

QB or not QB? Measuring Discrimination in Football Labor Markets

Magdalena Bennett The University of Texas at Austin

Abstract

This paper examines the presence of racial discrimination in the labor market of American football, focusing on recruitment for the quarterback (QB) position—a role often regarded as both the strategic leader on the field and the public face of a franchise. Leveraging a novel dataset that integrates high school, college, and professional football statistics, I apply two empirical strategies—a benchmark test and an outcome test—to identify patterns of discrimination. The findings reveal consistent evidence of racial bias in recruitment decisions during the transitions from high school to college and from college to the National Football League (NFL). Importantly, these results are robust to alternative explanations, including player reallocation to other positions, and hold under sensitivity analyses designed to account for potential unobserved confounding. Finally, I estimate the economic and competitive costs of these discriminatory practices, highlighting significant impacts on the team's potential performance.

Keywords Discrimination, Football, Outcome test, Benchmark test

1. Introduction

The identification and measurement of labor market discrimination remains a central challenge in empirical economics. While racial disparities are well-documented across various sectors (Lang & Kahn-Lang Spitzer, 2020), establishing causal evidence of discrimination is complicated due to data limitations and identification challenges (Neumark, 2018). This paper leverages the football labor market's unique features—specifically its rich performance metrics and clear career progression paths—to examine racial discrimination in recruitment, particularly for its main position: The quarterback (QB).

By leveraging a unique dataset that combines players performance and physical characteristics throughout high school, college, and the National Football League (NFL), I use two robust empirical strategies to assess racial discrimination during critical career transitions: a benchmark test to compare recruitment probabilities conditional on performance characteristics, and an outcome test to identify disparities in realized performance. Building on the framework developed by Gaebler & Goel (2024), these methods jointly address the identification challenges associated with measuring discrimination in complex labor markets. By incorporating data spanning high school, collegiate, and professional levels, this study provides robust evidence of racial bias in recruitment for the QB position. The findings underscore not only the persistence of these biases but also their economic implications for team performance and franchise valuation.

Working Paper

Last updated Jan 17, 2025

Key Points

- Evidence shows that there are large disparities in football recruitment by race for the QB position.
- Using a benchmark and an outcome test, I show that these results are consistent with racial discrimination.
- Findings are robust to other explanations (e.g. position tracking) and moderately robust to hidden bias.
- Bias in recruitment causes teams to reduce their probabilities of winning by 7% and their potential payouts by 6%.

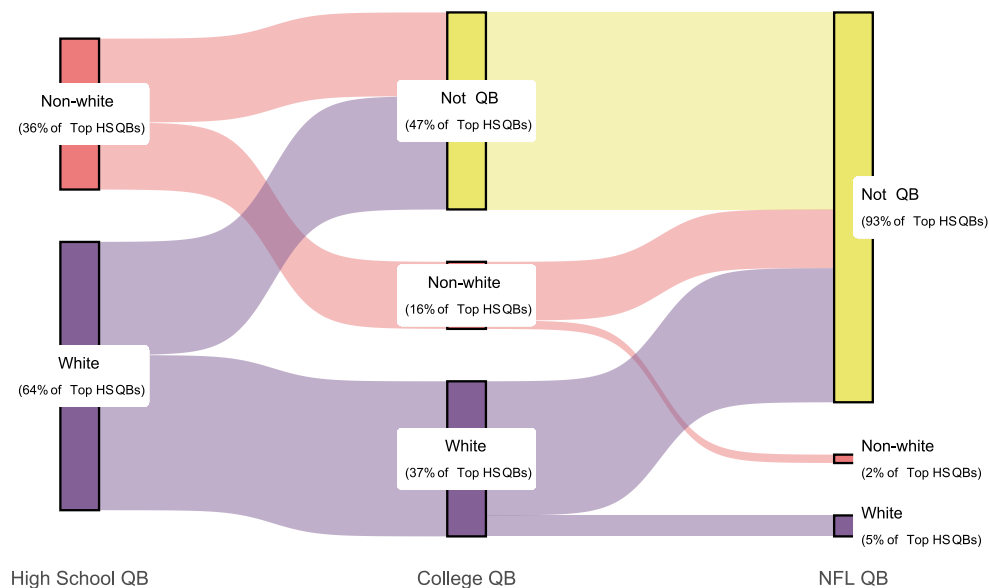
Correspondence to

Magdalena Bennett
m.bennett@austin.utexas.edu

Data Availability

Associated code will be made available on [GitHub](#).

Even though American football has been highly regarded as a sport where most players are African-American, this metric is different for the QB position (Bouchet, 2023; The Washington Post, 2021). For example, Figure 1 shows the transition through college (NCAA) and professional football for 2271 top QBs in high school (HS) between the years 2000 and 2018. Within top ranked QBs, only one third are players of color, which already shows potential unbalances in this position from an early start. However, these unbalances are only exacerbated as players transition to upper levels: While 58.3% of white HS QBs in our data are recruited as QBs for college, that number is only 44% of non-white QBs. These differences are sustained when advancing to the professional league, where white HS QBs are 40.6% more likely to be drafted as NFL QBs compared to HS QBs of color. The main question that remains after observing these patterns is whether these decisions are due to racial discrimination or other potential explanations, and it is the main focus of my analysis.



Note: The dataset includes 2271 high school quarterbacks ranked as top performers in their respective year (top HS QBs) from 2000 to 2018. Source: ESPN and 247Sports HS QB rankings (HS), ESPN QBR and Sports-Reference (college), and Pro-Football-Reference (NFL). See Data section for more details.

Figure 1: Proportion of top high school quarterbacks from 2000 to 2017 by stage

This paper makes several contributions to the literature on labor discrimination. Firstly, it expands on current applications by analyzing a case study that allows us to inspect not only recruitment processes, but also selection into specific positions, while having comprehensive measures of performance and contributions to the franchise. While audit studies provide a clean identification of discrimination in initial selection stages (Bertrand & Mullainathan, 2004; Jacquemet & Yannelis, 2012; Kline et al., 2022; Pager et al., 2009), one main drawback is that they are not able to assess actual recruitment or compare performance of candidates. By collecting rich information on potential recruits (e.g. top high school QBs and college QBs), their qualifications, teams' interests, and players' performance after selection, I can compare results for players that were not selected by specific teams or were not recruited at all.

Another contribution of this paper is that, unlike most discrimination literature that focus either on a benchmark test or an outcome test (Arnold et al., 2018; Becker, 1993; Fryer et al., 2013; Kleinberg et al., 2018), I look at the complementarity of both, providing robust evidence of discriminatory patterns, even under alternative explanations. These results complement other studies that have focused on analyzing discriminatory practices

in sports on other fronts, such as referee assessment or salary (Berri et al., 2023; Parsons et al., 2011; Price & Wolfers, 2010), highlighting the hurdles for minorities to even get to the game.

Finally, this paper also provides evidence of discrimination at different stages of career advancement, by showing results for the transition from high school to a Division 1 college team, and from college to the most elite football league, the NFL. Analyzing different stages of recruitment can be seen akin to differences in recruitment according to seniority, allowing us to better understand where are the largest stopgaps in terms of racial disparities. The findings have implications beyond sports, contributing to broader debates on labor market discrimination and systemic bias. By identifying recruitment bottlenecks and highlighting their long-term consequences, this study aligns with emerging research on systemic discrimination (e.g., Bohren et al. (2024)). It also provides a replicable framework for analyzing hierarchical labor markets, suggesting avenues for interventions.

The rest of this paper is structured in 5 sections, in addition to this introduction. Section 2 details the data sources and provides descriptions for the final datasets used for analysis. In Section 3, I explain the empirical strategy used for assessing discrimination patterns. Results are presented in Section 4, including the analysis of potential alternative mechanisms. Cost analysis for racial bias are shown in Section 5. Finally, Section 6 concludes.

