

# Gender and Willingness to Compete for High Stakes

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**Abstract:** Willingness-to-compete experiments typically use small stakes, which raises the question of whether the commonly observed lower competitiveness of women can be generalized to consequential real-world situations. The present paper examines gender differences in willingness to compete using a high-stakes TV game show. At several stages, contestants face a choice between continuing to compete and opting out in exchange for a comparatively modest prize. When strategic considerations are absent, we observe the well-known pattern that women are less likely to compete than men, but this difference derives entirely from women avoiding competition against men. When the decision to compete is strategic and contestants should factor in the competitiveness of others, women again avoid competing against men. Men, in turn, seem to anticipate the lower competitiveness of female opponents, as evidenced by their greater tendency to compete against women in such a situation. Ability differences are unlikely to explain these results. The findings underline the importance of the gender of competitors for the analysis of differences in willingness to compete, and shed new light on the persistent gender gap at the male-dominated higher rungs of the career ladder.

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## 1. Introduction

Despite a considerable decline of the gender wage gap over the last decades, gender differences at the top have proven to be highly persistent. For example, Blau and Kahn (2017) report that in the US, the gender gap at the top of the wage distribution has declined much less than the gap at the middle and bottom of the distribution, and that in Fortune 500 companies, women make up only 14 percent of executive officers, 4 percent of CEOs, and 17 percent of board members. According to the most recent Global Gender Gap Report (World Economic Forum, 2020), worldwide only 36 percent of senior private sector managers and public sector officials are women, and only 18 percent of firms are led by a woman.

A large literature based on lab experiments suggests that these gender differences can be partially explained by competitiveness differences: relative to men, women would be more reluctant to compete (see Gneezy, Niederle and Rustichini, 2003, and Niederle and Vesterlund, 2007, for seminal contributions, and Croson and Gneezy, 2009, and Niederle and Vesterlund, 2011, for surveys). Most of the studies in this literature base their experimental design on that of Niederle and Vesterlund (2007). In this design, participants determine how they are compensated for their performance in a series of math problems where they have to add up sets of two-digit numbers. They can choose between a noncompetitive piece rate and a competitive tournament incentive scheme. If they opt for the piece rate, they earn \$1 per correct answer; if they opt for the tournament, they compete against three others, with the highest performer receiving \$4 per correct answer and the others receiving nothing. In most studies, male and female subjects perform equally well, but men are more likely to choose the competitive option.<sup>1</sup>

Compared to the financial interests that are at stake in career competitions, the money amounts used in willingness-to-compete experiments are typically very small. Notwithstanding the copious experimental evidence for the existence of a gender difference in willingness to compete, the small stakes raise the question of whether the observed behavior can be generalized to consequential real-world decisions.

The present paper uses the Dutch version of the globally successful game show format Deal or No Deal to investigate whether the gender difference in the willingness to compete also occurs when the stakes are high. In every episode, one person plays a game of chance with an expected payoff of hundreds of thousands of euros. This finalist is selected from an audience of 500 through a series of elimination

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<sup>1</sup> Differences in willingness to compete can be driven by differences in risk attitudes, (over)confidence, and attitudes towards competition. In the literature, the term “competitiveness” is sometimes used in a narrow sense and then specifically refers to the latter driver. We follow Niederle and Vesterlund (2011) and use it for the overall tendency to compete.

games built around quiz questions. Similar to the tasks that are typically used in willingness-to-compete experiments, these quiz questions are often numerical or arithmetic in nature. In every episode, multiple contestants are offered the option to opt out of the elimination competition in exchange for a substantial, but comparatively small prize. These high-stakes choice situations almost appear to be designed by an economist as an experiment to analyze competitiveness differences under substantial incentives.

We focus on two different games, which differ in strategic complexity. In the first, contestants who most accurately answered an estimation question have to choose between competing in the next elimination game and opting out for a prize. This decision resembles the tournament-entry decision typically made by subjects in lab experiments. Mirroring the main result of Niederle and Vesterlund (2007), we find that women are more than twice as likely as men to opt out of the competition. Interestingly, the higher opt-out rate of women derives entirely from situations where the majority of their opponents in the next stage would be male. This result corroborates tentative experimental evidence in the literature that women have a particular dislike of competition against men (Große and Riener, 2010; Booth and Nolen, 2012; Geraldes, 2018). There is no evidence that men condition their behavior on the gender of their opponents.

The second game is a head-to-head confrontation at the end of the elimination competition. One quiz question determines the last elimination, unless one of the two contestants voluntarily accepts an opt-out prize. This game is more complex than the former, because the optimal choice depends on the anticipated behavior of the opponent. In the previous game, the number of competitors is predetermined, and people who want to compete do not benefit from others' reluctance to compete (contestants who opt out are replaced by another, randomly selected contestant). In this second game, however, those who choose to compete automatically win the competition if the other opts out. Such strategic interaction also plays an important role in many real-life competition choices. For example, if two colleagues are eligible for a job promotion but only one can actually get the position, both should not only factor in their comparative advantage when considering to compete for the position or not, but also the likelihood that the other will shy away from competing. Likewise, contestants who choose to compete in the head-to-head confrontation are not only betting on their relative performance, but also on the possibility that their opponent will bow out. If contestants' beliefs are based on the stereotypical view that women are less competitive than men, then both men and women will be more likely to compete against women than they will be against men. The same prediction follows from a dislike among women to compete against men—as we observe in the first game—and men being aware of women's reluctance to compete against them.

For this second game, we find that opt-out decisions occur approximately equally often in male and female single-sex pairs, suggesting the absence of a general gender difference in competitiveness. In mixed-gender pairs, however, we do observe a large difference: women are about twice as likely as men to be the one who opts out. These results are consistent (i) with a lower propensity among women to compete against men than against women, as we also found for the first game, (ii) with a higher propensity among men to compete against women than against men, and (iii) with a combination of (i) and (ii). To disentangle these explanations, we exploit the temporal aspect of the game. Contestants have a limited amount of time to decide. Every second that passes until someone opts out or until the time is up is informative about the two contestants' individual opt-out propensities: the longer a contestant waits, the more she risks that she has to compete. Second-by-second analysis of contestants' behavior shows that both men and women have a higher propensity to compete against women. There is no evidence of a main effect of gender on competitiveness in this setting.

The results for the two games confirm that gender differences in willingness to compete also occur in situations where the stakes are very high. The stereotypical image and widely-held belief that women are less competitive than men in general, however, appears to be overly simplistic. Combined, our results suggest that women have a particular dislike of competing against men, and that men expect their female competitors to be less competitive and act accordingly in a strategic setting. In both the non-strategic and the strategic game, women avoid competing against men. In the non-strategic game, there is no evidence that men care about the gender of their opponent. In the strategic game, where contestants should factor in the competitiveness of others, however, men seem to anticipate the lower competitiveness of their female opponents, as evidenced by their greater tendency to compete against women than against men. Further analyses show that there is little reason to believe that these results are driven by gender differences in the ability to answer the questions of the various games. In particular, men and women perform roughly equally well in the different tasks.

The findings shed new light on the persistent gender gap at the higher rungs of the career ladder. Typically, the competitor pool gradually becomes more male-dominated the closer one gets to the top. If women are more likely to give up when faced with a male competitor and men compete harder when faced with a female competitor, male dominance in professional environments could become self-perpetuating.

With the use of a combination of high stakes and a quasi-controlled setting we complement recent work that attempts to assess the external validity of competitiveness differences found in the lab. Various studies show that decisions to compete or not compete in the lab correlate with education choices, with career choices, and with labor market success (Zhang, 2013; Buser, Niederle and

Oosterbeek, 2014; Berge et al., 2015; Almås et al., 2016a; Buser, Peter and Wolter, 2017a, 2017b; Buser, Geijtenbeek and Plug, 2018; Reuben, Sapienza and Zingales, 2019; Buser, Niederle and Oosterbeek, 2020). Although such a correlation is supportive of the generalizability of laboratory findings to settings with higher stakes, it is not conclusive because laboratory behavior and real-world outcomes could both be driven by a third variable that is not, or not perfectly, controlled for. An alternative strategy is to directly study competitiveness in situations where the stakes are consequential. Flory, Leibbrandt and List (2015) and Samek (2019) take this approach, and conduct field experiments where individuals apply for real jobs. In line with the results from the laboratory, these two studies find that women are less willing to work under competitive incentive schemes than men. Our naturally occurring experiment offers more control than the first set of studies, and substantially higher stakes than the second.

Our results demonstrate the importance of considering the gender composition of the competitor base and the presence of strategic interaction when investigating gender differences in willingness to compete. Hitherto, the literature has largely ignored the potential importance of the gender of competitors. This neglect is surprising in the light of the substantial evidence that women perform worse when they compete with men (Gneezy, Niederle and Rustichini, 2003; Günther et al., 2010; Backus et al., 2016; de Sousa and Hollard, 2016; Booth, Cardona-Sosa and Nolen, 2018; Booth and Yamamura, 2018), which may reflect a reluctance among women to compete against men. Strategic interaction is typically ruled out by design in willingness-to-compete experiments, and how gender differences play out when the optimal choice depends on the anticipated behavior of competitors has therefore received even less attention.<sup>2</sup>

Our paper adds to a long list of papers that have employed TV game shows for the study of decision making. Starting in the 1990s, researchers have used the behavior of contestants to investigate, for example, risky choice (Gertner, 1993; Metrick, 1995; Post et al., 2008), strategic reasoning (Bennett and Hickman, 1993; Berk, Hughson and Vandezande, 1996; Tenorio and Cason, 2002), discrimination (Levitt, 2004; Antonovics, Arcidiacono and Walsh, 2005; Belot, Bhaskar and van de Ven, 2012), cooperation (List, 2006; Oberholzer-Gee, Waldfogel and White, 2010; van den Assem, van Dolder and Thaler, 2012; Turmunkh, van den Assem and van Dolder, 2019), and bargaining (van Dolder et al., 2015). Somewhat related to our study, Antonovics, Arcidiacono, and Walsh (2009) use data from American episodes of the game show *The Weakest Link* to analyze the impact of the gender of

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<sup>2</sup> An exception is Datta Gupta, Poulsen and Villeval (2013), who conduct an experiment with a game that resembles our head-to-head game. They find some evidence that men compete more against women in the treatment where the gender of the opponent is explicitly given, but the number of observations is small. Out of the eight males who faced a female opponent, five chose to compete (62.5%), whereas out of the twelve males who faced a male opponent, only four chose to compete (33.3%).

opponents on performance. They find some evidence that male contestants perform better when they face a female opponent than when they face a male opponent. The existing game show study that is closest to ours is Hogarth, Karelaia and Trujillo (2012). Hogarth, Karelaia and Trujillo analyze the Colombian game show “El Jugador”, which is built around a game that closely resembles the elimination game that we examine in the Appendix (for reasons explained in the next section). In line with our results, they report that women voluntarily exit the game more often than men, especially when in a minority.

