THE INFLUENCE OF DRIVER'S RACE ON TRAFFIC STOPS IN MISSOURI

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A small but growing body of research has produced several consistent findings regarding race and ethnic differences in traffic stops, searches, and arrests. However, prior research has not adequately addressed the potential bias associated with the use of residential population data to estimate the racial composition of the drivers in local areas. The authors present a new method of imputing the racial composition of drivers in a given locality based on the size and composition of nearby areas. Applying the method to traffic-stop data for 92 Missouri municipalities, the authors produce more accurate estimates than those based on residential population data of racial disproportionality in traffic stops for several suburban areas surrounding the city of St. Louis. Nonetheless, they find small but persistent group differences in the probability of being pulled over by the police for the 92 municipalities and larger differences in the probability of being searched and arrested.

Keywords: *policing; traffic stops; racial profiling; population weighting*

Prior to the terrorist attacks of September 11, 2001, a majority of Americans, regardless of race, condemned the use of racial profiling by law enforcement officers.[1] More than half of the respondents in a Gallup Poll

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released on December 9, 1999 believed that the police actively engage in the practice of racial profiling, and fully 81% said they disapprove of the practice (Newport, 1999). When the responses were broken out by race, 56% of Whites and 77% of Blacks responded that racial profiling was pervasive. The Gallup survey asked respondents how often they thought they had been stopped by the police based on their race alone. Six percent of Whites and 42% of Blacks responded that they had been stopped by the police because of their race; fully 72% of Black men between the ages of 18 and 34 believed that they had been stopped because of their race. Morin and Cottman (2001) reported national survey findings consistent with the Gallup results. Thirty-seven percent of Black respondents said that they were stopped unfairly by the police because of their race. Similarly, 1 in 5 Latinos and Asians in the survey reported that they had been targeted for a traffic stop owing to their race. Morin and Cottman reported that these experiences were consistent with a larger constellation of attitudes that reflect discriminatory experiences in a broad range of social encounters.

The perception of racial profiling potentially undermines confidence in the police and diminishes an officer's ability to enforce the law and preserve order. In addition, the widespread public perception of discrimination in police practices can have an undesirable effect on officers. Recently, reports have emerged of officers curtailing proactive practices, or "de-policing," as a result of their department being accused of racially biased policing (Leo, 2001; Peterson, 2001; Stockwell, 2001).

Given the consequences of perceptions of racial profiling for just and effective law enforcement in a democratic society, empirical research is needed on the nature and extent of profiling practices. In this article, we present results from a study of traffic stops in the state of Missouri on race and ethnic differences in the rate at which drivers are stopped, arrested, and searched by the police. We devote sustained attention to a measurement issue affecting prior studies of racial profiling: measuring the relevant population at risk for traffic stops in local jurisdictions.

DEFINING RACIAL PROFILING

A universally accepted definition of the concept of racial profiling does not exist. Some definitions, such as those adopted by the states of Connecticut and Rhode Island, specify that racial profiling has occurred only when race or ethnicity is the sole criterion for police action. Both define racial profiling as "the detention, interdiction, or other disparate treatment of an

individual solely on the basis of the racial or ethnic status of such individual" (State of Connecticut Public Act, 1999). Other definitions are more inclusive, requiring only that an individual's race or ethnic status be one of the grounds for detention, questioning, or other police action. Nonetheless, when race is the precipitating or determining factor in a police action against an individual, according to most definitions, racial profiling may be said to have occurred. A recent study completed for the U.S. Justice Department defines racial profiling as

> any police-initiated action that relies upon the race, ethnicity, or national origin of an individual rather than the behavior of that individual or information that leads the police to a particular individual who has been identified as being engaged in or having been engaged in criminal activity. (Ramirez, McDevitt, & Farrell, 2000, p. 7)

The Commission on the Accreditation of Law Enforcement Agencies (CALEA) (1999) has defined profiling as "the interdiction, detention, arrest, or other nonconsensual treatment of an individual because of a characteristic or status" (CALEA, 1999). Noting such differences, the Police Executive Research Forum (PERF) (2001) preferred the term "racially biased policing" over "racial profiling," which implies that race is the only factor in the decision of an officer to make a traffic stop, search a motorist, or make an arrest.

Whether construed narrowly or broadly, demonstrating the existence of racial profiling is no easy matter. It requires detailed data gathered at the individual level and would need to capture the actions of the driver and the thought process of the officer. That is not how the emerging empirical research on profiling has proceeded. Most studies gather information on the race and other demographic characteristics of the driver to determine whether the police are more likely to stop, interrogate, search, cite, or arrest members of some racial or ethnic categories than others. If "disproportionalities" or "disparities" are found in the treatment of persons in particular categories, those results may be viewed as consistent with the practice of racial profiling. More definitive conclusions would require an examination of the decisions behind the stops, but the existing research stops short of such assessments. The present study is no exception. We use information collected by police officers in traffic stops to determine whether members of particular racial or ethnic groups are more likely than members of other groups to be stopped, searched, and arrested. Our intention is not to prove or disprove the existence of racial profiling but rather to

develop a more secure foundation for claims that members of certain racial or ethnic groups are (or are not) subject to "disparate" treatment by the police.

