



Strategic behavior across gender: A comparison of female and male expert chess players

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ABSTRACT

This paper aims to measure differences in risk behavior among expert chess players. The study employs a panel data set on international chess with 1.4 million games recorded over a period of 11 years. The structure of the data set allows us to use individual fixed-effect estimations to control for aspects such as innate ability as well as other characteristics of the players. Most notably, the data contains an objective measure of individual playing strength, the so-called Elo rating. In line with previous research, we find that women are more risk-averse than men. A novel finding is that men choose more aggressive strategies when playing against female opponents even though such strategies reduce their winning probability.

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1. Introduction

In a number of areas the underrepresentation of women is a striking reality. This applies to top positions in politics, public and government administration, the academic professions, and not least corporate management. Such diverse outcomes have been observed even in markedly equality-aware societies such as the Swedish; see Albrecht et al. (2003), Booth (2007), Jonung and Ståhlberg (2008), and references therein. As noted by Booth (2007), economists have only recently tried to amend the standard human-capital model that seeks to explain gender differences in incomes and promotion by taking into account aspects such as culture, bargaining skills and tastes or preferences.¹ If it is the case that men, on average, are more competitive and less risk-averse than women, this might in part explain why promotion to higher positions has been advantageous for male candidates. Indeed, a number of studies provide evidence of systematic gender differences in terms of risk behavior and competi-

tiveness. One issue still open for debate is whether these are innate differences or not, i.e. whether observed differences across gender in terms of risk taking and competitiveness are biologically or socially determined.²

Our aim in this paper is threefold: First, we examine whether there are general gender differences in risk behavior. Second, as chess is a game between two players, it is possible to analyze the interactive risk behavior of a man playing against a woman compared to when he plays against a man and vice versa. This aspect relates to research on the importance of the composition of a group, i.e. whether individuals act differently in single-sex or mixed groups; see Gneezy et al. (2003) and Booth (2009) for a discussion on possible explanations for various outcomes found in the literature. Third, we investigate whether the behavior we have studied is rational or not in terms of winning probabilities.

The study relates to recent studies that have tried to test the supposition of differences across gender with respect to risk taking

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¹ For example, Bowles et al. (2001) point at the importance of non-cognitive skills as determinants for earnings. See also Bas ter Weel (2008) on the importance of non-cognitive skills for predicting labor market outcomes.

² On the importance of the position of women in society for competitive behavior see Gneezy et al. (2009). In a field study of the Khasi tribe in India and the Maasai tribe in Tanzania, they found that in a society organized along matrilineal lines, like the Khasi tribe, women chose competitive schemes more often than the men in their tribe. The authors take their result as evidence of the impact of social learning on behavior, but they also point at the fact that cultural choice may alter genetic evolution through various selection mechanisms.

and competitiveness.³ Much of the literature has focused on experimental evidence, for example by looking at children or students competing under controlled conditions. Our study adds to that literature by providing evidence from a non-experimental setting, using comprehensive records of games played by a great number of top-level chess players. There are few other studies that have focused on differences in risk behavior and competitiveness outside the laboratory environment. For example, [Bajtelmsmit and Bernasek \(1996\)](#) look at real-world investment decisions for non-professional investors, while [Olsen and Cox \(2001\)](#) look at professional female and male investors. As stressed in [Bajtelmsmit and Bernasek \(1996\)](#), differences across gender in financial placement strategies might be caused by the fact that the access to information varies in quality, where men might systematically receive “better” advice/information than their female counterparts. This could be due to male networks, but also to discriminatory treatment. None of these studies address the importance of mixed-sex competition.

As has been noted by several scholars within the field of cognitive sciences, there is a common set of skills appropriate for people working in advanced areas of the business world and academia, as well as for top-level chess. This holds not least because successes in these areas are associated with intelligence and expertise (see [Bilalić et al. 2007](#), p. 460), as will be discussed in more detail below. Moreover, since chess is a game between two players, it definitely constitutes a (highly) competitive setting, thereby reflecting the nature of what is the daily routine for many actors in the corporate world and the field of government, as well as in academia. Becoming an expert chess player is by no means an easy task. Those who attain the higher ranks are certainly more competitive than people in general. This may apply to a greater extent to female players, i.e. they are presumably more competitive than women in general. The latter supposition is based on experimental evidence showing that women are less prone to choose tournaments than men (see e.g. [Niederle and Vesterlund, 2007](#)). Thus, in our study we look at preferences for risk across gender for a selected group of competitive people. Our results point at significant differences in risk taking across gender. Most notably, both men and women seem to change strategy when they face a female opponent.

In [Section 2](#) we argue why research on chess data is a suitable complement to earlier research on (non-)cognitive differences across gender. [Section 3](#) provides a short theoretical background to our estimation approach, while [Section 4](#) presents the data. In [Section 5](#) we present and discuss the results of our estimations, while [Section 6](#) concludes the study.

2. Why study chess?

This section aims to emphasize that findings based on chess can be transferred to other professions that are characterized by a high level of expertise. It thereby highlights the importance of having an accurate measure of a person's skill level, the so-called Elo rating.

For a number of years, strategic aspects involved in playing the game of chess have become an established analytical tool in cognitive psychology. In his review of the literature, [Roring \(2008\)](#) describes what makes chess a constructive method for the analysis of different aspects of human behavior: “Finding the best move in a chess position is a highly complex, real-world human activity, and each chess position represents a well-defined problem environment, with a fixed

number of identifiable moves that can be played at any given point – perfect for studying search processes and problem solving” (p. 1).

A landmark for establishing chess as an analytical tool was the introduction of the Elo rating that made it possible to compare the strength of chess players on a metric scale. Named after its inventor, Arpad Elo, it has become the benchmark classification in chess.

[It] provides chess researchers with a valid measurement device unrivalled in other areas of expertise research. It is a true gold standard in individual-difference research. /.../ Other frequently investigated areas such as physics expertise /.../ do not permit such fine differentiation ([Charness 1992](#), p. 6).

