RIETI Discussion Paper Series 26-E-003

Affirmative Action, Competitive Intensity, and Effort: Evidence from Japanese speedboat racing

WANG, Liya
Waseda University

KITAGAWA, Ritsu
Columbia University

TAKAHASHI, Takuya
Waseda University

RIETI
Research Institute of Economy, Trade & Industry, IAA

The Research Institute of Economy, Trade and Industry
https://www.rieti.go.jp/en/

RIETI Discussion Paper Series 26-E-003

January 2026

Affirmative Action, Competitive Intensity, and Effort: Evidence from Japanese speedboat racing*

Liya WANG[†], Ritsu KITAGAWA[‡], and Takuya TAKAHASHI[†]

[†] Waseda University

[‡] Columbia University

Abstract

Japanese professional speedboat racing is one of the few sports where men and women compete in the same race, though the gender balance is skewed in favor of men. The Japan Motor Boat Racing Association randomly assigns racers to either single-sex or mixed-sex races and implemented a policy raising the minimum weight for male racers from 51kg to 52kg after November 1, 2020. The random assignment and the exogenous policy shock enable us to shed light on affirmative action policy, which can be regarded as a practice that reduces competitive intensity for female racers and to explore how it affects their incentives to exert effort. We use start time as a proxy measure of effort, as it is an objective absolute measure that is highly correlated with placements, and we use advanced starts, which result in disqualification and are a representation of risk-taking in an attempt to shorten start time to as close to zero seconds as possible, as a measure of risk-taking. Using over 175,000 female racer-race observations from January 1, 2017, to December 31, 2022, we find that: (1) shifting from single-sex to mixed-sex races decreases the effort of middle- and low-ability female racers, while increasing the risk-taking behavior of high-ability female racers; (2) the policy change mitigates the discouragement effect on the effort of middle- and low-ability female racers when shifting from single-sex to mixed-sex races, whereas it has no effect on high-ability female racers; (3) overall, the affirmative action can promote the effort of female racers on average.

Keywords: affirmative action, competitive intensity, effort, sports

JEL classification: J16, J24, Z22

The RIETI Discussion Paper Series aims at widely disseminating research results in the form of professional papers, with the goal of stimulating lively discussion. The views expressed in the papers are solely those of the author(s), and neither represent those of the organization(s) to which the author(s) belong(s) nor the Research Institute of Economy, Trade and Industry.

*This study is conducted as a part of the Project "Human Capital Investment, Role of Management, and Productivity" undertaken at the Research Institute of Economy, Trade and Industry (RIETI). The draft of this paper was presented at the DP seminar of the Research Institute of Economy, Trade and Industry (RIETI). We would like to thank participants of the RIETI DP Seminar for their helpful comments. We are grateful to Hideo Owan for advising us as the project leader at RIETI. We also thank Enzo Brox, Ian Gregory-Smith, Ryohei Hayashi, Aaron Sullivan, Ayano Yago, Eiji Yamamura, and participants at PEW, WEAI 2025, and COPE 2025 for their helpful comments. Wang gratefully acknowledges financial support from JSPS KAKENHI Grant Number 24KJ2075.

1 Introduction

Affirmative action (AA) refers to policies designed to provide preferential treatment to disadvantaged demographic groups in order to address underrepresentation and promote diversity and inclusion. AA is increasingly implemented across various economic contexts, including education, elections, and employment. For example, race-based affirmative action was once widely used in U.S. college admissions. In the European Union, member states are required to ensure that women hold 40 percent of non-executive and 33 percent of all director roles in listed companies by 2026.

A substantial body of literature examines the effects of AA policies, particularly within the context of higher education. This stream of literature primarily explores AA's impact on admissions and campus diversity (Abdulkadiroğlu and Sönmez, 2003; Arcidiacono, 2005; Hinrichs, 2020), and college graduation (Bowen et al., 1998; Hinrichs, 2012). However, in the existing literature, pre-college academic outcomes have been predominantly viewed as exogenous and attributed to students' innate characteristics and learning environments. Limited attention has been given to how AA policies influence students' efforts prior to enrolling in college.

Beyond the education context, there has been an active research agenda on how gender quota systems affect legislative diversity and legislative performance (Hessami and da Fonseca, 2020; Clayton, 2021). Several papers examine the effects of gender quotas imposed on corporate board seats (e.g., Ahern and Dittmar (2012), Matsa and Miller (2013), Bertrand et al. (2019)). Many studies have found that AA policies improved organizational diversity and performance. Similar to the literature on educational outcomes and AA, little is known about how AA policies influence individuals' efforts during electoral campaigns and promotion processes.

In this study, we use data from a real-world competition—Japanese speedboat racing—to investigate the effects of AA policies on incentives for individuals from disadvantaged and underrepresented groups to exert effort. Japanese professional speedboat racing, run by the Japan Motor Boat Racing Association (JMBR), is one of the few sports in which men and women compete on almost equal footing, although the gender balance is skewed in favor of men. Since male racers outperform female racers on average, we can consider female racers as the disadvantaged group. This setting allows us to measure worker efforts that are comparable across workers by using detailed racing records and evaluate the effects of the AA policy on female workers' behavior with those measurements.

Our identification strategy relies on the unique nature of the JMBR's race assignment rule and their policy change regarding the minimum required body weight. Each time a racer participates in a race, the JMBR randomly assigns them to one of two types of races: single-sex races or mixed-sex races. Racers are not permitted to refuse the JMBR's assignment decision. In addition, the JMBR changed its policy regarding the minimum body weight imposed on male racers in November 2020 to maintain their health. After November 1, 2020, the minimum weight requirement for male racers increased from 51.0 kg to 52.0 kg, while the minimum requirement for female racers remained unchanged at 47.0 kg. Racers who fall below the minimum weight are penalized by being required to wear additional weight blocks to meet the standard.

We consider AA as the practice of reducing the intensity of competition female racers face, thereby increasing their chances of winning. The AA policy of our interest takes two forms in our empirical setup. The first is shifting from mixed-sex to single-sex races for female racers before the policy change, which is similar to a representative quota that reserves a proportional set of prizes for the disadvantaged group before the competition begins. Second, we argue that the JMBR's policy change that stipulates male racers weigh more than 52.0 kg after November 2020 can be thought of as an *unintended* AA policy in favor of female racers. Since heavier body weight crucially affects the boat speed, most racers maintain their weight just above the minimum requirement. We confirm this by showing the strong negative association between body weight and race performance and the bunching at the minimum body weight, which supports our underlying assumption that the new minimum weight policy has a significant downward impact on male racers' performance.

By exploiting the random race assignment and the policy change, we estimate the effect of AA policies by using the difference-in-differences approach. Our primary research question is how female racers' efforts change in response to AA (i.e., shifts in competitive intensity). Specifically, we examine how their effort level varies when shifting from single-sex to mixed-sex races before the policy change and how the policy affects their effort gap between single-sex and mixed-sex races.

To formalize our hypothesis, we present a simple conceptual framework based on the tournament theory. We consider a model where two agents with different effort cost parameters (ability) compete for a prize under the setup where the probability of winning the prize is a function of one's own and the opponent's effort level. The theory predicts that an agent tends to exert greater effort when competing against an opponent of comparable ability to secure a better reward. In contrast, if there is a large ability gap between her and the opponent, her effort decreases. In a nutshell, the theory implies that the individual effect of an AA policy depends on each female racer's position in the ability distribution.

Guided by our conceptual framework, in addition to estimating the average effect of AA policies, we also disentangle the effects by showing significant heterogeneity in female racers' abilities. We first estimate racers' ability by regressing racers' placing in each race on racer fixed effects, where the random race assignment and high-frequency observations provide accurate estimates. We use the estimated racer fixed effects as a proxy for racer ability and estimate potential heterogeneous effects by dividing the sample into the top one-third and bottom two-thirds of the ability distribution.

Using 175,358 female racer-race observations from January 2017 to December 2022, we find that the AA policy increased the effort exerted by female racers on average. Before the policy change, being assigned to a mixed-sex race reduced female racers' effort by approximately 0.144 units, equivalent to a 1 percent decrease relative to the sample mean effort. The introduction of the new minimum weight policy, which we interpret as an unintended affirmative action, mitigated this discouragement effect. The policy change increased female racers' effort in mixed-sex races by 0.278 units on average, representing a 2 percent increase relative to the mean. Notably, this positive effect of the policy change outweighs the initial discouragement effect of mixed-sex race assignments, leading to a net increase in female racers' efforts on average.

Consistent with our theory, we find significant heterogeneous effects across female racers of different ability levels. Subsample analyses reveal significant heterogeneity in the effects of AA based on racer ability. For middle- and low-ability female racers, being assigned to a mixed-sex race before the policy change reduced their effort by approximately 0.273 units (a 2 percent decrease). This suggests that competing against male racers in mixed-sex races discouraged middle- and low-ability female racers from exerting their maximum effort, presumably due to a perceived inability to compete effectively. After the policy change, their effort in mixed-sex races increased by 0.448 units, corresponding to a 3 percent increase relative to their baseline. This result supports our hypothesis that reducing competitive intensity for middle- and low-ability female racers in mixed-sex races can encourage greater effort. These findings highlight that AA policies are particularly effective in motivating middle- and low-ability participants.

In contrast, high-ability female racers exhibit a different pattern. Before the policy change, although the mixed-sex race assignment did not significantly affect their effort, it did increase their risk-taking behavior, suggesting that the competition for better prizes became more intense for them. However, the policy change had no significant effect on their effort levels and risk-taking behaviors. This is consistent with our theoretical framework, which predicts an individual will not change her effort level if the ability gap between her and her opponents remains unchanged after the implementation of AA.

Overall, our findings demonstrate that AA policies positively influenced the efforts of disadvantaged groups on average because middle- and low-ability racers account for a large proportion of disadvantaged groups. By alleviating the competitive intensity faced by middle- and low-ability female racers, the policy encouraged them to exert greater effort, leading to improved performance outcomes. These results underscore the potential for AA policies to reduce disparities in competitive environments and enhance the participation and motivation of underrepresented groups.

Our study contributes to various strands of literature. First, we contribute to the literature on the link between AA and effort exertion. The implementation of AA is typically accompanied by vigorous public debate, focusing on the possible incentive distortions they may generate. However, two studies (Cotton et al., 2020, 2022) that are most relevant to our research challenge this argument. Cotton et al. (2020) develops a theory predicting that AA increases the average effort among minority groups, and Cotton et al. (2022) conduct a field experiment in the middle-school examination context and report that their empirical results are consistent with the theoretical predictions of Cotton et al. (2020).

