
Racial Discrimination among NBA Referees

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Introduction

Research question:

Do NBA referees display own-race biases?

Motivation:

- ◆ Many settings involve individuals making subjective evaluations of the actions of others:
 - Enforcer-offender (judges, officers, etc.)
 - Employer-employee
 - Customer-proprietor
 - Teacher-student
- ◆ Is there an own-race bias in these evaluations?
 - Employer hiring: Stoll, Raphael, and Holzer (2004)
 - Police arrests: Donohue and Levitt (2001):
 - Police vehicle search: Antonovics and Knight (2005)
 - Judicial sentencing: Abrams, Bertrand, & Mullianathan (2005); Schanzenbach (2005)
- ◆ Economics of discrimination:
 - Own-race bias cannot be statistical discrimination
 - In-group preference by majority \Rightarrow Anti-minority bias

Why Examine NBA Referees?

- ◆ Analytic advantages
 - (Essentially) random assignment of referee crews to games
 - Small set of agents, repeated interaction
 - No sorting of players to referees
- ◆ An unlikely place to find discrimination
 - High levels of transparency and monitoring
 - Continual feedback on accuracy of evaluation
 - Incentives to make the right decision
 - Extremely public setting
 - NBA referees “are the most ranked, rated, reviewed, statistically analyzed and mentored group of employees of any company in any place in the world.” (David Stern, NBA commissioner)
- ◆ Intriguing context
 - Quick decisions
 - Subjective evaluation (interpretation of physical contact)
- ◆ Legal implications? (“Disparate Impact”; *Title VII, Civil Rights Act*)
 - Players: 83% black
 - Referees: 68% white



Roadmap

- ◆ Motivation and Context
- ◆ Data: NBA boxscores 1991/92-2003/04
 - Descriptive statistics
- ◆ Checking randomization of referees to games
- ◆ Analysis:
 - Is there an own-race bias on the part of NBA referees?
 - » Individual-level analysis
 - ◆ Fouls awarded against players
 - ◆ Placebo: Does it affect free throw percentage?
 - ◆ Broader impacts
 - » Team-level analysis
 - ◆ Does the race of my opponent matter?
 - Interpreting the magnitudes:
 - » Does it affect who wins?
- ◆ Conclusions
- ◆ [Understanding the NBA's analysis...]

NBA Box Scores

ATLANTA (99)

		ft	rb				
	minutes	m-a	m-a	o-t	a	fouls	points
S Jackson	43	7-18	0-0	0-5	3	4	16
S Abdur-Rahim	43	8-14	9-10	1-10	3	2	26
T Ratliff	38	3-4	0-0	1-9	4	5	6
J Terry	47	10-15	7-13	1-4	8	4	29
D Glover	38	5-16	3-4	1-4	2	2	14
...							

Technical fouls: Indiana - 3 (COACH Carlisle, 3:33 1st; A Harrington, 9:47 3rd; A Harrington, 10:06 4th). Atlanta - 2 (S Jackson, 2:23 3rd; J Terry (ejected), 0:21 5ot).

Flagrant fouls: None. A: 18,818. T: 2:45.

Officials: Bernie Fryer, David Jones, Gary Benson.

Our Data

- ◆ Full boxscore info
 - Regular season games
 - Omit referee strikes (Nov. 1995; Dec. 1998-Jan .1998)
 - 1991/92-2003/04 seasons (12,263 games; 266,984 player-games)
 - Recent update: 2004/05-2006/07 seasons
- ◆ Race: Appears Black v. Non-black (“white”)
 - Players:
 - » Kahn and Shah (2005), Timmerman (2000)
 - » Photos in NBA Register
 - Referees
 - » Visual inspection of press photos
 - » Input from a former referee
 - Coach
 - » Photos in NBA register
- ◆ Player characteristics (height, weight, position)
 - www.basketball-reference.com

Summary Statistics

	Black players	White Players	Black-White Diff
Fouls	2.55	2.53	0.021***
Points	13.24	11.07	2.16***
Minutes	30.71	27.25	3.46***
Foul rate (per 48 min)	4.33	4.97	-0.640***
Points rate (per 48 min)	19.76	18.45	1.312***
Center	11.4%	33.6%	-22.2%***
Height (inches)	78.4	80.54	-2.13***
Weight (lbs)	211.5	223.2	-11.7***
Attendance	16,706	16,798	-92***
Televised?	12.6%	12.8%	-0.2%
Out-of-contention?	6.2%	6.0%	0.2%
Black coach	24.1%	19.8%	4.3%
N	214,291	52,693	
[%]	[80.3%]	[19.7%]	

Note: n=266,984 player-game observations weighted by minutes played.

