DWB in COMO:
Understanding Race Disparities in Vehicle Stops and Searches

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Executive Summary:

In response to public concerns regarding racial disparities in traffic stops and searches in Columbia, I investigate to what extent these differences result from racial profiling on the part of the Columbia Police Department (CPD). I examine incident-level data from 2014-2017 and apply standard statistical tests for identifying potential racial bias in stops and searches.

The major findings in this report are as follows:

1) The statistical analysis presented in the annual Vehicle Stops Reports (VSR) by the Attorney General of the state of Missouri (AG) is potentially misleading regarding the existence of racial bias among local police agencies. In particular, the "disparity index" calculated in these reports is *uninformative* about the existence of racial bias in traffic stops.

2) Evidence from VSR shows that the CPD makes fewer traffic stops and issues fewer citations per population than other large cities in Missouri (or compared to the state average); the CPD also conducts fewer searches per population than most other large cities in the state (or the state average). Further, both stops and vehicle searches by the CPD are particularly efficient in that they result in a relatively high rate of arrests, outstanding warrants and contraband.

3) Evidence from the VSR shows that while the CPD stops, searches and arrests black drivers at a higher rate than non-black drivers relative to the local population, black drivers who are stopped are also more likely to have outstanding warrants and contraband (including weapons).

4) Evidence from incident-level data for Columbia does not indicate racial profiling in vehicle stops for 2016-2017; however, there is evidence consistent with racial profiling of black drivers for stops made in 2014-2015 (especially among males and older drivers).

5) Evidence from incident level data on post-stop outcomes (citations, arrests and searches) does not indicate racial bias against black drivers in Columbia in 2016-2017 or 2014-2015.

6) Overall, despite persistent and growing disparities in vehicle stops and searches in Columbia, there is no consistent evidence of systemic racial bias by the CPD across stops, citations, arrests and searches, nor is there any evidence of an increase in racial bias in stops or post-stop outcomes from 2014-2015 to 2016-2017.

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Introduction:

In Columbia, black drivers are stopped by police at a disproportionately high rate compared to the black percentage of the local population. As documented by the most recent annual report on vehicle stops from the Attorney General of Missouri (AG), black drivers in Columbia are stopped by police at a rate roughly three times greater than the black share of the local population.[2] This disparity is higher than for the state overall and has been increasing in recent years. These facts have been cited by concerned citizens and local media as evidence of possible racial bias on the part of the Columbia Police Department (CPD).[3]

However, such disparities are by no means unique to Columbia or to vehicle stops. Racial disparities across all manner of economic and social indicators are the norm in America, so it is no surprise that interrelated differences in education, family structure, income and residential location are all reflected in criminal justice and policing statistics. Racial bias is also a fact of life in America, so at least some part of these differences in economic and social indicators are attributable to the effects of current and past racial discrimination. Moreover, racial bias may have a proximate impact on criminal justice statistics, as in the case of racial profiling in vehicle stops; or, the effects of bias may reverberate through a complex causal chain before impacting criminal justice outcomes, as may be the case with residential segregation or discrimination in employment. Consequently, there are many reasons for observed racial disparities in vehicle stops in Columbia and the presence of such disparities is by itself not evidence of racial profiling by the CPD.

This distinction between the existence of racial *disparities* in economic and social indicators and the existence of racial *bias* on the part of particular actors is both well-understood and uncontroversial in the social sciences. Nevertheless, these concepts are often conflated in public discourse and especially so in the context of racial profiling by police.[4] Given the sensitive and sometimes heated nature of the discussion over the existence and extent of racial bias, it is understandable if the fundamental distinction between disparities and discrimination is sometimes lost in the fray. This appears to be the case in Columbia, as multiple interested parties persist in erroneously treating disparities in vehicle stops as *prima facie* evidence of racial profiling by the CPD.

For this reason, in Part One of this report, I explain why the data on racial disparities presented in the annual Vehicle Stops Report (VSR) are not informative regarding the existence of racial

[2] Throughout this report, I confine attention to black versus white disparities. This focus is consistent with much of the public discussion of disparities in traffic stops and searches in Columbia (and Missouri), but also in part due to the relatively infrequency of stops involving drivers of other races or recorded Hispanic ethnicity.
[3] E.g., https://www.columbiamissourian.com/news/local/traffic-stop-report-shows-racial-disparities-as-officials-downplay-numbers/article_6018752a-65ac-11e8-b3c1-d319bcc3cee9.html; and http://www.columbiatribune.com/news/20180531/data-show-increased-racial-disparity-in-columbia-traffic-stops.
[4] E.g., http://news.stlpublicradio.org/post/missouri-report-traffic-stops-revives-call-anti-discrimination-policies#stream/0

bias in policing. The remainder of this report then analyzes more detailed data on vehicle stops than what is found in the VSR in order to diagnose whether the CPD engages in racial profiling.

In contrast to the aggregate data reported by the Missouri AG office, the CPD makes available a wealth of incident-level data on vehicle stops that is well-suited to conducting state-of-the-art statistical tests for racial bias in both stops and searches. Several police departments around the country have made similar data available as part of Police Data Initiative;[5] however, the information that has been made public by the CPD is particularly detailed and useful for analyzing the existence and extent of racial bias in policing.

In Part Two of this report, I analyze incident-level vehicle stop data for Columbia and conduct several tests for racial bias in both stops and searches. These tests exploit the fact that it is easier to identify the race of drivers in daylight versus darkness. Since twilight occurs at different times throughout the year, it is then possible to conduct a natural experiment on vehicle stops that occur in daytime versus nighttime – but at the same time of day. This technique holds constant the racial composition of the driving population and permits a direct statistical test for potential bias in vehicle stops and searches.

The results of these tests demonstrate that there is no statistically significant evidence of systematic racial profiling in recent traffic stops and searches by the CPD, nor any evidence that racial profiling in stops and searches is on the increase. However, there is some evidence consistent with profiling in 2014-2015, especially among male and older drivers. On the other hand, there is no corroborating evidence of racial profiling for either: i) other groups or ii) post-stop outcomes for the period 2014-2015.

This report is limited to what can be learned from the available data and speaks only to the average or overall behavior across all police officers. For example, the analyses conducted in this report cannot rule out the existence of racial bias in particular incidents or on the part of particular officers. Nevertheless, it can be stated with confidence that any such bias is not the norm for the CPD in recent years. Given the widespread attention and intense concern about racial disparities in stops and searches documented in recent AG reports – and what these disparities might imply regarding racial bias in policing, these findings should be very welcome news to everyone concerned about potential racial profiling in Columbia.

[5] https://www.policedatainitiative.org/

Part One: Analyzing Aggregate Data from the Vehicle Stops Report

In compliance with state law, local police departments in Missouri record information on all vehicle stops; these incident-level data have the potential to be very useful for diagnosing the presence of systematic racial bias in policing. However, only summary statistics are included in the annual VSR. Beyond listing simple rates and disparity indices by race\ethnicity for each police agency in the state, the VSR is devoid of any analysis of racial disparities.[6] This is unfortunate, since much more can be done with the incident-level data that is already being collected and because the disparity indices that are reported in the VSR are commonly misconstrued as a meaningful indicator of racial bias in policing.

Racial Disparities versus Racial Bias

The "disparity index" (DI) for black drivers involved in vehicle stops is simply the ratio of the percentage of black drivers among those drivers who are stopped divided by the percentage of the local black (driving age) population, or:

$$\textit{Disparity Index for Vehicle Stops} = \frac{\{100\% \times [(\text{Number of stops with black drivers})/(\text{Number of all stops})]\}}{\{\% \text{ Black in the Local Population}\}}$$

If the DI>1, then black drivers are over-represented in vehicle stops relative to the percent of the local population that is black. Conversely, if DI<1, then black drivers are underrepresented in vehicle stops. The disparity index can also be calculated for post-stop outcomes, by simply substituting the number of citations, arrests or searches for stops in the formula above.

As noted in the VSR, if the black and non-black populations are identical in all respects, then absent any racial bias in policing, DI=1. Likewise, assuming that there are no differences in the black and non-black populations, then DI>1 is evidence of racial bias against blacks by police. Of course, the black and non-black populations are not identical in many important respects, so racial bias in policing is only one of many possible causes of disparities in vehicle stops and searches. However, it should be expected that DI>1 even in the absence of proximate discrimination by police.

This is because, in general, the black and non-black population differ across numerous economic and social indicators, including educational attainment, income, and residential location. It is well-understood that these underlying differences produce differences in driving

[6] The VSR has been produced each year since 2000 by the same team of (mostly out-of-state) researchers at an annual cost of $22,000; the contents of the VSR reports remain essentially unchanged, despite advances in the methodology for analyzing racial disparities in policing.

patterns, exposure to police and offending that are reflected in racial disparities in traffic stops and searches.[7]

This means that simple descriptive measures of racial disparities like the "disparity index" may be high or low regardless of the presence and extent of racial bias on the part of police. Likewise, the disparity index for vehicle stops may be increasing or decreasing due to many factors other than a change in the presence and extent of racial bias in policing. In other words, the disparity index for vehicle stops reported in the VSR is *uninformative* about the existence of racial bias on the part of police.

Indeed, this is why such "disparity indices" are not the means by which researchers diagnose the presence of racial profiling in vehicle stops. Nevertheless, some concerned citizens may infer that the disparity indices reported in the VSR are actually an unambiguous indicator of racial bias on the part of police in Missouri; this is simply not true.

Despite the shortcomings of the disparity index as a measure of racial bias, it has become a familiar measure of raw differences (i.e., disparities) in vehicle stops data simply because it is reported as part of the annual VSR. For this reason, it is useful to consider how disparity indices are calculated and what actually can be learned from comparing these indices over time and across cities in Missouri.

Calculating the Disparity Index

The authors of the VSR use local population data from the most recent decennial census to calculate the disparity index for black drivers. However, the percent of population that is black is not constant over time. In Columbia, the percent black population has been increasing over the last several years (as has the percent of persons self-identifying as black in combination with another race). This means that the disparity index calculated in the VSR somewhat overstates the racial disparity in traffic stops.

