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Undergraduate Senior Thesis

Reexamining Ferguson: The effect of police officers on arrests by race

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1 Introduction

The shooting of Michael Brown in August of 2014 and the subsequent protests in Ferguson, Missouri brought a sharp spotlight to the issue of race and policing in the United States. The events prompted an investigation of the Ferguson Police Department by the Department of Justice, and a report was issued in March of 2015 [1]. According to the report, of all arrests after car stops from 2012 to 2014, 93% of those arrests were of African American individuals. Furthermore, at the time of the Michael Brown shooting, only 6% of the Ferguson police department was black. Hence the ratio between percent black (white) arrests and percent black (white) officers, which I will refer to as black (white) ratio, is 15.5.

The figures from Ferguson motivate the following research questions that I answer in this paper: 1) is the black ratio ratio in Ferguson (15.5) atypical of the US as a whole; 2) how have the black and white ratios changed over time; and 3) What is the effect of adding a black, white, or Asian officer on black, white, or Asian arrests. Aggregated over all years in my dataset, I find that the white ratio for every state in the US is less than 1, while the black ratio for every state is greater than 1 (the only exception is New Mexico). A plausible explanation for why African Americans are more represented in the arrested population as opposed to the police population is that disadvantaged groups are hurt by the discretionary process of defining and responding to criminal conduct[5, 6]. Another theory is that the ratios do not indicate racial discrimination, but rather differences in ability to enter the police force and differences in rates of offending[3]. In addition, systematic discrimination where police forces hire whites at disproportionate rates, and where white police officers discriminatorily arrest black suspects would also be consistent with the ratios observed.

In this paper, I also use OLS to answer the following question: What is the effect of adding a black, white, or Asian officer on black, white, or Asian arrests? Notable theories regarding the effect of officers on crime include the Deterrence and Incapacitation theories. The Deterrence theory states that criminal activity becomes less attractive as the probability of arrest increases; the Incapacitation theory states that adding police officers will eventually reduce criminal activity by arresting the most prolific offenders[2]. While both theories suggest that adding police officers reduces crime, the Deterrence theory implies that adding police officers would reduce arrests, while the Incarceration theory implies that adding police officers would initially increase arrests.

The Impact of Race on Policing and Arrests looks at a similar research question, and the authors find that increases in the number of minority police are associated with significant increases in arrests of whites but have little impact on arrests of nonwhites[8]. They also argue that more white police increase the number of arrests of nonwhites but do not systematically affect the number of white arrests. While this paper examines a similar question, the effect of adding a black, white, or Asian police officer on each of black, white, and Asian arrests, there are some notable differences in the methodologies used between this paper and *The Impact of Race on Policing and Arrests.*

First, the data that I use to examine the racial composition of municipal police departments comes from the Law Enforcement Management and Administrative Statistics (LEMAS), while the racial data on municipal police departments used in *The Impact of Race on Policing and Arrests* comes from EEOC tabulations. In the LEMAS dataset, we are able to see the number of full-time sworn officers by race. In the EEOC, the figures represent officers whose job function is protective services, which can include both sworn and unsworn police officers. Another difference between this paper and *The Impact of Race on Policing and Arrests* is the fact that in my paper, I do not divide my race categories into white and non-white. Instead, I have arrest and officer figures for blacks, whites, and Asians. Finally, another unique feature of my paper is the examination of the black, white, and Asian ratio both over time and across different states in the US.

I use agency and year fixed effects, as well as 1987 Population weights when implementing my regressions. Over various regression specifications, my dependent variable is either the sum of black, white, and Asian arrests in a given agency and year or the yearly sum of the number of arrests of a particulate race in a given agency and year. The three independent variables are the counts of the number of white, black, and Asian officers in a given agency and year. On the surface, the model immediately suffers from 1) Omitted variable bias 2) Simultaneity bias, and 3) Measurement Error. Indeed, the possibility that the level of officers is partly determined by the level of arrests has led to the creative use of instrumental variables to measure the effect of officers on crime[9, 7]. In addition, if the level of officers is correlated with potential omitted variables such as the local economy and city budgets, the coefficients on the officer variables would be biased. Thus I rely upon the fact that year over year changes in police have generally weak associations with potential omitted variables such as the local economy, city budgets, social disorganization, and recent changes in crime, suggesting that the Omitted Variable and Simultaneity biases are not particularly worrisome. Since the arrest data received from the Uniform Crime Reports (UCR) has measurement error, which stems from factors such as differences in police department reporting practices across jurisdictions, technological changes in crime reporting, and changes in crime reporting by victims over time, the coefficients on the officer variables will be biased downward[4].

The use of agency fixed effects is critical in obtaining an unbiased estimate of the effect of adding an officer on the number of arrests. If agency fixed effects were not included, increases in the number of officers could be correlated with unobserved omitted variables that vary over different agencies. For example, it is not out of the realm of possibility to imagine a world where agencies representing regions with poor socio-economic characteristics have more officers and arrests. Thus, if we do not include agency-fixed effects, we will most likely overstate the effect of adding officers on the number of arrests. Similarly, population weights are necessary for understanding the true relationship between officers and arrests. Since the data is presented at the agency level, there are simply more agencies representing small populations than large populations. Without population weights, we would give, for example, equal weight to New York Police Department as Abbeville Police Department. However, we know that New York Police Department represents a population much larger than Abbeville Police Department, and we can give more weight to agencies that represent larger populations.

2 Data

The FBI's Uniform Crime Reports (UCR) provides information regarding the number of arrests, broken down by race, undertaken by agencies across the United States in a given year. The UCR data is available annually from 1980 until 2012, and I access agency level data where arrests are organized by age, sex, and race. The relevant variables I access in the UCR data are adult white arrests, adult black arrests, adult Asian arrests, originating reporting agency identifier (ORI), agency name, and state. The ORI code uniquely identifies a police agency. Since the arrest data within a given year are reported monthly, for each agency, I sum arrests for all months to find the total yearly arrests undertaken by a given agency.

The Law Enforcement Management and Administrative Statistics (LEMAS) provides agency level information regarding the organization and administration of police and sheriff departments that employ 100 or more full time sworn officers. Information about a nationally representative sample of smaller agencies is also included. The LEMAS years that I access are 1987, 1990, 1993, 1997, 2000, and 2007. The 1999 LEMAS dataset is a limited version that doesn't contain the race variables for police officers. The relevant LEMAS variables that I access are full time sworn white officers, full time sworn black officers, full time sworn Asian officers, agency name, state, and ORI (if available).

To ultimately construct my final dataset, I merged the officer race information provided by LEMAS and the arrest race information provided by the UCR. For the years where the ORI code was included in both LEMAS and UCR, I merged using the ORI code as the unique identifier. When the ORI code was not available for both datasets, I merged based on agency name and state.

After the LEMAS and UCR information is merged together for the available years, there are 7847 total observations. Of the 7847 observations, there are 4293 unique agencies. Table 1 presents the number of observations in each year. There are fewer observations in 1987 due to difficulties in finding a common identifier between the LEMAS and UCR data. Table 2 presents the weighted means for the number of white, black, and Asian arrests or officers in a given agency. Since there are significant differences in the sizes of different agencies (measured by the size of the population an agency represents), weights proportional to the size of the population an agency represents are used. If weights are not used, we will overestimate statistics and features from the smaller agencies. I follow convention by using population weights that are measured in a particular year (I use 1987 population, which is the first year that I consider in my analysis). Table 3 shows that half the agencies represent a population that is less than 15,560. Naturally, half the agencies represent populations more than 15,560, but some agencies in the dataset are particularly large. In fact, there are 9 agencies in the dataset that represent 1987 populations greater than 1,000,000.

2.1 Data shortcomings

An important omission from my data is Hispanic arrest and race information. The reason Hispanic information is not included is because the UCR does not have any information about Hispanic arrests except in 2013[10]. The FBI discontinued collecting ethnic based crime data in 1987 (only to reinstate in 2013), and as a result, the Hispanic figures are implicitly part of white arrests and white officers. If the Hispanic information were available and if the ratio of Hispanic arrests to Hispanic officers were greater than the ratio of white arrests to white officers, then the current statistic of ${}^{\text{white officer}}/_{\text{white arrest}}$ overstates the true ratio.

