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A RIB LESS MAKES YOU CONSISTENT BUT IMPATIENT: A GENDER COMPARISON OF EXPERT CHESS PLAYERS

by

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Abstract

This paper presents empirical findings on gender differences in time preference and time inconsistency which are based on international chess data from 1.5 million expert games. Controls are included for age, nationality and playing strength where the latter accounts for gender differences in productivity. Impatience is measured by considering preferences for different game durations. Inconsistency is measured by exploiting the 40th move time control, where over-consumption of thinking time is inefficient. The results reveal that men are more impatient while women are more time inconsistent. Moreover, the difference in impatience *increases* with expertise while the difference in inconsistency *decreases.*

Keywords: Time preference, time inconsistency, impatience, gender

Classification codes: J16, D03, D91

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1. Introduction

We have all experienced moments of regret at leaving unpleasant tasks for later although we know we would be better off in the long run by doing them now. This is also true for pleasant tasks, or rewards, which we tend to carry out, or consume, earlier than we would prefer in the long run. Such acts are said to be due to self-control problems as we are just too tempted by the present utility to care about the long-term utility. We also know that people differ in degrees of impatience as some people seem to be able to wait patiently while others want instant action. The theory of economic preferences distinguishes between *time preference* and *time consistency*.

Time preference measures impatience or when in time we prefer to act. This is modeled with a discount factor where a lower discount factor means that we are more impatient and therefore value *sooner* higher than *later*. Our discount factor is the same over any two periods whenever in time we are asked. The concept of *time consistency* builds on the same premises but adds a second parameter to distinguish between the *present* and the *future*. There is no difference between time preference and time consistency as long as we *are* time consistent. The difference occurs when we are time *inconsistent*. The implication of an inconsistent behavior is that the discount factor changes in the present period compared to future periods.

Contrary to the concept of time preferences, time inconsistency distinguishes between short- and long-term values. Angeletos et al. (2001) give a neat example. When we go to bed at night most of us set the alarm to wake us up at a certain time. Nevertheless, when the alarm sounds some of us just hit the snooze button, pull up the duvet and go back to sleep. We then tend to hit the snooze button repeatedly until we have to skip the healthy breakfast, have a swift cup of coffee and lock the door at the same time as we put our coat on. In this case, we consume too much time (a pleasant activity), to the point where we experience subjective discomfort in the shape of stress. If, when programming the wake-up time the night before, we intended to wake up the first time the alarm sounded but failed to do so by hitting the snooze button, then the behavior is time inconsistent as our long-term preferences are not consistent with our short-term preferences. However, if we *intended* to snooze for a while before getting up then the behavior is time consistent as our preference did not change during the night. In practice, it may be difficult to observe whether there was an intention to snooze or not, which may be one explanation as to why there are so few empirical studies on time inconsistency, especially across gender.

Akerlof (1991) writes that time inconsistency could contribute to "poverty of the elderly due to inadequate savings for retirement, addiction to alcohol and drugs, criminal and gang activity, and the impact of corporate culture on firm performance." If one of the sexes is more impatient or time inconsistent than the other then consumption and savings could differ substantially during a lifetime. With their empirical paper, Ashraf et al. (2006) showed that the saving behavior can indeed be affected by time inconsistency. In addition, they find that women are, or at least consider themselves to be, more time inconsistent.[1] In his theoretical paper, Strotz (1956) was the first researcher to suggest that people are more impatient in the short run than in the long run. Pollack (1968) and Phelps and Pollack (1968) gave an early formal model of time inconsistency which has later been extended and refined by Akerlof (1991), Laibson (1997), Fischer (1999) and Barro (1999). The research results on time preference and gender diverge somewhat although there is some indication of male students being more impatient than female students. However, in an influential paper by Harison et al. (2002), no gender difference in discount factor was found when looking at a more representative (general) sample. The purpose of this paper is to examine potential gender differences in time preferences (impatience) and time inconsistency by using an extensive dataset from international chess played by expert chess players.

[1] See also DellaVigna & Paserman (2005) for an empirical work on time preferences, Benzion et al. (2004) on time inconsistency and Croson & Gneezy (2009) for an overview of gender differences in economic preferences.

To model impatience and time inconsistency, I use the theoretical stepping stone suggested by O'Donoghue and Rabin (1999). The degree of impatience in chess is measured by observing the game duration in moves when holding constant for gender differences in productivity (playing strength). Choosing to end the game early is assumed to be a signal of impatience and vice versa. To account for possible gender differences in risk aversion and aggressiveness, I also run a sensitivity check where I include a control for risk aversion in line with Gerdes and Gränsmark (2010). To study gender differences in time inconsistency I exploit the fact that the time available to each player in a chess game is restricted. At the 40^{th} move there is a time control requiring at least 40 moves to have been played within the first two hours. A player can *consume* or *save* time and I investigate to what extent women and men end up in time trouble just before the time control at the 40^{th} move.

