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Chakravarty, Shanti

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Judging Justice: Profiling in Policing Revisited

S. P. Chakravarty

Emeritus Professor of Economics

Business School, Bangor University, Gwynedd, Wales, LL57 2DG, UK

e-mail: s.p.chakravarty@bangor.ac.uk

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ABSTRACT:

Government rhetoric about unbiased policing in both the US and the UK sits uneasily with the practice of targeting disproportionately for scrutiny individuals belonging to certain minority groups in search of law breakers. Disproportionality may derive from profiling by group membership, reading evidence of the past to predict future behavior. If that exercise fails adequately to account for diversities within groups, interpretation of evidence becomes contaminated by prejudice, stereotyping individuals because of who they are thought to be and not what they are. If the interpretation of evidence is not clouded by prejudice against or animus towards any group, then profiling contributes to technical efficiency, also called efficiency, according to defenders of profiling. Profiling methods having come under attack for potential conflation of prejudice with probability of criminality, a strand of the literature in economics has emerged claiming to bypass the need to examine the profiling method to devise a statistical test for bias in policing. A test for efficiency as a test for the absence of bias is cleverly crafted not requiring knowledge of data and methods used in profiling. We argue that such a test cannot be a sufficient criterion because of what is missed out by the model. The cost to innocents of being targeted in search for the guilty and external costs which may give rise to endogeneity are ignored in the model. We construct numerical examples to illustrate that efficient strategies suggested by models which do not explicitly scrutinize profiling methods can result in troubled outcomes.

KEYWORDS: Racial bias; Group identity; Police search; Racial Profiling, Terrorism

JEL classification: K14, D6, H3, K4

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I. Introduction

Apprehension of criminals entails decisions about whom to investigate as a potential suspect, and there are different strategies open to law enforcement agencies. One of them is group-based profiling, justified by some as a necessity for devising efficient strategies for policing. This is controversial. The 1999 Clinton Order in the US against racial profiling states that it is a "morally indefensible, deeply corrosive practice" (quoted in Knowles et al 2001:204). A similar sentiment was expressed by President George W. Bush in his first address on the 27th of February 2001 before a joint session of Congress (Bush 2001): "It's wrong, and we will end it in America". Sharply critical comments on racial profiling also feature in the reports of judge-led enquiries on policing in the UK (Scarman 1981, McPherson 1999). While we focus on racial profiling, the arguments presented here apply also to profiling based on other characteristics, eg religious affiliation or class, which are known to occur (EPW 2006, Stuntz 2002).

Disquiet about profiling arises because of potential for the emergence of bias, due either to prejudice against or to animus towards certain groups in the selection of data and in the method of analysis. A strand of the literature in economics attempts to bypass the need to estimate group-wise probabilities of criminality in developing tests for efficient policing which is characterized as unbiased policing. A powerful critique of both the efficiency argument and the profiling exercise can be found in the literature (Harcourt 2004). We expand on the critique and scrutinise assumptions entailed in economic models articulating tests for the absence of bias as tests for efficiency. In these types of models, there is a failure to account for externalities, some of which become endogenous to police strategy, in the calculation of efficiency. The failure to account for targeting innocents in search of the guilty is especially problematic. We illustrate these arguments by constructing numerical examples to make a case against the reliance on efficiency tests to ascertain the absence of bias.

Targeting members of one group for investigation more often than members of another

group amounts to placing a disproportionate burden on members of the first group. The question is whether that adverse treatment can be construed as manifestation of prejudice or bias against the first group.¹ This question has long been the subject of debate in the literature on profiling (Borooah 2001, Harcourt 2004, 2006, 2007, Knowles et al 2001, McConville et al 1991, 1997, Smith 1997). Some criminologists argue that evidence-based profiling can enhance police efficiency without necessarily introducing bias in policing (Smith 1997). Profiling borrows from actuarial methods of prediction and shares their shortcomings (Harcourt 2007)². One of the difficulties of predictions by racial profiling is the problem of distinguishing between predictions informed purely by evidence and those tainted by prejudice in the way that past evidence is selected and interpreted to predict future behavior. If there are more than one way of achieving efficiency, the choice of an efficient strategy could be deliberately skewed against a group, targeting a higher proportion of innocents in the group for scrutiny in policing. Detailed knowledge of police strategy is required for rational discourse on the methodological concern about the profiling process.

The proposition that a test for efficiency can be cleverly crafted to bypass the need to examine the process of profiling is attractive because the test is simple. It has gained currency, but it is flawed. Strategies focusing on efficiency from the perspective of the police, apprehending the largest number of offenders with the least cost, do not take account the cost to innocents being targeted in pursuit of efficiency in policing (Chakravarty 2002, Dominitz 2003, Harcourt 2004). We find that models which claim to bypass the need to scrutinize the process of profiling entailed in testing for efficiency rely on a narrow remit for economics as a tool for analysing social problems that does not engage with the essential complexity of issues which arise in racial profiling.

Economic models which bypass the problem of scrutinising methods of profiling in policing to devise tests for the lack of bias require assumptions about functional forms

¹ Prejudice, animus, and bigotry are lumped together into one word, bias, in most of the rest of the paper.

² “The purpose of this article is to demonstrate [that] the problem is about profiling, not about race...” (Harcourt 2004:1282).

of payoffs (eg diminishing marginal cost) which are unobservable without detailed knowledge of how the police arrive at a view about the costs and benefits of strategies. The models are aimed to get an efficient strategy that is unique. If assumptions leading to the existence of a unique efficient point are discarded, it is possible to construct numerical examples where the strategy of least cost apprehension of law breakers can co-exist with the outcome of innocent members of a particular group being deliberately targeted more assiduously for investigation.

The paper is organized as follows. Section II outlines a brief background to the debate about police strategy even during periods when group-based profiling is not explicitly in operation. Section III introduces two different ideas of discrimination considered in the literature in utilitarian economics³ to distinguish between data-driven discrimination which is claimed to be needed for efficient policing and discrimination which indicates bias against specific groups. Section IV outlines an approach to modelling based on the postulate of maximising behavior of economic agents to test for efficient outcome. Efficiency is an equilibrium of behavioural decisions by police and law breakers. Section V examines the efficiency condition as an equilibrium in a game between utility maximising police and law breakers to derive a test for the absence of bias (eg Knowles et al 2001). The test for efficiency requires only data on the hit ratio, the proportion of guilty amongst those that are targeted, parsed by race. This approach bypasses the need for scrutiny of profiling, although profiling is implicit in the model, to derive the above test. The model entails assumptions about functional forms entering the game which are not tested against data to ascertain validity. Section VI provides numerical illustrations modifying some of the above assumptions to illustrate that race neutrality of the hit ratio may not be a sufficiency test for the absence of bias. Section VII concludes. Algebra is kept to a minimum in the text of the paper to appeal to a wider audience than economists and algebraic formulations are largely relegated to appendices at the end of the paper.

³ Utilitarian economics is also interchangeably called neo-classical economics and utilitarian economics.

