is bowing to political pressure makes her policy choice an imperfect signal of the most effective policy, and so the officer's equilibrium posteriors may not match the true state of the world.

This model differs from prior models of statistical discrimination such as Knowles, Persico and Todd in two significant ways. First, by removing potential offenders as players in the game, it does not impose the equilibrium requirement that officers are correct about the rates of arrest by race that produce optimal crime control. In this way it can identify the institutional features that prevent officers from having accurate beliefs.[1] Second, it does not model the relationship between arrest probability and crime rates, instead making this an exogenously varying feature that officers are uncertain about. This allows for an examination of how officer uncertainty about this fact influences their learning about optimal arrest rates by race.

This paper's primary contribution is to identify a source of racial disparity in police officer arrest decisions that does not rely on police officers failing to reason perfectly. In this model the chief's policy choice causes beliefs that would cause taste-based discrimination to develop endogenously. This results from the police chief having unverifiable information about what arrest intensity will produce optimal crime control. The theoretical insight of applying the concept of statistical discrimination to policing was to show an observational equivalence between two different scenarios, one in which officers were acting out of irrational prejudice, and another where they respond as part of a strategic interaction with law violators. I show in this paper that if we consider the information asymmetries within police departments, the preconditions for statistical discrimination to entirely account for racial disparity in police contact are frequently not met.

A second contribution is to show how the imperfect transformation of American police departments into expert-led and independent crime-control bureaucracies could produce new sources of disadvantage for already disadvantaged residents. Police reformers in the twentieth century United States articulated a vision of police chiefs as technocrats with sufficient expertise at the most effective ways to prevent crime that they should be given independence from political intervention. However, independence from political influence eluded most departments (Fogelson, 1977, pages). The results depend upon some chance that the chief knows which crime control policy is correct. A department whose chief had no pretensions to expertise would not produce this effect, thus it is the result of the imperfect implementation of these reformer's ideal.

Finally, these results identify conditions under which something akin to individual racism can arise endogenously within police departments. It identifies features of police departments that could produce discrimination by police officers over time, even if they held no prejudice when they began work for the police department. This complements individual-level explanations for racial disparity in police treatment of civilians that rely upon implicit bias (e.g. Eberhardt et al., 2004; Glaser, 2014), or overt biases that officers are theorized to acquire prior to police service (e.g. Kephart, 1957).

In section 3.1, I present and analyze a model of police chief policy choice in which the chief might respond to political demands that the officers observe. In

[1] In this paper I refer to accurate beliefs as those which match the true state of the world. Beliefs that are arrived at using Bayes' rule, but where officers have some uncertainty about the true state, I call inaccurate.

section 3.2, I analyze an extension in which the officer is uncertain what direction the political pressure is pushing. In section 3, I briefly discuss another extension in which the chief might be wrong. Finally, I discuss the application of this model to US police departments, and its implications for how scholars explain racial disparity in arrests.

3.1 Model of Chief Policy Choice and Officer Learning

In this section I present a game of imperfect information between a police chief, *P*, and the officers in her department, *A*. *P* starts the game by observing private information about the relative effectiveness of two arrest intensities, choosing one, and then sending a message ($m \in \mathbb{R}$) to A about why. A observes P's choice and message, and then chooses how much effort to devote to policing. The model represents a circumstance in which the officers are uncertain whether the chief is responding to crime conditions, or responding to political pressure to produce a particular arrest intensity.

The officer's effort choice ($e \in [e_{min}, 1]$, where $e_{min} \in (0, \frac{1}{2})$[2] and chief's policy choice, together with a random variable ($\omega \in \{0, 1\}$), determine the department's performance reducing crime in a particular area or among a sub-population (y).

$$y = e(x\omega + (1-x)(1-\omega)) \tag{3.1}$$

For simplicity, I limit the chief's possible arrest intensities to high and low ($x = 1$ and $x = 0$, respectively). The random variable ω represents conditions in the area or subpopulation that determine whether high ($\omega = 1$) or low ($\omega = 0$) intensity arrests would reduce crime more effectively.[3] The *ex ante* probability that $\omega = 1$ is $\eta \in (0, 1)$.[4]

I represent *A* as preferring more crime reduction, but paying an increasing cost for devoting effort toward his duties.

$$u_a = y - e^2$$

Where y is the department performance and e is *A*'s choice of effort.[5] The parameter e_{min} represents the minimum effort that a department can extract from the

[2]The upper bound on e_{min} ensures that A can devote higher than minimum effort if he is certain that the correct policy has been chosen, in equilibrium.

[3]I use ω to represent the most effective arrest intensity within a specific area or sub-population, not an optimal intensity relative to some other area or sub-population.

[4]I exclude the endpoints 0 and 1 to ensure that A has some uncertainty about the state of the world.

[5]The model assumes that effort is equally costly to officers, regardless of policy choice. This simplifies the analysis, but it may be that higher rates of arrest produce more work for officers. Such an assumption would not change the substantive results within a range of cost difference, as

officer. The squared cost of effort has the substantive implication of assuming that officers want to devote higher effort when the more effective policy is chosen, and minimum effort when the wrong policy is chosen. This represents an ideal officer in that he derives utility from the department doing well and will work harder if he knows that his efforts are making a difference.

The chief has two types, P^g and P^r. The 'good' chief, P^g, is exclusively motivated to select the most effective crime control strategy. However the 'responsive' chief, P^r, cares exclusively about responding to political demands. Therefore I represent her utility as determined by a parameter, $\alpha \in \{0, 1\}$, that represents the demands of some constituency in the jurisdiction. If $\alpha = 0$, the constituency wants low arrest intensity, while if $\alpha = 1$ the constituency wants high arrest intensity.

$$u_p = \begin{cases} y & \text{for } P^g \\ e(x\alpha + (1-x)(1-\alpha)) & \text{for } P^r \end{cases}$$

The good type chief represents the professional ideal that police reform advocates in the mid-twentieth century envisioned: she wants to select the most effective arrest intensity. The responsive chief, on the other hand, wants to implement whichever intensity her constituency wants.[6]

Both of P's types have complete information about the game. They observe the optimal arrest intensity (ω) and know their own type before making their policy and signaling choices. The officer chooses second and observes P's choice and signal, but only knows the *ex ante* probability that higher arrest rates would be more effective (η) and the *ex ante* probability that P is the good type (γ). In this way the model assumes that officers cannot tell directly whether the chief chose the most effective arrest intensity under the circumstances. This is how I represent that the chief's information about optimal arrest intensity is unverifiable (Laffont and Tirole, 1993, 212). The constituency demand (α) is common knowledge.

To summarize, the game proceeds as follows:

0. Nature chooses the chief's type (P^g or P^r) and the most effective arrest intensity (ω).

1. The chief observes her type and the most effective arrest intensity and then chooses one ($x \in \{0, 1\}$), and sends a message to the officer (m).

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it would reduce the officer's optimal effort on high-intensity arrests no matter their beliefs. If the difference in cost was large enough, however, it would change the good type chief's policy choice, and so the substantive results analyzed would no longer hold. I use the squared cost of effort for simplicity. The result would be substantively similar with a more general cost function $u_p = y - c(e)$ so long as $c' > 0$, $c'' > 0$ and $c(e_{min}) > 0$.

[6] In both cases, effort is only valuable to the chief if it is devoted to their desired approach, so the model does not represent a chief who cares about her officers looking busy.

2. The officer observes the chief's choice and message, then selects his effort (e).

Representation of Police Objectives

This model represents officers and the chief as motivated to reduce crime, and assumes the chief has better information than her officers about what arrest intensity is most effective at reducing crime. This representation of police objectives, while different than that in previous models(e.g. Knowles, Persico and Todd, 2001; Borooah, 2001; Anwar and Fang, 2006; Antonovics and Knight, 2009), has support in historical sources.

In his 1940 book *Police Systems in the United States*, Bruce Smith complained of police departments being "overburdened with many duties lying outside the proper sphere of criminal law enforcement" and so devoting less attention to their core task: "protecting life and property" (Smith, 1940, 18-19). Thus Smith, whom the historian Robert Fogelson calls "perhaps the nation's preeminent police consultant" at the time (Fogelson, 1977, 141), places prevention of crime at the core of the police purpose. Fogelson also recounts that although prominent police chiefs disagreed about how police could most effectively reduce crime, this definition of the police purpose was central to their project of winning political independence for police departments in the mid 20th century (Fogelson, 1977, 152, 186-187).

The notion that the purpose of policing is to reduce crime has endured. 'Order-maintenance policing', which involves intensive arrests for low level crimes, was justified publicly on the basis of its effect on rates of offending (Harcourt, 1998). Furthermore, on November 18th 2018, the website of the Los Angeles Police Department read:

> "It is the vision of the Los Angeles Police Department to, as closely as possible, achieve a City free from crime and public disorder."[7]

Equilibrium Analysis

In this section I characterize the Perfect Bayesian Equilibria of the game by first identifying A's optimal effort and then P's messaging and policy selection strategies. As I show, in equilibrium the good chief will choose the policy that is more effective, while the responsive chief will choose the policy that constituents want. The message that both send will be uninformative.

A's expected utility after *P* chooses arrest intensity $x = i$ and sends message m is $EU_a(e|x = i) = \Pr(\omega = x|x = i, m)e - e^2$. Taking the partial derivative with respect to e gives $\frac{\partial EU_a(e|x=i)}{\partial e} = \Pr(\omega = x|x = i, m) - 2e$, which equals 0 when $e = \frac{\Pr(\omega=x|x=i,m)}{2}$.

[7] Los Angeles Police Foundation and the Los Angeles Police Department, 2018

Since $\frac{\partial^2 EU_a(e|x=i)}{\partial e^2} > 0$, this is a maximum. If $\frac{Pr(\omega=x|x=i,m)}{2} < e_{min}$, A's unique best response is to choose e_{min} because his cost is increasing in effort.

Lemma 1. *A's equilibrium effort will be highest when he knows the policy chosen is the correct one. The less confident he is that the policy is correct, the less effort he will devote, until he is uncertain enough that he chooses the minimum effort.*

Formally, A's unique sequentially rational strategy is to choose $e^* = \max\{\frac{Pr(\omega=x|x=i,m)}{2}, e_{min}\}$.

In any PBE, *A* 's effort is weakly increasing in the probability that the most effective arrest intensity has been chosen. If $\frac{Pr(\omega=x|x=i,m)}{2} > e_{min}$, *A* 's equilibrium effort will be strictly increasing in the probability that the correct intensity has been chosen. The intuition behind this dependence is that A expects higher marginal benefit from his effort if there is a higher chance of the arrest intensity being correct. The fact that *A*'s equilibrium effort responds to the probability of the correct policy has been chosen is the driving force behind the communication inefficiency in the model. No matter her type, the chief knows which arrest intensity would be more effective, but in certain circumstances A will not be able to distinguish whether the chief chose it.

The good type chief will always choose the arrest intensity that is most effective, in equilibrium. Her expected utility from choosing the correct intensity, given the circumstances, is $EU_p(x = i|\omega = x) = Pr(\omega = x) \times \max\{\frac{Pr(\omega=x|x=i,m)}{2}, e_{min}\}$. If she chooses the wrong intensity, her utility is 0 for certain. Therefore since she knows the correct intensity with certainty, she will choose it.

Lemma 2. *In equilibrium the good chief will always choose the arrest intensity that is most effective.*

Formally, P^g*'s unique sequentially rational decision rule is to choose* $x = \omega$.

The responsive chief will always choose the policy that matches the constituency's demand. Her expected utility from satisfying the constituency and choosing policy $x = i$ is: $EU_p(x = i|\alpha = i) = Pr(\alpha = i) \times \max\{\frac{Pr(\omega=x|x=i,m)}{2}, e_{min}\}$. If she chooses the arrest intensity that does not match α, her utility is 0 for certain. Therefore since she observes α, P^r will choose the policy that matches it every time.

Lemma 3. *In equilibrium the responsive chief will always choose the policy her constituents want.*

Formally, P^r*'s unique sequentially rational decision rule is to choose* $x = \alpha$.

Since the responsive chief chooses arrest intensity according to α, and A observes α, A will have different information about P's type depending upon the match between the constituency demand and the arrest intensity chosen. If the intensity does not match α, then A knows that the chief must be the good type and so she chose the most effective arrest intensity for certain.

$$\Pr(\omega = x|x = i, \alpha = j, m) = 1 \qquad\qquad \text{when } i \neq j$$

This also means that the signal P sends after choosing the arrest intensity contrary to constituent demands conveys no additional information: P's choice demonstrates her type. If P's choice matches α, A cannot tell which type the chief is from her choice alone. However, the signal m will be uninformative in this case, too.

As I showed above, if A knows the correct policy has been chosen for certain, he will choose his highest equilibrium effort ($e^* = \frac{1}{2}$). Therefore if P^g could choose the policy that satisfies constituents and then send a message that communicates she is the good type, A would work his hardest. If P sends a message that leaves A uncertain about her type, he will devote strictly less effort. However, the responsive chief also benefits from higher officer effort, and so in equilibrium would mimic P^g's signaling choice because it is costless. Thus, after choosing the policy that satisfies constituents, P's signaling choice will also be uninformative.

Lemma 4. *A will not know if the chief is good or responsive on the basis of their equilibrium message (*m*).*

After observing the chief's policy choice, A's inferences about the state of the world can be expressed as:

$$\begin{aligned}\Pr(\omega = x|x = i, \alpha = i) =& \Pr(\omega = x|x = i, P^g, \alpha = i)\Pr(P^g|x = i, \alpha = i)\\ &+ \Pr(\omega = x|x = i, P^r, \alpha = i)(1 - \Pr(P^g|x = i, \alpha = i))\end{aligned} \tag{3.2}$$

[8] The good type chief will choose the arrest intensity that is most effective in equilibrium, so $\Pr(\omega = x|x = i, P^g, \alpha = i) = 1$. The responsive chief would have chosen the same policy regardless of ω, however, so her choice would not change A's priors about ω. Therefore $\Pr(\omega = x|x = i, P^r, \alpha = i) = \eta$.

The probability that A is facing the good type chief can be calculated using Bayes' Rule.

$$\Pr(P^g|x = i, \alpha = i) = \frac{\Pr(x = i|P^g, \alpha = i)\Pr(P^g|\alpha = i)}{\Pr(x = i|P^g, \alpha = i)\Pr(P^g|\alpha = i) + \Pr(x = i|P^r, \alpha = i)(1 - \Pr(P^g|\alpha = i))}$$

Where the probability of a good chief is independent of α, so $\Pr(P^g|\alpha = i) = \Pr(P^g) = \gamma$. Since the good chief will choose policy to match ω regardless of α, her probability of choosing $x = i$ is not influenced by α. Therefore $\Pr(x = i|P^g, \alpha = i) = \Pr(\omega = x)$.

[8] I suppress the dependence of A's beliefs on the signal m for the remainder of the paper because it is uninformative in equilibrium (i.e., I write $\Pr(\omega = x|x = i)$ in place of $\Pr(\omega = x|x = i, m)$).