The results show that men have a significantly lower discount factor and are thereby more impatient than women. Women are more time inconsistent and the fact that I cannot give any formal proof that the time inconsistency is really due to self-control problems is, at least partly, compensated by the findings showing that the effect decreases with increasing expertise. The gender differences in impatience, on the other hand, increase with expertise.

In experimental studies addressing discounting over time, it is common to include money as a means of measuring the degree of impatience. When doing so it is important to control for wealth, as a potential gender difference in impatience could otherwise be due to the fact that differences in wealth can lead to a different valuation of money. The time frame must typically be rather large as it would be difficult for most people to perceive a difference from one day to another. In a practical experiment $100 now is the same for most people as $100 a few hours later (the problem of *just perceptible differences*). For this reason, the experiments are abstract, i.e., the participants are supposed to imagine an abstract time period of, for instance, one year. If the experiments were to last for a whole year it would be impossible to control for changing factors in the lives of the participants as they could not be isolated from the world for a year. In a chess game, that usually lasts for a few hours, and no money is involved so the effect of wealth does not play an important role here.[2] As a corollary, there is no need to study agents for a longer time period. The longer the time frame in an experiment, the higher the risk that external conditions will change, with obscure impact to follow. Consequently, when using chess data we do not have to worry about wealth, remaining lifetime or different perceptions of the interest rate when measuring discounting over time.

The snooze example given by Angeletos et al. (2001) is an example of a "few-hours-game" (lasting for about eight hours), a game length perfectly comparable to the one in a chess game. Most experiments on time consistency use questions like "Would you prefer $100 today to $110 in a year?" By varying the amount it is possible to obtain an image of people's impatience. The drawback with such a method is that it measures people's *attitudes*, not their actual *behavior*. Economists primarily want to know how people really *act*, not how they *think* they act. With the dataset in this paper it is possible to measure actual behavior, i.e., we can observe how the players have actually played, not how they think they should have played.

For a number of years strategic aspects involved in playing chess have become an established analytical tool in cognitive psychology. A landmark for establishing chess as an analytical tool was the introduction of the so called "Elo" scale that made it possible to compare the strength of chess players on a metric scale. Following on from the work of Elo (1978), it has become possible to measure skills on objective grounds, i.e., there are no

[2] The prize money in chess levels below the absolute world elite can be ignored as it is too small to be important in this context.

"subjective assessments" (Chabris and Glickman 2006, p. 1040).[3] In a study by Moul and Nye (2009) the authors write that:

"Chess has numerous strengths for the purposes of econometric analysis. First, the outcomes are clear and objective: a win, a draw, or a loss. Moreover, a perfect record of all games is available for virtually all important championship and high-level tournament games of the modern era. Most important of all is that there exists a rating system that is a precise and accurate reflection of the performances of players and an excellent indicator of the relative strengths of players. These ratings are the best unbiased estimates of relative strengths and the differences in ratings correspond to the likelihood that the stronger player will defeat the weaker (cf. Elo 1978). These Elo-style ratings have since been applied not only to other sports but also to studies of revealed preference rankings in college selection." (Moul and Nye 2009, p. 11).

As argued by different scholars in the field, e.g., Gobet (2005), Ross (2006) and Roring (2008), chess has the potential to be applied to questions that concern issues even outside the world of chess. For example, one result resolved by 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 into "arts, sports, science, and the professions" (Gobet 2005, p. 185).

Undoubtedly, chess players constitute a selected group which is not representative of the whole population. Nevertheless, one may argue that there is a common denominator between chess players and employees in intellectually demanding professions. Furthermore, it has recently become more common to look at highly skilled athletes and sports competitions for the purpose of analyzing economic issues. For example, Duggan and Levitt (2002) look at corruption in the world of sumo wrestling by analyzing the frequency of arranged draws. The authors recognize that sumo wrestling in itself is not of much interest in economics but that

[3] The Elo rating is calculated through an algorithm that starts out from the assumption of a normal distribution of the chess players' strength. It takes into account the difference in current Elo between the two players (before the game) and the result of the game (1-0, 0-1 or ½-½). Elo points are then added or subtracted to the players' Elo score. Consequently, the Elo rating is a cardinal measure that evolves over time. An Elo rating that is superior to the rating of the opponent by 200 points corresponds to a winning probability of 75 percent.

economists can learn about the impact of corruption by studying it. From a game theoretical point of view, Levitt et al. (2009) focus on expert chess players in a lab experiment where they investigate whether it is reasonable to test backward induction through the centipede game.