II. Background

Claims to legitimacy of the criminal justice system entail that any differential treatment arising out of profiling by groups is non-discriminatory, in that it does not result in worse treatment being meted out to an individual from one group than a person from another simply because of membership of the group. Problems of legitimacy and fairness are placed in focus if police practice is perceived as displaying either animus towards certain groups or systemic prejudice against these groups in the selection or interpretation of objective evidence about law breaking. Concern has often been expressed that procedural justice may have been denied to visibly identifiable minorities in the pursuit of law breakers (Aust et al 2001, Bowles and Phillips 2007). This issue was discussed in a judge-led enquiry headed by Sir William McPherson (McPherson 1999) on policing in London. Worries which gave rise to the investigation of police practice in London are not unique to the UK. We quote from the McPherson report simply to illustrate arguments in society about allegations of racial bias in policing⁴.

The report highlighted the existence of prejudice, a tendency to act on stereotypes, which gives rise to racism. An earlier judicial report chaired by Lord Justice Scarman in 1981 put forward the argument (approvingly quoted in Para 6.10 McPherson 1999) that racial animus is not needed for biased policing to occur.

"Racial prejudice does manifest itself occasionally in the behavior of a few officers on the street. It may be only too easy for some officers, faced with what they must see as the inexorably rising tide of street crime, to lapse into an unthinking assumption that all young black people are potential criminals".

⁴ McPherson alludes to the possibility of some junior police officers holding negative views of suspects simply because of their race, survey results suggests that the problem may not be confined either to junior officers or to a small number of officers. Bowling and Phillips (2007:955) cite evidence that "Prejudice is not limited by rank; nor is it a mere artifact of the past." They quote from a study conducted by Her majesty's Chief Inspector of the Constabulary and reported to government in 1997:

"There was continuing evidence during Inspection of inappropriate language and behavior by police officers, but even more worrying was the lack of intervention by sergeants and inspectors."

It does not matter if individual police officers set out to work without animus towards any group of people. Policing can be biased if officers are too eager or too “unthinking” to interpret evidence in stereotypes⁵. If it is indeed the case that the canteen culture, what is said privately amongst officers, manifests unconscious bias stereotyping individuals as prone to commit crime simply because they are black (McPherson 1999 Para 6.11), this will contribute to a legitimate perception of the unfairness of stop and search decisions as applied to black people in public spaces⁶.

The McPherson report accused Metropolitan Police, the police force in London, of “institutional racism” (McPherson 1999, Para 6.5), defined as racism inherent in the way an institution operates even if the institutional mechanisms are not set up explicitly to promote racial bias. This is not a new debate although the term ‘institutional racism’ did not come into widespread general use in the UK before McPherson. However, institutional failure in the criminal justice system is not a new focus of the literature. Allegations that the criminal justice system targets socially disadvantaged groups -- whether based on class, religion, or race -- for worse treatment have long been raised in the literature. For example, Sanders (1985) cites evidence that crimes which are more likely to be committed by middle class people are not prosecuted as often as crimes committed by members of the working classes in Britain. This argument was further developed by Sanders and colleagues (McConville et al 1991) leading on to debates about discrimination against visibly identifiable groups (Bowling and Phillips 2007) profiled for special attention. Targeting by the police of individuals based on group identity is often justified by some if the decision to target is informed by objective evidence (Smith 1997). That argument opens a new debate about the methodology of interpreting evidence for profiling⁷.

⁵ Stereotypes fail to recognize diversities within diversities.

⁶ McPherson’s concern, although illustrated using an example of explicit stop and search rules (*sus laws*), is not limited to the application of these rules. Even in the absence of explicit recourse to stop and search powers, concern arises as to how individuals are chosen for investigation when they are in public space (Aust et al 2001).

⁷ Even unbiased police officers could misread signals of behaviour following unbiased decisions (Bunzel and Marcoul 2008).

This debate has parallel to attempts in economics at separating discriminatory treatment that is dictated by evidence-based search for efficiency and treatment that is due to animus or prejudice. The objective evidence defence does not provide any answer to the question of how to interpret evidence to rule out bias, whether conscious or unconscious. What may appear to be the objective probability of offending may be endogenous to the nature of policing, as illustrated by way of a numerical example by Harcourt (2004: 1301-1302). Aggressive detection policies can lead to a greater number of innocent people from one group over another being harassed (Chakravarty 2002, Dominitz 2003).

Due to lack of consensus about the method of separating statistical discrimination from bias, regression analysis has been used by economists to look for correlation between race and impacts of institutional decisions. For example, Munnell examines the success of mortgage applications and the race of the applicant in a multi-variate regression model (Munnell et al 1996). However, attempts at ascertaining whether any observation of disparate treatment between races is due to race or some other omitted variable raises questions about the nature of proxy data used in regression exercises (Knowles et al 2001:205):

“... the validity of this type of test for discrimination hinges crucially on judgments about what constitutes a set of admissible conditioning variables and on whether the analyst has access to the full set of variables.”

In recent years models of social and economic behavior informed by utilitarian theories in economics have been proposed by, *inter alia*, Becker (1976) and promoted muscularly by others (Becker 1976, Lazear 2000). An elegant model along these lines is discussed presently (Knowles et al 2001) which dispenses with the requirement of scrutinizing the method of profiling to articulate a statistical test for the absence of bias in policing. Their parsimonious requirement for data is a strength of the above approach, but we point out its weaknesses.

III. Two concepts of discrimination

To understand the main points of contention, it is necessary to recognize that a major aspect of the debate in neo-classical economic models of group-based discrimination concerns the delineation of the boundary between two types of discrimination in the economics literature: statistical discrimination and bias. The second type lumps together two different ideas -- prejudice and animus -- as bias. Statistical discrimination was originally suggested in the literature in labor economics (Arrow 1972, 1973; Phelps 1972). For example, Phelps argues that if employers are not familiar with qualifications offered by women and minorities, the selectors may put a larger variance on the score measuring these qualifications.⁸ This can then contribute to labor market discrimination against applicants from these groups, but that type of discrimination cannot be construed as bias because it is entailed in arriving at an economically efficient decision under uncertainty.

In a sweeping broadside on the methodology of sociology, Becker (1971, 1993) lumps together prejudice, animus, and bigotry into a single variable, taste for discrimination. This taste variable, which can also be construed as bias, enters as an argument within utility functions. Being a non-economic variable, it imposes an economic cost on decisions if utility functions contain bias. In the absence of non-economic variables like taste for discrimination in the objective functions being optimised by economic agents, any discrimination which might arise is statistical discrimination in pursuit of efficiency on the other hand optimises cost to allow efficient deployment of resources. This idea is carried into economic models testing for discrimination in policing.

As explained by Knowles et al (2001: 205), even unbiased police “may use race as a criterion in traffic stops because they are trying to maximize successful searches and

⁸ This is a problem that is encountered not just in interpreting data in labor economics but in a wider range of decisions under uncertainty, for example in lending money (Munnell et al 1996, Chakravarty 2006).

race helps predict criminality or because they prefer stopping one racial group over another.” The proportion of groups searched may not be identical to the proportion of the population belonging to these groups. This outcome, disproportionality in search, it is argued, is not necessarily evidence of bias. Only if the outcome is not efficient, then there could be bias. That is the underlying premise of their test for economic efficiency as a test for the lack of bias in the deployment of resources for policing⁹. There are behavioural assumptions which are not subjected to sceptical scrutiny.