The responsive chief will choose policy to match α, however, so $\Pr(x = i|P^r, \alpha = i) = 1$.

Making the substitutions into equation 3.2, A's beliefs consistent with P^r and P^g's strategies are:

$$\Pr(\omega = x|x = i, \alpha = i) = \begin{cases} \frac{\eta}{1-\gamma(1-\eta)} & \text{when i = 1} \\ \frac{1-\eta}{1-\gamma\eta} & \text{when i = 0} \end{cases}$$

With these it is straightforward to establish that the policy choice, effort choice, and posterior beliefs will be the same for a given set of parameter values in any Perfect Bayesian Equilibrium.

Proposition 7. *For any set of parameters, every Perfect Bayesian Equilibrium requires:* P^g *choose the policy that matches* ω *and* P^r *choose the policy that matches* α*, both choose the same messages* $m^*(\omega, \alpha)$*, A chooses effort* $e^* = \max\{\frac{\Pr(\omega=x|x=i,m^*)}{2}, e_{min}\}$*, and has beliefs:*

$$\Pr(\omega = 1|x = 1, m^*) = \begin{cases} \frac{\eta}{1-\gamma(1-\eta)} & \textit{if } \alpha = 1 \\ 1 & \textit{if } \alpha = 0 \end{cases}$$

$$\Pr(\omega = 0|x = 0, m^*) = \begin{cases} 1 & \textit{if } \alpha = 1 \\ \frac{1-\eta}{1-\gamma\eta} & \textit{if } \alpha = 0 \end{cases}$$

Proof. By Lemma 1, A's unique sequentially rational strategy is to choose $e^* = \max\{\frac{\Pr(\omega=x|x=i)}{2}, e_{min}\}$. By Lemmas 2 and 3, P's unique sequentially rational strategy is: P^g choose the policy that matches ω, and P^r choose the policy that matches α. By Lemma 4, messages will be uninformative in equilibrium. As I showed, above, the beliefs consistent with P's unique sequentially rational strategy are: $\Pr(\omega = 1|x = 1, \alpha = 1) = \frac{\eta}{1-\gamma(1-\eta)}$, $\Pr(\omega = 1|x = 1, \alpha = 0) = 1$, $\Pr(\omega = 0|x = 0, \alpha = 1) = 1$, and $\Pr(\omega = 0|x = 0, \alpha = 0) = \frac{1-\eta}{1-\gamma\eta}$.

Therefore for any set of parameters a PBE exists with these strategies and beliefs so long as for any $m' \notin m^*$, A has beliefs $\Pr(\omega = x|x = i, m') \leq \Pr(\omega = x|x = i, m^*)$. □

Officer Beliefs When Demands are Known

One aspiration of police reform advocates was to have 'street-level' bureaucrats within departments who have accurate information about the environment in which they operate. I refer to this as expertise. In this section I analyze the officer expertise that develops in the Perfect Bayesian Equilibria of the model.

I show that the possibility of a responsive chief introduces interference in information transmission. When the good chief uses her information to select the most effective policy, and that policy happens to match what constituents demand, she cannot perfectly communicate with A. Therefore using her information, in these circumstances, ensures that A will have inaccurate posteriors about the optimal arrest intensity to minimize crime.

Since the possible arrest intensity is binary in the model, the officer's posterior expectation of optimal arrest intensity is simply the probability that $\omega = 1$ (i.e. $\mathrm{E}(\omega|\mathrm{x} = \mathrm{i}, \alpha = \mathrm{i}) = \Pr(\omega = 1|\mathrm{x} = \mathrm{i}, \alpha = \mathrm{i})$). Since both types of chief are perfectly informed, her posterior expectation of ω is simply it's true value (0 or 1).

Proposition 8. *When the officer is unsure whether the chief is good or responsive and unsure whether high or low intensity arrests would be most effective, he will have inaccurate beliefs about what arrest intensity is best in equilibrium if the chief chooses what the constituents prefer.*

Formally, when $\gamma \in (0,1)$ and $\eta \in (0,1)$, $\mathrm{E}(\omega|\mathrm{x} = \mathrm{i}, \alpha) \neq \omega$ with positive probability in every Perfect Bayesian Equilibrium.

Proof. In any PBE A's posterior expectations of ω are:

$$\mathrm{E}(\omega|\mathrm{x} = 0, \alpha = 1) = 1 - \Pr(\omega|\mathrm{x} = 0, \alpha = 1) = 0$$
$$\mathrm{E}(\omega|\mathrm{x} = 0, \alpha = 0) = 1 - \Pr(\omega|\mathrm{x} = 0, \alpha = 0) = \frac{\eta(1-\gamma)}{1-\gamma\eta}$$
$$\mathrm{E}(\omega|\mathrm{x} = 1, \alpha = 1) = \frac{\eta}{1-\gamma(1-\eta)}$$
$$\mathrm{E}(\omega|\mathrm{x} = 1, \alpha = 0) = 1$$

When $\gamma \in (0,1)$ and $\eta \in (0,1)$, $\frac{\eta(1-\gamma)}{1-\gamma\eta} \in (0,1)$. Since ω is either 0 or 1, A's posterior belief after observing $\alpha = 0$ and $\mathrm{x} = 0$ is inaccurate. Similarly, so long as $\gamma \in (0,1)$ and $\eta \in (0,1)$, $\frac{\eta}{1-\gamma(1-\eta)} \in (0,1)$. Therefore A's posterior belief after observing $\alpha = 1$ and $\mathrm{x} = 1$ is inaccurate. Therefore so long as there is some chance that the policy chosen matches α, there is some chance that A will have inaccurate posterior expectations of ω. □

Proposition 8 captures the first argument of this paper: that uncertainty about whether the chief is making policy according to crime conditions or political pressure ensures that the officer will not necessarily have accurate posterior beliefs about the state of the world in equilibrium. The officers will only have accurate posteriors if they observe the chief go against the constituent demands. This inaccuracy arises despite the chief being perfectly informed with certainty.

Figure 3.1 illustrates the relationship between the probability that the chief is good and A's posterior expectations of ω. The plot on the left represents the case

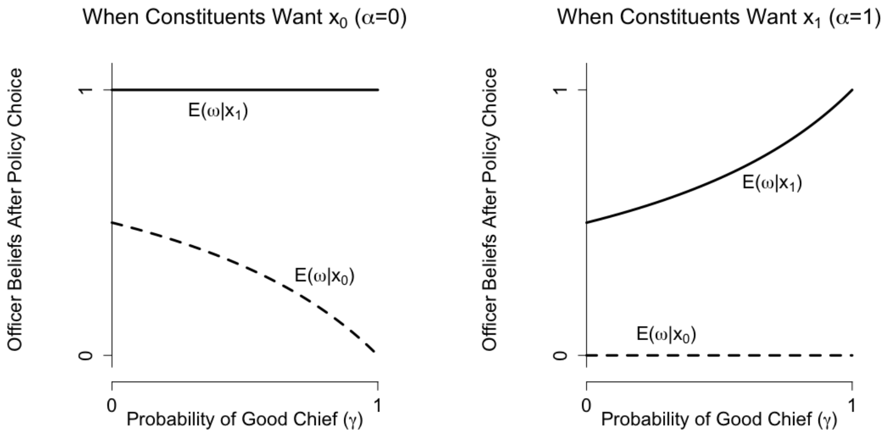

Figure 3.1: A's beliefs about optimal arrest intensity after seeing P's policy choice. The X-axis is the probability that P is the good type, and the Y-axis is the A's posterior expectation of ω. The left panel shows the case when the constituents want low arrest intensity ($\alpha = 0$). The right panel is when constituents want high arrest intensity ($\alpha = 1$). Both plots assume $\eta = \frac{1}{2}$.

when the constituency is demanding the policy x = 0, so observing x = 1 (the solid line) gives A accurate posterior beliefs about the value of ω. However, observing x = 0 (the dashed line) results in a posterior that is either inflated or contracted relative to the true parameter value of one or zero.

The right panel of figure 3.1 represents A's posterior beliefs when the constituents demand policy x = 1. If he observes x = 0 (the dashed line), A has an accurate posterior expectation of zero. If he observes x = 1 (the solid line), his posterior is either higher or lower than the true parameter value.

In both cases, the figure illustrates that as the probability of a good chief approaches one, A's posterior expectations approach the true parameter values. However, A's knowing the constituent demand preserves the possibility of information transmission as the probability that the chief is responsive approaches one. This demonstrates that it is uncertainty about the decision calculus of the chief that causes A to have inaccurate posterior beliefs.

3.2 When the Officer is Uncertain About Constituent Demands

In this section I present an extension of the model from section 3.1, in which the officer does not know what the chief's constituency demands. This better captures the dynamics in a circumstance where officers are aware that multiple politically relevant constituencies want contradictory policies from the chief, and so are uncertain which one she might respond to. For example, in 1960s San Francisco the police chief was under pressure from business groups to crack down on crime in the predominantly Black Filmore district, but also being lobbied by civil rights groups to stop arresting Black San Franciscans for minor infractions (cite).

To model this change, I make $\alpha \in \{0, 1\}$ a random variable rather than a fixed parameter. Instead of observing α, the officer observes a signal $\beta \in \{0, 1\}$, which matches the constituency demand with probability $\delta \in (0, 1)$. Formally, $\Pr(\alpha = i|\beta = i) = \delta$. In this way, when A must decide on his effort, he does not know for certain which policy the responsive chief would prefer.

All other elements of the model are the same as in section 3.1. The game proceeds as follows:

0. Nature chooses the chief's type (P^g or P^r), the state of the world (ω), and the constituency demand (α).

1. The chief observes her type, the state of the world, and constituent demands, then chooses policy (x = 0 or x = 1) and sends a message to the officer (m).

2. The officer observes the policy choice, message, and a signal of the constituency demand (β), then selects his effort (e).

Equilibrium Analysis

In this section I characterize the Perfect Bayesian Equilibria of this extension to the model in which the officer is uncertain what the constituents want. The arguments for Lemmas 1, 2, 3, and 4 hold in this extension, so the equilibrium strategies in this model are the same as those identified in section 3.1. Therefore it is sufficient to derive the officer's consistent beliefs under these new information conditions.

When the officer does not perfectly observe the constituent demands, he cannot be certain that the chief has not complied with constituent demands. Therefore he will never be certain that the chief is good, and so will always have uncertain posterior beliefs about the optimal arrest intensity. I solve out the two cases when P chooses x = 1 here.

After A observes x = 1, the probability that P has chosen the correct policy is:

$$\begin{aligned}\Pr(\omega = 1|x = 1, \beta = j) =& \Pr(\omega = 1|x = 1, \beta = j, P^g)\Pr(P^g|x = 1, \beta = j)\\ &+ \Pr(\omega = 1|x = 1, \beta = j, P^r)(1 - \Pr(P^g|x = 1, \beta = j)) \qquad (3.3)\end{aligned}$$

Regardless of the signal β, the good chief will select x = 1 if and only if it is the correct policy. Therefore $\Pr(\omega = 1|x = 1, \beta = j, P^g) = 1$. The responsive chief will choose x = 1 if it matches the constituent demands, which is independent of ω. Therefore $\Pr(\omega = 1|x = 1, \beta = j, P^r) = \Pr(\omega = 1) = \eta$.

As with the base model, the probability that A is facing the good type chief can be calculated using Bayes' Rule.

$$\Pr(\mathrm{P^g}|\mathrm{x}=1,\beta=\mathrm{i}) = \frac{\Pr(\mathrm{x}=1|\mathrm{P^g},\beta=\mathrm{i})\Pr(\mathrm{P^g}|\beta=\mathrm{i})}{\Pr(\mathrm{x}=1|\mathrm{P^g},\alpha=\mathrm{i})\Pr(\mathrm{P^g}|\beta=\mathrm{i})+\Pr(\mathrm{x}=1|\mathrm{P^r},\beta=\mathrm{i})(1-\Pr(\mathrm{P^g}|\beta=\mathrm{j}))}$$

Since the good chief responds to ω, which is independent of β, the probability of her choosing $\mathrm{x}=1$ is not influenced by β. Therefore $\Pr(\mathrm{x}=1|\mathrm{P^g},\beta=\mathrm{i}) = \Pr(\omega=1) = \eta$. Similarly, the chief's type is independent of β and so $\Pr(\mathrm{P^g}|\beta=\mathrm{j}) = \Pr(\mathrm{P^g}) = \gamma$. The signal β does provide information about the probability that the responsive chief will choose $\mathrm{x}=1$, however. $\Pr(\mathrm{x}=1|\mathrm{P^r},\beta=1) = \Pr(\alpha=1|\beta=1) = \delta$ and $\Pr(\mathrm{x}=1|\mathrm{P^r},\beta=0) = \Pr(\alpha=1|\beta=0) = 1-\delta$. Therefore the probability that A is facing the good type is:

$$\Pr(\mathrm{P^g}|\mathrm{x}=1,\beta=\mathrm{i}) = \begin{cases} \frac{\eta\gamma}{\eta\gamma+\delta(1-\gamma)} & \text{if i} = 1 \\ \frac{\eta\gamma}{\eta\gamma+(1-\delta)(1-\gamma)} & \text{if i} = 0 \end{cases} \tag{3.4}$$

Substituting the values from 3.4 into equation 3.3 and simplifying, this gives:

$$\Pr(\omega=1|\mathrm{x}=1,\beta=\mathrm{i}) = \begin{cases} \eta\left(\frac{\gamma+\delta(1-\gamma)}{\eta\gamma+\delta(1-\gamma)}\right) & \text{if i} = 1 \\ \eta\left(\frac{\gamma+(1-\delta)(1-\gamma)}{\eta\gamma+(1-\delta)(1-\gamma)}\right) & \text{if i} = 0 \end{cases} \tag{3.5}$$

These are A's beliefs that are consistent with $\mathrm{P^g}$ and $\mathrm{P^r}$'s unique sequentially rational strategies.

Following the same reasoning for the case when P has chosen $\mathrm{x}=0$, A's consistent beliefs are:

$$\Pr(\omega=0|\mathrm{x}=0,\beta=\mathrm{i}) = \begin{cases} (1-\eta)\left(\frac{\gamma+\delta(1-\gamma)}{(1-\eta)\gamma+\delta(1-\gamma)}\right) & \text{if i} = 0 \\ (1-\eta)\left(\frac{\gamma+(1-\delta)(1-\gamma)}{(1-\eta)\gamma+(1-\delta)(1-\gamma)}\right) & \text{if i} = 1 \end{cases} \tag{3.6}$$

Using these beliefs, the equilibria of the game are straightforward to identify.