A recent study (Akhtari et al., 2024) finds that racial AA policies increase pre-college human capital investments among minority groups on average, particularly for high- and middle-ability students. Some earlier work on the link between AA and effort includes Schotter and Weigelt (1992) and Bracha et al. (2019) providing laboratory evidence of the positive effect of AA on effort and performance by disadvantaged agents. Calsamiglia et al. (2013) report that AA policies are beneficial in providing incentives to all participants in a field experiment where children competed in Sudoku puzzles. Bodoh-Creed and Hickman (2018) theoretically show that the effect of AA on effort depends on both the relative academic ability of students and their demographic group.

We contribute to this literature by adding a novel piece of evidence on the link between AA and effort that comes from a more professional setting outside schools. Our unique data from the Japanese speedboat racing allows us to understand how professional workers respond to AA policies and also measure their behavioral responses in a relatively objective manner, which is most of the time difficult in typical workplaces where individual effort is hard to measure. Our findings are consistent with the prior studies that have shown that AA policies have a positive impact on motivating disadvantaged groups to exert efforts, bolstering our understanding of AA and effort by providing external validity.

Second, we also more broadly contribute to the literature on AA in general. In the context of U.S. college admissions, race-based affirmative action has been a longstanding topic of discussion among economists (Arcidiacono et al., 2015). Additionally, the impact of gender quota systems on legislator diversity and legislative performance has been a prominent focus in recent research (Hessami and da Fonseca, 2020; Clayton, 2021). Our findings contribute to the literature by extending the evidence base for AA policies.

Third, we contribute to the literature on sports economics. Rather narrowly, our paper is part of a growing body of research that focuses on the Japanese speedboat racing. The Japanese speedboat racing has quite many features that are attractive to researchers since many conditions are randomized, providing various exogenous variations that serve as a source of identification (e.g., Booth and Yamamura (2018); Booth et al. (2022); Koizumi (2024)). More broadly, our study is relevant to the body of literature on racing, such as marathon, horse racing, and car racing (e.g., Emerson and Hill (2018); Binder et al. (2021); Rockerbie and Easton (2022)). We provide another use case of unique data coming from professional sports, which can provide a relatively tractable structure of production process and professional setup. This approach can be widely applied to answer important questions in applied economics that are however difficult to answer with conventional observational data.

Lastly, our findings are also relevant to the literature on the nexus of personnel and gender (e.g., Sato et al. (2019); Cullen and Perez-Truglia (2023); Okudaira et al. (2024); Wang et al. (2024)). Our study builds on this stream of literature by providing evidence from a professional, competitive setting where gender-neutral rules intersect with affirmative action measures, offering new insights into how such policies shape gender equity and performance outcomes in workplaces.

The remainder of this paper is organized as follows. Section 2 explains the institutional context of the Japanese speedboat racing and the policy change, Section 3 describes our data set, Section 4 provides the conceptual framework we use for our empirical analysis, Section 5 discusses our empirical strategy, Section 6 presents the estimation results, and Section 7 concludes.

2 Institutional Context

2.1 Japanese Speedboat Racing

In this section, we briefly explain the institutional context regarding the Japanese speedboat racing. The explanation here is kept minimal but sufficient to understand our empirical strategy and results. Readers who are interested in more details should refer to Booth and Yamamura (2018), who provide a more comprehensive exposition of Japanese speedboat racing.

In Japan, speedboat racing is a unique competitive sport where male and female participants race under identical conditions. Governed by the JMBR in a centralized manner, the sport ensures a high level of equality, with men and women receiving the same rigorous training and competing on equal terms. All racers must pass through a single training institution, Yamato Boat School, where they undergo intensive training for one year before qualifying to race professionally. This institution admits applicants from diverse backgrounds, making speedboat racing accessible to a wide demographic within Japan.

Races are held in artificial pools or designated water areas that measure approximately 600 meters in length. Racers must complete three laps around this circuit, totaling an 1,800-meter race distance. A tournament usually consists of 4-6 racing meets. Each racing meet typically includes twelve races. Each race has six participants. Racers are assigned to either single-sex or mixed-sex races randomly before race day. The conditions for all participants are standardized to ensure fairness—boats and engines are assigned by lottery, and racers are responsible for maintaining their assigned equipment without external assistance.

A unique aspect of Japanese speedboat racing is the “premature start” system, where competitors must cross the starting line within a precise one-second window after the countdown reaches zero. A boat can take advantage by passing the starting line ahead of all the others. However, if a boat crosses the line too early before the needle on the giant clock hits 0, it’s called a “flying start”. If it crosses too late after the needle hits 1, it’s called a “late start”. In either case, the boat is scratched from the race. Starting positions, or “pits,” are predetermined, but racers can strategically change lanes to secure better positioning, adding an element of skillful maneuvering to the competition. However, any actions that interfere with another racer’s trajectory can result in disqualification or penalties. This rule ensures a balance between competitive strategy and adherence to race guidelines. For an intuitive understanding of the start process, please refer to Figure A1 and Figure A2.

Speedboat races vary by grade, with top-tier races offering significant financial rewards and attracting highly skilled racers. Prize money for high-ranking competitions, such as the Super Grade (SG) races, can reach hundreds of thousands of dollars. Racers accumulate points based on their performance across seasons, which influences their eligibility for higher-grade events and their annual earnings. This structured system encourages racers to balance competitive tactics with disciplined adherence to the rules to avoid costly penalties that could affect their ranking and income.

2.2 Minimum Weight Requirement Change

The JMBR revised its weight regulation for racers in November 2020. Prior to this change, male racers were required to weigh a minimum of 51.0 kilograms, while female racers had a minimum weight requirement of 47.0 kilograms. The purpose of this regulation was to safeguard racers’ health by discouraging excessive weight loss, as lighter weight can improve speed and thus creates an incentive for racers to reduce their body weight. To prevent underweight conditions, the JMBR imposed a rule requiring racers below the minimum weight to add additional weight blocks until their total weight met the requirement, with each block weighing 500 grams.

With the November 2020 policy change, the minimum weight requirement for male racers was increased to 52.0 kilograms, while the requirement for female racers remained unchanged. According to the JMBR, the goal of this adjustment was to better protect male racers' health by addressing the growing disparity between the minimum weight standard and the average weights of male racers and the general male population in Japan. The penalty for failing to meet the weight requirement remained the same as before the policy change.

Because this new regulation applied exclusively to male racers, we argue that it can be seen as an *unintended* affirmative action, inadvertently providing a relative advantage to female racers in mixed-sex competitions. Further discussion on this interpretation is provided in Section 5.3.

3 Data

3.1 Data and Sample

Our data are individual records for the period January 1, 2017, to December 31, 2022, from "Japanese Boat Race Official Website."[1] The dataset contains a rich set of variables, including detailed records of each race and the characteristics of participants. Each observation in the dataset corresponds to a unique combination of racer, date, stadium, and race event. Key elements of race information include the date, sequence number of the tournament day, race number within each meet, stadium location, type of entry (fixed or random), and environmental conditions such as weather, wave patterns, and wind levels.

For each race, racer-specific performance data is recorded, including their finishing position, starting position, entry place, start time, and total time taken. Additionally, essential background information on each racer is captured. This includes unique identifiers (racer ID), age, weight, ranking, and regional affiliation within the speedboat racing association (referred to as *shibu*). Detailed equipment data—such as boat and motor IDs and the likelihood of each boat and motor winning—is also available in the dataset.

We focus on the female racers who began competing before January 1, 2017, and continued racing through to December 31, 2022. Namely, we excluded those who retired during that period. This selection allows for an analysis of these racers' performance data both

[1] Available at https://www.boatrace.jp/owpc/pc/extra/data/index.html.

before and after specific policy changes within the sport.[2]

3.2 Summary Statistics

Table 1 presents summary statistics for all racers during our observation period, as well as separately for male and female racers. Female racers only account for approximately 10 percent of the total number of racers. Male racers have smaller race placements and entry placements on average compared to female racers. They also have shorter starting times and total race times, and are less likely to have invalid starts than female racers. Besides, male racers have higher racer ranks than their female counterparts. These facts preliminarily show that female racers underperform relative to male racers and can be considered the disadvantaged group.

4 Conceptual Framework

We provide a simple conceptual framework to formalize our hypothesis. Building on the framework presented by Cotton et al. (2015), we consider a model in which two agents compete. The agents are indexed $i \in \{1, 2\}$ and compete for two distinct rewards, W_H and W_L, with $W_H > W_L > 0$. Each agent chooses a level of effort, $e_i \geq 0$, which incurs a cost and influences their probability of securing the higher prize, W_H.

Let $c_i(e_i) = \theta_i e_i$ be the effort cost function, where $\theta_i \in (0, \bar{\theta}]$ with $\bar{\theta} > 0$ represents agent i's ability. Note that a lower θ indicates a higher ability because the agent can achieve a given effort level at a lower cost. We assume θ_1 and θ_2 are both publicly known. The agent's payoff, u_i, is the reward less the effort cost, i.e., $u_i = W_i - \theta_i e_i$. Each agent's probability of winning the higher prize W_H is assumed to be proportional to their chosen effort level relative to that of the opponent. Specifically, the probability of agent i winning W_H is given by $e_i / \sum_{j=1}^{2} e_j$ if $e_i > 0$ and 0 when $e_i = 0$. This setup captures the strategic interplay between effort costs and probabilities in a competitive environment, where the agents must balance the potential reward against the cost of effort.

Agent i chooses e_i to maximize her expected payoff

$$\mathsf{E}[u_i] = \frac{e_i}{e_i + e_j} W_H + \frac{e_j}{e_i + e_j} W_L - \theta_i e_i. \tag{1}$$

[2] In unreported analyses, we conduct regressions using the entire sample, and the results remain qualitatively unchanged.