The fact that an agency voluntarily submits reports on crimes also presents an issue. Agencies have the option of simply not reporting UCR data in a given year. As a result, many agencies are only observed in 1 year. The fact that a sizable number of agencies are only observed in 1 year reduces the relevant sample size when performing a demeaned regression. In addition, even if an agency does file UCR reports in a given year, the data have measurement error problems. The issue of agencies self-reporting statistics is also partially present in the LEMAS data. Large agencies with 100 or more full time sworn officers self report, while the smaller law enforcement agencies chosen through a stratified random sample were not allowed to self-report.

The exclusion of a host of covariates in the regression specification presents a concern if one is worried about omitted variable bias. Namely one could worry that even within an agency, an outside variable such as the local economy could influence both officer and arrest levels. While the inclusion of potential covariates would be ideal, I rely upon evidence that year over year changes in police levels are uncorrelated with the local economy, city budgets, social disorganization, and recent changes in crime[4].

Finally, the lack of a common identifier that is consistent in both the UCR and LEMAS data over all years presents difficulties in matching arrest data to police data. If such an identifier existed, my sample size would be larger, and there would be more agencies that are observed in multiple years.

3 Methodology

The primary statistic I use to compare a race's representation in the police force to representation in the arrest population is the race ratio := $^{\text{\% race arrested}}/_{\text{\% race officers}}$. If, for the sake of example, an agency has 100 officers, 10 black officers, 500 arrests, and 400 black arrests, then the black ratio = $^{.8}/_{.1} = 8$. A competing statistic that I elect not to use is the race difference:=% race arrests - % race officers. Empirically, if we compare the black difference statistic across states, we find that the black difference is inflated in states with large black populations. A strength of the race difference statistic that is not present in the race ratio statistic is that one can calculate the race difference statistic for every agency. When the denominator of the race ratio statistic is 0 (when there are 0 officers of a certain race), then we cannot calculate the race ratio statistic.

Figure 1 shows the weighted and un-weighted means of the race ratio statistic for blacks, whites, and Asians. Since the race ratio statistic cannot be calculated for agencies with 0 officers of a given race, I define the mean of race.ratio, $\overline{race.ratio}$ $= \frac{\overline{(\%race.arrested)}}{\overline{(\%race.officers)}}$. Analogously, the weighted mean of race.ratio = weighted mean (% race arrested) / weighted mean (% race officers), where the weights are provided by the size of the population an agency represents in 1987. Hence after canceling terms, the equation for the weighted mean ratio is the following, where the unit of analysis is the agency:

$$\frac{\sum_{i=1}^{n}(pop_i)(percent.race_i)}{\sum_{i=1}^{n}(pop_i)(percent.officer_i)}$$

Figure 2 shows how the weighted mean ratio for blacks, whites, and Asians have changed since 1990. Only agencies observed over all years are tracked. Hence the time series shows how the weighted mean ratio has changed for the same basket of agencies over time. Tracking the same agencies over time is important because in any given year, agencies might self-select to report their arrest or officer figures. A caveat of interpreting the figure is that the agencies that do appear in all the years tend to be larger agencies. The reason 1987 is not included is because there are relatively fewer observations in 1987 than in other years, as shown in Table 1. Thus, if 1987 were included, the number of agencies that we observe over all years in the data dwindles. In addition, the means for each year are weighted to give greater weight to agencies that represent larger populations.

Figures 3 and 4 show the weighted mean ratio for blacks and whites within each state. Thus for each state separately, I calculate the weighted mean using the weighted mean ratio formula presented earlier.

3.1 Regression Specification

I estimate models of two forms. The first form is as follows:

$$\sqrt{race.arrests_{it}} = B_0 + \sqrt{white.officers_{it}} * B_1 + \sqrt{black.officers_{it}} * B_2 + \sqrt{Asian.officers_{it}} * B_3 + D * \gamma + T * \phi + \epsilon_{it}$$

The second form is as follows:

$$\log \sqrt{BWA.arrests_{it}} = B_0 + \log B_1 * \sqrt{BWA.officers} + +D * \gamma + T * \phi + \epsilon_{it}$$

The unit of observation is at the agency-time level. In the first form, the dependent variable is the number of arrests of a certain race. The X matrix contains the level of black officers, white officers, and Asian officers. The T matrix consists of dummies for each year in the dataset (except the first year). The D matrix consists of dummies for each agency in the dataset (except the first agency). In the second form, the dependent variable is the sum of black, white, and Asian arrests in a given agency-year. The independent variable is the sum of black, white, and Asian officers in a given agency-year. ϵ represents the error term in both forms. Both forms also are weighted by the 1987 population. [1]

The use of agency fixed effects in both forms is very important in obtaining an unbiased estimate of the effect of adding an officer on the number of arrests. Suppose, for example, that a city's collective consciousness about crime is unobserved and influences both the officer counts and the number of arrests in a given agency. Also suppose that this unobserved variable is constant within a city but varies between cities. Then if agency fixed effects are not included, we will obtain an unbiased estimate. [2]

In the second form, the B_1 term represents the elasticity of BWA.arrests with respect to BWA.officers. Since the dataset only includes agencies that have total arrest counts and total officer counts greater than 0, the independent and dependent variable are finite under the log transformation. Hence the coefficient represents an elasticity: a 1% increase in BWA.officers is associated with a $\hat{\beta}_1$% increase in BWA.arrests. Also, the standard error of the elasticity is simply the standard error of $\hat{\beta}_1$

In the first form, we cannot report to taking logs of the dependent and independent variables without throwing observations away. The reason is that many agencies have 0 officers of a particular race (such as 0 Asian officers). Taking the log of a variable with 0 as a value would yield $-\infty$, and would consequently bias our estimate of the elasticity. Instead, we apply a square root transformation to the data, and calculate the elasticity of race.arrests with respect to race.officers in the following way:

$$\epsilon_{y,x} = \overline{\sqrt{x_i}}/\overline{\sqrt{y_i}} * \hat{\beta}$$

$$SE(\epsilon_{y,x}) = \overline{\sqrt{x_i}}/\overline{\sqrt{y_i}} * SE(\hat{\beta})$$

Here the averages are weighted averages, where the weights are determined by the 1987 population. Furthermore, $\hat{\beta}$ refers to coefficient on x when y is regressed

[1] In both forms, the coefficients are achieved through demeaning, rather than including dummies for every agency. In addition, due to large variation in the size of various police forces in the dataset, transformations that pull down extreme values (ie. sqrt and log) are used to prevent the regression coefficients from being unduly influenced by extreme values.

[2] Year fixed effects are also important in controlling for omitted variables that vary over time but not over agency.

on x and other independent variables. Note that for some agencies, y_{it}, the number of arrests of a certain race in a given year, is 0. Thus when calculating the elasticity, we calculate the weighted average of the numerator and denominator separately.

4 Results

4.1 Graphical Results

Figure 1 compares the weighted and unweighted means of the ratio statistic for blacks, whites, and Asians. In both the weighted and unweighted cases, the ratio for whites and Asians is less than or equal to 1, while the ratio for blacks is above 1. Hence, on average, the proportion of all arrests that are white or Asian is less than the proportion of all officers that are white or Asian. Conversely, the the proportion of all arrests that are black is greater than the proportion of all officers that are black by a factor of at least 2.5. Notice that when weighted averages are calculated by using population weights, the weighted mean ratio is less than the unweighted mean ratio for all races. The fraction of all arrests that are white decreases from .78 to .66 when we take into account population weights. The fraction of all officers that are white decreases from .93 to .86 when population weights are used. The results imply that in areas with larger populations, agencies have a smaller fraction of white officers and white arrests relative to the average agency in the dataset. On the other hand, the proportion of all arrests that are black increases from .21 to .32 when we use a weighted mean. The fraction of all officers that are black increases from .06 to .11 when we take into account the population weights. The results imply that in areas with larger populations, agencies have a larger fraction of black officers and black arrests relative to the average agency in the dataset. The change when we use population weights is greatest for Asians. The mean fraction of Asian arrests doubles from .005 to .01, while the mean fraction of Asian officers quadruples from .005 to .02. The results imply that in areas with larger populations, agencies have a larger fraction of Asian officers and Asian arrests relative to the average agency in the dataset.

