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Frisky business: race, gender and police activity during traffic stops

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Abstract Since the United States Supreme Court laid the foundation for "stop-and-frisk" activity by police departments, a substantial amount of research has explored the behavior of police departments, particularly with respect to race. But previous work rarely focuses on the individual's probability of receiving a frisk. By exploiting a traffic stop-level dataset from the Pittsburgh Police Department, the marginal effects of assorted driver characteristics are estimated. While the broad characterization of African-American drivers being more likely to receive a frisk remains accurate, several related factors are identified that create a more nuanced picture of a driver's probability of being frisked. The interaction of the gender of the driver, the time of day of the traffic stop, and the existence of passengers in the stopped vehicle with the race of the driver all impact the probability of receiving a frisk.

Keywords Frisking · Race · Traffic stops · Gender

JEL Classification K00 · K42

1 Introduction

Under United States law, police officers may frisk a civilian when they determine suspicious activity is afoot, or otherwise feel threatened. However, equality under the law prohibits officers from performing frisks based on race. This analysis incorporates a previously unexplored dataset to examine the determinants of

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frisking. Over 92,000 traffic stops from 2011 through 2013 in Pittsburgh, African-American drivers are up to 8 % more likely to be frisked than similar Caucasian drivers.

While the outcomes of stop-and-frisk policies have received extensive attention in the criminology, law and economics fields, the majority of empirical analyses tend to focus on a departmental-level analysis—namely, whether bias exists in the implementation of frisks across races in aggregate, across a department or precinct. The results herein are unique in that they present estimates for the marginal impact of several factors upon the probability *an individual* receives a frisk, based on factors specific to the individual (i.e., race, gender) and to the traffic stop (i.e., number of passengers, location, time of day). This individual-centric analysis augments the existing literature well by providing a much more pointed analysis of issues previously examined on a broader scale.

2 Literature review

The specific practices concerning "stop and frisk" procedures in the United States stem from *Terry v. Ohio* (1968):

> We merely hold today that where a police officer observes unusual conduct which leads him reasonably to conclude in light of his experience that criminal activity may be afoot and that the persons with whom he is dealing may be armed and presently dangerous, where in the course of investigating this behavior he identifies himself as a policeman and makes reasonable inquiries, and where nothing in the initial stages of the encounter serves to dispel his reasonable fear for his own or others' safety, he is entitled for the protection of himself and others in the area to conduct a carefully limited search of the outer clothing of such persons in an attempt to discover weapons which might be used to assault him.

Terry concerns only weapons; procedures for stops involving contraband come from *Minnesota v. Dickerson* (1993):

> The question presented today is whether police officers may seize nonthreatening contraband detected during a protective patdown search of the sort permitted by *Terry*. We think the answer is clearly that they may, so long as the officer's search stays within the bounds marked by *Terry*.

As such, these two United States Supreme Court cases form the foundation of the role of the police officers' permissible behavior concerning frisks.

An extensive literature has emerged to investigate the role of race in police activities. One popular area of inquiry is whether race plays a role in traffic stops. Using self-reported data by citizens, Lundman and Kaufman (2003) show that police made traffic stops more frequently of African-American males. Further, race and ethnicity played a role in determining the legitimacy of the traffic stop. Engel and Calnon (2004) similarly rely on survey data (the Police-Public Contact Survey), Huggins (2011) uses a supplemental survey to the National Crime Victimization

Survey and Warren et al. (2006) use a telephone survey of licensed drivers in North Carolina; all three studies point to race playing a role in explaining differences in traffic stops. A host of other studies, utilizing non-survey data, find that African-Americans receive a disproportionate share of police traffic stops and/or tickets; see Lamberth (1996), Verniero and Zoubeck (1999), Walker (2000), Berjarano (2001) and Mechan and Ponder (2001).

Beyond the issue of race during a traffic stop, Makowsky and Stratmann (2009) find evidence of effective tax exportation through the pointed issuing of traffic citations by local officers. Citizens from outside the local area in which the traffic stop occurred are more likely to receive a citation—and a more severe fine—when compared to citizens living near the location of the traffic stop.

Several extensive investigations show poorer outcomes for racial minorities amplifying over the last half-century. Alexander (2012) shows that, through a host of government policies, and the "War on Drugs" in particular, the United States has given back many of the gains achieved during the Civil Rights Movement of the mid-twentieth century. Also focusing on the "War on Drugs," Mauer (2006) finds policy as a catalyst for race-based inequities in legal outcomes, and that these outcomes were not incidental but intended by policy-makers.

A second area of research concerns the role of race in shaping police frisking behavior. "Stop-and-frisk" procedures have received ample scholarly attention, though largely depend on department-level aggregated statistics as compared to the individual, stop-level data used in this study. Ridgeway (2007) finds that, in New York City, nonwhites received slightly more frequent frisks; however, differences in raw statistics overstate racial disparities. Nevertheless, significant racial disparities exist in New York City pertaining to implementation of marijuana enforcement across both stops and arrests (Geller and Fagan 2010). Gelman et al. (2007) find significantly strong results with blacks and Hispanics being stopped twice as frequently as whites, though being arrested less frequently. While Gelman et al. (2007) examine precinct-level data in New York City, Ridgeway (2007) focuses mostly on establishing proper benchmarks for determining racial disparities stop-and-frisk data in New York City. MacDonald, et al. (2007) find that race plays a role in citizens' perceptions of police practices through a survey of 3000 Cincinnati residents. While most studies focus on the race of the (would-be) frisked, a number of other studies focus particularly on the race of the frisker (officer) and come to a range of conclusions; see Skogan and Frydl (2004), Brown and Frank (2006), Sklansky (2006), and Gilliard-Matthews et al. (2008).