IV. Models of behavior

Economic models of crime using utilitarian ideas and optimization techniques would be in keeping with a long tradition in economics, attempting to explain "behavior without reference to anything other than [observed] behavior" (Little 1949: 97). In an article extolling the virtues of this type of economic models, Lazear puts the claim thus (Lazear 2000:99-100):

“...during the last four decades, economics has expanded its scope of enquiry as well as its sphere of influence. Neither luck nor the charm of economists is responsible for the change. Rather, the ascension of economics results from the fact that our discipline has a rigorous language that allows complicated concepts to be written in relatively simple, abstract terms. The language permits economists to strip away complexity. Complexity may add to the richness of description, but it also prevents the analyst from seeing what is essential.”

These ideas robustly state views deriving from Gary Becker (1976). This approach to modelling police strategy to ascertain bias in policing attempts to devise an empirical test that is parsimonious on the requirements for data. The need to examine motive, considered essential by lawyers in criminal justice, is a non-essential complexity which is dispensed with by lumping together prejudice and animus to define bias. Surveys and

⁹ Emily Badger (2020) reports psychological trauma suffered by young people subjected to stop and frisk policies. These costs do not figure in the idea of efficiency in economic models like those mentioned here.

interviews with participants which might help in interpreting observed proxy data and could help illuminate feedback effects on the perceptions of costs are ruled out not just as being outside the scope of economics but as a distraction preventing “the analyst from seeing what is essential”.

An assumption central to much of economic analysis in the above framework when applied to criminal justice is that each of the parties -- police and potential law breakers -- maximize some objective function of their own, subject to their own understanding of the constraints. Lazear again (2000:100):

“Economists, almost without exception, make constrained maximization the basic building block of any theory. Many of our empirical analyses seek to test models that are based on maximising behavior.”

These objective functions are not modified through social interactions and perceptions of costs and benefits do not evolve through experience. The functional specifications of utility are restricted to allow for an equilibrium to emerge from maximising behavior.

We discuss here a model in the above genre of the interdiction of black and white motorists for contraband (Knowles et al 2001). The parties, police officers and potential law breakers, are postulated to maximize the expected values of their respective objectives anticipating how the other party would respond. Whatever information is knowable is known to all. The model devises a test to examine if the interdiction policy is racially biased. The proposed test cleverly bypasses any examination of the method by which motorists are profiled by race. In our view the test thus designed misses out on essential complexities of racial profiling. This line of modelling also assumes shapes of objective and probability functions being compatible with the existence of a unique equilibrium outcome.

In a static model like the one mentioned above, players maximize their respective

objectives simultaneously and not sequentially.¹⁰ Social interactions are not relevant. There is no private information, eg potential law breakers and the police have the same knowledge about detection and contravention probabilities. The model is not dynamic, and all decisions can be considered as instantaneous. This is a one-shot game. If the objective of the police is to minimize the cost of apprehending law breakers, and the objective is not contaminated by non-economic considerations like racial bias, the equilibrium outcome is an outcome of efficient use of resources. The question of whether there is bias in police strategy boils down to asking if the outcome is efficient. The idea of efficiency does not account for the external cost of pursuing efficiency even when the strategy employed could impact on the cost of policing, thereby impacting on the efficiency metric itself.

An attraction of the model (Knowles et al 2001) is that the data requirements for testing for efficiency are modest. Thus, any profiling by race which might go into the cost function of the police need not be scrutinized explicitly, bypassing difficult questions about the method of racial profiling which may inform the perception of the cost of different strategies through psychological or feedback effects. Discussion about social interactions and psychological effects in empirical economics are difficult because they are based on statistical methods using proxy data without additional investigation to scrutinize them to make sense, for example by collecting supplementary interviews and surveys.

In the one-shot game proposed in the above model, motorists and the police adjust their behavior instantaneously in response to their belief about the responses of each other. In deciding whether to carry contraband, motorists compare their expected utility gain if allowed to proceed undetected with the expected utility loss if interdicted.¹¹ The model allows for the utility values of gains and losses to be perceived differently by different motorists, even of the same race, depending on their personal circumstances. The police decide whom to interdict based *inter alia* on the characteristics, which may

¹⁰ We use “objective” and “utility” interchangeably.

¹¹ Anyone carrying contraband, if interdicted, is assumed to be detected as carrying contraband.

include race¹², of drivers. If the objective of the police is to apprehend criminals whatever their race, the objective function contains no taste for discrimination. It is then free of bias. If that is the case and race is included as a variable in formulating police strategy, the inclusion is construed simply as a factor in search for efficiency.

The efficiency point of interdiction obtains when the expected utility gain for the police from searching another motorist is the same as the expected utility cost of searching the extra motorist.¹³ If the assumption of the absence of a taste for discrimination obtains, and there is diminishing marginal utility of search, the expected utility gain at the above efficient point from searching a motorist at the margin is independent of race. On reaching the efficient point, searching a person from one subgroup for interrogation should not yield a "higher return" than searching a member of another subgroup (Knowles et al 2001: 206).¹⁴ We call this the condition of equal return (CER) between races in any search at the margin at the point of efficient equilibrium. If CER obtains, as the argument above goes, the hypothesis of police bias in their interdiction strategy can be rejected. The hypothesis cannot be rejected if CER does not prevail. When CER obtains, the hit rate is found to be the same for both races. The hit rate is the proportion of motorists found with contraband amongst those that are interdicted. When parsed by race, it is the same for both races when CER obtains.

V. Condition of equal return

Continuing with the example above, suppose that motorists can be classified into two visibly distinguishable groups, called races, $r = B$ and W . There is a potential gain to motorists in carrying contraband if not caught. All cars that are interdicted are searched. Success to the police of a search operation is the hit, discovery of contraband. Motorists

¹² Other indicators may include the type and registration of vehicles and whatever else the police may consider relevant.

¹³ Implicit in this sentence is the assumption made without examining data on the specifics that there is a diminishing benefit of interdicting motorists. Derivation of the efficiency condition requires that assumption.

¹⁴ Despite the use of phrases like "continue to interdict", "on reaching", there is no time in the model. Everything happens instantaneously. The dynamic process of reaching the equilibrium is not considered.

decide whether to break the law by maximising the expected gain from doing so. The objective of the police in deciding whom to interdict, if police officers are free of bias, is to minimize police resources required to detect crime. The decision criterion includes a set of characteristics of the motorist, one of which is race. “Let c denote all characteristics other than race that are potentially used by the officer in the decision to search cars.” (Knowles et al 2001:209).¹⁵ These unobservables are lumped together as a single scalar variable. Taking the reader through the steps to arrive at the efficient equilibrium, Knowles et al (2001) demonstrate that the data required for testing whether efficiency obtains at equilibrium is modest. Unrecorded or unobservable characteristics which are lumped together into the above scalar c are integrated away in the optimization exercise.¹⁶ The efficiency condition is that the hit rate (also called hit ratio), $H(r)$, is equal between races $r = W$ and B . The hit rate is defined as below:

$$H(r) = \frac{S(r)}{I(r)} \quad 5.1$$

where $r = B, W$. $I(r)$ and $S(r)$ are, respectively, the number of motorists interdicted and the number of those also found in possession of contraband when interdicted. Note that the number of motorists, $N(r)$, travelling on the road does not appear in the expression above. The expression 5.1 can be re-written to include $N(r)$, for $r = B, W$, as follows.