Figure 2 shows how the weighted mean ratio for blacks, whites, and Asians have changed since 1990 for agencies we observe in all years. As can be readily seen, the weighted mean ratio has been monotonically decreasing for blacks and has been monotonically increasing for whites. The ratio for Asians is lower in 2007 than the ratio in 1990; however, for all observed years before 2007, the ratio has been monotonically increasing. For each race, a paired difference t-test can be used to examine if the difference between the 2007 and 1990 ratio is significantly different from 0. I find that the t statistic for whites, blacks, and Asians is 3.09, -2.65, and -3.03 respectively. Hence for all races, the ratios in 2007 are significantly different from the ratios in 2000 at the 5% level. The formula used to calculate the t-statistic for a particular race is in the footnotes. [3]

Figures 3 and 4 show the weighted mean ratio for blacks and whites within each state over all years. From Figure 3, we see that the weighted white ratio is smallest in the southeastern states of the US. From Figure 4, we see that the weighted black ratio is typically larger for states in the north and north-east. Far west states tend to have lower black ratios and higher black ratios relative to other states.

4.2 Regression Results and Elasticities

We are interested in finding the effect of adding a police officer on arrested made by police officers, and figure 5 shows the general relationship between police officers and arrests. Quite unsurprisingly, we see that more total officers, which is referred to in this paper as BWA officers, is associated with more total arrests, denoted as BWA arrests. The scatterplot also compares the relationship between officers and arrests for each year available by fitting a separate line of best fit for each year. The slopes of the lines for each year is obtained by fitting a regression of total officers on total arrests and an interaction term between total arrests and year. As the visual analysis confirms, the effect of officers on arrests is stronger in 1987

[3]paired difference t stat = $\frac{\overline{\Delta ratio}}{\sqrt{\sum_{i=1}^{N} (\Delta ratio_i - \overline{\Delta ratio})^2 / N}}$, where we take a weighted mean of the Δ ratio, and N refers to the number of agencies that have a difference in ratio that is finite.

than it is in any other year [4]. While figure 5 demonstrates the general relationship between officers and arrests, the slopes overstate the impact of officers on arrests because the slopes are the product of a pooled regression. In effect, an increase in police officers might be associated with towns that have poorer socioeconomic standings, which could be associated with more arrests. To find a more accurate estimate of the effect of adding a police officer on arrests, we need to use the within estimator, and we also need to see how the effect of adding an officer on arrests depends on the race of the officer and the race of the arrestee.

The results obtained in tables 6 through table 9 are all products of regressions where agency fixed effects, time fixed effects, and population weights are used. Thus the coefficients can approximately be interpreted as the average effect of X on Y within each agency. We are primarily interested in the coefficients from tables 6 through 9 as a means of calculating the elasticity between arrests of a certain race and officers of a certain race [5]. However, the coefficients on the year dummies in these tables do carry some valuable information. The square root of black and white arrests has decreased significantly[6] from 1987 to 2007, while the square root of Asian arrests has increased during the same time period.

The most important numerical results in this paper are found in table 5, which represents the elasticities of arrests with respect to officers by race. The elasticity in the second row, for example, can be interpreted as follows: "At the weighted mean of white arrests and white officers, a 1% increase in white officers is associated with a .38% increase in white arrests." There are a couple important facts to note. First, for all races, the elasticity of arrests with respect to white officers is greater than the elasticity with respect to black and Asian officers. If we treat these results as causal estimates, the figures imply that on average, white officers arrest suspects of all races more frequently than black or Asian officers. Second, we observe that an officer is most likely to arrest an individual of his or her own race. The elasticity of arrests with respect to white officers is greatest for white arrests; the elasticity

[4] In fact, the slope in 1987 is significantly larger than the slope in any other year at the 5% level, except for 2007

[5] Recall the equation to calculate the elasticity using a square root transformation in page 7

[6] at the 5% level

of arrests with respect to black officers is greatest for black arrests; the elasticity of arrests with respect to Asian officers is greatest for Asian arrests. The third important fact is that on average, a 1% increase in police officers is associated with a .138% increase in arrests for all levels of officers and arrests[7]. Finally, we should notice that the estimates of the elasticity standard errors are smallest when measuring the elasticity of arrests with respect to Asian officers. However, the t-statistics are largest for the elasticities with respect to white officers.

5 Conclusion

This paper sets out to answer the following questions: 1) is the black ratio ratio in Ferguson (15.5) in 2014 atypical of the US as a whole; 2) how have the black, white, and Asian ratios changed over time; and 3) What is the effect of adding a black, white, or Asian officer on black, white, or Asian arrests. Of the 3891 observations of agency-pairs that have a finite black ratio, only 133 observations have a black ratio above 15.5. Thus Ferguson's black ratio in 2014 would place itself in the top 5%. Of the 169 observations in Missouri, only 3 agency-time observations have a black ratio above 15.5. In addition, table 4 shows that 23 states have 0 agencies that had a black ratio above 15.5 at any year observed in the dataset. Thus, by these measures, Ferguson's black ratio is atypical of the US' black ratio. The weighted black ratio has been steadily declining in every year observed in the dataset (As seen in Figure 2). However, in each year, the weighted black ratio is still greater than 1. The weighted white ratio has been fairly constant over all years at a value below 1. The Asian ratio has also been fairly constant over all years at a value below 1, although we observe a decline in 2007. Finally, we see that white officers arrest suspects of all races more frequently than black or Asian officers, and that an officer is most likely to arrest an individual of his or her own race. Further research could examine why an officer is more likely to arrest an individual of the same race.

[7] This is true because the coefficient from a log-log regression represents elasticity

References

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Table 1: means weighted by population

	weighted average over all agencies
white.officers	1,020.127
black.officers	298.697
Asian.officers	41.057
white.arrests	14,582.440
black.arrests	13,186.450
Asian.arrests	352.901
BWA.officers	1,359.881
BWA.arrests	28,121.790

Table 2: Distribution of size of agencies

	Q1	Q2	Q3	Q4
pop.quartiles	91 - 5156	5157 - 15560	15561 - 54530	54531 - 3,870,000
number.of.agencies	1367	1222	1048	658

Table 3: Number of observations by year

	years	obs.by.year
1	1987	430
2	1990	1,606
3	1993	1,515
4	1997	1,624
5	2000	1,553
6	2007	1,119

Table 4: Statistics by state

	State	Percent observations with black ratio above ferguson's	Number of observations
34	NY	14.516	124
39	RI	13.462	52
22	MI	8.215	353
7	CT	5.814	172
31	NJ	3.491	401
20	MD	2.941	68
23	MN	2.765	217
41	SD	2.128	47
3	AR	2.041	147
27	NC	1.792	279
24	MO	1.775	169
44	UT	1.754	57
38	PA	1.592	377
21	ME	1.408	71
16	KS	1.389	72
14	IL	1.351	148
25	MS	1.235	81
6	CO	1.136	176
48	WI	1.111	180
12	IA	1.075	186
43	TX	1.043	671
49	WV	0.962	104
35	OH	0.913	219
36	OK	0.885	226
2	AL	0.515	194
5	CA	0.462	649
10	GA	0.342	292
1	AK	0.000	16
4	AZ	0.000	111
8	DE	0.000	33
9	FL	0.000	149
11	HI	0.000	9
13	ID	0.000	63
15	IN	0.000	152
17	KY	0.000	79
18	LA	0.000	116
19	MA	0.000	208
26	MT	0.000	27
28	ND	0.000	51
29	NE	0.000	61
30	NH	0.000	64
32	NM	0.000	44
33	NV	0.000	19
37	OR	0.000	131
40	SC	0.000	171
42	TN	0.000	222
45	VA	0.000	183
46	VT	0.000	17
47	WA	0.000	141
50	WY	0.000	48