Related to the decision to perform a frisk, Persico and Todd (2006) find evidence to suggest that officers administer searches so as to maximize the number of successful searches.[1] Antonovics and Knight (2009) note that searches are more likely to occur when the races of the officer and the searched differ. The two previous analyses empirically test a theoretical model of officer search behavior initially put forth by Knowles et al. (2001). Further, Durlauf (2005) notes that there exists an equity/efficiency tradeoff in racial profiling—namely, the inequity in racial

[1] For a related discussion in this analysis pertaining to successful versus unsuccessful frisks, please see Sect. 4.3.

profiling must be weighed against the reduction in crime rates should underlying cross-race differences in illicit activity dictate such a relationship to exist.

A few previous studies have investigated the role of race in frisking behavior by police during traffic stops. Farrell (2011) examines nearly 150,000 traffic stops across the state of Rhode Island during the 2005 calendar year and incorporates a hierarchical generalized linear model to separate stop-level effects from assorted agency-level effects. While controlling for race, her discussion focuses in large part of the role of gender in explaining traffic stop-related outcomes. Rosenfeld et al. (2012), using traffic stop-level data on males from St. Louis, show that young African-American males are searched at higher rates than young White males, though this discrepancy diminishes among males aged 30 or older. Ritter (2013) examines traffic stop-specific searches in Minneapolis and finds results consistent with implicit discrimination.

3 Data

The data for this analysis consist of 92,644 individual traffic stops by the Pittsburgh Police Department from 2011 through 2013. These data represent the entirety of reported traffic stops by the Bureau of Police in the City of Pittsburgh for these 3 years. Captured in the data are the date and time of the traffic stop, the neighborhood in which the traffic stop took place, the race and gender of the driver of the vehicle, the number of passengers in the vehicle, whether the driver was frisked, and the results of the frisk in terms of weapons, contraband and/or evidence found. The data utilized for this analysis represents the extent of those provided by the City of Pittsburgh. While additional descriptive data would be of value—a number of previous studies had access to the race of the officer, for example—the data available here do allow for a pointed study of the issues at hand. Further, while a study examining the frisking behavior of police would benefit from a dataset containing all police reports—traffic-related or otherwise—the sizeable dataset utilized herein nonetheless represents a healthy, unbiased sample of police activity and can provide insight into the nature of police frisking activity. Moreover, the nature of the data allows not only for an aggregated overview of police frisking behavior as it pertains to traffic stops but also a regression analysis by which the various factors described above can be isolated and their partial effects on police behavior can be estimated.

Table 1 presents a broad overview of frisking activity during traffic stops in Pittsburgh from 2011 through 2013. The total number of traffic stops performed each year is largely constant during 2011 and 2012, though sees a decline in 2013—primarily due to a decrease in the number of traffic stops involving white drivers.[2]

[2] Note that the *rate* at which white drivers are frisked is mildly *higher* even though fewer white drivers were pulled over; see subsequent paragraph for additional race-specific discussion.

Table 1 Frisking statistics

	All					Female				Male			
	Race	Frisked	Not frisked	Total stops	Frisk %	Frisked	Not frisked	Total stops	Frisk %	Frisked	Not frisked	Total stops	Frisk %
Combined	Black	4293	28,554	32,847	13.07	372	9494	9866	3.77	3921	19,060	22,981	17.06
	White	2806	51,996	54,802	5.12	553	18,104	18,657	2.96	2253	33,892	36,145	6.23
	Other	172	4823	4995	3.44	21	1252	1273	1.65	151	3571	3722	4.06
	Total	7271	85,373	92,644	7.85	946	28,850	29,796	3.17	6325	56,523	62,848	10.06
	Black/White Statistical Significance				99.9	Black/White Statistical Significance			99.9	Black/White Statistical Significance			99.9
2013	Black	1393	9158	10,551	13.20	127	3046	3173	4.00	1266	6112	7378	17.16
	White	875	15,517	16,392	5.34	176	5445	5621	3.13	699	10,072	10,771	6.49
	Other	71	1907	1978	3.59	12	514	526	2.28	59	1393	1452	4.06
	Total	2339	26,582	28,921	8.09	315	9005	9320	3.38	2024	17,577	19,601	10.33
	Black/White Statistical Significance				99.9	Black/White Statistical Significance			95	Black/White Statistical Significance			99.9
2012	Black	1386	10,092	11,478	12.08	128	3376	3504	3.65	1258	6716	7974	15.78
	White	997	18,009	19,006	5.25	180	6253	6433	2.80	817	11,756	12,573	6.50
	Other	57	1715	1772	3.22	5	470	475	1.05	52	1245	1297	4.01
	Total	2440	29,816	32,256	7.56	313	10,099	10,412	3.01	2127	19,717	21,844	9.74
	Black/White Statistical Significance				99.9	Black/White Statistical Significance			95	Black/White Statistical Significance			99.9
2011	Black	1514	9304	10,818	14.00	117	3072	3189	3.67	1397	6232	7629	18.31
	White	934	18,470	19,404	4.81	197	6406	6603	2.98	737	12,064	12,801	5.76
	Other	44	1201	1245	3.53	4	268	272	1.47	40	933	973	4.11
	Total	2492	28,975	31,467	7.92	318	9746	10,064	3.16	2174	19,229	21,403	10.16
	Black/White Statistical Significance				99.9	Black/White Statistical Significance			90	Black/White Statistical Significance			99.9