Thus, with reference to [Elo \(1978\)](#), it has become possible to measure skills on objective grounds, i.e. there are no “subjective assessments” ([Chabris and Glickman 2006](#), p. 1040).⁴ Also, as argued by different scholars in the field, e.g. [Gobet \(2005\)](#), [Ross \(2006\)](#) or [Roring \(2008\)](#), chess is well-suited to address questions concerning cognitive and psychological processes, thus extending its relevance to various fields of research studying human behavior. For example, one result obtained from chess research is that it takes about ten years of intense learning and hard work to become an expert, a time frame that also fits with “arts, sports, science, and the professions” ([Gobet 2005](#), p. 185).⁵

Anecdotal evidence maintains that there is a positive correlation between skills in chess and intellectual capacity. Indeed, some research points at the legitimacy of such views; see for example [Frydman and Lynn \(1992\)](#). Other studies that have looked at the correlation between chess rating and intellectual capability have not provided support for this supposition; see [Waters et al. \(2002\)](#). As they argue, conflicting conclusions might be due to the fact that the groups that are scrutinized differ to some extent with respect to their demographic composition. In particular, [Frydman and Lynn \(1992\)](#) study children, while [Waters et al. \(2002\)](#) look at adult chess players. As argued by [Waters et al. \(2002\)](#), the importance of innate intellectual capacity will fade as children mature and learn to compensate for their weaknesses through purposeful training, resulting in approved chess skills and higher Elo ratings. One influential paper in the field of cognitive research arguing along these lines is [Ericsson et al. \(1993\)](#). It proposes the concept of “deliberate practice”, which denotes a person's commitment to persistently exercise laborious tasks. The authors see such a trait as a vital ingredient in attaining extraordinary (chess) skills. Thus, in their view, it is the capacity to direct one's attention to monotonous, repetitive tasks over a long period of time, which is decisive for the attainment of specialist knowledge, rather than innate aptitude. Recent studies suggest that advanced chess skills are the result of innate personal characteristics, as well as persistent practicing, see [Gobet and Campitelli \(2007\)](#) and [Grabner et al. \(2007\)](#).⁶

In the world of chess, information on strategic concerns is accessible to everyone, especially since the Internet has become commonplace in daily life. Moreover, the signal of a player's strength, i.e. the Elo rating, is of a similar quality irrespective of gender. In other words any incentive to invest in chess skills will not be distorted by

⁴ The Elo rating is calculated using an algorithm based on the assumption of a normal distribution of playing strength across chess players. See the Appendix A for a detailed description on how Elo points are estimated.

⁵ So far there are only few studies in economic literature that have studied chess players. In [Ariga et al. \(2008\)](#), a player's Elo rating is studied as a signal for talent and as advice to invest in becoming a (professional) chess player. Another study, by [Moul and Nye \(2009\)](#), looks at (illegitimate) cooperation among expert players. A third study is by [Levitt et al. \(2009\)](#), who let top-level chess players solve different games designed for testing their backward induction skills. Their study responds to [Palacios-Huerta and Volij \(2009\)](#), who use a similar experimental setup.

⁶ [Chabris and Glickman \(2006\)](#) and [Bilalić et al. \(2009\)](#) refute the assertion made by [Howard \(2005\)](#) who reads the lack of top-level female chess players as evidence for gender differences in intellectual capacity.

³ See [Booth \(2009\)](#) and [Croson and Gneezy \(2009\)](#) for a survey and references on the issue of differences in risk preferences and competitiveness across gender in experimental studies. A related aspect addressed in the literature on gender differences regards overconfidence; see e.g. [Bengtsson et al. \(2005\)](#), [Datta Gupta et al. \(2005\)](#), and [Nekby et al. \(2008\)](#). Sometimes the three concepts are used interchangeably, indicating that they overlap to a certain extent.

one's expectations of becoming a victim of (statistical) discrimination.⁷ Due to the lack of “old boys’ networks” or “gatekeepers to high positions” in chess (Chabris and Glickman, 2006), this will allow us to elucidate some genuine gender differences on risk decision-making.

3. Theoretical framework

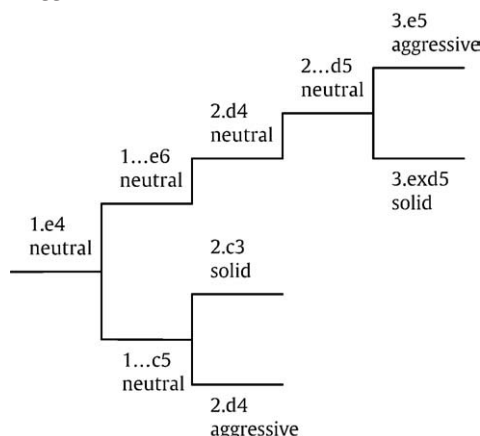
To obtain our measure of risk behavior we exploit the fact that chess players start each game by choosing a strategic development scheme for their pieces (called a chess opening). By exploiting a standardized classification of these openings, we can label the chosen strategies in each game as being either risky (aggressive) or safe (solid).

We use aggressiveness and solidity as our key concepts, meaning that a solid player is considered a risk-averse person, and an aggressive player is a risk-loving person. An aggressive playing tactic always involves a higher level of risk, as launching an attack on one part of the board implies that you neglect another. Typically, in such positions every move tends to be of utmost importance. Solid play avoids many possible weaknesses but at the cost of fewer attacking possibilities. Usually, one slip in a solid position will not lose the game.

A chess game is divided into three parts, the opening, the middlegame and the endgame. The opening moves are “theoretical” and are memorized before the game, and, since no calculation is needed, these moves are played quickly. The opening theory covers most reasonable moves by the opponent and usually includes somewhere between ten and twenty moves in depth for each variation.

In the opening, a player opts to have an answer to every reasonable move by the opponent. This very quickly becomes a great deal of theory to memorize, and to cut down on the theoretical preparation, a chess player limits his/her opening variation to include as few openings as possible (some deliberate variation is maintained to reduce predictability). A player's set of openings is called an *opening repertoire*. Considerable effort is dedicated to creating an opening repertoire that matches one's personality. A player with temperament will typically choose more aggressive openings, while a calm, “peaceful” person will more often choose a solid opening. Since opening preparation requires a lot of hard work, the main body of the opening repertoire is kept for a long time, usually for years. As a player develops, the opening repertoire will undergo changes, but the basis usually remains the same.

In a game theoretical framework chess is a sequential game where the players make moves in turn, as shown in the following game tree. We show one opening to exemplify the grounds on which it can be regarded as aggressive or solid.



⁷ The prevalence of diverse incentives to invest in human capital following from different prospects of signaling skill and expertise in a statistical discrimination framework has been addressed in numerous studies; see Bjerk (2008) and references given there.

After the first move for each side (1.e4 and 1...e6/1...c5), it is too early to classify the opening as being solid or aggressive.⁸ In the second and third moves, however, it is often possible to choose a move that leads to an aggressive or solid position, respectively. In the first end-node of the game tree, white grabs space with 3.e5, which will be used for an attack later on. In the second end-node, 3.exd5, white chooses a symmetric position without space advantage but avoiding weaknesses. In the third end-node, 2.c3, white chooses a more quiet system, but in the fourth, 2.d4, a pawn is sacrificed to assure initiative and attack.

There are thousands of books on opening theory, recommending openings for different styles, so there is a great deal of knowledge about the strategic nature of the openings among chess players. A classification of openings, called Eco codes, with 500 opening categories has been in use for the last fifty years. We have consulted eight chess experts of different strengths with Elo rates ranging from 2000 to 2600, five men and three women, and have asked them to give their opinion on the character of all the Eco codes.⁹ In more detail, they were instructed to define each opening as either *aggressive* or *solid*. We then compare the opinions of the experts and declare an Eco code to be *aggressive* [solid] if at least six out of eight experts define it as *aggressive* [solid].¹⁰ In cases when there are five or fewer votes for either *aggressive* or *solid*, the opening is considered to be unclear. About 1% of the games lack Eco codes and are excluded from the estimations; i.e. they enter into the category “A00”, which has become a residual of non-classified openings.