For example, the 2017 VSR reports a disparity index for black drivers of 3.28 based on 2010 demographic data (compared to a disparity index of 2.97 in the 2015 VSR). This increase in the reported DI has been the source of some consternation in the local political scene. However, the disparity index in 2017 is "only" 2.82 when calculated using the most recent demographic data from the 2016 American Community Survey (ACS) conducted by the U.S. Census.[8]

Table 1.1 (below) compares disparity indices based on these different sources of demographic data for the largest cities in Missouri and statewide. As calculated in the VSR using 2010 census

[7] E.g., National Institute of Justice, "Racial Profiling and Traffic Stops" available at: https://www.nij.gov/topics/law-enforcement/legitimacy/pages/traffic-stops.aspx); also see: Grogger and Ridgeway (2006). For a related application of the same concern, see Fryer (2018).

[8] The VSR also calculates disparity indices using only the "black alone" definition for race; if instead, "black alone or in combination" is used to calculate disparity indices, then the index for Columbia is even lower. This is because in the most recent ACS data from 2016 show 14.2% of the population is "black (alone or in combination)"; using this figure lowers the disparity index for vehicle stops in Columbia to 2.30 in 2017.

demographics, the disparity index for black drivers in Columbia falls in the mid-range for larger cities in Missouri. However, while the disparity index calculated using more up-to-date data from the ACS produces a lower score for Columbia, compared to other cities, the updated disparity index is second highest among the nine largest cities in Missouri (behind only O'Fallon) and still well above the average for the state.

Table 1.1: Measuring Disparities: 2010 Census versus 2016 ACS

	2010 Census			2016 American Community Survey		
Largest Cities	**Population (age 16+)**	**Black (%)**	**Disparity Index**	**Population (age 16+)**	**Black (%)**	**Disparity Index**
Kansas City	360,381	28.2	1.41	381,279	28.5	1.39
St Louis	260,218	45.7	1.40	256,102	46.1	1.37
Springfield	133,431	3.8	2.61	140,413	4.9	1.99
Columbia	***90,168***	***10.0***	***3.28***	***100,781***	***11.6***	***2.82***
Independence	92,953	4.8	3.96	92,346	7.1	2.65
Lee's Summit	68,685	7.6	2.59	71,474	8.0	2.46
O'Fallon	57,940	3.8	3.48	66,965	-	-
St Joseph	60,683	5.9	1.95	61,787	5.8	1.96
St Charles	54,357	5.4	4.33	57,841	5.5	4.22
Statewide						
Missouri State Highway Patrol	4,730,501	10.9	1.05	4,865,244	11.5	.99
Missouri (total)	4,730,501	10.9	1.72	4,865,244	11.5	1.63

Notes: The 2016 ACS is the latest available source of demographic data for local areas. For the ACS, percent black refers to the total population.

ACS data for 2017 is not yet available, but if the rate of increase in the black population of Columbia remained constant through 2017, then the disparity index calculated using forthcoming 2017 ACS data should fall to about 2.63 (down from 2.74 in 2015). Consequently, by using 2010 demographic data, the VSR somewhat overstates the disparity index for black drivers in Columbia and incorrectly gives the impression that the disparity index is increasing from 2015 to 2017, when in fact the entire apparent increase is more than accounted for by the changing demographic composition of Columbia.

However, a note of caution is in order: the disparity index for Columbia (as reported in the VSR) has been increasing since 2011, when it stood at 1.99. Demographic change is surely part of the explanation for this increase over the longer period, but not all of the explanation. For example, changes in crime trends and policing might contribute to this increase, but so also might an increase in racial profiling. Consequently, more sophisticated and definitive tests for racial profiling are needed (see Part Two).

The preceding discussion demonstrates that the measured disparity index is sensitive to the source of demographic data used in calculating the index. However, concerns with the exact measurement of disparity indices are somewhat beside the point; any consistent method is as good as any other, as long as the shortcomings of the index as a measure of bias (i.e., it isn't) are kept in mind.

Comparing Disparity Indices across the Largest Cities and Statewide

Table 1.2 and Table 1.3 report disparity indices (for stops and post-stop outcomes) for each of the largest cities in Missouri, as well as for the Missouri Highway Patrol and the state as a whole. These indices are calculated using data on stops and post-stop outcomes from the most recent VSR, along with the most recent available demographic data from the 2016 ACS (unlike the VSR which uses demographic data from the 2010).

Table 1.2: Disparity Indices for Stops

Largest Cities	**Stops**	**Citations**	**Arrests**	**Outstanding Warrants**
Kansas City	1.39	1.45	1.88	2.61
St Louis	1.37	1.48	1.59	1.66
Springfield	1.99	1.62	3.24	3.67
Columbia	***2.82***	***2.76***	***3.77***	***4.67***
Independence	2.65	2.91	3.55	3.84
Lee's Summit	2.46	2.88	5.26	6.25
O'Fallon	-	-	-	-
St Joseph	1.96	2.26	3.06	3.39
St Charles	4.22	4.63	5.55	7.60
Statewide				
Missouri State Highway Patrol	.99	1.31	1.72	2.35
Missouri (total)	1.63	2.00	2.24	3.07

Notes: The disparity index is calculated as the percent black in each category divided by the percent black in the local population (using 2016 ACS demographic data).

Consider the results in Table 1.2; across the board, Columbia has disparity indices that exceed one, but so do all the other larger cities in Missouri. Columbia has the second highest disparity index for vehicle stops but falls more in the middle for similarly measured disparities in citations, arrests and arrests for persons with outstanding warrant. These disparities are no doubt generated in part by socioeconomic differences between groups but may also be partially due to racial bias in policing. More sophisticated tests are needed to tease out how much of this difference might be attributable to biased policing.

However, it is worth noting that the disparity index for an arrest for outstanding warrants is 4.67 in Columbia; this means that black drivers who are stopped by police in Columbia are much more likely to have outstanding warrants than relative to the black share of the local population. This difference helps explain why the disparity index for vehicle stops resulting in arrests is also greater than one; it is because black drivers are not identical to non-black drivers in all respects.

Now consider the results in Table 1.3. Again, across the board, the disparity index for searches and the outcomes of searches are greater than one not only for Columbia, but for almost every other case, as well (the only exceptions are for searches lasting longer than 30 minutes, which are very infrequent events).

Table 1.3: Disparity Indices for Searches

Largest Cities	**Searches**	**Search > 30 min**	**Contraband**	**Weapons**
Kansas City	2.21	2.27	2.30	2.61
St Louis	1.58	1.38	1.49	2.00
Springfield	3.14	4.08	3.01	3.64
Columbia	***4.25***	***5.03***	***4.41***	***6.33***
Independence	3.45	0.61	2.94	3.52
Lee's Summit	5.04	5.00	5.26	6.09
O'Fallon	-	-	-	-
St Joseph	3.51	0.00	3.41	5.44
St Charles	4.97	4.03	4.79	10.09
Statewide				
Missouri State Highway Patrol	1.92	1.49	2.04	2.56
Missouri (total)	2.24	1.34	2.13	4.00

Notes: The disparity index calculated as the percent black in each category divided by the percent black in the local population (using 2016 ACS demographic data).

The disparity index for searches is relatively high in Columbia, but so is the hit rate for contraband among drivers searched. Again, this means that the population of black drivers who are searched is very different from other drivers in that they are much more likely to have contraband (i.e., stolen property, illegal drugs, weapons, etc.).

This exercise helps explain why black drivers are more likely to be stopped than non-black drivers in Columbia, as well as in Missouri. The characteristics of these groups are not identical and black drivers are disproportionately more likely to have outstanding warrants or contraband (including weapons). Of course, this doesn't mean that racial bias plays no part in generating racial disparities, but it is clear that racial disparities in stops and searches are not

driven entirely by racial bias in policing. This confirms what was explained earlier: racial disparity indices are not a reliable indicator of the presence or extent of racial bias in policing.

Why Does the Disparity Index Vary Across Cities?

The racial composition of drivers stopped will depend on many factors other than the percent of the driving population that is black or non-black. The allocation of local police to different activities will affect the number and type of drivers that are stopped, as might the relative amount of traffic on interstate highways versus city streets.

Table 1.4 provides a comparison of the number and types of vehicle stops across the largest cities in Missouri. Columbia stands out for the very low frequency of stops relative to local population (12% versus the statewide total of almost 32%).

Table 1.4: Frequency of Stops

Largest Cities	**Stops (%pop)**	**Interstate (% stops)**	**Speeding (% stops)**	**Investigative (% stops)**	**Other (% stops)**
Kansas City	22.0	17.3	47.5	7.3	45.2
St Louis	17.5	5.8	18.7	12.7	68.6
Springfield	17.7	0.1	29.8	3.1	67.1
Columbia	***12.3***	***3.8***	***14.8***	***2.5***	***82.8***
Independence	23.3	10.8	47.3	5.2	47.5
Lee's Summit	22.8	1.0	38.5	4.0	57.6
O'Fallon	25.6	20.2	28.2	2.1	69.7
St Joseph	16.3	0.8	22.7	2.1	75.1
St Charles	16.2	12.7	24.5	5.2	70.3
Statewide					
Missouri State Highway Patrol	7.7	30.3	56.5	4.2	39.3
Missouri (total)	31.7	13.7	40.9	4.4	54.7

Note: Stops as a percent of population is calculated using the 2016 ACS local area population for age 16 and older. For types of stops, the percent speeding, investigative and other may not sum to 100% due to rounding.

The CPD also makes relatively few stops for speeding (about 15% versus almost 41% state-wide). This is likely because most vehicle stops in Columbia are the result of interdiction patrols intended to prevent criminal activity by targeting persons with outstanding warrants or contraband. Such a focus means that the CPD likely stops a different subset of the local population compared to police departments in other cities in Missouri, and as a consequence has a higher disparity index for vehicle stops.

