Supplement to “Gender, competition, and performance: Evidence from chess players”

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Appendix A: Wins, draws, and losses

In Table A.I, we show the distribution of outcomes for player *i* by the gender composition of the game.

Table A.I. Percentage of game outcomes for player *i* by the gender composition of the game.

	(1)	(2)	(3)
	Outcome for Player		
Genders of Player and Opponent	*i* Losses	Draw	*i* Wins
Female–Female	31.0	30.2	38.7
Female–Male	41.8	24.8	33.5
Male–Male	28.3	32.1	39.6
Male–Female	24.9	26.9	48.2
Total	29.3	30.8	39.9

Note: This table shows the proportion of games ending in a loss, draw, or win for the player by the gender composition of the game. The first number in column (1) means that player *i* losses 31% of the games she plays against another woman.

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TABLE B.I. The effect of opponent's gender on the points a player earns, full results.

	(1)	(2)	(3)	(4)	(5)
	All Players			Females	Males
Opponent is male	−0.104	−0.026	−0.034	−0.033	−0.035
	(0.007)	(0.007)	(0.007)	(0.020)	(0.008)
P^*_{ij}		0.542	0.446	0.363	0.461
		(0.038)	(0.040)	(0.093)	(0.045)
Share of event that is male		0.001	−0.004	−0.011	0.032
		(0.015)	(0.014)	(0.022)	(0.038)
$\overline{Elo}_{ij}$		−0.001	−0.001	−0.001	−0.001
		(0.000)	(0.000)	(0.000)	(0.000)
i plays white			0.078	0.085	0.076
			(0.004)	(0.010)	(0.005)
Games	28,799	28,799	28,799	5702	23,097
R^2	0.01	0.21	0.20	0.18	0.20
Player FE	Yes	Yes	Yes	Yes	Yes
W_{ij}	No	Yes	Yes	Yes	Yes
X_{ij}	No	No	Yes	Yes	Yes

Note: The dependent variable is the number of points earned by i in the game: 1 for a win, 0.5 for a draw and 0 for a loss. The models are estimated by OLS on within-player-i mean differenced data. Robust standard errors (in brackets) are clustered at the player level.

Female players fare worse against a male opponent. Women playing male opponents win about 5% fewer games, they draw about 5% fewer games against men than they do against women. Men facing female opponents increase the probability they will win by nearly 9 percentage points. In chess, draws can be the result of several conditions: stalemates, threefold repetition of a board position, no captures in the last 50 moves, no pawn being moved in the last 50 moves, if checkmate is not possible given the material left on the boards, or most commonly, if a player offers a draw and the other opponent agrees. We cannot see in our data why a draw is realized or who offered the draw. As such, observing a draw tells us little about the behaviors of the player and their opponent.

APPENDIX B: ADDITIONAL RESULTS

In Table B.I, we present the estimated effects of the opponent being male on the points player i wins corresponding to the results in Figure 2, and for the nonfixed effect controls.

In column (1), we regress P_{ij} on m_j and α_i only. The coefficient of −0.10 (95% CI: −0.12 to −0.09) indicates that a player earns on average 0.1 fewer points when the opponent is male. In column (2), we add P^*_{ij}, $\overline{Elo}_{ij}$ and the share of players at the event who are male, other than i, to ensure the conditional randomness of the opponent's gender. The effect of the opponent's gender is reduced to −0.026 (95% CI: −0.04 to −0.01). In column (3), we add the other controls in **X**. The effect remains (95% CI:−0.05 to −0.02).[1]

[1]We have estimated the model excluding losses and again excluding wins. We find that players are more likely to draw than win against a male opponent. We also find a player is more likely to lose than draw against a male opponent.

In columns (4) and (5), we reestimate the model in column (3) using only female and male players, respectively.

We estimate 25 variants of Model C from Figure 2 including restrictions to the type of games, players, or events that are in the estimation sample; different sub-samples defined by the Elo differential, that is, $Elo_i - Elo_j$; for each quartile group of Elo_i; excluding opponents with Elo ratings less than 2000. We also test the robustness of the main result to a possible misspecification of the Elo ratings in the model. When a female player in our sample plays a male opponent, she faces a 32-point Elo disadvantage versus a 33-point advantage, on average, when she faces a female opponent. The Elo differential is thus correlated with the gender of the opponent. The correlation between the opponent being male and the P^*_{ij} is small but significant ($\rho = -0.05$, p-value< 0.00). We control for the Elo differential via P^*_{ij}. Still, we may be neglecting some nonlinearity in the effect of the Elo differential on the outcome of games. We reestimate equation (9) with 5 different specifications of Elo ratings by replacing P^*_{ij} and $\overline{Elo_{ij}}$ in equation (9) with the Elo ratings of the player and the opponent, Elo_i and Elo_j; then by excluding the player fixed effects because there is very little within-player-i variation in Elo_i; by adding the squares and cubes of P^*_{ij} and $\overline{Elo_{ij}}$; by including P^*_{ij}-decile and $\overline{Elo_{ij}}$-decile group dummies to allow for less structured nonlinearities and by including a dummy equal to 1 if the player is at an Elo-point disadvantage and 0 otherwise. We also reestimate equation (9) with a number of fixed effects added: event fixed effects, date of the game fixed effects and "opening" fixed effects as categorized by the Encyclopedia of Chess Openings (ECO).