As a result of our experts' assessments, there are two labels for each game, one for the player of the white pieces and one for the black. This means that white can open solidly while black chooses a more aggressive approach. In such a case the label is “S” for white and “A” for black. Consequently, there are four different possibilities for each Eco code: “AA”, “AS”, “SA” and “SS.” See the Appendix A for descriptions on the classification of openings.

3.1. Econometric model

In the estimations each game in our data is treated as one observation. We start by showing results on gender differences as regards the probability of choosing an aggressive [solid] opening strategy or not. In general, estimations with a binary dependent variable can be done in various ways. To facilitate interpretation, we have chosen to focus on OLS estimations in a “linear probability model” (LPM) framework. The equation we estimate looks as follows:

$$y_{ij} = \alpha_{ij} + \beta x_i + w_j \pi + e_{ij} \quad (1)$$

where y is the dependent variable of playing aggressive [solid] and x is a gender dummy which takes on the value one if the player observed

⁸ To ease notation, the game tree only shows the possible strategies from the perspective of the player of the white pieces. Also, for the sake of simplicity, only pawn moves are discussed here. The annotation “1...e6” should be understood as: “the first move (1.) for black (...) and a pawn is moved to the coordinate e6.” In “exd5” x reads as “takes on.”

⁹ According to the International Chess Federation (FIDE), a player is regarded as an expert if he/she has an Elo rating of 2000 or more. The lowest level required to obtain a Master title is a rating of 2300. A Grandmaster title usually implies an Elo rating of over 2500. In the year 1999 Garry Kasparov reached an Elo rating of 2851, the highest Elo rating ever measured.

¹⁰ See the Appendix A for the instructions given to the experts and an extract from the questionnaires they filled out. The time each expert spent on the classifications varied between 2 and 5 h. Each expert was unaware of the opinions of the other experts. In an earlier version of this paper we used the expertise of just four of our experts, two men and two women. The classification on openings differs slightly, but overall this does not affect the outcomes very much; see Gerdes and Gränsmark (2009) on results based on the previous classification. To test the reliability of our procedure, we also tested a “five out of eight experts” requirement rule. Overall the outcomes are rather similar. One reason to use the “six of eight experts” requirement rule is to guarantee that at least one woman is part of the decisive majority.

in a game is a woman, zero if a man, w is a vector of control variables (discussed below), while e denotes the standard error. Indexes i and j are used to denote players and games, respectively. The coefficient β states the difference across gender as to the propensity to choose an aggressive [solid] strategy. A negative [positive] β would point at women being more risk-averse than men, and vice versa.

Our set of control variables is motivated by the following aspects. The share of female chess players has been growing in later years. Since most new chess players appearing in the top ranks of international chess are fairly young, it follows that women are on average younger than men. Also, women may to a certain extent drop out when they reach child-rearing age. For this reason it is important to include control variables for age to pick up such patterns.¹¹ A control for Elo ratings is used to hold constant for systematic differences in chess skills across gender. We also include a control for the number of games recorded for a player in a given year, which is meant to account for the strength in the signal of risk preferences.¹²

Subsequent estimations aim at examining the importance of the gender of the opponent for the decision on what strategy to choose. There we include additional controls: individual fixed effects, the strategy chosen by the opponent, the Elo points that can be won or lost in a game, as well as differences in Elo points between the two players. These estimations are made separately for male and female players. In those estimations the variable of interest is defined as *playing against a female player*.

4. Data and statistics

The data in this study were taken from ChessBase 10, a commercial database collection with 3.8 million chess games played in international chess events. It contains about 200 thousand players from all over the world. The data are organized in two dimensions, player-specific information and game-specific information. The name, year of birth, nationality and gender of a player are available. For every game there is data on the names and current Elo ratings of both players, the year a game was played, number of moves, Eco codes and the score, i.e. if a game was won, lost or ended in a draw. Before the beginning of the 1990s, such information was coded by hand. With the arrival of digital storage facilities, data processing became the standard procedure, leading to a substantial increase in the number of games reported. Since 1997 the registration of players and games played has become smoother across events and countries and for this reason we have limited our study to include games played from 1997 to 2007. To assure a certain level of chess expertise we only include players with a minimum Elo rating of 2000. A player at this level is considered to be a chess expert and we assume that he/she has established his/her opening repertoire.¹³ After imposing these restrictions, our sample includes ca 15 thousand players and 1.4 million games.

Mean values are shown in Table 1. Regarding the information on a player's nationality, we have grouped the countries in regions based on geographical lines and chess popularity. The regions with the highest number of chess players are Western Europe, Eastern Europe and the former Soviet Union. These three regions account for about

90% of the expert chess players in the world. Western Europe alone accounts for 45%, Eastern Europe for 27% and the former Soviet Union for about 18%, see panel A. Latin America, North America, Africa and Asia account for about 10%. Women have about a hundred points lower Elo rating points than men when averaged over the whole sample. The female share varies considerably across regions, as can be seen in panel B, from just over 5% in Western Europe, to 10% in Eastern Europe, and to 15% in the former Soviet Union.

The female share among top players has been rising constantly in the last two decades; consequently women are on average younger than male chess players. The average male player is 34 years old while the average female player is 25. In the former Soviet Union the mean age is much lower and the difference between the sexes is not as great as in Western Europe (see panel B). The female share decreases as we move up the Elo ladder, as can be seen in Fig. 1 in the next section. At Elo rate 2000, the female share is 17%, while at the very top (Elo 2600–2851) the female share is only about 1%.¹⁴

5. Estimation results

In Table 2, the results from the OLS estimations are shown. As can be seen from column (1), the female dummy coefficient is 0.0205, implying that the marginal probability for women to choose a solid opening strategy is about 2 percentage points greater than for men, holding constant for age, Elo rating, number of games played and regional and year dummies. The estimate is significant on a one-percent level, which implies that there is strong statistical support for the claim that female players prefer opening strategies that are considered more risk-averse than their male counterparts. In column (3) we show the outcome of regression estimations where we use our measure of *aggressive* openings as dependent variable. The *solid* and the *aggressive* openings are close but not perfect reflections of each other, as some openings have been left uncategorized (i.e. they did not fulfill the “at least six out of eight experts” requirement).¹⁵ The female dummy coefficient is both negative and significant, which is consistent with the positive results found for *solid* openings as dependent variable. The marginal effect is estimated at -0.0197 , i.e. women have a 2 percentage point lower probability of choosing an aggressive opening than male players, after controlling for other covariates.¹⁶

In columns (2) and (4) we include interaction variables, indicating if women differ in their preferred strategy with respect to their regional heritage. The significant estimates point to that women from the Nordic countries, as well as those from countries in North Africa and the Middle-East, are less prone to play aggressive strategies than the comparison group of Western European female players. For the other groups we do not find any significant differences, which suggest that the less aggressive preferences for women differ in magnitude across regions, being considerably smaller in the larger regions. Doing separate estimations by region (not shown here) indicates that the overall pattern points at the same direction across regions, with the exception of Western Europe (not including the Nordic countries), where gender differences seem to be of minor magnitude.