Table 5: Elasticities of Arrests with Respect to Officers

	comparison	value	standard.error
1	BWA arrests;BWA officers	0.138	0.037
2	white arrests;white officers	0.380	0.092
3	white arrests;black officers	0.092	0.147
4	white arrests; Asian officers	-0.009	0.034
5	black arrests;white officers	0.335	0.109
6	black arrests; black officers	0.150	0.182
7	black arrests; Asian officers	0.051	0.047
8	Asian arrests;white officers	0.233	0.125
9	Asian arrests; black officers	0.098	0.148
10	Asian arrests; Asian officers	0.059	0.037

Table 6: Regression of Total Arrests on Total Officers

Variable	**Coefficient**	**(Std. Err.)**
lnBWAofficers	0.138	(0.037)
1987	0.000	(0.000)
1990	0.147	(0.050)
1993	0.079	(0.045)
1997	0.150	(0.044)
2000	0.088	(0.048)
2007	-0.035	(0.067)
Intercept	8.109	(0.200)

Table 7: Regression of white Arrests on Officers using sqrt transformation

Variable	**Coefficient**	**(Std. Err.)**
$\sqrt{white.officers}$	1.492	(0.361)
$\sqrt{black.officers}$	0.863	(1.379)
$\sqrt{Asian.officers}$	-0.268	(1.010)
1987	0.000	(0.000)
1990	0.320	(3.512)
1993	-4.592	(3.874)
1997	-3.300	(5.159)
2000	-5.353	(4.210)
2007	-11.965	(5.452)
Intercept	55.602	(12.462)

Table 8: Regression of black Arrests on Officers using sqrt transformation

Variable	**Coefficient**	**(Std. Err.)**
$\sqrt{white.officers}$	1.065	(0.347)
$\sqrt{black.officers}$	1.135	(1.379)
$\sqrt{Asian.officers}$	1.240	(1.147)
1987	0.000	(0.000)
1990	1.704	(2.068)
1993	0.375	(2.454)
1997	-1.994	(3.423)
2000	-3.197	(2.632)
2007	-9.116	(4.171)
Intercept	37.852	(9.564)

Table 9: Regression of Asian Arrests on Officers using sqrt transformation

Variable	**Coefficient**	**(Std. Err.)**
$\sqrt{white.officers}$	0.093	(0.050)
$\sqrt{black.officers}$	0.093	(0.141)
$\sqrt{Asian.officers}$	0.179	(0.114)
1987	0.000	(0.000)
1990	0.472	(0.489)
1993	1.504	(0.454)
1997	2.477	(0.501)
2000	2.217	(0.514)
2007	1.724	(0.658)
Intercept	4.202	(0.846)