The paper proceeds as follows. Section 2 describes the elimination competition of the Dutch version of Deal or No Deal in more detail, and discusses our data. Sections 3 and 4 cover the descriptions and analyses of the two different games of interest. Section 5 asks whether the results can be explained by gender differences in performance. Section 6 concludes.

## 2. Game Show and Data

The common and main part of all editions of the globally successful game show format Deal or No Deal is a high-stakes game that involves stop-go choices between accepting a sure amount and risky continuation.<sup>3</sup> The Dutch edition is called “Miljoenenjacht” (translated: “Chasing Millions”). This edition is unique because of the elimination competition that precedes the main game, and because the prizes are considerably larger than those in any other edition. Each episode starts with 500 contestants, and after various elimination games, the one remaining contestant plays the main game and in expectation takes home hundreds of thousands of euros. The Dutch edition owes the large stakes to the Dutch Postcode Lottery, which pays out all prizes as a part of their payout scheme. All 500 initial contestants have won their ticket through this lottery.<sup>4</sup> In addition to the lucrative possibility of becoming the finalist who plays the main game, contestants can win several other large prizes. These are allocated randomly or awarded as opt-out or consolation prizes.

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<sup>3</sup> This game is played by one contestant, who “owns” one sealed case—a briefcase or a box—out of a larger set of sealed cases that each contain a money prize. The prizes differ across editions, but are always known at the start and strongly right-skewed. Each round, the contestant opens a given number of cases and consequently learns which amounts are not in her own case. At the end of every round, a hypothetical “banker” makes an offer to buy her case, which she can then accept (“Deal”) or decline (“No Deal”). These stop-go decisions continue either until an offer is accepted, or until all cases are opened and the contestant receives the prize in her own case. The game can be considered as a naturally occurring risky choice experiment and has been exploited as such by many, including Deck, Lee and Reyes (2008), Post et al. (2008), Brooks et al. (2009), Blavatskyy and Pogrebna (2010), de Roos and Sarafidis (2010), Bombardini and Trebbi (2012), and Baltussen, van den Assem, and van Dolder (2016).

<sup>4</sup> A substantial fraction of the Dutch population take part in the Dutch Postcode Lottery. In 2017, for example, there were 7.8 million Dutch households, and 2.9 million participated. Sources: Annual Report 2017 Dutch Postcode Lottery, CBS Statline.

The first episode was aired on December 22, 2002. At the time of writing, the game show is still running. Our analysis uses the complete set of 183 episodes aired between inception and March 31, 2019. In this time span, there were 33 short series of weekly episodes, and 6 individual episodes on either New Year's Eve or New Year's Day. Most were recorded by the authors, and videotapes of early episodes were obtained from a Dutch broadcasting company. The expected value of the prizes in the main game varied between €391,411 in early episodes and €516,122 in later episodes. The largest prize was always five million euros. Most finalists at some point accepted a sure amount that was lower than the expected value of continuing. On average, a finalist took home €233,761.

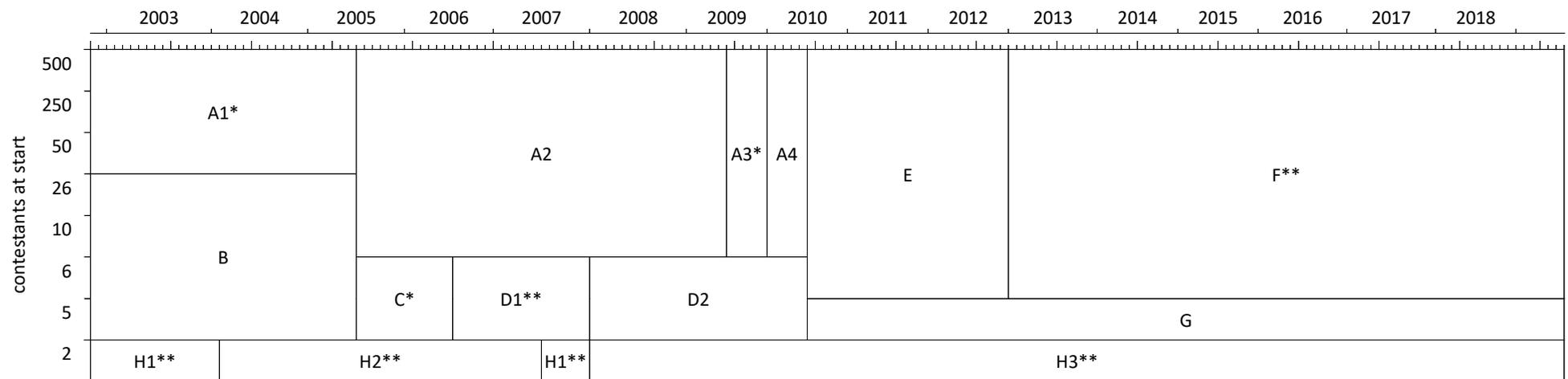
At the start of every elimination game, the 500 contestants are seated in the audience together with a friend or relative. To arrive at the final contestant, various elimination games are played. Figure 1 gives a schematic overview of the different games and how these were combined over time and episodes; thumbnail descriptions are in the notes. Games marked with one or two asterisks featured at least one opt-out opportunity. We analyze the three games that are marked with two asterisks.

The games featuring the opt-out options that we analyze in the next two sections are represented in Figure 1 as F and H1-3. Game F reduced the initial crowd from 500 to five, and is described and analyzed in Section 3. Games H1-3 are variants of the two-person game that determined the last elimination of every elimination competition, and are described and analyzed in Section 4.

Game D1 narrowed a group of six contestants down to two. The analysis of this game is in the Appendix for two reasons. First, the sample size is relatively small (17 episodes, 68 opt-out opportunities). Second, because of a censoring problem we are unable to draw clear conclusions. Nevertheless, the patterns that we observe in this third game are in line with the results for the two games that are the focus of our study.

We exclude the games labeled A1 and A3 because of small sample sizes and lack of choice variation. In Game A1, which lasted for 33 episodes, one randomly selected eliminated contestant was offered the choice between re-entering the competition and a prize worth between approximately €5k and €10k. The option to re-enter was absent in the very first episode, leaving a total of 32 observations for this game. Only two males (out of 21, or 10%) and two females (out of 11, or 18%) opted out. Similarly, in Game A3, three randomly selected eliminated contestants could either re-enter or accept a prize package worth between approximately €1k and €15k. That game lasted for only five episodes, and in all fifteen occasions the contestant chose to re-enter the competition.

We leave Game C out of consideration because of its complexity and the relatively small sample size. At the start of this game there were six contestants left. In each of four rounds, the contestant first to



**Figure 1: Schematic overview of elimination games across time and episodes.** Asterisks indicate that the elimination game featured one or more opt-out options, and whether we analyze it (\*\*) or not (\*). **A1\*** (33 eps.): The crowd is divided into five red and five blue blocks of 50 contestants each. Blocks consist of subblocks of 25 contestants. Contestants answer series of multiple-choice questions. In the first phase, either all red or all blue blocks are eliminated. In the second phase, four of the five remaining blocks are eliminated. The third phase determines the winning subblock. All 25 contestants in the winning subblock proceed to the next game. One previously eliminated person is randomly selected, and chooses between re-entering the competition and a known prize worth between approximately €5k and €10k. If she takes the prize, another randomly selected person re-enters the competition. **A2** (46 eps.): Six contestants proceed to the next game: the five best-performing contestants from the winning subblock and one randomly selected eliminated contestant (no opt-out option). Otherwise identical to A1. **A3\*** (5 eps.): Six contestants proceed to the next game. After each of the three phases, one previously eliminated person is randomly selected and chooses between re-entering the competition at the start of the next game and a known prize package worth between approximately €1k and €15k. The maximum of three re-entering contestants are complemented by the best-performing contestants from the winning subblock. Otherwise identical to A1. **A4** (5 eps.): Six contestants proceed to the next game. After each of the three phases, one randomly selected eliminated person gets a one-in-three chance of re-entering the competition at the start of the next game (no opt-out option). The maximum of three re-entering contestants are complemented by the best-performing contestants from the winning subblock. Otherwise identical to A1. **B** (33 eps.): The 26 contestants answer a series of multiple-choice questions. The two best-performing proceed to the next game, all others are eliminated. **C\*** (12 eps.): The game starts with six contestants, and features four quiz questions. Only the contestant first to press her button answers. If her answer is incorrect, she is eliminated. If her answer is correct, she must vote off one of her opponents. Prior to the revelation of the vote, these contestants can voluntarily leave the competition in exchange for a monetary opt-out prize. Only the contestant first to press her button opts out. If someone opts out, the vote is revealed but remains inconsequential. If no one opts out, the contestant voted against is eliminated. The total opt-out prize money available is €40k, divided unequally across four sealed cases. Opting-out contestants receive the prize in the case they select. Two contestants proceed to the next game. **D1\*\*** (17 eps.): The game starts with six contestants, and features four estimation questions. Contestants answer simultaneously and privately. Prior to identification of the contestant with the worst guess, they can voluntarily leave the game in exchange for a monetary opt-out prize. Only the contestant first to press her button opts out. If no one opts out, the contestant with the worst guess is eliminated. The total opt-out prize money available is €40k, divided unequally across four sealed cases. Opting-out contestants receive the prize in the case they select. Two contestants proceed to the next game. **D2** (27 eps.): No opt-out options. Otherwise identical to D1. **E** (25 eps.): The crowd of 500 contestants is divided into ten blocks of 50 contestants. In the first phase, contestants individually answer five multiple-choice questions. All but the best-performing contestant of each block are eliminated. In the second phase, the ten remaining contestants answer an estimation question in a head-to-head duel. The five winners proceed to the next game. **F\*\*** (69 eps.): The 500 contestants answer five estimation questions. Five opt-out prizes—the smallest always being €500 in cash and the largest always being an expensive car—are hidden in sealed cases. The contestant closest to the correct answer chooses between participation in the next game and one of the remaining hidden prizes. If she opts out, a randomly selected person takes her place in the next game. In total, five contestants proceed to the next game. **G** (94 eps.): The game starts with five contestants, and features three rounds of trivia quiz questions. In each round, one contestant is eliminated. Two proceed to the next game. **H1\*\*** (20 eps.): Head-to-head final elimination game. Throughout a short period of time, contestants can accept an unknown opt-out prize guaranteed to be worth at least €20k. The first to press her button receives the opt-out prize, the other then wins the elimination competition. If no one opts out, a sum is presented. The contestant first to press her button has to give the solution instantly. If her answer is correct (incorrect), she is the winner (eliminated). **H2\*\*** (42 eps.): If no one opts out, an estimation question and three possible answers are presented. The contestant first to press her button chooses one answer. If the chosen answer is correct, she is the winner. If it is incorrect, her opponent chooses one of the remaining answers. If that choice is correct (incorrect) the opponent (the first contestant) is the winner. Otherwise identical to H1. **H3\*\*** (121 eps.): Contestants can accept a cash opt-out prize that increases stepwise from €1k to an unknown maximum. The first to press her button fixes and receives the money amount, the other then wins the elimination competition. Otherwise identical to H1.