¹¹ Besides linear and quadratic age variables, we include a dummy for “age 0–20” to allow for different intercepts and to account for the fact that teenagers are often considered to be more aggressive and impatient due to high levels of sex and growth hormones; see Kimura (1996).

¹² Organizers of chess events report the results (including a complete move sheet) to FIDE immediately after the event. Information on chess players' records in the available registers are updated several times a year. Before a game, a player is informed about the name and playing strength of the opponent and can look up his or her playing record via the Internet.

¹³ To be more exact, we require that at least one of the two players in each game fulfills the lower bound of 2000 in Elo. Furthermore, only players that have a record of at least twenty games between 1997 and 2007 are included in our sample, this to assure variation in the choice of a player's strategy.

¹⁴ The chess rating system in the USA is somewhat different from the definition applied by the International Chess Federation (FIDE). The data in ChessBase 10 are based on the definition made by FIDE and, consequently, only a few US players are included in the dataset.

¹⁵ As can be seen in Table 1, about 47% of the played openings are considered to be solid, 20% aggressive according to their classification.

¹⁶ We also run probit estimations; the according marginal effects are similar to the OLS estimates. As another sensitivity test we estimated an ordered logit model with three different outcomes, i.e. solid, unrated, and aggressive openings. The outcomes are consistent with those presented here, indicating a lower propensity for women to choose “less solid” strategies. Results are available on request from the authors.

Table 1
Mean values at game level.

| Panel A | | | | | | | | |
|---------------------------------|---------------|---------------|------------------|-------------|-------------|----------------|---------------------|-----------|
| | All | | Men | | Women | | | |
| Variable | Mean | Std. dev. | Mean | Std. dev. | Mean | Std. dev. | | |
| Solid OR | 0.471 | (0.499) | 0.472 | (0.499) | 0.462 | (0.499) | | |
| Aggressive OR | 0.203 | (0.402) | 0.202 | (0.402) | 0.206 | (0.404) | | |
| Elo score | 2339.230 | (167.427) | 2348.023 | (167.103) | 2242.834 | (138.137) | | |
| Age | 32.809 | (13.499) | 33.532 | (13.565) | 24.887 | (9.701) | | |
| Aged max 20 in % | 0.212 | (0.409) | 0.192 | (0.393) | 0.435 | (0.496) | | |
| Number of games played per year | 33.959 | (29.624) | 34.017 | (30.135) | 33.314 | (23.288) | | |
| North America | 0.027 | (0.162) | 0.028 | (0.164) | 0.018 | (0.133) | | |
| Latin America | 0.036 | (0.187) | 0.038 | (0.191) | 0.020 | (0.141) | | |
| Nordic countries | 0.048 | (0.213) | 0.050 | (0.218) | 0.025 | (0.155) | | |
| Western Europe* | 0.398 | (0.489) | 0.412 | (0.492) | 0.241 | (0.428) | | |
| Eastern Europe | 0.271 | (0.445) | 0.266 | (0.442) | 0.323 | (0.468) | | |
| Fr. Soviet Union | 0.175 | (0.380) | 0.163 | (0.370) | 0.305 | (0.460) | | |
| N Africa/Mid East | 0.011 | (0.104) | 0.011 | (0.103) | 0.012 | (0.110) | | |
| East Asia | 0.027 | (0.162) | 0.024 | (0.154) | 0.055 | (0.227) | | |
| Africa | 0.001 | (0.023) | 0.001 | (0.023) | 0.001 | (0.029) | | |
| Number of games | 1399284 | | 1282315 | | 116969 | | | |
| Number of players | 15122 | | 13985 | | 1137 | | | |
| Panel B | | | | | | | | |
| Mean values over regions | | | | | | | | |
| | North America | Latin America | Nordic countries | West Europe | East Europe | Fr. Sov. Union | N. Africa/Mid. East | East Asia |
| Elo score | 2389.3 | 2364.5 | 2322.6 | 2291.6 | 2338.9 | 2433.0 | 2365.3 | 2373.9 |
| Fem share | 0.056 | 0.046 | 0.043 | 0.051 | 0.100 | 0.146 | 0.094 | 0.170 |
| Age | 34.1 | 32.6 | 32.9 | 34.8 | 32.7 | 29.6 | 27.5 | 26.2 |

Note: All mean values calculated on figures according to the period 1997 to 2007.

* Net of Nordic countries.

In order to understand how the female coefficient is affected at different levels of playing strength, we also run separate regressions for eleven intervals with a range of 50 Elo points each. The female dummy coefficients for the *solid* openings as dependent variable are positive over all intervals (except one), see Fig. 1; however, these estimates are not significantly different from zero.

As we turn to *aggressive* openings in Fig. 2, it reveals a mirror image of Fig. 1. The results appear to be even stronger as the female coefficients are consistently below zero and the standard errors notably smaller. It is worth pointing out that the negative coefficient estimates are paralleled by a substantial decrease in the share of females. This means that differences with respect to taste for risk are

more or less stable, irrespective of the actual level of skill of the players or the female share within each interval.

5.1. Impact of mixed-sex competition

As a result of the detailed information given in our data set it is also possible to take into account certain characteristics of the opponent in each game played. This allows us to look at gender-affected strategies, i.e. the issue of whether the choice of strategy depends on the sex of the opponent or not. In Table 3 we show the results from regression estimations that aim to test whether male players change their propensity of choosing openings considered to be aggressive when facing a female opponent. Correspondingly, in Table 4 we present the results from the perspective of a female player.¹⁷

As can be seen from Table 3, column (1), for male players the probability of choosing an aggressive strategy against female opponents is not significant in the setup with control variables as used in Table 2. However, when individual fixed effects are included, see column (2), the coefficient points to a 0.7 percentage point larger propensity. In column (3) three additional controls are included: *the opponent plays a solid strategy*, *Elo points at stake* and *Elo point differences*. The first addresses the fact that women choose solid openings to a greater extent (as we saw previously), which might per se trigger a player to respond by playing an aggressive strategy. The second control variable picks up the marginal amount of Elo points a player can gain by winning that game.¹⁸ Lastly, differences in Elo points are meant to hold constant for the statistical chances of winning. All in all, including these covariates does not change the results notably. We also compare the choice of strategy of players when they face an opponent with a lower or higher Elo rating respectively; see columns (4) and (5). The estimate in column (5)