MEASURING RACIAL DISPARITY

"Disparity" in this context refers to adverse treatment of members of certain groups in the absence of evidence that such treatment is warranted or deserved. For example, if police officers are more likely to stop Black motorists than White motorists without evident cause, we can say that a disparity exists in the treatment of Black drivers. But what does it mean to say the police are "more likely" to stop some motorists than others? It does not necessarily mean that the police intend to stop more of one type of motorist than another type. There may be more of that type of motorist on the roadways, and we would expect more of them to be stopped on the basis of chance alone (i.e., if the police simply pulled over drivers at random).

What is usually meant by disproportionality or disparity in traffic stops is that some motorists are pulled over more often than would be expected based on their presence in the population of either (a) drivers or (b) traffic law violators. The distinction between the two populations is quite important. If members of a particular group are stopped more often than expected based on their presence in the driver population, they are not necessarily subject to disparate treatment by the police. The disproportionality in the stops simply may reflect a greater tendency among members of that group to violate traffic laws or engage in other behavior meriting police intervention. In such instances, "disproportionality" does not equal "disparity."

In principle, it should be possible to determine whether members of a particular race or ethnic group are subject to disparate treatment by the police. For example, if members of Group X are stopped by the police at a rate greater than expected based on their presence in the population of drivers, but are not cited or arrested at a correspondingly high rate, one might presume that disparity in treatment exists. However, if the rate of citation or arrest does mirror the rate at which members of Group X are stopped, does that necessarily mean that they engage in more than their share of traffic infractions or criminal behavior? What if the police are more likely to issue questionable citations or warrants to such persons, as indexed by the rate at which the charges are later withdrawn or dismissed? Without follow-up information on the disposition of charges, this source of possible disparity

would be missed. As with most prior research, we do not have data on the disposition of citations issued or arrests made in connection with vehicle stops.

These considerations underscore the difficulty in drawing firm conclusions regarding the presence or absence of racial disparities from data on traffic stops, searches, citations, and arrests—even when the presence of disproportionality has been established. But determining whether members of certain groups are more likely than those from other groups to be stopped by the police also poses significant methodological challenges. It requires that we know all group members' expected probability of being stopped. The "expected probability" that a member of a particular group will be stopped is generally assumed to be equal to that group's proportion of the total population of drivers. For example, if Blacks comprise 25% of the driving population, we should expect that Black drivers on average will comprise 25% of all traffic stops (assuming that the distribution of traffic violations among groups is equal). If we observe a significant departure from the expected probability, we are alerted to the possibility of disparate treatment, although establishing disparate treatment is subject to the data limitations already mentioned.

Any conclusion regarding the presence or extent of racial profiling in traffic stops, then, depends on the validity of the baseline expected probabilities assigned to members of the race or ethnic groups under consideration. A brief review of prior research reveals few studies that have dealt adequately with the so-called denominator problem in measuring racial profiling in traffic stops (see Sherman, 2002, pp. 400-402).

PRIOR RESEARCH

Only a handful of recent empirical studies shed light on the issue of racial or ethnic disparity in traffic stops. A 1998 study of North Carolina Highway Patrol citations, written warnings, and arrests in highway patrol districts was the first to explicitly acknowledge the significance of the denominator in assessing the extent of racial profiling (Zingraff et al., 2000). A valid denominator, as noted, represents the expected probability that a driver of a particular race or ethnic group will be stopped by the police. The North Carolina researchers employed two alternative denominators in their evaluation. The first was composed of all North Carolina residents with a valid driver's license by race, sex, age, and highway patrol district of residence. The problem with such a measure is that it will miss drivers who are cited,

warned, or arrested in one patrol district but who reside in another district. In fact, the researchers noted that between 26% and 63% of citations were issued to drivers of vehicles licensed in another district. They addressed this problem by estimating the driving population in a given district with a weighting procedure based on the proportion of citations issued to drivers who reside outside of the district (see Zingraff et al., 2000, pp. 11-12). The second denominator was composed of the drivers licensed in the district, plus the estimated drivers from other districts. The choice of denominator generally had little effect on the results. The study found that African American males aged 23 to 49 had a somewhat higher than expected probability of receiving a citation by highway patrol officers. However, this result did not hold for African American males aged 16 to 22, who were even less likely to be cited than their White counterparts. The results for citations were similar for women in these age and race categories.

The North Carolina researchers found that African American males were much more likely than White males to be searched. However, it is difficult to know how to interpret this result because the researchers based the "search rate" not on the population of drivers who were stopped by the police but on the district residential population (denominator 1) and the estimated population of drivers (denominator 2). In related research on pedestrian stops in England, researchers found that Black citizens were more than 2.5 times as likely to be stopped by the police than was expected based on their proportion of the population (Norris, Fielding, Kemp, & Fielding, 1992). However, the study concluded that no differences existed in the treatment of Black and White citizens once a pedestrian stop has been made; all differences emerged as a consequence of the decision to make the initial stop. Thus, it is unclear whether the race differences found in North Carolina reflect corresponding differences in the distribution of initial stops, the distribution of citations or searches, or some mixture of the two.