"Black/White Statistical Significance" presents the level of confidence for a two sample proportion test of a significant difference between Black and White frisk rates

While differences in frisking activity across years are minor, differences in frisking behavior across races is substantial and persistent across years. Overall, 13.07 % of African-American drivers that were pulled over received a frisk, as compared to 5.12 % of Caucasian drivers; in 2011 (2012, 2013), the respective rates were 14.00 % (12.08 %, 13.20 %) and 4.81 % (5.25 %, 5.35 %). All four cross-race pairs—combined, 2011, 2012 and 2013—are statistically different at the 99.9 % level. In contrast to the differences in total frisking rates independent of race, the race-based differences are sizeable. African-American drivers are frisked over 2.5 times more frequently than Caucasian drivers. In fact, in aggregate terms, African-Americans were engaged in 40.1 % *fewer* traffic stops throughout the 3 years sample yet received 53.0 % *more* frisks.

The above cross-race frisking results are robust across genders, though largely driven by male-targeted frisks.[3] African-American males received a frisk in 17.06 % of all traffic stops as compared to 6.23 % of all Caucasian males. The respective frisking rates in 2011 (18.31–5.76 %), 2012 (15.78–6.50 %) and 2013 (17.16–6.49 %) are nearly equivalent, and the differences between all four cross-race pairs amongst males are statistically significant well beyond the 99.9 % level.

Differences in frisking rates amongst females are smaller in aggregate yet still statistically distinct. Overall, African-American females (3.77 %) are frisked at a higher rate than Caucasian females (2.96 %), a difference in rates significant to the 99.9 % level. African-American females were frisked at higher rates in 2011 (3.67–2.98 %), 2012 (3.65–2.80 %) and 2013 (4.00–3.13 %), though due to the correspondingly smaller sample sizes in each individual year the differences in rates are significant only to the 90 % level in 2011, and to the 95 % level in 2012 and 2013.

4 Probit analysis

4.1 Model

While the overview in Sect. 3 of the role of race in frisking paints a broad picture, the individual-level data allow for a more pointed estimate of the probability of receiving a frisk based on a number of factors—including race—during a traffic stop. In order to estimate the change in probability of being frisked due to race, while controlling for a host of factors, a probit model is estimated as follows.

The underlying latent variable, f_i^* for each traffic stop i, is a function of a vector of observed characteristics x_i, with unknown weights β and a random error term ε_i. This relationship is expressed as follows:

$$f_i^* = x_i'\beta + \varepsilon_i$$

where, under the assumption of normality, the probability that the driver is frisked is

[3] Indeed, there exists no racial subset of males in any year that receives a lower rate of frisking during a traffic stop than any racial subset of females in any year.

$$\Pr(f_i = 1|x_i) = \Pr\left(f_i^* > 0|x_i\right) = \varphi\left(x_i'\beta\right)$$

and, correspondingly, not frisked

$$\Pr(f_i = 0|x_i) = \Pr\left(f_i^* \leq 0|x_i\right) = 1 - \varphi\left(x_i'\beta\right)$$

where φ (·) represents the standard normal cumulative distribution function.

As mentioned above, x_i is a vector of observed characteristics during traffic stop *i*. Of primary importance to the analysis at hand is race. In 2011, the race of the driver was captured by three different categories: white, black, and other. In 2012 and 2013, the driver's race expanded to five categories: white, black, Asian, Hispanic and other. For consistency across years, the data from 2012 to 2013 are reorganized into the three race categories from 2011.[4] The remaining driver-specific variables are gender and whether the driver was traveling with passengers or in an otherwise unoccupied vehicle. Both of these variables are consistent across all years of data. A set of variables captures the shift in which the traffic stop occurred. Traffic stops occur over three shifts within the day: Shift 1 or AM (7:00 am to 3:00 pm), Shift 2 or PM (3:00 pm to 11:00 pm), and Shift 3 or Night (11:00 pm to 7:00am). Should variations in frisking occur throughout the day, these fluctuations can be controlled for. Finally, beyond time-specific variables, the data contain information on the zone in which the traffic stop took place. The city of Pittsburgh is split into six police zones; as such, the data place each traffic stop into one of seven zones (the six city zones and one final zone to capture any activity outside of the city limits).

A host of interaction terms have been included from the initial set of independent variables. Every pairwise combination of *Black*, *Male*, and *Solo* is included to test whether the joint existence of these states further explains variation in the probability of receiving a frisk beyond their inclusion separately. An additional interaction term combines all three terms. Finally, *Black* is interacted with *Shift 2* and *Shift 3* so as to provide a rudimentary test of Grogger and Ridgeway (2006).[5]

A range of fixed effects are also included as robustness checks for the sensitivity of the results to possible alternative explanations. A set of dummy variables capture the year in which the traffic stop took place; should policies or frisking behavior change across years, these effects can be isolated. A set of dummy variables capture the month in which the stop occurred, in the case that month-specific effects across years could be driving underlying behavior such that frisking is more or less likely across months. Finally, a dummy variable is included for each specific month within the dataset; should frisking behavior differ within a particular month in the data, then this effect can be captured as well.