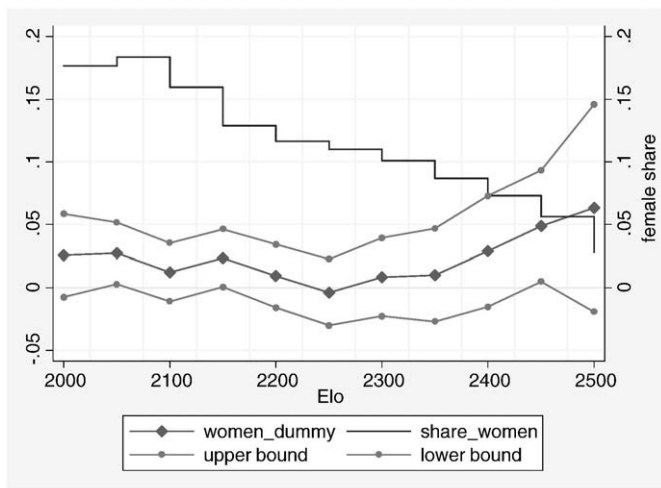


Fig. 1. Coefficient for women dummy for solid as dependent variable over Elo distribution. Upper and lower bounds indicating 95% confidence interval. Notes: Results from regression estimations using a window of 50 Elo rating points, e.g. 2200 ± 25 . Standard errors clustered on individual level. Control variables included similar as in Table 2.

¹⁷ The results for solid outcomes are not reported here. Overall those outcomes are consistent with those shown here. See Gerdes and Gränsmark (2010) for a comparison.

¹⁸ See the Appendix A for information on how this variable is constructed.

Table 2

OLS estimations regarding gender differences in playing opening strategies.

| | Dependent variable: | | | |
|---------------------------------|-------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| | Solid opening strategy | | Aggressive opening strategy | |
| | (1) | (2) | (3) | (4) |
| Elo | 0.0001 (0.0000)*** | 0.0001 (0.0000)*** | −0.0001 (0.0000)*** | −0.0001 (0.0000)*** |
| Female | 0.0205 (0.0075)*** | −0.0005 (0.0124)*** | −0.0197 (0.0054)*** | −0.0098 (0.0086)*** |
| Age | 0.0042 (0.0007)*** | 0.0043 (0.0007)*** | −0.0036 (0.0005)*** | −0.0036 (0.0005)*** |
| Age squared | −0.0000 (0.0000)*** | −0.0000 (0.0000)*** | 0.0000 (0.0000)*** | 0.0000 (0.0000)*** |
| Age max 20 | −0.0062 (0.0053) | −0.0063 (0.0053) | 0.0046 (0.0040) | 0.0047 (0.0040) |
| Log (number of games played) | 0.0009 (0.0021) | 0.0010 (0.0021) | 0.0008 (0.0015) | 0.0008 (0.0015) |
| North America female | | 0.0473 (0.0352) | | −0.0234 (0.0364) |
| Latin America female | | −0.0284 (0.0350) | | 0.0039 (0.0207) |
| Nordic countries female | | 0.0601 (0.0310)* | | −0.0705 (0.0165)*** |
| East Europe female | | 0.0217 (0.0191) | | −0.0024 (0.0134) |
| Former Soviet Union female | | 0.0263 (0.0180) | | −0.0139 (0.0130) |
| North Africa/Middle East female | | 0.0991 (0.0569)* | | −0.0942 (0.0388)* |
| East Asia female | | 0.0649 (0.0354)* | | −0.0337 (0.0224) |
| Africa female | | −0.0529 (0.0590) | | −0.0514 (0.0920) |
| Observations | 1 399 284 | 1 399 284 | 1 399 284 | 1 399 284 |
| Number of players | 15 122 | 15 122 | 15 122 | 15 122 |

Note: Nationality controls are: North America, Latin America, Nordic countries, East Europe, the former Soviet Union, North Africa/Middle-East, East Asia, Africa, with Western Europe as comparison. Year dummies included. Robust standard errors in parentheses, clustered at player level.

*Significant at 10%.

**Significant at 5%.

***Significant at 1%.

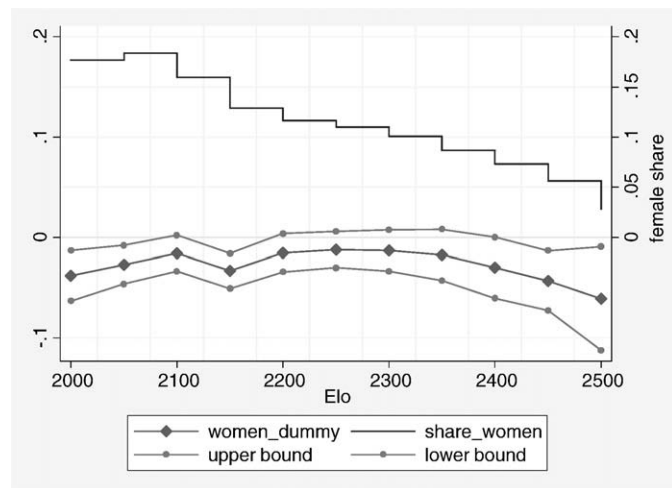


Fig. 2. Coefficient for women dummy for aggressive as dependent variable over Elo distribution. Upper and lower bounds indicating 95% confidence interval. Notes: Results from regression estimations using a window of 50 Elo rating points, e.g. 2200 ± 25. Standard errors clustered on individual level. Control variables included similar as in Table 2.

Table 3OLS estimations regarding the impact of playing against a woman on the choice of opening. **MEN.**

| | Dependent variable: choosing aggressive opening strategies, yes (1) or no (0) | | | | |
|---------------------------------------|---|-------------------------------------|-------------------------------------|------------------------------------|------------------------------------|
| | (1) | (2) | (3) | (4) | (5) |
| | | | | Elo > than opponent | Elo < than opponent |
| Female opponent | 0.0012 (0.0028) | 0.0068 (0.0020)*** | 0.0069 (0.0020)*** | 0.0057 (0.0024)** | 0.0082 (0.0035)** |
| Individual fixed effects | No | Yes | Yes | Yes | Yes |
| Indicator opponent playing aggressive | No | No | Yes | Yes | Yes |
| Elo points at stake | No | No | Yes | Yes | Yes |
| Elo differences | No | No | Yes | Yes | Yes |
| Observations | 1 282 315 | 1 282 315 | 1 282 315 | 678 652 | 599 418 |
| Number of players | 13 985 | 13 985 | 13 985 | 13 755 | 13 978 |

Note: Robust standard errors in parentheses, clustered at player level. Other control variables are *Elo*, *age*, *age squared*, *age_max_20*, *log (number of games played)*, and *year dummies*.

*Significant at 10%.

**Significant at 5%.

***Significant at 1%.

suggests that weaker players, in terms of their Elo rating, are even more likely to choose aggressive openings when they play against women.