Proposition 9. *For any set of parameters, every Perfect Bayesian Equilibria of the extended game requires:* $\mathrm{P^g}$ *choose the policy that matches* ω *and* $\mathrm{P^r}$ *choose the policy that matches* α*, both choose the same messages* $\mathrm{m}^*(\omega,\alpha)$*,* A *chooses effort* $\mathrm{e}^* = \max\{\frac{\Pr(\omega=\mathrm{x}|\mathrm{x}=\mathrm{i},\mathrm{m}^*)}{2},\mathrm{e_{min}}\}$*, and has beliefs:*

$$\Pr(\omega=1|\mathrm{x}=1,\beta=\mathrm{i},\mathrm{m}^*) = \begin{cases} \eta\left(\frac{\gamma+\delta(1-\gamma)}{\eta\gamma+\delta(1-\gamma)}\right) & \textit{if}\ \mathrm{i} = 1 \\ \eta\left(\frac{\gamma+(1-\delta)(1-\gamma)}{\eta\gamma+(1-\delta)(1-\gamma)}\right) & \textit{if}\ \mathrm{i} = 0 \end{cases}$$

$$\Pr(\omega=0|\mathrm{x}=0,\beta=\mathrm{i},\mathrm{m}^*) = \begin{cases} (1-\eta)\left(\frac{\gamma+\delta(1-\gamma)}{(1-\eta)\gamma+\delta(1-\gamma)}\right) & \textit{if}\ \mathrm{i} = 0 \\ (1-\eta)\left(\frac{\gamma+(1-\delta)(1-\gamma)}{(1-\eta)\gamma+(1-\delta)(1-\gamma)}\right) & \textit{if}\ \mathrm{i} = 1 \end{cases}$$

Proof. By Lemma 1, A's unique sequentially rational strategy is to choose $e^* = \max\{\frac{\Pr(\omega = x|x=i)}{2}, e_{min}\}$. By Lemmas 2 and 3, P's unique sequentially rational strategy is: P^g choose the policy that matches ω, and P^r choose the policy that matches α. As I showed, above, the beliefs consistent with P's unique sequentially rational strategy are given by equations 3.6 and 3.5.

Therefore for any set of parameters a PBE exists with these strategies and beliefs so long as for any $m' \notin m^*$, A has beliefs $\Pr(\omega = x|x = i, m') \leq \Pr(\omega = x|x = i, m^*)$. □

Officer Beliefs When Constituent Demands Are Uncertain

In this section I analyze A's posterior beliefs in the extended model where A is uncertain what P's constituents demand. In doing so I show that this uncertainty eliminates any probability of A having accurate posterior beliefs about the optimal arrest intensity in equilibrium.

Proposition 10. *When A is uncertain:*

1. *Whether the chief is goof or responsive,*
2. *Which arrest intensity is best, and*
3. *Whether P's constituents want high or low arrest intensity;*

A will have inaccurate beliefs about the optimal arrest intensity in equilibrium.

Formally, when $\delta \in (0,1)$, $\gamma \in (0,1)$ and $\eta \in (0,1)$, $E(\omega|X, \beta) \neq \omega$.

Proof. I showed in the preceding section that A's posterior expectations of ω in any PBE are:

$$E(\omega|x = 0, \beta = 1) = 1 - \Pr(\omega|x = 0, \beta = 1) = \eta\left(\frac{(1-\delta)(1-\gamma)}{(1-\eta)\gamma + (1-\delta)(1-\gamma)}\right)$$
$$E(\omega|x = 0, \beta = 0) = 1 - \Pr(\omega|x = 0, \beta = 0) = \eta\left(\frac{\delta(1-\gamma)}{(1-\eta)\gamma + \delta(1-\gamma)}\right)$$
$$E(\omega|x = 1, \beta = 1) = \eta\left(\frac{\gamma + \delta(1-\gamma)}{\eta\gamma + \delta(1-\gamma)}\right)$$
$$E(\omega|x = 1, \beta = 0) = \eta\left(\frac{\gamma + (1-\delta)(1-\gamma)}{\eta\gamma + (1-\delta)(1-\gamma)}\right)$$

When $\delta \in (0,1)$, $\gamma \in (0,1)$ and $\eta \in (0,1)$, each of these expectations will be strictly greater than 0 and less than 1. Therefore no matter what policy P chooses, A's posterior expectation of ω will not match its true value. □

Proposition 10 demonstrates that uncertainty about the chief's reasons for choosing one policy or the other, coupled with uncertainty about the direction that the responsive chief would decide, makes it impossible for the officer to have accurate posterior expectations in equilibrium. This is because there is no policy choice that A can observe and know that the chief is the good type. Therefore, no matter what he observes, there is a chance that the policy was chosen because of constituent pressure and is wrong. This inaccuracy arises despite the chief being perfectly informed with certainty.

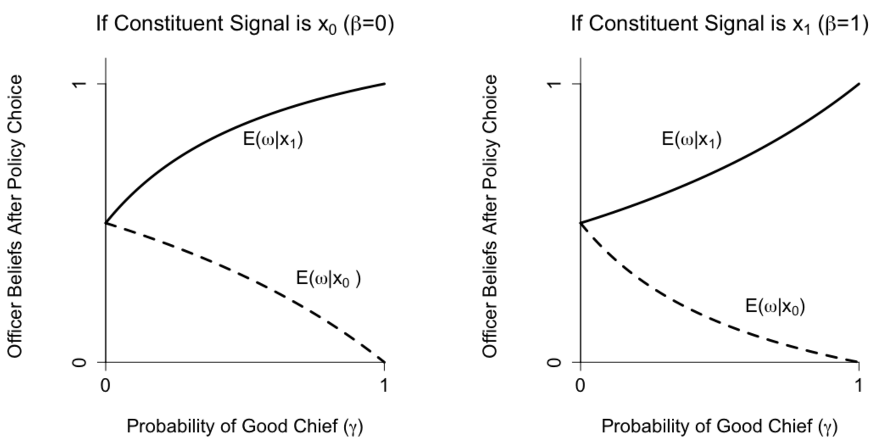

Figure 3.2: A's beliefs about optimal arrest intensity after seeing P's policy choice. The X-axis is the probability that P is the good type, and the Y-axis is A's posterior expectation of ω. The left panel shows A's beliefs if his signal says the constituents want low arrest intensity ($\beta = 0$). The right panel ia when the demand signal is for high arrest intensity. Both plots assume $\eta = \frac{1}{2}$ and $\delta = \frac{4}{5}$.

Figure 3.2 represents A's posterior expectations after observing P's policy choice, assuming that his signal of constituent policy demands will be correct 80% of the time. The left panel represents A's expectations when he observes a signal that the constituents want the policy x = 0, while the right panel represents his expectations when $\beta = 0$. In both cases, A's expectation after observing x = 1 (the solid line) increases as the probability of a good chief increases, and his expectation after observing x = 0 (the dashed line) decreases.

Figure 3.2 also illustrates that as the probability of a good chief approaches one, A's posterior expectations approach the true parameter values. If there is any chance the chief is a responsive-type, A's posteriors will be inaccurate. Conversely, as the probability that the chief is responsive approaches one, A's posterior expectations approach his *ex ante* beliefs (the figure assumes $\eta = \frac{1}{2}$). That is, he learns nothing in the limit.

3.3 If the Police Chief Could be Wrong

The models in sections 3.1 and 3.2 assume that the chief knows the most effective policy, but might differ from the officer in her incentive to select it. In the period during and immediately following the Civil Rights movement, at least, police departments did not have the information gathering and processing capacity necessary for this to be true. Some of the most professionalized police departments had only recently created units dedicated to data analysis, but the quality of information available to them, as well as criminogenic theories, were limited even in the best cases (Fogelson, 1977).

Police professionalization advocates envisioned a world where police officers were experts, whose opinions were respected in the same way doctors or lawyers were (Fogelson, 1977). The process of reform, however, would necessarily carry departments through a period of uncertainty about the accuracy of their chief's decisions. This uncertainty could arise because they are uncertain that their jurisdiction has successfully identified a chief who is, in fact, an expert. Uncertainty could also come about because of the low quality of data available to chiefs about local crime conditions and their causes.

To examine the effect of this historical shift, an (as of yet unfinished) appendix will analyze a model in which the chief wants to enact the most effective policy with certainty, but may not know which policy that is. The results are substantively similar to the threat of political interference. If the chief has more information than officers, but might be wrong about what the correct policy is, her policy choice will serve as an information signal to the officers. However, their uncertainty will give them inflated or understated posterior beliefs relative to the chief's information.

In equilibrium the officers would only have accurate posterior beliefs with certainty if they could tell exactly how much information the chief has. However, since the less informed chief would lose officer effort if she were identified, there is no Perfect Bayesian Equilibrium in which the officers know for certain that they are facing a less informed chief.

This demonstrates that the process of moving from an inexpert to expert led police department, which required the gradual development of information gathering infrastructure, could alone create conditions under which even Bayesian officers would develop inaccurate beliefs about the relationship between race and whether people should be arrested. Full political independence of the police department, even if it were achieved, would not be sufficient to ensure that officers have accurate beliefs about optimal arrest intensity by race.

3.4 Discussion

The model presented in section 3.1 shows that officer uncertainty about the independence of their police chief, when that chief has more information about optimal crime control strategy, will cause Bayesian officers to have incorrect equilibrium posteriors whenever the chief chooses policy that satisfies constituent demands. This approach takes officer prior beliefs as given, and examines only the marginal change that will be brought about by observing police chief policy choice. It demonstrates that even under these circumstances, officers can endogenously develop posterior beliefs that are wrong about how intensely members of a particular population should be arrested. As the model does not make any assumptions about the population group, this could apply to any group in society that could be discussed in the context of law enforcement, and depending on constituent demands, it could either lead to inflated or understated beliefs about the optimal arrest intensity.

When considering racial inequality in policing in the United States, a particular parameter combination deserves attention: when officers are aware that the chief's constituents want lower intensity policing. This could represent a circumstance where officers know that city leaders care little about crime in predominantly Black areas of the city, and are pressuring the police chief to devote fewer departmental resources to policing in those areas. In this case of the model, there is no way for the chief to convince the officers that low intensity policing is the best approach in that area. As a result, the officer posteriors about the optimal arrest intensity will be inflated whenever the true optimal intensity is low. In other words, police officers would believe that they should arrest Black people more intensely than would be most effective. Thus, the behavioral implication is taste-based discrimination against Black residents on the part of officers.

This shows that the institutional shift from police departments as 'adjuncts' of political machines to expert-led crime control bureaucracies would have, at least for some period of time, created circumstances in which police chief policy choice would cause officers to develop a taste for discrimination. Even if they did not have one to begin with. Furthermore, departments where officers are uncertain about the degree to which policy responds to democratic pressure, will be prone to this same outcome.

The model presented in section 3.2 shows that if officers are uncertain about constituency demands, they will have inaccurate posterior beliefs with certainty. Thus, the possibility of the police chief responding to a constituency rather than their best information, without the officers knowing what that constituency wants, is enough to ensure that officers will have inaccurate beliefs about the optimal intensity of arrests.

The key difference between this model and published models of statistical discrimination in policing is that I assume officers are motivated to reduce crime, rather than to make arrests. In particular, I assume that officers view arrests as a tool through which they might reduce crime, but whose effect on crime will not always be the same. In this sense, the model captures the professional ideal of U.S. police departments more precisely.

Chapter 4

Skeptical Officers and Uncertain Chiefs

In the early 20th century, large portions of American social scientists concluded that an individual's racial classification was causally related to their potential for criminality, and so concluded that the relatively high rate of arrest among Black people was the result of their innate criminality (Muhammad, 2010, chap. 2). Some scholars countered this interpretation by arguing that instead of innate criminality, the relatively high rate of arrest and incarceration among Black Americans was caused by social disadvantage and cultural deficiencies (Muhammad, 2010, chap. 3). Beginning in the 1940s, racial liberals within the Democratic party brought this set of explanations into national political debates as the cornerstone of a push for criminal justice modernization and social welfare expansion that culminated in the Great Society programs of the 1960s and the creation of the Law Enforcement Assistance Administration (Murakawa 2014, 13-15, chap. 2, Hinton 2016, 57-61). Murakawa argues that this position enabled these racial liberals to join conservatives in laying the political foundation for mass incarceration, by supporting purportedly race -neutral capacity building within criminal justice bureaucracies. Their mistake, on her account, was trusting a procedure-bound Weberian bureaucracy to eliminate the racial inequality in criminal justice (Murakawa, 2014, 17-19, chap. 3).

While she offers a compelling account of how party competition at the national level did not result in meaningful action to reduce racial disparity in criminal justice, she does not seriously contend with the possibility of bureaucratic entrepreneurs leading the way. Policy change is sometimes driven by bureaucrats themselves (e.g. Carpenter 2001). During the 1950s and '60s municipal police chiefs advocated for, and won, greater autonomy from local governments, so to this extent such innovation was more possible than ever before. Furthermore, nationally prominent police reformers aspired for local departments to become expertise-driven bureaucracies, and successful steps toward this goal included the creation of research and planning units, the creation of specialized enforcement units so officers could develop greater expertise at complex tasks, and a profusion of research on policing methods (Fogelson, 1977, 223-226).

The bureaucratic development that took place in this period raises the question: under the historical circumstances, would transforming policing such that it was governed by neutral experts have enabled bureaucratic entrepreneurs to reduce racial disparity in arrest exposure? I argue that it would not, in general.

Civil service protections for police officers were a central element of early 20$^{\text{th}}$ century reformers efforts to insulate police departments from political interference. However, these protections significantly hampered police chief's ability to induce effort from their officers. I use a two player game of imperfect information to show that officer uncertainty about the competence of their chief, combined with the chief's inability to compel effort, could cause police chiefs to eschew new policies that would be more effective than the status quo simply because her officers do not expect them to work. If police officers were aware of the research discussed by Muhammad, this would have induced a bias against selecting new policies that reduce racial disparity in arrests. Thus, I show that personnel systems designed to prevent political interference also created an organization selectively constrained in its ability to use the expertise of its police chiefs.

Prendergast and Stole (1996) present a model that demonstrates how an executive's concern for market assessment of their competence can cause an manager to use their expertise inefficiently. In particular, a manager has an incentive to over-correct on the basis of their information early in their tenure, and under-correct later on. As applied to policing, their model suggests that a police chief at the beginning of their tenure who learns of a new policy would have an incentive to make inefficiently large changes. Over time this effect reverses itself, and so later on they would be inefficiently conservative about changing policy. This result would apply to a chief whose competence cannot be verified by their superiors, such as the Mayor, and who cares about the assessment of those superiors. Such concern could easily be generated by the possibility of being replaced, which is an implication of police chiefs not being protected by civil service laws (Fogelson, 1977, pages).

The model presented by Predergast and Stole assumes that the audience whose expectations the manager cares about is symmetrically uncertain about the optimal choice, and so using the size of the manager's policy changes to draw inferences about their competence. When considering policy change, however, there is asymmetry in this uncertainty. In particular, a feature of policy change is that the effects of the status quo policy are better understood than the effects of the new policy under consideration.

Majumdar and Mukand (2004) investigate the effect of electoral oversight on a government's incentive to experiment with new policy when the electorate uses the outcome of policy experimentation to learn both about the effectiveness of new policies and the government's competence. They show that oversight concerns create an incentive to engage in two different forms of inefficiency. First, to experiment with policies less certain to succeed than would be efficient; and second, to preserve policies when the government believes it would be efficient to revert to the status quo. The substantive implications of this model for policing are similar to those of Prendergast and Stole.