The first-order condition for this maximization problem is

$$\frac{e_j}{(e_i+e_j)^2}(W_H - W_L) - \theta_i = 0. \tag{2}$$

The equilibrium solution is obtained by solving the system of two equations for $\{e_1, e_2\}$, where each agent's effort maximizes her own expected payoff conditional on the equilibrium effort of the other agent.[3] Therefore, the equilibrium effort level e_i^* is given by

$$e_i^* = \frac{\theta_j}{(\theta_i+\theta_j)^2}(W_H - W_L). \tag{3}$$

It is easy to see

$$\frac{\partial e_i^*}{\partial \theta_j} = \frac{\theta_i - \theta_j}{(\theta_i+\theta_j)^3}(W_H - W_L). \tag{4}$$

Observe that the sign of the derivative solely depends on $\theta_i - \theta_j$. It can be seen that e_i^* is increasing in θ_j if $\theta_j \in (0, \theta_i)$ while it is decreasing in θ_j when $\theta_j \in (\theta_i, \bar{\theta}]$. Equation (4) also implies that e_i^* is maximized with respect to θ_j when $\theta_j = \theta_i$.[4] We summarize these results as the following prediction:

Prediction 1 *When an agent competes against an opponent of similar ability, she will exert more effort to win a better prize. When there is a significant difference in ability between her and her opponent, she will put in less effort.*

We consider AA to be a practice that reduces the competitive intensity for disadvantaged individuals. That is, AA can handicaps the ability θ_j of the opponent faced by an agent from the disadvantaged group with fixed ability θ_i. Before the implementation of AA, an agent with θ_i competes against an opponent with θ_j. As larger θ induces higher cost for a given effort level, the implementation of AA results in an agent with θ_i competing against an opponent with θ_j^{AA}, where $\theta_j^{AA} > \theta_j$.

Given θ_i, W_H and W_L, if $\theta_j \in (\theta_i, \bar{\theta}]$, then $e_i^*(\theta_j) > e_i^*(\theta_j^{AA})$. This can be easily derived from the fact that $e_i^*(\theta_j)$ is a decreasing function over the interval $(\theta_i, \bar{\theta}]$ and that $\theta_j^{AA} > \theta_j$. So we have the following prediction:

Prediction 2 *If an agent from a disadvantaged group competes against an opponent weaker than her before AA, then the implementation of AA will reduce her effort because she faces less intense competition for the better prize under AA.*

[3] A check of the second order conditions ensures that this achieves a maximum.

[4] The second-order condition is satisfied.

Given θ_i, W_H and W_L, if $\theta_j \in (0, \theta_i)$, there are three cases. First, if $\theta_j^{AA} = \frac{\theta_i^2}{\theta_j}$, then $e_i^*(\theta_j) = e_i^*(\theta_j^{AA})$. Second, when $\theta_j^{AA} \in (\theta_j, \frac{\theta_i^2}{\theta_j})$, $e_i^*(\theta_j) < e_i^*(\theta_j^{AA})$. Finally, when $\theta_j^{AA} \in (\frac{\theta_i^2}{\theta_j}, \bar{\theta})$, $e_i^*(\theta_j) > e_i^*(\theta_j^{AA})$. This is due to the fact that $e_i^*(\theta_j) = e_i^*(\frac{\theta_i^2}{\theta_j})$ and e_i^* first increases on (θ_j, θ_i) and decreases on $(\theta_i, \frac{\theta_i^2}{\theta_j})$. So we have the following prediction:

Prediction 3 *If an agent from a disadvantaged group competes against an opponent who is much stronger than her before AA, then the implementation of AA will increase her effort because the better prize is not perceived to be out of reach under AA. If she competes against an opponent slightly stronger than her before AA, then the introduction of AA may reduce or not affect her effort because the ability gap between her and her opponent becomes larger or remains the same under AA.*

5 Empirical Strategy

In this section, we outline our empirical strategy used to evaluate the impact of AA policies on female racers' effort exertion in Japanese professional speedboat racing. The JMBR's random race assignment rule and policy change which raised the minimum weight requirement for male racers but left female requirements unchanged, provides a natural experiment to examine how changes in the competition intensity influence female racers' behavior. We begin by verifying the hypothesis that female racers can be interpreted as a disadvantaged group in Japanese speedboat racing and then explain our identification strategy.

5.1 Measuring Racer Ability

To measure racer ability, we estimate racers' time-invariant ability using the following specification:

$$Placing_{itsr} = \alpha_i + X'_{itsr}\beta + \varepsilon_{itsr}, \tag{5}$$

where $Placing_{itsr}$ is the place-in-race of racer i on date t at stadium s in race r. Note that (i, t, s, r) uniquely identifies every element in the universe of individual racing records. We regress placing on racer individual fixed effects (α_i), along with a vector of controls (X_{itsr}). The set of controls includes the number of races a racer participated in prior to a given race, as well as the quality of the boat and motor randomly assigned by the JMBA for that race. In estimation, we only use the observations before the JMBR's regulation change.

Since the assignment to races is randomized, and other components of races are also randomized and explicitly controlled in the estimation, we argue that our estimates of racer ability ($\hat{\alpha}_i$) cleanly capture the innate ability without soaking up variation from luck, experience and the regulation change. As a smaller placement means better performance, a smaller $\hat{\alpha}_i$ indicates a stronger ability.

One potential concern is that placing is a relative outcome. A racer's finishing position depends not only on their own ability but also on the ability of the other racers in the same race. Even racers of identical underlying ability may obtain different placings depending on whom they compete against. Although this relativity might appear to confound our estimates of racer ability, it does not. As long as all racers belong to the same connected set in the AKM sense, the racer fixed effects are identified on a common scale and therefore recover time-invariant racer abilities that are comparable across racers (Abowd et al., 1999; Abowd et al., 2002).

To illustrate the role of connectedness, consider a simple example with two races and twelve racers. Suppose racers can be ranked by ability, and the top six are assigned to one race (the "high-tier" race) while the bottom six are assigned to another (the "low-tier" race). Because no racer appears in both races, the two groups form separate connected components in the AKM sense. As a result, the fixed effects are only identified up to separate additive constants in each component and are therefore comparable within each race but not across races.

Now add a third race in which one high-tier racer competes alongside five low-tier racers. In expectation, the high-tier racer will finish first in this mixed race, revealing the ranking between the two previously disconnected tiers. This single linking race merges the two components into a single connected set. Once the data are connected, the fixed effects for all racers lie on a common scale, making them comparable across all individuals. In our empirical setting, the racing network is fully connected in this sense.

5.2 Switching between Single-Sex and Mixed-Sex Races as AA

Figure 1 shows the distributions of racer ability in our sample. As can be seen from Figure 1, male ability stochastically dominates female ability in the first-order sense. Namely, we have $F_m(\hat{\alpha}) \leq F_f(\hat{\alpha}), \forall \hat{\alpha}$, where F_m and F_f represent the distributions for male and female, respectively. This result validates our assumption that female racers can be considered as the disadvantaged group and male racers the advantaged group in the affirmative-action context.

Figure 1 also indicates that male ability has the first-order stochastic dominance over pooled ability and that the pooled ability has the first-order stochastic dominance over female ability, where the pooled distribution is the density estimated using both male and female racers. Formally, we have $F_m(\hat{\alpha}) \leq F_p(\hat{\alpha}) \leq F_f(\hat{\alpha}), \forall \hat{\alpha}$, where F_p denotes the pooled distribution. Note that holding a racer's own ability fixed and shifting the distribution to the left would result in more competitive opponents that the racer would face. The random assignment to races implies that male racers draw their opponents from F_m in single-sex and F_p in mixed-sex races. Likewise, female racers draw their opponents from F_f in single-sex and F_m in mixed-sex races. When they switch to single-sex races, the competitive intensity becomes less intense as they face less competitive opponents. Therefore, shifts from mixed-sex to single-sex races can be regarded as an affirmation action for female racers. However, as discussed in the next subsection, with female racers in mixed-gender races as the treatment group, our econometric model actually estimates the effect of shifts to mixed-gender races on female racers' behaviors. Consequently, the results can be interpreted as an inverse effect of the affirmative action.

5.3 Increased Minimum Weight as AA

We hypothesize that the JMBR's regulation change regarding the minimum weight requirement can be considered as an unintended affirmative action in favor of female racers and affect the behavior of female racers in mixed-sex races. Figure 2 presents racers' weight distributions before and after the regulation change. The left panel of Figure 2 shows that a nontrivial portion of male racers increased their weight due to the regulation change. In contrast, we do not observe any significant changes in the female weight distribution as can be seen in the right panel of the figure.

We interpret this shift in male racers' weights as a worsening of the male racer ability distribution in the sense of first-order stochastic dominance. That is, $F_m(\hat{\alpha}) \leq F_m^{AA}(\hat{\alpha}), \forall \hat{\alpha}$. Since $F_p(\hat{\alpha}) = \frac{N_m F_m(\hat{\alpha}) + N_f F_f(\hat{\alpha})}{N_m + N_f}$, where N_m and N_f denote the number of unique male and female racers, respectively, it is easy to see that $F_p(\hat{\alpha}) \leq F_p^{AA}(\hat{\alpha}), \forall \hat{\alpha}$. This means that after the regulation change, female racers draw their opponents from F_m in single-sex races and F_p^{AA} in mixed-sex races. Namely, female racers face a lower competitive intensity in mixed-sex races after the regulation change than in mixed-sex races before that.

In speedboat racing, it is common knowledge that a higher weight results in worse performance. We confirm this perception by correlating our performance and effort measurements with body weight. Table 2 shows the results from OLS regressions of performance and effort measures on racer body weight. Consistent with the common perception, higher body weight is significantly associated with worse performance. These results support our argument that the minimum body weight policy change functioned as if it handicapped male racers and that it can be interpreted as an unintended affirmative action.

Following the minimum body weight policy change, the competitive environment for female racers shifted in mixed-sex races, where the intensity of competition decreased compared to the period before the new policy was implemented. In contrast, competitive intensity for female racers in single-sex races remained relatively stable before and after the policy change. For this analysis, female racers participating in mixed-sex races are considered the treatment group, while those competing in single-sex races serve as the control group.

5.4 Measuring Racer Effort

We use start time as a proxy for racers' effort. Measured in centiseconds, start time reflects the initial reaction and intensity with which a racer begins the race. A lower start time indicates a faster reaction and thus a higher exertion of effort at the race's outset. By examining variations in start time, we can assess the level of effort racers put forth under different competitive conditions, such as mixed-sex and single-sex races, and how this effort may change in response to the policy shift.

Start time is also advantageous as it remains relatively independent of other racers' actions. For example, race placements depend not only on a racer's own effort but also on the efforts of other participants. Since the policy change may have influenced male racers' performance as well, isolating the effect of affirmative action on female racers' effort from its effect on male racers would be challenging with placement data alone. Additionally, placements are a relative measure, which may fail to capture the policy's impact if it uniformly increased effort or performance levels across all racers. Conversely, start time is an absolute measure, allowing us to make direct comparisons before and after the policy change. This helps to better isolate the policy's impact on racers' individual effort.