For example, both the Kansas City police and the Missouri Highway patrol stop a relative high percentage of drivers for speeding (and especially on interstates); in both cases, the disparity index for these agencies is much lower than for Columbia.

The results in Table 1.4 indicate that the nature of vehicle stops differs across localities in Missouri due to different policing priorities. The measured racial disparity index is expected to be higher in places where police emphasize interdiction, since vehicle stops will be more targeted toward drivers who are more likely to have outstanding warrants or contraband (e.g., black drivers in Columbia). As noted above, this implies that at least some of the observed disparity index in Columbia may be explained by unbiased police tactics, but it does not imply that there exists no bias in policing in Columbia. Conversely, this evidence again reinforces the point that observed disparities in Columbia vehicle stops are not a clear indicator of racial profiling against black drivers.

A Problem Comparing Disparity Indices

Because disparity indices compare rates of vehicle stops to the percent of black population in a place, there is an upper bound to the maximum possible disparity index that varies across cities. For example, St. Louis has a local population that is 48.5% black; so even if 100% of vehicle stops involve black drivers, the disparity index in St. Louis would be just 2.2! Compare this to Columbia, with a local population that is about 10% black; the maximum possible disparity index in Columbia is 10. In other words, comparing disparity indices across places is like using rulers with different scales.[9]

Comparing Outcomes of Vehicle Stops across Cities and Statewide

Table 1.5 and 1.6 (below) describe the outcomes of vehicle stops as a percent of population or total stops, respectively. Columbia again stands out for the very low citation rate: just 12% of stops result in citations compared to 51.5% statewide. However, as a percent of traffic stops, Columbia has a relatively high arrest rate (9%) and search rate (10%). In contrast, as a percent of population, search rates are at the low end compared to other cities and below average for the state. Likewise, compared to population, the arrest rate is at the median of other cities and below average for the state. This is simply because Columbia has such a low rate of vehicle stops per population, but it does mean that care should be taken in comparing rates for post-stop outcomes in Columbia to other communities or to the state average.

The combination of relatively infrequent stops together with relatively high arrest rates and hit rates for contraband suggest that the CPD is particularly efficient in targeting persons who have committed crimes (e.g., with outstanding warrants and contraband). This efficient targeting is consistent with the purpose of interdiction described above.

[9] One alternative is to normalize the disparity index by the range between 1 and the maximum possible value for each city. Using this normalized measure, disparities in vehicle stops in St; Louis are 33% of the maximum possible, while those in Columbia are 23% of the maximum possible.

Table 1.5: Outcomes of Stops (% Stops)

Largest Cities	Citations	Arrests	Outstanding Warrants	Searches	Hits for Contraband
Kansas City	74.2	3.6	1.0	2.3	0.8
St Louis	44.5	3.1	2.1	6.8	1.2
Springfield	34.8	4.2	2.6	9.5	3.0
Columbia	***11.8***	***9.2***	***4.0***	***9.8***	***4.3***
Independence	106.2	8.3	6.4	8.5	2.8
Lee's Summit	37.2	6.0	3.2	6.4	2.4
O'Fallon	47.0	5.4	2.7	8.4	2.9
St Joseph	71.8	4.6	3.2	4.9	1.7
St Charles	43.3	9.3	4.5	10.2	6.1
Statewide					
Missouri State Highway Patrol	70.8	3.6	1.3	5.4	2.0
Missouri (total)	51.5	4.7	1.8	6.5	2.2

Table 1.6: Outcomes of Stops (% Population)

Largest Cities	Citations	Arrests	Outstanding Warrants	Searches	Hits for Contraband
Kansas City	16.3	0.8	0.2	0.5	0.2
St Louis	7.8	0.5	0.4	1.2	0.2
Springfield	6.2	0.8	0.5	1.7	0.5
Columbia	***1.5***	***1.1***	***0.5***	***1.2***	***0.5***
Independence	24.8	1.9	1.5	2.0	0.7
Lee's Summit	8.5	1.4	0.7	1.5	0.5
O'Fallon	12.0	1.4	0.7	2.2	0.7
St Joseph	11.7	0.8	0.5	0.8	0.3
St Charles	7.0	1.5	0.7	1.7	1.0
Statewide					
Missouri State Highway Patrol	5.5	0.3	0.1	0.4	0.2
Missouri (total)	16.3	1.5	0.6	2.0	0.7

Notes: Percent of population calculated using the 2016 ACS local area population for ages 16 and older.

Comparing the Outcomes of Searches across Cities and Statewide

Table 1.7 reports several outcomes for searches. In general, very few searches last longer than 30 minutes; Columbia falls about in the middle compared to other cities on this indicator, although all of the larger cities are above average for the state on this measure. Columbia stands out for the percent of searches that yield hits for contraband (44%) and is relatively high on percent of hits that include weapons (4%). Again, this suggests that the CPD is relatively efficient in targeting searches to find contraband (e.g., stolen property, drugs, weapons, etc.).

Table 1.7: Results of Searches (% of Searches)

Largest Cities	**Searches > 30 min**	**Contraband**	**Weapons**
Kansas City	1.7	33.1	10.7
St Louis	0.4	17.7	6.0
Springfield	1.1	31.1	2.4
Columbia	***0.9***	***44.1***	***4.0***
Independence	1.3	33.5	5.2
Lee's Summit	3.3	37.1	3.7
O'Fallon	1.5	34.7	0.5
St Joseph	0.2	34.0	3.9
St Charles	0.9	59.8	1.9
Statewide			
Missouri State Highway Patrol	1.3	36.4	2.0
Missouri (total)	0.1	34.5	0.2

Notes: The hit rate is the percentage of searches that produce contraband (or weapons).

A Preliminary Test for Bias Using Aggregate Hit Rates

While the disparity indices contained in the VSR are not useful for diagnosing potential racial bias in stops or other outcomes, it is possible to get some preliminary indication about racial profiling in searches by comparing hit rates for contraband across race. Several studies take advantage of the fact that hit rates for contraband should be equal across racial groups (all else constant) as a test for potential racial profiling in police searches.[10] This is because if the hit rate for black drivers who are searched is lower than the hit rate for white drivers who are searched, then police must systematically be using information other than the true probability of finding contraband to guide their decision about whom to search. In other words, lower hit rates for blacks versus white is a symptom of racial profiling, all else constant.

[10] E.g., Knowles et al (2001) Hernández-Murillo and Knowles (2004); however, see Brock et al (2012).

Of course, not all else is constant. For example, it has been shown that black drivers are more likely to have outstanding warrants and are more likely to be arrested. Since most drivers arrested will also be searched, this may lower the hit rate for black drivers even in the absence of any racial profiling in searches. Consequently, the data in the VSR report can only be used as a preliminary and inconclusive test for racial profiling.

Table 1.8: Hit Rates by Race

	Hit Rates for Any Contraband		Hite Rates for Weapons	
Largest Cities	**Black**	**White**	**Black**	**White**
Kansas City	34.5	31.8	12.6	7.7
St Louis	16.8	21.0	7.8	1.6
Springfield	29.8	31.5	2.7	2.3
Columbia	***45.8***	***42.6***	***6.0***	***2.1***
Independence	28.5	35.6	5.3	5.1
Lee's Summit	38.6	36.4	4.4	3.0
O'Fallon	28.6	37.0	0.7	0.4
St Joseph	33.0	35.0	6.0	3.0
St Charles	57.6	60.7	3.8	1.2
Statewide				
Missouri State Highway Patrol	38.8	36.2	2.6	1.8
Missouri (total)	32.9	35.5	4.9	2.0

Notes: The hit rate is the percentage of searches that produce contraband (or weapons).

Table 1.8 describes the hit rates by race for Missouri cities and statewide. For most cities and statewide, the hit rate for searches of black drivers is less than that for white drivers, indicating potential racial bias in searches. However, some care is in order, not only because of the higher arrest rate for black drivers, but also because police may focus on particular types of contraband, rather than the potential for finding any contraband. It is therefore worth noting that in every case, the hit rate for weapons is higher for blacks than whites, which is contrary to what would be expected in the presence of racial profiling against black drivers.

Regardless of these concerns, in Columbia the hit rates for black drivers who are searched are *higher* than for white drivers. Consequently, there is no evidence from this simple test of any anti-black racial profiling in searches by the CPD. If anything, the CPD may be under-searching black drivers. However, more definitive tests can be performed with the incident-level data (see Part Two).

Conclusion to Part One

Thus far, I have explained why disparity indices are not indicators of racial bias in policing. Because many factors affect an observed disparity index, --- including differences in local population characteristics, driving patterns and policing tactics, --- it is simply not possible to diagnose the presence or extent of racial bias by looking at the value of a disparity index or whether a disparity index is increasing or decreasing over time.

For example, compared to other agencies in Missouri, the CPD conducts relatively few stops and does not focus on speeding violations; instead the CPD devotes more resources to interdiction. The success of this tactic is seen in the relatively high arrest rates for persons with outstanding warrants and the relatively high hit rate for contraband. However, this same success also drives up the observed racial disparities in vehicle stops in Columbia. This is one explanation for why the disparity index in Columbia is higher than in other large cities in Missouri and compared to the statewide disparity index.

Likewise, the change in the disparity index in Columbia over time is sensitive to any changes in demographics, driving patterns, and policing style. In particular, the percentage black of the local population in Columbia has been increasing; this alone appears to be the cause of the increasing disparity index as measured in the state VSR since 2015. This is because the AG report calculates disparity indices using demographic data from the most recent decennial census and does not adjust for changes to local populations that have occurred since the 2010 census.

Nevertheless, the finding that not all racial disparities in vehicle stops can be attributed to racial bias in policing is not much comfort to anyone concerned with the possible presence of racial bias. What is needed are more definitive tests for the presence of racial bias in vehicle stops and searches; this is the focus of the next section of this report.