press her button answered a quiz question. If her answer was incorrect, she was eliminated. If her answer was correct, she designated one of the other contestants for elimination. Prior to the revelation of the name of the targeted contestant, contestants had to choose between a monetary opt-out prize (average value: €10k) and continuing, with the risk of being the one sent home empty-handed. This game was part of twelve episodes, and in total there were 41 cases where contestants faced the possibility to opt out. A proper analysis of this game takes account of differences in contestants' probability of being nominated for elimination, but the sample size is too small to reliably perform such an analysis.

Clearly, the stakes in the decisions that we study are high. Contestants are competing for the unique opportunity to play a game that offers life-changing amounts of prize money. Would we have run the two elimination games that we analyze and the subsequent finals as an experiment ourselves, the total cost in subject payoffs alone would have been nearly €50 million (accepted opt-out prizes: €4.8m; money won in the final: €42.8m).

### **3. Game One: From 500 to 5**

#### *Description and Data*

From 2013 onwards, the initial crowd of 500 contestants was reduced to five through five estimation questions. Examples are “How many ambulances are there in the Netherlands?” and “How many words does the first verse of the Dutch National Anthem have?”. For each of the five questions, the person closest to the correct answer (and the fastest in the case of a tie) was offered a choice between one of the five seats in the next elimination game and one of the opt-out prizes hidden in five large numbered briefcases. The smallest and the largest opt-out prize were always a monetary amount of €500 and an expensive car (mostly worth roughly €50k), respectively. The other three varied across episodes, and had a value between approximately €2k and €10k (examples are gift cards, holidays, electronics, and city cars). If the winning contestant chose the seat, one of the remaining cases was randomly assigned to someone else in the audience. If the winning contestant opted out, the seat left vacant was similarly given to someone else. Contrary to the game in the next section (and that in the Appendix), there is no strategic interaction in this game. In this sense, the decisions are close to the tournament-entry decisions in typical willingness-to-compete experiments.

We collected the data for all 344 choices between a seat and an opt-out prize made in the 69 episodes featuring this elimination game.<sup>5</sup> The average age of the contestants was 49 years (min: 21, max: 81).<sup>6</sup> The majority was male (208 out of 344, or 60.5%).

### *Analyses and Results*

Most contestants prefer taking the seat in the next stage over picking an opt-out prize: the overall opt-out rate is 18.9%. As illustrated by Figure 2a, women are approximately twice as likely as men to opt out (women: 27.9%, men: 13.0%;  $\chi^2(1) = 12.010$ ,  $p = 0.001$ ).

We estimate a multivariate linear probability model to control for variation in contestants' age, the attractiveness of the remaining opt-out prizes, and the question number. The dependent variable takes the value of one if the contestant opts out (and zero otherwise). We include a quadratic specification for age, because the raw data suggest a u-shaped relationship.<sup>7</sup> Age is an integer, measured in years and centered on the mean. We use two variables to control for the attractiveness of the set of remaining opt-out prizes: the probability of winning the expensive car, and the probability of winning the small cash prize of €500. Last, we include question-number fixed effects because seats allocated after earlier questions offer a better starting position in the next round and are therefore more valuable. We correct the standard errors for clustering at the episode level.

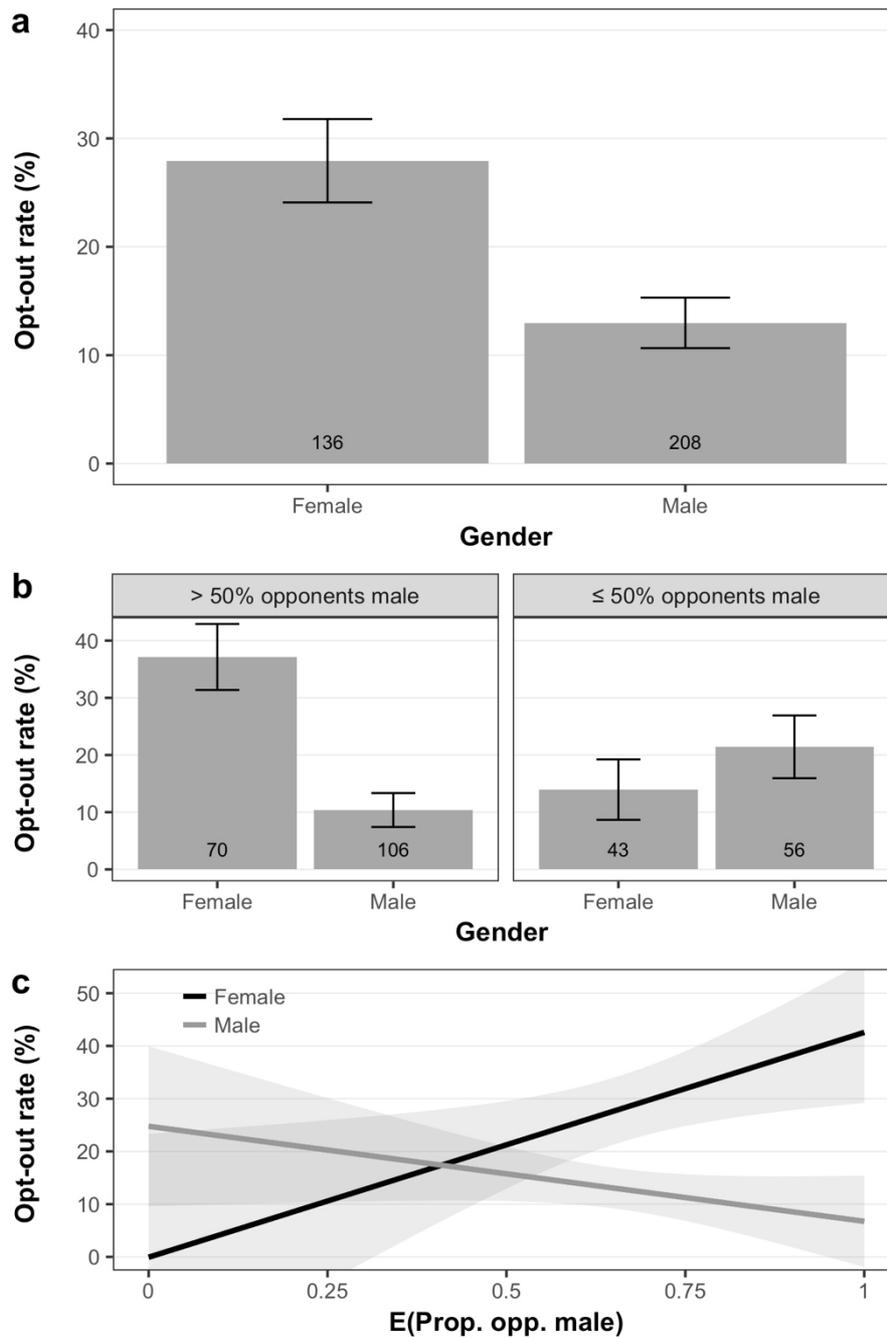
Table 1, Model 1 presents the results. The regression results closely match the raw comparisons of opt-out rates: after controlling for the effects of age, the attractiveness of the remaining prizes, and question-number fixed effects, women are 15.6 percentage points more likely to opt out than men. The regression results in addition confirm the u-shaped effect of age: the estimates imply that the opt-out rate decreases with age if the contestant is younger than 43 years, and increases with age for older contestants. As expected, contestants are more likely to opt out if the chance of winning the car is higher, and less likely to opt out if the chance of winning the small cash prize is higher.

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<sup>5</sup> Normally there were five choices per episode. In one episode, however, one contestant gave the best response to two estimation questions. Because she had already taken a seat in the next stage after the first question, she had no choice but to pick one of the remaining briefcases with an opt-out prize after the second.

<sup>6</sup> The age of the contestant was often mentioned in the episode itself or in a press release about the episode, or provided to us by the producer (213 cases, or 61.9%). In the remaining cases (131, or 38.1%), we estimated the contestant's age on the basis of physical appearance and other helpful information that was revealed in the episode or could be found on the internet, such as the age of children or when he or she went to secondary school.

<sup>7</sup> The opt-out rate is 19.0% for contestants younger than 40 years, 8.3% for contestants between 40 and 50 years, 18.2% for contestants between 50 and 60 years, and 35.2% for contestants 60 years or older.



**Figure 2: Opt-out rates for men and women in Game One.** (a) displays the opt-out rates for male and female contestants, measured across all questions. (b) displays the opt-out rates for male and female contestants across questions 2-5, conditional on whether more than half of the previously selected competitors for the next stage of the elimination competition are male (> 50% opponents male), and conditional on whether half or more of the previously selected competitors are female ( $\leq 50\%$  opponents male) at the time the contestant makes her opt-out decision. The number of observations is at the bottom of each bar. Error bars depict standard errors around the mean. (c) displays the univariate linear relationship between the opt-out rate and the expected proportion of male opponents, estimated across all questions, for male and female contestants separately. The shaded areas represent 90% confidence intervals.

**Table 1: Regression results for Game One**

The table displays results from regression analyses of contestants' decisions to opt out (1) or not (0) in the first game. *Female* is a dummy variable that takes the value of 1 if the contestant is female. *Age* is the contestant's age, measured in years and centered on the mean (48.7y). *Majority opp. male* is a dummy variable that takes the value of 1 if the majority of already selected competitors are male, and is missing if no competitors are selected yet. *E(Prop. opp. male)* is the expected proportion of male opponents, centered on the mean. *P(Car)* is the probability that a contestant who opts out wins the expensive car. *P(Small prize)* is the probability that a contestant who opts out wins the small prize of €500. All models include question-number fixed effects. Standard errors (in parentheses) are corrected for clustering at the episode level. Asterisks denote statistical significance at the one \*\*\*, five \*\* and ten \* percent level, respectively.

