Uneven Bars? Looking for Evidence of Environmental Microaggression Theory in NCAA Women's Gymnastics[1]

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Abstract

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Keywords: women's gymnastics, racial gaps, racial microaggression theory

JEL Codes: J15, Z2, Z20

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Uneven Bars? Looking for Evidence of Intergroup Anxiety in NCAA Women's Gymnastics

Abstract

Research on racial microaggression theory suggests that environmental factors such as the name of a building can negatively impact Black individuals. This study utilizes a unique dataset of scores from NCAA women's gymnastics meets to examine whether Black gymnasts experience any negative effect on their performance when competing at Brigham Young University (BYU), a university with a history of racial controversy and a namesake who promoted racist policies during his life. We model gymnasts and their coaches as score maximizers and estimate a fixed-effects regression model to analyze the full regular seasons of every gymnastics team that visited BYU between the 2017 and 2022 seasons. We find no evidence that being Black has any significant effect on gymnasts performing at BYU in any of the four individual women's gymnastics events. Notwithstanding, when we split our analysis to pre- and post-May 2020 (the death of George Floyd), we find that coefficient estimates for being a Black gymnast at BYU become more negative generally, with estimates in two of the four events showing statistically significant negative differences. We speculate on the implications of these results for people interested in the effects of environmental microaggressions on affected populations.

I. Introduction

After the death of George Floyd in May 2020, the longtime call from social activists to rename places named in honor of controversial historical figures and symbols such as KKK members, eugenicists, racially charged terms or slurs, slave holders, Confederate soldiers, and the likes gained significant momentum. The argument to change these names usually focuses on their perceived negative impact on members of the groups disparaged by those namesakes, which is in line with prominent research on microaggression theory that suggests that environmental factors such as the name of a place can implicitly communicate to someone that "[They] don't belong / [They] won't succeed here." and that "There is only so far [they] can go." (Sue et. al. 2007). This paper aims to expand on the general issue discussed in Pope & Schweitzer (2011) by investigating whether such a negative effect becomes detectable in the face of "competition, large stakes, and experience."

Our study examines a scenario in which this potential negative effect would likely be present. Brigham Young University (BYU) has a history of racial controversy in its athletics programs due in large part to its affiliation with the Church of Jesus Christ of Latter-day Saints (Bergera 2013), and its namesake, Brigham Young, promoted racist policies as a religious and political leader in Utah throughout the mid-1800s. This history and association is relatively well known, so we contend that if a visiting athlete were to experience any negative effect from name-based environmental microaggression at any place, they would experience it at BYU.

We analyze the performance of NCAA women gymnastics teams over the entire regular season(s) in which they 1) visited Brigham Young University at least once from 2017-2022; and 2) had at least one Black gymnast compete in the BYU meet. We include scores from the full span of the regular season in which they visited BYU. For example, we include every score from every Utah State University gymnast at every one of their regular season meets from 2017-2019 and 2021-2022

because USU had a Black gymnast compete at BYU every year from 2017-2022 except for 2020, but we include every score from every Illinois State University gymnast at every one of their regular season meets from just 2022 because this is the only season in which Illinois State had a Black gymnast compete at BYU over that timespan. We choose to analyze women's gymnastics because the score a gymnast receives in a given event is given at the individual level. This is key, as any negative effect from environmental racial microaggression should also present itself at the individual level.

We model gymnasts as score maximizers and propose a general model for event scores in college-level gymnastics competition. We then estimate a fixed-effects regression model of those scores that uses an indicator variable for being a Black gymnast competing at BYU as the independent variable of greatest interest. We argue that our model controls for all relevant factors that could affect a gymnast's score, including innate ability, preparation, potential judge bias, and so on. Though our model does not produce any statistically significant effect of being Black at BYU on scores in any of the four events, it does return some results that would be concerning if replicated on a larger dataset with greater statistical power. In addition, we run an event study around the death of George Floyd and find evidence that this event and its fallout may have affected Black gymnasts' vault scores when performing at BYU.