Finally, the model presented here extends the finding in Canes-Wrone, Herron and Shotts (2001), which models an executive's incentive to enact new policy when responsible to a less-informed electorate. They show that, under certain conditions the executive will 'pander' by enacting a policy that is worse for the voters because the voters believe it is more effective. This effect is driven by the executive's attempt to influence voter's posterior expectation of their competence, and the voter's simultaneous uncertainty about policy effectiveness and executive competence.

The model I present differs from these three predecessors in that there is no oversight from outside the police department. Instead, the police chief's inability to coerce effort from her officer and dependence on that effort create a form of inverted accountability when the chief is assumed to care exclusively about department performance. This shows that failure to solve enduring internal oversight problems within police departments can selectively reduce the improvement to information use brought about by making departments independent of political oversight. Innovation in ways that are not surprising to officers will become more efficient; the structure just makes changes officers are skeptical of less efficient.

The model I present incorporates a micro-foundation that, under certain conditions, generates an effect similar to what Prendergast and Stole assume. The asymmetry of this effect with respect to commonly held *ex ante* beliefs about the likelihood that a new policy will be effective is especially significant when thinking about the causes of racial inequality in policing because of the mid-20th century criminological consensus about Black criminality. In an environment where the only debate among experts was the reasons for heightened criminality among Black people, and consensus that higher arrest rates deterred crime, reducing disparity in arrests faced this distinctive difficulty.

When considering the causes of persisting racial inequality in policing, this result is significant because it articulates a mechanism by which police chiefs who have no discriminatory intent will be incentivized to perpetuate policing policy that they themselves believe to be inefficient. Because of the racially unequal objectives that US police forces pursued in the earlier part of the 20th century, this conservatism is more likely to preserve policies that disadvantage historically subordinated groups (because that was the status quo). In a department that was inefficiently discriminatory toward Whites over racial minorities, it could also serve to perpetuate disadvantage in the opposite direction.

This paper examines a particular way in which the factual beliefs held by officers in a police department influence the decisions made by the chief in command of their department. By factual beliefs, I mean propositional statements about the world that officers hold to be true; not what they *want to occur*, but what they *believe is the case*. These beliefs are likely shaped by many factors, such as personal experiences, social networks, and news coverage.

For the purpose of this paper I will refer to racism as wanting racial inequality for its own sake, but hold factual beliefs about racial groups as a distinct phenomenon. This departs from the use in Omi and Winant (2014, 71-76), Bonilla-Silva (2010, 8-12), Grant-Thomas and Powell (2006), Kendi (2016, chap. 1), but follows studies of statistical discrimination (e.g. Coate and Loury 1993, Knowles, Persico and Todd, 2001). Psychological studies concerning motivated reasoning suggest that, empirically, belief formation is not independent of what people want (Kunda, 1990; Kunda and Sinclair, 1999). It is also the case that individuals can strategically misrepresent their preferences as arising from factual beliefs. However, one output of the criminal justice system (and police departments in particular) is information about arrests that is broken down by racial group, and so creates the opportunity for such beliefs to arise independently of a desire for a particular distribution of punishment by race. Thus, the effect of this information on the functioning of the system needs to be understood.[1] One motivation of this analysis is to study an effect of aggregating arrest and offense information at the level of the racial group on police chief policy making.

The observational equivalence between a) genuine belief that a racially disparate policy is more effective and b) the expression of such a belief as a strategic means in pursuit of a preference for racial disparity, makes quantitative empirical study of such racial beliefs quite difficult. While measuring them accurately is hard, estimating their effects is fraught with even more difficulties because of possible confounding factors that could cause both racial policy preferences and such beliefs. A game theoretic model is a uniquely well suited method to study the effects of these beliefs, because it is possible within a model to be certain that the effects are driven by racial beliefs rather than racial preferences. It is not a perfect solution, because the burden is shifted from measurement of the key concepts, to demonstration that the mechanisms elucidated help us understand phenomena in the real world. Never the less, it is a step in the right direction.

In section 4.1 I briefly discuss the supervisory environment of municipal police departments in the 1950s, 60s, and 70s. Thereafter I present and analyze the model, in which I assume the chief observes a signal of a new policy's effective-

[1] One recommendation in the 1963 report of the California Advisory Committee to the US Commission on Civil Rights was that arrest and prosecution statistics no longer be broken into in racial categories when published publicly. They concluded that it is often misinterpreted to indicate higher criminality among Black people without providing relevant socio-economic controls (California Advisory Committee to the US Commission on Civil Rights, 1963, 32-33).

ness and then the officer chooses how much effort to devote to their police task. In section 4.3, I examine an extension to the model in which the officer has an independent source of information about the effectiveness of the new policy.

4.1 Supervision in Mid-20$^{\text{th}}$ Century Police Departments

The central modeling contribution of this paper is to analyze information use in a police department where the commonly valued outcome is determined both by the chief's policy choice and effort that 'street-level bureaucrats' cannot be forced to expend. I model a department in this way for two reasons. First, because supervisors had difficulty effectively overseeing their officers, and even when they identified misbehavior were limited in their ability to punish them. Thus it was an environment where officer effort was what they chose to devote, not what their supervisors or chief would have wanted. Second, police departments in the mid 20th century were plagued by a perpetual lack of manpower relative to the task they set for themselves, so low officer effort could not, in general, be mitigated by assigning additional officers to a task.[2]

That police chiefs had difficulty supervising their officers, and were aware of that difficulty, was noted in Bruce Smith Jr.'s study of police in the US:

> ”Virtually every police chief in the country today bewails the lack of effective street supervision. Almost universally the blame is laid at the door of the street sergeants, though a moment's thought will suggest that each level of command up to the highest in the municipal structure of government must be responsible” (Smith Jr, 1960, 244).

Smith's discussion of officer supervision focused on two problems: officer effort and compliance with instructions. I focus on the effort dimension here, as the complaince question has been dealt with extensively elsewhere (e.g. Lipsky 1983; Brehm and Gates 1999) Federal commissions convened during the 1960's also raised the problem of police officer supervision. In its report on the police, the Presidents Commission on Law Enforcement and the Administration of Justice gave two reasons why sanctioning of police officers was nearly always difficult. First, that officers were frequently required to act before being able to gather all relevant facts, and so it was ”difficult for the police administrator to hold an individual police officer to the same standard one would hold a person who had an opportunity to consult and to think about the matter before acting” (President's Commission on

[2] Lipsky (1983) discusses police work as an area where resource inadequacy is ”attributable to the nature of the job” (31), suggesting even relatively well-funded police departments should face a version of this problem.

Law Enforcement and the Administration of Justice, 1967, 28). Second, that officers are spread across a jurisdiction and so information about what actually took place could seldom be corroborated (ibid.).[3]

Civil service laws created an an additional complication in the supervisory environment of police departments. Smith Jr. wrote:

> ”Intended as a protection to the police service against persecution for individual political convictions, civil service commissions and trial boards have tended to protect the policeman from the consequences of his misdeeds...It is little wonder that police administrators and supervisors have become discouraged about establishing discipline when their most aggravated offenders are returned to duty with back pay by civil service trial boards” (Smith Jr, 1960, 246).

Fogelson also notes that leading police chiefs of the 1950s and 60s lamented their inability to make changes to the personnel system in order to sanction or fire officers they found to be ineffective or lazy (Fogelson, 1977, 229).[4]

The manpower concerns of police departments in the US was noted by the National Advisory Commission on Criminal Justice Standards and Goals in their 1973 report on police. ”Following World War II, urban police agencies began to experience severe problems in maintaining enough personnel to cope with their burgeoning populations. Because of low police-to-citizen ratios, these agencies found themselves unable to meet the increasing demands imposed by the rising crime rate” (National Advisory Commission on Criminal Justice Standards and Goals, 1973, 255). In addition, Fogelson recounts that police had difficulty recruiting prospective officers with substantial education or outside options (Fogelson, 1977, 227).

4.2 Model of Policy Change and Officer Effort Choice

I model the process of policy change within a police department as a two-player game of imperfect information, in which the police chief (P) has private information about her own competence and which of two possible policies will be more effective at controlling crime. The outcome depends both on P's policy choice and the non-contractible effort of a representative patrol officer (A). Both actors are assumed to be risk neutral.

[3] Lipsky makes a similar point (Lipsky, 1983, 15).

[4] These civil service systems were enacted, by and large, in a push to reduce the influence of local politicians on police behavior. Other steps intended to foster greater independence included changing precinct boundaries, often reducing their total number, so that they would not be coextensive with political units (Fogelson, 1977).

Policy is deteremined by *P*, who chooses a new policy (x^n) or the status quo (x^s). In response, *A* chooses how much costly effort to devote to policing ($e \geq 0$). The outcome of the players' choices, Y, represents the department's reduction of crime in the jurisdiction.

$$Y = e(\omega x^n + (1 - x^n))$$

Where x^n is an indicator that equals 1 if P chooses the new policy and 0 otherwise. The choice variable e represents *A*'s effort, and is non-negative. Finally, $\omega \in \{\underline{\omega}, \bar{\omega}\}$ (where $0 < \underline{\omega} < 1 < \bar{\omega}$) represents the influence of the new policy (x^n) on *Y*. The effect of the status quo policy is normalized at 1. This structure represents the new policy as having some probability of being better than the status quo and some probability of being worse, where exactly how much better or worse it could be are exogenous parameters.

P's payoffs are determined by the department's success reducing crime alone. Thus the model represents the chief as an exemplar of a performance-oriented bureaucrat.

$$u_p = y$$

Similarly, *A*'s payoffs are determined by the department's success and the cost of effort *A* chooses.

$$u_a = y - e^2$$

This represents an ideal street-level bureaucrat, in that greater success at the department's mission is assumed to make him strictly better off. The only constraint he faces is the cost of effort, which is increasing.

The probability that the new policy is more effective than the status quo, π_h, is common knowledge, but *A* does not observe ω's true value. At the start of the game nature chooses ω, and *P* receives private information about its value in the form of a signal $m \in \{0, 1\}$. P can either be competent or incompetent. If *P* is competent, m = 1 if and only if $\omega = \bar{\omega}$, so she knows the true realization of ω. If P is incompetent she observes a noisy signal of ω, where $\Pr(m = 1|\underline{\omega}) = \Pr(m = 0|\bar{\omega}) = \pi_w \in (0, \frac{1}{2})$. The parameter $\pi_g \in [0, 1]$ is the *ex ante* probability that the chief is competent, and also common knowledge.

The sequence of play is as follows.

1. Nature chooses ω, *P*'s type, and sends m to *P*.
2. *P* chooses the status quo or new policy (x^s or x^n)
3. *A* chooses effort ($e \geq 0$).

Throughout the analysis I use the Perfect Bayesian Equilibrium solution concept, because *A* and the low type P must choose their actions on the basis of beliefs about unobserved parameters in their utility functions, and all players update in response to information revealed during the course of the game.

Model Interpretation

Uncertainty over the chief's competence is represented by two different parameters: π_{g} and π_{w}. The first is the probability that the chief is perfectly informed, while the second is how precise the less informed chief's information is. Thus the model can represent two overall phenomena. First, we might imagine that the system for choosing a police chief improves, in the sense that it is less likely to allow less competent individuals through. Second, we could imagine a system raising the floor on individual's competence, but not necessarily being more likely to identify an exceptional candidate.

The competence of the chief can also be interpreted as the quality of their information. I would represent a police department with poor records systems and therefore in which a chief's judgments about effective policy are based largely on hunches as one with a relatively low π_{g}, where a department where the chief has access to high quality information about the operations of the department and its effects as having a relatively high π_{g}. In this interpretation, what I refer to as the chief's competence can be better understood as the limitations (or lack thereof) placed on them by the organization's pre-existing capacity for collecting and aggregating information vertically.

The distribution of the random variable ω is crucial in the model because it represents the chief and officers' ex-ante beliefs about how effective a new policy could be. By using a binary outcome the model separates the effect of two different features of those beliefs: first, how effective the policy could be relative to the status quo, and second, how certain they are of that belief. As the value of $\bar{\omega}$ increases, this represents a circumstance where the new policy has some chance of being more and more effective. Similarly, as $\underline{\omega}$ decreases this represents a circumstance where officers and chief have a lower and lower floor on how effective they think the new policy will be. The parameter π_{h} then represents their level of certainty. With values close to $\frac{1}{2}$, officers and chief are not at all certain which way the new policy will go, while as $\pi_{\mathrm{g}} \to 0$ and $\pi_{\mathrm{g}} \to 1$, their uncertainty about the new policy disappears.

The results I will present below hinge on differences in the prior beliefs for policies that would reduce racial disparity in arrests, relative to a generic new policy that would not. If beliefs about the optimal racial distribution of arrests were considered relatively certain, as Muhammad (2010) shows, these would face the standards engendered by officer skepticism and relative certainty in a new policy's ineffectiveness (low π_{h}). In contrast, a new policy that officers simply had never heard of before, but did not fly in the face of entrenched conventional wisdom, could have the same expected value but a much higher probability of being better than the status quo.

If a prospective new policy's influence on the outcome of interest can be conceptualized as an interval variable (which is assumed by any statistical analyses), then it has two crucial features with respect to the status quo: some probability of being better, and a set of values it could take that are better (and worse). An agent's expectation of this new policy is going to respond both to the relative location of those values and the probability weight given to them. For simplicity, in this model I have a single possible value of above and a single value below the effectiveness of the status quo.

Analysis

My analysis focuses on two questions: first, under what conditions will the chief's policy selection be responsive to the effectiveness of the new task; second, what criteria does the new policy have to meet in order to be enacted in equilibrium? The first question represents the minimum conditions for a police chief expertise to have any influence on her policy choices. The second question captures how good a new policy must be in order for the chief to enact it, and I focus on the decisions of the perfectly informed chief to highlight the effect of this structure on information use by police chiefs confident in and correct about their own expertise.

Equilibria of the game can be divided into three categories on the basis of the chief's strategy: responsive, semi-responsive, and unresponsive. A **responsive equilibrium** (RE) is one in which both types of chief enact the new policy if and only if their private signal indicates it is better than the status quo. In a **semi-responsive equilibrium**, the high type chief will enact the new policy if it is better and the status quo otherwise, but the low type chief does not respond to her signal. In an **unresponsive equilibrium**, the status quo or new policy is chosen with certainty by both types of the chief. I focus my analysis on the RE for most of the paper, because officer uncertainty about the chief's type is unresolved in this category of equilibrium and there is positive probability of either policy being chosen, so these equilibria capture the effects of officer uncertainty about chief information on the chief's decisions.[5]

RE have a common structure, in which P chooses the new task if and only if her expectation of ω is above a certain threshold (ω^*). A chooses his effort on the basis of his beliefs about how effective the chosen policy is. In order for there to be some chance of either policy being enacted, two conditions must be met for each type of chief.