2. Data

2.1. Sources

To analyze the progression of racial disparity in the quarterback position, I collect and harmonize data from several sources:

A. High School level

A.1) *ESPN Top Quarterbacks (2006 - 2018)*: Data set from [espn.com](#), which includes the top 100 recruits by position (QBs) each year. This dataset includes information about their college selection (if any), weight, height, high school, grade, and ranking. Since 2013 onwards, includes a classification for style of play (i.e. Pocket Passers and Dual Threats).

A.2) *247 Sports data for top high school quarterbacks (2000 - 2018)*: [Ranking list](#) for top high school quarterbacks each year (according to 247 Sports ranking), for both pocket passers and dual threat QBs. Data includes physical measures as well as scouts' ratings. Some players also have information about their combine¹ results.

A.3) *Rivals data for high school quarterbacks (2002-2018)*: [Information](#) for top high school recruits, including a star rating and college interest. It allows me to complement the existing data in terms of play style (e.g. for ESPN recruits prior 2013), and add information about teams that had interest in the player.

B. College level

B.1) *SR player Stats for College Football (2000 - 2023)*: Dataset that harmonizes information from [sports-reference](#). Includes information about player's position, and passing, rushing, and scoring stats, if available.

B.2) *ESPN College Football Total QBR (2004-2024)*: Data set from [espn.com](#), including 135 QBs per year, their ranking, Total Quarterback Rating (QBR), and other statistics.

B.3) *ESPN College Football Stats (2006-2023)*: Data set from [espn.com](#), with information about passing, rushing, and receiving leader boards for each year. It also includes specific statistics for each board, such as passing/rushing yards, touchdowns, and interceptions, among others. As a reference, the passing leader board includes

¹A combine is an event where players are tested both physically and mentally. I consider the results from their speed tests (40-yard dash), when available.

around 500 players per year (mostly QBs), while the rushing and receiving leader board include over 1200 players each.

B.4) *College Football Team Ratings (2000-2023)*: **Information** at the college team level for each year, including the Simple Rating System (SRS), as well as the record of wins and losses for the season.

B.5) *Season games (2000-2023)*: **Results** for each game in the season for Division I teams. I also include information for the **starting QBs** in each game for both teams.

C. NFL level

C.1) *Draft picks (2000-2024)*: **Dataset** with all draft picks by year and position.

C.2) *NFL Total QBR (2006-2024)*: **Dataset** with rating developed by ESPN for starting QBs in the regular season of the NFL. Includes Adjusted Total Quarterback rating, points contributed, and number of plays, among others.

Additionally, for all harmonized datasets from high school QBs and college QBs, I collected race data. This variable was manually gathered and is a *perceived race* classification based on images of the players, with three distinct categories: White, Black, and Other². Even though this variable does not capture the actual race of the player, it will be a proxy for race perception and how this aspect affects their selection at different stages.

2.2. Description

Using the previously mentioned sources, I built two different datasets: (a) high school (HS) dataset and (b) college dataset.

The high school dataset consists of a panel of 2271 HS quarterbacks, mostly from the 247Sports website (75.1%) from 2000 to 2018. In terms of HS variables, it includes identifying data (e.g. name, high school, city, state), physical characteristics (i.e. height and weight), performance metrics (e.g. scouts' rating and ESPN and/or 247Sports ranking for the year), style of play (pocket passer or dual threat), and recruitment data (e.g. name and total number of schools interested). These individuals are then merged by name³ to potential candidates within 6 years of their high school ranking.⁴ College data for the HS panel includes the player's position in college, ESPN Total Quarterback Rating (QBR) — a score that measures the overall QB contribution to the game —, passing, and receiving statistics. These metrics are available per year and are matched to the HS QB for all years available within the permitted window. Finally, I match this panel to the draft pick dataset using a similar approach as before⁵, and includes draft season, round, and pick, in addition to the team that drafted them and the player's position.

Table 1 shows the characteristics for the high school dataset, where NA% of the QBs included are non-white and NA% are white. In terms of physical characteristics, QBs of color tend to be slightly smaller in high school, but hold higher rankings and ratings compared to their white counterparts. In terms of style of play, most non-white QBs are classified as "Dual Threats" instead of "Pocket Passers", which refers to players who can both run and pass the ball.

²The Other category includes players that appear to be from Hispanic or Asian descent, in addition to QBs that seem to be mixed race.

³I perform a fuzzy match of the first and last name of the player within the college years permitted, using a maximum distance (*Jaro-Winkler*) of 0.1. If there are multiple matches, the match with the smallest distance is the one that is kept. As a robustness check, I also conducted a manual search for players with no matches using additional data (e.g. matching HS hometown) and changed some spellings accordingly.

⁴Potential matches for HS players come from a pool of college players with a starting year greater or equal to y and a final year of $y + 6$ at most, where y is the year where the player was on the HS ranking. This allows us to include players that are ranked during their junior year, for example. Starting and final year refers to the first and last year the college player appears on the dataset.

⁵Draft data is merged using a fuzzy matching by first and last name, within 3 and 6 years after high school ranking.

In terms of college recruitment, both groups are equally as likely to advance to play collegiate football, but there is a large disparity in their position: While 86.7% of white QBs that are recruited play in that same position in college, only 67.9% of non-white recruits stay as a QB in college. Comparing their college performance, their statistics show a clear difference in playing style, with QBs of color attempting much more rushing plays than white QBs, who have higher metrics in passing statistics. However, it is important to note that when comparing adjusted average passing yards per attempt⁶, both groups have comparable performance.

Table 1: High school panel - Data Description

		White HS QB (N = 1456)		Non-white HS QB (N = 802)			
Variable	All	Mean	SD	Mean	SD	Diff.	p-value
High School							
Height (ft)	6.207	6.227	0.134	6.172	0.144	−0.056	0.000
Weight (lb)	197.581	199.002	14.756	195.011	16.153	−3.991	0.000
Ranking (ESPN or 247sports)	32.595	34.639	23.886	28.890	19.810	−5.749	0.000
Rating (ESPN or 247sports)	82.757	82.617	7.708	83.010	7.485	0.393	0.236
Stars (Rivals)	2.893	2.879	0.760	2.919	0.782	0.040	0.289
Pocket Passer	0.533	0.706	0.456	0.219	0.414	−0.486	0.000
Dual Threat	0.467	0.294	0.456	0.781	0.414	0.486	0.000
N colleges interested (Rivals)	5.907	5.924	3.866	5.873	4.119	−0.051	0.796
N colleges offers (Rivals)	3.951	3.775	3.034	4.298	3.602	0.523	0.002
Team Football Power Index	4.390	4.468	11.015	4.235	11.928	−0.233	0.755
Team Ranking (ESPN)	53.583	53.087	32.765	54.578	34.825	1.491	0.496
Year HS	2010.365	2010.025	4.691	2010.973	4.811	0.948	0.000
College							
College recruit	0.664	0.672	0.470	0.648	0.478	−0.024	0.244
College QB	0.532	0.583	0.493	0.440	0.497	−0.143	0.000
QBR	57.769	56.973	17.034	59.425	17.752	2.452	0.120
Comp. pass	106.850	111.641	106.119	96.154	95.686	−15.488	0.012
Attempts pass	178.252	185.498	168.421	162.263	153.058	−23.235	0.018
Adj. avg passing yds	5.883	5.791	4.975	6.120	3.949	0.329	0.226
Attempts rush	71.192	63.724	38.615	87.938	52.827	24.214	0.000
Avg. rushing yds	1.362	0.707	2.553	2.854	2.467	2.148	0.000
Points scored	15.963	13.346	17.119	20.810	22.941	7.464	0.000
NFL							
Drafted	0.086	0.092	0.289	0.074	0.263	−0.017	0.147
Drafted as QB	0.075	0.082	0.275	0.062	0.241	−0.020	0.071

Note: College statistics per player correspond to the last year of college available.