Define $P(r)$ as the proportion of motorists of group (race) r that are interdicted.

$$P(r) = \frac{I(r)}{N(r)} \text{ where } r = B, W \quad 5.2$$

Now re-write the hit rate in Equation 5.1 by dividing both the denominator and numerator by $N(r)$, and then re-arranging terms using Expression 5.2 above.

$$H(r) = \left\{ \frac{S(r)}{N(r)} \right\} / P(r) \text{ where } r = B, W \quad 5.3$$

If CER obtains,

$$H(B) = H(W) \quad 5.4$$

¹⁵ The police decision may, for example, be influenced by the type of car being driven and the age and gender of the driver. These may not be recorded.

¹⁶ But note than the implicit assumption about the shapes of functions needed to guarantee the existence of an equilibrium remains without empirical scrutiny. We produce empirical illustrations of plausible decision models where this assumption is not made. Different efficiency conditions could then obtain.

Condition 5.4, if satisfied, rejects the hypothesis of police bias. By combining 5.3 and 5.4, this condition can also be expressed as

$$\frac{\{S(B)\}}{N(B)}/P(B) = \frac{\{S(W)\}}{N(W)}/P(W) \quad 5.5$$

Note some interesting features of the above equality. For Equation 5.5 to hold, there is no need for the numerator, $S(r)/N(r)$, to be race neutral. The number of motorists targeted for interdiction need not be equal for both races if $P(r)$, the probability of offending, is not identical between races. In testing whether Equation 5.5 holds, we need only to test if Equation 5.4 holds. To do that, no data is required about how the police may have come to believe in a particular set of values of offending probabilities $\{P(B), P(W)\}$. Therefore, any observation of racial disproportionality in targeting individuals in crime detection is not necessarily evidence of police bias. Further, in deciding whether to reject accusations of bias, one does not need information about how police profile individuals to assign characteristic-based, one of the characteristics could be race, probabilities of offending. From this perspective, judges like Sir William McPherson (McPherson 1999, Para 45.9) are barking up the wrong tree in search for racial bias in policing by focusing on figures published by government (circa 1998) that “*black people were, on average, five times more likely to be stopped and searched by the police than white people*”. What matters are the hit rates, $H(W)$ and $H(B)$. The exposition in Appendix A outlines the main steps needed to arrive at the result above.

Testing for the absence of bias focusing on the hit ratio appears attractive at first sight especially because the test is light on data requirement. But it is too attractive to provide a satisfactory analysis of a complex phenomenon. Especially problematic is the information that is not considered, data on innocents that are interdicted. Now consider another ratio, $U(r)$ defined below.

$$U(r) = \frac{F(r)}{N(r)}, r = W, B \quad 5.6$$

Where $F(r)$ is the number of innocent (faultless) members of Group r that are

unfortunately interdicted. $U(r)$ is the fraction of the innocent members of Group r as a proportion of the number of motorists $N(r)$ in that group.¹⁷ This, in our view, is an important ratio. It just so happens that in the Knowles et al (2001) model, the equilibrium is unique and there is only one hit ratio at the equilibrium. Therefore, there is only one set of $\{U(W), U(B)\}$ associated with that equilibrium hit ratio. Assumptions implicit in the model to ensure the existence of a unique equilibrium efficient condition are highlighted in Appendix A by following the derivation of the efficiency result.

When there is only one efficient point defined by the hit ratio $H(r)$ being race neutral, there follows only one ratio $U(r)$ which may or may not be race neutral. Police do not have an opportunity to choose a value of $U(r)$ when seeking efficiency.

An investigation of $U(r)$ becomes necessary in establishing whether there is police bias if there is a choice of more than one condition guaranteeing efficiency. We cannot just assume away the problem by postulating behavior leading to a unique solution in search for efficiency. If the empirically untested assumptions about the shape of functions in the model are dropped, there can be more than one efficient point and associated values of $U(r)$. Then it is open to the police to choose $U(B)$ and $U(W)$, depending on police officers' taste for discrimination, in ranking the different efficient points. Efficiency alone is then not a sign of lack of bias in the choice of police strategy. That is explained by way of numerical illustrations below.

VI. Numerical illustration going beyond CER

Consider the following exercise. Suppose that police and potential law breakers independently decide on their respective strategies without trying to anticipate how the other side would react. Take a subset of the possibilities of the type of motorists who travel on the road. For this subset, the probability of offending is race neutral and equal.

¹⁷ In decisions under uncertainty, there are two types of errors which can be made (Chakravarty 1993). We denote innocents by the letter F, faultless, because the letter I has been used for interdiction. The letter U denotes unfortunate.

This is also a non-dynamic case in that there is no sequential behavior. In this framework, there could be more than one efficient strategy for the police as illustrated in the first numerical example below. Different efficient points can also give rise to fractions of innocents being targeted being dependent on race. That disproportionality can arise by design in the choice of the efficient point, there is more than one such point in the illustration (Case 1) below, in law enforcement. This brings into sharper focus that the lack of bias in police strategy cannot be based exclusively on a test for efficiency.

When the interdependence between targeting potential criminals and innocent individuals is considered together in the economics literature (eg Dominitz 2001, Borooah 2002), that is done as a normative question of trade-off. Our illustrative example below (Case 1) suggests that the problem of ignoring detention rates of the innocent is not just a normative issue which could be kept in abeyance in constructing statistical tests for the absence of racial bias in police strategy. If there are more than one efficient point, information about the detention rate of innocents is a logical requirement for developing tests for the absence of bias. Even if there is only one efficient point, Case 2 brings into sharper focus another problem with an equilibrium one-shot model of policing to derive the efficient point. In Case 2, law breakers of one group can be given *carte blanche* to offend without compromising on efficiency.

Case 1:

Consider the case of motorists that are indistinguishable from each other except being observationally different. The assumption implies that the two groups have equal propensity to offend.¹⁸ The difference boils down to motorists being categorized in two observationally distinguishable groups, blacks (B) and whites (W). There are 200 motorists, 100 each of the two races, B and W, and they travel in no discernible order. Now further assume that there is a 50 per cent chance of an interdicted motorist of any

¹⁸ Equal probability of offending assumption can be disposed if it is assumed that the probability of someone at the margin being an offender is the same between races, as we discuss in Appendix B.

race being found in possession of contraband.¹⁹ Suppose that the police budget allows for searching only half of the total population of 200 motorists. There is money to interdict 100 motorists in total.

Now consider two strategies for the police to choose from in deciding whom to interdict: Policy 1 and Policy 2. Policy 1 is to interdict randomly a total of 100 motorists. Policy 2 is also to stop a total of 100 motorists but proportionately more motorists from one group than the other. We retain “[t]he key implication of the model is that if a police officer has the same cost of searching two subgroups of the population and if these two subgroups are searched at equilibrium, then the returns from searching will be equal across the subgroups” (Knowles et al 2001: 206). Both policies lead to 50 offenders being stopped. They are both efficient. The consequences of these two policies are tabulated in tables 6.1 and 6.2 below.

We find that $H(r)$ is the same for $r = W, B$ under both policies. While under Policy 1, both $H(r)$ and $U(r)$ are race neutral, $U(r)$ is not neutral under Policy 2. Race independence of $H(r)$ is no guarantee that police strategy is free of bias.