Table B.II presents the results from the robustness checks corresponding to those plotted in Figure 3.

The models estimated in panels A–C are the same as those in column (3) of Table 2 but using different subsamples. In panel A, we apply a number of restrictions to the type of games, players, or events included in the estimation sample. In column (1), we estimate the model excluding any games played in single-sex tournaments, either those explicitly women-only, or those all male or all female by chance. In column (2), we follow Gerdes and Gränsmark (2010) by estimating the model excluding games that ended in a draw, and in column (3) we estimate the model using players who play at least 20 games in our sample. In column (4), we exclude Blitz chess events[2] and in (5) we exclude Junior (under −20) events.

In panel B, we reestimate the model for different subsamples defined by the Elo differential, that is, $Elo_i - Elo_j$. In column (1), we include only games where the Elo differential between the player and the opponent is less than or equal to 300 Elo points; in column (2) less than or equal to 200 Elo points, in column (3) less than or equal to 100 Elo points, in column (4) less than or equal to 50 Elo points, and in column (5) greater than or equal to 50 Elo points.

In panel C, we reestimate the model for each quartile group of Elo_i, column (1) for the first quartile up to the top quartile in column (4). As noted, we restrict our sample of players to those having Elo ratings of at least 2000 but allow opponents with lower Elo ratings. In column (5), we exclude opponents with Elo ratings lower than 2000.

[2] Blitz games generally have a 5-minute time limit.

TABLE B.II. Robustness checks for the effect of opponent's gender on the points a player earns.

	(1)	(2)	(3)	(4)	(5)
Panel A: Sample restrictions					
	No single-sex events	No draws	≥20 games played	No Blitz events	No Junior events
Opponent is male	−0.035	−0.040	−0.023	−0.033	−0.034
	(0.007)	(0.010)	(0.010)	(0.007)	(0.007)
Games	24,306	19,347	18,182	28,377	28,241
R^2	0.21	0.25	0.19	0.20	0.20
Panel B: $\lvert Elo_i - Elo_j \rvert$					
	≤300	≤200	≤100	≤50	≥50
Opponent is male	−0.035	−0.031	−0.044	−0.056	−0.033
	(0.008)	(0.010)	(0.018)	(0.032)	(0.008)
Games	25,223	19,564	9607	4584	24,312
R^2	0.17	0.13	0.06	0.03	0.22
Panel C: Levels of Elo					
	Quartiles of Elo_i				
	2000–2258	2259–2400	2401–2523	2524–2788	$Elo_j \geq 2000$
Opponent is male	−0.046	−0.031	−0.037	−0.029	−0.033
	(0.014)	(0.014)	(0.014)	(0.016)	(0.008)
Games	7234	7207	7177	7181	27,144
R^2	0.20	0.22	0.20	0.18	0.18
Panel D: Variant specification of Elo					
	Elo_i and Elo_j		Squares	Elo decile	Intercept
		No player FE	and cubes	groups	shift
Opponent is male	−0.034	−0.024	−0.034	−0.038	−0.034
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Games	28,799	28,799	28,799	28,799	28,799
R^2	0.20	0.23	0.20	0.20	0.20
Panel E: Additional fixed effects					
	Event FE	Date FE	Event+Date FE	ECO FE	All
Opponent is male	−0.032	−0.031	−0.044	−0.032	−0.045
	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)
Games	28,799	28,799	28,799	28,799	28,799
R^2	0.18	0.19	0.18	0.18	0.16

Note: The dependent variable is the number of points earned by i in the game: 1 for a win, 0.5 for a draw and 0 for a loss. Reported standard errors (in brackets) are clustered at the player i level.

In panel D, we test the robustness of the main result to a possible mis-specification of the Elo ratings in the model. In column (1), we replace P^*_{ij} and $\overline{Elo}_{ij}$ in equation (9) with the Elo ratings of the player and the opponent, Elo_i and Elo_j. In column (2), we exclude the player fixed effects because there is very little within-player-i variation in Elo_i. In column (3), we control for nonlinearities by adding the squares and cubes of P^*_{ij} and $\overline{Elo}_{ij}$. In column (4), we use P^*_{ij}-decile group and $\overline{Elo}_{ij}$-decile group dummies to

TABLE B.III. The effect of opponent's gender on a player's quality of play, full results.

