Do Women Give up Competing More Easily? Evidence from Speedcubers

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Abstract

We analyze a large sample of participants in mixed-gender Rubik's Cube competitions. Focusing on participants who barely made or missed the cut for the second round in a competition, we examine their likelihood of joining another competition in the future. We find a significant gender difference: Whereas boys are slightly discouraged by failing to qualify for the second round, girls are affected more and are more likely to give up forever. Furthermore, we find that this gender difference is most significant in countries with larger gender gaps in labor market outcomes.

Keywords: Gender gap, competition, Rubik's Cube.

JEL Classification: D91, J16, L83.

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1 Introduction

We analyze a sample of 58,167 speedcubers from 135 countries who participated in mixed-gender competitions for the fastest solves of the Rubik's Cube. We examine whether a person is less likely to participate in another competition if he or she failed to qualify for the second round in a previous competition. From each competition, our analysis sample includes ten participants right above and ten participants right below the cutoff score. Given that Rubik's Cubes are randomly scrambled in competition, these sampled participants are more or less equally skilled. Our empirical analysis further controls for performance using a regression discontinuity design.

We find a significant gender difference: While boys are slightly discouraged by failing to qualify for the second round, girls are affected more and they are more likely to drop out forever. Further analysis reveals that this gender difference in giving up competition is nonexistent among individuals from European and North American countries and it is only significant in countries with larger gender gaps in labor market outcomes.

This study contributes to the economic literature on gender gaps in competition. It is now widely documented that men are more willing to join competition and less likely to give up competition than women. Extensive research has been devoted to understanding why this is happening and whether these gender differences can explain observed gender gaps in labor market outcomes such as the gender wage gap.[1] The bulk of the existing studies use relatively small scale experimental data. Even if observational data are used, they tend to come from one or two countries. Here we study gender difference in competition using 16 years of records on tens of thousands of speedcubers from all over the world. Our study is most closely related to Buser and Yuan (2019), who show that in the Dutch Math Olympiad, girls (but not boys) who fail to make the second round are less likely to compete again one year later. Our marginal contribution is to examine whether this kind of gender difference in competition is related to cross-country differences in labor market outcomes.

2 Data and Sample Construction

The data are downloaded from the World Cube Association's (WCA) website on June 9, 2020.[2] Founded in 2004, the WCA organizes and regulates competitions for the Rubik's

[1] See, for example, Buser et al. (2014), Buser and Yuan (2019), Gneezy et al. (2009), and Niederle and Vesterlund (2007); Niederle and Vesterlund (2011) provide a review of the early literature.

[2] The WCA's website is here: https://www.worldcubeassociation.org/. They continuously update their database as new competition results come in.

Cube and similar puzzles around the world.[3] We drop Rubik's Cube competitions prior to 2004 when the current format was not adopted; we also exclude competitions held in 2020 to avoid potential biases caused by the global pandemic. Our analysis focuses on participating in the *standard 3×3×3 Rubik's Cube* (henceforth simply referred to as Rubik's Cube) competition, which has always been the most popular speedcubing event.[4] Thus we drop any competition that does not include a Rubik's Cube event. By the end of 2019, 138,440 competitors from 145 countries had participated in 6,414 WCA's Rubik's Cube competitions held in 109 countries.

Our empirical analysis examines how an individual's performance in one competition affects her or his participation in the future. One would expect that better performers are more likely to participate continuously, partly because better performance brings more enjoyment and partly because better performance indicates more interest and effort.[5] Therefore, to control for performance, we focus on a sample that includes twenty competitors from each competition: ten above and ten below the cutoff time to qualify for the second round of the competition.[6] This yields an analysis sample of 58,167 individual competitors from 135 countries observed 122,753 times (many individuals meet our sample selection criteria for more than one competition). The top ten countries by the number of competitors are: USA, China, India, Brazil, Russia, the Philippines, Poland, Spain, Canada, and Indonesia. For each competitor in each competition, we construct two outcome variables: whether this individual participates in another Rubik's Cube competition within a year (365 days) and at any future time by the end of our sample period.

Table 1 presents descriptive statistics for this analysis sample. Of these individuals, 63% participate in another competition within a year and 69% participate in another competition by the end of our sample period. Only 8% of them are female competitors (compared to 9.87% in the whole sample). Position relative to cutoff is set to be zero for the person right above the cutoff, thus it ranges from -10 to 9.[7] The average individual has participated in

[3]See Scheffler (2016) for an engaging history of speedcubing competition.