Football Power Index and Team Ranking are metrics of the strength of the team that either recruited the player or had the highest interest. These metrics are created by ESPN and are measured at the year of graduation.

⁶Adjusted passing yards per attempt is a formula calculated by *Sports-Reference* to take into account other characteristics of the play, such as interceptions and touchdowns. The metric is calculated as $\text{Adj. avg pass yds per att} = \text{Yds} + 20 \times \text{TD} - 45 \times \text{Int}/\text{Att}$ (Sports References, 2024)

For the college data, I built a panel with 7407 observations and 3132 unique QBs (68.5% white). In terms of college performance, and unlike the HS data we previously observed, there is no statistically significant differences in most passing stats between white and non-white QBs in college, but QBs of color still show better results in terms of rushing metrics. With respect to overall performance, it appears that non-white QBs have overall better rankings (in rushing and QBR), and a general edge in terms of their QB Total Rating (QBR), the metric created by ESPN to encompass the contribution of the QB to the team.

Regarding college QBs' performance in the NFL, only a few get drafted and play as QBs in the National Football League. However, QBs of color still outperform white QBs in terms of QBR and their ranking in the NFL.

Table 2: College panel - Data Description

Variable	All	White QB (N = 2168)		Non-white QB (N = 1012)		Diff.	p-value
		Mean	SD	Mean	SD		
High School							
HS Top QB	0.434	0.431	0.495	0.440	0.497	0.009	0.646
College							
Team Football Power Index	1.152	1.118	11.986	1.228	12.080	0.110	0.853
Team Ranking (ESPN)	63.296	63.218	34.961	63.474	35.332	0.256	0.883
Games (pass)	6.863	6.621	3.421	7.429	3.339	0.808	0.000
Comp. pass	68.181	69.786	77.286	64.437	69.996	-5.348	0.081
Attempts pass	116.078	118.294	124.726	110.909	114.305	-7.385	0.138
Adj. avg passing yds	5.246	5.155	6.559	5.461	7.048	0.305	0.309
Interceptions	3.541	3.637	3.594	3.317	3.188	-0.320	0.023
Pass. efficiency rating	112.979	112.065	67.216	115.148	68.551	3.083	0.298
Games (rush)	5.070	4.833	3.448	5.454	3.550	0.621	0.049
Attempts rush	53.116	48.426	45.891	62.760	62.730	14.334	0.000
Avg. rushing yds	1.686	1.038	2.567	3.059	2.461	2.020	0.000
Points scored	12.335	10.282	12.182	15.926	17.289	5.644	0.000
Ranking (pass) ESPN	68.141	66.277	33.842	72.565	35.699	6.288	0.011
Ranking (rush) ESPN	675.300	791.751	484.935	398.982	361.937	-392.770	0.000
QBR college	53.889	53.109	15.974	55.608	16.595	2.499	0.022
Ranking (QBR) ESPN	64.989	66.249	32.246	62.212	34.447	-4.037	0.072
NFL							
Drafted	0.097	0.094	0.292	0.103	0.305	0.009	0.421
Drafted as QB	0.078	0.082	0.274	0.068	0.252	-0.014	0.159
Draft round	3.918	4.059	2.164	3.637	2.193	-0.422	0.113
Draft pick	116.974	122.535	81.494	105.961	81.123	-16.574	0.095
QBR NFL	49.006	47.461	12.194	52.140	13.775	4.679	0.093
Ranking (QBR) NFL	20.396	21.183	7.842	18.800	9.116	-2.383	0.191
Play as NFL QB	0.034	0.033	0.179	0.035	0.185	0.002	0.732

Note: College statistics per player correspond to the average of all years available.

3. Empirical Strategy

As an empirical strategy, I employ a method developed by Gaebler & Goel (2024) to test for discrimination in recruitment decisions for quarterbacks across different stages of their careers. The approach leverages two widely used tests in discrimination research: the benchmark test and the outcome test. The benchmark test compares recruitment probabilities across racial groups, adjusting for observable performance indicators such as player's statistics and physical attributes. The outcome test, in contrast, assesses whether differences in realized performance, conditional on recruitment, suggest unequal standards for different groups. While each test has limitations when used in isolation, Gaebler & Goel (2024) demonstrate that their combined application under a monotonicity assumption produces robust conclusions about discrimination.

In the context of this study, this combined method evaluates whether racial disparities in quarterback recruitment can be attributed to different performance thresholds applied to white and non-white players. Specifically, the monotonic likelihood ratio property (MLRP) (Karlin & Rubin, 1956) ensures that at least one of the tests – benchmark or outcome – yields correct conclusions when discrimination exists. By applying this hybrid test to data from high school, college, and NFL recruitment processes, I am able to identify whether observed disparities are consistent with racial discrimination.

Following Gaebler & Goel (2024) notation for this specific setup, I assume scouts or recruiters have an estimated measure of success (e.g. estimated QBR) for a potential QB, which can be represented as follows:

$$R \stackrel{\text{def}}{=} Pr(Y = 1 | X) = E(QBR | X) \quad (1)$$

Where R is the recruiter's estimate of the QB's performance and Y is a latent binary variable of QB success. To operationalize this setup, I use QBR (Total Quarterback Rating), which is a measure of the probability of success of a QB's team based on the specific contributions of the QB (ESPN Stats & Information, 2016). Then, recruiters would make hiring decisions based on the following threshold rules:

$$D \stackrel{\text{def}}{=} \begin{cases} 1 & \text{if } W = w \text{ and } t_w \leq R \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

Where W is a binary variable that takes the value of 0 for non-white QBs and 1 for white players. If there is discrimination, specifically in this case if $t_0 > t_1$, then recruiters adopt a higher standard when selecting white QBs compared to QBs of color. Gaebler & Goel (2024) show that if $P(W = 0 | QBR = q)$ is a monotonic function of q , and:

- (1) The decision rate is lower for QBs of color than for white QBs: $Pr(D = 1 | W = 1) > Pr(D = 1 | W = 0)$, and,
- (2) QB performance is greater for non-white QBs than white QBs: $E(QBR | W = 0) > E(QBR | W = 1)$,

then recruiters apply a higher threshold for QBs of color compared to their white counterparts ($t_0 > t_1$).

In the following section, I show the empirical results for these tests and the monotonicity assumption, both for football recruitment to college as well as the NFL.

4. Results

As previously mentioned, I use two different tests to assess whether recruitment behaviors are consistent with discrimination. The first one is the benchmark test, where I estimate the difference in probability of being re-

cruited as a QB in college/NFL for two different groups (i.e. white and non-white QBs) adjusted by multiple potential confounders, such as style of play, scouts' metrics, and physical characteristics for the high school-to-college transition, and game performance for the college-to-NFL stage. Even though these characteristics are relevant determinants of recruitment for the QB position, there could be other unobserved confounders that could skew this test (e.g. leadership skills, arm strength, among others).

The second test corresponds to an outcome test, which measures the differences in performance by group for those that were selected as QBs in the next stage. As an outcome for high school-to-college transition as well as the college-to-NFL progression, I use the Total QBR rating, as this is the most comprehensive metric in the data for QB performance, unlike the NFL Passer Rating⁷ that does not take into account the play level or other intricacies of the game. The Total QBR rating is a complete measure on how the QB "impacts the game on passes, rushes, turnovers, and penalties" (ESPN Stats & Information, 2016). Unlike passing yards statistics, QBR also considers the success or failure at the play level, providing context to the measures.