Compared to sports economics, chess has the advantage that different groups can be compared more easily as there is no requirement of physical strength. Men and women can be compared on an equal basis which is not always the case in sports economics. Indeed, chess is one of the few competitive events which men and women enter in direct competition.[4] Moreover, the rules in chess are the same all over the world which facilitates comparisons ever further.

This paper aims to contribute to the literature by studying gender differences in two related topics: time preference and time inconsistency. This is done by employing a large, international and non-experimental panel data over eleven years. The main advantage of this dataset is the Elo rating which makes it possible to hold constant for gender differences in productivity. In addition, the control variables for age, nationality and individual fixed effects contribute to reduce the impact of other confounders such as cultural differences.

The next section provides a theoretical background while Section 3 discusses the data and statistics. Section 4 presents the results of the estimations and Section 5 concludes.

2. Conceptual framework

The theory of time inconsistency builds on the theory of exponential discounting. It is modified to account for the fact that people tend to give a higher weight to the present than the future. This is usually the case in exponential discounting as well but in that case it does

[4] For a discussion about women's situation in the chess world, see Shahade (2005).

not matter when in time the agent is asked, the discounting is always the same. In the model of exponential discounting, let U^t be a person's utility in period *t*. In period *t* we do not only care about our present utility, but also about our future utilities. Let $U^t(u_t, u_{t+1}, ..., u_T)$ represent a person's *intertemporal preferences* from the perspective of period *t*, where U^t is continuous and increasing in all components. Formally, the model is defined as:

(1) For all *t*, $U^t(u_t, u_{t+1}, ..., u_T) \equiv \sum_{\tau=t}^{T} \delta^\tau u_\tau$

where $\delta \in (0, 1]$ is a discount factor. *t* denotes the time period of interest (the current period) and τ the time period in which the activity is carried out. A δ smaller than one is interpreted as impatience by economists.

By considering the duration of a chess game it is possible to obtain an image of the impatience of the players, i.e., an impatient player will strive to end the game earlier than a patient player. The utility when looking at impatience in a chess setting equals the outcome of the game, i.e., a win, a loss or a draw (1, 0 or ½ a point respectively). Since the short-term utility, as defined here, only appears once (a game only ends once), the short- and long-term utilities are related as $U^t(u_t) \equiv \delta^t u_t$. Controlling for playing strength, the short-term utilities for men and women are the same, i.e., they score equally well. The period *t* is represented by the number of moves, i.e., the higher the number of moves, the later the period. The relationship between the discount factors for each sex can then be calculated. Let δ_{fem} be the female and δ_{mal} the male discount factor and ϕ and λ the average number of moves (the time period *t*) when the game is ended for females and males respectively, where ϕ, λ >0. Since $u_\phi^{fem} = u_\lambda^{mal}$ we have that $\delta_{fem}^\phi = \delta_{mal}^\lambda \Rightarrow \delta_{fem} = \delta_{mal}^{\lambda/\phi}$. Thus, if $\phi > \lambda$, then $\delta_{fem} > \delta_{mal}$, since δ <1. The implication is that if men end their games in fewer moves on average than women, then their discount factor is lower, indicating a more impatient behavior than for women. The first aim of this paper is to determine the relationship between ϕ and λ after controlling for productivity.

The second aim concerns potential gender difference in time inconsistency which is said to occur when a person has self-control problems. An intuitive definition of time inconsistency was suggested by Solomon and Rothblum (1984): "An act of needlessly delaying tasks to the point of experiencing subjective discomfort." In line with the work of O'Donoghue and Rabin (1999) I extend this definition to also include: carrying out a pleasant activity too soon to the point of experiencing subjective discomfort. To be able to measure possible gender differences in time inconsistency it is essential to be able to distinguish between short-term temporal utility and long-term intertemporal utility. A time inconsistent behavior implies that the short-term utility is not compatible with the long-term utility. Although we know what is best in the long run, sometimes we temporarily disregard the long-term intertemporal utility in favor of the short-term utility.

Time inconsistency is usually referred to as *present-biased preferences* (O'Donoghue and Rabin, 1999) or *hyperbolic discounting*[5] (Laibson, 1997). It can be elegantly modeled by adding only one parameter to the model of exponential discounting, namely the β parameter.

(2) For all t, $U^t(u_t, u_{t+1}, ..., u_T) \equiv \delta^t u_t + \beta \sum_{\tau=t+1}^{T} \delta^\tau u_\tau$

where $0 < \beta, \delta \leq 1$. As before, δ is the discount factor and can be set equal to 1 without loss of generality. β is the present-bias factor which equals 1 in the case of time consistency. In the case of time inconsistency β <1, indicating that the present utility is more important than the future utility. If β =1 then the (β, δ)–preferences are simply exponential discounting.