	(1)	(2)	(3)	(4)	(5)	(6)
	Women			Men		
Opponent is male	0.112	0.114	0.117	−0.014	0.013	0.022
	(0.029)	(0.047)	(0.040)	(0.020)	(0.021)	(0.019)
i plays white		−0.015	−0.031		−0.001	−0.023
		(0.025)	(0.021)		(0.013)	(0.011)
P^*_{ij}		0.313	−0.009		−0.257	−0.244
		(0.235)	(0.201)		(0.125)	(0.105)
$\overline{Elo}_{ij}$		0.001	0.001		−0.001	0.001
		(0.001)	(0.000)		(0.000)	(0.000)
Share of event that is male		0.013	−0.001		−0.006	−0.121
		(0.055)	(0.046)		(0.100)	(0.085)
Games	5702	5702	5702	23,097	23,097	23,097
R^2	0.00	0.00	0.26	0.00	0.00	0.26
Player FE	Yes	Yes	Yes	Yes	Yes	Yes
W_{ij}	No	Yes	Yes	No	Yes	Yes
X_{ij}	No	Yes	Yes	No	Yes	Yes
$ln(\overline{error}_{ji})$	No	No	Yes	No	No	Yes

Note: The dependent variable is the logged mean error committed by i between moves 15 and 30. Reported standard errors (in brackets) are clustered at the player level.

allow for less structured non-linearities. In column (5), we include a dummy equal to 1 if the player is at an Elo point disadvantage and 0 otherwise.

In panel E, we add different fixed effects in addition to those in equation (9). In column (1), we add event fixed effects. In column (2), we add date of the game fixed effects. In column (3), we use both event and date fixed effects.

We then add controls for the opening of the game. In column (4), we include fixed effects for openings as classified in the ECO. In column (5), we include event, event date, and opening fixed effects. The point estimate and precision are both notably stable in all these variations. The point estimates lie between −0.056 and −0.024 and in all but two cases the 95% confidence interval excludes 0. These results suggest that women fare worse against male opponents, underperforming the expected outcomes as determined by the relative Elo ratings of the player and opponent.

In Table B.III, we present the estimated effects of the opponent being male on the mean error committed by i, corresponding to the results in Figure 4, and for the nonfixed effect controls.

In columns (1)–(3), we report the results for female players, and for male players in columns (4)–(6). We find that the mean error committed by a female player between moves 15 and 30 increases by about 11% when facing a male opponent (95% CI: 0.054 to 0.169 in column (1)). The point estimates maintain when we add the controls in **X** and **W** in column (2) and when we also add the mean error of the opponent j in column (3). Columns (4)–(6) are analogous for male players.

TABLE B.IV. Robustness checks for the effect of opponent's gender on female players' quality of play.

	(1)	(2)	(3)	(4)	(5)
Panel A: Sample restrictions					
	No single sex events	No draws	≥20 games played	No Blitz events	No Junior events
Opponent is male	0.120	0.149	0.213	0.116	0.112
	(0.036)	(0.058)	(0.067)	(0.048)	(0.047)
Games	4472	4012	3825	5569	5681
R^2	0.05	0.05	0.05	0.05	0.05
Panel B: $\lvert Elo_i - Elo_j \rvert$					
	≤300	≤200	≤100	≤50	≥50
Opponent is male	0.083	0.070	0.176	0.118	0.026
	(0.051)	(0.061)	(0.100)	(0.187)	(0.024)
Games	5122	3980	1975	931	16,970
R^2	0.03	0.03	0.01	0.00	0.05
Panel C: Levels of Elo					
	Quartiles of Elo_i				
	2000–2258	2259–2400	2401–2523	2524–2788	$Elo_j \geq 2000$
Opponent is male	0.078	−0.006	0.283	0.039	0.120
	(0.098)	(0.101)	(0.105)	(0.116)	(0.051)
Games	1430	1429	1429	1414	5262
R^2	0.06	−0.01	0.03	0.02	0.04
Panel D: Variant specification of Elo					
	Elo_i and Elo_j				
		No player FE	Squares and cubes	Elo decile groups	Intercept shift
Opponent is male	0.114	0.105	0.096	0.102	0.114
	(0.047)	(0.044)	(0.047)	(0.047)	(0.047)
Games	5702	5702	5702	5702	5702
R^2	0.05	0.04	0.05	0.05	0.05
Panel E: Additional fixed effects					
	Event FE	Date FE	Event+Date FE	ECO FE	All
Opponent is male	0.085	0.103	0.142	0.085	0.126
	(0.061)	(0.054)	(0.056)	(0.061)	(0.072)
Games	5702	5702	5702	5702	5702
R^2	0.06	0.06	0.07	0.06	0.07

Note: The dependent variable is the logged mean error committed by i in between moves 15 and 30. Reported standard errors (in brackets) are clustered at the player i level.