II. Background & Related Literature

II.1 Women's Artistic Gymnastics

In women's artistic gymnastics, a regular season meet is composed of four events: vault, floor, balance beam, and uneven bars. Gymnasts typically compete in only one or two of these events, but they are allowed to compete in all four at any given meet. Each performance is scored out of 10 by two to four judges whose independent scores are averaged to a final performance score.

The typical regular season meet has four judges – two from in region and two from out of region – each judging two events, with two judges per event. When there are more than two teams at a given meet, at least eight individual judges judge one event each (still with two judges per event) with no rotation between events.

In each event, six gymnasts from each team perform, and the lowest of those six scores is dropped. At the NCAA level, scores are determined by two factors: the "start value" of the routine, which is the score a gymnast would receive by performing their prepared routine perfectly, and deductions taken from the start value that are related to technical or execution errors. Routines are required by rule to have at least a 9.4 start value, but gymnasts at the collegiate level are sufficiently skilled such that almost all routines begin at the maximum 10 point start value.

Though an individual score can theoretically range anywhere from zero to 10 in each event, they typically cluster within the 9.7 - 9.9 range. After all events are complete, the sum of the five highest scores in each event are summed to compute the team's meet score. Because the practical range of scores is so small, tiny differences in average scores separate elite teams from great and decent teams: elite gymnastics teams have the potential to hit a 198.00 meet score, which is obtainable only with an average score of 9.9 from every gymnast in every event across the entire meet; great teams can consistently hit a 197.00 meet score (a 9.85 average performance score); and good teams can consistently hit a 196.00 meet score (a 9.8 average performance score).

Choosing to analyze artistic gymnastics meets offers us several key advantages. One such advantage is that scores are assigned to gymnasts on an individual basis. Though research has shown that there may be an overall ordering bias in judging (Damisch, Mussweiler, & Plessner 2006; Morgan & Rotthoff 2014; Rotthoff 2015; Joustra, Koning, & Krumer 2020; Rotthoff 2020), that same research generally shows that a gymnasts' score is not affected by the performances

immediately preceding it. Because scores are mostly independent across individual gymnasts, we can look for the presence of an environmental effect that would manifest at the individual level.

Each of the four gymnastics events is a high-intensity, high-focus exercise. We hypothesize that any unusual outside pressure could cause gymnasts to make mistakes they would not make absent such pressure, with potential pressures of this kind including a negative environmental microaggression effect as defined previously. We argue that if a gymnast were to experience such an effect at any venue, she would be likely to experience it at Brigham Young University, a university with a history of racial controversy in its athletics programs (Bergera 2013). Whether such an effect would be significant enough to affect competitive performance is the focus of the study.

Research that investigates behavioral effects using women's gymnastics has primarily focused on elite-level gymnasts. These papers most frequently deal with race-agnostic biases present in judges, such as difficulty bias (Rotthoff 2020) and the aforementioned ordering bias (Damisch, Mussweiler, & Plessner 2006; Morgan & Rotthoff 2014; Rotthoff 2015; Joustra, Koning, & Krumer 2020; Rotthoff 2020). However, other gymnastics-based research has focused on biases held by competitors, like the paper from Meissner, Rai, and Rotthoff (2021) on Simone Biles' superstar effect. These papers make use of the unique context of gymnastics competitions (individual scoring, tournament settings, judge panels, etc.) to investigate these biases in a convincing way. However, due to the infrequent nature of elite-level tournaments relative to other gymnastics competitions, these papers frequently rely on a single tournament's worth of data to draw their conclusions (with Meissner, Rai, & Rotthoff (2021) being a notable exception.)

II.2 Environmental Microaggression Theory

Recent research that investigates the effects of environmental microaggressions on Black individuals is largely based on the model of microaggression theory Sue et al. (2007), which suggests

that environmental factors such as the names of buildings or overall racial climates can constitute "[m]acro-level microaggressions, which are more apparent on systemic and environmental levels" than other types of interpersonal microaggression. This research is often focused on qualitative interviews or surveys of Black students' experiences at predominantly White institutions (or PWIs) (Mills 2020; Holliday & Squires 2020). This observation is also generally true of literature in this field historically, as evidenced by the many hundreds of papers based on interviewing Black students attending perennially White institutions (or PWIs) published from 1965-2013 that are summarized in Willie & Cunnigen (1981), Sedlacek (1987), and Holliday & Squires (2020).