[5] In the present model, it is rather a quasi-hyperbolic discounting as the β is constant over time.

Increasing the move quality in the present period by consuming thinking time is considered to be an immediate reward in the framework by O'Donoghue and Rabin. If a person consumes time in period τ, then her intertemporal utility in period $t \le \tau$ is

(3) $U^t(\tau) = v_t - \beta c_\tau$, if $\tau = t$ or $U^t(\tau) = \beta v_\tau - \beta c_\tau$, if $\tau > t$

τ is the time period when the action is carried out while t is the present time period. *v* is a reward schedule while *c* is the cost schedule.

Almost a century ago the grandmaster Rudolf Spielmann stated that it is *wrong to search for the best chess move* in every position. One should only try to find *a sufficiently good move*.[6] In the search for the "perfect" move you will exhaust your energy and most probably end up in time trouble. This summarizes the dilemma for expert chess players. On the one hand, you want to find a "killer" move in the present position, and on the other hand you know that if you pursue this ambition you will probably lose due to bad moves later in the game when you run short of time and are forced to play without much reflection. This is a topical matter in the mind of any expert chess player. Most players at higher levels are aware of the fact that it is *tempting to give in to the desire to search for the best move in the present position,* but that such an impulse is dangerous to pursue as the clock is ticking. As the aim is to win the game, not to play good chess moves, the players constantly have to remind themselves not to give in to "romantic" impulses. Webb (2005) writes in his chess book that:

"…many leading grandmasters are so fascinated by chess that they cannot resist the challenge of finding the very best move in a position, even if this means spending up to an hour on a single move. Consequently they often end up having to make their last 10 or 15 moves in less than a minute." (Webb 2005, p. 102)

[6] For an interesting discussion on the rational choice procedure of a chess player, see Simon (1955).

Expressed differently, the task of an expert chess player is to maintain a constant, high quality game, not to play a few excellent moves followed by some less impressive moves under time pressure. In a context of time inconsistency this could be expressed as the choice between giving in to the short-term goal of finding the best move in the present position or the long-term goal of playing a set of good moves that eventually wins the game.

To obtain a measure of potential time inconsistency in chess, I exploit the existence of the time control limit at the 40th move. In chess there is a time constraint where you have limited time at your disposal. In standard international chess *each player* has a maximum of two hours for the first 40 moves and then an additional 60 or 90 minutes for the remainder of the game.[7] Under these conditions the maximum duration of a game would be six to seven hours. The two hours can be distributed among the 40 moves in the way the player wishes. Just as in exponential discounting, one can choose to *consume* or *save* time for each move. Time is the *good* that can be consumed or saved and each chess move represents a time period. It is possible to consume less time in the beginning of the game which can be used later in the game. If you consume (too) much time in the beginning of the game you could end up in time trouble when approaching the time control limit at the 40th move. If fewer than 40 moves have been played when the two hours end, the game is lost. Frequently, some players tend to fall short of time over and over again before reaching the 40th move and as I argue below, this is due to self-control problems. It is not uncommon to see a player use about one hour and 45 minutes for the first 20 moves and then have to play 20 moves in only a quarter of an hour, while other players almost never end up in time trouble. Webb (2005) continues:

> "…many experienced players, including some grandmasters, seem unable to avoid getting into time-trouble game after game. As a result they regularly throw away good positions and fail to achieve the results of which they are capable." (Webb 2005, p.100)

[7] A chess clock contains two clocks, one for each player.

Surprisingly often a superior position reached after hours of play is given away in just a few seconds in the last move(s) before the time control. It can be perfectly time consistent to win, draw and even lose a game. The time *inconsistency* occurs when you lose on time which was certainly not part of the plan when the game started. I assume that all games lost in the 40th move are due to time inconsistency. The fact that some of these games were lost in a natural manner (not due to time trouble) is not a problem as both sexes are expected to be equally affected (I control for playing strength through the Elo rating).

The purpose of introducing a time control limit is reflected in the *Chess Organiser's Handbook.*

> "[chess games without time limit] are rarely seen. Some players are extremely ill-disciplined and will end up making all the remaining moves in 5 minutes, even if they had 3 hours at the start. It is nannyism to prevent players doing this but someone has to exhibit a measure of control." (Reuben 2005, p. 54)

In other words, by imposing the 40th move time control, the organizer forces a *commitment* upon the players to help them avoid getting trapped by the romantic task of finding the best move in every position.