Random Assignment of Referees

	Black Starters per Team				χ^2 -test of independence(a) [p-value]
	0 White Referees	1 White Referee	2 White Referees	3 White Referees	
1991	4.33	4.33	4.27	4.28	p=.82
1992	4.20	4.20	4.26	4.25	p=.03
1993	4.27	4.27	4.31	4.30	p=.80
1994	4.20	4.27	4.29	4.25	p=.26
1995	4.35	4.26	4.29	4.23	p=.60
1996	4.11	4.17	4.19	4.17	p=.97
1997	4.22	4.18	4.19	4.21	p=.98
1998	4.05	4.13	4.10	4.14	p=.99
1999	4.26	4.25	4.14	4.25	p=.07
2000	4.15	4.19	4.22	4.18	p=.99
2001	4.12	4.08	4.11	4.15	p=.82
2002	4.16	4.20	4.11	4.20	p=.79
2003	4.03	4.05	4.03	4.04	p=.12
Sample size	668	4,928	11,580	7,350	n=24,526
(% of all player-games)	(2.7%)	(20.1%)	(47.2%)	(30.0%)	

Notes: Each observation is a team*game observation.

(a) Final column tests: H_0 : #White referees is independent of #black players

(b) Sample includes all regular season NBA games from 1991/92-2003/04, excluding referee strike.

Difference in Difference Analysis of Foul Rate

*(Foul Rate = 48*fouls/minutes)*

	Black Players	White Players	<i>Difference: Black – White Foul Rate</i>
Majority white refs	4.330 (.008)	4.954 (.018)	-0.623*** (.020)
Majority black refs	4.329 (.015)	5.023 (.032)	-0.94*** (.036)
<i>Difference: Majority White - Majority Black</i>	0.001 (.016)	-0.069*** (.040)	<i>Diff-in-diff</i> 0.070* (.041) [p=.084]

- n=266,984 player-game observations
- Player-game observations weighted by minutes played
- ***, **, * denote statistically significant at 1%, 5% and 10%
- (Standard errors in parentheses)

Comparison of Foul Rates

	Black Players	White Players	<i>Difference: Black – White Foul Rate</i>	<i>Slope: $\Delta(\text{Black-White}) /$ $\Delta\% \text{White Refs}$</i>
0% White Refs	4.418 (.043)	5.245 (.094)	-0.827 (.106)	
33% White Ref	4.317 (.016)	4.992 (.035)	-0.675 (.038)	0.455 (.331)
67% White Refs	4.335 (.010)	4.989 (.023)	-0.654 (.025)	0.064 (.137)
100% White Refs	4.322 (.013)	4.897 (.029)	-0.574 (.032)	0.240** (.121)
Average slope: $\Delta\text{Fouls} / \Delta\% \text{White Refs}$	-0.022 (.027)	-0.204*** (.066)		<i>Diff-in-diff</i> 0.182*** (.066) [p=.006]

- n=266,984 player-game observations
- Player-game observations weighted by minutes played
- ***, **, * denote statistically significant at 1%, 5% and 10%
- (Standard errors in parentheses)