Besides, start time can predict race outcomes as well. As shown in Table 3, start time is positively correlated with race placement and total race time. One might also consider using total race time as a measure of effort since it serves as a place-order index and directly reflects the effort made during the race. However, the total race time is missing for racers in 5th and 6th place, which can cause a sample selection problem, as low-ability racers are automatically eliminated in the analysis. In contrast, the start time is recorded for all racers, including those finishing races in 5th and 6th places. Therefore, we choose start time as a proxy for effort.

5.5 Effects of AA Policies

We estimate the effects of the unintended affirmative action by using a difference-in-differences (DID) framework. One thing to note is that our setting is slightly different from the standard

DID context in the sense that racers switch between the treatment and control groups after the policy change. We estimate the following regression model:

$$Y_{itsr} = \tau_1 \, (\textit{Mixed Sex})_{itsr} + \tau_2 \, (\textit{Mixed Sex})_{itsr} \times \textit{Post}_t + \mathbf{Z}_{itsr}^{\top}\beta + \delta_i + \sigma_t + \varepsilon_{itsr}. \quad (6)$$

The dependent variable Y_{itsr} is our effort measure for each racer, calculated as start time, where start time is recorded in centiseconds (with 100 centiseconds equal to 1 second). A smaller value of Y_{itsr} indicates greater effort, as a faster start time implies a more intense exertion at the beginning of the race.

The model includes an indicator variable $(\textit{Mixed Sex})_{itsr}$, which is set to 1 if the racer is in a mixed-sex race and 0 if the racer is in a single-sex race. Since the policy only affects male weight, female racers' behavior should not change in single-sex races before and after the policy change. Female racers in single-sex races are considered as the control group. Another indicator variable, $\textit{Post}_t$, is equal to 1 for dates after November 1, 2020, to capture the period following the policy change. The interaction term $(\textit{Mixed Sex})_{itsr} \times \textit{Post}_t$ helps to isolate the effect of being in a mixed-sex race after the policy was implemented, allowing the model to assess changes in effort levels specific to this environment.

We also control individual racer characteristics and race-level attributes. δ_i represents fixed effects for each racer to control for unobserved characteristics that are constant over time. σ_t denotes time fixed effects, capturing variations across years, months, days, and specific dates to account for temporal influences on effort levels.

Additionally, the regression includes a vector $\mathbf{Z}_{itsr}$ of control variables, which captures both racer-level and race-level characteristics. Racer-level (and racer-race level) controls include variables such as the initial starting position (pit), entry position, racer rank, regional affiliation (Shibu), boat number, motor number, and respective win probabilities for the boat and motor. Race-level controls cover information such as the stadium, race number, day number, entry type (whether fixed or random), and environmental factors like weather conditions, wave levels, and wind intensity. These controls are essential to isolate the effect of mixed-sex participation on effort by accounting for factors that could otherwise confound the results.

The least square estimators $\hat{\tau}_1$ and $\hat{\tau}_2$ are unbiased due to the random assignment and the nature of the policy intervention. Here, $\hat{\tau}_1$ captures the change in effort for female racers when they switch from single-sex to mixed-sex races prior to the policy change. On the other hand, $\hat{\tau}_2$ represents the impact of the policy change itself, effectively measuring the difference in effort levels between mixed-sex and single-sex races after the policy was implemented, relative to the period before the change. This distinction helps in isolating the effects of both race composition and the policy intervention on female racers' incentives to exert effort.

Our identification strategy relies on the following three assumptions: (i) racers are randomly assigned to mixed-sex and single-sex races; (ii) there are no intertemporal effort effects that spillover from mixed-sex races to single-sex races, and vice versa; (iii) the policy change does not affect female racers' behavior in single-sex races.

According to the race assignment rule, JMBR randomly assigns racers to either mixed-sex or single-sex races. We empirically test this by examining whether a racer's ability is orthogonal to the assignment of these two race types. Specifically, we regress a dummy variable, which equals to one if the current assignment is a mixed-sex race and zero otherwise, on the racer's estimated ability and the same set of control variables used in equation (6). The results, reported in Table 4, fail to reject the null hypothesis of zero correlation, thereby confirming the random nature of the assignment.

The second assumption is that there are no intertemporal spillovers between mixed-sex and single-sex races. If racers allocate effort intertemporally across races, our identifying assumption would be dubious because participation in one type of race could influence behaviors in the other. For example, participation in races on the previous day may cause fatigue or facilitate learning from competing against other racers, which could subsequently reduce or increase effort in races held immediately thereafter. In such cases, comparisons between mixed-sex and single-sex races could either overstate or understate the true effort exerted in current races, as behavior in one setting would be influenced by prior exposure to the other. Since speedboat racing is less physically demanding than sports such as track and field, and the interval between the last race and the next for a given racer is typically long enough, racers are likely able to recover from physical fatigue before the start of the next race. However, we cannot completely rule out the possibility of a learning effect. Therefore, we test whether racer i's effort on a given race day is influenced by participation in a mixed- or single-sex race on the previous race day. Specifically, we run the regression of effort separately for the mixed-sex and single-sex race samples on a categorical variable indicating whether the racer participated in a mixed-sex race on the previous day, a single-sex race on the previous day, or did not participate in any race on the previous day (the reference group). The results, presented in Table 5, indicate that effort exertion is not affected by spillovers between mixed-sex and single-sex races.

Our last assumption is that female racers' behavior in single-sex races does not change in response to the policy. If some female racers reduce their weight after the policy to gain an advantage in mixed-sex races and subsequently maintain that lower weight, the control group may be contaminated. We observe a slight leftward shift in the female weight distribution after the policy, as shown in Figure 2. We then test whether this difference implies stochastic dominance using the Wilcoxon rank-sum test. The Somers'd statistic is -0.95, indicating that the post-policy female weight distribution does not stochastically dominate the pre-policy distribution. In addition, we regress female weight on the the indicator variable, $Post_t$, which equals to one after the policy implementation. The results, reported in Column (1) of Table 6, indicate no significant association between female weight and the policy change. Furthermore, we regress female racers' effort in single-sex races on $Post_t$. The results, presented in Column (2) of Table 6, suggest no significant change in female racers' behavior before and after the policy implementation.

Finally, to test the model's prediction that the effect varies by ability level, we divide our sample into two distinct groups: female racers who rank in the top third of the pooled ability distribution and those in the remaining two-thirds. This subsample analysis allows us to assess whether the impact differs between higher- and lower-ability racers. We then estimate equation (6) separately for each subsample to determine if the effect is indeed heterogeneous across different levels of racer ability.[5]

6 Results

6.1 Estimation results

Table 7 presents the estimation results of equation (6). Recall that the assignment to single- or mixed-sex races is random and that the policy is an exogenous shock, which allows us to identify the causal effects of mixed-sex race assignment and the policy change even in the most parsimonious specification as in column (1) of Table 7. Across the four specifications in Table 7, assignment to a mixed-sex race discourages female racers from exerting effort. The effect of the unintended affirmative action policy is also significantly positive across the four specifications, which inductees that affirmative action mitigates the discouragement effect of the mixed-sex assignment and that female racers exert more effort. Based on the estimates in column (4) of Table 7, the effect of mixed-sex race assignment and the affirmative action policy are equivalent to approximately a 1 and 2 percent increase and decrease from the average start time in our sample as the baseline, respectively.

Table 8 shows the estimation results from the subsample analysis. Columns (1) to (4) present the estimates for the subsample of high-ability female racers, and columns (5) to (8) lower- and middle-ability female racers. For middle- and low-ability female racers, shifting from single-sex to mixed-sex races before the policy change decreases their effort, whereas the

[5]The results of male racers are reported in the Appendix C for readers' reference.

policy change mitigates this discouragement effect. However, for high-ability female racers, shifting from single-sex to mixed-sex races does not affect their effort, nor does the policy change influence the effort gap between single-sex and mixed-sex races.

We also examine the effect of the affirmative action policy on risk-taking behavior. We follow Booth et al. (2022) in using flying as a measure of risk-taking. A flying start will cause the boat to be scratched from the race. Racers can gain an advantage by crossing the starting line ahead of others, so they exert effort to pass the starting line as close to zero seconds as possible. However, doing so may increase the likelihood of a flying start and disqualification. Disqualification is very costly because it reduces both aggregated points and the likelihood of advancing to a higher grade with greater earning potential. Thus, a flying start can be interpreted as the outcome of taking a risk in an attempt to shorten start time. Table 9 reports the results. Column (2) shows that high-ability female racers take more risks when switching from single-sex to mixed-sex races before the policy change. However, the policy change does not affect their risk-taking behavior.

6.2 Robustness checks

To validate the robustness of our results, we first control for the average ability of opponents. The pre-run tactics may get tougher as opponents are more skillful, which could lead to slower start times and a higher likelihood of false starts. Consequently, our baseline results may be overestimated. To address this concern, we additionally control for the average ability of opponents in the same race in our regressions. The results are reported in Table B1 Although the magnitudes of the coefficients on Start time and Flying start become slightly smaller compared with those in Table 7, 8, 9.

Second, we utilize pre-policy change data to estimate the impact of transitioning from single-sex to mixed-sex races on racers' incentives to exert effort. Given that racers are randomly assigned to single-sex and mixed-sex races, the estimated coefficient represents the difference in outcome variables between the control and treatment groups in a randomized controlled trial (RCT). Table B2 shows the results. The main results do not change significantly when we restrict the sample to the period before the policy change.

Third, we apply different ability cutoffs. Specifically, we define high-ability female racers as those who rank in the top one-fourth, top one-fifth, and top one-tenth of the pooled ability distribution; while middle- and low-ability female racers are those who rank in the bottom three-fourths, bottom four-fifths, and bottom nine-tenths of the distribution. Table B3 and Table B4 present the results, and we find that the main findings remain largely unchanged.

Fourth, we consider an alternative measure of ability. In the main regression, ability is measured by estimated racer fixed effects, which are time-invariant. In this robust test, we employ a time-varying winning probability, defined as the probability of winning first place before participating in the current race. Table B5 and Table B6 show the results including different cutoffs for this ability measure. Our main results are qualitatively unchanged when utilizing the alternative time-variant ability measure.