Part Two: Analyzing Incident-Level Data from the CPD

Over the last 15 years or so, economists and statisticians have developed a set of statistical tests for diagnosing racial profiling in incident-level vehicle stops and searches. In addition, Missouri law requires police officers to record detailed information about every vehicle stop (see Figure A1 in the Appendix); the information recorded for every incident includes: the date, time, and location of the stop, as well as the estimated age and race of the driver, the reason for the stop, whether there was a citation or an arrest, whether there was a search, etc. Nevertheless, the annual VSR contains only a superficial description of aggregated data by agency. Consequently, despite a wealth of incident-level data being collected by every police agency in the state for nearly 20 years, the analysis conducted by the AG office each year does not use these incident-level data to implement the now standard statistical tools for properly investigating racial profiling in vehicle stops and searches.

Incident-Level Data for Columbia

Detailed information on every one of the over 50,000 vehicle stop in Columbia from 2014 to 2017 has been made available to the public by the CPD.[11] In all of the analyses that follow, I employ these public data augmented with information on the police division (patrol, traffic or other) and geographic location of each stop.[12] Descriptive statistics for vehicle stops by year are listed in Tables 2.1-2.3 (below); although, a few trends are worth noting here.

First, the number of vehicle stops has fallen about 25% since 2014, from about 16,416 stops to 12,437 stops. Table 2.1 (below) presents details on vehicle stops broken down by several categories. Not only is the percentage of stops that lead to a citation relatively low in Columbia compared to other cities in Missouri (see Part One), the frequency of citations has also been falling. In 2014, just over 27% of stops led to a citation; in 2017, just under 12% of stops led to a citation. In addition, the share of stops for speeding has dropped by almost 50% since 2014.

In addition, the share of stops occurring in beat 20, 30 and 40 have all increased (see table 2.2, below; and Figure A2 in the Appendix). In 2014, these three beats accounted for just over 28% of all vehicle stops; in 2017, just over 42% of all stops occurred in these three beats.

These trends suggest a possible shift in police effort over time away from routine traffic enforcement and toward interdiction of more serious crimes. This conjecture is supported by the increased percentage of stops involving drivers with outstanding warrants, stops leading to leading to arrests and stops and searches leading to hits for contraband (including weapons).

[11] https://www.como.gov/police/crime-data/.

[12] Data on police division and beat were obtained with permission from the CPD for the purpose of this study.

Table 2.1: Vehicle Stops in Columbia (by Year)

	2014	2015	2016	2017
Number of Stops	16,416	11,304	11,819	12,437
Outcome (%)				
Citations	27.1	15.5	11.0	11.8
Arrests	6.8	7.7	8.7	9.2
Outstanding Warrants	2.2	2.6	3.4	2.9
Searches	7.1	10.9	11.4	9.8
Any Contraband	2.1	3.3	4.5	4.3
Weapon	0.1	0.2	0.4	0.4
Race (%)				
Asian	2.6	2.5	2.6	2.9
Black	24.4	29.6	31.2	32.7
Hispanic	1.3	1.5	1.7	1.8
White	70.7	65.1	62.7	60.8
Other	1.0	1.2	1.7	1.8
Age (%)				
< 30	55.2	56.3	54.6	52.8
30-39	18.1	19.2	20.0	21.2
40+	26.7	24.6	25.4	26.0
Type of Stop (%)				
Investigative	2.2	2.8	3.0	2.5
Equipment	28.3	33.1	35.1	27.4
License	20.8	23.1	27.2	34.0
Speeding	27.8	20.1	15.6	14.8
Other	20.9	20.9	19.1	21.3
Division (%)				
Patrol	52.8	56.5	66.4	65.9
Traffic	36.1	26.5	15.8	20.9
Other	11.1	17.0	17.8	13.2
Location (%)				
City Street	53.4	51.9	47.0	46.3
State Route	40.0	40.8	44.8	46.0
Other	6.6	7.3	8.2	7.7

Table 2.2: Geographic Location of Vehicle Stops in Columbia (by Year)

	2014	2015	2016	2017
Number of Stops	16,416	11,304	11,819	12,437
Beat (% of stops)				
10	10.8	7.5	10.7	8.7
20	13.2	17.0	20.6	17.1
30	6.8	12.9	12.0	11.6
40	8.4	10.1	9.9	13.4
50	12.9	10.7	9.9	10.3
60	13.6	11.0	11.0	11.3
70	8.2	6.3	6.2	7.7
70D	6.8	7.6	5.9	4.5
80	11.7	11.1	9.4	11.2
Other	7.6	5.8	4.6	4.3

Finally, Table 2.3 (below) describes the percent of stops involving black drivers for all vehicle stops and for stops by subcategory. As the number of vehicle stops has declined in recent years, the percent of stops involving black drivers has increased from a little less than one-in-four stops to almost one-in-three stops. This increase appears to be general as the percent black has been increasing across the board in almost every subcategory of stops.

Table 2.3: Vehicle Stops in Columbia – Percent Black in All Categories (by Year)

	2014	2015	2016	2017
All Stops	24.4	29.6	31.2	32.7
Outcome				
Citations	19.8	22.3	26.5	32.0
Arrests	42.7	45.7	45.1	43.8
Outstanding Warrant	50.4	54.5	48.6	54.3
Searches	46.2	48.0	45.5	49.4
Any Contraband	44.0	43.2	45.1	51.2
Weapon	59.1	40.0	53.2	73.5
Age				
< 30	25.3	29.7	32.5	34.0
30-39	27.2	33.5	33.9	33.8
40+	20.6	26.4	26.3	29.0
Type of Stop				
Investigative	46.0	46.0	41.7	50.8
Equipment	26.6	31.7	30.3	32.0
License	30.6	37.6	40.0	39.1
Speeding	16.9	18.2	24.9	26.0
Other	24.0	27.3	26.6	28.3
Division				
Patrol	27.4	32.1	31.9	33.8
Traffic	15.4	15.4	21.1	27.5
Other	39.7	43.9	37.7	34.9
Location				
City Street	26.0	31.6	34.5	34.9
State Route	23.0	27.5	28.9	31.1
Other	19.6	27.3	25.4	28.6
Geographic Location				
Beat 10	31.8	32.9	35.3	40.8
Beat 20	40.1	47.8	44.2	44.1
Beat 30	44.2	38.1	36.7	39.8
Beat 40	33.9	39.7	39.6	40.9
Beat 50	16.5	17.6	22.8	21.1
Beat 60	14.2	18.6	19.8	21.6
Beat 70	17.6	22.6	18.2	24.8
Beat 70D	18.2	20.5	19.4	21.8
Beat 80	16.7	20.5	25.8	27.5
Other	15.2	16.4	20.9	21.7

The Veil of Darkness Method: Daylight as a Natural Experiment

The fundamental challenge to identifying racial profiling from statistical data is that many factors influence whether a driver is stopped or not. Worse, not all of these factors are readily observable and quantifiable making it impossible to directly control for all such "confounding" variables. In short, this is why simple descriptive statistics on racial disparities in vehicle stops are useless for testing whether racial profiling exists.

However, racial profiling in vehicle stops requires that police officers identify the race of drivers. This means that acting on racial biases to stop black drivers is more easily done in daylight than nighttime. Thus, all else constant, fewer black drivers will be stopped at night if police engage in racial profiling. On the other hand, this same effect is not expected to be observed in post-stop outcomes, such as citations, arrests and searches (see below).

Of course, many other factors also vary between day and night; for example, the composition of drivers on the road at 11:00AM is likely very different from those on the road at 11:00PM. This means that it is necessary to hold constant the characteristics of the driving population, as well as enforcement efforts. This is accomplished by taking advantage of the fact that the clock time associated with sunrise and sunset varies over the course of the year, so that there is a range of clock times that are sometimes daylight and sometimes dark.

The "Veil of Darkness" method (VoD) for investigating racial profiling in vehicle stops exploits this natural experiment by comparing the probability that a stopped driver is black in daylight or darkness *at the same time of day* (and controlling for other relevant factors via multivariate regression analysis).[13] This approach has become standard and has been used to investigate racial profiling in vehicle stops in Cincinnati, Massachusetts, Minneapolis, New Orleans, North Carolina, Oakland, Philadelphia, Portland, Rhode Island, San Diego, and Syracuse.[14]

Of course, there are some important caveats to keep in mind when interpreting VoD tests for racial profiling. First, some street locations are well-lit at night, so the strength of the natural experiment varies with geographic location within a city.[15] Second, it is possible that black drivers choose to drive more carefully (e.g., by obeying the speed limit) in daytime, precisely because they are at potentially higher risk to be stopped during the day.[16] Both of these phenomena may cause the simple VoD test to understate the extent of racial profiling. However, these concerns can be mitigated. The problem of ambient light at night can be addressed by incorporating controls for the location of stops into the statistical analysis. Concerns about offsetting driver behavior can be addressed by looking at different types of stops, for example, comparing stops made for speeding to those for other reasons.

[13] Grogger and Ridgeway (2006).

[14] See: Grogger and Ridgeway (2006); Ridgeway (2009); Ritter and Bael (2009); Ritter (2017); Worden et al. (2010 and 2012); Horace and Rohlin (2016); Renauer et al. (2009); Taniguchi et al. (2016a,b,c,d); Masher (2016); Chanin et al. (2016); Kalinowski et al (2017); Ross et al. (2018); and Geary (2018).

[15] Horrace, W. and S. Rohlin (2016).

[16] Kalinowski et al (2017).

A final caveat is more difficult to address and so must be kept in mind when interpreting the results of VoD tests. Profiling may not only be based on race, but also on the identity of a car, driver or passenger. If police are "on the lookout" for persons suspected of drug dealing, possessing an illegal weapon or stolen goods, etc., and if race is correlated with offending behavior, then patterns in the data that are consistent with racial profiling may in fact result from legitimate and desirable efforts at interdiction. Consequently, there is good reason to be concerned that VoD tests *overstate* the extent of racial profiling in traffic stops, since it is more difficult to identify persons and vehicles of interest in darkness, as well.