[4]Other than the standard 3×3×3 Rubik's Cube competition, there are one-handed, blindfolded, multiple blindfolded, with feet, and fewest moves Rubik's Cube competitions. In addition, a WCA competition may also feature 2×2×2, 4×4×4, 5×5×5, 6×6×6, and 7×7×7 cubes; square-1; pyraminx; megaminx; Skewb; and Rubik's Clock.

[5]Participation is voluntary and mainly for fun. At most competitions, competitors have to pay a small registration fee in order to participate. There is typically only a nominal prize, such as a twenty-dollar gift card, for the top performers.

[6]Note that this cutoff time is not known in advance. In our sample, the average WCA Rubik's Cube competition has 67 participants, and 33 of them with the fastest average times in the first round advance to the second round. By the WCA rules, each competitor has an opportunity to try five solves of different scrambles, and the average time is calculated after dropping the fastest and the slowest solves.

[7]This position variable can be thought of as a normalized performance score to make cross-competition comparisons meaningful. We do observe the actual performance (average time) for each participant in

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
=1 if participate again within a year	0.63	0.48	0	1
=1 if participate again at any future time	0.69	0.46	0	1
=1 if female	0.08	0.27	0	1
=1 if below cutoff	0.49[a]	0.50	0	1
Position relative to cutoff	-0.34	5.67	-10	9
Number of competitions participated in until now	6.46	12.19	1	192

Analysis sample includes ten competitors above and ten below the cutoff to qualify for the second round in each Rubik's Cube competition organized by the WCA from 2004-2019. Each variable has 122,753 observations generated by 58,167 individual competitors.

[a] In some small competitions, fewer than ten participants are excluded from the second round, so this mean is slightly less than 0.5.

6.46 competitions up to the current one, but the distribution is very skewed with a median of 3.

3 Empirical Analysis

3.1 Specification

Our specification is a difference-in-differences setup with a regression discontinuity design. We estimate the following equation:

$$P_{ji} = \alpha + \beta \cdot Female_i + \gamma \cdot Below_{ji} + \delta \cdot Female_i * Below_{ji} + f\left(Position_{ji}\right) + \tau \cdot \log(competitions_{ji}) + C_j + \epsilon_{ji},$$

where the outcome variable P_{ji} indicates whether person i, after the current competition j, will participate in another competition within a year or at any future time. It is assumed to be a linear function of whether person i is a female ($Female_i$), whether person i is below the cutoff in competition j ($Below_{ji}$) and thus fails to advance to the second round, the interaction term between these two dummies, a continuous function of person i's position relative to the cutoff in competition j ($f\left(Position_{ji}\right)$), log number of competitions participated by person i up to competition j ($\log(competitions_{ji})$), and a competition fixed effect (C_j); ϵ_{ji} is an idiosyncratic error term.

We expect that individuals right below the cutoff, compared to those just above, experience some discouragement and that this effect is different between men and women. The key

each competition. However, the actual performance is not comparable across different competitions because overall performance has continuously improved over the years. For example, in January 2004, the average time world record was 16.53 seconds; by November 2019, it had improved to 5.53 seconds, held by the legendary Australian speedcuber Feliks Zemdegs. See the history of the records at https://www.worldcubeassociation.org/results/records?show=history.

coefficient of interest is δ; a negative δ implies that compared to men, women are more likely to give up competing after a disappointing performance. Controlling for position relative to the cutoff allows for the interpretation of γ and δ as the differences at the cutoff. By including a competition fixed effect, we are comparing individuals in the same competition. This is important because the ability to come back for another competition varies across locations and over time. For example, since Rubik's Cube competitions are popular in the U.S., several competitions are organized every month and it is fairly easy for a person in the U.S. to find a nearby competition within a short period of time; however, this is not true for competitors in many other countries. Similarly, Rubik's Cube competitions have become more popular over time, and thus joining another competition has become easier in recent years. The competition fixed effect helps eliminate biases due to these factors: Whereas time and location may affect the probability of participating in another competition, they should affect individuals in the same competition (thus in the same location at the same time) in similar ways.

The number of already attended competitions is expected to be a powerful predictor of whether this person will compete again in the future. We take the natural log to allow for a nonlinear effect. One might want to control for some other individual characteristics. Unfortunately, the WCA's database does not reveal any individual level information other than a personal ID, gender, country, and performance in each competition. Thus we are unable to add any more controls.