1. **New Policy Belief Constraint.** After observing $\mathrm{m} = 1$, P believes ω is high enough to choose x^{n} ($\mathrm{E}(\omega|\mathrm{m} = 1) \geq \omega^*$).

[5] I show that these are the only types of pure strategy Perfect Bayesian Equilibria of the game in appendix section .1.

2. **Status Quo Belief Constraint.** After observing $m = 0$, *P* believes ω is low enough to choose x^s ($E(\omega|m = 0) \leq \omega^*$).

In the next section I solve for the officer and chief's choices in a RE, and the chief's beliefs. In the subsection that follows I solve for A's beliefs in a RE, before analyzing equilibrium dependence on parameters in subsection 4.2

Effort Choice, Policy Selection, and Chief Beliefs

In this section I characterize the two players' equilibrium choices, showing how they are dependent upon prior beliefs.

In any PBE, *A*'s effort choice will depend solely on his expectation of how effective the chosen policy is. Since PBE requires sequential rationality and A chooses his effort after P's policy choice, *P* has no way to punish *A* in equilibrium. Formally, *A*'s equilibrium effort choice is made to maximize $EU_a(e|x) = E(y|e, x) - e^2$, subject to the constraint that $e \geq 0$. Differentiating A's expected utility after P chooses the new policy gives $\frac{\partial EU_a}{\partial e} = E(\omega|x^n) - 2e$, with $\frac{\partial^2 EU_a}{\partial e^2} < 0$, so A's optimal effort is $e^* = \frac{E(\omega|x^n)}{2}$. Similarly, when *P* chooses the status quo, A's optimal effort is $e = \frac{1}{2}$. This gives A's unique sequentially rational strategy:

$$e^* = \begin{cases} \frac{E(\omega|x^n)}{2} & \text{if } P \text{ chose the new policy} \\ \frac{1}{2} & \text{if } P \text{ chose the status quo} \end{cases} \tag{4.1}$$

A's equilibrium effort choice demonstrates that *P*'s only mechanism through which to influence A's effort is by signaling how effective the chosen policy is. A key quantity to the existence of RE is, therefore, the expected value of ω that A will infer after observing P choose the new policy. This is the avenue through which A's beliefs can influence policy change decisions.

The chief's decision to enact the new policy is sensitive to the effort A will choose in response to x^n, which P anticipates correctly when making her decision in equilibrium. She will choose the new policy if and only if $EU_p(x^n|m) \geq EU_p(x^s|m)$. Therefore *P* will choose x^n when:

$$\frac{E(\omega|a^n)}{2} E(\omega|m) \geq \frac{1}{2} \implies \qquad E(\omega|m) \geq \frac{1}{E(\omega|x^n)}$$

Since the chief is assumed to be risk neutral, she will use the same threshold for deciding whether to choose the new policy regardless of the quality of her information. This gives P's two belief constraints for a RE:

$$E(\omega|m = 1) \geq \frac{1}{E(\omega|x^n)} \qquad \text{New Policy Belief Constraint} \tag{4.2}$$

$$E(\omega|m = 0) \leq \frac{1}{E(\omega|x^n)} \qquad \text{Status Quo Belief Constraint} \tag{4.3}$$

Notice, the denominator on the right side of (4.2) and (4.3) is the officer's expectation of ω conditional on observing the chief's choice. If A expects the new task to be less effective than the status quo, he will devote lower effort to it, and so P will not choose it unless she believes the new policy will be enough better to make up for the difference. Conversely, if A expects the new task to be more effective, P will choose it so long as it surpasses some threshold that is possibly below the effectiveness of the status quo.

If the chief is competent, she knows exactly how effective the new policy is, so her posterior belief after observing m is $E(\omega|m = 1, P^H) = \bar{\omega}$ or $E(\omega|m = 0, P^H) = \underline{\omega}$. Using Baye's rule we can derive P^L's beliefs after observing her signal:

$$E(\omega|m = 1, P^L) = \frac{\bar{\omega}(1-\pi_w)\pi_h + \underline{\omega}\pi_w(1-\pi_h)}{(1-\pi_w)\pi_h + \pi_w(1-\pi_h)} \tag{4.4}$$

$$E(\bar{\omega}|m = 0, P^L) = \frac{\bar{\omega}\pi_w\pi_h + \underline{\omega}(1-\pi_w)(1-\pi_h)}{\pi_w\pi_h + (1-\pi_w)(1-\pi_h)} \tag{4.5}$$

Where π_w is the probability that her signal is wrong and π_h is the *ex ante* probability that $\omega = \bar{\omega}$. Both of these beliefs are increasing in the probability that ω is high, but they move in opposite directions as the signal m becomes more reliable.

Officer Beliefs in a Responsive Equilibrium

In this section I derive A's beliefs in a RE using Bayes' rule. A's expectation of ω after seeing P choose the new task can be decomposed using the law of total probability:

$$E(\omega|x^n) = Pr(P^H|x^n)E(\omega|x^n, P^H) + Pr(P^L|x^n)E(\omega|x^n, P^L) \tag{4.6}$$

Each of these terms depends on equilibrium actions by P, so in rest of this section I solve for A's beliefs consistent with a RE (where both types of P choose x^n if $m = 1$ and x^s otherwise).

If the chief is competent in a RE, observing x^n signals to A that $\omega = \bar{\omega}$ with certainty. Therefore $E(\omega|x^n, P^H) = \bar{\omega}$. If the chief is incompetent, observing x^n signals that $m = 1$, which gives A additional information about the probability that the new policy would have effectiveness $\bar{\omega}$. Therefore his expectation of ω is the same as equation (4.4). His posterior belief will be a linear combination of these two.

In general, A's belief about the probability the chief is competent can be expressed as:

$$Pr(P^H|x^n) = \frac{Pr(x^n|P^h)Pr(P^h)}{Pr(x^n|P^h)Pr(P^h) + Pr(x^n|P^l)(1 - Pr(P^h))}$$

Where $Pr(P^h) = \pi_g$, and both $Pr(x^n|P^h) = \pi_h$ and $Pr(x^n|P^L)$ depend on the equilibrium. In a RE, $Pr(x^n|P^h) = \pi_h$ and the chance of P^L choosing the new policy is:

$\pi_h(1-\pi_w)+(1-\pi_h)\pi_w$. Therefore A's belief that P is competent after observing the new policy is:

$$\Pr(P^H|x^n) = \frac{\pi_h\pi_g}{\pi_h\pi_g + [\pi_h(1-\pi_w)+(1-\pi_h)\pi_w](1-\pi_g)}$$

Plugging the expression for the probability that the chief is high type into equation (4.6) and simplifying, this gives:

$$E(\omega|x^n) = \frac{\bar{\omega}\pi_h\pi_g + (1-\pi_g)(\underline{\omega}\pi_w(1-\pi_h)+\bar{\omega}\pi_h(1-\pi_w))}{\pi_h\pi_g + (1-\pi_g)(\pi_w(1-\pi_h)+\pi_h(1-\pi_w))} \tag{4.7}$$

In a RE A's expectation of ω after observing the policy choice x^n is strictly higher than his prior. This is because regardless of the chief's type, their choosing the new policy is an unambiguous signal that the policy's effectiveness meets some minimum threshold. Intuitively, as the chief is more likely to be competent or the new policy is more likely to be highly effective, A's expectation of its effectiveness go up. However, as the less competent chief becomes less competent, it brings down A's expectation.

Lemma 5. *A RE exists for any parameters where the incompetent chief's New Policy Belief Constraint and Status Quo Belief Constraint are both satisfied.*
Formally, $E(\omega|P^L, m=1) \geq \frac{1}{E(\omega|x^n)}$ *and* $E(\omega|P^L, m=0) \leq \frac{1}{E(\omega|x^n)}$.

Proof. A responsive PBE exists when it is sequentially rational for P to choose the new policy if and only if m = 1, while A chooses sequentially rational effort levels in response to either policy and both have beliefs consistent with these strategies and the signals or actions they observe.

As I showed in the text, 4.1 is A's unique sequentially rational effort choice in response to each policy. As I showed in the text, it is sequentially rational for P to follow a RE if 4.2 and 4.3 hold for both types of P.

$$\text{a) } E(\omega|P^H, m=1) \geq \frac{1}{E(\omega|x^n)} \qquad \text{b) } E(\omega|P^H, m=0) \leq \frac{1}{E(\omega|x^n)}$$
$$\text{c) } E(\omega|P^L, m=1) \geq \frac{1}{E(\omega|x^n)} \qquad \text{d) } E(\omega|P^L, m=0) \leq \frac{1}{E(\omega|x^n)}$$

So long as $\pi_w > 0$, $\bar{\omega} >$ (4.4) and $\underline{\omega} <$ (4.5), so $E(\omega|P^H, m=1) > E(\omega|P^L, m=1)$ and $E(\omega|P^H, m=0) < E(\omega|P^L, m=0)$. Therefore c) $\implies$ a) and d) $\implies$ b), so the existence of a RE is guaranteed by conditions c) and d). □

The intuition behind this lemma is that both types of chief have the same threshold for when the new policy is sequentially rational, but the high type chief's certainty drives their beliefs to the extremes. When they observe m = 1 their posterior is higher than the incompetent chief's belief, and when they observe m = 0 it is lower because they know there is no chance that $\omega = \bar{\omega}$.

Implications for Policy Change With Skeptical Officers

I examine the perfectly informed chiefs decisions in order to isolate the effect of the department effectiveness depending on officer effort when officers are uncertain about the chiefs competence. I accomplish this by examining the decision threshold of the chief type without uncertainty.

The second feature I study is the parameter values that can support a RE. In this model where the chief has only two possible types, RE are the only ones that preserve the officers uncertainty about the chiefs type. The parameters where they exist are therefore the parameters where the police department, represented in this way, can use the information available to its chief when officers are uncertain about her competence.

Proposition 11. *The minimum effectiveness that the new policy must meet for the perfectly informed chief to enact it in a RE is:*

1. *increasing in the probability the less informed chief is wrong;*
2. *increasing in the probability of a low type chief;*
3. *decreasing in the probability that the new policy is more effective than the status quo.*

Proof. The minimum effectiveness at which the fully informed chief will enact the new policy in equilibrium is given by condition (4.2) and (4.7) as:

$$\bar{\omega} = \frac{\pi_{\mathrm{h}}\pi_{\mathrm{g}} + (1-\pi_{\mathrm{g}})(\pi_{\mathrm{w}}(1-\pi_{\mathrm{h}}) + \pi_{\mathrm{h}}(1-\pi_{\mathrm{w}}))}{\bar{\omega}\pi_{\mathrm{h}}\pi_{\mathrm{g}} + (1-\pi_{\mathrm{g}})(\underline{\omega}\pi_{\mathrm{w}}(1-\pi_{\mathrm{h}}) + \bar{\omega}\pi_{\mathrm{h}}(1-\pi_{\mathrm{w}}))}$$

Solving the equation for $\bar{\omega}$, the unique positive solution is:

$$\bar{\omega} = \frac{-(1-\pi_{\mathrm{g}})(1-\pi_{\mathrm{h}})\pi_{\mathrm{w}}\underline{\omega}}{2(\pi_{\mathrm{h}} - (1-\pi_{\mathrm{g}})\pi_{\mathrm{h}}\pi_{\mathrm{w}})} + \frac{\sqrt{4\pi_{\mathrm{h}}(\pi_{\mathrm{h}} + \pi_{\mathrm{w}}(1-\pi_{\mathrm{g}}) - 2\pi_{\mathrm{h}}\pi_{\mathrm{w}}(1-\pi_{\mathrm{g}}))(1-\pi_{\mathrm{w}} + \pi_{\mathrm{g}}\pi_{\mathrm{w}}) + (1-\pi_{\mathrm{g}} - \pi_{\mathrm{h}} + \pi_{\mathrm{g}}\pi_{\mathrm{h}})^2\pi_{\mathrm{w}}^2\underline{\omega}^2}}{2(\pi_{\mathrm{h}} - (1-\pi_{\mathrm{g}})\pi_{\mathrm{h}}\pi_{\mathrm{w}})}$$

The partial derivative of the solution with respect to π_{g} is always negative, so the threshold is decreasing in the probability of a high type chief. The partial derivative with respect to π_{w} is always positive, so the threshold is increasing with the probability that the low type chief is wrong. The partial derivative with respect to π_{h} is always negative, so the threshold is decreasing in the probability of that the policy is more effective than the status quo. □

The new policy being etter than the old is not necessarily sufficient for the competent chief to enact it in equilibrium. If the officers are not convinced of the policy's effectiveness, the new policy must be good enough to make up for their relatively low effort. Exactly how much better the new policy must be depends on each of the factors that effect A's beliefs. P will use a higher threshold as the probability of an incompetent chief increases and as the chance the incompetent chief is wrong increases. The threshold threshold decreases as the chances that the policy is better than the status quo increases.

The logic behind the result is that A has a lower expectation of the value of ω when an incompetent chief chooses it than when a competent chief did. This arises because the incompetent chief could be wrong, so the officer is no longer certain of the new policy's effectiveness. Thus, as the probability that the chief is competent decreases, so too does the officer's expectation of the new policy when it is enacted. Similarly, as the incompetent chief's information gets worse, the officer's expectation of the new policy goes lower.

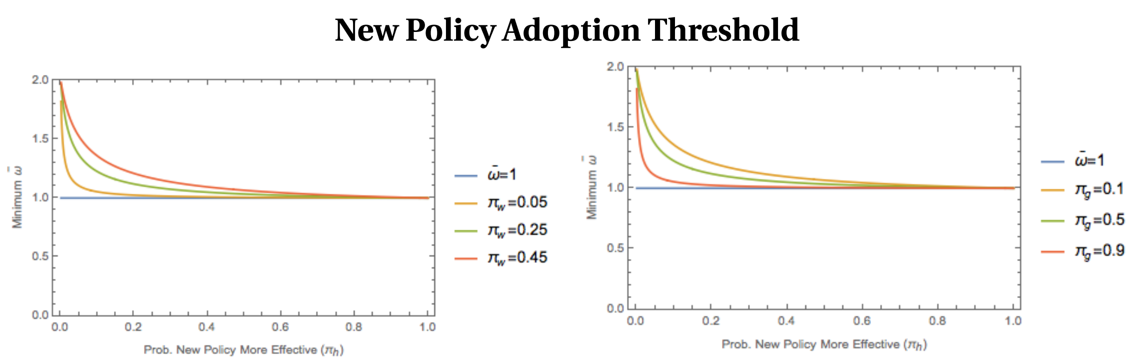

Figure 4.1: Value of $\bar{\omega}$ at which the competent chief will choose the new policy in a RE. Left: $\pi_{\mathrm{g}} = .5$, $\underline{\omega} = .5$. Right: $\pi_{\mathrm{w}} = .25$, $\underline{\omega} = .5$.