It is also possible that the findings in North Carolina are specific to the type of agency examined. The highway patrol has primary responsibility for traffic enforcement. It may be that municipal or county agencies that place more emphasis on call response and community policing will produce a different racial pattern in vehicle stops.

The San Diego Vehicle Stop Survey (Bejarano, 2001) collected data on all vehicle stops during the year 2000—more than 168,000 traffic stops. The denominator used for the San Diego study was the driving-age resident population based on adjusted 1998 census data. Three outcome measures were used: stops, searches, and arrests.

Hispanic and Black drivers were overrepresented on each measure. Hispanics represent approximately 20% of the driving age population in the city but accounted for 29% of all vehicle stops. Blacks represent 8% of the driving age population in the city but nearly 12% of all traffic stops. Although San Diego is located close to one of the busiest ports of entry with Mexico, no attempt was made to adjust the data to reflect the fact that Hispanics were probably underrepresented in the denominator used to establish the expected probability of being stopped by the San Diego police.

In contrast with the North Carolina analysis, the San Diego researchers examined disproportionality in searches and arrests in relation to the number of drivers who were stopped by the police. Race and ethnic differences were also observed for the probability of being searched and arrested. Only 3% of Whites were searched, once stopped, compared to 10% of Blacks and 11% of Hispanics. Arrest rates for Blacks (3%) were higher than for Whites (1.3%) and roughly the same as those for Hispanics (2.7%). The San Diego study also calculated "hit rates," the percentage of all searches by race that resulted in the seizure of contraband. Contraband was found in 5% of the cases in which Hispanics were searched, compared to 14% of the searches of Blacks and 13% of the searches of Whites. These results are suggestive of disparate treatment but for the reasons discussed earlier, cannot be considered conclusive.

In a similar city-level study, Smith and Petrocelli (2001) examined 2,673 traffic stops by the Richmond, Virginia, police that occurred over a 6-week period. The stop data were normed by the race-specific population of city residents aged 16 and older. The study found that Blacks, who comprise 51% of the city population, accounted for 64% of drivers stopped, whereas Whites, who make up 48% of the Richmond population, accounted for only 32% of the drivers stopped.

Smith and Petrocelli (2001) conducted a logistic regression analysis of the effect of driver's race on the likelihood of being stopped, searched, arrested, and warned. The analysis controlled for the driver's age and sex; the officer's age, race, sex, and years of service; the crime rate of the stop location; and time of the stop. Race of the driver emerged as a significant predictor of type of search conducted and application of legal sanction. White drivers were significantly more likely than Black drivers to submit to a consent search and to be arrested or receive a summons. Interestingly, the race of the officer was not a significant predictor in any of the regression analyses. This is an important finding because an underlying assumption in the accusation of racial profiling is discrimination, which is inferred from

White officers stopping minority drivers. However, the findings do not support this assumption.

In 1999, the Connecticut General Assembly passed Public Act No. 99-198, which required the chief state's attorney to collect data on all traffic stops in Connecticut. The 2001 interim report presents results from an analysis of the traffic stop data for the first 6 months of 2000 (Cox, Pease, Miller, & Tyson, 2001). The denominator in the Connecticut report is the distribution of the residential population by race in local law enforcement jurisdiction. The study found that Black and Hispanic drivers are overrepresented among traffic stops in the state. Blacks and Hispanics represent 8.4% and 6.4% of the state population, respectively, yet Black drivers were 12.1% of traffic stops and Hispanic drivers 8.7%.

The Connecticut researchers (Cox et al., 2001) sought to identify what they refer to as "extraneous" influences on the racial composition of the driving population—for example, sharing a border with a jurisdiction with a different racial composition or the presence of an entertainment or retail district in the area that attracts drivers from other jurisdictions. The study found that jurisdictions bordering areas with a high percentage of Blacks or Hispanics showed higher levels of disproportionality in drivers stopped than other jurisdictions (p. 20).

The Connecticut study also captured information on six types of traffic stop dispositions: arrest, misdemeanor summons, infraction tickets, written warnings, verbal warnings, and no disposition. Similar to the San Diego study, the base for group comparisons with respect to these indicators was the race/ethnic composition of the drivers stopped and not of the residential population. Only misdemeanor summons showed a high level of disproportionality for Black and Hispanic drivers.