	Model 1	Model 2	Model 3	Model 4	Model 5
Female	0.156*** (0.051)	0.148** (0.060)	-0.033 (0.078)	0.156*** (0.051)	0.156*** (0.046)
Age	0.004** (0.002)	0.004** (0.002)	0.004** (0.002)	0.004** (0.002)	0.004** (0.002)
Age <sup>2</sup> / 100	0.035*** (0.010)	0.031*** (0.010)	0.027** (0.011)	0.035*** (0.010)	0.033*** (0.010)
Majority opp. male		0.012 (0.043)	-0.109 (0.066)		
Female x Majority opp. male			0.289*** (0.108)		
E(Prop. opp. male)				0.054 (0.096)	-0.158 (0.148)
Female x E(Prop. opp. male)					0.495** (0.247)
P(Car)	0.309*** (0.100)	0.305*** (0.101)	0.311*** (0.102)	0.310*** (0.102)	0.304*** (0.103)
P(Small prize)	-0.202*** (0.074)	-0.204*** (0.073)	-0.202*** (0.073)	-0.199*** (0.073)	-0.204*** (0.074)
Question-number fixed effects	yes	yes	yes	yes	yes
Data included	all	questions 2-5	questions 2-5	all	all
R <sup>2</sup>	0.153	0.152	0.180	0.153	0.165
No. of observations	344	275	275	344	344
No. of episodes	69	69	69	69	69

The contestant who decides following the first estimation question does not yet know the gender of her competitors in the next game, but those who make their choice after the other four do know the gender of some (questions 2-4) or all (question 5) competitors. To investigate whether men and women condition their opt-out decision on the gender composition of the existing set of competitors, we distinguish between situations where most of the occupied seats in the next game are taken by men (> 50% male) and situations where half or more of the seats are taken by women ( $\leq$  50% male) at the time the contestant makes her opt-out decision.<sup>8</sup> Because of the higher proportion of male

<sup>8</sup> A player who makes her opt-out decision after question  $i$  knows the identity of  $i-1$  competitors. The majority of seats are therefore filled by male contestants if 1/1 is taken by a man after question 2, if 2/2 are taken by men

contestants in the initial crowd and because of the higher opt-out rate among women, a majority (177 out of 276, or 64.1%) was facing predominantly male opponents when they had to make their decision.

Figure 2b depicts the opt-out rates for men and women across questions 2-5, conditional on whether most of the previously selected competitors are male and conditional on whether half or more are female. The differences are large. Women are significantly more likely to opt out than men if the majority of filled seats are occupied by men (women: 37.1%, men: 10.4%;  $Chi^2(1) = 18.191, p < 0.001$ ). If at least half of the seats are taken by women, however, the opt-out rates of men and women are statistically not significantly different (women: 14.0%, men: 21.4%;  $Chi^2(1) = 0.913, p = 0.339$ ). Based on these opt-out rates, both men and women appear to dislike competing against the opposite sex: if more than half of the previously selected opponents are male, women are significantly more likely to opt out ( $> 50\%$  male: 37.1%,  $\leq 50\%$  male: 14.0%;  $Chi^2(1) = 7.056, p = 0.008$ ), and men are marginally significantly less likely to opt out ( $> 50\%$  male: 10.4%,  $\leq 50\%$  male: 21.4%;  $Chi^2(1) = 3.674, p = 0.055$ ) as compared to situations where at least half are female.

In Table 1, Model 2 adds a dummy variable to the regression analysis that takes the value of one if more than half of the previously selected opponents are male (and zero otherwise), and shows that there is no significant main effect of the gender composition on opt-out rates ( $p = 0.782$ ). Model 3 adds the interaction of this dummy variable with the contestant's own gender. In line with the raw statistics, men and women respond significantly different to the gender composition ( $p = 0.009$ ). Women are 18.0 percentage points more likely to opt out if the majority of already selected contestants are male as compared to situations where half or more are female ( $-0.109 + 0.289 = 0.180$ ;  $p = 0.013$ ). Men, in contrast, are 10.9 percentage points less likely to opt out when the majority of selected opponents are male as compared to situations where half or more are female, but statistically this difference is not significant ( $p = 0.104$ ). The opt-out rates differ significantly between men and women in male-dominated environments only: women are 25.6 percentage points more likely to opt out than men when the majority of selected opponents are male ( $-0.033 + 0.289 = 0.256$ ;  $p = 0.001$ ), but statistically neither more nor less likely to opt out when half or more are female ( $p = 0.676$ ).

The binary division of whether more or less than half of already selected opponents are male is rather crude, and also neglects that the ultimate composition depends on the gender of the opponents who take the remaining vacant seats. We therefore in addition investigate the effect of gender composition by looking at the expected proportion of males among the total of four competitors in the next elimination game. Across all episodes, 219 out of the 345 contestants who proceed to the next stage

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after question 3, if 2/3 or 3/3 are taken by men after question 4, and if 3/4 or 4/4 are taken by men after question 5.

are male (63.5%). To calculate the expected number of male opponents at the moment a contestant makes her opt-out decision, we adopt this proportion and assume that the likelihood that a vacant seat is taken by a male (female) is 0.635 (0.365). Figure 2c shows the linearly fitted relationship between the opt-out rate and the expected proportion of male opponents, for male and female contestants separately. The graph indicates that the difference in opt-out rates between men and women reaches statistical significance only if the expected proportion of male opponents is high.

In Table 1, Model 4 includes the expected proportion of males as a regressor, and shows again that there is no significant main effect of gender composition on contestants' opt-out propensity ( $p = 0.575$ ). Model 5 adds the interaction of the expected proportion of males and contestants' own gender, and confirms that men and women respond differently to the expected gender composition ( $p = 0.049$ ). If the expected proportion of male opponents increases by 0.25—an increase that corresponds to one additional male opponent—women become 8.4 percentage points more likely to opt out ( $0.25 \times -0.158 + 0.25 \times 0.495 = 0.084$ ;  $p = 0.045$ ), while the opt-out propensity of men is not significantly affected ( $0.25 \times -0.158 = -0.040$ ;  $p = 0.289$ ). The opt-out rates of men and women are statistically significantly different at the five percent level if the expected proportion of male opponents exceeds fifty percent.

In summary, the results for this first game confirm that the gender difference in willingness to enter competitions—robustly found in lab and classroom experiments with low stakes—is also present in an environment with very high monetary stakes: 13 percent of men and 28 percent of women choose to opt out of the competition in return for a relatively modest prize. Interestingly, the comparatively high opt-out rate of women derives entirely from situations where the majority of their opponents are (or are expected to be) male, which suggests that women have a particular dislike of competition against men, rather than a higher general aversion to competition.

#### **4. Game Two: Head to Head**

##### *Description and Data*

At the very last stage of every elimination competition there are two contestants left. Only one of them will play Deal or No Deal, the game of chance worth hundreds of thousands of euros. A final question determines the last elimination, unless one of the two contestants voluntarily accepts an opt-out prize to avoid the head-to-head confrontation and the risk of leaving empty-handed. This opportunity to opt out starts as soon as the light bulb located in between the two contestants turns green, and lasts only briefly. As long as the light bulb is green, one of them can accept the prize by being the first to hit a

button located within their reach. If no one moves and the light turns red, indicating that the possibility to opt out is over, the two contestants proceed to the decisive question.

In contrast to the previous section, the opt-out decisions studied here are of a strategic nature. If one of the contestants opts out, the other automatically proceeds to the lucrative final. Contestants should therefore not just consider their willingness to bet on their ability to beat their opponent, but also the likelihood that their opponent will opt out.

All 183 episodes featured a variant of this game. In Figure 1, these variants are represented as H1, H2 and H3. In the first 62 episodes (H1 and H2), the exact opt-out prize was unknown to the contestants, but guaranteed to be worth at least €20,000. Frequently, the prize turned out to be an expensive car (mostly worth roughly €50,000). Other common prizes were luxurious trips (often with pocket money or a suitcase set included), electronics packages, and gift cards for traveling, jewelry, or furniture. In 23 episodes with this variant (37%) one of the two contestants opted out. This happened after 3 seconds on average (min: 1s; max 9s). When no one budged (39 episodes; 63%), the maximum time available for opting out varied between 6 and 17 seconds (avg: 9s).

In the remaining 121 episodes (H3), contestants could opt out for a cash prize that increased stepwise from €1,000 to a predetermined maximum. This maximum was unknown to the contestants, and ranged between €20,000 and €108,000 (avg: €51,470). The first contestant to press her button stopped the clock and received the then shown cash prize. In 78 episodes (64%), one of the two contestants opted out, for an amount between €16,600 and €70,900 (avg: €38,712). This happened after 28 seconds on average (min: 8s; max 45s). In the other 43 episodes, in which nobody pressed the button, the time window during which the opt-out prize kept increasing lasted for between 19 and 55 seconds (avg: 32s).

In 143 episodes (H1 and H3), the decisive question was (or would have been) a relatively simple math problem. Examples are “ $356 + 147 = ?$ ”, “ $4 \times 44 = ?$ ”, and “ $314 - 118 = ?$ ”. The first contestant to press her button had to give the solution instantly. If her answer was correct, she was the winner and subsequently played Deal or No Deal. If her answer was incorrect, she was eliminated and the other contestant played the final game. The answers given were correct in 39 out of 54 attempts (72%).

In the remaining 40 episodes (H2), the decisive question was (or would have been) an estimation question. Contestants could choose from three possible answers. The first to press her button chose first. If the chosen answer was correct, she was the winner. If the chosen answer was incorrect, her opponent chose one of the two remaining answers. If that choice was correct, this second contestant was the winner. If it was incorrect, the first contestant would proceed to the final game. First attempts were correct 7 out of 28 times (25.0%), second attempts 11 out of 21 times (52.4%).

We collected the data for this elimination game for all 183 episodes. Owing to the introductory talk of the game show host with the two contestants, we could also estimate each contestant's level of education. Education is usually not explicitly mentioned, but it is often clear from the stated profession. We coded education as a dummy variable, with a value of one assigned to contestants with a bachelor's degree level or higher (including students) or equivalent work experience.