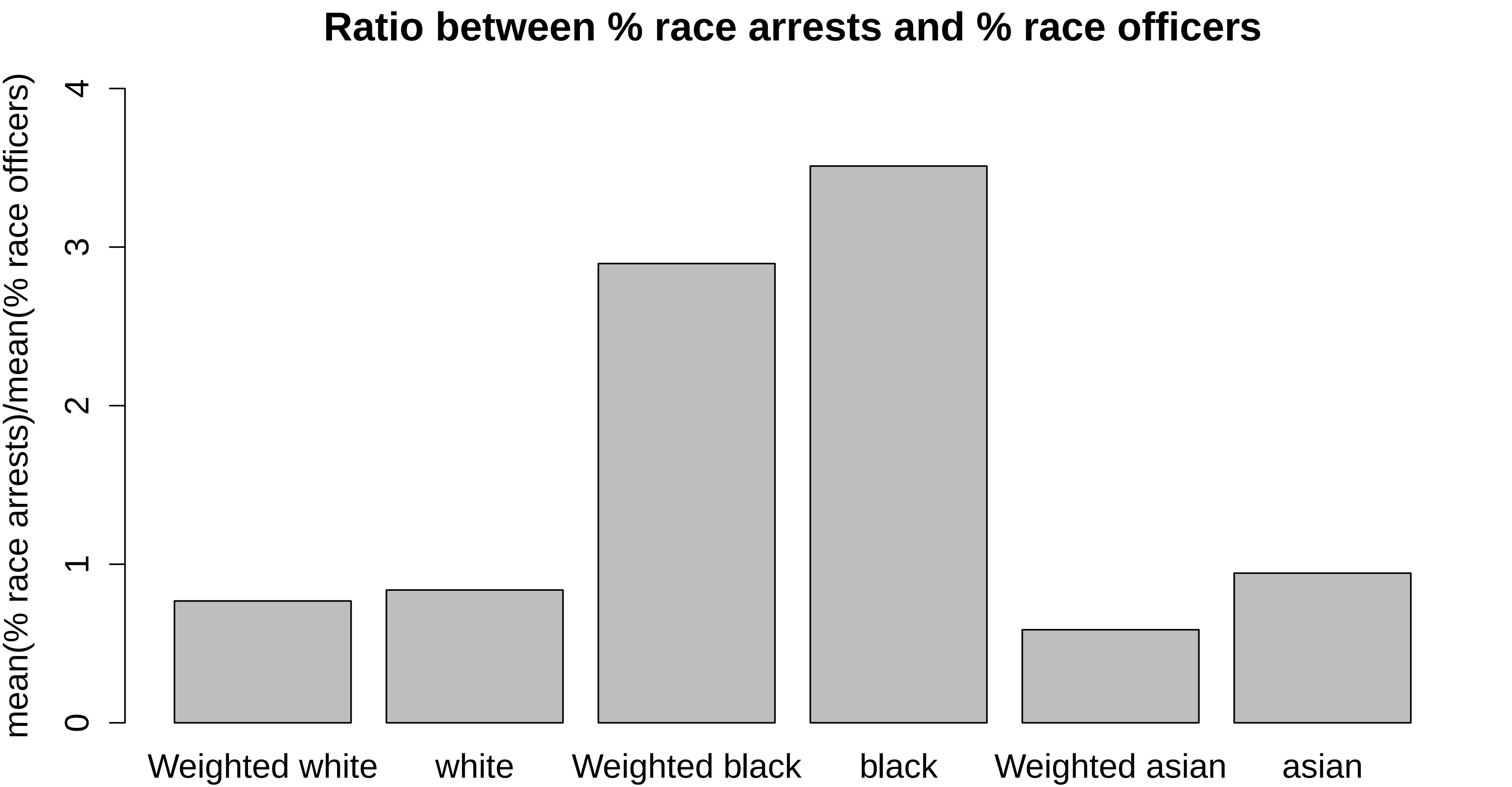
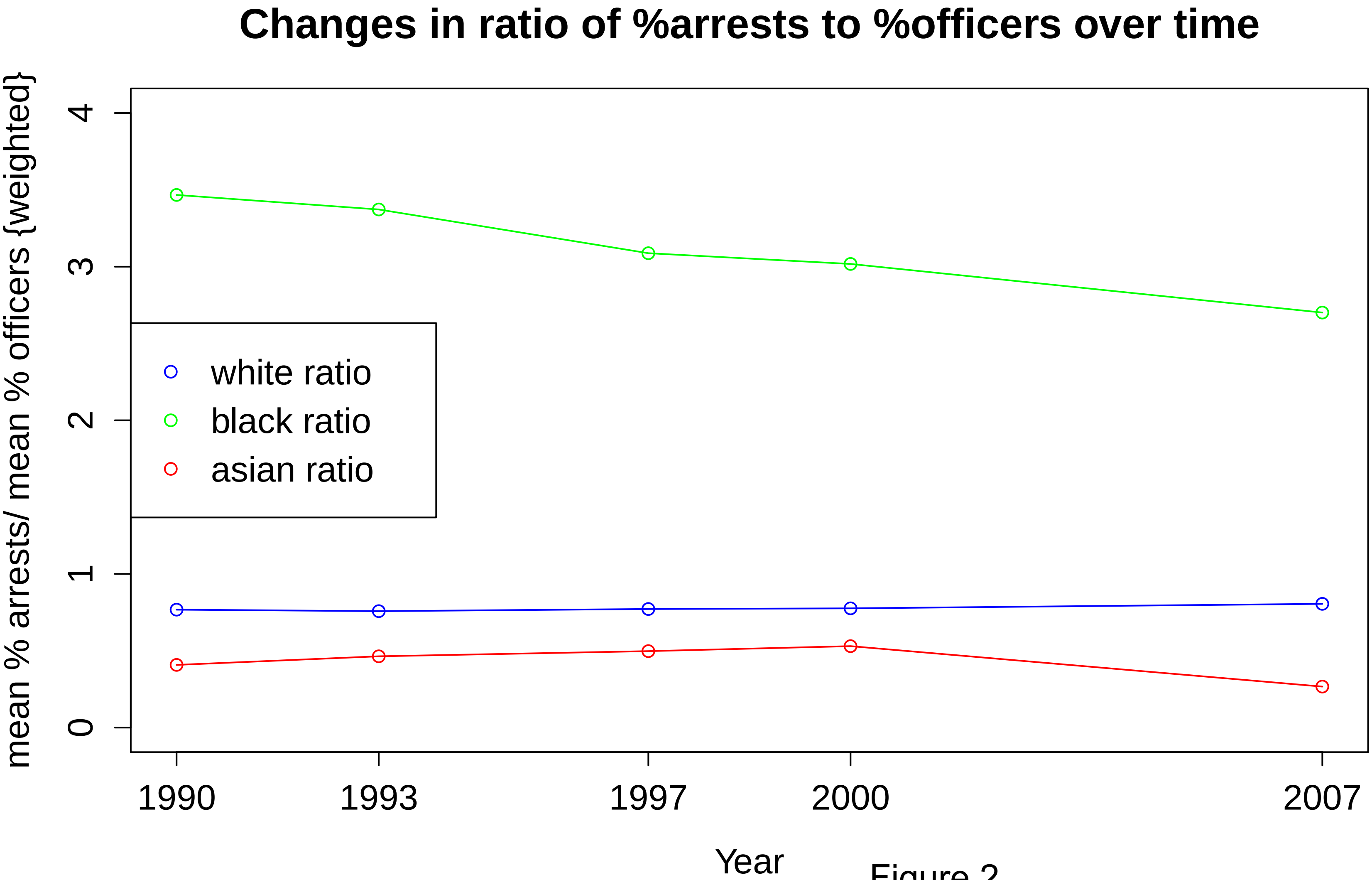
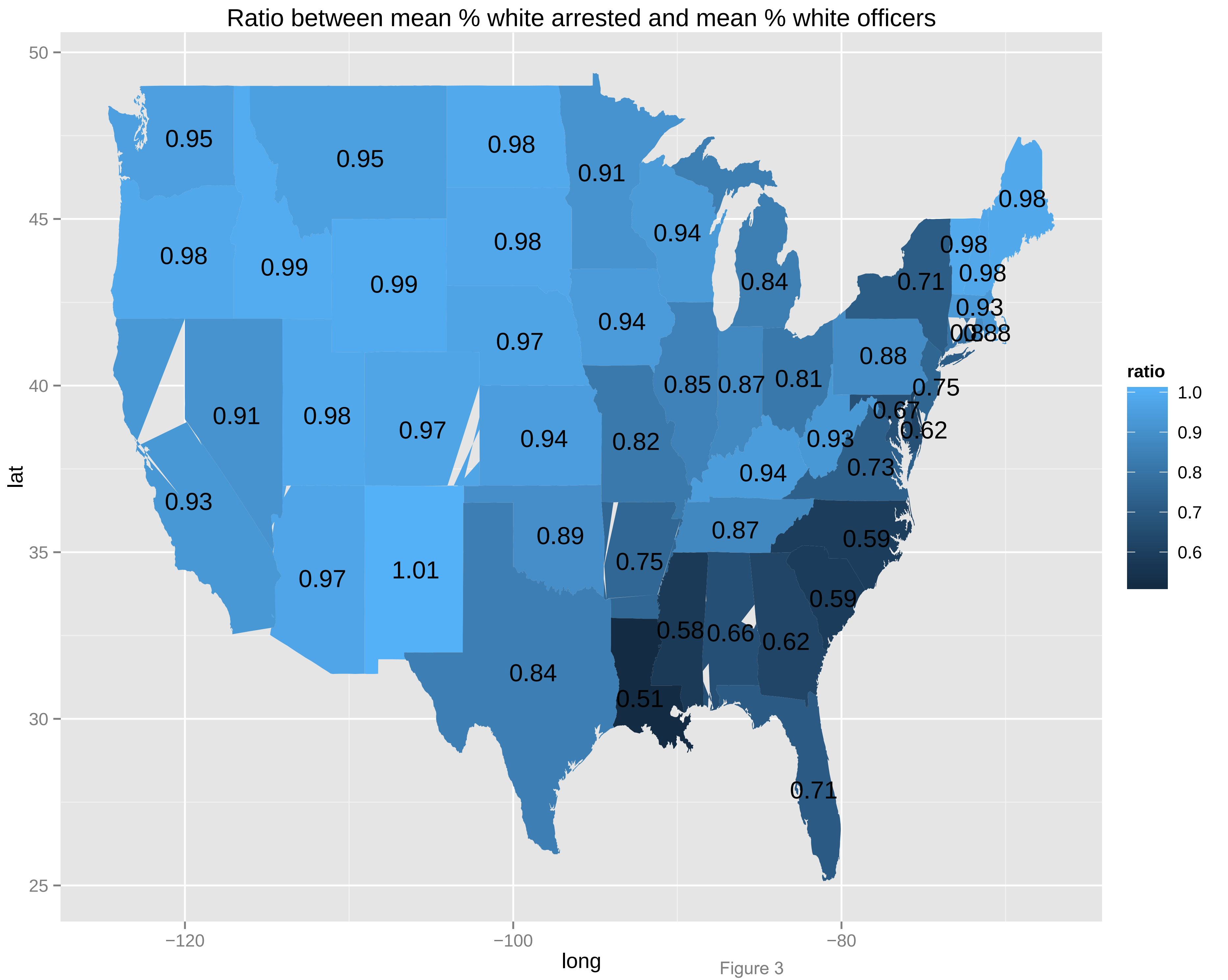

Ratio between % race arrests and % race officers
mean(% race arrests)/mean(% race officers)
0
1
2
3
4
Weighted white
white
Weighted black
black
Weighted asian
asian

Figure 1



Changes in ratio of %arrests to %officers over time
mean % arrests/ mean % officers {weighted}
0
1
2
3
4
white ratio
black ratio
asian ratio
1990
1993
1997
2000
2007
Year

Figure 2



Ratio between mean % white arrested and mean % white officers
50
45
40
35
30
25
lat
−120
−100
−80
long
ratio
1.0
0.9
0.8
0.7
0.6
0.95
0.95
0.98
0.91
0.98
0.98
0.94
0.98
0.99
0.99
0.98
0.84
0.71
0.98
0.94
0.97
0.93
0.88
0.88
0.85
0.87
0.81
0.75
0.91
0.98
0.97
0.94
0.82
0.67
0.62
0.93
0.94
0.73
0.93
0.89
0.87
0.59
0.75
0.97
1.01
0.59
0.58
0.66
0.62
0.84
0.51
0.71