The Bureau of Justice Statistics reports national-level results on traffic stops by race and ethnicity from the Police Public Contact Survey (PPCS) conducted in 1999 (Langan, Greenfeld, Smith, Durose, & Levin, 2001). Traffic stops are the largest single category of police-citizen contacts reported by survey respondents, accounting for 52% of the total. Just more than 10% of all licensed drivers were pulled over by the police at least once. The majority of those stopped (60.8%) were male, 77.0% were White, 11.6% were Black, and 8.4% were Hispanic. Blacks were somewhat more likely to be pulled over than Whites or Hispanics: 12.3% of Black compared with 10.4% of White and 8.8% of Hispanic licensed drivers were stopped at least once. Therefore, Blacks were 18% more likely than Whites (12.3/10.4) and 40% more likely than Hispanics (12.3/8.8) to report being pulled

over by the police in 1999. Blacks and Hispanics were more than twice as likely as Whites to report that the driver or vehicle was searched (11% vs. 5%). However, searches of Whites were more likely to uncover contraband than searches of Blacks or Hispanics. Evidence of contraband was found in 17% of the searches of White traffic stops, 8% of Black traffic stops, and 10% of Hispanic traffic stops.

The PPCS also asked survey respondents who reported a traffic stop whether they believed that they had been stopped "for a legitimate reason." Regardless of race or ethnicity, large majorities of the respondents indicated that they had indeed been stopped for a legitimate reason. However, Whites (86%) and Hispanics (82%) were somewhat more likely than Blacks (74%) to agree with this statement. These group differences remain the same regardless of the race of the officer who made the stop.

Despite differences in methods and population studied, several consistent findings emerge from prior research on racial profiling in traffic stops. Black drivers are somewhat more likely than Whites to be stopped by the police. Some studies find that Hispanics are more likely than Whites to be stopped, whereas others, including the national PPCS study, do not. Prior research consistently finds that Blacks and Hispanics are more likely than Whites to be searched and arrested and that contraband is more likely to be found in searches of Whites than Blacks or Hispanics. A key limitation of prior research is the use of residential population figures as the basis for measuring the expected probability that a driver of a given race or ethnic group will be subject to a traffic stop. The residential population of an area may or may not accurately reflect the characteristics of those who drive through the area. The present study uses traffic-stop data for municipalities in the state of Missouri to investigate race and ethnic differences in the probability of being stopped by the police, searched, and arrested. We present a new method for adjusting residential population data to better reflect the race and ethnic composition of the drivers who are stopped in a given municipality but who may reside elsewhere.

DATA AND METHODS

In 2000, the Missouri General Assembly passed Senate Bill No. 1053 requiring that all law enforcement agencies in the state collect and report to the state attorney general information on traffic stops. The mandated information includes the race and ethnicity of the driver, traffic violations alleged, and whether a warning or citation was issued, a search was

conducted, or an arrest was made. More than 95% of law enforcement agencies in the state submitted traffic-stop data to the attorney general for the last four months of 2000, the period under investigation in the present study.

We present comparative data on stops, searches, and arrests for non-Hispanic Whites, non-Hispanic Blacks, and Hispanics from the 92 Missouri municipalities with driving-age populations of 5,000 or greater. The population threshold was used to insure reliability in the counts of stops, searches, and arrests obtained for the 4-month period during which the traffic data were collected. The 92 municipalities represent roughly a quarter of the 495 Missouri municipalities for which the traffic data are available, but they account for two thirds of all traffic stops recorded by the 495 municipalities during the 4-month period. We limit our group comparisons to Hispanics, non-Hispanic Blacks, and non-Hispanic Whites because non-Hispanic persons of other races constitute a very small percentage of the state population, and prior research has focused on those three race/ethnic groups.

Group comparisons of searches and arrests are straightforward. In both cases, we computed a rate, expressed as a percentage, equaling the number of searches (arrests) of persons of a given race or ethnicity divided by the number of persons of that race or ethnicity stopped by the police in a given municipality ($\times$ 100). For reasons discussed earlier, the calculation of a valid "stop rate" for each race and ethnic group raises difficult measurement issues. We constructed a Disproportionality Index (DI) to determine the degree to which members of a given race or ethnic group are over- or underrepresented among drivers stopped by the police. DI is computed by dividing the proportion of stops accounted for by a given group by that group's proportion of the population. A value of 1 on DI indicates no over- or underrepresentation in traffic stops; it is the expected probability of being stopped. A value greater than 1 indicates overrepresentation, and a value less than 1 indicates underrepresentation in traffic stops for a given race or ethnic group.

When the Missouri Attorney General released the traffic-stop data collected during 2000, including the disproportionality measure described above, several police agencies responded that the use of the residential population for determining the race and ethnic composition of drivers in their jurisdictions was invalid, because persons who drove through their areas did not necessarily live there or resemble the race/ethnic characteristics of the local population. The strongest complaints came from agencies located in suburban areas surrounding the city of St. Louis. For example, one

agency complained that its DI score of 12 for Blacks was implausibly high and grossly inaccurate because Blacks were much more likely to drive through its jurisdiction than live there. Less than 1% of the city's population is Black.