Recent Data: 2004/05-2006/07

	Black Players	White Players	Difference: Black – White Foul Rate	Slope: $\Delta(\text{Black-White}) /$ $\Delta\% \text{White Refs}$
0% White Refs	4.437 (0.063)	5.126 (0.120)	-0.690 (0.139)	
33% White Ref	4.401 (0.026)	4.938 (0.049)	-0.537 (0.056)	0.458 (0.443)
67% White Refs	4.366 (0.021)	4.797 (0.040)	-0.430 (0.045)	0.321 (0.215)
100% White Refs	4.276 (0.034)	4.693 (0.065)	-0.417 (0.071)	0.038 (0.256)
Average slope: $\Delta\text{Fouls} / \Delta\% \text{White Refs}$	-0.162*** (0.053)	-0.405*** (0.107)		Diff-in-diff 0.243** (0.116) [p=.035]

- n=71,759 player-game observations
- Player-game observations weighted by minutes played
- ***, **, * denote statistically significant at 1%, 5% and 10%
- (Standard errors in parentheses)

Interpretation

- ◆ Our fact:
 - Players earn fewer fouls under own-race referees
- ◆ Likely interpretation:
 - Own-race bias
- ◆ Alternative interpretations:
 - Redistribution of fouls within a team
 - Omitted variables
 - » Different refereeing styles interacting with different playing styles
 - Correlation reflects player behavior, not referee behavior
- ◆ Legal interpretation
 - “Disparate impact” on black players of hiring mainly white referees (*Title VII, Civil Rights Act*)
 - Precise mechanism is less important than its impact

Testing for Own-Race Bias

$$\begin{aligned} \text{Fouls per 48 minutes played}_{igrt} = & \\ & \beta_1 \% \text{White referees}_g * \text{Black player}_i \\ & + \beta_2 \% \text{White referees}_r \\ & + \beta_3 \text{Black} \cdot \text{player}_i \\ & + \beta_4 \text{Player characteristics}_i [\text{Height, weight, position, age}_{yr}, \text{experience}_{yr}, \text{allstar}_{yr} \\ & \quad \text{Playing "style"}_i = \text{sample average of player stats}^* \\ & \quad \dots \text{all interacted with \%white referees}_t] \\ & + \beta_5 \text{Team characteristics}_t [I(\text{Out-of-contention}_{g,t})] \\ & + \beta_6 \text{Game characteristics}_g [\text{Home game}_{gr}, \text{attendance}_{gr}, \text{home} * \text{attendance}] \\ & + \text{Fixed effects} \\ & \quad \gg I(\text{player}_i) \quad 1190 \text{ players} \\ & \quad \gg I(\text{referee}_r) \quad 135 \text{ referees} \\ & \quad \gg I(\text{team}_t); I(\text{team}_t) * \text{Home}_g; I(\text{Stadium}) \quad 31 \text{ teams; 31 home stadiums} \\ & \quad \gg I(\text{team}_t) * I(\text{season}_{yr}) \quad 339 \text{ team-seasons} \\ & \quad \gg I(\text{player}_i) * I(\text{season}_{yr}) \quad 5037 \text{ player-seasons} \\ & \quad \gg I(\text{game}_g) \quad 13,326 \text{ games} \\ & \quad \gg I(\text{game}_g) * I(\text{team}_t) \quad 26,647 \text{ team-games} \end{aligned}$$

* Player stats include: Points, free throws, 2 point attempts, 3 point attempts, assists, blocks, defensive rebounds, fouls, offensive rebounds, steals and turnovers (all per 48 minutes), plus free throw, 2 point and 3 point percentage.