As it has been shown in the literature, each of these tests have several shortcomings (Anwar & Fang, 2006; Becker, 1993; Canay et al., 2024; Knowles et al., 2001) for detecting discrimination, as other behaviors might produce the same patterns. For example, if white QBs have better leadership skills than non-white QBs, it could explain the differences in recruitment and the benchmark test would not be capturing racial discrimination, but differences in potential performance that cannot be measured in the data. For the outcome test, a common threat is infra-marginality, where the underlying distributions of risk or outcomes differ by race and the researcher cannot observe the marginal recruit. In the case of QB performance, comparing the average outcome (e.g. QBR) of white QBs and non-white QBs is not enough to determine if there is discrimination or not.

The point that Gaebler & Goel (2024) make is that, under mild monotonicity conditions, both tests cannot be wrong at the same time. If non-white QBs have a lower probability of being recruited than white players because they lack certain skills, then the outcome test should show a lower performance on the next stage, not higher. Similarly, if recruiters believe that overall QBs of color perform better than white QBs, they should be recruited at higher rates. Thus, in order to obtain robust evidence of racial discrimination in the recruitment process (i) non-white QBs have to be less likely to be recruited than white QBs, conditional on certain characteristics, and (ii) QBs of color have to show better performance than white players.

For this robust test to provide conclusive evidence, the monotone likelihood ratio property (MLRP) has to hold. The authors show that this assumption is equivalent to assuming that the probability of the lower base group (e.g. QBs of color) given a specific risk rate r is monotonic.

4.1. High school to College

4.1.a. *Benchmark test:* For the benchmark test, I estimate the probability of a top HS QB to be recruited into college as a QB by race group, adjusting by relevant characteristics that are of importance in the recruitment process. Some of these characteristics are scouts' HS rating (from 0 to 1), playing style classification (i.e. pocket passer or dual threat), as well as physical characteristics such as height and weight. I also include a binary variable to indicate the source of the data (ESPN or 247Sports).

Results in Table 3 show that HS QBs of color are, on average, 11 percentage points less likely to be recruited, even after controlling for performance and physical characteristics. These findings hold even after adjusting by playing style, which is one of the main reasons analysts argue that Black QBs are recruited at a lower rate than white QBs (Berri & Simmons, 2009; Bopp & Sagas, 2014).

⁷The NFL passer rating combines passing yards, as well as passing touchdowns and interceptions

Table 3: Benchmark Test for QB recruitment from high school to college

	College QB	College QB	College QB	College QB
NonWhiteQB	-0.143*** (0.022)	-0.098*** (0.024)	-0.107*** (0.023)	-0.111*** (0.023)
Pocket Passer		0.099*** (0.023)	0.102*** (0.023)	0.112*** (0.023)
HS Rating			0.022*** (0.002)	0.023*** (0.002)
ESPN			-0.080* (0.032)	-0.077* (0.032)
Height (in)				-0.074 (0.082)
Weight (lb)				-0.001+ (0.001)
Avg. Outcome (Control)	0.583	0.583	0.583	0.583
Years	00-18	00-18	00-18	00-18
N	2269	2269	2269	2268

Note: Robust standard errors in parenthesis.

p-value < 0.01: **, <0.05 *, and <0.1 +

If we look at these results by year, before 2011 there is a significant difference in non-white QB presence in colleges, even after adjusting for HS performance and play style. After 2011, however, these differences become smaller, which could be due to a larger presence of successful Black QBs in the NFL.

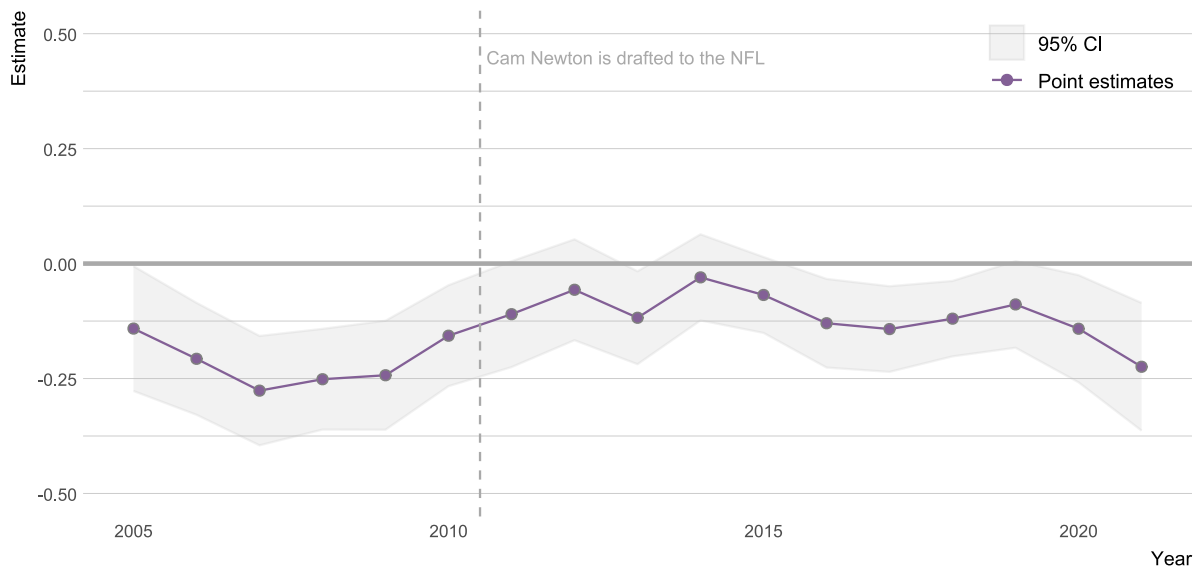


Figure 2: Marginal effects by year for college QB recruitment by race

In order to provide additional evidence for the benchmark test, also conducted a robustness tests to assess the possibility of unobserved confounding by using a sensitivity analysis to hidden bias (Rosenbaum, 1987). Using

the `designmatch` package (Zubizarreta et al., 2018), I match a white QB with a non-white QB, matching exactly on play style (e.g. pocket passer or dual threat) and balance them on ranking, rating, height, and weight with a tolerance of 0.025 SD. I also set a fine balance restriction for year of graduation, and exact match players based on data source availability: (i) ESPN only, (ii) 247Sports only, or (iii) both. Table 4 shows the balance between both matched groups, where both white and non-white HS QBs now have comparable recruitment characteristics.

Table 4: Balance table for matching white and non-white HS QBs on HS performance and physical characteristics

Variable	White HS QB (N = 534)		Non-white HS QB (N = 534)		Diff.	p-value
	Mean	SD	Mean	SD		
Height (ft)	6.19	0.14	6.19	0.13	0.00	0.97
Weight (lbs)	196.33	16.39	196.49	14.42	0.16	0.86
Ranking (ESPN)	29.37	21.75	29.51	21.93	0.14	0.94
Grade (ESPN)	76.43	4.72	76.51	4.77	0.07	0.85
Ranking (247Sports)	23.94	14.41	23.91	13.48	-0.03	0.98
Rating (247Sports)	0.85	0.06	0.85	0.06	0.00	0.77
Dual Threat (247Sports)	0.69	0.46	0.69	0.46	0.00	1.00
Year	2010.23	4.83	2010.23	4.83	0.00	1.00

Note: Mean restricted balance at 0.025 SD, fine balance for HS graduation year, and exact match on data source.

In this case, the difference in probability between matched groups is -0.101 (95% $CI = [-0.157, -0.046]$), which means that QBs of color, after matching by play style classification, performance, physical characteristics, and year, are 10.1 percentage points less likely to be recruited as a college QB than a white high school quarterback. There is also a 0.062 (95% $CI = [0.019, 0.105]$) increase in probability for black QBs of being recruited in a different position for college.

The advantage of matching units is that we can directly compare both groups without using extrapolation or relying on parametric functional form assumptions. Additionally, this approach lends itself nicely to simple and straightforward sensitivity analysis to hidden bias (Rosenbaum, 2002). The idea behind this type of sensitivity analysis relies on the fact that, within a matched set in a randomized experiment, each unit has the same probability of assignment to treatment (50% in a two-way matching design). In an observational study, however, there can be unobserved confounding that skews these probabilities. In this case, for a matched pair of QBs of different race, we will assume that one unit is $\Gamma > 1$ times more likely to be recruited as a college QB based on unobserved characteristics, and those characteristics can explain away any significant differences we find.