Figure 3

Ratio between mean % black arrested and mean % black officers

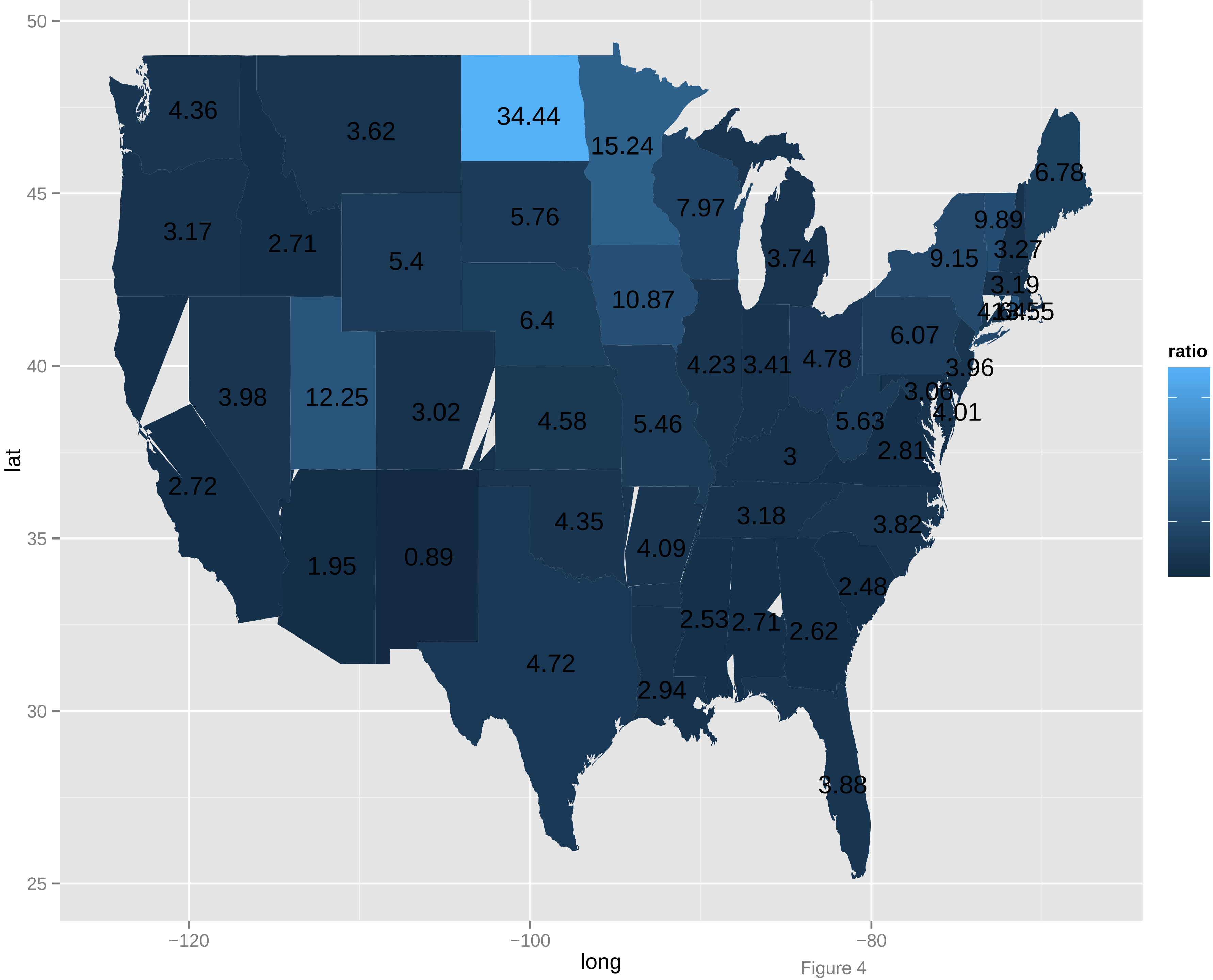
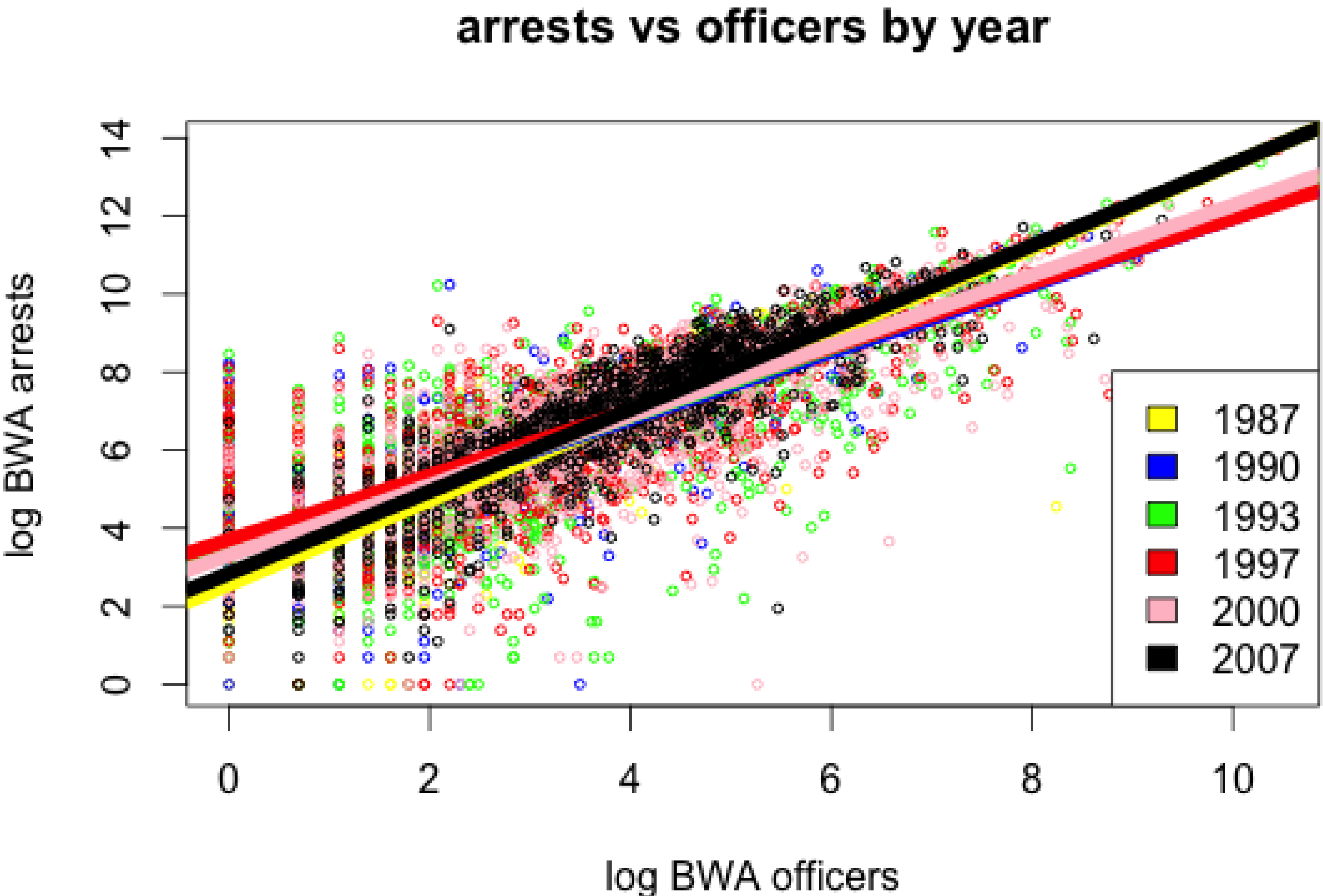


Figure 4



arrests vs officers by year
log BWA arrests
0
2
4
6
8
10
12
14
log BWA officers
0
2
4
6
8
10
1987
1990
1993
1997
2000
2007