The comparative statics in Proposition 1 are illustrated in figure 4.1. The left panel shows how the chief's adoption threshold changes as a function of the prior probability that the new policy is more effective, with different lines to show how the threshold changes as the incompetent chief's information changes. As the chance she is wrong goes lower, the chief's threshold approaches 1. In this model the status quo is assumed to have an effectiveness of 1, so this would be the point at which the chief chooses the new policy if and only if it is better than the status quo. A key feature of this figure is how the difference between the curves drops as the prior on the new policy increases: the constraining effect of the officer's prior beliefs is decreasing in th chance the new policy is better. If the officers have low priors, their beliefs will have a larger constraining effect than if they have high prior beliefs that the new policy will be effective. The right panel shows that this same relationship holds as the chance the chief is competent increases.

To examine the effects of officer skepticism on police chief information use, a benchmark is required. The benchmark I compare against is if the police chief were making decisions without concern for officer effort. This is what would happen if officer effort were a non-zero constant, or if the chief had a means to maximize effort regardless of policy choice. This is informationally efficient in that it most efficiently uses the chief's private information about the effectiveness of the new policy.[6]

Since the effectiveness of the status quo policy is normalized to 1, a police chief responding exclusively to her information would choose the new policy if $E(\omega|m) > 1$ and the status quo if $E(\omega) < 1$ (and would be indifferent when $E(\omega|m) = 1$). The sufficient conditions for a RE to exist are still that the low type chief choose the new policy when $m = 1$ and the status quo otherwise. Therefore the minimum value of $\bar{\omega}$ for a RE solves:

$$\frac{\bar{\omega}(1-\pi_w)\pi_h + \underline{\omega}\pi_w(1-\pi_h)}{(1-\pi_w)\pi_h + \pi_w(1-\pi_h)} = 1$$

$$\implies \bar{\omega} = 1 + (1-\underline{\omega})\left(\frac{\pi_w(1-\pi_h)}{(1-\pi_w)\pi_h}\right)$$

The maximum value of $\bar{\omega}$ for which a RE can be sustained solves:

$$\frac{\bar{\omega}\pi_w\pi_h + \underline{\omega}(1-\pi_w)(1-\pi_h)}{\pi_w\pi_h + (1-\pi_w)(1-\pi_h)} = 1$$

$$\implies \bar{\omega} = 1 + (1-\underline{\omega})\left(\frac{(1-\pi_w)(1-\pi_h)}{\pi_w\pi_h}\right)$$

In this efficient benchmark, the high type chief chooses the new policy if and only if it is more effective than the status quo.

Figure 4.2 represents the difference between where RE exist in this model and in the benchmark. Since the figure represents the boundaries of equilibrium existence, it is an analysis of how the less informed chief uses her information in equilibrium (see lemma 1). The lower shaded region represents the area where a RE exists only in the model where the chief cannot control officer effort. The interior unshaded region represents the overlap in where the equilibria exist, and the upper shaded region can sustain RE only when the officer's effort does not respond to their beliefs about policy effectiveness.

The figure highlights an effect of the chief's competence being private: the incompetence chief responds to information lower than would be efficient, and stops responding to information lower than would be efficient. That the low type chief is responding to information at a lower value of $\bar{\omega}$ than would be efficient

[6]This is equivalent to what would happen if the officer knew the chief's type and signal, since his effort following either task is identical when $E(\omega|m) = 1$.

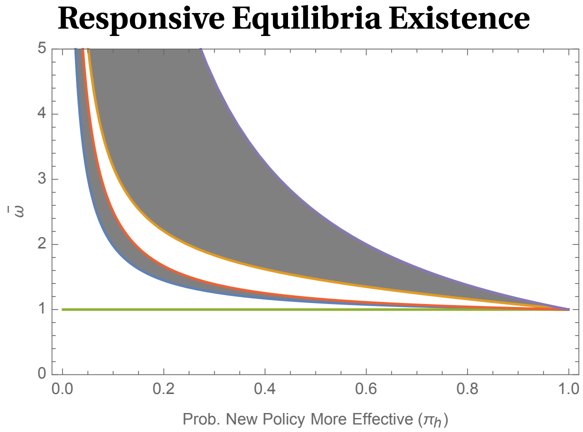

Figure 4.2: Lower shaded region: RE only exists in model with strategic officer. Interior unshaded region: RE exists in both model and benchmark. Upper shaded region: RE exists only in benchmark. Assumes: $\pi_g = .5$, $\pi_w = .25$, and $\underline{\omega} = .5$.

means that dependence on officer effort causes them to over-react to their information, and take risks that would not be efficient if officer effort were constant. That the incompetent chief stops responding to her information at a lower value of $\bar{\omega}$ is driven by the same problem: at a level of certainty that is lower than would be efficient, they stop relying on their information and always choose the new policy. This is analogous to results in Prendergast and Stole (1996) and Majumdar and Mukand (2004), except arises in this circumstance where the police chief is not responding to external oversight. It is induced by an unresolved moral-hazard problem.

4.3 When the Officer Has Information

Policing is a policy domain where the perspective of patrol officers and the chief can be quite different, but both still convey information. It is a different sort of information, anecdotal and detailed rather than aggregated across the different officers and precincts, but is never the less related to outcomes that the whole department cares about. Therefore the assumption in the baseline model that the officers have no information about the new policy's effectiveness beyond the chief's policy choice is worth relaxing.

In this section I extend the model to allow the officer to receive independent information about the policy's effectiveness. In this version, the chief's information remains unchanged, but after she makes her policy choice the officer makes two effort choices. He decides his initial effort ($e_1 \geq 0$) knowing nothing about the new policy's effectiveness beyond what he infers from the chief's choice. The officer then observes a signal, $m_2 \in \{0, 1\}$ where $\Pr(m_2 = 0|\omega = \bar{\omega}) = \Pr(m_2 =$

$1|\omega = \underline{\omega}) = \pi_{wA}$, before making his subsequent effort choice ($e_2 \geq 0$). The parameter π_{wA} is the probability that the officer's signal is wrong, so a lower π_{wA} means a better informed officer.

To accommodate the officer's choice structure, the chief and officer now have their utility weighted between two department performance measures: y_1 and y_2.

$$u_p = \delta y_1 + (1-\delta)y_2$$
$$u_a = \delta(y_1 - e_1^2) + (1-\delta)(y_2 - e_2^2)$$

The parameter δ represents the delay before the officers observe their information: a higher δ means that the officers remain with their effort choice longer before they observe m_2 and have the chance to reevaluate.

The sequence of play is as follows:

1. Nature chooses the new policy's effectiveness (ω), the chief's competence, and sends signal to the chief (m_1).
2. The chief chooses the status quo or new policy (x^s or x^n)
3. The officer chooses initial effort (e_1).
4. Nature sends signal to the officer (m_2)
5. The officer chooses subsequent effort (e_2).

In the next section I show the officer and chief's choice rules, and then their beliefs. As with the previous model, my focus is on when a RE can be sustained, and the minimum effectiveness that a perfectly informed chief must see in order to choose the new policy in equilibrium.

Analysis

As in the basic model, the existence of a RE depends on the willingness of both types of chiefs to enact the new policy if their signal indicates it is better than the status quo. Also as in the basic model, the officer's effort will depend on his expectation of the new policy's effectiveness. However, since the officer gets additional information after making his initial effort decision, there is some chance that he will revise it up or down after learning.

P's expected utility from choosing the status quo policy can be simplified to: $EU_p(x^s) = \frac{1}{2}$. Similarly, her expected utility from the new policy is: $EU_p(x^n) = \frac{E(\omega|m_1)}{2}[\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1)]$. P will only choose the new policy in equilibrium if: $EU_p(x^n) \geq EU_p(x^s)$, which implies:

$$E(\omega|m_1) \geq \frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1)} \tag{4.8}$$

In a RE $E(\omega|x^n)$ is the same as the officer's belief after observing the new policy in section 4.2 (equation 4.7). For both types of P, the information structure remains the same, so the high type is perfectly informed after observing m_1 and $E(\omega|m_1, P^L)$ is the same as $E(\omega|m, P^L)$ in section 4.2 (equations 4.4 and 4.5). The new quantities in this extension of the model are the officer's beliefs after observing his signal, and the chief's expectation of those beliefs after observing her signal.

When the officer sees the signal m_2 in a RE he has already observed the chief choose x^n, so his beliefs are higher than the prior π_h. Regardless of the signal, they can be expressed using Bayes' rule as:

$$\Pr(\bar{\omega}|x^n, m_2) = \frac{\Pr(m_2|\bar{\omega}, x^n)\Pr(\bar{\omega}|x^n)}{\Pr(m_2|\bar{\omega}, x^n)\Pr(\bar{\omega}|x^n) + \Pr(m_2|\underline{\omega}, x^n)\Pr(\underline{\omega}|x^n)} \tag{4.9}$$

In a RE, the quantity $\Pr(\bar{\omega}|x^n)$ is the same as the officer's posterior after observing x^n in section 4.2. The probability of the two possible signals, conditional on $\bar{\omega}$ are simply the probability that m_2 is right or wrong: $1 - \pi_{wA}$ and π_{wA}, respectively. Since $E(\omega|x^n, m_2) = \Pr(\bar{\omega}|x^n, m_2)\bar{\omega} + (1 - \Pr(\bar{\omega}|x^n, m_2))\underline{\omega}$, one can substitute the relevant values into equation 4.9, and obtain his posterior expectations after observing either signal:

$$E(\omega|x^n, m_2 = 1) = \frac{\bar{\omega}(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}\pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}{(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w} \tag{4.10}$$

$$E(\omega|x^n, m_2 = 0) = \frac{\bar{\omega}\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}(1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}{\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + (1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w} \tag{4.11}$$

As long as $\pi_{wA} > 0$, the officer's posterior after observing m_2 is increasing in the chances that the chief is competent and that the new policy is more effective than the status quo, and decreasing in the chance that the chief is wrong. The two signals push the officer's posterior in opposite directions as the officer's information quality changes: as π_{wA} approaches 0, the officers uncertainty after his two signals disappears, but as it goes to $\frac{1}{2}$ the two posteriors converge to $E(\omega|x^n)$.

The chief's expectation of the officer's beliefs at the end of the game will depend on the chief's type. In general, they can be expressed as:

$$E(E(\omega|x^n, m_2)|m_1) = \Pr(m_2 = 1|m_1)E(\omega|x^n, m_2 = 1) + \Pr(m_2 = 0|m_1)E(\omega|x^n, m_2 = 0)$$

Where the two probabilities depend on the chief's type and the signal m_1.

The high type chief knows the true value of ω, so her subjective probability of the officer receiving either signal is just the probability that the officer's signal is wrong or right. After observing $m_1 = 1$, the probability that $m_2 = 1$ is $1 - \pi_{wA}$, and the probability that $m_2 = 1$ after she observes $m_1 = 0$ is the same. Thus, after observing m_1 the high type chief's possible expectations of the officer's beliefs in the second period are linear combinations of equations (4.10) and (4.11):

$$
\begin{aligned}
&E(E(\omega|x^n, m_2)|m_1 = 1, P^H) = \\
&\quad (1-\pi_{wA})\left(\frac{\bar{\omega}(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}\pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}{(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + \pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}\right) \\
&\quad +\pi_{wA}\left(\frac{\bar{\omega}\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}(1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}{\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + (1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}\right) \\
&\qquad \text{and} \\
&E(E(\omega|x^n, m_2)|m_1 = 0, P^H) = \\
&\quad \pi_{wA}\left(\frac{\bar{\omega}(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}\pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}{(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + \pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}\right) \\
&\quad +(1-\pi_{wA})\left(\frac{\bar{\omega}\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}(1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}{\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + (1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}\right)
\end{aligned}
$$

As $\pi_{wA} \to \frac{1}{2}$, $E(E(\omega|x^n, m_2)|m_1 = 1, P^H) \to E(\omega|x^n)$, that is as the officer's signal gets less and less reliable, his belief after seeing it converges to the same value: his prior.

I solve for the low type chief's expectation in appendix section .1.

As in the first model, the conditions under which the low type chief will adhere to a RE are more stringent than those for the high type chief, so the sufficient conditions for the existence of an RE are simply it being incentive compatible for the low type chief (I show this formally in appendix section .1).

Policy Change with an Informed Officer

In this section I discuss the effect of the officer's information quality, and the delay in when they receive their information, on the competent chief's decision to enact the new policy in equilibrium.

Proposition 12. *In a RE the minimum threshold at which the fully informed chief will enact the new policy is:*

1. *Increasing in* π_{wA}
2. *Increasing in* δ

As the officer's information gets better, the chief has greater certainty that they will get relatively high effort out of the officer. As a result, the perfectly informed chief's decision threshold gets closer to simply requiring that the new policy be better than the old. However, as the officer's information gets worse, there is a greater chance that their signal will indicate that the policy is less effective. This lowers the chief's expectation of effort that the officer will devote to the new policy, and so increases the threshold they require the new policy to meet.

As the delay in the officer's information increases, the chief has to wait a longer time before the officer gets his information. Since the competent chief knows that the policy is more effective, and the officer's information is more likely to be right than wrong, she expects his effort will increase after observing his signal.

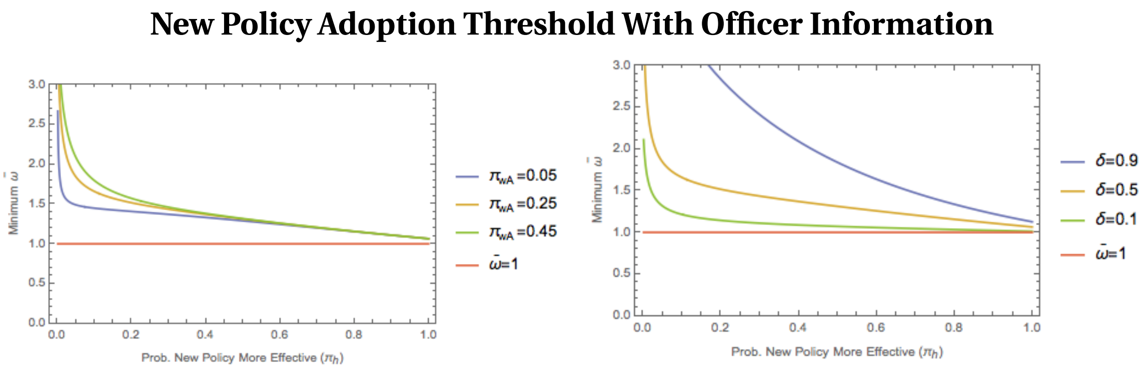

Figure 4.3: Value of $\bar{\omega}$ at which the competent chief will choose the new policy in a RE. Both panels: $\pi_{\mathrm{g}} = \frac{1}{2}$, $\underline{\omega} = \frac{1}{2}$, $\pi_{\mathrm{w}} = \frac{1}{4}$. Left: $\delta = \frac{1}{2}$. Right: $\pi_{\mathrm{wA}} = \frac{1}{4}$.