To inspect for possible bias in DI due to a mismatch in the race and ethnic characteristics of the residential and driving populations, we computed DI for each of the three race/ethnic groups using two alternative estimates of its proportion of the driving population (or, more precisely, the "driver population") in each municipality. In the first instance, we used the race and ethnic composition of the municipal population aged 16 or older from the 2000 Census. This measure of disproportionality is similar to most previous efforts to norm the traffic-stop data with information on the race and ethnic composition of the residential population, including the Missouri Attorney General's report for 2000. Our second estimate of the population of drivers subject to a traffic stop takes into account the fact that persons driving through a municipality may not reside there, and therefore the race and ethnic composition of the drivers may diverge from that of the residents.

We developed an estimation procedure for imputing the race/ethnic composition of the drivers in each municipality. The procedure is based on three assumptions about the relationship between the residential and driving populations for any given municipality: (a) Residents are more likely to drive in the municipality than nonresidents; (b) nonresidents who live in nearby municipalities form a larger fraction of the driving population than those who live further away, and (c) nonresidents who reside in larger municipalities form a larger fraction of the drivers than those from smaller municipalities. Taken together, the three assumptions imply a procedure for determining the race/ethnic composition of the driving population that gives greater weight to residents than nonresidents, to nearby nonresidents, and to nonresidents from larger municipalities. Although these assumptions appear reasonable enough, the results of an imputation procedure based on them require validation against an observed distribution of driver characteristics. We first describe the procedure and then discuss the validation exercise.

Estimating the Driving Population With Spatial Weights

We estimated the race/ethnic characteristics of the driving population by first obtaining the distances between the geographic centers of the 92 municipalities included in the analysis using ArcView GIS 3.2. We then

created an inverse distance matrix (1/D) with these data in SpaceStat 1.91. For a given municipality, the inverse matrix gives more weight to adjoining and nearby municipalities and diminishes the influence of those further away. We used an inverse distance to a power of 3 (1/D3), which best fit the validation results. The inverse matrix also allows for a cutoff point to limit the distance within which one municipality may influence another. Based on the validation results, we set the distance cutoff at 20 miles. Thus, for each municipality, the influence of all municipalities within 20 miles is included in the distance matrix. The distance weights were then multiplied by the White, Black, and Hispanic populations of each municipality within 20 miles of a given municipality to create "inverse distance-weighted" populations of nonresidents for each group. We added the weighted nonresident populations to the corresponding residential populations, multiplied by a factor of 2 to reflect the greater expected influence of residents on the municipality's driving population. Finally, we summed the three "spatially weighted" subgroup populations to obtain estimates of the proportion of White, Black, and Hispanic drivers for each municipality.

VALIDATING THE IMPUTATION PROCEDURE

The validity of our imputation procedure depends on the accuracy of the distance and population weights used to generate the estimated race/ethnic composition of the driving population. We sought to validate the procedure with observational data on the racial distribution of drivers in three St. Louis suburban areas with exceptionally high values on DI for Blacks: the cities of Ladue, Clayton, and Sunset Hills.[2] We sent a team of trained observers to four different locations within each city that had been identified by the local police as having heavy traffic volume and enforcement activity. Observations were carried out during the morning and evening rush hours over a period of several days and included traffic moving in all directions at intersections and on highways. The team consisted of two observers and a driver. Both observers recorded the race of the driver in oncoming vehicles at each location. A total of 868 observations were made in Ladue, 763 in Clayton, and 616 in Sunset Hills. The degree of interobserver agreement exceeded 95% in each of the three cities.

The results were used to recalibrate the distance and population weights in the imputation formula. To avoid overfitting, we began with weights that on a priori grounds appeared reasonable, estimated the racial composition of the driving population for all 92 municipalities using those weights, and

TABLE 1. Traffic Stop, Search, and Arrest Data by Race and Ethnicity for 92 Missouri Municipalities, 2000

	Total[a]	*Black*	*White*	*Hispanic*
Population 16 and older	2,155,211	335,870	1,692,625	54,967
Stops	196,558	35,446	153,506	3,770
Searches	15,590	4,374	10,108	488
Arrests	11,640	3,775	7,575	368
Population %	100.00	15.58	78.54	2.55
Disproportionality Index (DI)		1.16	0.99	0.75
Search rate	7.93	12.34	6.58	12.94
Arrest rate	5.92	10.65	4.93	9.76

a. Totals include persons of any race. Non-Hispanic Blacks, non-Hispanic Whites, and persons of Hispanic origin comprise 97% of the population.

then re-estimated the driving populations with weights that maximized fit to the observed data without substantially altering the results for the other municipalities. The results turned out to be fairly robust against differing distance cutoff points and population multipliers.[3] Ideally, we would have validated our imputation procedure with observational data from additional sites, but the cost was prohibitive. Indeed, if it were not expensive and time-consuming, observational data would be used to estimate the racial composition of the driving population in all studies of racial profiling based on traffic stops.