An Illustrative Example of the VoD Method

The information listed in Table 2.4 provides an example of the logic of the VoD method using actual vehicle stop data for Columbia. Consider the first column of Table 2.4, which describe the percent of stops involving black drivers in daylight (24.5%) versus nighttime (32.0%) for all vehicle stops in 2014-2017. If the driving population and enforcement patterns are the same in daytime and night, then this constitutes an experiment for testing whether impaired visibility of a driver's race leads to fewer stops of black drivers. In this case, the black proportion of stopped drivers actually increases at night by 7.5 percentage points, which is not consistent with racial profiling against black drivers. Of course, this interpretation is based on a false premise regarding the driving population and enforcement patters at day and night, so this is not a good test for the existence of racial profiling.

Table 2.4: Veil of Darkness – Illustrative Example

	Full Sample 2014-2017	**Intertwilight Period; 2014-2017**		
		All	**Friday**	**November**
Total Number of Stops	51,976	9,671	1,740	801
Daylight - %Black	24.5	32.5	32.2	25.8
Nighttime - %Black	32.0	28.5	30.8	27.1
Effect of Darkness on %Black	+7.5	-4.0	-1.4	+1.3
Effect of Darkness Significantly Different than Zero	Yes (p<.01)	Yes (p<.01)	No (p>.60)	No (p>.80)
Consistent with Racial Profiling Against Black Drivers	No	Yes	No	No

Notes: Statistical significance is based on a difference in means test.

The remaining columns of Table 2.4 describes vehicle stops made during the "intertwilight period"; these are all of the times of day that are sometimes daylight and sometimes nighttime (depending on the time of the year). For Columbia, this "intertwilight" period ranges from 5:11AM to 7:42AM and 4:47PM to 9:11PM; stops made during these windows of time constitute a "natural experiment," since some stops are made in darkness when the

characteristics of drivers are more difficult to discern than in daylight. The results in the second column show that during the intertwilight period, the percentage of stops involving black drivers falls at night by 4.0 percentage points, which is consistent with racial profiling. However, this approach is also not a good test since it makes no attempt to control for other factors that may affect the composition of the driving population and enforcement patterns.

The final two columns of Table 2.4 demonstrate that even restricting attention to the intertwilight period Is not sufficient to guarantee that "everything else is constant." For example, there is a much smaller and statistically insignificant reduction in the percent black among stopped drivers in darkness on Fridays during the intertwilight period than for the entire intertwilight period. Further, there is actually a small (albeit insignificant) *increase* in the share of black drivers stopped after dark in November. These examples are sufficient to illustrate the importance of accounting for differences in the driving population and enforcement patterns that are associated with different times within the intertwilight period, as well as over the course of the week or year.

Data and Methods

The standard VoD test follows the methods employed by Grogger and Ridgeway (2006). The basic idea is to compare the percent of stops involving black drivers in daylight and nighttime, while controlling for the differences in the driving population and police enforcement that occur at different times of the day. This is accomplished in part by focusing only on stops that occur during clock times that may be light or dark (i.e., the "intertwilight" period).

Of course, stops made during twilight itself are neither fully daylight nor fully night. Previous studies address this problem by simply omitting stops made during twilight on any given day; I follow this standard approach for the main analysis in this report. [17] However, some information is lost by omitting stops made in twilight.

For this reason, I also replicate the main analysis using an alternative definition of "darkness" that takes the value of zero during daylight, one during nighttime and fractional values during twilight (e.g., the midpoint between sunset and the end of twilight is literally "half-dark," etc.). In addition to "rescuing" observations on stops made during twilight, I also expand the time period examined by rounding to the nearest half-hour outside the intertwilight period (e.g., 5:00AM to 8:00AM and 4:30PM to 9:30PM). This expansion of the sample of stops examined does not help identify the effects of darkness on vehicle stops, but it does help with the estimation of control variables in the analysis. These changes mean that the analysis using the expanded sample is based on just over 13,000 vehicle stops from 2014-2017, rather than just 9,600 as would be the case otherwise. Tables A1 and A2 in the Appendix contain descriptive statistics for both the basic "intertwilight" sample and the "expanded" sample.

[17] I also follow common practice by omitting investigative stops from the analysis; however, there are so few investigative stops recorded that this has no substantive impact on any of the findings presented in this report.

Overall, there is little substantive difference in the results using either sample. Therefore, all subsequent results in the text of this report are based on the standard intertwilight sample, while results using the expanded sample are found in Tables A3-A11 in the Appendix.

All analyses in the main text below are based on estimating the probability that a stopped motorist is black. This estimation is performed by logit regression with a linear time trend in clock time for both morning and evening hours. The trend in clock time is then interacted with the day of the week. Other controls include indicators for month, year, beat, type of street, and police division. All results reported below are for the average marginal effect of darkness on the probability that a stopped (or searched) motorist is black. However, for the analysis using the expanded sample in the Appendix, the dependent variable is the probability that a driver is black or Hispanic (see Tables A3-A11). This change has no substantive effect on findings.

Finally, the public discussion of racial profiling in Columbia has focused not only on the extent of profiling but whether profiling is on the increase. For this reason, I split the available data into two time periods, 2016-2017 and 2014-2015, in order to facilitate comparisons over time. A year-by-year analysis of stops is shown in Table A3 in the Appendix, while Table A4 describes the results when data is pooled over all four years.

VoD Estimates for Vehicle Stops

Table 2.5 (below) describes the results of VoD tests for all drivers and by sex and age. The format of this table is the same for all subsequent tables describing estimated VoD effects. Each cell entry in Table 2.5 is associated with a different estimation model, although only the coefficient of interest on darkness is reported. A negative coefficient estimate is consistent with racial bias against black drivers, while a positive coefficient is consistent with bias against non-black drivers. Estimates that are statistically different from zero are flagged with asterisks; however, robust standard errors are listed in parentheses, as well.

Table 2.5: Effect of Darkness on the Probability that a Stopped Driver is Black (by Driver)

	All	Female	Male	Age<30	Age 40+
Pooled by Two-Year Periods					
VoD 2016-2017	-.001 (.020)	.018 (.031)	-.014 (.027)	.029 (.031)	-.024 (.036)
VoD 2014-2015	-.052** (.021)	-.013 (.033)	-.065** (.028)	.004 (.031)	-.113*** (.035)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses);* ***negative*** *estimates indicate potential racial profiling. Investigative stops are omitted. Controls include time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Looking across the first row of Table 2.5 (above) at the estimated VoD effects for 2016-2017, none of the effects are statistically significant. Even ignoring statistical significance, the estimated VoD effects are either positive or very close to zero for all but older drivers. Consequently, there is no evidence of racial profiling of black drivers in 2016-2017.

However, for 2014-2015, the VoD estimates for all drivers, male and older drivers are all negative and statistically significant, which is consistent with racial profiling among black drivers, although this effect is limited to black males and is particularly prominent for older black drivers. Further, the magnitude of these effects is non-trivial (although not nearly as large as the differences implied by naïve interpretations of disparity indices).

For example, for all drivers, the VoD effect is -.052; this means that the percentage of black drivers stopped in darkness is 5.2 percentage points *lower* than the percentage of black drivers stopped in daylight. Considering that on average about 30% of drivers stopped by the CPD are black (see Table 2.3), removing the effects of the visibility of a driver's race on vehicle stops would reduce the percent of black drivers stopped in Columbia by about 1/6th, from 30% to 25%.[18]

Looking instead at the VoD estimate for older drivers, the 11 percentage point change is not only twice as large as for all drivers, but the baseline for the percent of black drivers among older drivers who are stopped is also lower (about 26%, see Table 2.3). This means that removing the visibility of a driver's race reduces the percentage of black drivers *among drivers over 40 years old who are stopped* by over 40% (from 26% to 15%).

These estimated VoD effects for 2014-2015 are consistent with racial profiling but may also be attributable to other behavior. If profiling is the main cause for these differences, then it is not a general anti-black bias, since the effect is not seen for women or for younger drivers. It is also difficult to reconcile these patterns with implicit bias (i.e., a "hard-wired" subconscious bias against black drivers), since it is not only selectively focused on older drivers, but also appears to completely disappear in 2016-2017. For these reasons, it is possible that this evidence of profiling is not so much race-based, but instead based on both policing practice and the identity of drivers and vehicles. However, it is beyond the scope of this report to explain why this change occurs over time, but it is a question that merits further investigation.

Tables 2.6 and 2.7 (below) present findings on potential racial profiling against black drivers when stops are broken down by the reason for a stop (equipment, license, speed or other) or the police division making the stop (patrol, traffic or other). Results are consistent with those seen above in that the effect of darkness is not consistent with profiling in 2016-2017, but there is some evidence consistent with profiling in 2014-2015. The effect is mainly seen in "other" reasons for stops (including failure to signal and lane violations) and "other" police divisions

[18] Notice that even in this scenario the associated "disparity index" for stops in 2014-2015 would only fall from about 3 to 2.5; this reinforces the point made in Part One of this report regarding the difference between measures of disparities and measures of racial profiling.

(including K-9 and special assignment). Again, the absence of a consistent pattern of negative VoD effects across all categories suggests that profiling is not systemic racial profiling, but something else.

Table 2.6: Effect of Darkness on the Probability that a Stopped Driver is Black (by Reason)

	Equipment	License	Speed	Other
VoD 2016-2017	.002 (.042)	-.005 (.038)	.042 (.059)	.023 (.042)
VoD 2014-2015	-.043 (.039)	.022 (.041)	.016 (.053)	-.106*** (.041)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses);* ***negative*** *estimates indicate potential racial profiling. Investigative stops are omitted. Controls include time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Table 2.7: Effect of Darkness on the Probability that a Stopped Driver is Black (by Division)

	Patrol	Traffic	Other
VoD 2016-2017	-.008 (.024)	-.067 (.081)	.054 (.058)
VoD 2014-2015	-.035 (.027)	-.007 (.049)	-.109** (.050)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses);* ***negative*** *estimates indicate potential racial profiling. Investigative stops are omitted. Controls include time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Finally, Table 2.8 (below) shows VoD estimates for vehicle stops by police beat within Columbia. The only significant and negative effect of darkness is seen in beat 20 for 2014-2015, although there is a sizable positive effect in beat 70 for 2016-2017. The negative estimate for beat 20 in 2014-2015 is consistent with racial profiling. The size of this effect is fairly large (almost 16 percentage points) but must be compared to the approximately 45% black among stopped drivers in beat 20; in other words, eliminating the effect of darkness would reduce the percent black among stopped drivers in beat 20 by just over one-third.