3.2 Results

Table 2 presents the baseline regression results. Columns (1) and (3) examine whether an individual participates again within a year; columns (2) and (4) examine whether an individual participates again at any future time. While columns (1)-(2) only include one *position* control, columns (3)-(4) add the interaction terms between *position* and $female$, *below*, and $female * below$, allowing for different slopes for each gender and different slopes below and above the cutoff. We cluster standard errors by $competition\_country * year$.

Across the four columns, the coefficients of *Below* are negative but relatively small and not always statistically significant. That is, among male competitors (the base group), those who barely missed and barely made the second round have almost the same probability of competing again in the future, thus failing to reach the second round only has a small (if any) discouragement effect. However, the interaction term $Female * Below$ has a negative and statistically significant coefficient in all four columns, implying a discouragement effect that is 2.7-3.3 percentage points larger among female competitors. Allowing for different

Table 2: Baseline Regression Results

	Participate again *within a year* (1)	Participate again *at any future time* (2)	Participate again *within a year* (3)	Participate again *at any future time* (4)
Female	0.059***	0.055***	0.073***	0.073***
	(0.007)	(0.007)	(0.012)	(0.011)
Below	-0.011**	-0.008	-0.010**	-0.006
	(0.005)	(0.005)	(0.005)	(0.005)
Female*Below	-0.027***	-0.027***	-0.028*	-0.033**
	(0.009)	(0.009)	(0.015)	(0.014)
Position	0.005***	0.006***	0.004***	0.005***
	(0.0004)	(0.0004)	(0.001)	(0.001)
log(competitions)	0.119***	0.106***	0.120***	0.106***
	(0.002)	(0.003)	(0.002)	(0.003)
Constant	Yes	Yes	Yes	Yes
Extra position controls			Yes	Yes
Competition fixed effect	Yes	Yes	Yes	Yes
No. of observations	122,753	122,753	122,753	122,753
R^2	0.304	0.302	0.304	0.302

Standard errors clustered by $competition\_country * year$ are in parentheses. ** $p < 0.05$; *** $p < 0.01$. In columns (3)-(4), extra position controls include $position * female$, $position * below$, and $position * female * below$, allowing for different slopes for each gender and different slopes below and above the cutoff.

slopes of the continuous *position* control (columns (3)-(4)) slightly reduces the precision of estimation but hardly affects the magnitude of the coefficient on $Female * Below$. Consider column (4) of Table 2. Among male competitors, those failing to make the second round are almost equally likely to ever compete again; in contrast, among female competitors, those failing to make the second round are 3.3 percentage points less likely to ever compete again. Given that the average person in our sample has a 69 percent probability of ever competing again, this gender difference is considerable.[8] These findings are similar to those reported by Buser and Yuan (2019), although we are studying a different group of individuals in a different context.

The coefficient of $Female$ has a positive and statistically significant coefficient, implying that in our analysis sample female competitors are generally more likely to participate in another competition. There are two possible reasons. First, this is a male-dominated activity and any female who is willing to participate must be keenly interested and highly motivated to persist. Thus, conditional on participating, female competitors appear to be more likely

[8]Alternatively, we tried dropping the log(competitions) control from the regressions in Table 2. Under each specification, the coefficient of our key independent variable ($Female * Below$) is a little more precisely estimated and implies a slightly larger gender gap (between 3.2 and 4.2 percentage points).

to carry on than male competitors. Second, advancing to or getting close to the second round is a more prestigious achievement for girls than boys. While 9.87% of all Rubik's Cube competitors are female in the WCA's database, only 4.20% are female among those who have ever competed in a second round. Therefore, if using competitors of their own gender as the reference, females are more accomplished than males in our analysis sample. This may have given female competitors a bigger incentive to continue.