Finally, we apply the quantile regression to test our main results. Table B7 reports the results, indicating that our results remain robust under an alternative specification.[6]

6.3 Interpretation

The competition becomes more intense for female racers when they shift from single-sex to mixed-sex races before the policy change, as they face a higher number of high-ability opponents. Female racers respond differently to this shift depending on their ability level. High-ability female racers are more likely to face racers with similar abilities in mixed-sex races, so they will exert more effort to win better prizes, as outlined in Prediction 1. Consistent with the prediction, we find that high-ability female racers take more risks to reduce their start time when switching to mixed-sex races. The increased competition for better prizes in mixed-sex races leads them to exert greater effort to secure a win.

In contrast, middle- and low-ability female racers tend to reduce their effort when shifting to mixed-sex races, as they perceive the top prizes to be out of reach, which diminishes their incentive to compete as intensely. This is also aligned with our Prediction 1: the ability gap between middle- and low-ability female racers and their opponents tends to be larger in mixed-sex races, thereby disincentivizing them from exerting effort.

The policy change on male minimum weight puts male racers at a disadvantage, as increased weight is typically associated with longer race times and lower rankings, as shown in Table 2. This change particularly worsens the performance of high-ability male racers because higher ability is typically associated with lower body weight, as indicated in Table 10. For middle- and low-ability female racers, this policy reduces the competitive intensity they face in mixed-sex races after the policy shift compared to before. Consistent with Prediction 3, we find that the policy change alleviates the discouragement effect when they shift to mixed-sex races, as they are now closer to competing for better prizes, thereby increasing their motivation.

However, we do not observe a significant effect of the policy change on high-ability female racers. This may be because, prior to the policy change, high-ability male racers generally had a greater ability than high-ability female racers, as seen in the left tail of the male

[6] We do not report the results on risk-taking behavior because quantile regression is not applied to discrete variables.

ability distribution in Figure 1. We suspect that the ability of high-ability male racers, which previously exceeded that of high-ability female racers, may now be only slightly lower after the weight increase. As a result, the ability gap between high-ability female and male racers in mixed-sex races may not have changed significantly after the policy change, explaining the null effects of the new policy on their effort, which is consistent with Prediction 3.

On average, we find that the shift from single-sex to mixed-sex races results in an overall decrease in effort among female racers, while the policy change leads to an overall increase in effort among female racers. This is because middle- and low-ability racers make up a large proportion of the disadvantaged group.

7 Conclusion

In this paper, we have investigated the effects of affirmative action policies within Japanese professional speedboat racing, where male and female racers compete on relatively equal terms. The Japanese Speedboat Racing Association's random race assignment rule and policy change which increased the minimum weight requirement for male racers, created a unique opportunity to examine how a shift in competitive conditions can impact racer behavior, particularly for female participants.

Our analysis has provided several important findings. First, we have shown that the transition from single-sex to mixed-sex races generally reduced the effort exerted by both male and lower-ability female racers, while higher-ability female racers maintained their effort levels but increased their risk-taking behaviors. This suggests that mixed-sex competition can have discouraging effects on female racers' effort levels, particularly for individuals who may perceive themselves as being at a competitive disadvantage.

Most importantly, the new minimum body weight policy, which we interpreted as an unintended affirmative action, mitigated this discouragement effect for middle- and low-ability female racers, suggesting that the increased weight requirement for male racers reduced the competitive intensity in mixed-sex races. As a result, female racers in these ability groups exerted greater effort, suggesting that affirmative action policies can be effective in encouraging effort exertion from disadvantaged groups. Our findings contribute to the broader literature on gender differences in competitive environments and also the literature on affirmative action in general.

Overall, our study provides empirical support for the idea that affirmative action policies can positively influence the incentives of female participants in competitive settings. By reducing disadvantages and encouraging effort, such policies may help to foster more equitable outcomes and promote sustained engagement among participants. Future research could explore the long-term impacts of such policies on career trajectories and overall success within competitive fields, as well as investigate whether similar effects are observed in other domains beyond professional sports.

The implications of our findings extend beyond our setting to public policy, schooling, and organizations. For policymakers, the results highlight the importance of designing interventions that account for heterogeneity in ability and that recognize how even subtle, non-salient changes to competition structures can shift incentives. For schools and firms, the results imply that structuring evaluation, admission, tracking, or promotion systems in ways that grant preferential treatment to disadvantaged individuals can, on average, enhance their motivation, particularly among mid- and low-tier participants who might otherwise disengage. Of course, designing such systems is challenging, and it requires careful effort to identify approaches that preserve fairness while also encouraging motivation.

As is typical of studies that exploit the structure of professional sports, our analysis is subject to concerns about external validity. This study shows that AA can increase incentives for disadvantaged individuals to exert effort. However, our setting—professional speedboat racing—is a highly competitive environment characterized by relative evaluation and individual performance. This could limit the generalizability of our findings, particularly in settings where performance is evaluated absolutely or where success depends on teamwork and coordination. Nevertheless, many important real-world situations, such as college admissions, recruitment, promotions under quota systems, and the allocation of scholarships or research grants, also involve relative evaluation and individual competition. Therefore, our findings may be generalizable to such contexts. Further research examining how AA influences behavior and efficiency in team-based or absolute-performance contexts would be valuable.

References

Abdulkadiroğlu, A. and Sönmez, T. (2003). School choice: A mechanism design approach. *American Economic Review*, 93(3):729–747.

Abowd, J. M., Creecy, R. H., and Kramarz, F. (2002). Computing person and firm effects using linked longitudinal employer-employee data. Technical report, Center for Economic Studies, US Census Bureau.

Abowd, J. M., Kramarz, F., and Margolis, D. N. (1999). High wage workers and high wage firms. *Econometrica*, 67(2):251–333.

Ahern, K. R. and Dittmar, A. K. (2012). The changing of the boards: The impact on firm valuation of mandated female board representation. *Quarterly Journal of Economics*, 127(1):137–197.

Akhtari, M., Bau, N., and Laliberté, J.-W. (2024). Affirmative Action and Precollege Human Capital. *American Economic Journal: Applied Economics*, 16(1):1–32.

Arcidiacono, P. (2005). Affirmative Action in Higher Education: How Do Admission and Financial Aid Rules Affect Future Earnings? *Econometrica*, 73(5):1477–1524.

Arcidiacono, P., Lovenheim, M., and Zhu, M. (2015). Affirmative action in undergraduate education. *Annual Review of Economics*, 7(1):487–518.

Bertrand, M., Black, S. E., Jensen, S., and Lleras-Muney, A. (2019). Breaking the glass ceiling? the effect of board quotas on female labour market outcomes in norway. *Review of Economic Studies*, 86(1):191–239.

Binder, A. D., Grimes, P. W., and Winterbotham, R. G. (2021). In the money: Gender and jockey success on the thoroughbred racetrack. *Journal of Sports Economics*, 22(3):295–328.

Bodoh-Creed, A. L. and Hickman, B. R. (2018). College assignment as a large contest. *Journal of Economic Theory*, 175:88–126.

Booth, A., Hayashi, R., and Yamamura, E. (2022). Gender differences in tournament-performance over time in single-sex and mixed-sex environments. *Labour Economics*, 76:102173.

Booth, A. and Yamamura, E. (2018). Performance in Mixed-Sex and Single-Sex Competitions: What We Can Learn from Speedboat Races in Japan. *Review of Economics and Statistics*, 100(4):581–593.

Bowen, W. G., Bok, D., Shulman, J. L., Nygren, T. I., Dale, S. B., and Meserve, L. A. (1998). *The Shape of the River: Long-Term Consequences of Considering Race in College and University Admissions*. Princeton University Press, rev - revised edition.

Bracha, A., Cohen, A., and Conell-Price, L. (2019). The heterogeneous effect of affirmative action on performance. *Journal of Economic Behavior & Organization*, 158:173–218.

Calsamiglia, C., Franke, J., and Rey-Biel, P. (2013). The incentive effects of affirmative action in a real-effort tournament. *Journal of Public Economics*, 98:15–31.

Clayton, A. (2021). How do electoral gender quotas affect policy? *Annual Review of Political Science*, 24(1):235–252.

Cotton, C., Hickman, B. R., and Price, J. P. (2020). Affirmative action, shifting competition, and human capital accumulation: A comparative static analysis of investment contests. *QED Working Paper no. 1433, Department of Economics, Queen's University, Ontario.*

Cotton, C., Hickman, B. R., and Price, J. P. (2022). Affirmative Action and Human Capital Investment: Evidence from a Randomized Field Experiment. *Journal of Labor Economics*,

40(1):157–185.
Cotton, C., Li, C., McIntyre, F., and Price, J. P. (2015). Which explanations for gender differences in competition are consistent with a simple theoretical model? *Journal of Behavioral and Experimental Economics*, 59:56–67.
Cullen, Z. and Perez-Truglia, R. (2023). The Old Boys Club: Schmoozing and the Gender Gap. *American Economic Review*, 113(7):1703–40.
Emerson, J. and Hill, B. (2018). Peer effects in marathon racing: The role of pace setters. *Labour Economics*, 52:74–82.
Hessami, Z. and da Fonseca, M. L. (2020). Female political representation and substantive effects on policies: A literature review. *European Journal of Political Economy*, 63:101896.
Hinrichs, P. (2012). The Effects of Affirmative Action Bans on College Enrollment, Educational Attainment, and the Demographic Composition of Universities. *The Review of Economics and Statistics*, 94(3):712–722.
Hinrichs, P. (2020). Affirmative Action and Racial Segregation. *The Journal of Law and Economics*, 63(2):239–267.
Koizumi, H. (2024). How much of merit is due to luck? evidence on the butterfly effect of luck. Working paper, Research Institute of Economy, Trade and Industry (RIETI).
Matsa, D. A. and Miller, A. R. (2013). A female style in corporate leadership? evidence from quotas. *American Economic Journal: Applied Economics*, 5(3):136–169.
Okudaira, H., Kitagawa, R., Aizawa, T., Kuroa, S., and Owan, H. (2024). Middle managers and employee health. Working paper, Research Institute of Economy, Trade and Industry (RIETI).
Rockerbie, D. W. and Easton, S. T. (2022). Race to the podium: Separating and conjoining the car and driver in f1 racing. *Applied Economics*, 54(54):6272–6285.
Sato, K., Hashimoto, Y., and Owan, H. (2019). Gender differences in career. *Journal of the Japanese and International Economies*, 53:101028.
Schotter, A. and Weigelt, K. (1992). Asymmetric tournaments, equal opportunity laws, and affirmative action: Some experimental results. *Quarterly Journal of Economics*, 107(2):511–539.
Wang, L., Kawata, Y., and Takahashi, K. (2024). Peer effects in human capital investment decisions and gender differences. Working paper, Research Institute of Economy, Trade and Industry (RIETI).