The result in proposition 2 is illustrated in figure 4.3, which shows the different thresholds the new policy must meet for the competent chief to choose it as a function of the prior probability that the new policy is more effective than the status quo. As in the model presented in section 4.2, the differences are smaller for larger values of π_{h}. The left panel of the figure illustrates the effect of different information quality for the officer. As the officer's information gets worse, the threshold that the chief will use increases, especially for low values of π_{h}. The right panel shows different delay lengths, where longer delays cause the chief to require a higher threshold in order to enact the new policy. These results demonstrate that the officer having a timely and reliable source of information mitigates the effects identified in the first section.

4.4 Discussion

In this paper I have argued that limits to the ability of police chiefs to induce officer effort, combined with the dependence of department performance on that effort and officer uncertainty about the chief's competence, causes a performance-oriented police chief's decisions to be responsive to officer priors about the efficacy of new policies. Policies that the officer is skeptical of must meet a higher standard in order for the chief to enact it, in order to make up for the officer's relatively lower effort. This responsiveness of police chief decisions to officer beliefs would have made police departments less likely to enact reforms that reduced racial disparity in arrest during the civil rights era, because of the social-scientific and political consensus that Black people were more likely to commit crimes.

This result suggests a limit to the ability of police departments, once made independent of political influence and committed entirely to reducing crime, to act on evidence that efficient policing requires less concentrated punishment among Black people. Instead they would continue to rely on inefficient policies with significant human cost.

This result also suggests that historical efforts to reduce political influence on policing, such as the enactment of civil service laws or the recognition of collective bargaining rights and strong workplace protections for police officers, might have helped entrenched racial disparity in punishment. Further research is needed to examine whether this empirical prediction is borne out in arrest statistics.

.1 Proofs

Equilibrium Existence

All equilibria of the game are either unresponsive, semi-responsive, or responsive, as defined in section 4.2.

Proof. Conditional on their signals, each type of chief has four types of pure strategies. Neither type of chief will choose a policy opposite their signal in equilibrium (that is, choose the new policy when $m = 0$ and the status quo when $m = 1$), because when $\pi_w < \frac{1}{2}$, both types know that the opposite policy would be better. Therefore each type has three strategies, for a total of nine possible choices. Using the notation ($P^H\&m = 1, P^H\&m = 0, P^L\&m = 1, P^L\&m = 0$), the candidate strategies for the chief are:

$$\begin{array}{ccc} (1,0,0,0) & (1,1,0,0) & (0,0,0,0) \\ (1,0,1,0) & (1,1,1,0) & (0,0,1,0) \\ (1,0,1,1) & (1,1,1,1) & (0,0,1,1) \end{array}$$

If it's IC for low type to choose x^n when $m = 1$ then x^n is P^H's unique sequentially rational strategy. Similarly, if it's IC for low type to choose x^s when $m = 0$ then it's P^L's unique sequentially rational strategy to do the same. These eliminate four candidate strategies leaving:

$$\begin{array}{ccc} (1,0,0,0) & (0,0,0,0) & (1,0,1,0) \\ (1,0,1,1) & (1,1,1,1) & \end{array}$$

These are the possible equilibrium. Two of them are semi-responsive, where the low type always chooses either the new policy (SRE^n) or the status quo (SRE^s). Two of them are unresponsive, where both types choose the new policy (URE^n) or status quo (URE^s). The last is a RE, where both types follow the signal *m*. □

Boundary conditions for equilibrium types:

Proof. There are four conditions that determine which kind of the five equilibrium-types exists for any set of parameters.

$$\text{a) } E(\omega|P^H, m = 1) \geq \frac{1}{E(\omega|x^n)} \qquad \text{b) } E(\omega|P^H, m = 0) \leq \frac{1}{E(\omega|x^n)}$$

$$\text{c) } E(\omega|P^L, m = 1) \geq \frac{1}{E(\omega|x^n)} \qquad \text{d) } E(\omega|P^L, m = 0) \leq \frac{1}{E(\omega|x^n)}$$

The expectations on the LHS of each condition fall in the following order: $E(\omega|P^H, m = 1) > E(\omega|P^L, m = 1) > E(\omega|P^L, m = 0) > E(\omega|P^H, m = 0)$. In a PBE, the RHS of each inequality is identical because they are consistent with equilibrium strategies using Bayes rule. Therefore the equilibrium types that exist for any given parameters depend on where the quantity $\frac{1}{E(\omega|x^n)}$ falls in the order of chief's expectations.[7]

When $\frac{1}{E(\omega|x^n)} > E(\omega|P^H, m = 1)$, neither chief will choose the new policy no matter their signal so a URE^s exists. Since neither chief will choose the new policy in equilibrium, Bayes' rule does not restrict the officer's beliefs after observing the new policy. An equilibrium does not exist if the officer believes the policy is more effective after seeing it selected. If $E(\omega|x^n) = \bar{\omega}$, the equilibrium would require:

$$\bar{\omega} \leq \frac{1}{\bar{\omega}} \qquad \Longrightarrow \bar{\omega} \leq 1$$

which is false. Therefore, so long as the officer has beliefs $E(\omega|x^n) = \bar{\omega} - \varepsilon$ where $\varepsilon > 0$, a URE^s exists if:[8]

$$\bar{\omega} \leq \frac{1}{\bar{\omega} - \varepsilon} \qquad \Longrightarrow \bar{\omega} \leq \frac{\sqrt{\varepsilon^2 + 4} - \varepsilon}{2}$$

When $E(\omega|P^H, m = 1) > \frac{1}{E(\omega|x^n)} > E(\omega|P^L, m = 1) >$, only the high type chief will respond to her signal so a SRE^s exists. In this case the officer knows the new policy is highly effective if he sees it chosen in equilibrium, so the unique belief consistent with the strategy profile is $E(\omega|x^n) = \bar{\omega}$. Therefore the equilibrium exists so long as:

$$\bar{\omega} \geq \frac{1}{\bar{\omega}} \qquad \Longrightarrow \bar{\omega} \geq 1$$

and

$$\frac{\bar{\omega}(1-\pi_w)\pi_h + \underline{\omega}\pi_w(1-\pi_h)}{(1-\pi_w)\pi_h + \pi_w(1-\pi_h)} \leq \frac{1}{\bar{\omega}}$$

$$\Longrightarrow \bar{\omega} \leq \frac{-\pi_w\underline{\omega}(1-\pi_h) + \sqrt{\underline{\omega}^2\pi_w^2(1-\pi_h)^2 - 4\pi_h(1-\pi_w)(2\pi_h\pi_w - \pi_h - \pi_w)}}{2\pi_h(1-\pi_w)}$$

[7] Note, the officer's expectation of the new policy when the chief chooses it in equilibrium depends upon the chief's equilibrium strategies, so for some parameters more than one kind of equilibrium may exist. When a condition is satisfied exactly you may also get two equilibria to exist at the same parameters.

[8] The least restrictive weak PBE exists when the officer has posterior $E(\omega|x^n) = \underline{\omega}$, which would imply that only the competent chief chooses the new policy (and only when it is less effective than the status quo). Under this off-the equilibrium path belief, a PBE that is unresponsive can be sustained so long as $\bar{\omega} \leq \frac{1}{\underline{\omega}}$.

When $E(\omega|P^L, m=1) > \frac{1}{E(\omega|x^n)} > E(\omega|P^L, m=0)$ a RE exists. By Lemma 1 and equations (4.4) and (4.2), the lower bound of equilibrium existence solves:

$$\frac{\bar{\omega}(1-\pi_w)\pi_h + \underline{\omega}\pi_w(1-\pi_h)}{(1-\pi_w)\pi_h + \pi_w(1-\pi_h)} \geq \frac{\pi_h\pi_g + (1-\pi_g)(\pi_w(1-\pi_h) + \pi_h(1-\pi_w))}{\bar{\omega}\pi_h\pi_g + (1-\pi_g)(\underline{\omega}\pi_w(1-\pi_h) + \bar{\omega}\pi_h(1-\pi_w))}$$
$$\implies \bar{\omega} \geq$$

By Lemma 1, and equations (4.5) and (4.3), the upper bound of equilibrium existence solves:

$$\frac{\bar{\omega}\pi_w\pi_h + \underline{\omega}(1-\pi_w)(1-\pi_h)}{\pi_w\pi_h + (1-\pi_w)(1-\pi_h)} \leq \frac{\pi_h\pi_g + (1-\pi_g)(\pi_w(1-\pi_h) + \pi_h(1-\pi_w))}{\bar{\omega}\pi_h\pi_g + (1-\pi_g)(\underline{\omega}\pi_w(1-\pi_h) + \bar{\omega}\pi_h(1-\pi_w))}$$
$$\implies \bar{\omega} \leq$$

When $E(\omega|P^L, m=0) > \frac{1}{E(\omega|x^n)} > E(\omega|P^H, m=0)$ a SRE^n exists. In this equilibrium observing x^n means that either the chief is the low type or the chief is the high type and $\omega = \bar{\omega}$. Therefore his beliefs are:

$$E(\omega|x^n) = Pr(P^H|x^n)E(\omega|x^n, P^H) + Pr(P^L|x^n)E(\omega|x^n, P^L)$$

Where $E(\omega|x^n, P^H) = \bar{\omega}$, $E(\omega|x^n, P^L) = \pi_h\bar{\omega} + (1-\pi_h)\underline{\omega}$, and $Pr(P^H|x^n) = \frac{\pi_h\pi_g}{\pi_h\pi_g + 1 - \pi_g}$, so

$$E(\omega|x^n) = \frac{\pi_h\bar{\omega} + (1-\pi_g)(1-\pi_h)\underline{\omega}}{\pi_h\pi_g + 1 - \pi_g}$$

Therefore the equilibrium exists for parameters where:

$$\frac{\bar{\omega}\pi_w\pi_h + \underline{\omega}(1-\pi_w)(1-\pi_h)}{\pi_w\pi_h + (1-\pi_w)(1-\pi_h)} \geq \frac{(\pi_h\pi_g + 1 - \pi_g)}{\pi_h\bar{\omega} + (1-\pi_g)(1-\pi_h)\underline{\omega}}$$
$$\implies \bar{\omega} \geq \frac{-(1-\pi_h)(1-\pi_g\pi_w)\underline{\omega}}{2\pi_h^2\pi_w} +$$
$$\frac{\sqrt{\pi_h^2(4\pi_w(1-\pi_g+\pi_h\pi_w)(1-\pi_w+\pi_h(2\pi_w-1)) + (\pi_h-1)^2(1+(\pi_g-2)\pi_w)^2\underline{\omega}^2}}{2\pi_h^2\pi_w}$$

and

$$\underline{\omega} \leq \frac{\pi_h\pi_g + 1 - \pi_g}{\pi_h\bar{\omega} + (1-\pi_g)(1-\pi_h)\underline{\omega}}$$
$$\implies \bar{\omega} \leq \frac{1-\pi_g(1-\pi_h) - \underline{\omega}^2(1-\pi_g)(1-\pi_h)}{\underline{\omega}\pi_h}$$

Finally, when $E(\omega|P^H, m = 0) > \frac{1}{E(\omega|x^n)}$ a URE^n exists. In this equilibrium the officer does not learn any new information from observing the new policy chosen, and so $E(\omega|x^n) = \pi_h$. Therefore the equilibrium exists if:

$$\underline{\omega} \geq \frac{1}{\pi_h\bar{\omega} + (1-\pi_h)\underline{\omega}} \qquad \Longrightarrow \bar{\omega} \geq \frac{1-\underline{\omega}^2(1-\pi_h)}{\underline{\omega}\pi_h}$$

□

Remark: SRE^s **does not overlap with** SRE^n **or** URE^n**,** RE **does not overlap with** URE^n**, and** SRE^n **does not overlap with** URE^n**.**

Proof. As I showed above, a SRE^s only exists for parameters where $E(\omega|m = 1, P^L)\bar{\omega} \leq 1$, and a SRE^n only exist for parameters where $E(\omega|m = 0, P^L)E(\omega|x^n, SRE^n) \geq 1$. To be satisfied simultaneously, these conditions require:

$$E(\omega|m = 0, P^L)E(\omega|x^n, SRE^n) \geq E(\omega|m = 1, P^L)\bar{\omega}$$

However, $E(\omega|m = 0, P^L) < E(\omega|m = 1, P^L)$ (see equations 4.5 and 4.4), and $E(\omega|x^n, SRE^n) < \bar{\omega}$ (see previous proof). Therefore there are no parameters for which SRE^n and SRE^s both exist.

SRE^n requires $E(\omega|m = 0, P^H)E(\omega|x^n, SRE^n) \leq 1$ while URE^n requires $E(\omega|m = 0, P^H)E(\omega|x^n, URE^n) \geq 1$. For the equilibrium types to overlap would therefore require:

$$E(\omega|m = 0, P^H)E(\omega|x^n, SRE^n) \leq E(\omega|m = 0, P^H)E(\omega|x^n, URE^n)$$
$$E(\omega|x^n, SRE^n) \leq E(\omega|x^n, URE^n)$$

Which is false, therefore there are no parameters for which SRE^n and URE^n both exist.

Since URE^n requires a higher value of $\bar{\omega}$ (as a function of $\underline{\omega}, \pi_h, \pi_g, \pi_w$) than does SRE^n, and SRE^n requires a higher value of $\bar{\omega}$ does SRE^s, therefore there are no parameters for which SRE^s and URE^n both exist.

RE requires $E(\omega|m = 0, P^L)E(\omega|x^n, RE) \leq 1$ while URE^n requires $E(\omega|m = 0, P^H)E(\omega|x^n, URE^n) \geq 1$. For the equilibrium types to overlap would therefore require:

$$E(\omega|m = 0, P^L)E(\omega|x^n, RE) \leq E(\omega|m = 0, P^H)E(\omega|x^n, URE^n)$$

Which is false, because $E(\omega|m = 0, P^L) > E(\omega|m = 0, P^H)$ and $E(\omega|x^n, RE) > E(\omega|x^n, URE^n)$ when $\pi_w < \frac{1}{2}$. Therefore there are no parameters for which RE and URE^n both exist.

□

Department Effectiveness by Equilibrium

In general, the expected effectiveness of the department in equilibrium is:

$$\begin{aligned} E(Y) =& Pr(P^H, m = 1)E(Y|P^H, m = 1) + Pr(P^H, m = 0)E(Y|P^H, m = 0) \\ &+ Pr(P^L, m = 1)E(Y|P^L, m = 1) + Pr(P^L, m = 0)E(Y|P^L, m = 0) \end{aligned}$$

Where the probability of a high type chief receiving the signal m = 1 is: $Pr(P^H, m = 1) = Pr(P^H)Pr(m = 1|P^H) = Pr(P^H)Pr(\bar{\omega}) = \pi_g\pi_h$, and the probability of the low type chief receiving the signal m = 0 is: $Pr(P^L, m = 0) = Pr(P^L)Pr(m = 0|P^L) = (2-\pi_g)(\pi_w\pi_h + (1-\pi_w)(1-\pi_h))$. Therefore:

$$\begin{aligned} E(Y) =& \pi_g\pi_h E(Y|P^H, m = 1) \\ &+ \pi_g(1-\pi_h)E(Y|P^H, m = 0) \\ &+ (1-\pi_g)(\pi_h(1-\pi_w) + (1-\pi_h)\pi_w)E(Y|P^L, m = 1) \\ &+ (1-\pi_g)(\pi_w\pi_h + (1-\pi_w)(1-\pi_h))E(Y|P^L, m = 0) \end{aligned} \tag{12}$$

In a URE^s, the department effectiveness will be $\frac{1}{2}$, regardless of the chief type or signal m.