¹⁹ Case 2 considers a different illustrative example where Black motorists are more likely than White motorists to carry contraband.

Table 6.1: Policy 1: Randomly stop a total of 100 motorists

	r = W, B, (W+B)		
	W	B	Total
Number of motorists on the road	100	100	200
Number carrying contraband	50	50	100
Number stopped	50	50	100
Number found with contraband	25	25	50
Number of innocents stopped	25	25	50
	H(r)		
	25/50=0.5	25/50=0.5	
	U(r)		
	25/100=0.25	25/100=0.25	

Table 6.2: Policy 2: Stop a total of 100 motorists with greater emphasis on stopping Black motorists

	r = W, B, (W+B)		
	W	B	Total
Number of motorists on the road	100	100	200
Number carrying contraband	50	50	100
Number stopped	40	60	100
Number found with contraband	20	30	50
Number of innocents stopped	20	30	50
	H(r)		
	20/40=0.5	30/60=0.5	
	U(r)		
	20/100=0.2	30/100=0.3	

Policy 1 is color blind and randomly interdicts motorists. This policy targets 100 motorists and yields on average 50 offenders in total. The policy would, on average,

interdict 50 motorists and yield 25 offenders (hits) of each group. The hit ratios $H(B)$ and $H(W)$ will on average be equal and 0.5, satisfying CER and, hence, the efficiency condition. Of the 50 motorists of each group that are stopped, 25 on average will be found innocent. There are 100 motorists belonging to each race and Therefore, $U(B)$ and $U(W)$ are also equal and take the value 0.25. There is no race premium, a penalty, on being innocent and becoming a target of interrogation.

Policy 2 is not color blind. There is a disproportionate focus on stopping one group in search for contraband. Of the total of 100 motorists interdicted, 60 are B and only 40 are W. This policy would also yield on average 50 offenders in total, the same as Policy 1. Of the motorists stopped for searching their car, on average 30 B and 20 W motorists, respectively, are found to carry contraband. The hit ratios $H(B)$ and $H(W)$ are again, as in Policy 1, equal. However, now more innocent amongst B motorists in the total population of B motorists are interdicted under Policy 2. On average, 30 B motorists out of a total population of 100 such motorists are stopped for interrogation. The corresponding figure for W is 20 out of 100. Thus, $U(B)$ and $U(W)$ are $3/10$ and $2/10$, respectively. There is a race premium. More innocent motorists from B group can be targeted, even deliberately, for interrogation without deviating from efficiency in outcome. The excess burden on innocent motorists simply because of their race cannot be justified by “business necessity”, to borrow a phrase to describe statistical discrimination without racial bias (Borooah 2001).

Both the above police strategies are efficient and unbiased, if we accept the test of being unbiased as being efficient as defined earlier. We can create a jargon, bias, and define lack of bias accordingly. But the jargon does not capture the meaning of bias as that word is generally understood. Even if the police deliberately choose Policy 2 over Policy 1 because of animus towards a particular race, no racial bias in policing would be detected if only the efficiency condition is examined. A more general proof is shown in Appendix B below. Testing for the absence of bias in policing by reference only to technical efficiency is not helpful. This is a problem repeatedly flagged up by lawyers (McPherson 1999 Para 45.9).

Case 2:

Again, suppose that the total number of 200 motorists is equally divided between the two groups as in Case 1, but now allow the propensity to break the law to be race dependent. Assume that the likelihood of one group (B) of motorists breaking the law is 60 per cent but that of the other group (W) is only 40 per cent., there is a total of 100 (40 W and 60 B), law breakers to be found if all cars are interdicted. As in Case 1, assume that there is enough resource available for the interdiction of only 100 motorists in total. Then the efficient interdiction policy is to use up the entire resource to stop one group of motorists, letting off scrutiny law breakers from the other group. Note that this conclusion is not dependent on the probability of offending by B and W motorists being 0.6 and 0.4, respectively. The exclusive focus on one group of motorists will obtain as an efficient strategy even if the probability of offending by that group is only infinitesimally greater than that of the other group of motorists. $H(r)$ is not race neutral.

Table 6.3: Stop a total of 100 motorists to yield 60 offenders

	r		
	W	B	Total: W+B
Number of motorists on the road	100	100	200
Number carrying contraband	40	60	100
Number stopped	0	100	100
Number found with contraband	0	60	60
Number of innocents stopped	0	40	40
	$H(r)$		
	n/a	60/100=0.6	
	$U(r)$		
	0	40/100=0.4	

Now reconsider the example in the table above with a different twist. Suppose that there

is enough money to stop 150 motorists. An efficient strategy would be to net 80 offenders, the maximum possible through the interdiction of 150 motorists. The efficient strategy is detailed below.

Table 6.4: Stop a total of 150 motorists to yield 80 offenders

	r = W, B, (W+B)		
	W	B	Total
Number of motorists on the road	100	100	200
Number carrying contraband	40	60	100
Number stopped	50	100	150
Number found with contraband	20	60	80
Number of innocents stopped	30	40	40
	H(r)		
	20/50=0.4	60/100=0.6	
	U(r)		
	30/50=0.6	40/100=0.4	

Since the rate of return to the police of stopping a motorist at the margin is assumed in our illustrative examples to be independent of the number of motorists already stopped, and the probability of offending is not the same between the two races, H(r) is not race neutral. Interestingly, U(W) is greater than U(B) in Table 6.4.

The result in Table 6.3, where efficiency dictates that members of only one race should be interdicted, and Table 6.4, where efficiency dictates that the W motorists should be interdicted only if there are no more B motorists to interdict, would obtain even if the difference between the offending rates of the two groups were infinitesimally small but finite. The signal that the outcome above sends out with potential to modify law breaking behavior does not appear in one-shot models.

Now, it might be argued that the exercises above assume that the probability of offence

is related only to race. The model proposed by Knowles et al, on the other hand, does contain other characteristics of drivers than race. All the characteristics other than the race of the driver – for example, the age of the driver, if the car has “tinted windows” (Knowles et al 2001:215) – are lumped together into a single variable which appears in the model. What enters c “hinges crucially on judgments about what constitutes a set of admissible conditioning variables” (Knowles et al 2001: 205). The selling point of their exercise lies in the model being so formulated as to allow c to be integrated away in finding the efficiency criterion used to test for the absence of bias in policing. This is not how things happen. Knowledge of the conditioning variables is essential to understand the idea of bias in policing. For example, it transpired at a recent court case in London discussed below that how two individuals greeted each other, one such conditioning variable, was the critical factor in profiling in that instance about drug dealers. The court did not find the explanation of the police acceptable as to why the nature of greetings (bumping fists) was used to profile the suspects who turned out to be innocent.

Allowing c to be integrated away in devising a test for the absence of racial bias is indeed clever, but misleading as a policy tool. The following illustration demonstrates that an efficient interdiction policy need not be unique even when characteristics other than race are included in the model. In Case 3 below, we consider two policies of arriving at efficient points. Under both policies, efficiency points are characterized by $H(B)$ being equal to $H(W)$, but the corresponding $U(r)$ is not race neutral at one of these efficient points. The police can choose either of the efficient points, depending on their taste for discrimination.