For this specific design, I find a sensitivity to hidden bias of $\Gamma = 1.36$, which means that an unobserved confounder should change the probability of assignment from 50%-50% to 42.4% - 57.6% in order to qualitatively explain away our findings, which implies that our estimate is moderately robust to hidden bias, according to literature parameters. To put this measure in context of other characteristics, the prior result would be equivalent to the difference in QB recruitment for two matched groups that are balanced in expectation on all characteristics (observed and unobserved), with the exception of an imbalance of 0.32 SD in rating score (247 Sports). This means that an unobserved confounder that has not been accounted for would have to have the same effect on QB recruitment as a 0.32-standard-deviation difference in HS QB performance based on scouts ratings.

4.1.b. Outcome test: For the outcome test, as it was previously described, I use ESPN's total QBR as a measure of performance in college. This metric is only available for players with more than 20 plays within a game, so usually only starting QBs are able to be properly assessed. Additionally, I also show the results for two other scores associated with winning strategies: Number of points scored and touch downs.

Table 5 show that non-white college QBs outperform white players in the same position by approximately 1.8 points (3.2%) in QBR, providing evidence that recruiters could have a higher bar set for players of different race. These differences stand using other metrics, such as points and touch down scored, which measure scoring directly contributed by the QB. Given that these last two metrics are related to style of play (e.g. non-white QBs rush the ball more than white QBs), I also compare a comprehensive passing statistic: Passing Efficiency Rating. This metric combines passing yards, touchdowns, interceptions, and completions ($Rate = (8.4 \times Yards + 330 \times TD - 200 \times Int + 100 \times Cmp)/Att$), and I find no difference in this measure between white and non-white QBs.

Table 5: Outcome Test for QB performance in college based on race

	QBR	QBR	Points scored	TD scored	Pass. Efficiency Rating
NonWhiteQB	2.093*	1.814*	7.121***	1.126***	-0.014
	(0.911)	(0.891)	(1.184)	(0.185)	(2.143)
Avg. Outcome (Control)	55.73	56.031	11.153	1.555	121.022
Year FE	No	Yes	Yes	Yes	Yes
Years	04-24	04-24	00-23	00-23	00-23
N	2547	2547	2763	3394	3121

Note: Clustered robust standard errors in parenthesis. Clusters at the player level.

Points and TD scores measure rushing and receiving TDs (as per Sports-reference.com). Passing Efficiency Rating combines yards, TDs, interceptions, and completions.

p-value < 0.01: **, <0.05 *, and <0.1 +

4.1.c. *Robust test for discrimination*: The results previously presented would provide robust evidence of racial discrimination if and only if the probability of being in the minority group conditional on a risk level – in this case, the performance metric QBR – is monotonic. I choose QBR as a risk measure because given its range (0-100) it can be seen as a probability of success (or a probability of the QBs contribution to game success).

To assess monotonicity, I need to estimate $Pr(NonWhiteQB | QBR = q)$ for our entire sample. Given that we only observe the QBR for QBs that are recruited into college as QBs (and also are starting players), I use a prediction model to impute the missing values in the distribution. Specifically, I use a random forest approach⁸, withholding 10% of the sample. The model performs well, with a normalized RMSE of 26.8% with respect to the testing sample.

Figure 3 shows the predicted QBR for the entire sample at different levels of QBR, showing overall a monotonically increasing function.

⁸In the model, I use as predictors: HS rating and ranking, height, weight, style of play, and race, in addition to adding college year as a factor. After tuning the hyper-parameters using 5-fold cross-validation, the model randomly selects 28 predictors with a minimum node size of 1.

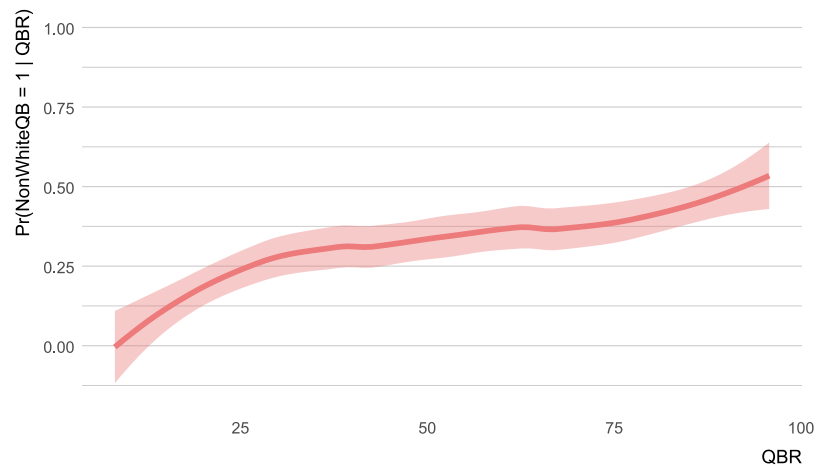


Figure 3: Proportion of HS QBs of color for different levels of predicted QBR

Given the results provided in [Table 3](#) and [Table 5](#), evidence points to the fact that recruitment practices for the QB position appear to be discriminatory towards players of color.

4.2. College to the NFL

4.2.a. *Benchmark test*: Analyzing the transition between college and the NFL, I only consider players that played as QB in college. In total, I observe around 3,200 QBs between the years 2000 and 2023, and around 1,500 of those QBs are present in the ESPN Total QBR dataset⁹. Results in [Table 6](#) show that college QBs of color are 2.2 percentage points less like to be drafted as QBs to the NFL compared to white QBs, even after controlling for their QBR score, when available. This difference increases to 3.7 percentage points when adjusting for other statistics, such as games played and their adjusted average passing yards.

⁹ESPN Total QBR is only available since 2004 and only has records of QBs with at least 20 plays.

Table 6: Benchmark Test for QB NFL draft for College QBs

	Drafted QB	Drafted QB	Drafted QB	Drafted QB
NonWhiteQB	-0.018 (0.014)	-0.022+ (0.012)	-0.029+ (0.015)	-0.037* (0.015)
QBR		0.009*** (0.001)	0.009*** (0.001)	0.009*** (0.001)
QBR (miss)		-0.192*** (0.013)	-0.192*** (0.014)	-0.135*** (0.016)
Adj. Pass Yards			0.002*** (0.000)	0.002*** (0.000)
Games				0.010*** (0.002)
Avg. Outcome (Control)	0.115	0.115	0.136	0.136
Year FE	Yes	Yes	Yes	Yes
Years	00-23	00-23	00-23	00-23
N	7407	7407	5986	5986

Note: Clustered robust standard errors in parenthesis. Clusters at the player level.

p-value < 0.01: **, <0.05 *, and <0.1 +

4.2.b. *Outcome test*: In terms of outcomes in the NFL, I use the ESPN's Total QB Rating for the same reasons why the same rating was used for college QBs. Even though it is not a perfect measure of performance, it is the most comprehensive measure for measuring the contribution of a QB (ESPN Stats & Information, 2016; Stuart, 2014). Table 7 shows that even within a small sample (approximately 100 QBs), QBs of color outperform white NFL QBs by 4.1 points (though this last point estimate is not statistically significant at conventional levels).