Figures

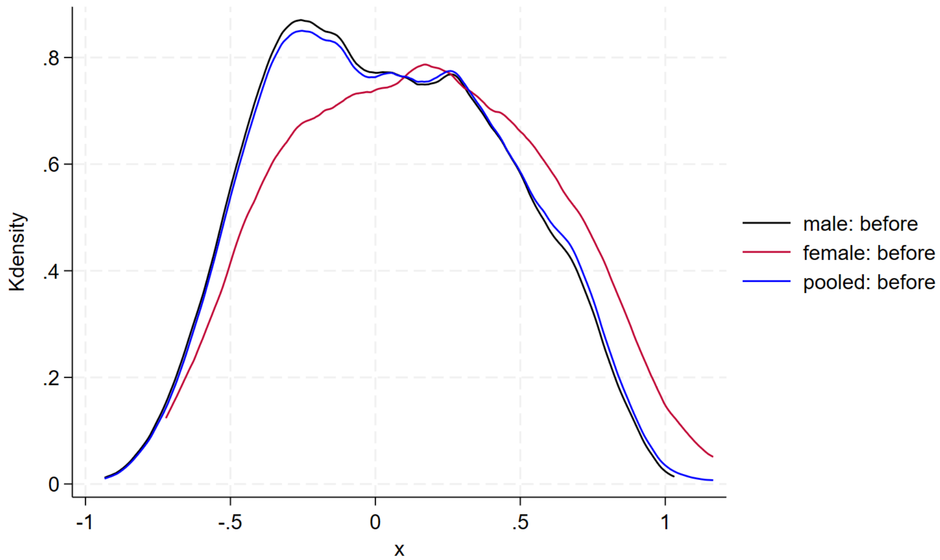

Figure 1: Racer Ability Distribution

Notes: The figure shows the estimated densities of racer ability. The racer ability is estimated by regressing placing in a race on racer fixed effects, race fixed effects, and other controls. We restrict our estimating sample to observations before the JMBR's policy change. See Section 5.1 for more details about the regression specification. We then estimate the density functions of racer ability for male only, female only, and both together by the kernel smoothing method. The black, red, and blue lines each represent male, female, and both.

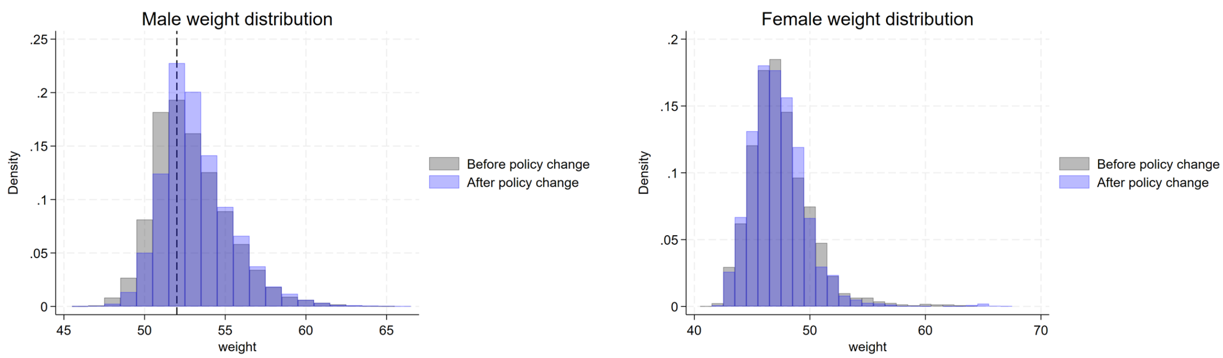

Figure 2: Racers' Weights Before and After the Regulation Change

Notes: The figure shows the histograms of racer for each gender and before and after the JMBR's regulation change raising the minimum weight for male racers from 51.0 kilograms to 52.0 kilograms.

Tables

Table 1: Summary Statistics

Variable	N	Mean	Min	Max	Male	Mean	Female	Mean	MeanDiff
Place-in-race	1,709,516	3.353	1	6	1,535,713	3.335	173,803	3.509	−0.173***
Enter place	1,730,820	3.419	1	6	1,554,591	3.410	176,229	3.490	−0.080***
Start time	1,724,400	16.68	0	99	1,549,042	16.59	175,358	17.52	−0.931***
log(Total race time)	1,733,630	4.721	4.268	5.057	1,557,159	4.721	176,471	4.724	−0.003***
Fly & Late	1,733,841	0.004	0	1	1,557,335	0.004	176,506	0.005	−0.001***
Fly	1,733,761	0.004	0	1	1,557,270	0.003	176,491	0.005	−0.001***
Late	1,727,538	0	0	1	1,551,885	0	175,653	0	−0.000**
Estimated ability	1,733,841	−0.000	−0.964	1.213	1,557,335	−0.006	176,506	0.051	−0.057***
Mix sexed race	1,733,841	0.155	0	1	1,557,335	0.139	176,506	0.304	−0.165***
Initial pit	1,733,841	3.437	1	6	1,557,335	3.433	176,506	3.472	−0.039***
Weight	1,733,841	52.46	41	67	1,557,335	53.03	176,506	47.41	5.614***
Age	1,733,841	38.66	18	75	1,557,335	39.03	176,506	35.39	3.639***
Racer rank A1	1,733,841	0.282	0	1	1,557,335	0.292	176,506	0.192	0.100***
Racer rank A2	1,733,841	0.271	0	1	1,557,335	0.275	176,506	0.239	0.036***
Racer rank B1	1,733,841	0.419	0	1	1,557,335	0.413	176,506	0.470	−0.057***
Racer rank B2	1,733,841	0.028	0	1	1,557,335	0.020	176,506	0.099	−0.079***
Boat win rate	1,733,841	32.21	0	100	1,557,335	32.17	176,506	32.58	−0.401***
Motor win rate	1,733,841	32.44	0	100	1,557,335	32.34	176,506	33.27	−0.928***
Enter type	1,733,841	0.964	0	1	1,557,335	0.964	176,506	0.967	−0.004***
SG	1,733,841	0.012	0	1	1,557,335	0.012	176,506	0.011	0
Race round	1,733,841	6.666	1	12	1,557,335	6.680	176,506	6.537	0.143***
Tournament day	1,733,841	3.307	1	7	1,557,335	3.297	176,506	3.392	−0.095***

Notes: The table presents summary statistics for all racers during our observation period, January 1, 2017, to December 31, 2022, as well as separately for male and female racers. *, ** and *** represent statistical significance at the 10%, 5% and 1% levels, respectively.

Table 2: The Effect of Body Weight on Race Outcomes

	Start time	log(Total time)	Placings
	(1)	(2)	(3)
Weight	0.073***	0.001***	0.052***
	(7.26)	(14.32)	(21.44)
Observations	1,724,400	1,730,610	1,709,516
R-squared	0.101	0.261	0.252
Racer char	Yes	Yes	Yes
Race char	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Racer FE	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of race outcomes on body weight using both male and female observations. The *t*-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** represent statistical significance at the 10%, 5% and 1% levels, respectively.

Table 3: The effect of Start time on Race Outcomes

	log(Total time)	Place-in-race
	(1)	(2)
Start time	0.001***	0.038***
	(90.47)	(152.77)
Observations	1,724,366	1,709,516
R-squared	0.223	0.267
racer char	Yes	Yes
race char	Yes	Yes
time FE	Yes	Yes
racer FE	Yes	Yes

Notes: The table shows the results from OLS regressions of race outcomes on start time using both male and female observations. The *t*-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** represent statistical significance at the 10%, 5% and 1% levels, respectively.

Table 4: Random assignments of racers to race

	Mixed-sex race Dummy	
	(1)	(2)
Racer ability	−0.004	−0.005
	(−1.19)	(−1.56)
Racer ability squared		0.007
		(1.36)
Observations	1,733,841	1,733,841
R-squared	0.093	0.093
racer char	Yes	Yes
race char	Yes	Yes
time FE	Yes	Yes
racer FE	No	No

Notes: Columns (1) and (2) represent the results from OLS regressions of mixed-sex race dummy on racer's ability using both male and female observations. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** represent statistical significance at the 10%, 5% and 1% levels, respectively.

Table 5: Intertemporal spillovers

	Effort: Start Time (centiseconds)	
	Mixed-sex races	Single-sex races
	(1)	(2)
Attending mixed-sex races on previous race-day	0.033	0.038
	(0.84)	(1.37)
Attending single-sex races on previous race-day	−0.021	−0.052
	(−0.58)	(−1.50)
Observations	267,569	1,454,764
R-squared	0.127	0.102
racer char	Yes	Yes
race char	Yes	Yes
time FE	Yes	Yes
racer FE	Yes	Yes

Notes: The table shows the result from OLS regressions of attending mixed-sex and single-sex races compared with not attending races previous race-day on racers' effort using mixed-sex races and single-sex races observations separately. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** represent statistical significance at the 10%, 5% and 1% levels, respectively.

Table 6: The effect of policy on female racers' behavior

	Weight	Start time in single-sex races
	(1)	(2)
Post	0.076	−0.123
	(1.10)	(−0.98)
Observations	176,506	122,041
R-squared	0.868	0.101
racer char	Yes	Yes
race char	Yes	Yes
time FE	No	No
racer FE	Yes	Yes

Notes: Column (1) shows the result from OLS regressions of post policy dummy on racers' weight using only female observations. Column (2) shows the result from OLS regressions of post policy dummy on female racers' effort using only single-sex observations. The *t*-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** represent statistical significance at the 10%, 5% and 1% levels, respectively.