Figure 1 presents the regression discontinuity graphs corresponding to the regressions in columns (3)-(4) of Table 2, demonstrating the sources of variation that help identify the DID estimates at the cutoff. Both graphs suggest that it is more reasonable to allow for different slopes of the position control.[9]

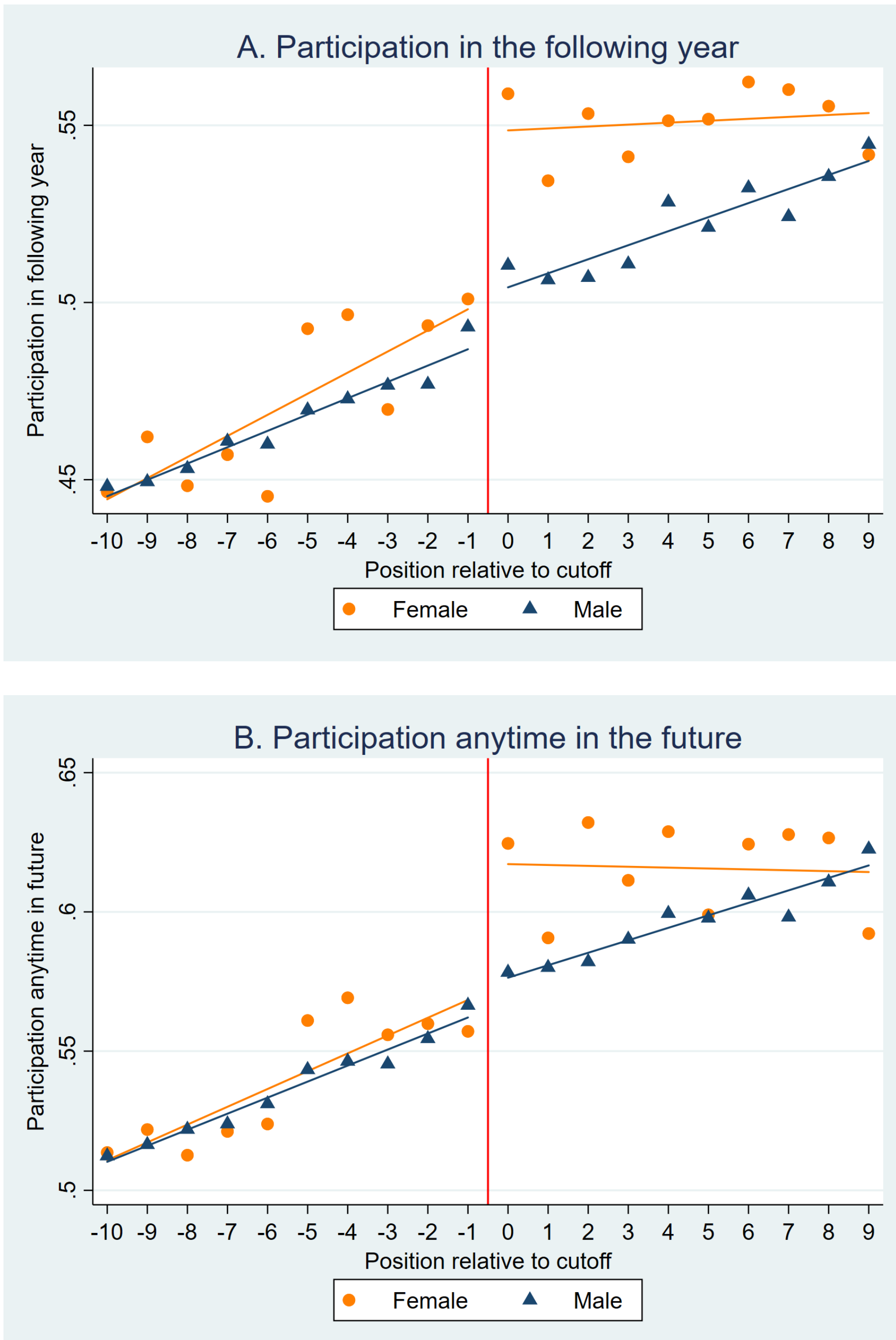
Table 3 explores heterogeneity across different groups of countries. To conserve space, we only present results using the second outcome variable (participate again at any future time), with the same specification as in column (4) of Table 2, and only show the coefficient of $Female * Below$. Panel A shows the results separately for different continents based on the competitor's home country. We find that the gender gap is virtually nonexistent for European and North American countries. This gap is sizable (5.5 percentage points) and marginally significant for Asian countries, and it is the largest (10.0 percentage points) and most statistically significant in the rest of the world. This confirms our impression that the gender gap is larger in less developed countries.