Table B.IV is analogous to Table B.VI. We present in it the estimates from the robustness checks for the effect of the opponent being male on the quality of play of female players. These are the results plotted in Figure 5.

This table is analogous to Table B.II.

TABLE B.V. The effect of opponent's gender on the number of moves in resigned games.

	(1)	(2)	(3)	(4)	(5)	(6)
		Women			Men	
Opponent is male	−0.079	−0.064	−0.063	−0.083	−0.078	−0.078
	(0.023)	(0.040)	(0.041)	(0.020)	(0.022)	(0.022)
i plays white		−0.035	−0.036		−0.008	−0.008
		(0.022)	(0.023)		(0.012)	(0.012)
P^*_{ij}		−0.237	−0.250		−0.056	−0.053
		(0.196)	(0.195)		(0.127)	(0.127)
$\overline{Elo}_{ij}$		−0.000	−0.000		−0.000	−0.000
		(0.000)	(0.000)		(0.000)	(0.000)
Share of event that is male		−0.052	−0.050		−0.059	−0.060
		(0.046)	(0.046)		(0.092)	(0.092)
Games	1605	1605	1605	5268	5268	5268
R^2	0.01	0.02	0.02	0.00	0.00	0.00
Player FE	Yes	Yes	Yes	Yes	Yes	Yes
W_{ij}	No	Yes	Yes	No	Yes	Yes
X_{ij}	No	Yes	Yes	No	Yes	Yes
$ln(\overline{error}_{ji})$	No	No	Yes	No	No	Yes
$ln(\overline{error}_{ij})$	No	No	Yes	No	No	Yes

Note: The dependent variable is the logged number of moves of games ended by resignation. Reported standard errors (in brackets) are clustered at the player level.

Table B.V presents the estimated effect of the opponent being male on the logged number of moves to resignation by player i.

In columns (1)–(3), we report the results for female players and for male players in columns (4)–(6).

Columns (1) and (4) are the bivariate regression of the logged number of moves on the gender of the opponent and player fixed effects. In columns (2) and (5), we add the control vectors **X** and **W**. In columns (3) and (6), we add the logged mean errors of both player i and opponent j to control for how well the game was played (between moves 15 and 30).

In Table B.VI, we present the estimates from the robustness checks for the effect of the opponent being male on the number of moves until a male player resigns. These are the results plotted in Figure 7.

This table is analogous to Table B.II.

TABLE B.VI. Robustness checks for the effect of opponent's gender on the number of moves until a male player resigns.

	(1)	(2)	(3)	(4)	(5)
Panel A: Sample restrictions					
	No single sex events	No draws	≥20 games played	No Blitz events	No Junior events
Opponent is male	−0.062	−0.078	−0.110	−0.073	−0.087
	(0.022)	(0.022)	(0.033)	(0.022)	(0.022)
Games	4527	5268	3180	5209	5090
R^2	0.08	0.08	0.14	0.08	0.08
Panel B: $\|Elo_i - Elo_j\|$					
	≤300	≤200	≤100	≤50	≥50
Opponent is male	−0.076	−0.032	−0.029	0.131	−0.071
	(0.025)	(0.030)	(0.067)	(0.309)	(0.024)
Games	4767	3714	1741	818	4466
R^2	0.08	0.06	0.05	−0.90	0.08
Panel C: Levels of Elo					
	Quartiles of Elo_i				
	2000–2258	2259–2400	2401–2523	2524–2788	$Elo_j \geq 2000$
Opponent is male	−0.078	−0.104	−0.005	−0.005	−0.053
	(0.037)	(0.036)	(0.045)	(0.052)	(0.021)
Games	1430	1429	1429	1414	5262
R^2	0.06	0.12	0.12	0.14	0.11
Panel D: Variant specification of Elo					
	Elo_i and Elo_j		Squares	Elo decile	Intercept
		No player FE	and cubes	groups	shift
Opponent is male	−0.078	−0.074	−0.077	−0.078	−0.078
	(0.022)	(0.017)	(0.022)	(0.022)	(0.022)
Games	5268	5268	5268	5268	5268
R^2	0.08	0.06	0.08	0.08	0.08
Panel E: Additional fixed effects					
	Event FE	Date FE	Event+Date FE	ECO FE	All
Opponent is male	−0.066	−0.078	−0.099	−0.066	−0.073
	(0.025)	(0.023)	(0.027)	(0.025)	(0.030)
Games	5268	5268	5268	5268	5268
R^2	0.09	0.08	0.29	0.09	0.32

Note: The dependent variable is the logged number of moves of games ended by resignation. Reported standard errors (in brackets) are clustered at the player i level.

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