In addition to this research on racial bias founded on microaggression theory, much research exists on racial biases within the world of sports. Generally, this research focuses on racial biases in referee/judge decisions (as in Price & Wolfers 2010; Parsons et al. 2011; Gallo, Grund, & Reade 2012; Rotthoff 2020; Eiserloh, Foreman, & Heintz 2020; and Pelechrinis 2023) or in fan/commentator preference outside of competition (as in Andersen & La Croix 1991; Preston & Szymanski 2008; Reilly & Witt 2011; Principe & van Ours 2022; and Quansah, Lang, & Frick 2023). These studies use data from professional sports leagues in many sports and around the world to generally show that racial biases can affect sports teams both in competitive outcomes and in perceived value.

Two more investigations warrant particular note in this paper. The first is Dix's body of work on sports programs at historically Black colleges and universities (or HBCUs) in which he shows teams from HBCUs experiencing negative effects in football (Dix 2017, 2021a), men's basketball (Dix 2022a, 2022b), women's basketball (Dix 2019, 2020a, 2022b), baseball (Dix 2020b), softball (Dix 2021b), and volleyball (Dix 2023). This line of research is helpful for bridging the gap between the above mentioned studies on professional sports to studies at the college level. Though it focuses

only on averaged team results and not on individual level effects, it is nonetheless useful for contextualizing our work in this paper.

The second investigation of note is found in Caselli, Falco, & Mattera (2023). In this paper, the authors show that African players in a professional Italian soccer league improved their performance when COVID-19 prevented fans from attending their games. They argue that this effect stems from the absence of overtly racist fan behavior, which is reportedly common in that league. This research is relevant to our paper because to our knowledge it is the closest existing paper to this one. Like we will in this paper, Caselli, Falco, and Mattera evaluate individual-level performance scores (in this case, assigned algorithmically to individual soccer players) in a generalized fixed effects model that allows them to control for player- and match-based fixed effects. They also model the effects of a quasi-environmental removal of direct racial aggressions, which mirrors our empirical strategy in which we exploit the introduction of a potential environmental microaggression.

Our research contributes to the literature using sports to research behavioral effects by trying to find evidence of an environmental microaggression in a competitive gymnastics setting. We contribute to racial microaggression research by trying to find evidence of it in a novel setting that may be externally valid to the experiences of students generally, especially in strenuous situations of high pressure such as difficult classes or exam season. Additionally, we aim to quantify this specific type of microaggression effect within a statistical framework that could uncover causality, which has not generally been done around environmental microaggression theory to this point. In regards to the two lines of research that most closely approach ours (the Dix papers and the Caselli, Falco, & Mattera paper), we differentiate ourselves from Dix by focusing on individual-level effects as opposed to team-level effects, and we differentiate ourselves from Caselli, Falco, and Mattera by

focusing on the introduction of a racial microaggression on college-level athletes as opposed to the removal of an overt, quasi-environmental set of racial aggressions from professional athletes.

III. Model & Data

In order to attribute causality to any estimate we produce, we must be reasonably sure that we have controlled for as many other factors that could influence a gymnast's score as possible. As such, we suggest a simple model of a gymnasts score in any given event that breaks down influential factors into three main categories:

$$(1) \quad score = ability + preparation + environment + \varepsilon$$

In this model, ability-related factors could include, for example, the genetic makeup of a given gymnast, the age at which they began training, and the set of skills they have the physical capacity to perform. Preparation-related factors might include the quality of the team and coaches surrounding a gymnast, the number of years a gymnast has been competing, the types of skills a gymnast chooses to practice, and the number of meets that have already occurred in a season. Environment-related factors could include the relative competency or biases of judges at a given meet, the altitude, location, quality, and name of the venue, the time of the meet, and so on. There is also bound to be stochastic error in any model of human behavior.