In panels B-E, we divide countries into three different groups based on four different types of gender gaps: wage gender gap, labor force participation gender gap, economic participation and opportunity gender gap, and the overall gender gap.[10] In each case, we sort observations based on the competitor's country's gender gap index value. The countries with a gender gap smaller than the $33.33th$-percentile country are categorized as small-gender-gap countries; the country at the $66.67th$-percentile together with all countries with a larger gender gap are categorized as large-gender-gap countries; the rest are medium-gender-gap countries. We run the regression separately for the three groups of countries. In all four panels, the gender gap in competition is relatively small and statistically insignificant for small-gender-gap countries; this gender gap in competition is much larger (between 6.8 and 9.0 percentage points) and always statistically significant for large-gender-gap countries. Its correlation with gender gaps in labor market outcomes is particularly evident: In panels B-C, the gender gap

[9] In addition, we tried to control for a second-order polynomial of *position*, which reduces the statistical significance of the coefficient on $Female * Below$. Given that we are focusing on a narrow band around the cutoff and that the position variable only takes whole-number values, we want to avoid overfitting the data. We therefore believe that this linear approach is preferable, as similarly argued by Buser and Yuan (2019).

[10] The economic participation and opportunity gender gap is defined as a weighted average of five different gender gap measures, and the overall gender gap is a simple average of four gender-gap indexes. See Zahidi et al. (2018, pp. 4-7) for details.

Figure 1: Regression Discontinuity Graphs



Notes: These graphs correspond to the regressions in columns (3)-(4) of Table 2. For each individual competitor, we first calculate $P_{ji} - \hat{\tau} \cdot \log(competitions_{ji})$, purging out the effect of the number of competitions participated in until now. This adjusted outcome variable is then averaged over all individual competitors in the same position.

Table 3: Coefficients on $Female * Below$ across Different Groups of Countries

DV: = 1 if participate again at any future time			
A. By continents			
Asia	Europe	North America	Other
-0.055*	-0.007	0.0001	-0.100***
(0.030)	(0.024)	(0.029)	(0.031)
N=34,738	N=39,167	N=30,080	N=18,768
B. By wage gender gap in 2018[a]			
Small gap	Medium gap	Large gap	
0.003	-0.044	-0.068***	
(0.029)	(0.029)	(0.020)	
N=39,814	N=29,869	N=49,907	
C. By labor force participation gender gap in 2018[a]			
Small gap	Medium gap	Large gap	
-0.003	-0.037	-0.073***	
(0.026)	(0.023)	(0.026)	
N=34,090	N=45,993	N=40,282	
D. By economic participation and opportunity gender gap in 2018[a]			
Small gap	Medium gap	Large gap	
-0.025	-0.006	-0.090***	
(0.030)	(0.023)	(0.022)	
N=38,903	N=36,861	N=44,601	
E. By overall gender gap in 2018[a]			
Small gap	Medium gap	Large gap	
-0.019	-0.014	-0.080***	
(0.027)	(0.026)	(0.021)	
N=36,248	N=43,048	N=41,069	

Standard errors clustered by $competition\_country * year$ are in parentheses. N indicates the number of observations in the regression. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Each cell presents the coefficient of $Female * Below$ from one regression. In each regression, the dependent variable is whether the individual will participate again at any future time. The specification is identical to those in the last column of Table 2.

[a] Data on gender gap indexes are from the Global Gender Gap Report (Zahidi et al. 2018), available at the World Bank: https://tcdata360.worldbank.org/indicators/af52ebe9.

in competition becomes larger and more statistically significant as we move from low- to high-gender-gap countries in terms of wages and labor force participation.

Overall, this heterogeneity analysis in Table 3 not only discovers which groups of countries are driving the baseline results, but also helps us understand why those estimates of the gender gap in competition using the whole analysis sample are relatively moderate in size and not very precisely estimated in columns (3)-(4) of Table 2.

4 Conclusion

We find that the gender gap in participating in Rubik's Cube competitions is closely related to other gender gaps at the country level. Causality may run both ways. On the one hand, our results suggest that girls are more likely to give up competition if they grow up in a society with larger gender gaps in the labor market. This is consistent with earlier findings that relate gender gaps in competition with cultural and institutional differences between different societies (Gneezy et al. 2009, Zhang 2019, Booth et al. 2019). On the other hand, our results also support the notion that gender gaps in competition lead to gender gaps in career choice and labor market outcomes (Buser et al. 2014, Reuben et al. 2019). We expect future work to determine the direction of causality.

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