Table 7: Outcome Test for NFL Total QB Rating by race

	NFL QBR	NFL QBR
NonWhiteQB	5.747* (2.913)	4.053 (3.521)
Avg. Outcome (Control)	47.578	47.578
Year FE	No	Yes
Years	06-24	06-24
N	338	338

Note: Clustered robust standard errors in parenthesis. Clusters at the player level.

p-value < 0.01: **, <0.05 *, and <0.1 +

4.2.c. *Robust test for discrimination*: In order to analyze the monotonicity condition necessary to conclude that there are discriminatory practices in NFL recruitment, I assess the rate of non-white QBs at different levels of QBR. Figure 4 shows a monotonically increasing function of non-white QBs on NFL performance, which, in combination with the benchmark and outcome test for the college-NFL transition, are indicative of racial bias in QB recruitment.

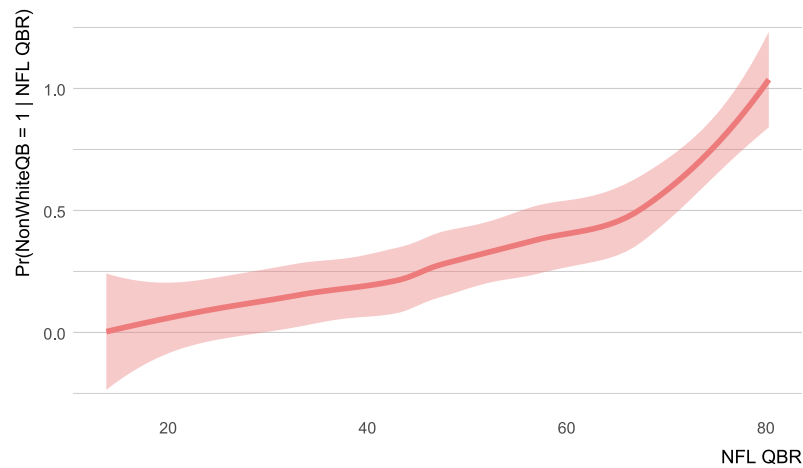


Figure 4: Proportion of College QBs of color for different levels of predicted NFL QBR

4.3. *Alternative mechanisms: Switching positions*

Previous results show that recruiters have a higher bar for non-white QBs with respect to white QBs, consistent with discriminatory behavior. However, someone could argue that given that football is a team sports, not selecting a player for the QB position but *for another position in the team* could, overall, increase the performance of the team as a whole. This explanation could be plausible, given that there is no significant difference by race in the probability of being recruited into college, but there is a large difference when assessing QB recruitment.

For the sake of testing this hypothesis, let's assume that QBs of color have an advantage on other positions with respect to white players. Given that the data shows the largest transition for non-recruited QBs to the position of wide receiver in college (39.7%), speed could play an important role in this decision.

Table 8 shows the results for the same benchmark test that was used in Table 3, but adding information on the 40-yard dash from high school combines¹⁰, in addition to an accuracy measure also captured in the event. Given that only a few players have combine data, the sample size is reduced significantly and results are no longer statistically significant. However, the point estimate still suggests a lower probability of non-white QBs being recruited to that position for college.

¹⁰Data on 40-yard dash is not available for HS QBs that are exclusively in the ESPN ranking (and not in 247Sports).

Table 8: Benchmark test for HS to College transition including combine results

	College QB	College QB	College QB
NonWhiteQB	-0.102*** (0.026)	-0.078 (0.070)	-0.127 (0.146)
Pocket Passer	0.155*** (0.029)	0.082 (0.077)	0.087 (0.173)
HS Rating	0.014*** (0.004)	0.016 (0.012)	-0.029 (0.036)
HS Rank	-0.006*** (0.002)	-0.008 (0.005)	-0.022+ (0.012)
Height (in)	-0.154 (0.099)	-0.139 (0.300)	0.059 (0.605)
Weight (lb)	-0.001 (0.001)	0.003 (0.003)	0.005 (0.006)
Forty-yard dash		0.216 (0.208)	-0.012 (0.341)
Accuracy			0.010 (0.058)
Avg. Outcome (Control)	0.67	0.682	0.774
Years	00-18	02-17	13-17
N	1702	221	49

Note: Robust standard errors in parenthesis. Observations only for HS QBs in 247Sports

p-value < 0.01: **, <0.05 *, and <0.1 +

In terms of advantages, I also analyze whether HS QBs that are switched to a different position in college perform better than their counterparts. If that is the case, it could make sense to track certain QBs to other positions if they have an overall advantage over players in persistent positions. I once again focus on the wide receiver position, given that it has the largest share of tracked QBs.

Table 9 shows the results for different metrics of performance by a wide receiver, including average receiving yards, touch downs from receptions, and receptions in general. In all metrics, non-white HS QBs that were tracked into this position perform no better (and even worse) than their counterparts, which suggests that they do not stand out in performance compared to non-HS QBs.

Table 9: Tracked QB performance as a wide receiver vs persistent wide receivers

	Avg. Receiving Yards	TD Receptions	Receptions
Top HS QB non-white	-2.401*** (0.437)	-1.319*** (0.208)	-8.390*** (2.361)
Avg. Outcome (Control)	12.531	1.886	20.825
Year FE	Yes	Yes	Yes
Years	02-23	02-23	02-23
N	17386	17436	17422

Note: Clustered robust standard errors in parenthesis. Clusters at the player level.

p-value < 0.01: **, <0.05 *, and <0.1 +

5. How much does discrimination cost?

One natural question that follows the previous analysis is “How much does discrimination cost a team?”. In this case, cost can be translated into different measures, such as monetary earnings for the franchise, team wins, or game points.

To analyze the cost of discrimination in terms of team performance, I use the results for each college game between 2005 and 2023. In general, there are around 900 games per year (including playoffs), and each of them can be considered a match-up. I build a dataset with all teams’ games and their final results, including each squads’ and their opponents’ statistics for the previous year¹¹. Additionally, to track the specific contribution of the QB, I identify the main QB that played in each game¹² and use their QBR for the prior year as a predictor. To account for the strength of the offensive team outside of the QB, I use the residuals of a regression between the team’s offensive score and the QBR for that year’s main QB. The rest of the predictors for the model are based on the teams’ and their opponents’ defensive statistics. Given that not all QBs have QBR metrics, I only use approximately 130 games from each season for this analysis.

Using this data, I build a prediction model for winning a game (binary). As previously mentioned, I use the aggregated information of the prior year for both the incumbent and the opposing team as predictors, such as Simple Rating System (SRS)¹³ score for the defense ([Sports Reference, 2024](#)), the offense SRS contribution aside from the QB (i.e. residuals), and I also include as predictors the main QB’s Total Quarterback Rating (QBR) for the previous year for both contending QBs in a match-up.

For prediction, I use 75% of the match-up data for training and the rest for testing¹⁴. The prediction model is a Random Forest using 5-fold cross-validation¹⁵, with an accuracy of 65.6%, a sensitivity of 65.9%, and specificity of 65.2%.

Results in [Figure 5](#) show that the strength of a QB is one of the most important predictors for a win (e.g. 99.9% of relative importance). This finding is relevant considering that non-white QBs have, on average, 2 additional points in terms of QBR compared to white QBs. Then, if some teams are recruiting sub-optimally due to discriminatory practices, that could affect their probability of winning.

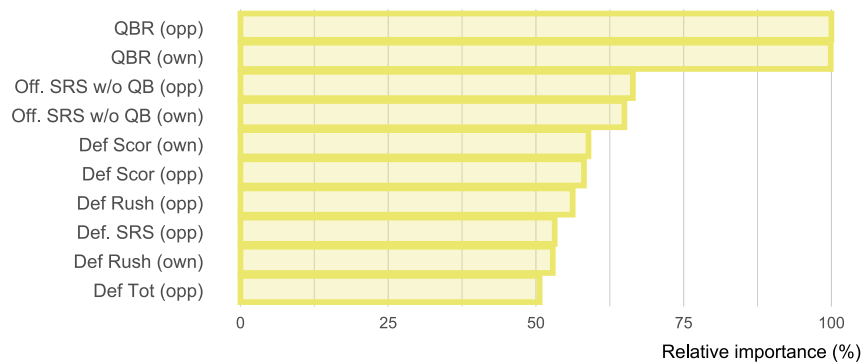
¹¹ Given that current year statistics are affected by the results of each game, I use the prior years’ statistics to avoid using post-game information in the prediction process

¹² The main QB for a game is considered the one that had the most attempts.