Turning to female players, shown in Table 4, we see some notable differences compared to their male peers. When women are playing against female players, they do not show a greater inclination to use an aggressive strategy compared to when playing against a man even after controlling for individual fixed effects, see column (2). This result changes, however, once the three additional covariates are included, see column (3). Looking at columns (4) and (5) it becomes evident that the effect is driven by the outcomes from a setting where women meet female opponents with higher Elo ratings than themselves.

The results highlight the marginal importance of single-sex vs. mixed-sex competition as regards the choice of (aggressive) strategy. In particular, on the margin both men and women condition their

Table 4OLS estimations regarding the impact of playing against a woman on the choice of opening. **WOMEN.**

| | Dependent variable: choosing aggressive opening strategies, yes (1) or no (0) | | | | |
|---------------------------------------|---|----------------------------------|------------------------------------|----------------------------------|-------------------------------------|
| | (1) | (2) | (3) | (4) | (5) |
| | | | | Elo > than opponent | Elo < than opponent |
| Female opponent | 0.0022 (0.0037) | 0.0031 (0.0025) | 0.0059 (0.0024)** | 0.0010 (0.0036) | 0.0106 (0.0036)*** |
| Individual fixed effects | No | Yes | Yes | Yes | Yes |
| Indicator opponent playing aggressive | No | No | Yes | Yes | Yes |
| Elo points at stake | No | No | Yes | Yes | Yes |
| Elo differences | No | No | Yes | Yes | Yes |
| Observations | 116 969 | 116 969 | 116 969 | 53 864 | 62 768 |
| Number of players | 1137 | 1137 | 1137 | 1087 | 1137 |

Note: Robust standard errors in parentheses, clustered at player level. Other control variables are *Elo*, *age*, *age squared*, *age_max_20*, *log (number of games played)*, and *year dummies*.

*Significant at 10%.

**Significant at 5%.

***Significant at 1%.

Table 5

OLS estimations regarding the probability of winning a game when playing against a woman and using an aggressive strategy. **MEN.**

| Dependent variable: bivariate outcome of winning (1) or losing (0) a game | | | | | |
|---|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| | (1) | (2) | (3) | (4) | (5) |
| | | | | Elo > than opponent | Elo < than opponent |
| Playing aggressive | −0.0140 (0.0015)*** | −0.0132 (0.0015)*** | −0.0149 (0.0013)*** | −0.0184 (0.0018)*** | −0.0097 (0.0019)*** |
| Female opponent | 0.1106 (0.0037)*** | 0.1341 (0.0034)*** | 0.0099 (0.0029)*** | 0.0116 (0.0034)*** | 0.0073 (0.0054) |
| Playing aggressive against female opponent | −0.0012 (0.0063) | 0.0006 (0.0063) | −0.0016 (0.0056) | 0.0008 (0.0069) | −0.0059 (0.0101) |
| Individual fixed effects | No | Yes | Yes | Yes | Yes |
| Indicator opponent playing solid | No | No | Yes | Yes | Yes |
| Elo points at stake | No | No | Yes | Yes | Yes |
| Elo differences | No | No | Yes | Yes | Yes |
| Observations | 805 000 | 805 000 | 805 000 | 432 262 | 370 515 |
| Number of players | 13 985 | 13 985 | 13 985 | 13 615 | 13 965 |

Note: Robust standard errors in parentheses, clustered at player level. Other control variables are *Elo*, *age*, *age squared*, *age_max_20*, *log (number of games played)*, and *year dummies*.

*Significant at 10%.

**Significant at 5%.

***Significant at 1%.

choice on the sex of their opponent.¹⁹ Our findings are to some extent consistent with those reported in Maass et al. (2008). Their results show that female players were less prone to announce an “aggressive intent” when they were told they were facing a male opponent.²⁰

5.2. Rational, yes or no?

Why do chess players, especially men, choose to refrain from playing a solid game and opt for more aggressive strategies when they play against female opponents? Could it be rational to pursue a more aggressive strategy? In an attempt to find an answer, we investigate whether men and women have a greater winning probability when they use such a strategy in games where they face a female opponent. For a strategy to be seen as rational, we simply require that it should result in a higher probability of winning a game. For analytical clarity, it is desirable to use an unambiguous outcome measure, so here we only consider wins and losses, not draws.²¹ The results of estimations are shown in Table 5 where the

¹⁹ For men estimations with *solid opening* as the dependent variable result in similar outcomes (apart from the sign), while for women there are no significant changes caused by the gender of the opponent. See results in Gerdes and Gränsmark (2010) for a comparison.

²⁰ In Maass et al. (2008) top-level chess players were asked to compete against each other via a computer platform, so no participant had any personal contact with his/her opponent. The authors argue that their findings can be explained by gender stereotyping that would depress women's self-confidence.

²¹ As a robustness check we estimated ordered logit models, with loss, draw, and win, as three distinct outcomes. The results are consistent with the binary approach shown in this section; see Table A.3 in the Appendix A, showing results for male players. We also looked at the importance of regional heritage, estimating a triple interaction of playing aggressive openings against women from various countries (not shown here); overall the according estimates do not point to any regional patterns and the estimates are mostly insignificant.

Table 6

OLS estimations regarding the probability of winning a game when playing against a woman and using an aggressive strategy. **WOMEN.**

| Dependent variable: bivariate outcome of winning (1) or losing (0) a game | | | | | |
|---|----------------------------|----------------------------|----------------------------|----------------------------|-----------------------------|
| | (1) | (2) | (3) | (4) | (5) |
| | | | | Elo > than opponent | Elo < than opponent |
| Playing aggressive | −0.0002 (0.0069) | −0.0042 (0.0069) | −0.0076 (0.0058) | −0.0073 (0.0092) | −0.0097 (0.0071) |
| Female opponent | 0.0905 (0.0049)*** | 0.0843 (0.0050)*** | 0.0009 (0.0040) | 0.0030 (0.0055) | 0.0015 (0.0054) |
| Playing aggressive against female opponent | −0.0099 (0.0090) | −0.0107 (0.0090) | −0.0111 (0.0079) | −0.0010 (0.0115) | −0.0196 (0.0103)* |
| Individual fixed effects | No | Yes | Yes | Yes | Yes |
| Indicator opponent playing solid | No | No | Yes | Yes | Yes |
| Elo points at stake | No | No | Yes | Yes | Yes |
| Elo differences | No | No | Yes | Yes | Yes |
| Observations | 78 917 | 78 917 | 78 917 | 36 457 | 42 247 |
| Number of players | 1137 | 1137 | 1137 | 1069 | 1137 |

Note: Robust standard errors in parentheses, clustered at player level. Other control variables are *Elo*, *age*, *age squared*, *age_max_20*, *log (number of games played)*, and *year dummies*.

*Significant at 10%.