Figure 5

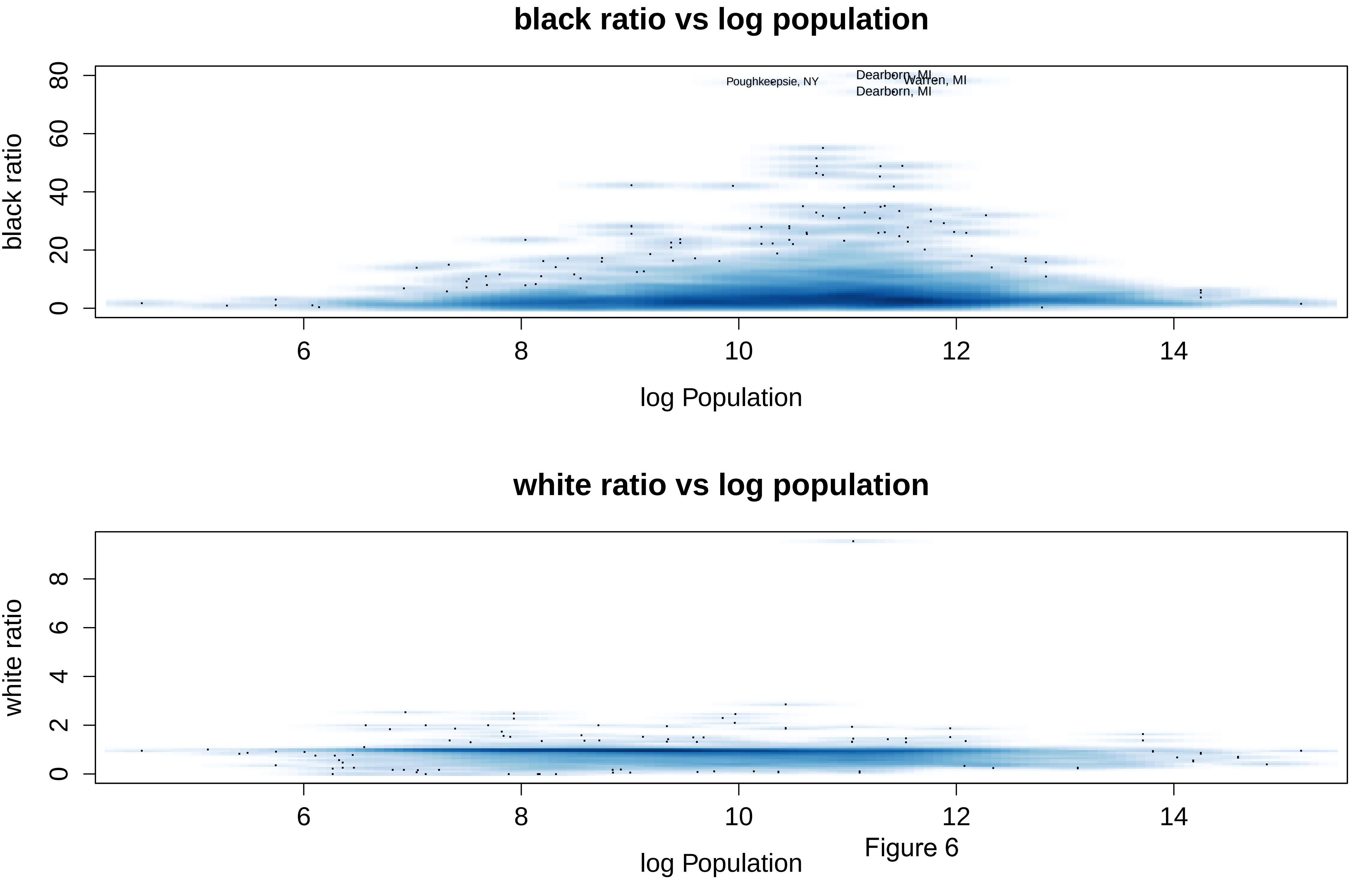
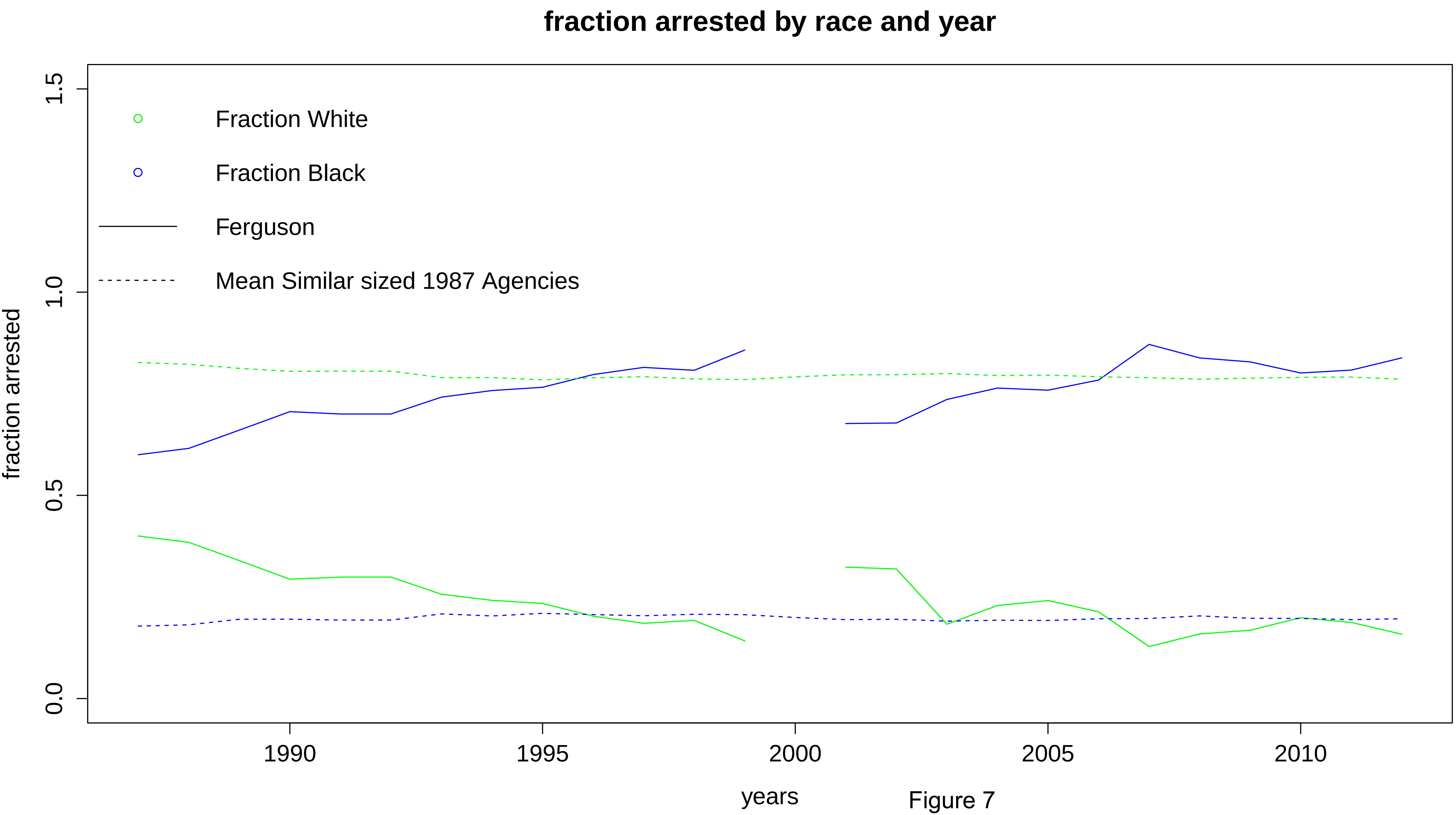

black ratio vs log population
black ratio
log Population
Poughkeepsie, NY
Dearborn, MI
Warren, MI
Dearborn, MI
0
20
40
60
80
6
8
10
12
14
white ratio vs log population
white ratio
log Population
0
2
4
6
8
6
8
10
12
14

Figure 6


fraction arrested by race and year
Fraction White
Fraction Black
Ferguson
Mean Similar sized 1987 Agencies
fraction arrested
0.0
0.5
1.0
1.5
1990
1995
2000
2005
2010
years
Figure 7