Personal Fouls Analysis

Dependent Variable: Foul Rate (=48*Fouls / Minutes) [Mean=4.43; SD=3.34]									
Independent Vars	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Black player *	0.182***	0.122*	0.197***	0.215***	0.202***	0.201***	0.211***	0.205***	0.188**
%White refs	(0.066)	(0.063)	(0.061)	(0.071)	(0.071)	(0.071)	(0.071)	(0.074)	(0.078)
Control Variables									
Black player	-0.763***	-0.079*							
	(0.048)	(0.046)							
%White refs	-0.204***	-0.137**							
	(0.060)	(0.057)							
Forward		-0.943***							
		(0.021)							
Guard		-1.426***							
		(0.032)							
Height (inches)		0.029***							
		(0.005)							
Weight (lbs)		-0.059***							
		(0.005)							
All-star		-0.752***	-0.388***	-0.442***	-0.421***	-0.429***			
		(0.019)	(0.026)	(0.062)	(0.062)	(0.064)			
Starting Five		-1.247***	-0.998***	-1.025***	-1.005***	-0.980***	-0.814***	-0.797***	-0.782***
		(0.014)	(0.016)	(0.039)	(0.039)	(0.039)	(0.041)	(0.042)	(0.043)
Out of contention		-0.202***	-0.126***	-0.126***	-0.085***	-0.048*	-0.059**		
		(0.026)	(0.027)	(0.027)	(0.028)	(0.029)	(0.029)		
R²	0.01	0.10	0.18	0.18	0.19	0.19	0.22	0.26	0.28
Other Controls									
Observables^(a)		✓	✓	✓	✓	✓	✓	✓	✓
Referee fixed effects			✓	✓	✓	✓	✓	✓	✓
Player fixed effects			✓	✓	✓	✓	✓	✓	✓
Player characteristics %White refs				✓	✓	✓	✓	✓	✓
Stadium*Black player fixed effects					✓	✓	✓	✓	✓
Team*Home fixed effects					✓	✓	✓	✓	✓
Team*Year fixed effects						✓	✓	✓	✓
Player*Year fixed effects							✓	✓	✓
Game fixed effects								✓	✓
Game*Team fixed effects									✓

Further Foul-Related Outcomes

Outcome	<i>Mean</i> (<i>Standard dev.</i>)	Estimated effect^(a) (Standard error)
Fouls	4.44 (3.34)	0.188** (0.078)
Technical Fouls	0.08 (0.38)	0.016 (0.014)
Flagrant Fouls	0.012 (0.17)	0.009 (0.006)
Minutes played	30.13 (10.1)	-0.403*** (0.155)
Fouled out	0.025 (0.16)	0.002 (0.004)
Free throw attempts	5.09 (4.90)	-0.034 (0.112)

(a) Estimated coefficient on %White referee * Black player from most complete regression equation: – including referee effects, player*year, team*year, and team*game fixed effects.

Broader Impacts

Outcome	<i>Mean</i> (<i>Standard dev.</i>)	Estimate effect (Standard error)
Placebo: No Effects		
Free Throw %	74.6% (23.3)	+0.4% (0.8)
Other Margins: Consistent patterns		
Points per 48 min	19.54 (10.1)	-0.430* (0.221)
Player aggression: No visible increase		
Steals per 48 min	1.63 (1.89)	-0.053 (0.046)
Blocks per 48 min	1.02 (1.81)	-0.022 (0.038)
Turnovers per 48 min	2.95 (2.57)	+0.091 (0.063)

Estimated coefficient on %White referee * Black player from most complete regression equation: – including referee effects, player*year, team*year, and team*game fixed effects.

Indirect Effects

◆ Consider:

- Direct effect: Race of “offender” (my team) affects fouls called
- Indirect effect: Race of “victim” (my opponent) may also be relevant
 - » But: Indirect effects hard to measure directly

◆ Solution: Aggregate data to the team-game level:

- Dependent variable: *Fouls earned*, or *points scored*, by team
- Independent variables:
 - » Direct effect: $\%White\ referees * \%black\ playing\ time$ (“Offender”)
 - » Indirect effect: $\%White\ referees * Opponent's\ \%black\ playing\ time$ (“Victim”)

◆ Further advantages:

- Team-level regressions estimate the *net team effect* (Direct+indirect effects)
 - » Including “unmeasured” contributions

◆ Disadvantage:

- $\%black\ playing\ time$ is endogenous
- IV using average $\%black\ playing\ time$ over previous 10 games