Thus, when modeling time inconsistency, the short-term utility increases with increasing consumption of time and is defined as: $u_t \equiv$ *the quality of the* t^{th} *move as a function of the time consumed for the* t^{th} *move.* The intertemporal utility builds on an optimal usage of the disposable time and is defined as: $U^t(u_t, u_{t+1}, ..., u_T) \equiv$ *surviving the 40th move time control.*

The chess player faces a maximization problem with a time constraint where the intertemporal utility is maximized with respect to the short-term utility. The two-hour time frame in which the 40 moves must be played constitutes the time constraint. To learn to master the maximization problem under the time constraint is an integral part of the process of becoming an expert chess player. That is, the players are very well aware of where and when they can and should spend time on a move and when they should not. Even if they miscalculate, they have access to the chess clocks at all times and can easily re-evaluate the distribution of time consumption and adjust accordingly.

The assumption I make in this context is that it is not time consistent to lose a chess game on time. This assumption is not obvious and cases when it does not apply are discussed in the results section.

In the econometric analysis, I use a *Linear Probability Model* (LPM) with a binary dependent variable which I choose to estimate by OLS for its transparency and interpretational simplicity. The LPM looks like:

(4) $$y_i = \alpha + \beta d_i + x_i \gamma + \varepsilon_i$$

where the dependent variable y is defined as $y_i = 1$ if the result of the game i = *win/loss/draw* for a certain period (to be specified in each case, see the data section), zero otherwise. α is the intercept, d_i is the female dummy. x_i are control variables and ε_i the (robust) standard errors. The female dummy coefficient gives the marginal probability for women to win/lose/draw compared to men in the estimated period. The control variables included in the model are: Elo rating (playing strength), Elo difference, age (age, age squared, age 0–20 years old), nationality and number of games played. As a sensitivity analysis I also include a control for risk aversion (aggressive opening strategy) in line with the conceptual framework of Gerdes and Gränsmark (2010). The games are treated as independent observations but as individuals play more than one game I employ clustered standard errors in the estimations.

3. Data and Statistics

The data in this study were obtained from ChessBase 10, a database collection with 3.8 million chess games played in international chess events. It contains about 200,000 players from 140 countries. Two levels of data are available: player-specific information and game-specific information. The name, year of birth, nationality and gender of a player are available. For every game there are data on the names and Elo ratings of both players, year of the game, number of moves and score. The years included in this study range from 1997 to 2007 and the minimum Elo rating required is 2,000.[8]

The regions with the highest number of chess players are Western Europe, Eastern Europe and the former Soviet Union.[9] These three regions account for about 90 percent of the expert chess players in the world. Western Europe alone accounts for 45 percent, Eastern Europe for 27 percent and the former Soviet Union for about 18 percent.[10] The remaining 10 percent are from other parts of the world, mainly South and North America and Asia.

Women have an Elo rating of about a hundred points lower than men, averaged over the whole population. The female share varies substantially across regions from about 5 percent in Western Europe, to 10 percent in Eastern Europe and 14 percent in the former Soviet Union. The female share for players with a playing strength of between 2,000 and 2,300 is 12 percent while 5 percent for players stronger than 2,300. The overall female share is about 8 percent.

Since the female share has been rising continuously in the last two decades women are much younger on average than male chess players. The average male is 35 years old while

[8] An Elo rating of 2,000 corresponds to an expert level. An Elo rating of about 2,500 is required to become a grandmaster. The highest score ever reached by a human is 2,851 (Kasparov).
[9] As the USA applies a different rating system than the Elo, many American players are not included in the international dataset used here.
[10] See Table 1 in Gerdes & Gränsmark (2010) for further details.

the average female is ten years younger. In the former Soviet Union the mean age is much lower and the difference between the sexes is not as large as in Western Europe.

To model impatience I look at the game durations measured in moves which, for practical reasons, are divided into five-move intervals. Figure 1 presents the number of wins, losses and draws that are realized in each interval.

Figure 1 about here

The mean game duration for women is about three moves longer, approximately 42 moves, (see Table 1) while men's games end after 39 moves on average. The standard deviation is approximately the same. Table 1 also gives the mean game duration for two subgroups with different playing strengths. Roughly, the group with an Elo rating lower than 2,300 are expert amateurs and the higher rated group with an Elo rating higher than 2,300 are professionals or semi-professionals. The reason for looking at two subgroups is to see if there are differences between the groups and if the observed pattern changes with playing strength. For the professionals, the female games last about four moves longer than male games. For the amateurs the difference is smaller, about 2.5 moves.

Table 1 about here

When turning to time inconsistency, the critical period is the 40th move and the moves around it (not intervals as when looking at time preferences). Table 2 presents descriptive statistics for each period. It gives the number of won and lost games played by both males and females. It also gives won and lost, female and male games for each period as a share of the total number of female and male games played.