Case 3

There is a difference in the way we introduce c into the model from the way that it is done in Knowles et al (2001). The probability of breaking the law is not a continuous function of c in the example here. There are two values of c : c_1 and c_2 . Motorists are categorized by race and c . So an individual falls into one of the four descriptive

categories: (B, c_1), (B, c_2), (W, c_1), (W, c_2). The probability of an individual breaking the law depends on the category into which the person fits. In this example, the total number of motorists is equally divided between B and W, but the proportion of each race representing categories c_1 and c_2 is not equal. For example, if c represents “tinted windows”, to borrow a phrase from Knowles et al (2001:215), c_1 might be light tint and c_2 might be dark tint. Tables 6.5-6.7 define the structure here.

Table 6.5: Probability of offending by four descriptive categories

	W	B
c_1	0.2	0.6
c_2	0.5	0.2

Table 6.6: Proportion of B and W population by c_1 and c_2

	W	B
c_1	0.6	0.3
c_2	0.4	0.7
$c_1 + c_2$	1.0	1.0

Suppose that 400 motorists travel on average on the highway in random order and they are equally divided between B and W. Applying tables 6.5 and 6.6, we can write:

Table 6.7: Number of motorists, offenders, and innocents by category

Motorists	W	B
Total	200	200
c_1	120	60
c_2	80	140
Offenders (Innocents)	W	B
Total	64 (136)	64 (136)
c_1	24 (96)	36 (24)
c_2	40 (40)	28 (112)

Suppose there are just enough resources to interdict only 200 motorists in total. A technically efficient strategy will net 64 offenders in total. Consider, as before, two interdiction policies both of which lead to 64 offenders being caught, but not necessarily equally distributed between B and W. Distribution of offenders would depend on police strategy on targeting. Consider a race neutral strategy, Policy 1: random interdiction. This results on average the number interdicted to be in proportion to the race of the motoring population. Then 32 law breakers would be found on average from each group, B and W, the total being 64. Now consider a different strategy, Policy 2: focussing more on one group (B) of drivers. Under this policy, 150 B and 50 W motorists are interdicted, netting 48 B and 16 W law breakers, again a total of 64. Both policies are efficient in that a total of 64 offenders are nabbed in each case. The outcomes of the two policies, Policy 1 and Policy 2, are given in tables 6.8 and 6.9 respectively.

Note that $H(r)$ is equal between $r = B$ and W under both strategies. $U(r)$ is also race neutral under Policy 1 in that $U(B)$ and $U(W)$ are equal. This neutrality in outcome for $U(r)$ does not obtain under Policy 2, disproportionately targeting innocents amongst one group of motorists. Police officers have room for indulging in their taste for discrimination in choosing between these strategies without compromising on technical efficiency.

Table 6.8: Policy 1: Race neutral interdiction of 200 motorists

	W		B		Total	
	c_1	c_2	c_1	c_2	W	B
Motorists on the road	120	80	60	140	200	200
Number Stopped	60	40	30	70	100	100
No found with contraband	12	20	18	14	32	32
No of innocents stopped	48	20	12	56	68	68
$H(r)$					0.32	0.32
$U(r)$					0.34	0.34

Table 6.9: Policy 2: Interdiction of 200 motorists but higher fraction Black

	W		B		Total	
	c ₁	c ₂	c ₁	c ₂	W	B
Motorists on the road	120	80	60	140	200	200
Number Stopped	30	20	45	105	50	150
No found with contraband	6	10	27	21	16	48
No of innocents stopped	24	10	18	84	34	102
H(r)					0.68	0.68
U(r)					0.17	0.51

VII. Conclusions

Criminal justice systems in all societies profess to treat individuals equally, but the claim has always been the rhetoric of an ill-defined principle²⁰. Allegations of egregious violation of the declared aim keep highlighting the need to understand better the essential features of equal treatment before the law. A consensus has gradually emerged in the public declarations of post-war governments in Western democracies that race must not again become a singular determining factor by the institutions of governance for disadvantaging people. Unequal treatment in the criminal justice system between citizens because of their race no longer sits easily with any claim to legitimacy of the criminal justice system in a modern democracy. But the perception of the outcome of that system remains divergent from the declared aspirations of government. The extent to which the negative perception of the criminal justice system is based on an appropriate reading of the evidence is a matter that has been debated in the law and social science literature. This paper is concerned with one aspect of the that discussion. It is about testing for race neutrality of strategies for targeting individuals for the

²⁰ Definition of impartiality was changed in the police constables' oath in England and Wales until the Police Reform Act 2002 (UK Gov 2002).

detection of crime. The examples here are concerned with targeting individuals for interrogation during the use of public space, but the discussion applies to all strategies for the selection of people for attention in the detection of crime.

Statements like ‘discrimination is a major element’ have been put under the scanner by lawyers, sociologists, and economists. A strand in the literature in economics has focused on comparing perception with reality. For example, Knowles et al (2001) examine the extent to which perception matches reality by modelling the problem of selection and evasion as a transactional issue following the methodology of the literature in economics inspired by Becker (1976). These models focus on searching for an efficient equilibrium arising out of above transactions. Absence of bias in policing is defined as the outcome being an efficient equilibrium. Strong concern has been expressed by lawyers and judges about the racial disproportionality in crime detection strategies of targeting non-white members of society compared to their white counterparts when they are in public space. Economists of the above genre argue that a disproportionate focus on targeting members of one race over another is not necessarily admissible evidence of racial discrimination in policing. The focus should be on efficiency. If the outcome is technically efficient, detection of the maximum number of law breakers with any given resource for policing, then police strategy is not racially biased. For example, the model proposed by Knowles et al (2001), concerned with the interdiction of motorists in search for contraband, concludes that equality of the hit ratio between races in the interdiction of individuals is the efficiency condition and hence a sufficiency test for the absence of racial bias. No other information is required to examine bias. In our view, there is a problem with the definition of efficiency and the assumptions about unobservable factors in models in economics which seek an efficient equilibrium as the outcome of an unbiased police strategy.

Judicial enquiries on policing in London, enquiries chaired by Lord Scarman in 1981 and, two decades later, by Sir William McPherson have expressed disquiet about matters ignored in the above approach to deriving tests for the lack of bias (McPherson 1999 Para 45.8):

“If there was one area of complaint which was universal it was the issue of ‘stop and search’. Nobody in the minority ethnic communities believes that the complex arguments which are sometimes used to explain the figures as to stop and search are valid. In addition, their experience goes beyond the formal stop and search figures recorded under the provisions of the Police and Criminal Evidence Act and is conditioned by their experiences of being stopped under traffic legislation, drugs legislation and so called 'voluntary' stops. It is not within our terms of reference to resolve the whole complex argument on this topic. Whilst there are other factors at play, we are clear that the perception and experience of the minority communities that discrimination is a major element in the stop and search problem is correct.”

Issues of concern flagged above by the likes of McPherson cannot be accommodated in the language of these models in economics. Their derivation of an efficient strategy misses out a critical outcome of criminal justice, innocents that are targeted in search for the guilty. Assumptions implicit in describing efficiency need scrutiny. These models are formulated to obtain a unique strategy leading to an efficient condition, missing out the possibility that there may be more than one strategy which could lead to that efficient condition. With a modified model, technical efficiency as defined above can be shown to co-exist with a choice by officers to target disproportionately one group over another.