**Significant at 5%.

***Significant at 1%.

outcome of the game (a win is coded as 1, a loss as 0) has been regressed on choosing an aggressive strategy, holding constant for other aspects, similar to the earlier regressions. Beside of an indicator for aggressive opening, the model includes an interaction term, which measures if there are significant differences in winning probabilities if the opponent is a woman, or not. We find that an aggressive strategy has about a 1.3 percentage point lower probability of winning compared to not using such strategy. Looking at the interaction term of a female opponent and playing an aggressive strategy, the according estimates are not significant, indicating that playing aggressive strategies reduces winning probability regardless of the gender of the opponent.

For female players the pattern looks somewhat different, see Table 6. Even here there is a negative correlation between an aggressive strategy and the probability of winning, but the estimates are not statistically significant. From the interaction variables one can see that playing against a female opponent reinforces the negative patterns, but also here the effects are not significantly different from zero. Thus, for women there is no statistical evidence that choosing aggressive openings would reduce winning probabilities.

In spite of the fact that we are able to control for a number of relevant issues, estimations could be biased due to non-observed mechanisms that could act on both the choice of strategy and winning probabilities. For example, this might be the case if a player has some relevant information, like the opponent's current health status, which could weaken the opponent's capacity to ward off an aggressive attack. To what extent such aspects would confound our estimates is hard to say, though we do not believe the scope for this kind of omitted variable bias to be very large. This follows as aspects not controlled for would have to differ across gender to affect our estimates of interest.

5.3. Discussion of results

We have looked at different outcomes aimed at measuring strategic behavior. We have found that women choose more cautious strategies than men, which we interpret as women being more risk-averse on average. As this study provides a new way of studying risk behavior, it is not obvious how to relate the size of the measured

effects to other findings in the literature. At first sight, the estimates may not seem very great. However, this does not mean that they are negligible. Remember that the estimates state the average gender differences for one game; the number of games played in FIDE approved tournaments and other events over a one-year period is about 34 for men and 33 for women, see [Table 1](#). This implies that the impact of differences in the choice of strategies on a player's prospect of advancing in his/her career might cumulate over time.²² In addition, the measured effect is important because it turns out to be pervasive, i.e. it even holds when we restrict estimations to comprise the world's best-performing chess players, as can be seen in [Fig. 2](#). In particular, estimates for the players with lowest and highest Elo ratings are significantly smaller than zero.²³

A rather novel result in this study regards the fact that men choose to refrain from using solid strategies, as well as becoming more prone to using aggressive strategies, when facing a female opponent. Women too behave more aggressively against their female peers by choosing a more aggressive strategy when playing against higher ranked opponents.²⁴ It is striking that both men and women seem more inclined to choose a risky strategy when facing a female opponent on occasions when the opponent is superior by means of their respective Elo ratings. We are not in a position to provide a conclusive explanation for the latter result; however, some theories on stereotyping within the social psychological literature fit nicely with our results. According to these studies “judgment can become more stereotypic under cognitive load” ([Macrae and Bodenhausen 2000](#), p. 105). Under the assumption that the “cognitive load” becomes greater when playing against a stronger player, gender stereotyping could be used as a “cognitive shortcut”, i.e. used as a means of processing information in a heuristic mode. As [Hilton and von Hippel \(1996\)](#) report, stereotyping can manifest itself through the selective judgment of evidence, for example regarding another person's intelligence. Thus, stereotyping seems to be a plausible explanation for our findings, especially as we find the elevated aggressiveness against women not to be rewarding, i.e. irrational in economic terms.

6. Concluding remarks

In our introduction we sought to establish a link between the strategic thinking of highly skilled chess players on the one hand, and the chances of successfully climbing the career ladder on the other. There are innumerable situations where men and women compete, for example in a negotiating situation, which might be characterized as a “two-person competition”, as noted by [Niederle and Vesterlund \(2007\)](#). They show that compared to men women avoid competitive schemes, and when forced to compete, they fail to do so appropriately. Basically, our results are consistent with theirs; however, we add a new facet by showing that men become more inclined to choose aggressive strategies when they face a female opponent. One might read this result in terms of overconfidence. Some studies point at men being more overconfident than women, especially in “male-dominated realms” such as trading, see [Barber and Odean \(2001\)](#). Based on our results, male overconfidence might become even stronger when men face a female opponent. Alternatively one might read the results in terms of gender stereotyping, leading to the undervaluation of the real capacity of women in cognitive

demanding situations. The latter aspect might also explain why women too are more prone to choosing aggressive (i.e. risky) strategies when playing against female opponents who on objective grounds are stronger players.

One objection that might be raised against this study is that it focuses on a non-representative selection of people, i.e. a group more accustomed to complex strategic thinking than people in general. Arguably the latter point suggests that the found estimates are to be seen as lower bounds, not the least as “ordinary” people are more likely to adhere to less rational, subjective standards, where the perception of women's competence is more likely to be fraught with prejudice. Another issue connected to sample selection regards the fact that the female share among chess players is rather low, which might imply that the motivation that drives women to participate in chess tournaments is different from the motivation that drives men. As a counter-argument to this criticism, we would argue that the gender balance in higher ranks of the business world (e.g. among corporate board members) is not that different. Also, by using a large panel data set, we are in a position to control for individual heterogeneity by means of including individual fixed effects. In combination with the Elo rating, which permits controlling for differences in skills (i.e. productivity), this study adds a new dimension to the existing research on risk behavior. Furthermore, as our sample of chess players comprises people from (almost) all over the world, the behavioral patterns found are not tied to a specific cultural, religious or social environment. Rather, they reflect expressions of human interaction that people share irrespective of heritage.

The fact that we can observe mixed-group behavior in a competitive environment is a main contribution of the paper. It thereby emphasizes the importance of interpersonally determined mechanisms occurring in highly competitive situations. In particular, our results shed a new light on the discussion on what determines differences between men and women in intellectually demanding professions. Naturally, our findings should be tested and validated in other settings. If they stand up to comprehensive examination, they will certainly become important for designing policy measures aimed at counteracting the disadvantaged position of women in different parts of society.

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Appendix A. Expert enquiry: instructions to the chess experts

For every Eco code you must decide whether the opening is to be considered as aggressive, solid, or unclear. Denote your definitions using A, S or 0 respectively. This should be done from the perspectives of both players (white and black). As most Eco codes contain sub-openings where some can be aggressive and others solid within the same Eco code, you should focus on what you believe is the principal opening and that is played most frequently. The key moves are those where the players must decide on the character of the game, i.e. “am I to choose the safe path or the risky path?” It is your feeling or belief about the opening that is important, not “the philosophical truth” from a theoretical perspective that is still to be discovered. Try to use the same information as you would when you choose what openings to include in your (opening) repertoire. You will be compensated for a maximum of five working hours.

²² See [Eagly \(1995\)](#) for a discussion on the task of interpreting the real impact of measured statistics in the context of behavioral research, especially as regards gender differences.