The majority of the contestants were male (255 out of 366, or 61.9%). The average age was 46 years (min: 21, max: 86), and 38.0 percent were high-educated (139 out of 366).<sup>9</sup> An opt out occurred in 55.2 percent of the episodes (101 out of 183).

### *Analyses and Results*

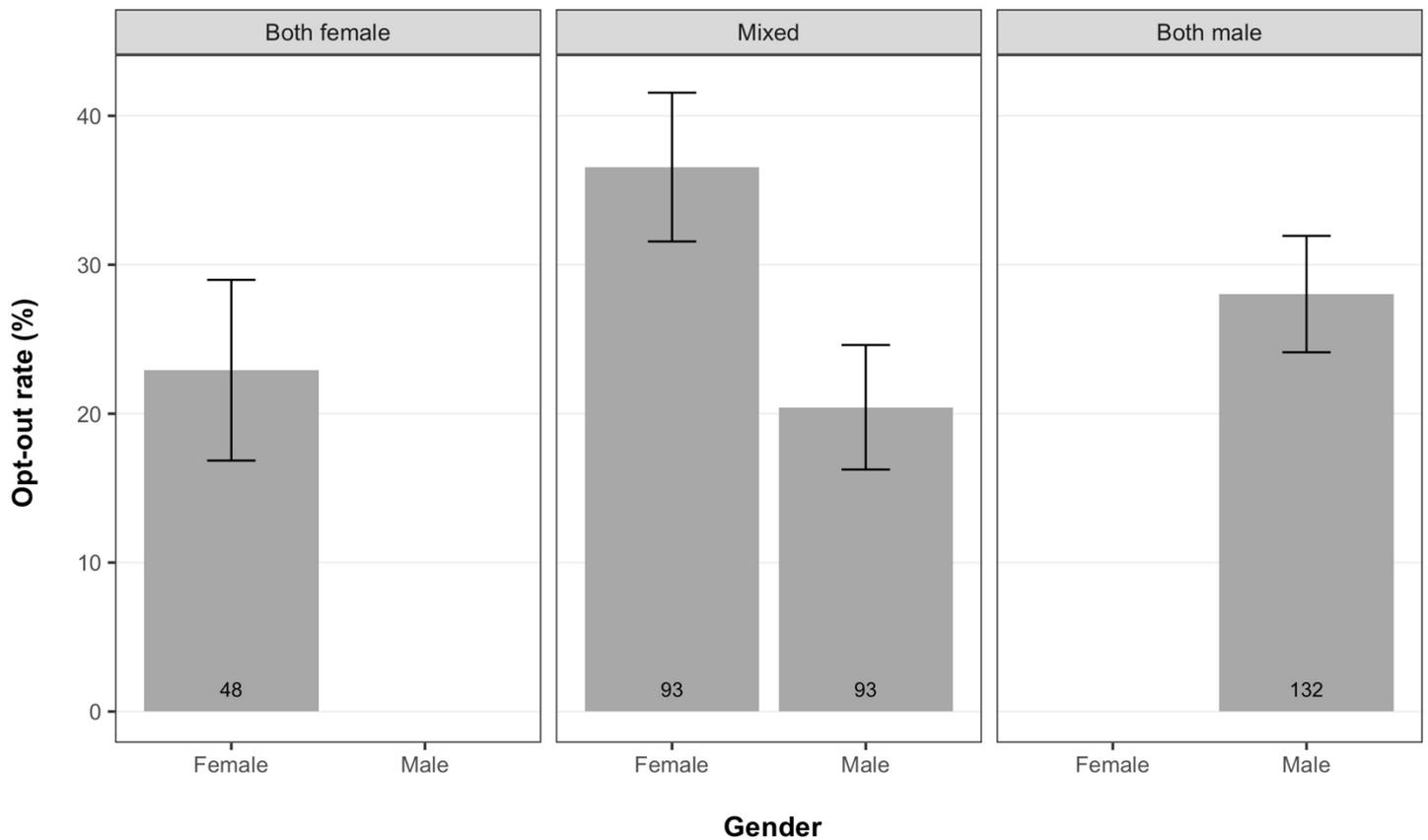
Across all episodes combined, women opt out more frequently than men, but this difference is not statistically significant: 45 out of 141 women (31.9%) and 56 out of 225 men (24.9%) at some point press their button ( $Chi^2(1) = 2.14, p = 0.143$ ).

Of the 183 pairs that we observe, 24 consist of two women (13.1%), 66 consist of two men (36.1%), and 93 are mixed (50.8%). Figure 3 depicts the opt-out rates of men and women for the different kinds of pairs. In mixed-gender pairs, women are almost twice as likely to opt out as men (women: 36.6%, men: 20.4%;  $Chi^2(1) = 5.937, p = 0.015$ ). On the other hand, women facing a woman do not opt out significantly more frequently than men facing a man (women vs. woman: 22.9%, men vs. man: 28.0%;  $Chi^2(1) = 0.471, p = 0.493$ ). These two comparisons suggest that opt-out decisions depend on the gender of the opponent.

We cannot use simple comparisons to examine how men and women respond to the gender of their opponent, because the present game comes with a censoring problem: at most one of the two contestants can opt out, and we do not observe what a contestant whose opponent opts out would have done if her opponent had not opted out. Consequently, observed opt-out rates do not only depend on contestants' own opt-out propensity, but also on that of their opponents. For example, if women always immediately opt out when they face a man, we would mechanically observe an opt-out rate of zero for men who face a woman. If the opt-out intentions of men are not affected by the gender of their opponent, a simple comparison of the behavior of men in the two possible situations—men facing a man vs. men facing a woman—would wrongly suggest that such a dependency does exist.

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<sup>9</sup> Age was given for 207 (56.6%) and estimated for 159 (43.4%) contestants; sources and procedures are identical to those used for the previous game (see footnote 6).



**Figure 3: Opt-out rates for men and women in Game Two.** The figure displays the opt-out rates for male and female contestants, separately for female-female (both female), female-male (mixed), and male-male (both male) pairs. The number of observations is at the bottom of each bar. Error bars depict standard errors around the mean.

To deal with this censoring issue, we analyze the behavior of contestants on a second-by-second basis. Contestants can wait for an unknown but considerable amount of time in the hope that the other opts out. Every second that passes until either someone opts out or time runs out is informative about the two contestants' opt-out propensities: the longer a contestant waits, the more she risks that she has to compete.

We exploit this temporal aspect of the game with a Cox proportional hazards approach (Cox, 1972), and study contestants' decisions to opt out or not during all seconds in which they could make this decision.<sup>10</sup> The format of the elimination game with the unknown prize (H1 and H2) differs substantially

<sup>10</sup> We exclude the second in which a contestant's opponent opted out, because it is unknown whether or not the contestant would otherwise have opted out herself in that second. Eight contestants are not included in the

from the elimination game with the increasing cash prize (H3), and therefore we allow the baseline hazard to differ between these two variants. Furthermore, the models include a dummy variable to distinguish between games where the decisive question is (or would be) a sum and games featuring a multiple-choice estimation question, and a variable that equals the natural logarithm of the predetermined maximum opt-out cash prize for games where the opt-out prize increased stepwise (H3).<sup>11</sup> In addition, we include a quadratic specification for age, and a dummy variable for education that differentiates between those with at least a bachelor's degree and those without. Last, we correct the standard errors for clustering at the episode level.

Table 2 presents the results. Model 1 considers all pairs and confirms the descriptive result that there is no significant gender difference in opt-out rates ( $p = 0.555$ ). As expected, contestants facing a stepwise increasing opt-out prize are more likely to opt out if there is more money on offer. We again find a u-shaped relation with age: the estimates imply that the opt-out rate decreases with age if the contestant is younger than 46 years, and increases with age for older contestants. Education and type of decisive question do not significantly affect opt-out rates.

Model 2 exclusively considers mixed-gender cases, and confirms the descriptive result that women are significantly more likely to opt out than men in these situations. At any given moment, women are 85.3 percent more likely to opt out ( $p = 0.029$ ). Model 3 exclusively considers single-gender pairs, and confirms that women facing a woman are not significantly more likely to opt out than men facing a man. In fact, the estimated hazard rate implies that women facing a woman are, at any given moment, 34.6 percent *less* likely to opt out than men facing a man. This difference, however, is statistically insignificant ( $p = 0.272$ ).

The results for Models 1, 2, and 3 suggest that in this strategic game men and women are roughly equally willing to compete (Models 1 and 3), but at the same time show that there is a large difference when they face an opponent of the opposite sex (Model 2). This combination of findings is consistent (i) with a lower propensity among women to compete against men than against women, as we also found for the first game, (ii) with a higher propensity among men to compete against women than against men, and (iii) with a combination of (i) and (ii).

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analysis, because their opponent opted out in the very first second. We find similar results if we include these seconds (assuming no opt out by the contestant).

<sup>11</sup> For variant H1 and H2 we set the value of the maximum opt-out prize variable to zero. The results do not depend on this choice, as long as the same value is applied for all H1 and H2 episodes.

**Table 2: Regression results for Game Two**

The table displays hazard ratios from Cox proportional hazards model analyses of contestants' decisions to opt out (1) or not (0) in the second game. The estimation is stratified such that the baseline hazard is allowed to vary between the variant with an unknown prize and the variant with the money counter. *Age* is the contestant's age, measured in years and centered on the mean (46.4y). *High educ.* is a dummy variable that takes the value of 1 if the contestant has completed or is enrolled in higher education (bachelor's degree or higher), or has equivalent working experience. *Opp. male* is a dummy variable that takes the value of 1 if the opponent is male. *Sum* is a dummy variable that takes the value of 1 if the final question is a sum. *Maximum prize (log)* is the natural logarithm of the predetermined maximum opt-out cash prize in the H3 variant (and takes the value of zero for variants H1 and H2). *Time at risk* is the total number of seconds during which contestants could opt out. Standard errors (in parentheses) are corrected for clustering at the episode level. Other definitions are as in Table 1.