Table 7: The Effect of the Affirmative Action on Female Racers' Effort

	Effort: Start Time (centiseconds)			
	(1)	(2)	(3)	(4)
Mixed-sex race	0.283***	0.062	0.065	0.144**
	(3.23)	(0.93)	(0.84)	(2.02)
Post	−0.569***	−0.628***		
	(−5.96)	(−6.40)		
Mixed-sex race × Post	−0.448***	−0.326***	−0.336***	−0.278***
	(−4.34)	(−3.73)	(−3.43)	(−3.17)
Observations	175,358	175,358	175,358	175,358
R-squared	0.002	0.058	0.096	0.133
Racer-level controls	No	Yes	Yes	Yes
Race-level controls	No	Yes	Yes	Yes
Time FE	No	No	Yes	Yes
Racer FE	No	No	No	Yes

Notes: The table shows the results from OLS regression of start time on the affirmative action policy. The *t*-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 8: The Effect of Affirmative Action on Female Racers' Effort by Ability Level

	Effort: Start Time (centiseconds)							
	High-ability				Middle- and low-ability			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mixed-sex race	−0.052	−0.120	−0.233*	−0.108	0.363***	0.205**	0.257***	0.273***
	(−0.36)	(−1.22)	(−1.96)	(−0.92)	(3.83)	(2.57)	(2.72)	(3.12)
Post	−0.741***	−0.790***			−0.550***	−0.538***		
	(−5.39)	(−5.31)			(−4.50)	(−4.49)		
Mixed-sex race × Post	−0.075	0.012	0.045	−0.022	−0.499***	−0.512***	−0.578***	−0.448***
	(−0.51)	(0.10)	(0.32)	(−0.15)	(−4.05)	(−4.41)	(−4.49)	(−4.04)
Observations	59,343	59,341	59,337	59,337	116,015	116,015	116,014	116,014
R-squared	0.003	0.053	0.115	0.133	0.002	0.054	0.098	0.138
Racer char	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Race char	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	No	No	Yes	Yes
Racer FE	No	No	No	Yes	No	No	No	Yes

Notes: The table shows the results from OLS regressions of start time on the affirmative action policy for high-ability racers and the middle/low-ability racers. The *t*-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 9: The Effect of Affirmative Action on Female Racers' Risk-Taking Behavior by Ability level

	High-ability			Middle- and Low-ability		
	Fly/Late (1)	Fly (2)	Late (3)	Fly/Late (4)	Fly (5)	Late (6)
Mixed-sex race	0.002**	0.002**	0.000	−0.001*	−0.001*	0.000
	(2.37)	(2.16)	(1.14)	(−1.92)	(−1.93)	(0.22)
Mixed-sex race × Post	0.001	0.001	−0.000	0.001	0.001	0.000
	(0.31)	(0.38)	(−0.84)	(1.02)	(1.01)	(0.12)
Observations	59,633	59,630	59,344	116,590	116,586	116,025
R-squared	0.048	0.048	0.038	0.030	0.030	0.024
Racer char	Yes	Yes	Yes	Yes	Yes	Yes
Race char	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Racer FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of risk-taking behaviors on the affirmative action policy for high-ability racers and the middle/low-ability racers. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** represent statistical significance at the 10%, 5% and 1% levels, respectively.

Table 10: The Relationship Between Ability and Weight

	Body Weight (kg)
	(1)
Racer Ability	1.453***
	(5.95)
Observations	1,733,841
R-squared	0.082
Racer char	Yes
Race char	Yes
Time FE	Yes
Racer FE	No

Notes: The table shows the result from OLS regression of body weight on estimated racer ability using both male and female observations. Racer ability is estimated in a separate regression of race placings on racer fixed effects and other covariates. The *t*-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** represent statistical significance at the 10%, 5% and 1% levels, respectively.

A Figures for the Start Process

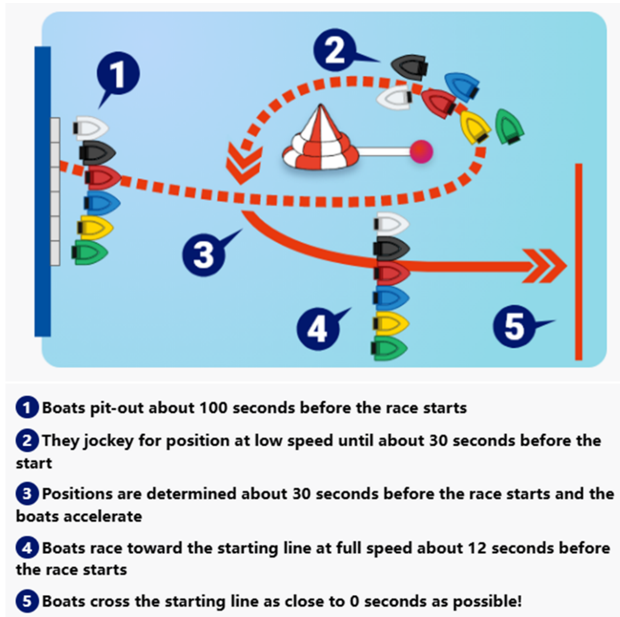

Figure A1: Japanese Speedboat Racing Start Process

Notes: Source: https://www.marugameboat.jp/lang-en.htm

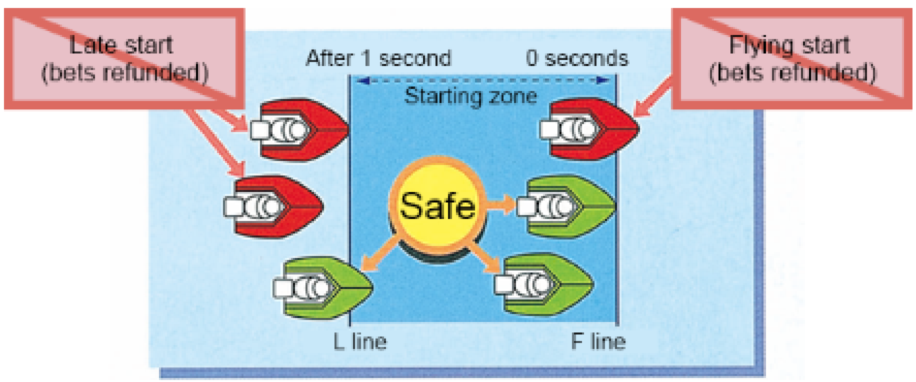

Figure A2: Japanese Speedboat Racing Invalid Start

Notes: Source: https://www.marugameboat.jp/lang-en.htm

B Robustness Check

Table B1: The Effect of Affirmative Action on Female Racers' Behavior: Additional control

VARIABLES	Start time			Fly		
	All female	High-ability	Middle- & low-ability	All female	High-ability	Middle- & low-ability
	(1)	(2)	(3)	(4)	(5)	(6)
Mixed-sex race	0.178**	0.023	0.284***	-0.000	0.002**	-0.001*
	(2.55)	(0.20)	(3.26)	(-0.57)	(2.43)	(-1.90)
Mixed-sex race × Post	-0.261***	0.017	-0.431***	0.001	0.001	0.001
	(-2.98)	(0.12)	(-3.88)	(1.27)	(0.42)	(1.05)
Observations	175,292	59,327	115,958	176,155	59,620	116,529
R-squared	0.134	0.134	0.138	0.022	0.048	0.030
racer char	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes
Opponents' abilities	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of start time and start flying on the affirmative action policy, controlling for the average ability of opponents in the same race. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table B2: The Effect of Switching to Mixed-sex races on Female Racers' Behavior: Pre-policy Change Sample

	All female	High-ability				Middle- and low-ability			
VARIABLES	Start time	Start time	Fly&Late	Fly	Late	Start time	Fly&Late	Fly	Late
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Mixed-sex race	0.147**	−0.059	0.002**	0.002**	0.000	0.261***	−0.001**	−0.001**	0.000
	(2.08)	(−0.51)	(2.44)	(2.16)	(1.16)	(3.01)	(−2.25)	(−2.16)	(0.33)
Observations	111,211	38,075	38,269	37,402	37,214	73,131	73,527	74,387	74,001
R-squared	0.129	0.131	0.052	0.053	0.040	0.134	0.032	0.032	0.025
racer char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of start time on the affirmative action policy for the sample before the policy change. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table B3: The Effect of Affirmative Action on Female Racers' Effort: Different Ability Cutoffs

VARIABLES	Effort: Start time					
	Top 1/4	Bottom 3/4	Top 1/5	Bottom 4/5	Top 1/10	Bottom 9/10
	(1)	(2)	(3)	(4)	(5)	(6)
Mixed-sex race	−0.150	0.227***	0.089	0.197**	−0.063	0.162**
	(−1.02)	(2.79)	(0.57)	(2.54)	(−0.39)	(2.18)
Mixed-sex race × Post	0.004	−0.383***	−0.360*	−0.291***	−0.235	−0.298***
	(0.02)	(−3.67)	(−1.97)	(−2.85)	(−0.73)	(−3.10)
Observations	42,125	133,223	30,496	144,834	14,942	160,368
R-squared	0.153	0.137	0.182	0.135	0.250	0.134
racer char	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of start time on the affirmative action policy for high-ability racers and the middle/low-ability racers. High-ability female racers are those who rank in the top one-fourth, top one-fifth, and top one-tenth of the pooled ability distribution; while middle- and low-ability female racers are those who rank in the bottom three-fourths, bottom four-fifths, and bottom nine-tenths of the distribution. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table B4: The Effect of Affirmative Action on Female Racers' Risk-Taking Behavior: Different Ability Cutoffs

VARIABLES	Risk-taking: Fly					
	Top 1/4	Bottom 3/4	Top 1/5	Bottom 4/5	Top 1/10	Bottom 9/10
	(1)	(2)	(3)	(4)	(5)	(6)
Mixed-sex race	0.002	−0.001	0.001	−0.000	0.002	−0.000
	(1.51)	(−1.20)	(0.49)	(−0.76)	(0.85)	(−0.86)
Mixed-sex race × Post	0.002	0.001	0.004	0.000	0.002	0.001
	(0.74)	(0.96)	(1.50)	(0.46)	(0.53)	(0.82)
Observations	42,339	133,873	30,653	145,551	15,011	161,165
R-squared	0.062	0.027	0.084	0.025	0.176	0.023
racer char	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of start time on the affirmative action policy for high-ability racers and the middle/low-ability racers. High-ability female racers are those who rank in the top one-fourth, top one-fifth, and top one-tenth of the pooled ability distribution; while middle- and low-ability female racers are those who rank in the bottom three-fourths, bottom four-fifths, and bottom nine-tenths of the distribution. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table B5: The Effect of Affirmative Action on Female Racers' Effort: Alternative Measure of Racer's Ability