¹³ The Simple Rating System is a measure that takes into account “average point differential and strength of schedule” ([Sports Reference, 2024](#)), and it captures points either above or below average

¹⁴ Given that each match-up appears twice (once for the incumbent and once for the opponent as the incumbent), the randomization for the training and testing data is done at the game level to avoid contamination.

¹⁵ Hyper-tuning parameters include 41 randomly chosen variables, minimum node size of 10, and the gini metric is used to create the splits.



Note: All variables measured at the team level or QB level for the prior year. QBR fc

Figure 5: Relative importance of features in prediction model for winning

To assess the cost of bias in terms of wins, I build a simulation scenario where teams would pick a similar QB to their own in term of high school statistics, but without considering race. For this, I match high school data to the previous dataset, and create by-year deciles of HS QBs based solely on their scouts' rating. Then, for each year, a team would randomly select a QB from the same decile as their QB, replacing the QBR stat of their player with the new randomly selected one. With this new team dataset¹⁶, I use the same random forest model previously described to predict the new probabilities of winning.

Figure 6 show the difference in predicted and observed probability of winning based on whether the QB change is from white to non-white or vice-versa¹⁷. When the simulation randomly selects a non-white QB (instead of the teams' white QB), we can see that there is a slight increase in the probability of winning (2.09 p.p.) compared to the inverse shift.

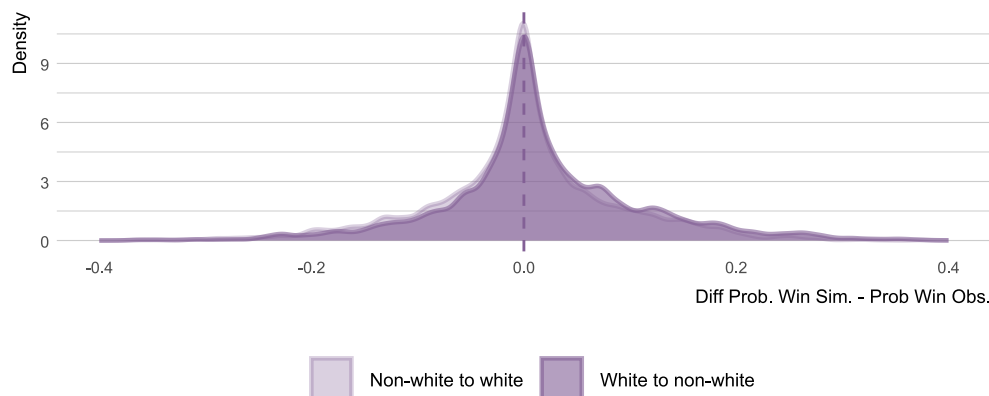


Figure 6: Difference in predicted probability of winning and observed probability of winning for different QB switches

I also focus in particular on teams which have a significant lower rate of non-white starting QBs in their games compared to the simulations, and use this as a proxy of over-representation of white QBs in specific teams (OR

¹⁶A limitation of this data is that I can only use teams that have a starting QB that is on our HS dataset. Thus, I only use games where I am able to match both datasets.

¹⁷Changes of QB within the same race/ethnicity are not shown.

white QB). In this case, if a team has a non-white QB representation that is below the 95% CI of the simulated rate, then OR white QB takes the value of 1, and 0 in another case¹⁸.

Table 10 shows the results for additional wins (in number and percentage points) for teams with over-representation of white QBs, comparing their average simulated results and the observed outcome. These teams, who are more likely to have discriminatory patterns of recruitment, would increase their wins by 6.5% if they recruited similar HS QBs in terms of performance, but without considering race in the recruitment. These findings highlight some of the costs that are associated with racial bias in recruiting, specifically due to QB performance¹⁹.

Table 10: Differences in winning between teams with white QB over-representation vs not based on simulations

	Num. extra wins/year	% extra wins/year
OR White QB	0.125*	0.031*
	(0.064)	(0.014)
Avg. Obs. Wins (Control)	2.225	0.47
Year FE	Yes	Yes
Years	05-22	05-22
N	1218	1218

Note: Clustered robust standard errors in parenthesis. Clusters at the team level.

Additional wins are estimated as the difference between simulated wins and observed wins.

p-value < 0.01: **, <0.05 *, and <0.1 +

But what is the monetary cost associated with these discriminatory decisions? To analyze some of the direct costs associated with recruiting bias, I conduct some back-of-the-envelope estimations on the probability of making to the playoffs based on the QB performance. In the NCAA, teams receive substantial compensation if they make it past the regular season, which accumulates as they progress through the playoffs: For example, In 2024-2025, teams that advanced to the playoffs would receive \$4 million dollars each (Business of College Sports, 2024), with an equal increase if they advanced to quarter-finals.

Table 11 shows the average increase in QBR from random selection based on performance compared to the observed QBR²⁰. On average, teams who are more likely to discriminate during recruitment have a 1.29-point increase in QBR when selecting a similar QB in terms of HS performance, without considering race. In Table 12, I run a simple model to capture the association between QBR and the probability of making it to the playoffs: In general, a 1-point increase in QBR is associated with a 0.7 p.p. increase in the probability of making it past the regular season, which is a 5.8% increase in the baseline probability. Using these probabilities to compare the expected payout²¹ under the observed scenario and then under the simulated scenario for 1,000,000 simulations, there is an increase in expected payout of US\$26680 (95% CI = [15267,38093]), equivalent to a 5.7% increase. It is important to note that these calculations most likely provide a lower bound for the costs of discrimination, as they do not consider additional payouts for moving to the next rounds or shifts in other team's QBs. Additionally, recruiting more capable QBs could have other impacts in the franchise, like improving recruitment prospects and increasing the performance of other players on the team.

¹⁸This measure is created at the team level, aggregating their white QB rate by year. In that case, if teams systematically select white QBs over non-white QBs over several years, they are more likely to be categorized as over-representing white QBs.

¹⁹Simulations only shifts in QB performance measured as their QBR metric, but other costs can also arise if there are positive associations between QB performance and other offensive team performance as well.

²⁰Just like in the prediction model, QBR measured the performance of the current quarterback the previous year.

²¹I assume that the payout for moving to the playoffs is \$4 million dollars, which is the amount that was paid in 2024-2025.

Table 11: Difference in QBR performance (simulated vs obs) for teams with over representation of white QBs

	QBR sim - QBR obs (pts)	QBR sim - QBR obs (%)
OR White QB	1.286* (0.506)	0.026** (0.010)
Avg. Outcome (Control)	-1.312	-0.021
Year FE	Yes	Yes
Years	05-22	05-22
N	1218	1218

Note: Clustered robust standard errors in parenthesis. Clusters at the team level.

QBR represents the performance of the current QB and team for the previous year, respectively.

p-value < 0.01: **, <0.05 *, and <0.1 +

Table 12: Association between QBR performance and probability of going to the playoffs

	Playoffs	Playoffs
QBR	0.007*** (0.001)	0.004*** (0.001)
Off SRS w/o QB		0.006* (0.003)
Def. SRS		0.014*** (0.002)
Avg. Outcome (Control)	0.117	0.117
Year FE	Yes	Yes
Years	05-22	05-22
N	959	959

Note: Clustered robust standard errors in parenthesis. Clusters at the team level.