	Model 1	Model 2	Model 3	Model 4	Model 5
Female	1.126 (0.226)	1.853** (0.523)	0.654 (0.253)	1.049 (0.219)	1.109 (0.426)
Age	1.001 (0.008)	0.986 (0.012)	1.008 (0.012)	0.999 (0.008)	0.999 (0.008)
Age <sup>2</sup> / 100	1.145*** (0.046)	1.242*** (0.060)	1.039 (0.108)	1.163*** (0.050)	1.163*** (0.050)
High educ.	0.780 (0.175)	0.556* (0.187)	0.708 (0.245)	0.736 (0.170)	0.734 (0.168)
Opp. male				1.649** (0.343)	1.701** (0.452)
Female x Opp. male					0.924 (0.422)
Maximum prize (log)	3.625*** (1.368)	2.784** (1.282)	5.273*** (2.657)	3.485*** (1.298)	3.531*** (1.302)
Sum	1.803 (0.746)	1.853 (0.939)	1.639 (1.091)	1.750 (0.720)	1.745 (0.718)
Data included	all	mixed-gender	single-gender	all	all
<i>LL</i>	-454.77	-198.33	-181.19	-452.16	-452.14
Time at risk	7,777	3,919	3,858	7,777	7,777
No. of contestants	358	181	177	358	358
No. of opt-outs	101	53	48	101	101
No. of episodes	183	93	90	183	183

To disentangle these possible explanations, Models 4 and 5 use the data of all pairs of contestants. Model 4 includes a dummy variable that captures the gender of the opponent, and shows that contestants are 64.9 percent more likely to opt out when facing a man than when facing a woman ( $p = 0.016$ ). Model 5 adds the interaction of the contestant's own gender and the opponent's gender, and indicates that there is no significant evidence that men and women respond differently to the gender of the opponent ( $p = 0.863$ ). Altogether, the results for this strategic game show that men and women are roughly equally willing to compete, and that both avoid competing against a male opponent.

A difference with the previous game is that, before they entered this game, many contestants had been offered (and declined) one or more opportunities to opt out of the elimination competition. Consequently, it is likely that there was some degree of self-selection on competitiveness among the contestants that we observe, which may have decreased a possible gender difference. However, it is unclear how self-selection could explain why both genders avoid competing against men in this game. The game that we analyze in the Appendix also has strategic interaction but no prior self-selection, and similarly yields evidence that both men and women avoid competing against men.

Combined, the analyses of the different games suggest that women have a particular dislike of competing against men, and that men are aware of this preference and exploit it in a strategic setting. There is barely any evidence for a general gender difference in the willingness to compete.

### **5. Do the Quiz Questions Favor Men?**

A possible alternative explanation for some of the main results of our analyses is that women perform worse on the type of questions that are used in the elimination contest. If the questions favor men, it is rational for both men and women to respond to the gender composition of the competitor base, by being more likely to opt out if the pool of competitors is more male-dominated. Such behavior is observed in the second game (and in the game in the Appendix), but not in the first.

A priori, there is little reason to believe that there are material gender differences in performance among the contestants. First, the literature suggests that there are no gender differences in semantic memory (storing factual information) and in math ability, the two basic abilities that are fundamental to answering the type of questions in the elimination games (Herlitz, Nilsson and Bäckman, 1997; Nilsson, 2003; Hyde et al., 2008; Lindberg et al., 2010). Second, because most of the contestants in our analyses are from a high segment of the skill distribution, differences between contestants are likely to be relatively small. In the games that we study, almost all are people who made it up to that point because of exceptional performance.<sup>12</sup> If there were any gender difference in skill among our audience members to begin with, it would be less pronounced among the select group of people that we observe in our games.

We can also use our data to explore whether men and women perform similar or not. In the stage-one game studied in Section 3, we can compare the gender of contestants who provided the best answer

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<sup>12</sup> In the first game, all gave a better response to an estimation question than nearly 500 competitors. In the second, all survived multiple elimination games (see Figure 1). In the game analyzed in the Appendix, five out of the six contestants were top performing contestants after three series of multiple-choice questions (one was randomly selected; this person is the only exception).

to one of the five questions—which are similar in nature to questions used in subsequent games—with the gender of randomly selected contestants who were given a seat in the next stage if the opt-out prize was chosen. In other words, we can examine whether the gender composition of successful contestants matches the gender composition of the population they are from. If one gender were better at the task, we would expect that gender to be overrepresented among the successful contestants. In total, there were 345 winners in the 69 episodes that featured this game. Among those winners there were 208 men (60.3%). The number of contestants who received a seat in the next stage at random was 66. Among these lucky contestants, 38 were male (57.6%). The similarity of the two proportions suggests that the estimation questions did not particularly favor one of the two genders ( $Chi^2(1) = 0.170, p = 0.680$ ).

We can also compare the overall performance of the two genders for Game G (see Figure 1). This game starts with five contestants and ends with two after three rounds of trivia quiz questions, with no possibility to opt out. The total pool of 345 contestants entering this game from Game F was composed of 219 (63.5%) men and 126 (36.5%) women. Out of the 138 survivors, 91 (65.9%) were male and 47 (34.1%) female. These statistics suggest that Game G does not favor one gender: considered ex-post, the two genders had a similar chance of survival (men: 41.6%, women: 37.3%;  $Chi^2(1) = 0.602; p = 0.438$ ).<sup>13</sup> Note, however, that most of the contestants in this comparison have chosen to continue the competition and enter this game when they were offered the possibility to opt out. If opting-out contestants were anticipating poor performance and those who continued believed they are good enough, the previous comparison might not capture the true gender difference in performance. Reassuringly, the same picture emerges when we exclusively focus on the 66 contestants who received their seat in this game at random and were not given the opportunity to opt out: 12 of the 38 men survive (31.6%), and 8 of the 28 women (28.6%;  $Chi^2(1) = 0.069, p = 0.793$ ).

The notion that the quiz questions might favor men should be less of a concern for the game analyzed in the Appendix. Contestants gave their answers to the estimation questions in that game before they made the decision to opt out or not, and our regressions control for whether the contestant's answer ranked worst (which meant elimination if no one opted out). Moreover, our data does not yield compelling evidence of a gender difference in performance for this game. In the first round, where all 102 contestants answered the question, the frequencies by which men and women gave the worst answer are statistically indistinguishable (men: 19.2%, women: 14.0%;  $Chi^2(1) = 0.502, p = 0.479$ ).

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<sup>13</sup> We obtain a similar result when we run a multivariate linear probability model where the dependent variable takes the value of one if the contestant survived (and zero otherwise), and where we include fixed effects for the contestant's seat number (lower numbers are more advantageous) and a quadratic specification for age. The coefficient for the contestant's gender in this regression is statistically insignificant ( $p = 0.372$ ).

Combining all the data for this game in a regression—where we include fixed effects for the round number and a quadratic specification for age, and where we correct standard errors for clustering at the contestant and at the episode-round level—similarly yields no convincing evidence of a difference: women are 7.4 percentage points more likely to give the worst answer, but this effect is statistically insignificant ( $p = 0.108$ ).

In the last game, the head-to-head game studied in Section 4, gender differences in ability are least likely to occur: those who made it to this stage have survived the previous stages of the elimination competition, and all can therefore be expected to be relatively strong. Still, we can empirically examine whether there are performance differences in the subset of 82 cases where neither of the two contestants opted out. This sample comprises 98 (59.8%) men and 66 (40.2%) women. Out of the 82 cases, 54 were decided through a sum and 28 through a multiple-choice estimation question. We find no significant gender difference in performance among the contestants who pressed the button first and answered the decisive question, neither when we consider the sum nor when we consider the multiple-choice estimation question: in the former case, 26 out of 34 men (76.5%) and 13 out of 20 women (65.0%) provided a correct answer ( $Chi^2(1) = 0.826$ ,  $p = 0.363$ ); in the latter case 3 out of 17 men (17.7%) and 4 out of 11 women (36.4%) provided a correct answer ( $Chi^2(1) = 1.248$ ,  $p = 0.264$ ). Furthermore, we can use the mixed-gender pairs to explore whether men and women differ in their propensity to press the button and answer the question. Any such difference could reflect a gender difference in competitiveness, but also a gender difference in the ability to give the correct answer. The data, however, suggest that men and women are roughly equally likely to press the button. Out of the 26 mixed-gender cases where the final question is a sum, the man (woman) presses the button 14 (12) times (men: 53.8%, women: 46.2%;  $Chi^2(1) = 0.308$ ,  $p = 0.579$ ). Out of the 14 mixed-gender cases with a multiple-choice question, the man (woman) is the first to press the button 8 (6) times (men: 57.1%, women: 42.9%;  $Chi^2(1) = 0.571$ ,  $p = 0.450$ ).

In conclusion, our data provide no compelling evidence that men and women perform differently on the tasks that are central in the elimination competition. Taken together, it is unlikely that the results in the previous sections are driven by differences in the ability of men and women to answer the questions.

## 6. Conclusion and Discussion

The present paper examined gender differences in willingness to compete for high stakes, using a TV game show where the winner of an elimination competition plays a game of chance worth hundreds of thousands of euros. The amounts that are at stake in this real-life setting are much closer to the

sums involved in promotion competitions at the top of the labor market than the financial rewards that are commonly employed in laboratory experiments.

We focused on two different games. In the first, contestants choose between competing in the next elimination game and opting out for a prize. This decision resembles the tournament-entry decision that subjects typically make in lab experiments. In line with the picture that emerges from the experimental literature, we find that women are twice as likely as men to avoid the competition. The comparatively high opt-out rate of women, however, derives entirely from situations where they will face predominantly male opponents. This suggests that women have a particular dislike of competing against men, rather than a more general dislike of competition. Men do not appear to condition their behavior on the gender of their opponents in this non-strategic game.

In the second game, one question determines the last elimination, unless one of the two remaining contestants voluntarily accepts an opt-out prize. This head-to-head game is relatively complex, because the optimal choice depends on the anticipated behavior of the opponent. The results show that both genders avoid competing against a male opponent in this strategic setting. The same pattern arises in the strategic game analyzed in the Appendix. This confirms the result for the first game that women avoid competing against men, and suggests that in strategic interactions men anticipate a lower willingness to compete among their female opponents. In line with the results for the first game, there is no evidence of a main effect of gender on competitiveness.

Altogether, the results confirm that gender differences in willingness to compete also occur in situations where the stakes are very high, but they also indicate that the stereotypical image and widely-held belief that women are less competitive than men is too simplistic. The findings show the importance of both the gender of competitors and the presence of strategic interaction. Hitherto, the literature on gender differences in willingness to compete has largely ignored these two factors.

The few studies that examine the importance of the gender of opponents on willingness to compete in a non-strategic setting report somewhat mixed results. Große and Riener (2010), Booth and Nolen (2012) and Geraldes (2018) find that women avoid competing against men in small-stake laboratory experiments, but Flory, Leibbrandt and List (2015) find no such evidence in a field experiment on job-entry decisions. Combined, these results seem to suggest that women's distaste of competing against men is relatively weak, and easily dwarfed when the incentive to compete increases. Our study shows that this is not the case, and provides the first high-stakes field evidence that women particularly avoid competing against men.