It is important to note that the functional model used by judges to assign scores to gymnasts in a meet takes the following form:

$$(2) \quad score = difficulty + execution$$

where the skills a gymnast chooses to perform are assigned "difficulty scores" that are then added to or subtracted from based on how well the gymnast performs those skills. We suggest that, generally, our model can be viewed as an alternate interpretation of this official model. A gymnast's ability will generally inform the skills they choose to perform,

Having put forth this general framework, we further posit that gymnasts and their coaches behave as score-maximizers. We assume that these agents aim to maximize the score a gymnast will receive in a given event by selecting routines of appropriate difficulty and practicing them adequately; this implies that a gymnast has perfect information about and control over the ability- and preparation-related elements of the proposed scoring model. In our simple model, we assume that a gymnast has no control over the environment-related factors of her scoring. We discuss these assumptions further when we define the empirical model we use to estimate scores in a later section.

This study uses hand-compiled data from official meet reports. These report sheets contain information on each gymnasts' score(s) at a meet, the judges for each event, and the venue of the meet. Most of those sheets were found at RoadToNationals.com, the official statistical website of NCAA Gymnastics. Any sheets not found on RoadToNationals were pulled from individual team websites. Each gymnast's race was coded as Black or not Black based on visual inspection of their official photographs as posted on each school's official gymnastics website. The data is well-suited for our study because it allows for analysis of scores across race groups and across meet venues. Because variation in scores is still small and the "perfect 10" upper bound can give undue weight to exceptionally low scores, we drop the top and bottom first percentiles of scores for each event prior to estimation.

Kernel density estimations of score distributions by event (Figure 1) show that scoring in vault and floor appears consistent between race groups and venues, while scoring distributions in beam and bars appear to be less consistent across the same groups. This apparent gap motivates our primary analysis, in which we use a fixed-effects regression model to see if those gaps are statistically significant. However, tracking the actual score a gymnast receives is not the only way to determine whether they were under any unexpected outside stress.

In NCAA scoring, every gymnast's routine is worth 9.5 points as a baseline value with additional points available for meeting certain requirements up to a maximum starting value of 10 points. At the skill level represented in our dataset, almost every routine any gymnast runs will be worth 10 points if performed perfectly; as such, a score below 9.5 on any given routine would represent a (potential series of) major error(s) that could be interpreted as being independent of any individual judge's decision or bias. A binary indicator marking such scores serves as the dependent variable in a conditional logit model that we run to supplement the primary analysis.

Our analysis is hindered by the number of scores received by Black gymnasts at BYU making up less than two percent of all scores in the dataset (see Table 1 for full summary statistics). For example, it makes running conditional logit on the large deduction binary variable impossible for the vault, as the dataset does not contain a single instance of a Black gymnast scoring that low on vault when performing at BYU. Indeed, running any model with such a small sample in the "treated group" likely gives undue weight to outlier scores and obfuscates its results; we discuss these implications further in Section IV.

IV. Empirical Strategy

Our analysis begins by using a fixed-effects regression design to isolate any heterogeneous effect of competing at BYU for Black and non-Black gymnasts. Our set of fixed effects control for gymnast, venue, year, and judge-specific characteristics that might influence the score a gymnast receives at a given meet. In Table 2, we report the results from estimating the following linear model:

$$\begin{aligned}(1)\quad Score_{imvjy} = {} & \alpha + \beta(\text{Black x atBYU})_{imv} + meet_m + [\text{gymnast effects}]_i \\ & + [\text{venue effects}]_v + [\text{judge effects}]_j + [\text{year effects}]_y \\ & + [\text{gymnast x year effects}]_{iy} + \varepsilon_{imvjy}\end{aligned}$$

where subscripts *i, m, v, j,* and *y* refer to individual gymnasts, meet weeks, venues, judges, and years, respectively. The dependent variable is the score earned by a gymnast in a given event. Each of the square brackets denote a set of fixed effects, $meet_m$ denotes the match week (i.e. $meet_m = 1$ for the first meet of the season), and the interaction term $(Black \times atBYU)_{iv}$ takes a value of 1 if a score is received by a Black gymnast competing at BYU and 0 otherwise. α is a regression constant, and the coefficient of interest is β, which we interpret as the differential impact of competing at BYU on Black gymnasts relative to non-Black gymnasts. To account for possible correlation between the scores received by a given gymnast, we report standard errors clustered at the gymnast level.