Table 2 about here

Figure 2 displays the number of male/female games for wins, losses and draws but where the number of male games has been divided by ten for easier comparison. Notice that, although there are only three outcomes in chess, in this context there is also a fourth outcome in each period, namely *not ending* the game in that period.[11]

Figure 2 about here

Figure 2a shows that men increase their number of wins substantially more than women in the critical period while Figure 2b shows that there is barely any gender difference in the number of losses. Although the 40th period is the critical point for potential gender difference in time inconsistency, some of the effect is expected to spill over to the 41st period as it is not uncommon that the last moves before the time control are played so quickly that the player in

[11] As a matter of fact, not ending the game in the current move is the most common outcome as only about 1 percent of games end in a win, loss or draw. This typically produces small coefficients.

time trouble does not have time to properly evaluate the position. Once the time control is passed, the player realizes that the position is lost (given that it is) and resigns. For this reason, some of the games won/lost due to time trouble are registered as won/lost in period 41. This fact can be observed in Figure 2. Notice that the maximum for draws occurs in the 41^{st} move. This is natural since under time pressure there is no time to either evaluate the position nor propose/accept a draw. Quite often the position on the board is clearly drawn but the player/s continue until the time control is reached in the hope of the opponent making a mistake.

The regressions in the next section test if the descriptive patterns for impatience and time inconsistency remain after the inclusion of the control variables Elo, Elo difference age, age-squared, teenage, nationality and number of games played.

4. Results

This section starts by presenting the results on time preference (impatience) and then continues with the results on time inconsistency. The analysis of time preference begins with a regression where the game duration is regressed on the female dummy and controls (i.e., no LPM) with the purpose of obtaining a result in the shape of a single coefficient. This is followed by multi-regressions for different intervals of game durations for wins, losses and draws separately and also for amateurs and professionals. The analysis of time inconsistency starts by an LPM for wins and losses for different game durations around the 40^{th} move. To also take the draws into account this is followed by an ordered logit model where the total performance around the 40^{th} move is analyzed. Finally, I examine the performance when taking the gender of the opponent into account to see how men and women score against female and male opponents around the 40th move. In these regressions it is possible to control for individual fixed effects which net out the effects that are constant over time.

4.1 Time preference

Table 3 shows the results when the game duration in moves is regressed on the female dummy and the controls, including playing strength. The first column of Table 3 shows that the game duration is about 2.5 moves longer for women and the coefficient is significantly different from zero. Columns (2) and (3) show that the gender difference in game duration is smaller among expert amateurs (about 1.5 moves) than among the professionals (about 3.5 moves).

Table 3 about here

The coefficients in Table 3 change somewhat compared to the mean values in Table 1 but the pattern remains, that is, there is a gender difference and it is smaller among expert amateurs than among professional players.[12] To see how sensitive the results are to differences in the female share, I have run the same regression on amateurs in Eastern Europe and the former Soviet Union where the female share is about 20 percent (compared to about 8 percent in the whole sample). The coefficient for the amateurs is 1.1598 with the standard error (.1628)*** which shows that the gender difference remains even when the female share is as high as 20 percent.

Figure 3 displays the female dummy coefficients from the main model of the paper (the LPM) where separate regressions are run for each move interval for wins, draws and

[12] Including a control variable for risk-aversion/aggressiveness only changes the results marginally.

losses. A positive female dummy coefficient implies that the probability for women to end the game in the corresponding interval is greater than for men. The figure reveals a smooth, S-shaped pattern where men prefer shorter games relative to women. The smoothed pattern is interrupted for draws in 10–19 moves, where men are heavily overrepresented. The explanation for this irregularity is to be found in the fact that men agree to pre-arranged or semi-arranged draws to a much higher extent.[13]

Figure 3 about here

Thus, the probability for men to end games in 35 moves or fewer is greater than for women while the probability for women to end games in more than 40 moves is higher than for men. Table 4 gives the coefficients, robust standard errors and significance levels of the results displayed in Figure 3.

Table 4 about here

These results suggest that $\phi > \lambda$, i.e., the female games last longer than the male games on average. As a result $\delta_{fem} > \delta_{mal}$, i.e., the male discount factor is smaller than the female discount factor. The conclusion is that men are more impatient than women.

[13] When running the regressions presented in Table 3 with a control for draws in less than 20 moves, the female coefficients decrease by about 25 percent and the significance level increases. The control for teenagers becomes insignificant in all models. Teenagers agree to pre-arranged draws to a lower extent.