In a SRE^s the officer's equilibrium effort after observing the new policy is $\frac{\bar{\omega}}{2}$, so (12) simplifies to:

$$E(Y|SRE^s) = \pi_g\pi_h\frac{\bar{\omega}^2}{2} + \frac{1-\pi_g\pi_h}{2}$$

In a RE the officer's equilibrium effort is given by equation 4.1 and 4.7, so(12) simplifies to:

$$\begin{aligned} E(Y|RE) =& \frac{\left(\bar{\omega}\pi_h(\pi_g + (1-\pi_g)(1-\pi_w)) + \underline{\omega}(1-\pi_g)(1-\pi_h)\pi_w\right)^2}{2} \\ &+ \frac{\pi_g(1-\pi_h) + (1-\pi_g)(\pi_w\pi_h + (1-\pi_w)(1-\pi_h))}{2} \end{aligned}$$

In a SRE^n, officer effort in equilibrium will be: $\frac{\pi_h\bar{\omega}+(1-\pi_g)(1-\pi_h)\underline{\omega}}{2(\pi_h\pi_g+1-\pi_g)}$, so (12) simplifies to:

$$E(Y|SRE^n) = \frac{\pi_g(1-\pi_h)}{2} + \frac{(\pi_h\bar{\omega} + (1-\pi_g)(1-\pi_h)\underline{\omega})^2}{2(\pi_h\pi_g + 1-\pi_g)}$$

In an URE^n, the officer learns nothing from observing the new policy so his equilibrium effort will be $\frac{\pi_h\bar{\omega}+(1-\pi_h)\underline{\omega}}{2}$ and (12) simplifies to:

$$\mathrm{E}(\mathrm{Y}|\mathrm{UE}^n) = \frac{(\pi_h\bar{\omega} + (1-\pi_h)\underline{\omega})^2}{2}$$

Since $\bar{\omega} > 1$, $\mathrm{E}(\mathrm{Y}|\mathrm{SRE}^s) > \mathrm{E}(\mathrm{Y}|\mathrm{URE}^s)$, so where they overlap the SRE yields a higher department effectiveness.

$\mathrm{E}(\mathrm{Y}|\mathrm{SRE}^s) > \mathrm{E}(\mathrm{Y}|\mathrm{RE})$ in parameters where a SRE^s exists, so where they overlap the SRE yields a higher department effectiveness.

$\mathrm{E}(\mathrm{Y}|\mathrm{SRE}^n) > \mathrm{E}(\mathrm{Y}|\mathrm{UE}^n)$, so where they overlap the department is more effective in a semi-responsive equilibrium.

Extension: Officer Information

Officer Beliefs after m_2

The officer's equilibrium belief in the probability that ω is high after observing m_2 is: (need to add line references for where I pull A's belief after seeing x^n)

$$\begin{aligned}
\Pr(\bar{\omega}|x^n, m_2) &= \frac{\Pr(m_2|\bar{\omega}, x^n)\Pr(\bar{\omega}|x^n)}{\Pr(m_2|\bar{\omega}, x^n)\Pr(\bar{\omega}|x^n) + \Pr(m_2|\underline{\omega}, x^n)\Pr(\underline{\omega}|x^n)} \\
&= \frac{\Pr(m_2|\bar{\omega}, x^n)\frac{\pi_h\pi_g+(1-\pi_g)\pi_h(1-\pi_w)}{\pi_h\pi_g+(1-\pi_g)(\pi_w(1-\pi_h)+\pi_h(1-\pi_w))}}{\Pr(m_2|\bar{\omega}, x^n)\frac{\pi_h\pi_g+(1-\pi_g)\pi_h(1-\pi_w)}{\pi_h\pi_g+(1-\pi_g)(\pi_w(1-\pi_h)+\pi_h(1-\pi_w))} + \Pr(m_2|\underline{\omega}, x^n)\frac{(1-\pi_g)\pi_w(1-\pi_h)}{\pi_h\pi_g+(1-\pi_g)(\pi_w(1-\pi_h)+\pi_h(1-\pi_w))}} \\
&= \frac{\Pr(m_2|\bar{\omega}, x^n)[\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)]}{\Pr(m_2|\bar{\omega}, x^n)[\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)] + \Pr(m_2|\underline{\omega}, x^n)[(1-\pi_g)\pi_w(1-\pi_h)]}
\end{aligned}$$

In a RE, the quantity $\Pr(\bar{\omega}|x^n)$ is the same as the officer's posterior after observing x^n in the base model. (reference line), and the probability of the different signals m_2 depends on the particular signal.

$$\begin{aligned}
\Pr(m_2 = 1|\bar{\omega}, x^n) &= 1 - \pi_{wA} \\
\Pr(m_2 = 1|\underline{\omega}, x^n) &= \pi_{wA}
\end{aligned}$$

Substituting in the component pieces:

$$\begin{aligned}
\Pr(\bar{\omega}|x^n, m_2 = 1) &= \frac{(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w))}{(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + \pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w} \\
\Pr(\bar{\omega}|x^n, m_2 = 0) &= \frac{\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w))}{\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + (1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}
\end{aligned}$$

Since $\mathrm{E}(\omega|x^n, m_2) = \Pr(\bar{\omega}|x^n, m_2)\bar{\omega} + (1 - \Pr(\bar{\omega}|x^n, m_2))\underline{\omega}$, this gives:

$$\mathrm{E}(\omega|x^n, m_2 = 1) = \frac{\bar{\omega}(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}\pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}{(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + \pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}$$
$$\mathrm{E}(\omega|x^n, m_2 = 0) = \frac{\bar{\omega}\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}(1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}{\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + (1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}$$

Chief's beliefs

In general,

$$\mathrm{E}(\mathrm{E}(\omega|x^n, m_2)|m_1) = \Pr(m_2 = 1|m_1)\mathrm{E}(\omega|x^n, m_2 = 1) + \Pr(m_2 = 0|m_1)\mathrm{E}(\omega|x^n, m_2 = 0)$$

Where the two probabilities depend on the chief's type and the signal m_1.

The high type chief knows the true value of ω, so her beliefs are:

$$\Pr(m_2 = 1|m_1 = 1, P^H) = \Pr(m_2 = 1|\bar{\omega}) = 1 - \pi_{wA}$$
$$\Pr(m_2 = 1|m_1 = 0, P^H) = \Pr(m_2 = 1|\underline{\omega}) = \pi_{wA}$$

Thus, after observing m_1 the high type chief's expectation of the officer's effort in the second period is:

$$\begin{aligned}&\mathrm{E}(\mathrm{E}(\omega|x^n, m_2)|m_1 = 1, P^H) = \\ &(1-\pi_{wA})\left(\frac{\bar{\omega}(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}\pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}{(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + \pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}\right) \\ &+ \pi_{wA}\left(\frac{\bar{\omega}\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}(1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}{\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + (1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}\right)\end{aligned}$$

and

$$\begin{aligned}&\mathrm{E}(\mathrm{E}(\omega|x^n, m_2)|m_1 = 0, P^H) = \\ &\pi_{wA}\left(\frac{\bar{\omega}(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}\pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}{(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + \pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}\right) \\ &+ (1-\pi_{wA})\left(\frac{\bar{\omega}\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}(1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}{\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + (1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}\right)\end{aligned}$$

The low type chief's beliefs need to be weighted by the two possible values of ω:

$$
\begin{aligned}
\Pr(m_2 = 1|m_1 = 0, P^L) &= \Pr(m_2 = 1|\bar{\omega})\Pr(\bar{\omega}|m_1 = 0) + \Pr(m_2 = 1|\underline{\omega})\Pr(\underline{\omega}|m_1 = 0) \\
&= \pi_{wA}\left(\frac{\pi_w\pi_h}{\pi_w\pi_h + (1-\pi_w)(1-\pi_h)}\right) + (1-\pi_{wA})\left(\frac{(1-\pi_w)(1-\pi_h)}{\pi_w\pi_h + (1-\pi_w)(1-\pi_h)}\right) \\
&= \frac{\pi_{wA}\pi_w\pi_h + (1-\pi_{wA})(1-\pi_w)(1-\pi_h)}{\pi_w\pi_h + (1-\pi_w)(1-\pi_h)}
\end{aligned}
$$

Similarly,

$$
\Pr(m_2 = 1|m_1 = 1, P^L) = \frac{\pi_{wA}(1-\pi_w)\pi_h + (1-\pi_{wA})\pi_w(1-\pi_h)}{(1-\pi_w)\pi_h + \pi_w(1-\pi_h)}
$$

Therefore the low type's expectation of A's expectation of ω is:

$$
\begin{aligned}
&E(E(\omega|x^n, m_2)|m_1 = 1, P^L) = \\
&\left(\frac{\pi_{wA}(1-\pi_w)\pi_h + (1-\pi_{wA})\pi_w(1-\pi_h)}{(1-\pi_w)\pi_h + \pi_w(1-\pi_h)}\right)\left(\frac{\bar{\omega}(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}\pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}{(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + \pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}\right) \\
+&\left(\frac{(1-\pi_{wA})(1-\pi_w)\pi_h + \pi_{wA}\pi_w(1-\pi_h)}{(1-\pi_w)\pi_h + \pi_w(1-\pi_h)}\right)\left(\frac{\bar{\omega}\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}(1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}{\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + (1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}\right)
\end{aligned}
$$

and

$$
\begin{aligned}
&E(E(\omega|x^n, m_2)|m_1 = 0, P^L) = \\
&\left(\frac{\pi_{wA}\pi_w\pi_h + (1-\pi_{wA})(1-\pi_w)(1-\pi_h)}{\pi_w\pi_h + (1-\pi_w)(1-\pi_h)}\right)\left(\frac{\bar{\omega}(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}\pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}{(1-\pi_{wA})(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + \pi_{wA}(1-\pi_g)(1-\pi_h)\pi_w}\right) \\
+&\left(\frac{(1-\pi_{wA})\pi_w\pi_h + \pi_{wA}(1-\pi_w)(1-\pi_h)}{\pi_w\pi_h + (1-\pi_w)(1-\pi_h)}\right)\left(\frac{\bar{\omega}\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w)) + \underline{\omega}(1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}{\pi_{wA}(\pi_h\pi_g + (1-\pi_g)\pi_h(1-\pi_w) + (1-\pi_{wA})(1-\pi_g)(1-\pi_h)\pi_w}\right)
\end{aligned}
$$

With this, the parameters for which a RE exist can be solved for.

Responsive Equilibrium Conditions

RE existence conditions can be reduced to low type's IC constraint

Proof. A RE exists if and only if:

$$
\begin{aligned}
E(\omega|m_1 = 1, P^H) &\geq \frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^H)} \\
E(\omega|m_1 = 1, P^L) &\geq \frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^L)} \\
E(\omega|m_1 = 0, P^H) &\leq \frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^H)} \\
E(\omega|m_1 = 0, P^L) &\leq \frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^L)}
\end{aligned}
$$

I showed in the proof for Lemma 1 that $E(\omega|m_1 = 1, P^H) > E(\omega|m_1 = 1, P^L)$ and $E(\omega|m_1 = 0, P^H) < E(\omega|m_1 = 0, P^L)$.

Therefore the incompetent chief's incentive compatibility constraint guarantees that the competent chief will follow the responsive equilibrium strategy if the following hold:

$$\frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^H)} < \frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^L)}$$
$$\frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^H)} > \frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^L)}$$

Notice,

$$\begin{gathered}\frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^H)} < \frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^L)} \\ \implies E(E(\omega|x^n, m_2)|m_1 = 1, P^L) < E(E(\omega|x^n, m_2)|m_1 = 1, P^H) \\ \Downarrow \\ Pr(m_2 = 1|m_1 = 1, P^L)E(\omega|x^n, m_2 = 1) + Pr(m_2 = 0|m_1 = 1, P^L)E(\omega|x^n, m_2 = 0) \\ < Pr(m_2 = 1|m_1 = 1, P^H)E(\omega|x^n, m_2 = 1) + Pr(m_2 = 0|m_1 = 1, P^H)E(\omega|x^n, m_2 = 0) \\ E(\omega|x^n, m_2 = 0)\Big(Pr(m_2 = 0|m_1 = 1, P^L) - Pr(m_2 = 0|m_1 = 1, P^H)\Big) \\ < E(\omega|x^n, m_2 = 1)\Big(Pr(m_2 = 1|m_1 = 1, P^H) - Pr(m_2 = 1|m_1 = 1, P^L)\Big)\end{gathered}$$

This can be further simplified as follows:

$$\begin{aligned}Pr(m_2 = 0|m_1 = 1, P^L) - Pr(m_2 = 0|m_1 = 1, P^H) &= \frac{(1-\pi_{wA})(1-\pi_w)\pi_h + \pi_{wA}\pi_w(1-\pi_h)}{(1-\pi_w)\pi_h + \pi_w(1-\pi_h)} - \pi_{wA} \\ &= \frac{(1-2\pi_{wA})(1-\pi_w)\pi_h}{(1-\pi_w)\pi_h + \pi_w(1-\pi_h)}\end{aligned}$$

Similarly:

$$Pr(m_2 = 1|m_1 = 1, P^H) - Pr(m_2 = 1|m_1 = 1, P^L) = \frac{(1-2\pi_{wA})(1-\pi_w)\pi_h}{(1-\pi_w)\pi_h + \pi_w(1-\pi_h)}$$

Therefore:

$$\begin{gathered}E(\omega|x^n, m_2 = 0)\Big(Pr(m_2 = 0|m_1 = 1, P^L) - Pr(m_2 = 0|m_1 = 1, P^H)\Big) \\ < E(\omega|x^n, m_2 = 1)\Big(Pr(m_2 = 1|m_1 = 1, P^H) - Pr(m_2 = 1|m_1 = 1, P^L)\Big) \\ \implies E(\omega|x^n, m_2 = 0) < E(\omega|x^n, m_2 = 1)\end{gathered}$$

And this is true whenever $\pi_{wA} < \frac{1}{2}$.

Using similar steps:

$$\frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^H)} > \frac{1}{\delta E(\omega|x^n) + (1-\delta)E(E(\omega|x^n, m_2)|m_1 = 1, P^L)}$$
$$\implies E(E(\omega|x^n, m_2)|m_1 = 1, P^L) > E(E(\omega|x^n, m_2)|m_1 = 1, P^H)$$
$$\implies E(\omega|x^n, m_2 = 1) > E(\omega|x^n, m_2 = 0)$$

Which is true whenever $\pi_{wA} < \frac{1}{2}$. Therefore RE existence conditions can be reduced to low type's IC constraint $\square$

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