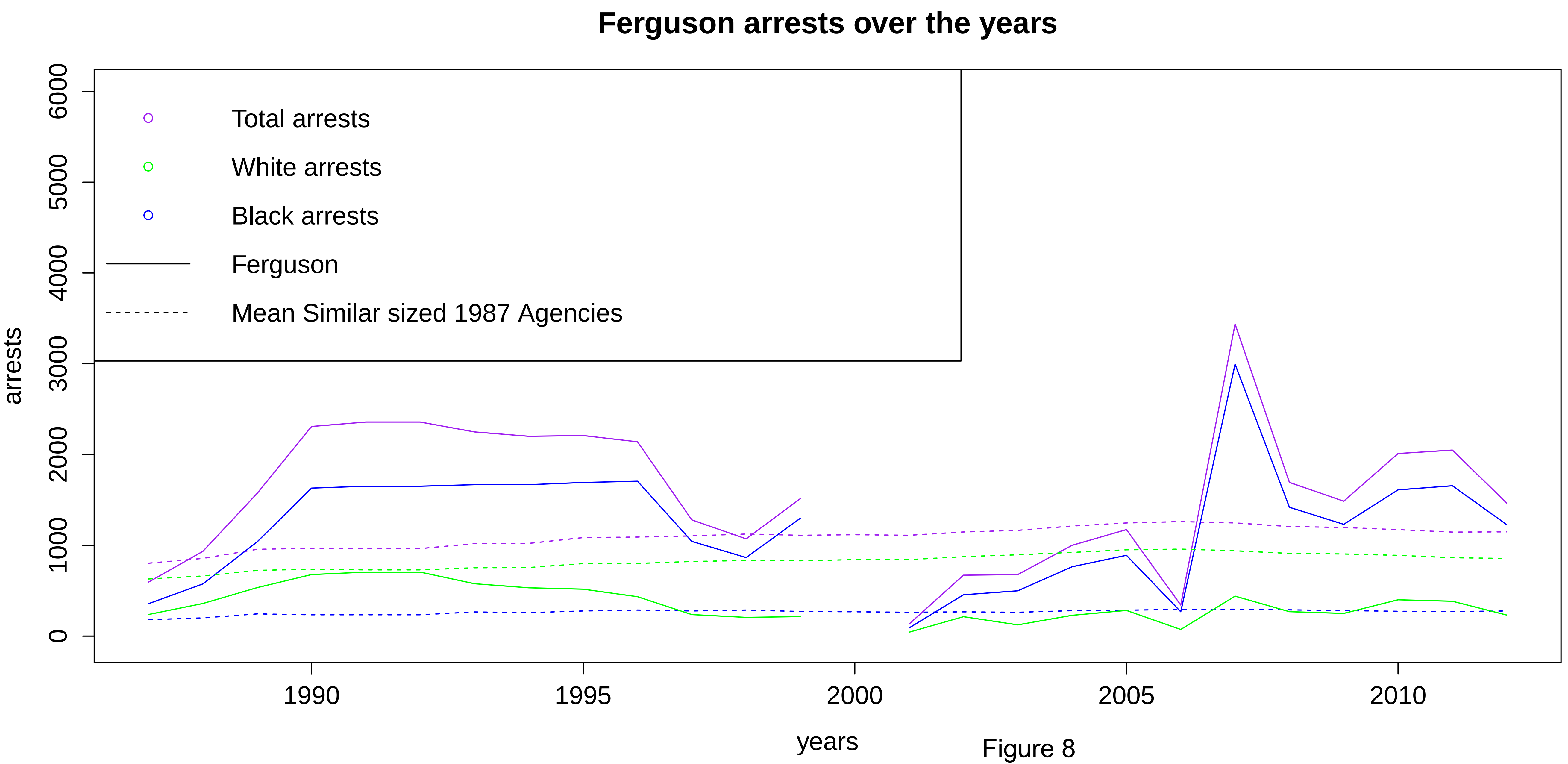
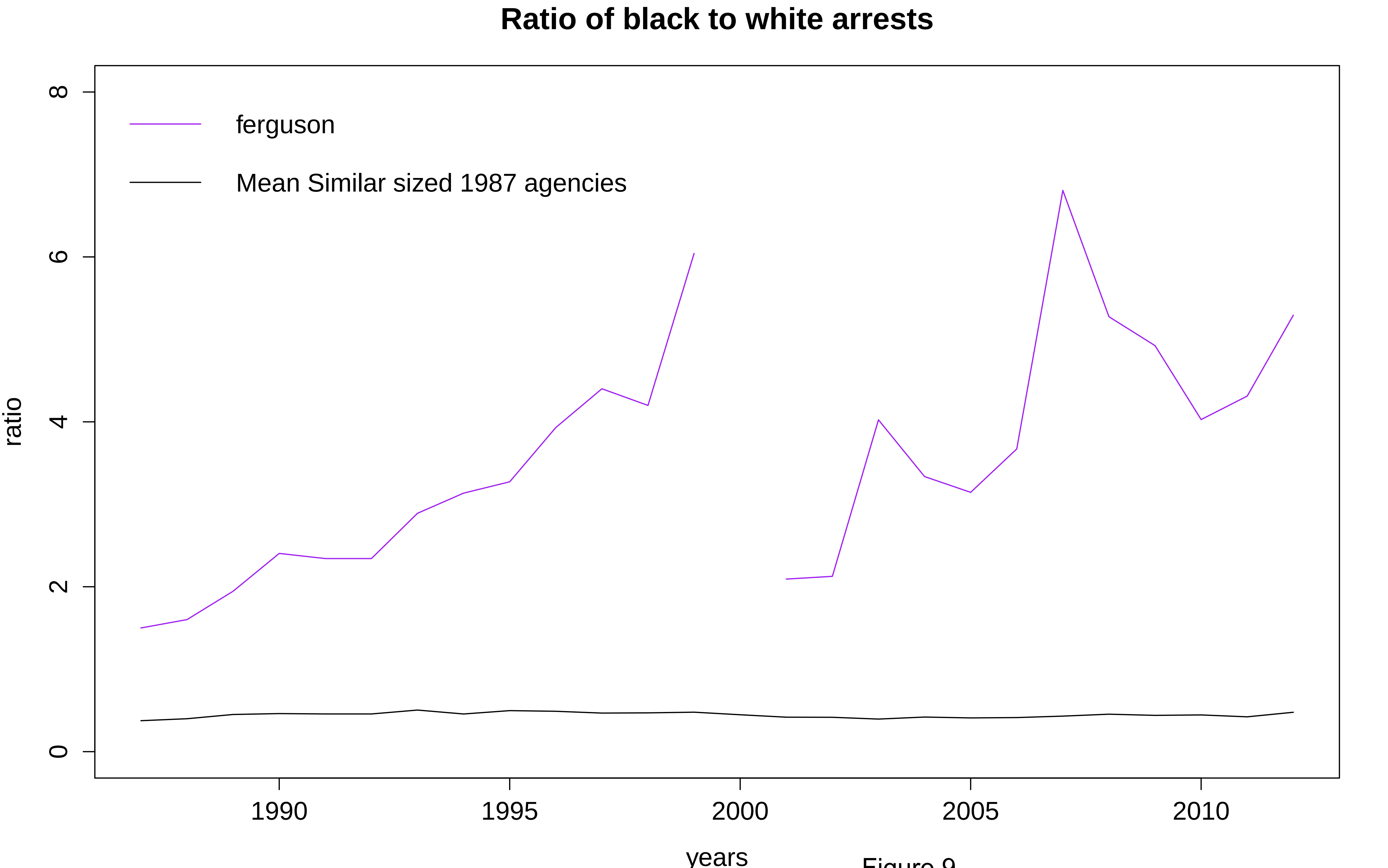

Ferguson arrests over the years
Total arrests
White arrests
Black arrests
Ferguson
Mean Similar sized 1987 Agencies
arrests
0
1000
2000
3000
4000
5000
6000
1990
1995
2000
2005
2010
years

Figure 8



Ratio of black to white arrests
ferguson
Mean Similar sized 1987 agencies
ratio
0
2
4
6
8
1990
1995
2000
2005
2010
years

Figure 9