Once again, the estimated VoD effects do not indicate systemic racial profiling against black drivers, since for most beats the estimated effects of darkness are either positive or statistically insignificant. Further, not only is there no evidence of anti-black profiling in 2016-2017, there is even some evidence consistent with profiling of non-black drivers in beat 70.

Table 2.8: Effect of Darkness on the Probability that a Stopped Driver is Black (by Beat)

	Beat 10	**Beat 20**	**Beat 30**	**Beat 40**	**Beat 50**
VoD 2016-2017	.073 (.071)	-.025 (.054)	.062 (.072)	.030 (.067)	-.029 (.058)
VoD 2014-2015	-.081 (.072)	-.158*** (.057)	.064 (.068)	-.098 (.068)	.023# (.049)
	Beat 60	**Beat 70**	**Beat 70D**	**Beat 80**	**Other**
VoD 2016-2017	-.070 (.064)	.147* (.089)	-.071 (.135)	-.051 (.058)	-.100# (.126)
VoD 2014-2015	-.027 (.057)	-.080 (.086)	-.007 (.094)	-.035 (.072)	-.046 (.074)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses);* ***negative*** *estimates indicate potential racial profiling. Investigative stops are omitted. Controls include time of day for each day of the week, month, year, geographic beat, type of street, and police division. # Estimates from a linear probability model.*

The VoD Effect for Post-Stop Outcomes

Many casual observers infer bias in post-stop outcomes by simply comparing the probability that a stopped black driver receives a citation (or is arrested or searched) to the same probabilities for non-black drivers. The false premise of such comparisons is that higher rates of citations, arrests or searches are an indicator of potential racial bias. However, while this may be so when vehicle stops are unrelated to race, it does not obviously follow if there is racial profiling in stops.

To see this, consider what happens when black drivers are more likely to be stopped, all else constant; this means that black drivers are less likely to have exhibited behavior that would objectively lead to a citation, arrest or search. Of course, bias in post-stop outcomes would also mean that black drivers are nonetheless more likely to receive citations or to be arrested or searched. Consequently, there are two potential effects of bias on post-stop outcomes, one working through excessive stops, and one working directly on the post-stop outcomes. These two sources of bias have opposite effects on the observed rates for citations, arrests and searches, meaning that racial profiling could lead to higher or lower frequency of citations, arrests or searches for black drivers compared to other drivers who have been stopped.

Once again, the natural experiment associated with the VoD effect helps identify racial profiling behavior in post-stop outcomes. This is because the confounding scenario described above is less likely to occur for stops made at night, when visibility of a driver's race is impaired. Consequently, racial bias will lead to a higher proportion of citations, arrests and searches among black drivers stopped at night versus black drivers stopped during the day. This means

that the VoD effect on post-stop outcomes is *positive* when police are biased against black drivers in making citations or arrests or in conducting searches.

To see how this works, consider the extreme case in which the race of a driver is always known in daylight and never known at night. For stops in daylight, racial bias may work through both excessive stops and excessive citations, etc. But at night, race plays no role in the probability that a driver is stopped, only in the probability that a driver receives a citation, is arrested or searched. Consequently, if the citation rate, arrest rate and search rate for black drivers increases in darkness, then this is a symptom of racial bias in post-stop outcomes.

VoD Estimates for Post-Stop Outcomes

Table 2.9 presents the estimated VoD effects for citations and arrests, as well as arrests after omitting drivers with outstanding warrants. This last modification is made, since 90% of stopped drivers with outstanding warrants are arrested (compared to just 6% of drivers without outstanding warrants), which strongly suggests that these arrests are not produced by the same data-generating process as other arrests.

For 2016-2017, the estimated VoD effects are positive but not statistically significant. In contrast, the estimates for 2014-2015 are all negative (but also not statistically significant). This pattern is the opposite of what would be expected if there was bias against black drivers in post-stop outcomes, especially since the evidence from stops strongly indicated no profiling in 2-016-2017, but some evidence of potential profiling in 2014-2015.

Table 2.9: Effect of Darkness on the Probability that a Ticketed or Arrested Driver is Black

	Citation	**Arrest**	**Arrest (No Warrant)**
VoD 2016-2017	.058 (.083)	.128 (.109)	.087 (.135)
VoD 2014-2015	-.027 (.050)	-.023 (.106)	-.048 (.137)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses);* ***positive*** *estimates indicate potential racial profiling. Investigative stops are omitted. All models include controls for the time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Table 2.10: Effect of Darkness on the Probability that a Searched Driver is Black

	Search	Consent Search	Search with No Incident to Arrest
VoD 2016-2017	-.092 (.092)	-.239# (.201)	-.087 (.108)
VoD 2014-2015	-.138 (.097)	-.255 (.170)	-.196* (.114)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses);* ***positive*** *estimates indicate potential racial profiling. Investigative stops are omitted. All models include controls for the time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Table 2.10 describes the estimated VoD effects for searches. The effects of darkness on the probability that a search involves a black driver are all negative, which is the opposite of what would be expected in the presence of racial bias against black drivers. One concern with searches as an outcome variable is that not all searches are performed for the same reason. All drivers who are arrested for an incident will likely be searched, but only about 7% of other stops lead to a search. For this reason, observations where "incident-to-arrest" are recorded as the reason for a search are omitted for the analysis described in column three of Table 2.10. However, regardless of the sample of searches examined, black drivers are less likely to be searched in darkness compared to daylight. These findings do not indicate the presence of racial bias in searches after stops.

Thus far, the analysis of post-stop outcomes indicates no significant evidence of bias against black drivers; however, the preceding analysis of vehicle stops did reveal some evidence consistent with racial profiling for male and older drivers in 2014-2015. For this reason, the analysis of post-stop outcomes is repeated for these two subgroups for 2014-2015; however, none of the VoD estimates are positive and significant (and most are negative). Consequently, there is no evidence of racial bias in post-stop outcomes, even for those groups for which there was some evidence consistent with profiling in stops in 2014-2015.

Differential Hit Rates

Another standard test for bias in police searches involves comparing the hit rate for searches of black and non-black drivers. If police are unbiased and use searches primarily for the purpose of finding contraband, then it follows that the "hit rate" for contraband should be equalized across groups. This is because police search only those persons with a sufficiently high likelihood of possessing contraband. If instead, the hit rate for black drivers is lower than for non-black drivers, then police could search fewer black drivers and more non-black drivers and thereby find more contraband.

However, the interpretation of differential hit rates as a test for biased searches requires that police optimize the probability of finding contraband; further just as with other post-stop outcomes, the interpretation of hit rates may be complicated by racial profiling in vehicle stops. For these reasons, simple comparisons of hit rates are not particularly compelling evidence for or against racial bias in searches.[19]

Once again, however, it is possible to exploit the natural experiment that occurs with darkness in the intertwilight period for the purpose of identifying racial bias in searches from hit rates.[20] As was explained above, darkness should be associated with more bias in searches and therefore a lower hit rate for black drivers. Table 2.11 presents the results for estimates of the VoD effect on the hit rate for black drivers who are searched. For this test, negative estimates for the effect of darkness are consistent with racial bias. The estimated effects in Table 2.11 are negative in three of four cases, but in no case are the estimates statistically significant. Consequently, there is no compelling evidence of bias in searches, which corroborates the previous analysis of post-stop outcomes (above).

Table 2.11: Effect of Darkness on the Probability that a Hit Occurs for a Black Driver

	Hits from All Searches	**Hits from Searches with No Incident to Arrest**
VoD 2016-2017	-.044 (.187)	.054 (.244)
VoD 2014-2015	-.019 (.169)	-.121 (.177)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses);* ***negative*** *values indicate potential racial profiling. Investigative stops are omitted. All models include controls for the time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

[19] Brock et al (2012).
[20] Ritter (2017).

Conclusion to Part Two

The analysis of incident-level vehicle stop data provides much more definitive evidence regarding the presence of racial profiling than does the aggregate data found in the VSR produced by the AG office. This section applies statistical tools that were not in use when the very first VSR was issued but are now standard; however, the contents of the VSR have not changed in almost 20 years, even as the scientific literature on diagnosing racial bias in policing has made great advances.

This section presents the findings for multiple tests for racial bias based on the "veil of darkness" method pioneered by Grogger and Ridgeway (2006) and extended by Ritter (2017). Overall, there is no evidence of racial bias against black drivers in 2016-2017 based on an extensive examination of vehicle stops and post-stop outcomes. In contrast, there is evidence consistent with racial profiling in vehicle stops for 2014-2015, especially for male and older drivers, as well as stops made in beat 20. However, the fact that evidence of racial profiling is not seen for other groups of drivers (e.g., female or young drivers), nor for stops made in other police beats, nor in post-stop citations, arrests or searches is difficult to reconcile with either racial animus or implicit bias on the part of the CPD as causes for these differences, ---all the more so, given the absence of any evidence of racial bias in 2016-2017.

All of the statistical tests presented in this section are based on separate analyses of data from either 2016-2017 or 2014-2015, in order to facilitate a comparison over time. However, estimating the year-by-year VoD effects for stops reveals that it is primarily stops in 2015 that produce the evidence consistent with profiling in stops from 2014-2015 (see Table A3).