Team-Level Analysis

		Coefficient on %Black Playing Time * % White Referees							
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	
	Mean (SD)	Dependent Variable: Total Fouls by Team							
<i>Total effect</i> ($\beta_1-\beta_2$)	22.4 (4.65)	1.911* (0.995)	1.927** (0.982)	2.148** (0.965)	2.063** (0.968)	2.152** (0.970)	1.906** (0.942)	1.671 (1.043)	Effect on foul differential
<i>Of which:</i>									
<i>Direct effect</i> (β_1) (fouls committed)		0.816 (0.503)	0.789 (0.497)	0.980 (0.775)	1.082 (0.781)	1.372* (0.778)	1.330* (0.738)	1.098 (0.812)	Offender
<i>Indirect effect</i> (β_2) (fouls awarded)		-1.095** (0.503)	-1.138** (0.497)	-1.168 (0.797)	-0.981 (0.803)	-0.780 (0.803)	-0.576 (0.762)	-0.573 (0.837)	Victim
		Dependent Variable: Points Scored by Team							
<i>Total effect</i> ($\beta_1-\beta_2$)	98.4 (12.4)	-4.094** (2.152)	-4.777*** (2.041)	-5.726*** (2.010)	-5.425*** (2.021)	-5.640*** (2.017)	-3.832** (1.952)	-6.287*** (2.222)	Effect on winning margin
<i>Of which:</i>									
<i>Direct effect</i> (β_1) (points scored)		-0.415 (1.101)	-0.882 (1.044)	-2.366 (1.988)	-1.768 (2.002)	-2.139 (1.991)	-2.302 (1.789)	-3.303* (1.994)	Offense
<i>Indirect effect</i> (β_2) (points conceded)		3.678*** (1.093)	3.894*** (1.041)	3.360* (1.975)	3.657* (1.987)	3.501* (1.966)	1.531 (1.798)	2.984 (1.998)	Defense
<i>Observables</i>			✓	✓	✓	✓	✓	✓	
<i>Referee</i>				✓	✓	✓	✓	✓	
<i>Team / Opponent</i>				✓	✓	✓	✓	✓	
<i>Blk coach * %W. refs</i>					✓	✓	✓	✓	
<i>Team/Opp*Home</i>						✓	✓	✓	
<i>Stadium*%Black</i>						✓	✓	✓	
<i>Team/Opp*Year</i>							✓	✓	
<i>Model</i>		OLS	OLS	OLS	OLS	OLS	OLS	IV	