RESULTS

The Missouri traffic-stop data for the 92 municipalities with a driving-age population of 5,000 or more are presented in Table 1. Just less than 200,000 stops were recorded by the police in these municipalities, an average of 2,136 stops in each jurisdiction. The police conducted 15,590 searches and made 11,640 arrests, yielding a total search rate of 7.93% and a total arrest rate of 5.92%. Table 1 also presents the values on the Disproportionality Index for non-Hispanic Whites, non-Hispanic Blacks, and Hispanics. Whites were stopped by the police at about the rate expected on the basis of their proportion of the driving-age population (DI = .99). Hispanics were stopped at a rate 25% below the expected rate, and Blacks were stopped at a rate 16% above that expected on the basis of their proportion of the driving-age population. Blacks were 17% more likely than Whites (1.16/0.99) and 55% more likely than Hispanics (1.16/0.75) to be pulled over by the police in the 92 Missouri municipalities.

The race/ethnic distribution of searches and arrests is quite different. Blacks and Hispanics were roughly twice as likely as Whites to be searched and arrested. These results are highly consistent with those from prior research. Blacks are somewhat more likely than Whites to be pulled over by the police. However, stops of Blacks are much more likely to result in a search and arrest. Once stopped by the police, Hispanics are also more likely than Whites to be searched and arrested. But Hispanics are considerably less likely than Whites or Blacks to be stopped. Before discussing the import of these results, we present our findings from the imputation procedure used to develop an alternative estimate of the race and ethnic composition of the driving population.

IMPUTATION RESULTS

Although the statewide results are consistent with prior research, those for particular municipalities may be subject to systematic error, especially in the population data used to norm the traffic stops by race and ethnicity. As mentioned above, police officials from several St. Louis suburban areas objected to use of residential population figures for determining the racial composition of the drivers in their jurisdictions. The complaints came mainly from suburban areas with relatively small Black populations located near the city of St. Louis. Many city residents work and shop in the suburbs, as do the residents of other suburban areas with substantial Black populations. These nonresidents are counted in the numerator of the measure of racial disproportionality in traffic stops for their jurisdictions, but not in the denominator, the suburban officials argued, thereby creating the false appearance of racial profiling by their officers.

Our imputation procedure was developed to address such concerns as well as the general problem of spatial mismatch in areas where nonresidents comprise a significant fraction of the driving population. Figure 1 displays a scatter plot of the relationship between the DI scores based on the residential Black population and those derived from the imputation procedure for the 92 Missouri municipalities. The results for Hispanics and Whites (not shown) remain substantively identical regardless of which population denominator is used. The same is not true for Blacks. Although it makes little difference for the great majority of the municipalities whether the residential or imputed population figures are used to norm traffic stops of Black drivers, it makes a great deal of difference for some municipalities.

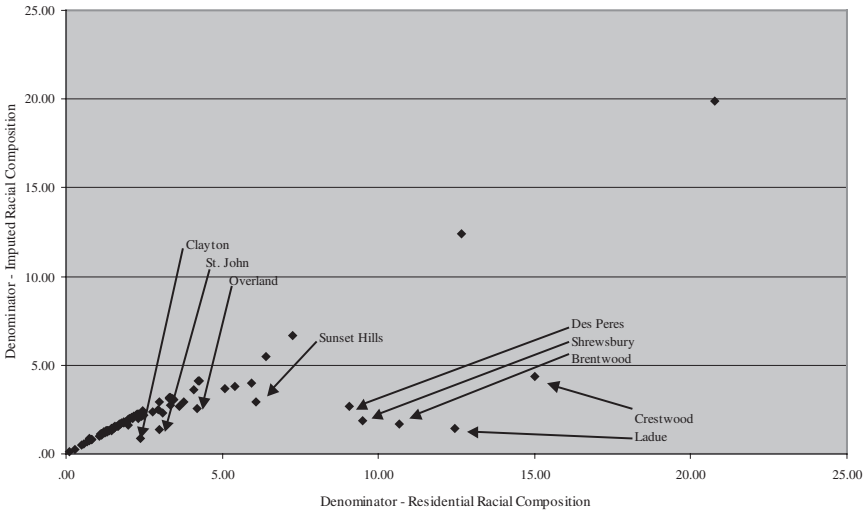

FIGURE 1: Disproportionality Index Values for Blacks Using Residential-Population Denominator and Imputed Denominator in 92 Missouri Municipalities, 2000

We have identified in Figure 1 the nine municipalities for which use of the imputed population data appreciably reduces the DI value from the value based on the residential population. In all instances, these off-diagonal cases are suburbs of St. Louis, and in some, the discrepancy between the two measures is quite large. Table 2 provides the residential and imputed population data and DI values for Blacks in selected Missouri cities and suburban areas. The St. Louis suburbs of Crestwood and Ladue have DI values of 15.02 and 12.45 when the Black proportion of the residential population is used to norm the traffic stops of Blacks. The values drop to 4.37 and 1.46, respectively, when DI is based on the imputed population data. Shifts of similar magnitude in racial disproportionality in traffic stops occur for the suburbs of Brentwood, Des Peres, and Shrewsbury, and somewhat smaller but notable reductions are observed for the other St. Louis suburbs identified in Figure 1.