This report has also focused exclusively on racial bias against black drivers. Applying the same VoD tests to other groups based on race, ethnicity, sex and age there is no evidence of profiling in vehicle stops, except for Hispanic drivers in 2014-2015 (see Table A12). However, there are very few drivers coded as Hispanic in the incident-level data (<2%), which may be attributable to the difficulty of identifying Hispanic ethnicity in a vehicle stop. Regardless, all of the analyses presented above for black drivers have been repeated for the set of black or Hispanic drivers as part of the expanded sample (see Tables A3-A11). The results of this exercise are consistent with the main findings presented for black drivers alone.

Taking all of these findings together, the overall lesson is that there is really no consistent and statistically significant evidence of racial bias in vehicle stops and searches in Columbia (and especially so for 2016-2017). This report also demonstrates the importance of distinguishing between simple descriptive statistics on racial disparities and actual evidence on racial bias in policing. Despite the presence and persistence of racial disparities in vehicle stops and searches in Columbia, there is no indication of systemic racial bias by the CPD. However, as additional data become available over time, it is possible that the weight of evidence may shift, so continued monitoring and testing is warranted.

Addendum: Lessons for Policy Makers

1) It is possible to diagnose the existence and extent of racial bias in policing using appropriate statistical tools and incident-level data. The state of Missouri already requires that local police agencies collect a wealth of data on incident-level vehicle stops; these data should be analyzed in the manner laid out in this report and policy responses to racial profiling should be based upon the findings of such studies.

2) Conversely, policy makers must understand that racial disparities are not an indicator of bias or discrimination in policing. Disparities in vehicle stops are caused by multiple factors outside the control or authority of police. Therefore, holding police accountable for racial disparities (as opposed to actual bias) in vehicle stops and searches is illogical and futile.

3) Furthermore, holding police accountable for racial disparities (as opposed to actual bias) in vehicle stops and searches is likely to be counterproductive in that it sets up an impossible standard and fuels animosity and mistrust between citizens and police. It also creates an incentive for police to reduce interdiction and enforcement efforts, or even to engage in countervailing profiling of non-black drivers in order to improve measured disparities in vehicle stops and searches.

4) There is no compelling evidence of systemic racial bias against black drivers in Columbia; this is welcome news and confirms the professionalism of the CPD. However, given the existence of evidence from 2014-2015 that is consistent with racial profiling in vehicle stops (albeit not post-stop outcomes), continued monitoring is desirable.

5) The annual VSR provides only a desultory examination of racial disparities and racial bias in policing and is in dire need of improvement. As things stand, the VSR probably does more harm than good. First, it is essentially useless as tool for monitoring racial profiling by police. Second, because the "disparity index" is so focal and sound-bite worthy, each year local police departments around the state are handed a public relations disaster by the AG office and left to deal with the mess. The issue of racial bias in policing deserves much more serious investigation than is the current practice in Missouri.

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Figure A1: Missouri Vehicle Stop Information Form

VEHICLE STOP INFORMATION

DATE MM DD YY TIME AM PM

1 VIOLATION RESULTING IN STOP (√ all that apply)

☐ Moving ☐ Equipment ☐ License ☐ Investigative

If a "moving" violation, √ category of violation.

☐ Speed ☐ Lane Violation ☐ Follow too close

☐ CVE ☐ Fail to Signal ☐ Other Moving Violation

2 RESULT OF STOP (√ all that apply)

☐ Citation ☐ Warning ☐ No action ☐ Other

3 DRIVER'S RACE/MINORITY STATUS (based **only** on visual observation)

☐ White ☐ African-American/Black ☐ Hispanic/Latino

☐ American Indian/Alaska Native ☐ Asian ☐ Other/Unknown

4 DRIVER'S AGE ☐ Under 18 ☐ 18-29 ☐ 30-39 ☐ 40+

5 DRIVER'S GENDER ☐ Male ☐ Female

6 IS DRIVER A RESIDENT OF LAW ENFORCEMENT AGENCY'S JURISDICTION? ☐ Yes ☐ No

7 LOCATION OF STOP

☐ Interstate Highway ☐ U.S. Highway ☐ State Highway

☐ County Road ☐ City Street ☐ Other

8 WAS A SEARCH INITIATED? ☐ Yes ☐ No

If YES, probable cause/authority for search. √ all that apply.

☐ Consent ☐ Reasonable suspicion-weapon (terry stop)

☐ Incident to arrest ☐ Plain View Contraband ☐ Other

☐ Drug Dog Alert ☐ Inventory ☐ Drug/Alcohol Odor

9 WHAT WAS SEARCHED?

☐ Driver Only ☐ Property Only ☐ Driver and Property

10 DURATION OF SEARCH

☐ 0-15 minutes ☐ 16-30 minutes ☐ 31+ minutes

11 WAS CONTRABAND DISCOVERED? ☐ Yes ☐ No

If YES, type of contraband. √ all that apply.

☐ Drugs/Alchol/Paraphernalia ☐ Currency

☐ Weapon ☐ Stolen Property ☐ Other

12 WAS DRIVER ARRESTED? ☐ Yes ☐ No

13 IF ARREST MADE, CRIME/VIOLATION ALLEGED (√ all that apply)

☐ Outstanding Warrant ☐ Offense against person

☐ Resisting Arrest ☐ Drug Violation ☐ DWI/BAC

☐ Property Crime ☐ Traffic Violation ☐ Other

Modified June 2017

VEHICLE STOP INFORMATION

DATE MM DD YY TIME AM PM

1 VIOLATION RESULTING IN STOP (√ all that apply)

☐ Moving ☐ Equipment ☐ License ☐ Investigative

If a "moving" violation, √ category of violation.

☐ Speed ☐ Lane Violation ☐ Follow too close

☐ CVE ☐ Fail to Signal ☐ Other Moving Violation

2 RESULT OF STOP (√ all that apply)

☐ Citation ☐ Warning ☐ No action ☐ Other

3 DRIVER'S RACE/MINORITY STATUS (based **only** on visual observation)

☐ White ☐ African-American/Black ☐ Hispanic/Latino

☐ American Indian/Alaska Native ☐ Asian ☐ Other/Unknown

4 DRIVER'S AGE ☐ Under 18 ☐ 18-29 ☐ 30-39 ☐ 40+

5 DRIVER'S GENDER ☐ Male ☐ Female

6 IS DRIVER A RESIDENT OF LAW ENFORCEMENT AGENCY'S JURISDICTION? ☐ Yes ☐ No

7 LOCATION OF STOP

☐ Interstate Highway ☐ U.S. Highway ☐ State Highway

☐ County Road ☐ City Street ☐ Other

8 WAS A SEARCH INITIATED? ☐ Yes ☐ No

If YES, probable cause/authority for search. √ all that apply.

☐ Consent ☐ Reasonable suspicion-weapon (terry stop)

☐ Incident to arrest ☐ Plain View Contraband ☐ Other

☐ Drug Dog Alert ☐ Inventory ☐ Drug/Alcohol Odor

9 WHAT WAS SEARCHED?

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10 DURATION OF SEARCH

☐ 0-15 minutes ☐ 16-30 minutes ☐ 31+ minutes

11 WAS CONTRABAND DISCOVERED? ☐ Yes ☐ No

If YES, type of contraband. √ all that apply.