4.2 Results

Table 2 presents the results from the main probit model estimations; marginal effects, not coefficients estimates, are reported. Due to the preponderance of data,

[4] Models run solely on 2012 and 2013 data utilizing five race variables produce equivalent results.

[5] The author thanks an anonymous referee for this useful suggestion.

Table 2 Impact factors on the probability of being frisked, main specifications

	(1)	(2)	(3)	(4)
Fixed effects	(None)	(None)	(None)	(None)
Race				
Black	**0.0784*** (0.0021)**	**0.0145*** (0.0040)**	−0.0073 (0.0045)	0.0006 (0.0052)
Other	**−0.0225*** (0.0037)**	**−0.0239*** (0.0033)**	**−0.0251*** (0.0030)**	**−0.0241*** (0.0023)**
Driver characteristics				
Male		**0.0415*** (0.0022)**	**0.0328*** (0.0030)**	**0.0259*** (0.0026)**
Solo			**−0.0965*** (0.0060)**	**−0.0694*** (0.0052)**
Time of day				
Shift 2				**0.1022*** (0.0034)**
Shift 3				**0.1287*** (0.0057)**
Interaction terms				
Black Male		**0.0731*** (0.0060)**	**0.0704*** (0.0075)**	**0.0592*** (0.0066)**
Black Solo			**0.0259*** (0.0090)**	**0.0185*** (0.0077)**
Male Solo			**0.0189*** (0.0053)**	**0.0149*** (0.0046)**
Black Male Solo			0.0031 (0.0085)	0.0012 (0.0072)
Black Shift 2				**−0.0104*** (0.0035)**
Black Shift 3				**−0.0161*** (0.0033)**
N	92,644	92,644	92,644	92,644
χ^2	1851.8	3469.4	4835.3	7070.7

Bold values indicate statistical significance

Marginal effects reported for independent variables

*** Denotes marginal effects estimate significant to the 99 % level

the vast majority of reported coefficients in Table 2 are statistically significant at the 99 % level of confidence. The only instances of an estimate failing to achieve statistical significance—the variables *Black* and *Black Male Solo*, both in regressions 3 and 4—occur when multiple interaction terms involving African-Americans are included. The marginal effect of being an African-American remains a significant determinant of whether a driver receives a frisk during a traffic stop (see below for further discussion). As such, the forthcoming discussion will focus primarily on the economic significance of the estimates.

The main specification of interest—regression 4 in Table 2—offers several results of note. First, being an African-American increases the probability of

receiving a frisk during a traffic stop. Due to the inclusion of several interaction terms, the marginal effect of being an African-American is beyond a single variable's (i.e., *Black*) calculated marginal effect. Table 3 presents the overall marginal effect of race on receiving a frisk dependent on race, gender, shift in which the traffic stopped occurred relative to the base condition of a white female with passengers stopped during Shift 1. In addition, the difference between African-American and Caucasian frisking rates, dependent on particular circumstances, are presented as well. These differences highlight the importance of categorizing racial discrepancies as non-uniform across scenarios. Black males, relative to white males, are more likely to receive a frisk during a traffic stop. When driving with passengers, an African-American male driver is between 4 and 6 percentage points more likely than a Caucasian male driver to be frisked during a traffic stop while a solo African-American male driver is between 6 and 8 percentage points more likely than a solo Caucasian male driver to be frisked during a traffic stop. The role of passengers also plays a role in the propensity of black females to receive a frisk relative to white females. When driving alone, African-American females are up to 2 percentage points more likely to receive a frisk as compared to Caucasian female driving without passengers. However, when driving with passengers, African-American female drivers are up to 1.5 percentage points *less* likely to receive a frisk as compared to Caucasian female drivers. It is tempting to paint racial discrepancies with a broad brush; however, as these results show, the issue is nuanced and should not be over-generalized.

Beyond the African-American/Caucasian dynamic, there are a number of other results worth noting. Compared to Caucasians, "other" races appear about 2 percentage points less likely to receive a frisk during a traffic stop. As approximately

Table 3 Estimated relative probability of receiving a frisk

	Solo		Passengers	
	Male (%)	Female (%)	Male (%)	Female (%)
Black				
Shift 1	5.09	−5.03	8.57	0.06
Shift 2	14.27	4.15	17.75	9.24
Shift 3	16.35	6.23	19.83	11.32
White				
Shift 1	−2.86	−6.94	2.59	–
Shift 2	7.36	3.28	12.81	10.22
Shift 3	10.01	5.93	15.46	12.87
Other				
Shift 1	−5.27	−9.35	0.18	−2.41
Shift 2	4.95	0.87	10.40	7.81
Shift 3	7.60	3.52	13.05	10.46
Black/White difference				
Shift 1	7.95	1.91	5.98	0.06
Shift 2	6.91	0.87	4.94	−0.98
Shift 3	6.34	0.30	4.37	−1.55