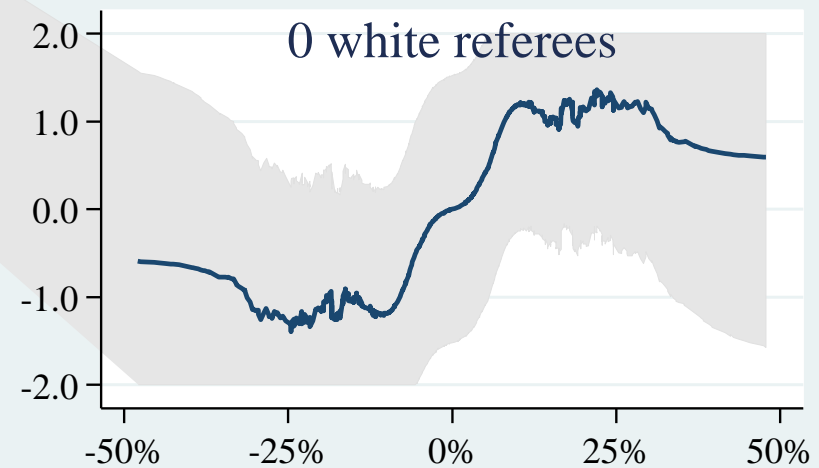
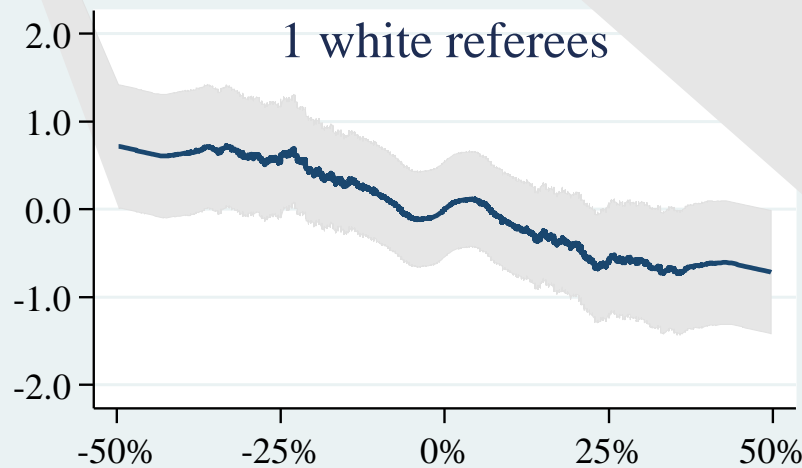
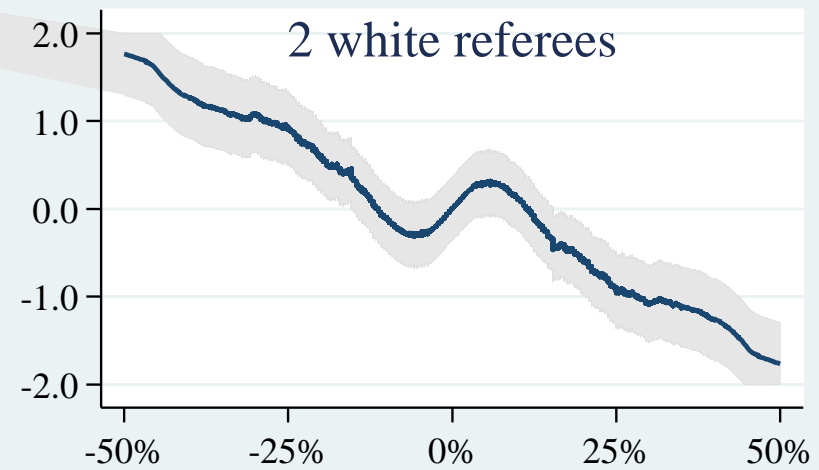
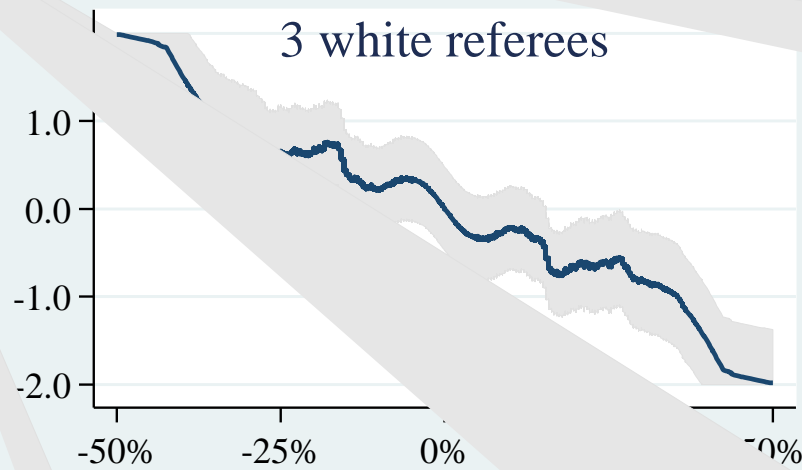
Notes: Sample=24,526 team-game observations. Each cell reports results from a separate regression. (Standard errors in parentheses, clustered by game.)

“Direct” effect refers to coefficient on %Black playing time * % white referees; “Indirect” effect refers to coefficient on Opponent %Black playing time * % white referees.

Game-Level Analysis

$$\begin{aligned} I(\text{home team wins}) = & \beta_1 \%White\ referees_g * (\%Black^{home} - \%Black^{away}) \\ & + \beta_2 \%White\ referees + \beta_3 (\%Black^{home} - \%Black^{away}) \\ & + \beta_4 (Black\ coach^{home} - Black\ coach^{away}) \\ & + \beta_5 (Team\ characteristics^{home} - Team\ characteristics^{away}) \\ & [+ Home\ team\ fixed\ effects + Away\ team\ fixed\ effects + Referee\ fixed\ effects \\ & + Home\ Team * Season\ effects + Away\ Team * Season\ effects] + \varepsilon \end{aligned}$$

Effects of Own-Race Bias on Winning Margins



Difference in Racial Composition of Teams

%Black relative to Opponent (measured as difference in share of playing time)

Line shows running mean calculated using epanechnikov kernel with bandwidth=0.4; Shading shows symmetric 95% confidence intervals (if within scale).