In the first row of Table 2, we report coefficients on the interaction term from regressions of event score on binary variables for being Black, being at BYU, and being Black at BYU. In the second row, we replace the binary Black and at BYU variables with gymnast and venue fixed effects, respectively. In the third row, we add judge and year fixed effects, and in the final row, we add gymnast by year linear time trends.

We then use a fixed-effects logistic regression to estimate odds ratios for getting a score below 9.5 on any given individual routine. We control for match week number in all models, and add various sets of fixed effects as above. In Table 3, we report odds ratios from estimating the following logit model:

$$(2) \quad Logit(P_{low}) = ln(P_{low} / 1\text{-}P_{low}) = \tau_0 + \tau_1(\text{Black x atBYU}) + \tau_2(\text{meet number}) + [\text{gymnast effects}] + [\text{venue effects}] + [\text{year effects}] + u_{low}$$

where P_{low} is the probability of getting a score below 9.5, $(P_{low} / 1\text{-}P_{low})$ is the reported odds ratio, the set of τ_k represent marginal effects, and the square bracketed terms represent sets of fixed effects as defined above. As in Equation (1), standard errors are clustered at the gymnast level.

In the first row of Table 3, we report odds ratios for the interaction term from the above logit of event score on binary variables for being Black, being at BYU, and being Black at BYU. In the second row, we replace the binary Black and at BYU variables with gymnast and venue fixed effects, respectively, and in the third row, we add year fixed effects. Unlike in Table 2, we do not include a specification with judge fixed effects or gymnast-year fixed effects, for two reasons. First, including those sets of fixed effects made the log-likelihood function non-concave, precluding us from including them. Second, it could be argued that these sets of fixed effects are not relevant when considering such large deductions, as they seem more likely to occur if a gymnast is under unusual pressure than as a result of any particular judge's influence or gymnast's experience level.

V. Empirical Results

We find that the coefficient on the interaction term (Black x atBYU) is not statistically different from zero in any individual event under any robust fixed-effect regression specification. The odds ratios and corresponding marginal effects obtained via logit are similarly insignificant. This analysis reveals that even the most obvious looking racial gaps in event scoring from Figure 1 are not statistically significant. This implies that competing at BYU does not have an adverse effect on Black gymnasts' performance, meaning these gymnasts are either 1) fully unaffected by intergroup anxiety or other implicit social pressures at BYU; or 2) not sufficiently affected by such pressures to suffer a detectable drop in performance when at BYU.

Our models appear to be hindered by fact that the proportion of our sample made up of scores received by Black gymnasts while performing at BYU is so small. If one were to see the same distributions of scores reflected in Figure 1 in a better-balanced sample of similar size, one would likely see practically large and statistically significant effects on event scores produced by our models. However, a larger sample would also push those distributions closer to their asymptotic