²³ The latter result is in contrast to studies referred to in [Croson and Gneezy \(2009\)](#), saying that gender differences among managers and entrepreneurs in risk taking attenuate with experience and profession.

²⁴ This is in line with the findings by [Holm \(2000\)](#) who showed that both men and women behaved more aggressively against women.

Table A.1

Classification of standard opening by expert chess players.

| Extract from the questionnaire | | | | | | | | | | | | |
|--------------------------------|--------------------|---------------------|--------|-------|----|-----|----|-----|-----|----|-----|-----|
| Eco | Opening | Variation | Player | | w1 | b1 | w2 | b2 | w3 | b3 | w4 | b4 |
| | | | White | Black | | | | | | | | |
| B01 | Center counter | | S | S | e4 | d5 | | | | | | |
| B02 | Alekhine's defence | | S | A | e4 | Nf6 | | | | | | |
| B03 | Alekhine's defence | | A | A | e4 | Nf6 | e5 | Nd5 | d4 | | | |
| B04 | Alekhine's defence | Classical variation | S | A | e4 | Nf6 | e5 | Nd5 | d4 | d6 | Nf3 | |
| B05 | Alekhine's defence | Classical variation | S | A | e4 | Nf6 | e5 | Nd5 | d4 | d6 | Nf3 | Bg4 |
| B06 | Modern defence | | S | A | e4 | g6 | | | | | | |
| B07 | Pirc defence | | S | A | e4 | d6 | d4 | Nf6 | | | | |
| B08 | Pirc defence | Classical variation | S | A | e4 | d6 | d4 | Nf6 | Nc3 | g6 | Nf3 | |
| B09 | Pirc defence | Austrian attack | A | A | e4 | d6 | d4 | Nf6 | Nc3 | g6 | f4 | |
| B10 | Caro–Kann defence | | S | S | e4 | c6 | | | | | | |

Note: w1: first move white; b2: second move black; etc. e4, d5, etc. denoting chessboard coordinates, while N and B denote knight and bishop, respectively.

Summary statistics on the classification of openings are shown in Table A.2. For example, an opening on the part of a white player is considered *solid* in 50% of all the 499 openings classified.

Table A.2

| | Obs | Mean values | Standard deviations |
|-------------------------------------|-----|-------------|---------------------|
| <i>Solid</i> OR, playing white | 499 | 0.501 | (0.501) |
| <i>Solid</i> OR, playing black | 499 | 0.405 | (0.491) |
| <i>Aggressive</i> OR, playing white | 499 | 0.251 | (0.434) |
| <i>Aggressive</i> OR, playing black | 499 | 0.297 | (0.457) |

The Elo rating system

The following section is to some extent drawn from “Arpad Elo and the Elo Rating System” by Daniel Ross, see <http://www.chessbase.com/newsdetail.asp?newsid=4326>. The description aims to show how winning probabilities are calculated and how Elo rates of chess players are subsequently updated.

In the late 1950s, Arpad Elo, physicist and himself a devoted chess player, introduced a new system of classifying the strength of chess players. By observing results from chess tournaments, he noted that the distribution of individual performances in chess resembled a normal distribution. On the basis of his observations, he introduced a point scale, where he determined the standard deviation to be 200. The distribution relates to the difference in ability between two players. Defining μ as the difference in Elo strength between two players, this gives us the following probability density function, i.e. the marginal probability of winning:

$$f(x) = \frac{1}{\sigma' \sqrt{2\pi}} e^{-\frac{(\mu)^2}{2\sigma'^2}}. \quad (1)$$

As there are two participants, each of them having an assumed performance deviation of 200 Elo points, the standard deviation used in Eq. (1) can be rewritten as follows:

$$\sigma' = \sqrt{\sigma_1^2 + \sigma_2^2} = \sqrt{2\sigma^2} = \sigma\sqrt{2} = 200\sqrt{2} \quad (2)$$

$$\int \frac{1}{\sigma' \sqrt{2\pi}} e^{-\frac{(\mu)^2}{2\sigma'^2}} d\mu = \frac{1}{400\sqrt{\pi}} \int e^{-\frac{(\mu)^2}{400^2}} d\mu. \quad (3)$$

For example, this is saying that the probability of winning is 76 [24] percent if one player has 200 Elo points more [less] than his/her opponent. Where two players are equally strong (i.e. an Elo difference equal to zero), the most likely outcome is a draw.

Elo ratings: a sequential estimate of strength

The probability of winning as shown in Eq. (3) is used to update a player's Elo rating. The algorithm for doing this reads as follows:

$$Elo_new = Elo_old + (Score - Prob(winning)) * k. \quad (4)$$

Here Elo_old is the Elo rating before the game starts, while Elo_new is the updated rating. The *Score* indicates the actual outcome of a game, where a win [loss] is valued as 1 [0], and a draw counts as 0.5 point. The coefficient k is a weighting factor that determines how much the outcome of a game counts for a player's Elo rating. It is negatively correlated with skill level, i.e. the less experienced a player is, the higher the k .

In some of our estimations a variable denoted “Elo points at stake” is included as a covariate. It is determined by setting the *Score* in Eq. (4) equal to one, and by determining k as follows:

$$k = \begin{cases} 130 - Elo_old / 20 & \text{if } Elo_old \in [2000; 2400) \\ 10 & \geq 2400 \end{cases}$$

Thus, Elo points at stake reads $(1 - Prob(winning)) * k$.

Table A.3

Ordered logit estimations (odds ratios) with categories *loss*, *draw* and *win*, when playing against a woman and using an *aggressive* strategy. **MEN.**

| | (1) | (2) | (3) | (4) |
|---|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| | | | Elo > than opponent | Elo < than opponent |
| Playing aggressive | 0.9699 (0.0049)*** | 0.9408 (0.0048)*** | 0.9607 (0.0067)*** | 0.9216 (0.0063)*** |
| Female opponent | 1.4976 (0.0202)*** | 0.9631 (0.0116)*** | 1.0060 (0.0146) | 0.8970 (0.0175)*** |
| Playing aggressive against female opponent | 1.0048 (0.0236) | 1.0189 (0.0240) | 1.0169 (0.0305) | 1.0020 (0.0399) |
| Individual fixed effects | No | No | No | No |
| Indicator opponent playing Solid | No | Yes | Yes | Yes |
| Elo points at stake | No | Yes | Yes | Yes |
| Elo differences | No | Yes | Yes | Yes |
| Observations | 1282315 | 1282315 | 678652 | 599418 |
| Number of players | 13985 | 13985 | 13755 | 13978 |

Note: Robust standard errors in parentheses, clustered at player level. Other control variables are *Elo*, *age* *age squared*, *age_max_20*, *log (number of games played)*, and *year dummies*. No individual fixed effects included.

*Significant at 10%.

***Significant at 5%.

***Significant at 1%.

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