Reported marginal effects derived from Table 2, Regression 4. Baseline case is white, female, Shift 1, with passengers

5 % of all traffic stops in the data concern drivers that are neither African-American nor Caucasian, the practical importance of such a finding is questionable. Male drivers are more likely to be frisked than female drivers; not only is the marginal effect of *Male* positive and statistically significant, so, too, are the marginal effects on both interaction terms utilizing *Male*. Table 3 shows males to be more likely than females to receive a frisk in every pairwise combination. The smallest estimate puts the difference at approximately 2.5 percentage points; the largest puts the difference at approximately 10 percentage points. The probability of receiving a frisk during a traffic stop increases during Shift 2 and Shift 3, relative to Shift 1. Table 3 again displays this result; the increase for these two shifts compared to Shift 1 is between 10 and 13 percentage points. Drivers without passengers appear approximately 3 to 6 percentage points less likely to receive a frisk than those riding with passengers; while speculative, individuals riding with passengers may be pursuing criminal activity at a higher rate than those driving alone, and the results may be capturing this possibility. For an extended analysis of the role of passengers in determining traffic stop outcomes, please see Ryan (2014).

As mentioned in the above section, the data allow for a test of Grogger and Ridgeway (2006). The authors set forth the "veil of darkness" hypothesis "which asserts that police are less likely to know the race of a motorist before making a stop after dark than they are during daylight." The initial hypothesis pertains to the racial composition of traffic stops during daytime hours as compared to nighttime. Assuming constant driving behavior, interaction with police and the like, discrepancies between the race distributions of drivers stopped during the daytime and at night serve as a test for racial profiling. Table 4 presents broad statistics on the race of drivers by the shift in which the traffic stop occurred. As outlined above, Shift 1 contains stops performed from 7:00 am to 3:00 pm, Shift 2 contains stops performed from 3:00 pm to 11:00 pm, and Shift 3 contains stops performed from 11:00 pm to 7:00 am. Because Shift 2 straddles sundown, the best comparison for the data at hand is to compare stop rates from Shift 1 to Shift 3. Stop rates across African-Americans and Caucasians differ dramatically from Shift 1 to Shift 3;

Table 4 Stops and frisks, by shift

	Total stops	Black stops	Black frisks	White stops	White frisks	Other stops	Other frisks
Shift 1: 7:00 am–3:00 pm	33,610	8219	307	23,743	232	1648	14
Shift 2: 3:00 pm–11:00 pm	38,523	14,995	2549	21,327	1767	2201	98
Shift 3: 11:00 pm–7:00 am	20,511	9633	1437	9732	807	1146	60

	Black stop (%)	Black frisk (%)	White stop (%)	White frisk (%)	Other stop (%)	Other frisk (%)
Shift 1: 7:00 am–3:00 pm	24.45	3.74	70.64	0.98	4.90	0.85
Shift 2: 3:00 pm–11:00 pm	38.92	17.00	55.36	8.29	5.71	4.45
Shift 3: 11:00 pm–7:00 am	46.97	14.92	47.45	8.29	5.59	5.24

"Stop %" denote percentage of stops by race by shift. "Frisk %" denotes percentage of stops within each race within each shift that results in a frisk

whereby any traffic stop is almost equally likely to be either an African-American or a Caucasian during Shift 3, any traffic stop during Shift 1 is nearly three times more likely to have a Caucasian driver. According to these data, police officers do not appear to be targeting minority drivers during the shifts in which they would be able to visually confirm the race of the driver prior to engaging in a traffic stop—in fact, the opposite appears to be true. Interestingly, stop rates amongst other races remain nearly constant between Shift 1 and Shift 3; the difference between 4.90 and 5.59 % is statistically significant at the 99.9 % level of confidence due to the volume of traffic stops in the data. Nevertheless, the difference constitutes a less than 1 % change. The rate increase in stopping African-American drivers almost perfectly mirrors the rate decrease in stopping Caucasian drivers.

While the main specification—Regression 4 in Table 2, with the corresponding marginal effects reported in Table 3—provides the foundation for the analysis of the determinants of the probability of receiving a frisk during a traffic stop, there exists the possibility that a range of confounding factors could be biasing the results. Indeed, all of the specifications in Table 2 contain no comprehensive fixed effects of any kind. Tables 5 and 6 augment Regression 4 in Table 2 with numerous combinations of fixed effects gleaned from the dataset.

The inclusion of these fixed effects does nothing to change the results from the main specification. Table 5 presents three additional specifications that incorporate a variety of time-specific fixed effects. Regression 1 simply controls for the year in which the traffic stop occurred; should frisking behavior have varied across the 3 years—due to, say, adjustments in internal police policy—then these controls can capture these changes. Regression 2 considers both year and month fixed effects; should similar frisking variances occur across months—say, increased frisking rates during the summer months as compared to the winter months—then these effects are appropriate. Regression 3 considers the same year and month fixed effects from Regression 2 but also adds fixed effects for each specific month ("year-month") in the dataset. Should a particular month have witnessed a strong departure in frisking rates—due to, say, a spike in illegal activity—then these effects can control for this scenario. Again, the addition of these fixed effects does not change the results of the main specification.[6]

Table 6 considers location-specific fixed effects. Regression 4 controls for the zone in which the traffic stop took place. Should frisking rates vary by zone—perhaps higher frisking rates in the central business district as opposed to more suburban areas—then these effects can capture these distortions. In addition, should race disparities in the data be correlated with the location of the traffic stop, then the race-specific estimates should show some difference in estimation due to the inclusion of these fixed effects. None of these possibilities appear to be true; the estimates, race-specific and otherwise, remain remarkably consistent across the assorted fixed effect specifications. Regressions 5 and 6 include zone fixed effects along with year and month fixed effects. Regression 7 considers zone-year-month

[6] Note that "Controlled conditions" in Tables 5 and 6 do not constitute the total number of additional variables added to the model but the number of conditions considered—i.e., year fixed effects over three years are three conditions.