VARIABLES	Effort: Start time							
	Top 1/3	Bottom 2/3	Top 1/4	Bottom 3/4	Top 1/5	Bottom 4/5	Top 1/10	Bottom 9/10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mixed-sex race	−0.247**	0.268***	−0.283**	0.234***	−0.314*	0.217***	−0.407	0.183**
	(−2.15)	(3.27)	(−2.19)	(2.97)	(−1.71)	(2.81)	(−1.30)	(2.47)
Mixed-sex race × Post	−0.216	−0.346***	−0.240	−0.319***	−0.281	−0.309***	−0.137	−0.305***
	(−1.39)	(−3.22)	(−1.13)	(−3.03)	(−1.11)	(−3.03)	(−0.33)	(−3.22)
Observations	44,508	130,839	31,444	143,897	24,019	151,318	11,027	164,225
R-squared	0.149	0.134	0.169	0.134	0.196	0.133	0.278	0.133
racer char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of start time on the affirmative action policy for high-ability racers and the middle/low-ability racers. Ability is measured by the probability of winning first place before participating in the current race. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table B6: The Effect of Affirmative Action on Female Racers' Risk-Taking Behavior: Alternative Measure of Racer's Ability

VARIABLES	Risk-taking: Fly							
	Top 1/3	Bottom 2/3	Top 1/4	Bottom 3/4	Top 1/5	Bottom 4/5	Top 1/10	Bottom 9/10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mixed-sex race	0.002*	−0.001	0.002	−0.001	0.003*	−0.001	0.002	−0.000
	(1.80)	(−1.62)	(1.51)	(−1.03)	(1.69)	(−1.16)	(0.67)	(−0.78)
Mixed-sex race × Post	0.001	0.001	0.003	0.000	0.005	0.000	0.002	0.001
	(0.56)	(0.67)	(0.98)	(0.41)	(1.43)	(0.44)	(0.40)	(0.94)
Observations	44,713	131,498	31,596	144,610	24,135	152,065	11,074	165,044
R-squared	0.061	0.027	0.085	0.026	0.097	0.025	0.211	0.023
racer char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of start time on the affirmative action policy for high-ability racers and the middle/low-ability racers. Ability is measured by the probability of winning first place before participating in the current race. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table B7: The Effect of Affirmative Action on Female Racers' Effort: Quantile Regression

VARIABLES	Effort: Start time								
	qtile_10	qtile_20	qtile_30	qtile_40	qtile_50	qtile_60	qtile_70	qtile_80	qtile_90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Mixed-sex race	−0.061	0.001	0.048	0.090	0.131*	0.174**	0.221***	0.279***	0.365***
	(−0.86)	(0.02)	(0.74)	(1.36)	(1.89)	(2.35)	(2.73)	(3.05)	(3.33)
Mixed-sex race × Post	−0.151	−0.190**	−0.219***	−0.245***	−0.270***	−0.297***	−0.326***	−0.362***	−0.415***
	(−1.64)	(−2.28)	(−2.72)	(−3.01)	(−3.17)	(−3.23)	(−3.21)	(−3.11)	(−2.93)
Observations	175,358	175,358	175,358	175,358	175,358	175,358	175,358	175,358	175,358
racer char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from quantile regressions of start time on the affirmative action policy for female racers. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

C Results of Male Racers

Table C1: The Effect of Switching to Mixed-sex races on Male Racers' Behavior: Pre-policy Change Sample

	All male	High-ability				Middle- and low-ability			
VARIABLES	Start time	Start time	Fly&Late	Fly	Late	Start time	Fly&Late	Fly	Late
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Mixed-sex race	0.070***	0.093**	0.000	0.000	−0.000	0.048	0.001**	0.000**	0.000
	(2.95)	(2.39)	(0.11)	(0.12)	(−0.07)	(1.64)	(2.10)	(2.05)	(0.47)
Observations	989,664	385,389	386,756	386,746	385,414	604,274	606,505	606,485	604,320
R-squared	0.101	0.092	0.008	0.008	0.006	0.086	0.007	0.007	0.004
racer char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of start time on the affirmative action policy for the sample before the policy change. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table C2: The Effect of the Affirmative Action on Male Racers' Effort

VARIABLES	Effort: Start Time (centiseconds)			
	(1)	(2)	(3)	(4)
Mixed-sex race	0.141***	0.141***	0.115***	0.087***
	(5.09)	(5.43)	(4.46)	(3.68)
Post	−0.410***	−0.483***		
	(−13.85)	(−15.61)		
Mixed-sex race × Post	−0.049	−0.057	−0.045	−0.026
	(−1.20)	(−1.47)	(−1.14)	(−0.74)
Observations	1,549,042	1,549,042	1,549,042	1,549,042
R-squared	0.001	0.050	0.060	0.100
Racer-level controls	No	Yes	Yes	Yes
Race-level controls	No	Yes	Yes	Yes
Time FE	No	No	Yes	Yes
Racer FE	No	No	No	Yes

Notes: The table shows the results from OLS regression of start time on the affirmative action policy. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table C3: The Effect of Affirmative Action on Male Racers' Effort: Different Ability Cutoffs

VARIABLES	Effort: Start time							
	Top 1/3	Bottom 2/3	Top 1/4	Bottom 3/4	Top 1/5	Bottom 4/5	Top 1/10	Bottom 9/10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mixed-sex race	0.114***	0.066**	0.165***	0.055**	0.155***	0.067**	0.170**	0.076***
	(2.90)	(2.23)	(3.62)	(1.99)	(3.10)	(2.49)	(2.43)	(3.02)
Mixed-sex race × Post	0.006	−0.051	0.031	−0.058	0.045	−0.056	0.076	−0.040
	(0.11)	(−1.13)	(0.46)	(−1.36)	(0.62)	(−1.35)	(0.75)	(−1.04)
Observations	601,914	947,128	453,994	1,095,047	367,847	1,181,193	182,787	1,366,254
R-squared	0.090	0.085	0.091	0.087	0.086	0.089	0.094	0.094
racer char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of start time on the affirmative action policy for high-ability racers and the middle/low-ability racers. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table C4: The Effect of Affirmative Action on Male Racers' Risk-Taking Behavior: Different Ability Cutoffs

VARIABLES	Risk-Taking: Fly							
	Top 1/3	Bottom 2/3	Top 1/4	Bottom 3/4	Top 1/5	Bottom 4/5	Top 1/10	Bottom 9/10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mixed-sex race	−0.000	0.000*	−0.000	0.000**	0.000	0.000	0.000	0.000
	(−0.03)	(1.92)	(−0.28)	(2.00)	(0.35)	(1.60)	(0.45)	(1.54)
Mixed-sex race × Post	0.000	−0.001**	0.000	−0.001**	−0.000	−0.001*	−0.001	−0.000
	(0.07)	(−2.20)	(0.33)	(−2.25)	(−0.17)	(−1.92)	(−0.90)	(−1.60)
Observations	604,019	950,530	455,624	1,098,924	369,225	1,185,322	183,516	1,371,032
R-squared	0.007	0.006	0.008	0.006	0.010	0.005	0.017	0.005
racer char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of start time on the affirmative action policy for high-ability racers and the middle/low-ability racers. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table C5: The Effect of Affirmative Action on Male Racers' Effort: Alternative Ability Measure

VARIABLES	Effort: Start time							
	Top 1/3	Bottom 2/3	Top 1/4	Bottom 3/4	Top 1/5	Bottom 4/5	Top 1/10	Bottom 9/10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mixed-sex race	0.153***	0.045	0.136***	0.061**	0.142***	0.067**	0.129*	0.074***
	(3.90)	(1.56)	(3.17)	(2.19)	(2.80)	(2.51)	(1.86)	(2.94)
Mixed-sex race × Post	0.029	−0.050	0.079	−0.065	0.079	−0.059	0.077	−0.039
	(0.47)	(−1.14)	(1.16)	(−1.55)	(1.01)	(−1.46)	(0.69)	(−1.03)
Observations	530,489	1,018,553	401,248	1,147,793	322,156	1,226,884	162,766	1,386,276
R-squared	0.093	0.086	0.094	0.088	0.096	0.090	0.107	0.093
racer char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of start time on the affirmative action policy for high-ability racers and the middle/low-ability racers. Ability is measured by the probability of winning first place before participating in the current race. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table C6: The Effect of Affirmative Action on Male Racers' Risk-Taking Behavior: Alternative Ability Measure

VARIABLES	Risk-taking: Fly							
	Top 1/3	Bottom 2/3	Top 1/4	Bottom 3/4	Top 1/5	Bottom 4/5	Top 1/10	Bottom 9/10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mixed-sex race	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.43)	(1.64)	(0.36)	(1.58)	(0.52)	(1.44)	(0.76)	(1.43)
Mixed-sex race × Post	−0.000	−0.001*	−0.001	−0.000	−0.000	−0.000	−0.001	−0.000
	(−0.32)	(−1.78)	(−0.87)	(−1.39)	(−0.62)	(−1.54)	(−1.27)	(−1.52)
Observations	532,295	1,022,254	402,627	1,151,921	323,261	1,231,286	163,340	1,391,209
R-squared	0.008	0.006	0.010	0.005	0.012	0.005	0.022	0.005
racer char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from OLS regressions of start time on the affirmative action policy for high-ability racers and the middle/low-ability racers. Ability is measured by the probability of winning first place before participating in the current race. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table C7: The Effect of Affirmative Action on Male Racers' Effort: Quantile Regression

VARIABLES					Effort: Start time				
	qtile_10	qtile_20	qtile_30	qtile_40	qtile_50	qtile_60	qtile_70	qtile_80	qtile_90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Mixed-sex race	0.031	0.049**	0.061***	0.073***	0.084***	0.095***	0.108***	0.123***	0.147***
	(1.21)	(2.11)	(2.78)	(3.27)	(3.61)	(3.82)	(3.92)	(3.92)	(3.82)
Mixed-sex race × Post	−0.012	−0.016	−0.020	−0.023	−0.026	−0.029	−0.032	−0.036	−0.042
	(−0.29)	(−0.46)	(−0.58)	(−0.67)	(−0.73)	(−0.76)	(−0.77)	(−0.76)	(−0.72)
Observations	1,549,042	1,549,042	1,549,042	1,549,042	1,549,042	1,549,042	1,549,042	1,549,042	1,549,042
racer char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
race char	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
racer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the results from quantile regressions of start time on the affirmative action policy for male racers. The t-statistics in parentheses are based on racer-level clustered standard errors. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.