☐ Drugs/Alchol/Paraphernalia ☐ Currency

☐ Weapon ☐ Stolen Property ☐ Other

12 WAS DRIVER ARRESTED? ☐ Yes ☐ No

13 IF ARREST MADE, CRIME/VIOLATION ALLEGED (√ all that apply)

☐ Outstanding Warrant ☐ Offense against person

☐ Resisting Arrest ☐ Drug Violation ☐ DWI/BAC

☐ Property Crime ☐ Traffic Violation ☐ Other

Modified June 2017

Figure A2: CPD Beat Map

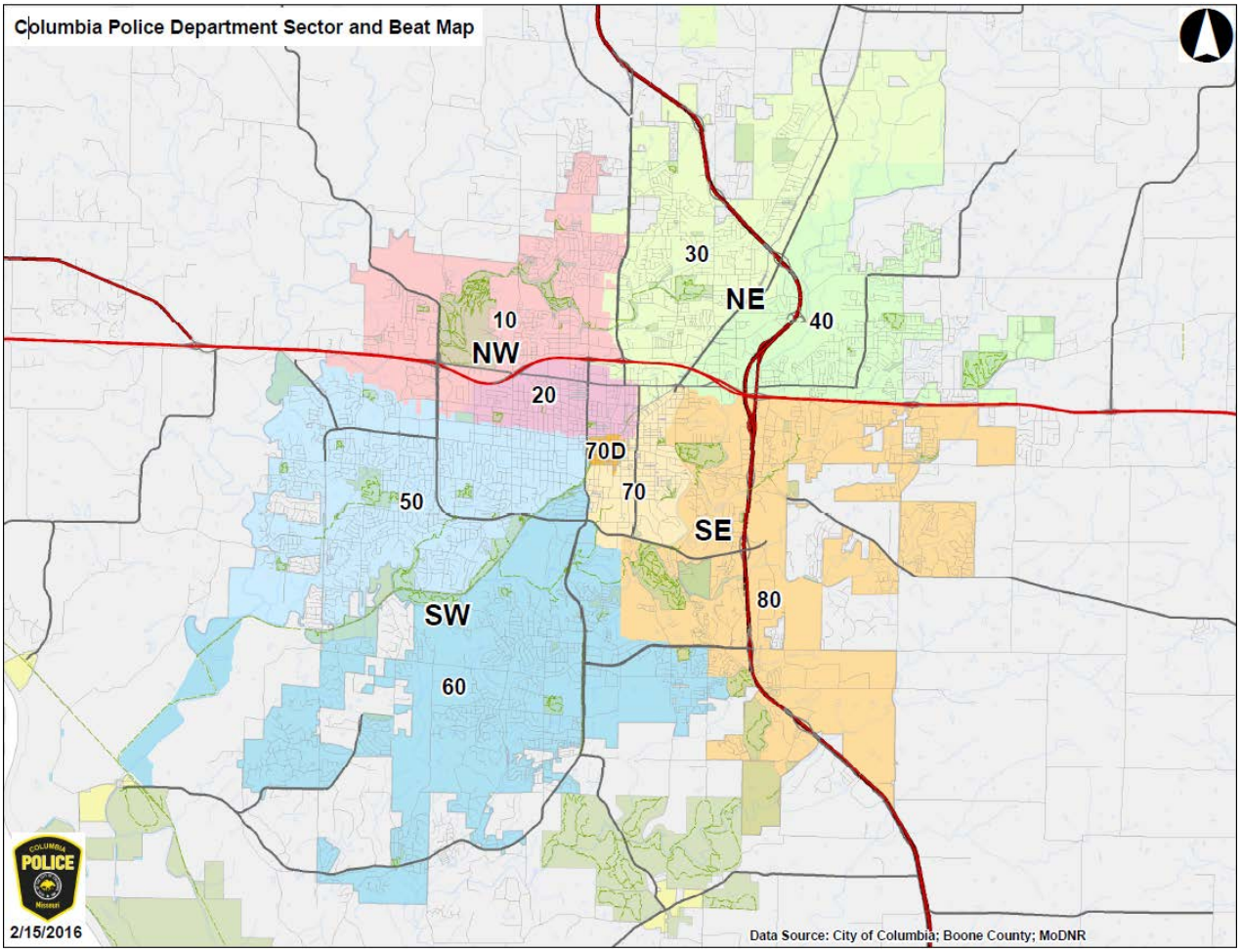

Table A1: Vehicle Stops in Columbia, 2014 -2017

	All Stops	Intertwilight	Expanded
Number of Stops	51,976	9,671	13,147
Outcome (%)			
Arrests	8.0	7.3	7.0
Citations	17.2	12.8	13.5
Searches	9.6	9.3	9.1
Year (%)			
2014	31.6	31.2	31.0
2015	21.7	26.9	25.6
2016	22.7	23.1	23.1
2017	23.9	18.8	20.3
Race (%)			
Asian	2.6	2.4	2.6
Black	29.1	30.1	29.9
Hispanic	1.6	1.6	1.4
White	65.3	64.4	64.5
Other	1.4	1.5	1.5
Age (%)			
<30	54.7	49.9	49.8
30-39	19.5	22.1	21.7
40+	25.8	28.0	28.5
Type of Stop (%)			
Investigative	2.6	3.2	3.1
Equipment	30.7	33.3	33.3
License	25.9	30.9	30.0
Speeding	20.2	12.2	13.3
Other	23.2	20.4	23.0
Division (%)			
Patrol	59.8	65.5	22.6
Traffic	25.8	11.3	12.8
Other	14.4	23.2	22.6
Location (%)			
City street	49.9	51.4	51.0
State route	42.7	41.9	42.0
Other	7.4	6.7	7.0

Notes: "Intertwilight" is the time between the earliest start of twilight and the latest end of twilight during the year (i.e., 5:11AM to 7:42AM and 4:47PM to 9:11PM). The expanded sample is the intertwilight period extended to the nearest half hour (i.e., 5:00AM to 8:00AM and 4:30PM to 9:30PM).

Table A2: Geographic Location of Vehicle Stops in Columbia, 2014 -2017

	All Stops	Intertwilight	Expanded
Number of Stops	51,976	9,671	13,147
Beat (%)			
10	9.5	9.1	9.2
20	16.6	20.3	19.9
30	10.4	12.8	12.5
40	10.3	11.0	11.1
50	11.1	11.0	11.1
60	11.9	10.6	10.8
70	7.2	6.3	6.2
70D	6.2	4.9	5.0
80	10.9	9.5	9.5
Other	5.7	4.6	4.7

Notes: "Intertwilight" is the time between the earliest start of twilight and the latest end of twilight during the year (i.e., 5:11AM to 7:42AM and 4:47PM to 9:11PM). The expanded sample is the intertwilight period extended to the nearest half hour (i.e., 5:00AM to 8:00AM and 4:30PM to 9:30PM).

Table A3: Effect of Darkness on the Probability that a Black Driver is Stopped, by Year

	2014	2015	2016	2017
VoD 2014-2017 Intertwilight Sample	-.033 (.028)	-.077** (.033)	-.018 (.029)	.018 (.033)
VoD 2014-2017 Expanded Sample	-.030 (.023)	-.084*** (.027)	.001 (.024)	.017 (.027)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses); negative (positive) estimates indicate potential profiling for stops and contraband hits (citations, arrests and searches). Investigative stops are omitted. Controls include time of day for each day of the week, month, geographic beat, type of street, and police division.*

Table A4: Summary of VoD Effects for Pooled Analysis, 2014-2017

	Stop	Citation	Arrest No warrants	Search No Incident	Contraband No Incident
VoD 2014-2017 Intertwilight Sample	-.022 (.014)	-.018 (.040)	.043 (.090)	-.087 (.074)	-.007 (.116)
VoD 2014-2017 Expanded Sample	-.017 (.012)	.006 (.035)	.001 (.077)	-.031 (.062)	.001 (.098)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses); negative (positive) estimates indicate potential profiling for stops and contraband hits (citations, arrests and searches). Investigative stops are omitted. Controls include time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Table A5: Effect of Darkness on the Probability that a Stopped Driver is Black or Hispanic – Expanded Sample (by Driver)

	All	Female	Male	Age<30	Age 40+
VoD 2016-2017	.009	.033	-.002	-.002	-.023
(n=3,911)	(.017)	(.026)	(.023)	(.029)	(.030)
VoD 2014-2015	-.059***	-.016	-.081***	-.026	-.101***
(n=5,449)	(.017)	(.028)	(.023)	(.026)	(.030)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses); negative estimates indicate potential racial profiling. Investigative stops are omitted. Controls include time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Table A6: Effect of Darkness on the Probability that a Stopped Driver is Black or Hispanic – Expanded Sample (by Reason)

	Equipment	License	Speed	Other
VoD 2016-2017	-.015	.036	.068	.020
	(.035)	(.032)	(.042)	(.035)
VoD 2014-2015	-.067**	-.026	-.002	-.057
	(.032)	(.034)	(.039)	(.035)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses); negative estimates indicate potential racial profiling. Investigative stops are omitted. Controls include time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Table A7: Effect of Darkness on the Probability that a Stopped Driver is Black or Hispanic – Expanded Sample (by Division)

	Patrol	Traffic	Other
VoD 2016-2017	.014	-.079	.030
	(.021)	(.069)	(.052)
VoD 2014-2015	-.056***	.055	-.100**
	(.022)	(.035)	(.044)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses); negative estimates indicate potential racial profiling. Investigative stops are omitted. Controls include time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Table A8: Effect of Darkness on the Probability that a Stopped Driver is Black or Hispanic – Expanded Sample (by Beat)

	Beat 10	**Beat 20**	**Beat 30**	**Beat 40**	**Beat 50**
VoD 2016-2017	.078 (.066)	-.017 (.044)	.039 (.062)	.085 (.053)	.007 (.044)
VoD 2014-2015	-.060 (.062)	-.171*** (.049)	.041 (.055)	-.042 (.059)	-.007# (.041)
	Beat 60	**Beat 70**	**Beat 70D**	**Beat 80**	**Other**
VoD 2016-2017	-.031 (.040)	.080 (.078)	.043 (.084)	-.070 (.052)	-.093 (.093)
VoD 2014-2015	-.015 (.045)	-.037 (.066)	-.032 (.064)	-.028 (.049)	.016 (.059)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses); negative estimates indicate potential racial profiling. Investigative stops are omitted. Controls include time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Table A9: Effect of Darkness on the Probability that a Ticketed or Arrested Driver is Black or Hispanic – Expanded Sample

	Citation	Arrest	Arrest (No Warrant)
VoD 2016-2017	.046 (.060)	.010 (.090)	.045 (.136)
VoD 2014-2015	.002 (.041)	.014 (.088)	-.030 (.116)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses); positive estimates indicate potential racial profiling. Investigative stops are omitted. All models include controls for the time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Table A10: Effect of Darkness on the Probability that a Searched Driver is Black or Hispanic – Expanded Sample

	Search	Consent Search	Search with No Incident to Arrest
VoD 2016-2017	-.048 (.082)	-.192 (.158)	-.071 (.094)
VoD 2014-2015	-.054 (.086)	-.104 (.142)	-.072 (.099)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses); positive estimates indicate potential racial profiling. Investigative stops are omitted. All models include controls for the time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Table A11: Effect of Darkness on the Probability that a Hit Occurs for a Black or Hispanic Driver – Expanded Sample

	Hits from All Searches	Hits from Searches with No Incident to Arrest
VoD 2016-2017	.019 (.148)	.006 (.179)
VoD 2014-2015	-.058 (.156)	-.062 (.172)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses); negative values indicate potential racial profiling. Investigative stops are omitted. All models include controls for the time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

Table A12: Effect of Darkness on Race/Ethnicity/Sex/Age of a Stopped Driver

	VoD for Asian	VoD for Hispanic	VoD for Female	VoD for Age<30	VoD for Age 40+
2016-2017 (n=3,911)	.009 (.010)	-.005 (.006)	.007 (.023)	.040* (.023)	.015 (.020)
2014-2015 (n=5,449)	-.005 (.007)	-.013* (.007)	-.002 (.023)	.018 (.024)	.012 (.021)

****p<.01; **p<.05; and *p<.10. Cells report the average marginal effect from a logistic regression (robust standard errors in parentheses); negative estimates indicate potential profiling. Investigative stops are omitted. Controls include time of day for each day of the week, month, year, geographic beat, type of street, and police division.*

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Milyo served on the research staff for the Presidential Election Administration Commission and was a member of two different expert task forces examining federal campaign finance reform. He is currently a member of the Missouri State Advisory Committee to the United States Commission on Civil Rights.