Table 5 Impact factors on the probability of being frisked, robustness checks (time fixed effects)

	Table 2, Reg. (4)	(1)	(2)	(3)
Fixed effects	(None)	Year	Year, month	Year, month, year–month
Controlled conditions	0	3	15	51
Race				
Black	0.0006 (0.0052)	0.0007 (0.0052)	0.0005 (0.0052)	0.0004 (0.0052)
Other	**−0.0241*** (0.0023)**	**−0.0238*** (0.0023)**	**−0.0236*** (0.0023)**	**−0.0234*** (0.0023)**
Driver characteristics				
Male	**0.0259*** (0.0026)**	**0.0259*** (0.0026)**	**0.0258*** (0.0026)**	**0.0258*** (0.0025)**
Solo	**−0.0694*** (0.0052)**	**−0.0693*** (0.0052)**	**−0.0693*** (0.0052)**	**−0.0692*** (0.0052)**
Time of day				
Shift 2	**0.1022*** (0.0034)**	**0.1027*** (0.0034)**	**0.1022*** (0.0034)**	**0.1021*** (0.0034)**
Shift 3	**0.1287*** (0.0057)**	**0.1292*** (0.0057)**	**0.1286*** (0.0057)**	**0.1291*** (0.0057)**
Interaction terms				
Black Male	**0.0592*** (0.0066)**	**0.0591*** (0.0066)**	**0.0592*** (0.0066)**	**0.0590*** (0.0066)**
Black Solo	**0.0185*** (0.0077)**	**0.0185*** (0.0077)**	**0.0186*** (0.0077)**	**0.0190*** (0.0077)**
Male Solo	**0.0149*** (0.0046)**	**0.0148*** (0.0046)**	**0.0149*** (0.0046)**	**0.0150*** (0.0046)**
Black Male Solo	0.0012 (0.0072)	0.0013 (0.0072)	0.0011 (0.0072)	0.0008 (0.0071)
Black Shift 2	**−0.0104*** (0.0035)**	**−0.0104*** (0.0035)**	**−0.0103*** (0.0035)**	**−0.0102*** (0.0035)**
Black Shift 3	**−0.0161*** (0.0033)**	**−0.0161*** (0.0033)**	**−0.0160*** (0.0034)**	**−0.0161*** (0.0033)**
N	92,644	92,644	92,644	92,644
χ^2	7070.7	7084.9	7133.2	7205.8

Bold values indicate statistical significance

Marginal effects reported for independent variables

*** Denotes marginal effects estimate significant to the 99 % level

Table 6 Impact factors on the probability of being frisked, robustness checks (zone fixed effects)

	Table 2, Reg. (4)	(4)	(5)	(6)	(7)	(8)	(9)
Fixed Effects	(None)	Zone	Zone, year	Zone, year, month	Zone, year, month, zone-year–month	Zone, zone-shift	Zone, zone-solo
Controlled Conditions	0	7	10	22	274	21	14
Race							
Black	0.0006 (0.0052)	0.0001 (0.0051)	0.0000 (0.0051)	−0.0002 (0.0051)	−0.0006 (0.0050)	−0.0020 (0.0051)	−0.0003 (0.0052)
Other	**−0.0241*** (0.0023)**	**−0.0227*** (0.0023)**	**−0.0224*** (0.0023)**	**−0.0222*** (0.0023)**	**−0.0218*** (0.0022)**	**−0.0224*** (0.0022)**	**−0.0226*** (0.0023)**
Driver characteristics							
Male	**0.0259*** (0.0026)**	**0.0253*** (0.0025)**	**0.0253*** (0.0025)**	**0.0252*** (0.0025)**	**0.0246*** (0.0025)**	**0.0251*** (0.0025)**	**0.0253*** (0.0025)**
Solo	**−0.0694*** (0.0052)**	**−0.0673*** (0.0052)**	**−0.0672*** (0.0052)**	**−0.0672*** (0.0052)**	**−0.0649*** (0.0051)**	**−0.0659*** (0.0051)**	**−0.0721*** (0.0073)**
Time of day							
Shift 2	**0.1022*** (0.0034)**	**0.1008*** (0.0034)**	**0.1013*** (0.0034)**	**0.1007*** (0.0034)**	**0.0980*** (0.0033)**	**0.0864** (0.0515)**	**0.1009** (0.0034)**
Shift 3	**0.1287*** (0.0057)**	**0.1296*** (0.0057)**	**0.1300*** (0.0057)**	**0.1293*** (0.0057)**	**0.1274*** (0.0057)**	**0.1838*** (0.0036)**	**0.1296*** (0.0057)**
Interaction terms							
Black Male	**0.0592*** (0.0066)**	**0.0577*** (0.0065)**	**0.0575*** (0.0065)**	**0.0577*** (0.0065)**	**0.0565*** (0.0064)**	**0.0555*** (0.0064)**	**0.0578*** (0.0066)**
Black Solo	**0.0185*** (0.0077)**	**0.0173*** (0.0075)**	**0.0172*** (0.0075)**	**0.0173*** (0.0075)**	**0.0162*** (0.0073)**	**0.0163*** (0.0074)**	**0.0178*** (0.0076)**
Male Solo	**0.0149*** (0.0046)**	**0.0143*** (0.0045)**	**0.0143*** (0.0045)**	**0.0144*** (0.0045)**	**0.0136*** (0.0044)**	**0.0135*** (0.0045)**	**0.0144*** (0.0045)**
Black Male Solo	0.0012 (0.0072)	0.0018 (0.0071)	0.0019 (0.0071)	0.0017 (0.0071)	0.0019 (0.0070)	0.0028 (0.0071)	0.0017 (0.0071)
Black Shift 2	**−0.0104*** (0.0035)**	**−0.0102*** (0.0034)**	**−0.0102*** (0.0034)**	**−0.0101*** (0.0034)**	**−0.0094*** (0.0034)**	**−0.0089** (0.0036)**	**−0.0102** (0.0034)**
Black Shift 3	**−0.0161*** (0.0033)**	**−0.0167*** (0.0032)**	**−0.0166*** (0.0032)**	**−0.0165*** (0.0032)**	**−0.0162*** (0.0031)**	**−0.0117*** (0.0036)**	**−0.0167*** (0.0032)**