Strategic interaction is typically ruled out by design in willingness-to-compete experiments, but plays an important role in many real-life competition choices. Research somewhat removed from the

willingness-to-compete literature similarly shows that in strategic interactions both men and women respond to the gender of their opponent. Booth and Yamamura (2018) study Japanese speedboat races and find that men adopt a more aggressive racing style in mixed-gender races than in single-gender races, whereas women act less aggressively in mixed-gender races than in single-gender races. Babcock et al. (2017) show that both men and women are less likely to volunteer for an undesirable task when there are more women in the group.

Our setting differs in a number of ways from that of a traditional laboratory experiment. In addition to the markedly higher stakes, the subject pool that we observe is much more diverse, and because of the presence of a large audience and cameras, our contestants' decisions are observed by many and subject to considerable public scrutiny. A benefit of the diverse pool of contestants is that we can also explore how competitiveness varies with age. We consistently find a u-shaped relation, with people who are in their forties displaying the lowest opt-out propensity. Mayr et al. (2012) find a similar relation between age and competitiveness among subjects in an incentivized experiment. Flory et al. (2018) and Buser, Niederle and Oosterbeek (2020), however, report different age patterns.

A benefit of the public nature of the competition is that this feature is shared by many consequential real-world competitions. In the political arena and upper echelons of the corporate world, for example, people face considerable public scrutiny when they compete for top positions. This is another argument for why our naturally occurring setting is more similar to such real-world situations than anonymous, low-stakes laboratory experiments. Because opting out of the competition ends public observability and choosing to compete extends it, a difference in the attitudes of men and women towards public observability would obfuscate the relation between gender and competitiveness. To the best of our knowledge, the only paper that studies the impact of public observability on competitiveness is Buser, Ranehill and van Veldhuizen (2019). They find suggestive evidence that public observability increases men's willingness to compete, but conclude that public observability does not alter the magnitude of the gender gap in willingness to compete in an economically or statistically significant way.<sup>14</sup> This possible confound also occurs in many real-life settings, but cannot explain why women display a particular dislike of competing against men and why men are more competitive when they face women in a strategic setting.

Similar to the tasks that are typically used in willingness-to-compete experiments, the questions that are central in the elimination competition are often numerical or arithmetic in nature. This similarity facilitates the comparison of results. Research on competitiveness often intentionally uses such tasks

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<sup>14</sup> In line with these results, Cahlíková, Cingl and Lively (2020) find that psychosocial stress induced by speaking before a committee of experimenters does not affect the gender gap in willingness to compete.

because mathematics is a stereotypically male area, which brings the research closer to competitive situations in male-dominated workplaces or male-connotated areas such as management (Niederle and Vesterlund, 2011). Although we cannot entirely rule out that our results are partly driven by a gender difference in the ability to answer the questions, none of the additional analyses of our data provide evidence that the quiz questions actually favor men. Second, based on research into math performance and research into recall of factual information, there is little reason to believe that such a difference holds true for the general population (Herlitz et al., 1997; Nilsson, 2003; Hyde et al., 2008; Lindberg et al., 2010). Last, even if any gender difference would exist among the initial pool of contestants, it would be relatively small among those we study because weaker contestants are less likely to reach the stages of interest.

Of course, contestants may have held non-rational expectations about their own ability and that of others, possibly inspired by stereotypes about the performance of men and women on math questions. Indeed, in experimental work that uses a neutral or stereotypically female type of task, competitiveness differences between men and women are sometimes, but not always, weak or absent (Große and Riener, 2010; Shurchkov, 2012; Dreber, von Essen and Ranehill, 2014; Wozniak, Harbaugh and Mayr, 2014). Stereotype-biased beliefs about performance may explain why women display a relatively low propensity to compete against men in all the games that we study, and why men display a relatively high propensity to compete against women when the game is strategic. This explanation, however, is not supported by the behavior of men in the first game: there is no evidence that men are especially eager to compete against women. If anything, men are more likely to opt out against women than against men in this game.

A possible concern about our findings is that their generalizability might be limited because of selection effects. Selection procedures are inevitable in any lab experiment or field setting, and could potentially bias comparisons of the behavior of men and women (Larkin and Pines, 2003; Reback and Stowe, 2011; Hogarth, Karelaia and Trujillo, 2012; Dariel, Nikiforakis and Stoop, 2020). Unlike contestants in most other game shows, however, contestants in our elimination competition do not need to self-select into auditions and are not screened and then selected by producers prior to their participation. All have won their ticket through the popular Dutch Postcode Lottery. Even for competition-averse individuals, using this ticket is attractive: in addition to the lucrative possibility of becoming the finalist, contestants can win many other large prizes. Nevertheless, subjects in our study are not selected perfectly at random: all are lottery players who were able to attend the recording, and couples might send the best or most competitive of the two of them. Still, as a group the subjects in our study do resemble a cross-section of the general population much more closely than subjects in most lab experiments and other

field studies do. More importantly, it is not clear how selection mechanisms could explain that the competitiveness of men and women depends on the gender of their opponent.

Our study finds that women avoid competition against men, but remains silent on the underlying causes of this behavior. According to the literature, differences in reluctance to compete can be driven by differences in risk attitudes, (over)confidence, and intrinsic attitudes towards competition. However, even in controlled experiments, and even without strategic interaction and consideration of the role of the gender of opponents, careful disentangling of the possible determinants of competitiveness has proven to be methodologically challenging (van Veldhuizen, 2018; Gillen, Snowberg and Yariv, 2019). Our field data is not rich enough for delving into the possible explanations, but it seems implausible that risk preferences depend on the gender of the opponents. This leaves opponent-dependent confidence in performance and intrinsic opponent-dependent attitudes towards competition as the most likely drivers: women could be less confident about their performance in a competition against men, or have a more deeply rooted, intrinsic aversion to competing against men. Such a specific response to the opponent's gender can, in turn, be partly determined by the culture in which people grew up (Gneezy, Leonard and List, 2009; Andersen et al., 2013; Booth et al., 2019; Zhang, 2019).

Research into the effects of social class and ethnicity on competitiveness suggests that gender differences in competitiveness—including those identified in the present study—may derive from a more general phenomenon, where willingness to compete relates to social power and status. Almås et al. (2016b) find that gender differences in competitiveness arise between boys and girls from families with a high socioeconomic status only, and not between those who have a low socioeconomic background. Siddique and Vlassopoulos (2019) report that people from a disadvantaged ethnic minority group are more likely to compete when their competitors are all co-ethnic than when their competitors are predominantly from the majority group.

Regardless of the possible psychological mechanisms, the finding that women avoid competing against men has the important implication that male dominance in a professional environment becomes self-perpetuating. This is especially the case if there is strategic interaction, where those who want to compete are better off when others abstain from competing. In such a setting, women can expect more pushback from both male and female competitors. At the higher rungs of the career ladder, where overrepresentation of men and strategic interaction are both ubiquitous, affirmative action may therefore be necessary to alter the status quo.

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## Appendix: Game D1 (From 6 to 2)

### *Description and Data*

Between November 2006 and December 2007, the elimination competition featured a game that reduced the number of contestants from six to two in four rounds. In each round, the remaining contestants were given an estimation question. Examples are “How many pieces does the largest jigsaw puzzle sold in ordinary stores contain?” and “How many items of clothing does a woman on average have in her wardrobe, according to onepoll.com?”. All contestants had to privately give their best guess by entering it into their terminal, and the correct answer was then publicly revealed. Prior to the identification of the player with the worst guess, contestants were given the opportunity to voluntarily leave the game in exchange for a monetary opt-out prize. The total opt-out prize money available for the four rounds was always €40,000 per episode, divided unequally across four sealed briefcases. Opting-out contestants were rewarded with the contents of one of these cases, selected by themselves. Only one contestant, the fastest, could opt out. If no contestant opted out, the player with the worst guess was sent home empty-handed. In contrast to the second game analyzed in the main text, where contestants who want to opt out can wait for an unknown but considerable amount of time in the hope that the other opts out, contestants in the present game needed to do so almost instantly. The six contestants who played this game were selected from the larger crowd through a series of multiple-choice questions (Game A2 in Figure 1). This preceding game did not have any opt-out options, and therefore no self-selection on competitiveness had occurred yet.

We collected the data for all 17 episodes that featured this elimination game. The overall gender distribution at the start was balanced, with 50 of the 102 (49.0%) contestants being male. The average age was 48 years (min: 23, max: 83). In 41 of the 68 rounds (60.3%) one of the contestants opted out. Contestants who opted out had given the worst answer 61.0 percent of the times. In the other 27 rounds (39.7%) no one opted out, and consequently the contestant with the worst answer was automatically eliminated. The expected value of the remaining opt-out prizes at the time the opt-out decisions were made varied between €4,000 and €16,000.

## *Analyses and Results*

Across all rounds combined, the opt-out rate is 13.4 percent.<sup>15</sup> As illustrated in Figure A1a, women are about twice as likely to opt out as men (males: 9.8%, females: 17.6%;  $Chi^2(1) = 4.041$ ,  $p = 0.044$ ).