Probability of Winning

Panel A: Dependent Variable: $I(\text{Home Team wins game})$						
<i>% White refs*</i> (<i>%Black^{home} - %Black^{away}</i>)	-0.139 (0.087)	-0.167* (0.086)	-0.230*** (0.085)	-0.218** (0.085)	-0.160* (0.084)	-0.226** (0.092)
<i>% White refs *</i> (<i>Black coach^{home} - Black coach^{away}</i>)				-0.045 (0.028)	-0.055** (0.028)	-0.052* (0.028)
<i>Adjusted R²</i>	0.002	0.038	0.091	0.091	0.184	0.184
Panel B: Dependent Variable: <i>Home Team's Winning Margin</i>						
<i>% White refs*</i> (<i>%Black^{home} - %Black^{away}</i>)	-4.020* (2.162)	-4.790** (2.115)	-6.210*** (2.069)	-5.593*** (2.077)	-4.256** (2.007)	-6.574*** (2.196)
<i>% White refs *</i> (<i>Black coach^{home} - Black coach^{away}</i>)				-1.056 (0.684)	-0.850 (0.666)	-0.766 (0.667)
<i>Adjusted R²</i>	0.003	0.047	0.118	0.118	0.244	0.244
<i>Observable controls</i>		✓	✓	✓	✓	✓
<i>Home team fixed effects</i>			✓	✓	✓	✓
<i>Away team fixed effects</i>			✓	✓	✓	✓
<i>Stadium*(%Black^{home} - %Black^{away})</i>			✓	✓	✓	✓
<i>Home team * year fixed effects</i>					✓	✓
<i>Away team * year fixed effects</i>					✓	✓
<i>Model</i>	OLS	OLS	OLS	OLS	OLS	IV

Notes: Sample = 12,263 home game observations (IV regressions: n=12,247) Each column in each panel represents a separate regression. (Standard errors in parens) Coefficient on *%White refs * (%Black^{home} - %Black^{away})* measures own-race bias. *%Black* measured as share of minutes played by black players. Observable controls include home-away differences in: out-of-contention, home*attend and black coach. IV: Instrumenting for *%Black^{home} - %Black^{away}* and its interaction with *%white referees*, using the average *%Black* for the home team over the preceding ten games less the average *%Black* for the away team over the preceding ten games, interacted with *%white referees*.