Table 6 continued

	Table 2, Reg. (4)	(4)	(5)	(6)	(7)	(8)	(9)
N	92,644	92,644	92,644	92,644	92,644	92,644	92,644
χ^2	7070.7	7500.1	7510.4	7554.4	8121.6	7711.4	7506.4

Bold values indicate statistical significance

Marginal effects reported for independent variables

*** (**) Denotes marginal effects estimate significant to the 99 % (95 %) level

specific fixed effect as well—should a particular disturbance to frisking rates have occurred in a particular area of Pittsburgh during a particular period in time for any reason then this possibility, too, can be captured. Regression 8 considers the interaction of the location of the traffic stop and the time of day; should certain locations witness increased frisking rates during certain times of the day, then these effect capture these disturbances. Regression 9 considers the location of the traffic stop and whether the vehicle contained passengers. Once again, there exists no combination of fixed effects that modify the results of the main specification in even a minor manner. The marginal effects presented in Table 3 are robust across all specifications.

4.3 Alternative analysis on race and frisks

Pennsylvania follows the "stop and frisk" rule set forth in *Terry*. Police officers can frisk an individual for weapons only when the officers have a reasonable suspicion that "criminal activity may be afoot" or otherwise feel threatened. Further, frisking suspects on the basis of race or gender is illegal. That African-American males are significantly more likely to be frisked, however, is not itself proof of officer misconduct. An outcome of significantly higher percentages of African-American males receiving frisks could be the logical result of an increased suspicion of illegal activity or a heightened sense of endangerment by law enforcement officers in the presence of African-American males. While possibly satisfying the letter of the law, though, such an ex ante belief hardly addresses its spirit of racial equality under the law.

While legally murky, higher rates of frisking could conceivably be justified should higher rates of weapons, or other contraband, be found across certain racial groups. To provide a clearer, if nonsensical, example: In some sense, it may be justified to test men for Y chromosomes more frequently than women because, once tested, men exhibit a higher propensity to possess Y chromosomes than women. More directly, per the above results, it may make sense ex ante to frisk higher percentages of African-Americans as compared to Caucasians because African-Americans are found ex post to be carrying items of interest more frequently than are Caucasians.

Table 7 presents the results of frisks across races by year. Frisks can generate the discovery of evidence, contraband, or weapons, or any combination thereof. Frisks resulting in such a discovery are noted in Table 7 as "Frisks: Outcome." A frisk that fails to generate any of the aforementioned discoveries are noted as "Frisks: No outcome." Absent any underlying differences in behavior across the two races, as well as any preconceptions about possible illicit behavior across races, the rates of unsuccessful frisks across races should not vary. Not only are African-Americans more likely to receive a frisk, they are also decidedly more likely to receive a frisk that does not discover any evidence, contraband or weapons. In every year of the data, the rate of unsuccessful frisks upon an African-American during a traffic stop is significantly higher—to the 99.9 % level of confidence—than the rate of unsuccessful frisks upon a Caucasian. Aggregated across all years, the rate of unsuccessful frisks among African-Americans is twenty-four percentage points higher than the rate of unsuccessful frisks among Caucasians. That African-Americans are frisked more

Table 7 Frisks, by race

	Race	Frisks: outcome	Frisks: No outcome	Unsuccessful frisk (%)
Combined	Black	1539	2754	64.2
	White	1686	1120	39.9
	Other	59	113	65.7
	Total	3284	3987	54.8
	Black/White Statistical Significance			99.9
2013	Black	458	935	67.1
	White	500	375	42.9
	Other	21	50	70.4
	Total	979	1360	58.1
	Black/White Statistical Significance			99.9
2012	Black	626	760	54.8
	White	614	383	38.4
	Other	25	32	56.1
	Total	1265	1175	48.2
	Black/White Statistical Significance			99.9
2011	Black	455	1059	69.9
	White	572	362	38.8
	Other	13	31	70.5
	Total	1040	1452	58.3
	Black/White Statistical Significance			99.9

"Black/White Statistical Significance" presents the level of confidence for a two sample proportion test of a significant difference between Black and White

frequently, and more unsuccessfully, than Caucasians is an important statistical reality to note when considering the intersection of frisking and race.