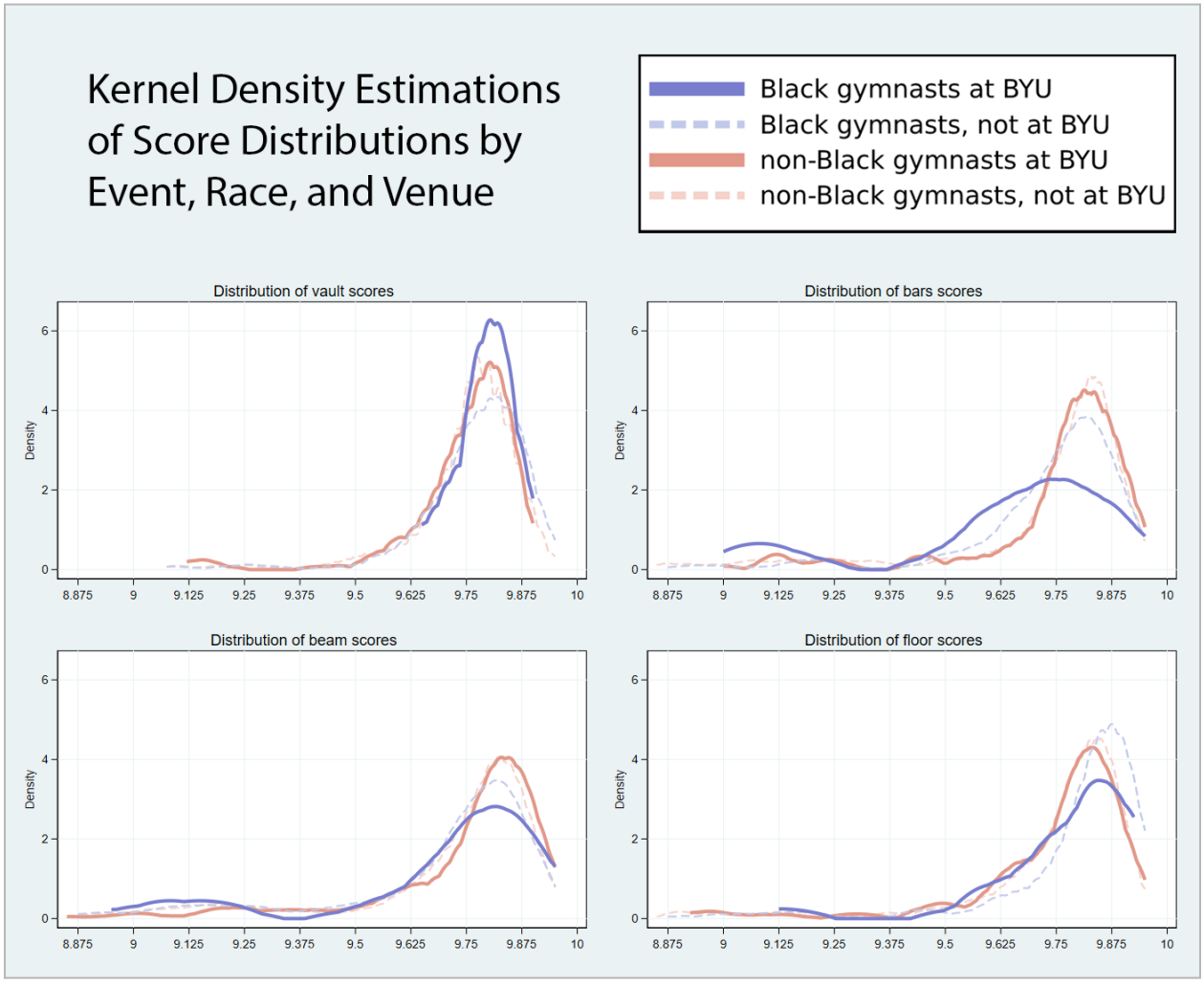
distributions, which may truly be equal to each other. As it stands, our analysis provides no evidence to support the presence of intergroup anxiety or other unique social pressures for Black gymnasts visiting BYU.

VI. Conclusion

Using a unique dataset on collegiate women's gymnastics scores composed of teams that visit BYU, we test whether Black gymnasts experience a change in performance when competing at BYU that their non-Black competitors do not experience. Our data allows us to introduce many sets of fixed effects to control for relevant factors that influence scores, which allow us to isolate the interaction between a gymnast's race and the venue at which they perform. We find no significant difference in score distributions at BYU between Black and non-Black gymnasts in any individual event and fail to detect a similar type of difference via logit odds ratio estimation, indicating no evidence of intergroup anxiety or any similar bias affecting gymnasts' performance to a notable degree. However, we note that a more robust sample could yield different results under the same models if the score distributions we observe in our present sample persisted.