Race neutrality of the hit ratio alone as a test for the lack of bias in Knowles et al (2001) derives from separating the variable r (race) from all other characteristics (c) in the model, and then to impose functional forms which allow for c to be integrated away. The separability and integrability assumptions require evidence to back them up. These are not obvious assumptions. Consider a recent court case in London, reported in *The Guardian* newspaper on 09 December 2022 under the headline “Met police apologise to brothers stopped and searched after fist bump” (Dodd 2022):

“The Metropolitan police [Metropolitan Police is the police service in London] have apologised and paid tens of thousands of pounds in damages and costs to two young black men who were stopped and searched after officers saw them bump fists in the street and wrongly suspected them of dealing drugs. ... As part of a legal settlement, the Met declared that brothers Dijon and Liam Joseph, 33 and 31, were blameless for their ordeal four years ago, which involved Dijon being handcuffed and left them traumatised and humiliated. ... They sued for false imprisonment, assault and racial bias, and they say the stop was one of more than 25 they have experienced since childhood. ... The Met chose to fight the case, which started on Monday. On Wednesday, lawyers for the Met police asked to change their defence after evidence began to be heard, leading to a rebuke from the judge.”

If the Joseph brothers were not black, then the characteristic fist bumping might be read differently by officers who handcuffed them suspecting them of drug dealing. Variables r and c may not always be independent. Also, even if they were independent, it may not follow that technical efficiency is a sufficiency test for the absence of racial bias. We provide a numerical illustration (tables 6.8 and 6.9 above) where r and c are independent, but it is possible for the police to choose to satisfy the efficiency condition while disproportionately targeting for interrogation members of one group above another. This happens because there are more than one way of attaining efficiency in our illustrative example.

We do not make a case against profiling, *per se*. That is a different matter. We simply question the misplaced claims of the ability to test for racial bias in profiling by not having to examine the process of profiling but by looking simply at the hit ratio parsed by race. We also question the view of efficient policing which does not engage with the problem of targeting innocent members of society in search of law breakers. That vision of economics is focussed on fitting observations of behavior as an outcome of a transactional exercise between potential law breakers and police officers which results in a unique equilibrium which is also efficient. The process does not matter, psychology

does not matter, and the quality of data does not matter²¹. The perception of the legitimacy of the process of law enforcement of innocent victims of police attention is not confronted. These restrictions placed on the remit of economic analysis have come under scrutiny (Hirschleifer 1985)²².

Modelling without complexity may be desirable for a good reason: “Complexity may add to the richness of description, but it also prevents the analyst from seeing what is essential.” (Lazear 2000:100). But leaving out complexity that is essential to the issue at hand may mislead. It is not justified (Hirschman 1985). It cannot be a basis for policy.

Psychology matters in perceptions of cost and benefit of participants in the criminal justice system. A criminal justice system which is perceived as unfair can become costly to enforce. For example, surveys carried out in Oakland and Los Angeles found corroborative evidence in support of other studies that perception of fairness in the treatment of individuals matter for the cost of policing (Tyler and Wakslak 2004:276). These are all complexities that are essential to understanding the cost of policing, but they are outside the scope of this paper.

²¹ Taking data at face value, let alone regarding data as observations of equilibrium behavior, is fraught in criminal justice. Disturbing survey results, admittedly only based of what a small sample of African American young males described as their experience, have been reported alleging evidence tampering, for example keeping drugs and letting the suspect go (Brunson and Miller 2006).

²² Robert Frank and colleagues report (Frank et al. 1993) an interesting study in experiments on students’ view of their own interest. The views diverge substantially between those that have studied and done well in microeconomics modules and others, especially those that have not been exposed to the doctrine of undergraduate microeconomics.

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Appendix A: Condition of Equal Return

In a behavioural model where the test for unbiased policing does not require knowledge of the statistical method of racial profiling is discussed here (Knowles et al 2001). A necessary condition for unbiased policing is defined as absence of a taste for discrimination which makes a police officer discount the cost of interdiction of a motorist of a particular race. Characteristics of motorists, including race, may be used to predict the success of interdiction. A condition for the absence of bias entails that the predictive model is not contaminated by prejudice. The clever trick in this behavioural model is to make it unnecessary to examine the profiling data to establish a single necessary and sufficient condition for rejecting the hypothesis of biased policing. Salient steps in arriving at the result in the above paper are outline below. First the notation.

$F(c|r)$ - the distribution of characteristic c amongst racial group r . The characteristic c is a scalar containing information about age, type of car, gender, demeanour and whatever other information that is taken into account by officers.

$p(c,r)$ = Probability that police stop a motorist possessing characteristic c and belonging to racial group r ($r=B$ and W) to search for contrabands.²³ Characteristic c represents all other variables other than race lumped together (eg driving style, size, make and year of manufacture etc) which impact on the stop and search decision.

$\zeta(c,r)$ = Probability that the potential law breaker thinks that the police are likely to interdict his car, which is the same as $p(c,r)$ if, as is assumed in this model, there is no private information.

$P(G|c,r)$ = Probability that a motorist interdicted possessing characteristic c and belonging to race r is found in possession of contraband.

$f(c|r)$ = Probability that a person belonging to group r has the characteristic c

t_r = Marginal cost to police of interdicting and searching a person. This can be expressed as a fraction of the expected marginal benefit, normalized to 1. Thus $t_r \in (0,1)$

²³ Decision models based on group characteristics — gender, race, religion etc.— use these characteristics as proxies “for data not sampled” (Phelps 1972: 659).

$j(c, r)$ = Cost to the motorist carrying contraband if interdicted.

$v(c,r)$ = Gain to the motorist if carrying contraband if detection is avoided.

Thus, an unbiased officer would perceive

$$t_B = t_W = t \quad (A.1)$$

The focus is on equilibrium values of the probability of interdiction by the police and the probability that a motorist may carry contraband. When the two parties perceive that net gain from law breaking and interdicting, for the motorist and the police, respectively, is nil, they will randomize in a cat and mouse game. The objective of the exercise is to identify that equilibrium tuple of probabilities and test using observable data if the outcome is commensurate with unbiased policing condition (A.1) above.

An officer may, however, include the characteristics of the motorist, including race, in decisions to interdict. Using these characteristics to predict the tendency to break the law is called profiling. If the way these characteristics for prediction are read is informed by prejudice, racial bias enters the officer's decision in the choice of targets through this route. What the article (Knowles et al 2001) does is to model the decision problem such that no knowledge of the method of profiling is needed. Going through steps of the decision process and applying Equation A.1 to the algebra, it turns out that if A.1 is satisfied, then

$$H(B) = H(W) \quad (A.2)$$

Where $H(r)$ is the hit rate defined by Equation 5.1 in the text above. There is no need to examine the profiling method to establish if Equation A.2 is satisfied. This is the ingenuity of the model, and the steps are outline below.