A point of clarification is in order. An expectation of zero unsuccessful frisks—that every single frisk results in the discovery of evidence, contraband, or a weapon—is not only overly idealistic, it may not even be desirable. A degree of uncertainty exists when deciding whether to frisk an individual; in light of this uncertainty, police must determine which error type is preferable. An officer can decide to (a) aggressively frisk all individuals in the hopes that few individuals fall through the cracks of possessing contraband or a weapon or being taken into custody (Type I error), or (b) conservatively frisk all individuals so as to minimize the incidence of unsuccessful frisks (Type II error). Neither error is ideal; engaging in frisking behavior that minimizes Type II error could put officers and civilians at risk, while engaging in behavior that minimizes Type I error could be burdensome on a police department's resources. Under the reasonable assumption of increasing marginal cost of reducing each error type, there exists an equilibrium—and, in fact, a cost-minimizing—level of Type I and Type II error in a department's frisking behavior. This cost-minimizing point likely does not exist where either Type I or Type II error equals zero; as such, from a purely cost-minimizing perspective, some

level of unsuccessful frisking is efficient. Assuming the Pittsburgh Police Department to be cost-minimizing—a wide assumption, to be certain—a cursory look at the above data on unsuccessful frisks implies, in the broadest sense, a minimizing of Type I error in favor of an increase in Type II error.

Nevertheless, Type II errors—unsuccessful frisks—should not vary across races. Table 7 shows that excess frisking rates vary substantially across race lines. Overall, 64.2 % of frisks performed on African-Americans are unsuccessful as compared to just 39.9 % of frisks performed on Caucasians. A similar explanation above applies here as well; while differences in cross-race unsuccessful frisking rates do not itself necessitate illegality, the spirit of law likely seems compromised when African-Americans are unsuccessfully frisked substantially more often.[7] "Other" races witness unsuccessful frisking rates more in line with African-Americans. As such, a dichotomy exists between Caucasians and minority races as compared to African-Americans and all other races.

5 Conclusion

This analysis exploits 3 years of traffic stop-level data to explore the determinants of the decision to frisk a driver. While previous studies explore a wide range of issues pertaining to race-based disparities in policing, the data here allow for a probit analysis to isolate the respective probabilities of being frisked due to driver- and stop-specific characteristics. Most significantly, African-American males are up to 8 % more likely to receive a frisk during a traffic stop when compared to an equivalent Caucasian driver. African-American females are up to 2 % more likely to receive a frisk when driving alone when compared to Caucasian female drivers without passengers, though up to 1.5 % less likely to receive a frisk when driving with passengers.

Frisks occur with greater frequency during later shifts and amongst those traveling with passengers. While most studies consider frisking across races with broad strokes, the stop-level data allow for a much more nuanced picture of exactly how race plays a role in an officer's decision to perform a frisk. To say that African-American face a higher probability of receiving a frisk is an accurate statement; the reality, however, is far more subtle.

Despite the clear empirical fact that African-Americans—and in particular, African-American males—get frisked at decidedly higher rates, this finding alone does not itself prove that contra-*Terry* frisking practices are taking place. Police officers are permitted to frisk an individual for weapons only when the officers have a reasonable suspicion that "criminal activity may be afoot" or otherwise feel threatened. As there exists no objective way within the data to control for a feeling of suspicion or threat, it could be the case that police officers simply suspect more criminal activity or feel threatened more often when dealing with African-American

[7] Another possibility for a greater rate of unsuccessful frisks among African-American drivers is a rational response by African-American drivers to carry fewer items of interest knowing that they have a higher probability of receiving a frisk.

males. This outcome is fully within the scope of the letter of the law; however, the result is hardly satisfying of the spirit of the law.

To be certain, the data in this study is of a more limited scope than comparable studies; consider Ferrandino (2012), whose 3.4 million stops over 7 years easily dwarf the 92,644 stops over 3 years in this analysis. Furthermore, only traffic stops are included in this analysis. However, these differences should not be taken as a root cause to questioning the empirical results in light of previous studies. All 3 years of data in this study, analyzed separated, produce extremely similar results. In adding further data (say, non-traffic stop instances of frisking), to statistically invalidate the results from this analysis any additional police records would, by necessity, need to show not an indifference towards race but rather an exact opposite result as set forth in this study—that African-Americans received not the same treatment as other racial groups but *preferential* treatment—in order to offset the results of this study. While such a result would be interesting on its own—that frisking tendencies varied wildly between traffic- and non-traffic-related circumstances—its existence is both highly unlikely and, improbability aside, still would not overcome the apparent traffic-related behavior along race and gender lines. Nevertheless, additional data as it becomes available will provide a broader picture of the frisking activities discussed herein.

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