FIGURE 1

KERNEL DENSITY ESTIMATIONS OF SCORE DISTRIBUTIONS



Note: It uses an Epanechnikov kernel with the bandwidth selected by Silverman's h. All data and code can be accessed at github.com/tmorg46/uneven_bars.

TABLE 1. SUMMARY STATISTICS

VARIABLES		(1) Vault	(2) Bars	(3) Beam	(4) Floor
Score	Mean	9.746	9.684	9.687	9.740
	(SD)	(0.160)	(0.410)	(0.280)	(0.240)
Deducted		0.033	0.125	0.142	0.068
		(0.180)	(0.331)	(0.349)	(0.252)
Black		0.162	0.127	0.107	0.126
		(0.375)	(0.333)	(0.309)	(0.332)
at BYU		0.100	0.101	0.103	0.100
		(0.300)	(0.301)	(0.304)	(0.300)
Black and at BYU		0.014	0.012	0.010	0.012
		(0.119)	(0.111)	(0.099)	(0.111)
Observations		2,003	2,016	2,027	2,005

Notes. The non-score variables are binary variables, so they represent the fraction of scores in a given event that fall in a given category. All data and code can be accessed at github.com/tmorg46/uneven_bars.

TABLE 2. Fixed Effects Regression Estimates of Interaction Term on Scores by Event

		Coefficient on (Black x atBYU)			
MODELS		(1) Vault	(2) Bars	(3) Beam	(4) Floor
Baseline	Coefficient	0.038*	-0.078	-0.027	-0.008
	(Std. Error)	(0.022)	(0.081)	(0.064)	(0.040)
Adding Gymnast effects		0.027	-0.046	-0.041	-0.014
		(0.018)	(0.069)	(0.070)	(0.040)
Adding Meet effects		0.078**	0.002	-0.024	-0.008
		(0.038)	(0.080)	(0.075)	(0.048)
Adding Gymnast and Meet effect		0.042	0.035	-0.024	-0.008
		(0.029)	(0.075)	(0.078)	(0.049)
Observations		2,003	2,016	2,027	2,005
R-squared, by Model		0.013	0.006	0.007	0.023
		0.354	0.211	0.289	0.381
		0.276	0.175	0.205	0.239
		0.476	0.331	0.423	0.498

*** p<0.01, ** p<0.05, * p<0.1

TABLE 3
FIXED EFFECTS LOGIT ODDS RATIOS OF BEING DEDUCTED (SCORE<9.5)

		Odds Ratio on (Black x atBYU)		
MODELS		(1) Bars	(2) Beam	(3) Floor
Logit on Black, atBYU, meet week, and interaction	Odds Ratio	2.763	1.264	0.526
	(Std. Error)	(1.801)	(0.921)	(0.605)
Introduce Gymnast and Venue effects		2.058	1.494	0.512
		(1.596)	(1.270)	(0.626)
Adding Year fixed effects		2.035	1.491	0.597
		(1.585)	(1.265)	(0.727)
Observations, by Model		2,009	2,030	1,995
		1,476	1,467	996
		1,476	1,467	996

** Significant at the 5% confidence level
* Significant at the 10% confidence level

TABLE 1A. Fixed Effects Regression Estimates on Vault Scores

VARIABLES		(1)	(2)	(3)	(4)
Black and at BYU	Coefficient	0.027**	-0.117**	-0.027	-0.008
	(Std. Error)	(0.014)	(0.050)	(0.064)	(0.040)
Black		0.016	-0.079*	-0.041	-0.014
		(0.016)	(0.047)	(0.070)	(0.040)
At BYU		0.021	-0.040	-0.024	-0.008
		(0.018)	(0.050)	(0.075)	(0.048)
Constant		0.020	-0.035	-0.024	-0.008
		(0.019)	(0.051)	(0.078)	(0.049)
Observations		2,057	2,057	2,057	2,057
R-squared		0.007	0.328	0.426	0.462
Gymnast Effects			X	X	X
Venue Effects			X	X	X
Year Effects				X	X
Judge Effects				X	X
Gymnast-Year Effects					X

** Significant at the 5% confidence level * Significant at the 10% confidence level

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