QBR and SRS represents the performance of the current QB and team for the previous year, respectively.

p-value < 0.01: **, <0.05 *, and <0.1 +

6. Conclusions

This paper contributes to the growing literature on labor market discrimination by providing robust evidence of racial bias in quarterback recruitment across the high school, college, and professional levels of American football. Using a combination of benchmark and outcome tests, the analysis reveals clear disparities in recruitment probabilities and performance expectations, with non-white quarterbacks facing higher recruitment thresholds despite demonstrating comparable or superior on-field performance. These findings are consistent with theoretical models of discrimination and lend empirical support to the hypothesis that racial bias persists in decision-making processes within this labor market.

The results highlight several important implications for economic theory and policy. First, the findings underscore the role of implicit biases in labor market sorting, even in contexts where performance metrics are readily observable. The disproportionate representation of white quarterbacks at the collegiate and professional levels, despite the comparable performance of non-white quarterbacks, suggests that decision-makers may be over-relying on heuristics or outdated stereotypes rather than objective measures of ability.

Second, this paper emphasizes the economic costs of discrimination. By demonstrating that teams with racially biased recruitment practices underperform relative to their potential, the analysis highlights the inefficiency in-

roduced by discriminatory decision-making. This inefficiency not only reduces the competitiveness of individual teams but may also distort broader market dynamics in the industry, such as salary structures and franchise valuations.

While the results are robust and address many potential confounders, there are limitations that warrant further exploration. For instance, unobservable characteristics, such as leadership skills or off-field behavior, could partially explain some of the observed disparities in recruitment. Although the outcome tests mitigate this concern by showing that non-white quarterbacks outperform their white counterparts when recruited, additional data on non-performance-related attributes could strengthen the analysis, providing additional evidence on the decision-making process of recruitment.

Finally, these findings open several avenues for future research. The use of football as a case study provides a controlled setting with objective performance metrics and clear career paths, but similar methodologies could be applied to other labor markets with hierarchical structures and performance-based promotions. Additionally, exploring how the observed biases interact with other characteristics of the team (e.g. location and how liberal colleges campus are), could yield a more comprehensive understanding of the barriers faced by minority groups in this labor markets.

In conclusion, this study highlights the persistence of racial bias in a high-profile labor market and its implications for both equity and efficiency. The findings call for further promotion of transparency and accountability in recruitment decisions, ensuring that talent allocation aligns more closely with performance metrics. By addressing these biases, not only can we improve fairness and representation, but we can also enhance performance outcomes in ways that benefit all stakeholders in the industry.

References

- Anwar, S., & Fang, H. (2006). An Alternative Test of Racial Prejudice in Motor Vehicle Searches: Theory and Evidence. *The American Economic Review*, 3(96), 127–151.
- Arnold, D., Dobbie, W., & Yang, C. S. (2018). Racial Bias in Bail Decisions. *The Quarterly Journal of Economics*, 133(4), 1885–1932.
- Becker, G. S. (1993). Nobel Lecture: The Economic Way of Looking at Behavior. *Journal of Political Economy*, 101(3), 385–409.
- Berri, D. J., & Simmons, R. (2009). Race and the Evaluation of Signal Callers in the National Football League. *Journal of Sports Economics*, 10(1), 23–43.
- Berri, D., Farnell, A., & Simmons, R. (2023). The Determinants of Black Quarterback Pay in the National Football League. *Managerial and Decision Economics*, 44(3), 1491–1503.
- Bertrand, M., & Mullainathan, S. (2004). Are Emily and Greg More Employable Than Lakisha and Jamal? A Field Experiment on Labor Market Discrimination. *American Economic Review*, 94(4), 991–1013.
- Bohren, J., Hull, P., & Imas, A. (2024). Systemic Discrimination: Theory and Measurement. *Working Paper*, 0, .
- Bopp, T., & Sagas, M. (2014). Racial Tasking and the College Quarterback: Redefining the Stacking Phenomenon. *Journal of Sport Management*, 28(2), 136–142.
- Bouchet, A. (2023). The 2023 Racial and Gender Report Card: National Football League. *The Institute for Diversity and Ethics in Sport*. <https://www.tidesport.org/nfl>
- Business of College Sports. (2024). *College Football Playoff Payouts 2024-2025*. https://businessofcollegesports.com/college-football-playoff-payouts/?utm_source=chatgpt.com#how-much-does-a-team-get-for-making-the-college-football-playoff-in-2024-2025
- Canay, I. A., Mogstad, M., & Mountjoy, J. (2024). On the Use of Outcome Tests for Detecting Bias in Decision Making. *Review of Economic Studies*, 91(4), 2135–2167.
- ESPN Stats & Information. (2016). *How is Total QBR calculated? We explain our quarterback rating*. https://www.espn.com/blog/statsinfo/post/_id/123701/how-is-total-qbr-calculated-we-explain-our-quarterback-rating
- Fryer, R. G. J., Pager, D., & Spenkuch, J. L. (2013). Racial Disparities in Job Finding and Offered Wages. *The Journal of Law and Economics*, 56(3), 633–689.

- Gaebler, J. D., & Goel, S. (2024). A Simple, Statistically Robust Test of Discrimination. *Arxiv Preprint Arxiv:2407.06539*. <https://arxiv.org/abs/2407.06539>
- Jacquemet, N., & Yannelis, C. (2012). Indiscriminate Discrimination: A Correspondence Test for Ethnic Homophily in the Chicago Labor Market. *Labour Economics*, 19(6), 824–832.
- Karlin, S., & Rubin, H. (1956). The theory of decision procedures for distributions with monotone likelihood ratio. *The Annals of Mathematical Statistics*, 0, 272–299.
- Kleinberg, J., Lakkaraju, H., Leskovec, J., Ludwig, J., & Mullainathan, S. (2018). Human Decisions and Machine Predictions. *The Quarterly Journal of Economics*, 133(1), 237–293.
- Kline, P. M., Rose, E. K., & Walters, C. R. (2022). Systemic Discrimination Among Large U.S. Employers. *The Quarterly Journal of Economics*, 137(4), 1963–2036.
- Knowles, J., Persico, N., & Todd, P. (2001). Racial Bias in Motor Vehicle Searches: Theory and Evidence. *Journal of Political Economy*, 109(1), 203–229.
- Lang, K., & Kahn-Lang Spitzer, A. (2020). Race Discrimination: An Economic Perspective. *Journal of Economic Perspectives*, 34(2), 68–89.
- Neumark, D. (2018). Experimental Research on Labor Market Discrimination. *Journal of Economic Literature*, 56(3), 799–866.
- Pager, D., Western, B., & Bonikowski, B. (2009). Discrimination in a Low-Wage Labor Market: A Field Experiment. *American Sociological Review*, 74(5), 777–799.
- Parsons, C. A., Sulaeman, J., Yates, M. C., & Hamermesh, D. S. (2011). Strike Three: Discrimination, Incentives, and Evaluation. *American Economic Review*, 101(4), 1410–1435.
- Price, J., & Wolfers, J. (2010). Racial Discrimination Among NBA Referees. *The Quarterly Journal of Economics*, 125(4), 1859–1887.
- Rosenbaum, P. R. (1987). Sensitivity analysis for certain permutation inferences in matched observational studies. *Biometrika*, 74, 13–26.
- Rosenbaum, P. R. (2002). *Observational studies*. Springer.
- Sports Reference. (2024). *College Football Stats Glossary*. <https://www.sports-reference.com/cfb/about/glossary.html#srs>
- Stuart, C. (2014). *Is ESPN's QBR the best measure of quarterback play?*. <https://www.footballperspective.com/is-espn-qbr-the-best-measure-of-quarterback-play/>
- The Washington Post. (2021). *Black quarterbacks are taking over the NFL. But there is more ground to be gained*. <https://www.washingtonpost.com/sports/2021/09/10/black-quarterbacks-nfl-2021/>
- Zubizarreta, J. R., Kilcioglu, C., & Vielma, J. P. (2018). designmatch: Matched samples that are balanced and representative by design. *R Package Version 0.3*, 0.