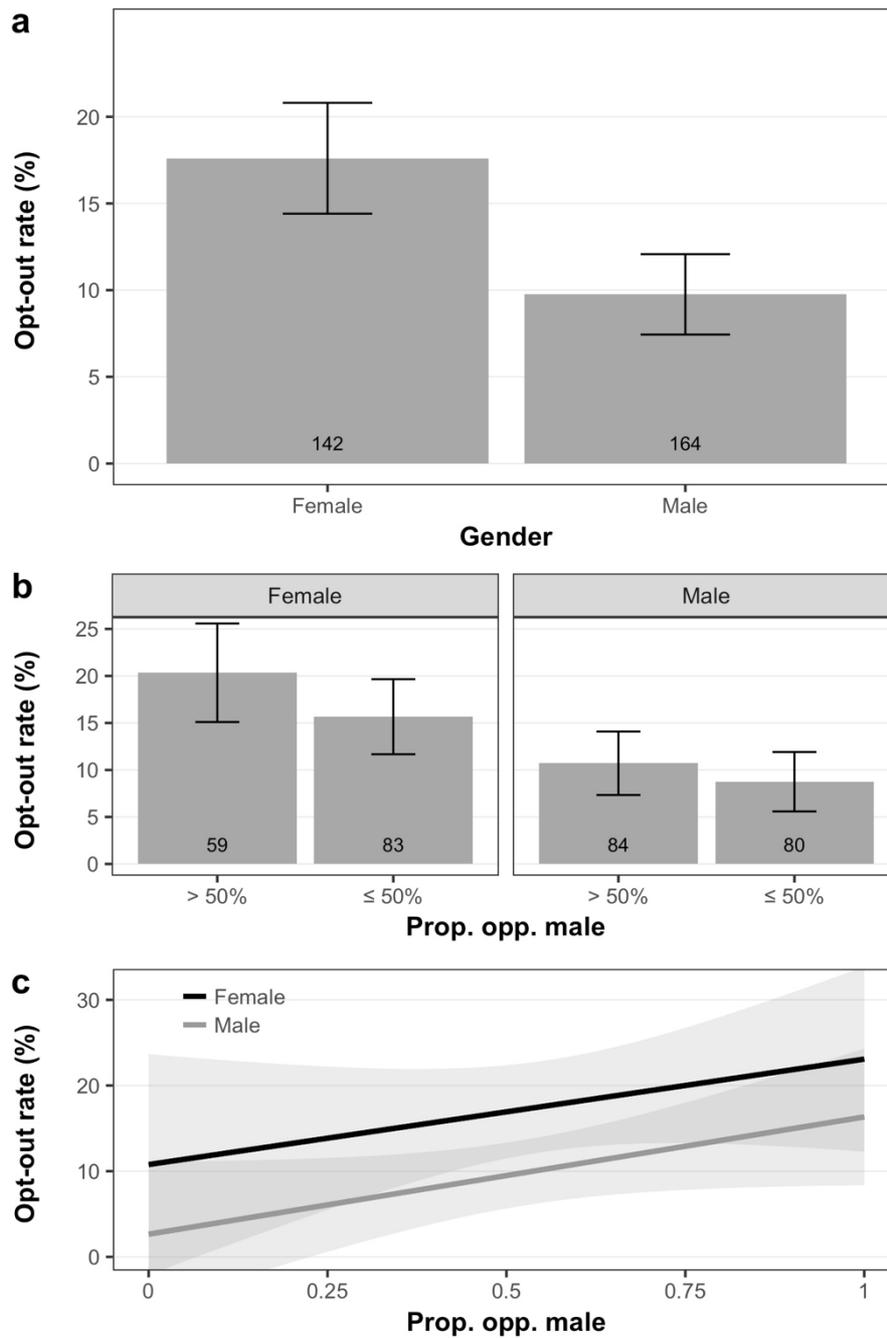
We estimate a multivariate linear probability model to control for differences in contestants' age, the expected value of taking an opt-out prize, and round-number fixed effects. The dependent variable takes the value of one if the contestant opts out (and zero otherwise). As in the analyses of the other games, we use a quadratic specification for age. In addition, we include round-number fixed effects. Controlling for round number is important, because the possible range of the opt-out rate differs across rounds: in the first round no more than one in six contestants can opt out, whereas in the last round no more than one in three can opt out. We correct the standard errors for clustering at the contestant level and at the episode-round level (Cameron, Gelbach and Miller, 2011; Thompson, 2011).

Table A1, Model 1 presents the results. Controlling for age, expected value of opting out, and round number, women are 9.4 percentage points more likely to opt out than men. As in the other games, there is a u-shaped relation between the opt-out rate and age; the coefficients imply that the rate is lowest at 41 years. Contestants do not appear to be very concerned with the expected value of the cash opt-out prize.

Model 2 includes a dummy variable that takes the value of one if a contestant provided the worst guess in that round, and zero otherwise. When contestants make up their mind about whether they should opt out or not, they probably factor in their subjective impression of the likelihood that they are the one who has given the worst answer to the estimation question. Contestants know both their own guess and the correct answer, but they do not know the guesses that the others have entered and how likely these others are to give up. The dummy variable is a strong predictor: contestants who provided the worst guess are 28.7 percentage points more likely to opt out than those who did not provide the worst guess, and incorporating this variable increases the  $R^2$  from 0.053 to 0.173. Importantly, the effect of gender is robust to including the worst-guess variable. As compared to Model 1, the coefficient of the gender variable decreases from 9.4% to 7.2%, which can be attributed to women's slightly worse—but statistically not significantly worse—performance (see Section 5).

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<sup>15</sup> The highest possible opt-out rate is 16.7 percent in round one (1 out of 6 contestants can opt out), 20.0 percent in round two (1 out of 5), 25.0 percent in round three (1 out of 4), and 33.3 percent in round four (1 out of 3). Across all choices combined, the opt-out rate could not have been higher than 22.2 percent.



**Figure A1: Opt-out rates for men and women in Game D1.** (a) displays the opt-out rates for male and female contestants. (b) displays the opt-out rates for male and female contestants, conditional on whether more than half of the remaining opponents are male (> 50% opponents male), and conditional on whether half or more of the remaining opponents are female (≤ 50% opponents male). The number of observations is at the bottom of each bar. Error bars depict standard errors around the mean. (c) displays the univariate linear relationship between the opt-out rate and the proportion of male opponents, for male and female contestants separately. The shaded areas represent 90% confidence intervals.

**Table A1: Regression results for Game D1**

The table displays results from regression analyses of contestants' decisions to opt out (1) or not (0) in Game D1. *Age* is the contestant's age, measured in years and centered on the mean (46.9y). *Prop. opp. male* is the proportion of male opponents, centered on the mean (0.54). *Worst guess* is a dummy variable that takes the value of 1 if the contestant provided the worst guess in the given round. *EV opt out* is the expected value of opting out in euros. All models include round-number fixed effects. Standard errors (in parentheses) are corrected for clustering at the contestant level and at the episode-round level. Other definitions are as in Table 1.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Female	0.094** (0.039)	0.072** (0.036)	0.076** (0.038)	0.073 (0.046)	0.068* (0.036)	0.068* (0.036)
Age	0.003 (0.002)	0.003* (0.002)	0.003* (0.002)	0.003* (0.002)	0.003 (0.002)	0.003 (0.002)
Age <sup>2</sup> / 100	0.029* (0.017)	0.028* (0.014)	0.029** (0.014)	0.029** (0.014)	0.031** (0.014)	0.031** (0.014)
Majority opp. male (> 50% male = 1)			0.038 (0.032)	0.035 (0.044)		
Female x Majority opp. male				0.007 (0.075)		
Prop. opp. male					0.126** (0.059)	0.139* (0.073)
Female x Prop. opp. male						-0.030 (0.135)
Worst guess (worst = 1)		0.287*** (0.061)	0.287*** (0.062)	0.287*** (0.062)	0.284*** (0.062)	0.284*** (0.062)
EV opt out / 1000	0.008 (0.010)	0.008 (0.010)	0.009 (0.009)	0.009 (0.009)	0.009 (0.009)	0.009 (0.009)
Round-number fixed effects	yes	yes	yes	yes	yes	yes
R <sup>2</sup>	0.053	0.173	0.176	0.176	0.182	0.182
No. of observations	306	306	306	306	306	306
No. of contestants	102	102	102	102	102	102
No. of rounds	68	68	68	68	68	68
No. of episodes	17	17	17	17	17	17

Given the strategic nature of this game—if someone opts out, the rest are safe—contestants should condition their choices on the likelihood that one of their opponents will opt out. If contestants' beliefs are based on the stereotypical view that women are less competitive than men, then both men and women will be more likely to compete against women than against men. The same prediction follows from a dislike among women to compete against men—as we observed in the first game—and men being aware of women's reluctance to compete against them.

Figure A1b shows the opt-out rates of men and women, and distinguishes between situations where more than half of the opponents are male and situations where half or more are female. Both men and women are somewhat more likely to opt out when most of their opponents are male as compared

to situations where half or more of their opponents are female, but statistically the two differences are insignificant (women: 20.3% vs. 15.7%;  $Chi^2(1) = 0.520$ ,  $p = 0.471$ ; men: 10.7% vs. 8.8%,  $Chi^2(1) = 0.180$ ,  $p = 0.672$ ). In Table A1, Model 3 incorporates the binary distinction between male and female dominated competition in the regression analysis through the inclusion of a dummy variable that takes the value of one if more than half of the opponents is male (and zero otherwise), and shows that there is no significant effect of this dummy variable on the opt-out rates of men and women combined ( $p = 0.228$ ). Model 4 adds the interaction of the dummy variable with the contestant's own gender, and shows that the effect of the dummy variable does not differ significantly between men and women ( $p = 0.927$ ).

The binary distinction is rather crude, which likely limited the statistical power. We therefore repeat the analyses with the (demeaned) exact proportion of male opponents. Figure A1c shows the linearly fitted relationship between the opt-out rate and this continuous measure, for male and female contestants separately. The graph suggests that both men and women are more likely to opt out when the proportion of male opponents is higher. In Table A1, Model 5 includes this proportion in the regression analysis, and confirms that opt-out rates vary significantly with the gender of opponents: contestants are 12.6 percentage points more likely to opt out if they exclusively face male competitors, as compared to the situation where they exclusively face female competitors ( $p = 0.034$ ). Model 6 adds the interaction of the proportion of male opponents and the contestant's own gender. The results suggest that men and women respond similarly to the gender composition ( $p = 0.823$ ). The stand-alone effect of contestants' gender is now marginally significant: according to Models 5 and 6, women are 6.8 percentage points more likely to opt out than men ( $p = 0.059$  and  $p = 0.056$ , respectively).

In summary, in this game where beliefs about the competitive behavior of others matter for the decision to opt out, we observe that women are marginally significantly more likely than men to be the one who opts out, and that both men and women opt out more often when the proportion of male opponents is larger. The results, however, have to be interpreted with caution. If one contestant opts out, it remains unknown what the other contestants would have done. As a consequence of this censoring problem, the opt-out choices that we observe for individual contestants do not only depend on individuals' own opt-out propensity, but also on those of their opponents. The relatively high opt-out rate among women, for example, can reflect a higher general opt-out propensity, which would be at odds with the finding in the previous game that women exclusively dislike competing against men. At the same time, it can also derive from censoring: if people are less likely to opt out when they face a woman, then a female contestant with a given propensity to opt-out will more often be the one who actually opts out than a male contestant with the exact same propensity, simply because less often someone else was quicker to opt out.

Notwithstanding this caveat, the results for this game imply that men are better off than women in a setting where people who choose to compete have higher chances to be successful if others abstain from competing.