Interpreting the Magnitudes

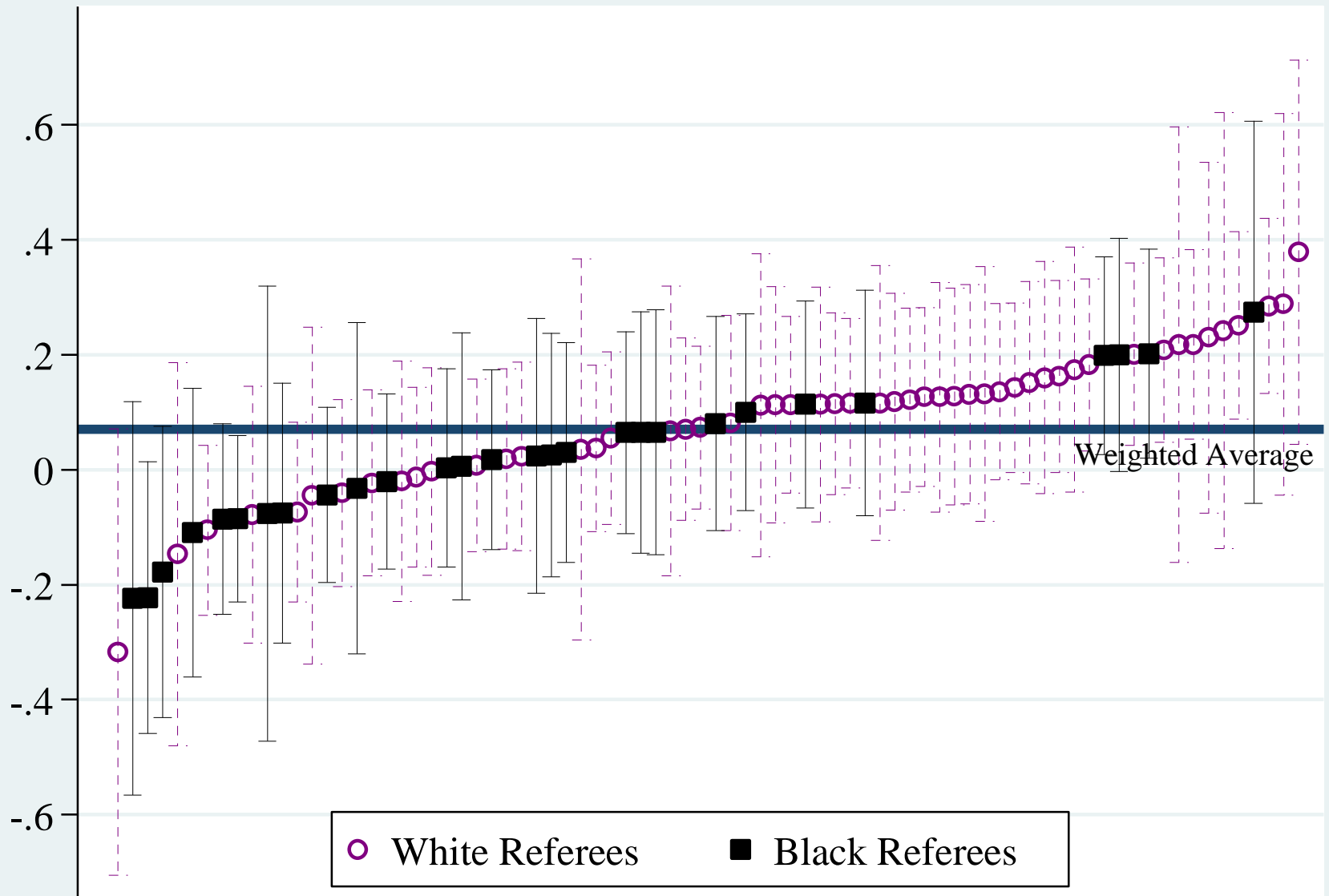
- Average racial difference between teams:
 - One team gives 15% more playing time to blacks
 - That team wins 48.6% of all games

- Implications: Consider an “average” game ($x\%$ black v. $x-15\%$)
- ◆ Two extreme cases:
 - If all white referees: The “black” team would win 47.6% of all games
 - If all black referees: The “black” team would win 51.0% of all games
 - Implies: Outcomes of 3.4% of games *could* change if the racial composition of the refereeing crew changed
- ◆ Alternative policy: If referee pool matches player pool (83% black)
 - The “black” team would win 50.5% of the time
 - Implies: Race-norming would have changed outcomes in 1.8% of all games

- Financial consequences of this bias: (Szymanski, 2003)
$$\text{Win Percentage}_{tm, yr} = 0.21 + 0.29 * (\text{Team wage bill} / \text{League ave. wage bill})_{tm, yr}$$

Referee-specific Black-White Differences in Foul Calling

Regression Estimates and 95% Confidence Intervals



Each Point Reports a Referee-Specific Estimate of Racial Bias in Foul-Calling

Conclusion

- ◆ Evidence of own race bias on the part of referees
- ◆ Large enough to affect the outcome of the game
- ◆ Surprising, since we were looking in very unlikely place for racial discrimination to occur.
 - everyone watching, lots of supervision
 - large incentives to make the right call
- ◆ Implications for other settings?
- ◆ Next steps:
 - Unlikely (but still hoping): Get NBA referees to perform “Implicit Association Test”
 - » Does the IAT predict own-race preference?
 - Likely: Rebuttal to NBA analysis