Figure IV shows the game duration (irrespective of outcome) for expert amateurs and professionals. The patterns for both groups follow the same S-shape as in Figure 3. Moreover, in line with the results presented in Table 3, it is clear that the gender difference is higher in the group with higher playing strength, that is, men are even more impatient relative to women among the professionals compared to the expert amateurs.

Figure 4 about here

4.2 Time inconsistency

When turning to time inconsistency, the outcome variable changes from game duration for five-move intervals over the whole move spectra to wins and losses for one-move “intervals” around the 40^{th} move. Figure 5 displays the estimation results for the female dummy coefficients. Four separate regressions are run, one for wins and one for losses and for the higher- and lower-rated groups. For the amateurs the coefficient drops for wins at the 40^{th} move, indicating that the probability to win for women in the 40^{th} period is lower than for men. The difference is significant at the 1 percent level (see Table 5). Looking at losses for the amateurs, women lose more games compared to men in the 41^{st} move. As can be seen in Figure V the coefficient patterns for the amateurs for wins and losses are close to parallel for all moves except for the 40^{th} and 41^{st} move. For the professionals, however, there is barely any difference between the two curves. Although women win fewer games in the 40^{th} move, they also lose fewer games than men and there is no increase in losses in the 41^{st} move, as there is for the amateurs.[14]

[14] The inclusion of a control variable for risk-aversion/aggressiveness only changes the results marginally.

Figure 5 about here

As regards the draws (not reported in the figure), there are no significant gender differences in the moves 39–41 which implies that the results found in Figure 5 are not driven by changes in the pattern for draws.

Table 5 about here

Table 6 gives the results from an ordered logit model where the dependent variable is the total result, i.e., losses, draws and wins. For amateurs, there is a drop in winning probability for women in the 40^{th}, and to some extent also for the 41^{st} move. The coefficient for the amateurs in the 40^{th} move is significantly different from zero at the 5 percent level (almost at the 1 percent level). For the professionals, however, there is no clear pattern at all and none of the coefficients is significantly different from zero. The results presented in Table 6 are convincing and they show that the time inconsistent behavior that is found for the amateurs disappears when looking at the professionals.

Table 6 about here

The corresponding results for the amateurs in Eastern Europe and the former Soviet Union with a female share of 20 percent, is similar to the pattern for the whole population. The coefficients are insignificant for all moves except for the 40th move where the coefficient estimate is -.1218 and the standard error (.0669)*. Thus, the gender difference in time inconsistency seems to remain even with a female share of 20 percent.

As chess is a two-player game it is possible to observe the performance around the 40th move for men and women respectively, when controlling for the gender of the opponent. Figure 6 displays the MEN/WOMEN vs. female opponent coefficients for wins and losses when controlling for individual fixed effects. For the amateurs both men and women win more against female opponents in the 40th or 41st period compared to when playing against male opponents. Both men and women lose relatively less in the 40th move when playing against female opponents. For the professionals the patterns are weaker and there is no sharp difference in the 40th and 41st moves as there is for the amateurs.[15]

Figure 6 about here

Let us hypothesize that women end up in time trouble more frequently than men. In such a case, and when two women play against each other, the probability that both players are in time trouble is greater than when two men or opposite-sex opponents meet. When both players find themselves in time trouble, then neither one is trying to decide the game at that point (in period 40). The objective is simply to pass the time control by making 40 moves in two hours which is required to obtain extra time. When only one of the players is in time trouble then the player without time trouble will try to find decisive or complicated moves to

[15] There are few observations for women vs. women at the professional level which may explain the irregularity for those curves.

force the opponent to make a mistake under time pressure.[16] If the assumption that women end up in time trouble more frequently is correct, then they would simply prefer not to end the games in the 40th period to the same degree as men would. To test this hypothesis I look at game duration which includes wins, losses and draws. The regression results are displayed in Figure 7 and they show that women end fewer games in the 40th period when playing against a female opponent (the WOMEN female opponent coefficient) compared to when playing against male opponents.

Figure 7 about here

The intertemporal change between periods 39/40 and 40/41 is larger than any other two-period change. The conclusion from Figure 7 is that women prefer to avoid time-requiring (decisive) moves in the 40th period which indicates that women are more often in time trouble.

In section 2, I made the assumption that losing on time is not a time consistent behavior. A relevant question is whether this assumption is reasonable or not. Are there situations when a loss on time is *not* a result of self-control problems? First, could it be that women are just worse at planning? Second, could it be the case that it is rational to adopt a plan which results in a time loss once in a while but that wins in the long run?

For the gender difference found here to be due to self-control problems, it must be that the short-term utility is not compatible with the long-term utility. The definition of a time inconsistent behavior requires that we are *aware* of the divergence from the optimal short-term behavior that results from self-control problems. If we are not aware of the optimal short-term behavior then the divergence cannot be said to be due to self-control problems.