VALIDATION RESULTS

Table 2 also shows the observed values for the racial composition and DI of the three suburbs used to validate the imputation procedure. In two of the

TABLE 2. Comparison of Racial Composition and Disproportionality in Traffic Stops Using Residential and Imputed Population Data, Selected Missouri Municipalities, 2000

	Residential Population		*Imputed Population*	
City	*Percentage Population Black*	*Disproportionality Score*	*Percentage Population Black*	*Disproportionality Score*
Central cities				
Kansas City	28.41	1.14	29.59	1.09
St. Louis	46.57	1.06	48.47	1.02
Kansas City suburban areas				
Belton	2.48	2.49	2.80	2.21
Blue Springs	2.78	2.04	2.86	1.98
Gladstone	1.90	3.36	2.35	2.72
Grandview	30.17	1.24	31.00	1.20
Independence	2.12	3.36	2.22	3.21
Lee's Summit	3.24	1.99	3.35	1.92
Raymore	1.83	1.92	1.97	1.78
Raytown	10.08	3.32	10.48	3.20
St. Louis suburban areas				
Bellefontaine Neighbors	39.81	1.48	44.88	1.31
Brentwood	1.73	10.66	10.92	1.69
Clayton	8.87	2.38	23.64	0.89
			(15.30)	(1.38)
Crestwood	0.68	15.02	2.35	4.37
Des Peres	0.84	9.05	2.85	2.68
Ferguson	48.51	1.33	50.33	1.28
Jennings	74.86	1.22	72.94	1.25
Ladue	0.86	12.45	7.34	1.46
			(9.33)	(1.15)
Maplewood	15.09	1.95	16.38	1.79
Overland	8.87	4.21	14.59	2.56
Richmond Heights	12.58	1.99	15.20	1.64
Shrewsbury	1.35	9.48	6.88	1.85
St. John	11.80	2.97	25.58	1.37
Sunset Hills	1.00	6.07	2.04	2.95
			(2.50)	(2.51)
University City	42.99	1.28	42.47	1.30
Webster Groves	6.05	2.30	6.97	2.00
Other cities				
Cape Girardeau	7.74	1.48	7.93	1.44
Columbia	9.32	2.14	9.92	2.01
Jefferson City	14.57	1.45	14.99	1.41
Joplin	2.50	1.39	2.60	1.34
Kirksville	1.70	1.35	1.75	1.30
Marshall	7.06	1.13	7.19	1.11
Moberly	6.06	1.12	6.16	1.10
O'Fallon	2.11	2.10	2.15	2.06
Springfield	2.94	2.30	3.04	2.22
St. Charles	3.17	2.46	3.31	2.35
St. Joseph	4.91	1.47	5.00	1.45
St. Peters	2.65	2.29	2.73	2.22

Note: Observed values are in parentheses.

three cases, Ladue and Sunset Hills, the percentage of Black drivers derived from the observational data is much closer to the imputed percentage than to the percentage based on the residential population. The observed percentage of Black drivers in Ladue is 9.33%, and the imputed percentage is 7.34%, whereas the Black percentage of the residential population of driving age is only .86%. In Sunset Hills, the observed and imputed percentages of Black drivers are nearly identical (2.4% and 2.04%, respectively), and the Black percentage of driving-age residents is only 1%. Clearly, the imputation procedure was successful in these two cases in approximating the racial composition of the driving population.

Basing DI on the imputed data, in turn, yields more accurate estimates of racial disproportionality in traffic stops. This can be seen in Table 2 by comparing the DI values derived from the imputed data with those from the observed data. The value of DI for Ladue based on the imputed data is 1.46, compared with a value of 1.15 based on the observed data. Although the imputed value exceeds the observed value, they are much closer to one another than to the value based on the residential population of 12.45. The value of DI for Sunset Hills based on the observed data is 2.51, compared with a value of 2.95 derived from the imputed data. Again, although they diverge somewhat, they are considerably closer to one another than to the value of 6.07 based on the residential population.

The imputed figures for the St. Louis suburb of Clayton do not come as close to those derived from the observational data. The imputed Black proportion of the driving population in Clayton is just less than 24%, compared to an observed value of 15.3%, and the imputed DI value of .89 is well below the observed value of 1.38. The imputation procedure produces an inflated estimate of the Black proportion of the driving population and a downward bias in the measure of racial disproportionality in traffic stops. Although we cannot be certain why this is so, part of the reason is likely due to Clayton's close proximity to the city of St. Louis, its status as the major commercial and government center in St. Louis County, and the ample public transportation linking the suburb to the city. Many Black St. Louisans with business in Clayton take the bus and therefore were not counted in our observations of drivers. The other suburban areas are less accessible by public transportation and so the imputation procedure is less likely to produce inflated estimates of the proportion of Black drivers in them. A direct way of testing these speculations would be to compare the racial composition of drivers and pedestrians in selected areas, an important task for further research using the imputation procedure presented in this article.