By assumption, there is no private information, and all the parties are aware that a law breaker's net expected gain from carrying contraband

$$NET = p(c, r)\{-j(c, r)\} + \{1 - p(c, r)\}v(c, r)$$

At the equilibrium value of $p(c, r)$, NET is nil and motorists will randomize whether to carry contraband with probability $P(G|c,r)$. Likewise, the police will randomize when

the net expected gain to the police is nil given the equilibrium probability $P(G|c,r)$ of the law breaker. By setting the expression above for NET as nil, we can write the equilibrium value (denoted by $*$) of the probability of detention of a motorist characterized by (c, r) as follows:

$$p^*(c,r) = v(c, r) / \{j(c, r) + v(c, r)\} \quad (\text{A.3})$$

By the requirement of rational choice as mentioned above, everybody knows that the net expected gain to the police, NEG, from the interdiction of motorists over the range of the characteristic c as follows.

$$\text{NEG} = \int [\{P(G|c, B) - t_B\}p(c, B)f(c|B)]dc + \int [\{P(G|c, W) - t_W\}p(c, W)f(c|W)] dc \quad (\text{A.4})$$

Police will randomize decisions at the margin, whether to interdict another person, when the equilibrium value of $P(G|c,r)$ obtains,, ie when NEG is zero. By denoting equilibrium values by $*$, we can write:

$$P^*(G|c, B) - t_B = 0 \quad \text{and} \quad P^*(G|c, W) - t_W = 0 \quad (\text{A.5})$$

The underlying assumption in separating the two integrals in A.4 is that searching one group does not impose searching cost of the other group through change of behavior.

The definition of lack of bias in policing, Equation (A.1), in the model is that there is no taste for bias amongst police officers. This leads to an equilibrium outcome of unbiased interdiction as follows:

$$P^*(G|c, B) = P^*(G|c, W) = t \quad (\text{A.6})$$

To reiterate, an equilibrium characterised by the two equilibrium probabilities (equations A.3 and A.6) is an equilibrium following from a racially unbiased interdiction policy, by the definition of bias above. The following steps outline how the two equations lead to the equality, Condition of Equal Return (CER), expressed in Equation A.2 above. Whether the CER holds can be tested using observable data. The CER then becomes a statistical test for rejecting the hypothesis of racial bias in policing.

CER requires that the proportion of motorists found to be carrying contraband amongst those that are indicted, parsed by race, is the same for both races. Note that

$$H(r) = \text{Fraction of those interdicted found to carry contraband.}$$

At equilibrium,

$$H(r) = \int [P^*(G | c, r) \{p^*(c,r)f(c | r)\}]dc / [\{p^*(s,r)f(s | r)ds\}]dc$$

Using A.6, the expression becomes

$$H(r) = t \int [\{p^*(c,r)f(c | r)\}dc] / \{p^*(s,r)f(s | r)ds\} = t \quad (A.7)$$

Equality A.7 is the equality A.2, namely that $H(r)$ has a value t which is independent of r , when efficiency as defined in the model is achieved. This is the test as to whether the police strategy is free of bias. Whether the equality obtains can be tested using observable data which do not require knowledge of the characteristics c , and hence do not require engagement with controversies about profiling methods used by the police in decisions to interdict. The integration exercise over the characteristics of motorists take all these characteristics out of further consideration obviating any need to examine profiling data and methods, how the police may have related those characteristics to target, to interdict. There is no need to scrutinize the shape of $f(c|r)$. All that is required is to assume that the relevant functions in A.4 are integrable.

Appendix B: Stopping the not guilty vs the guilty

There are two types of errors entailed in decisions in the selection of targets in criminal justice, for example interdiction of motorists to search for contraband. One source of error occurs in thinking that a person is guilty and needs to be interdicted when the person is not carrying contraband. The other source of error arises from assuming innocence and letting a vehicle pass unchallenged when the vehicle is indeed carrying contraband. Even if one of these errors is not contaminated by prejudice or animus, the other error could be due to prejudice or animus. We explain how this can lead to the Condition of Equal Return to be satisfied even when there is bias in decisions to interdict the innocent. This claim is illustrated below.

Suppose there are black and white motorists on the road, whose characteristics apart from race are identical, and some of them carry contraband. There is an interdiction policy to search selected motorists for contraband. The problem is to test if the interdiction policy is racially unbiased. A test proposed in the economics literature is the Condition of Equal Return at the margin. At this point, a motorist who is stopped for search is found to be carrying contraband is the same whatever the color of the individual. Also there is no marginal net benefit from interdiction to the police. Cost of the search is the same as perceived benefit by the police of the outcome of the search.

The notations for individual, joint and conditional probabilities of search and arrest are given below. S denotes search and G denotes guilty of being in possession of contraband. NG denotes not guilty, ie without possession of contraband. We write:

$P^r(S|G)$ = conditional probability that a person belonging to race r (where $r=B$ or W) who is carrying contraband and is also searched.

$P^r(S|NG)$ = conditional probability that a person belonging to race r (where $r=B$ or W) is not carrying contraband but is also searched.

$P^r(G|S)$ = conditional probability that a person belonging to race r (where $r=B$ or W) who is searched and found to be carrying contraband.

$P^r(NG|S)$ = conditional probability that a person belonging to race r (where $r=B$ or W) is searched but found not to be carrying contraband.

$P^r(G,S)$ = joint probability that a person belonging to race r (where $r= B$ or W) is carrying contraband and is also searched.

$P^r(NG,S)$ = joint probability that a person belonging to race r (where $r= B$ or W) is not carrying contraband but is searched.

$P^r(G)$ = probability that a person belonging to race r (where $r= B$ or W) carries contraband.

$P^r(NG)$ = probability that a person belonging to race r (where $r= B$ or W) does not carry contraband.

$P^r(S)$ = probability that a person belonging to race r (where $r= B$ or W) is searched.

Now by Baye's rule, we can write, for $r= B, W$

$$P^r(G|S) P^r(S) = P^r(G, S) \quad (B.1)$$

$$P^r(S|G) P^r(G) = P^r(G, S) \quad (B.2)$$

Now note that

$$P^r(S) = P^r(G) P^r(S|G) + P^r(NG) P^r(S|NG) \quad (B.3)$$

Equation (B.3) can also be written as

$$P^r(S) = P^r(G) P^r(S|G) \{1 - P^r(G)\}P^r(NG|S) \quad (B.4)$$

Combining equations B.1, B.2 and B.4, we can write

$$P^r(G|S) = [P^r(S|G) P^r(G)] / [P^r(G) P^r(S|G) + \{1 - P^r(G)\}P^r(NG|S)] \quad (B.5)$$

The conditional of equal return entails

$$P^B(G|S) = P^W(G|S) \quad (B.6)$$

Using Equation B.5,

$$\begin{aligned} [P^B(S|G)P^B(G)]/[P^B(G) P^B(S|G) + \{1 - P^B(G)\}P^B(NG|S)] = \\ [P^W(S|G)P^W(G)]/[P^W(G) P^W(S|G) + \{1 - P^W(G)\}P^W(NG|S)] \end{aligned} \quad (B.7)$$

Now note that the above condition can be satisfied even when the innocent belonging to one group is deliberately or otherwise likely to be targeted for investigation more than members of the other group. For example, the equality B.7 holds even when

$$P^B(NG|S) > P^W(NG|S) \quad (B.8)$$

Equation B.8 suggests that statistical evidence in support of the condition of equal return is not sufficient evidence that police decisions on stop and search are racially unbiased.

To illustrate the inequality B.8 in a particular case, let

$$P^B(G) > P^W(G) \text{ but } P^B(S|G) = 2P^W(S|G).$$

Then the conditional of equal return, equality B.7, holds if

$$P^B(NG|S) = 2P^W(NG|S)$$

That can be construed as racial bias.