In summary, for most of the 92 Missouri municipalities under consideration, it makes little difference whether the residential population or the "imputed" population is used to determine the degree of racial disproportionality in traffic stops. Only in some of the St. Louis suburbs—specifically, those located close to the city and with very small Black populations—do we find a wide disparity in the disproportionality values based on the differing estimates of the proportion of Black drivers.[4] The influence of these few cases on the overall relationship between the two measures of DI plotted in Figure 1 can be demonstrated by comparing the correlations between the measures including and excluding those cases. The correlation (r) for the full sample of 92 municipalities is .782.[5] Excluding the five most extreme off-diagonal cases identified in Figure 1 (Crestwood, Ladue, Brentwood, Shrewsbury, and Des Peres), the correlation increases to .982.

Our second major finding is that the imputation procedure produces reasonably accurate estimates of the racial composition of the driving population of those St. Louis suburban areas. The single exception, Clayton, may be related to its greater accessibility by public transportation or to its closer proximity to the central city than the other suburban areas. By diminishing the influence of nearest neighbors in the imputation method, it is possible to move the value for Clayton on the measure of racial disproportionality in traffic stops much closer to the observed value. However, doing so reduces the fit for the other areas. Additional research is needed to determine whether the imputation procedure can be modified by census information on the use of public transportation and whether such modifications withstand validation through direct observation.

DISCUSSION

The small but growing research literature on racial profiling has produced several common findings regarding race and ethnic differences in police stops, searches, and arrests. Including the present study, the accumulated research indicates that Black motorists are more likely than Whites, and in some studies Hispanics, to be pulled over by the police. The racial difference in the probability of being stopped is small but consistent across local and national-level investigations employing different methods of data collection and analysis. In addition, Black and Hispanic drivers who have been stopped by the police are about twice as likely as Whites to be searched and arrested. In light of the consistency of these results, it can now be concluded with some confidence that Black drivers attract more police

attention on the nation's roadways than do Whites, and, if stopped, Blacks and Hispanics are much more likely to face serious sanctions.

We cannot yet say why these differences in treatment occur—specifically, whether they reflect profiling of race and ethnic minorities by the police. Alternative explanations must first be ruled out. We have addressed one of those alternative claims in this article, to wit, that evidence of racial disproportionality in being pulled over by the police is an artifact of using the racial composition of the residential population to norm the traffic stops. We presented a procedure for imputing the racial composition of the drivers in a local area as a function of the racial composition of the population in nearby areas. The closer that two areas are to one another, the more that they are allowed to influence one another. Areas with larger populations are given greater weight than areas with smaller populations. We validated our imputation methods with observational data from three St. Louis suburban areas. The imputed estimates of the racial composition of drivers in a municipality are generally more accurate than those based on the residential population; however, the procedure should be modified to take account of differences across areas in the use of public transportation.

With appropriate modification, our method for imputing the characteristics of the local population appears to be a promising way of addressing the "denominator issue" in studies of racial profiling, short of continuous observation of the racial identification of drivers. However, alternatives to direct observation are not as apparent for ruling out other explanations of race and ethnic differences in traffic stops, such as differences in the condition of vehicles or the rate of traffic infractions. Use of traffic citation data to measure infractions is subject to the criticism of differential enforcement. We conclude that direct-observation studies of drivers, vehicles, and driving patterns will continue to be necessary to validate the statistical procedures of the sort we have presented and to gather data that is unavailable by any other means.

Additional research also is necessary to uncover the sources of the race and ethnic differences in search and arrest rates. One possibility is that Black and Hispanic drivers are more likely than White drivers to have outstanding arrest warrants and, therefore, are more likely to be arrested once stopped. Because a search is typically conducted when an arrest is made, Blacks and Hispanics would have higher search rates than Whites. Contraband would be found more often on Whites, in turn, if searches of Whites are prompted by suspicious behavior at the scene rather than record checks

of past arrests. Even if this explanation turned out to be correct, it would not necessarily rule out the possibility of discriminatory treatment if more arrests of Blacks and Hispanics than Whites were later withdrawn or proven unfounded. Without data on the legal disposition of the enforcement activity, it will not be possible to conclude that differential enforcement reflects racial profiling.

NOTES

1. Since September 11, 2001, racial and ethnic profiling has assumed a different meaning for the American public, most of whom now approve of profiling to combat terrorism (Schaum, 2001). Absent evidence to the contrary, it is reasonable to assume that Americans continue to disapprove of racial profiling when not directed at terrorist activity.

2. We did not attempt to identify Hispanic drivers in the validation exercise. Therefore, comparison of the residential and weighted population estimates is limited to non-Hispanic Blacks and Whites.

3. Detailed results of the validation exercise are available on request.

4. We do not find comparable disparities for the Kansas City suburbs included in the analysis, which seems to be due to the relatively smaller Black population of the central city and to the geographical size of the suburban areas, which would reduce the fraction of nonresident drivers.

5. The corresponding correlations for Whites and Hispanics are .903 and .993, respectively.

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