[16] Playing waiting moves under time pressure instead of first-best moves is a well-known phenomenon in chess, for example, move repetition where a piece moves back and forth. See for example Webb (2005) for a discussion.

Being bad at planning, for instance, would be an example of a behavior that does not necessarily result from self-control problems. If women are worse at planning than men, then the results could be due to inferior planning skills rather than due to a time inconsistent behavior. However, expert chess players are very experienced and they have a well developed feeling for the optimal behavior. Under such highly competitive conditions, means have been employed to maximize productivity. Weaknesses and inefficiencies have been minimized through dedicated training. Moreover, the chess clocks and the remaining time can be observed during the whole game so it is easy to re-evaluate the remaining time and adjust accordingly should the conditions change. The most applied rule of thumb in chess as regards the planning of the time distribution is to simply divide the total number of minutes available between the number of moves that have to be played, i.e., 120 minutes/40 moves gives three minutes for each move. For these reasons, the planning is relatively easy, i.e., the time constraint and move requirements are perfectly known and the requirements on the cognitive skills necessary for planning are relatively low. Moreover, women, not men, are generally considered to be better at planning which would lead to the opposite result from the one found here.[17]

As regards the second question as to whether it might be rational to adopt a time consumption distribution that more often leads to time losses, the fact that the gender difference in time inconsistency is considerably reduced for the professionals suggests that the phenomenon is inefficient and undesired. My interpretation is that players with a lower degree of self-control problems have a greater probability of reaching the higher ranks while those with a higher degree of self-control problems remain amateurs, to a larger extent.

Although the observational dataset applied here may not be perfect for analyzing time inconsistency, we should recall that in lab experiments we usually have to settle with

[17] See Naglieri & Rojahn, (2001) and references given there.

considerably fewer observations which often produce insignificant results. It is very difficult to obtain ideal conditions for analyzing time inconsistency for the reasons discussed in the introduction and both experimental and non-experimental studies are necessary to obtain the complete picture of potential gender difference. Whatever the underlying explanation to the findings, there *is* a gender difference which may be important to help us understand gender interactions in daily life.[18]

5. Conclusions

This paper finds that men are more *impatient* than women when it comes to ending a chess game and that the gender difference in impatience increases with expertise, that is, the gender difference is even greater among professionals. Furthermore, women lose more games on time than their male counterparts which I interpret as women being more *time inconsistent.* The time inconsistency, however, decreases with increasing expertise. For the professional players there is basically no evidence at all for gender difference in time inconsistency. My conclusion is that women are more time inconsistent than men among amateur players but only those with a low degree of time inconsistency reach the top ranks.

It is not obvious how to interpret the size of the gender difference. At first sight the size may seem small but we should recall that the fraction of games actually ended in each period is very low, producing seemingly low coefficients. In a single game the gender difference in impatience and time inconsistency has only a small impact but when cumulated over many games the difference may definitely be of importance. In relative probabilities, there seems to be a gender difference in impatience of about 5 percent for amateurs and about

[18] Furthermore, the fact that the gender differences survive nationality controls makes it tempting to conclude that the behavior is universal. However, this does not necessarily mean that the difference is genetic, see, for example, Lundborg & Stenberg (2009) for a discussion.

10 percent for professionals (see Figure 4). The corresponding difference for time inconsistency would be about 10–15 percent for amateurs but close to none for professionals (see Tables 5 and 6). Nonetheless, as has been stated in the literature, also very small differences can lead to huge effects on savings in the long run.

From a theoretical perspective the findings imply that the discount factor in the model of exponential discounting is lower for men than for women, implying that men value future payoffs less than women. In the case of time inconsistency, the beta parameter in the theoretical model with present-biased preferences is lower for women than for men. This implies that, relative to men, women consume more time in the short run than they would like to do in the long run.

One objection that could be raised against this study is that it focuses on a non-representative selection of people. For this reason we should be careful not to generalize the results too far. Also, as the female share among chess players is low it is possible that the motivation that drives women into playing chess is different from the motivation that drives men. However, we should recall that the pattern remains when studying a subgroup where the female share is as high as 20 percent (see Section 4). The dataset also has a number of strengths as it contains international, non-experimental data with a large number of observations in a panel data structure which allows controlling for nationality (individual fixed effects), age, gender and playing strength. The fact that it permits controlling for gender differences in productivity makes the findings very strong. Having such powerful econometric tools at hand in a two-agent game is rather rare in practice.

There is some research on impatience across gender. Some studies have found that male students in small-scale experiments are more impatient than female students but Harison et al. (2002) found no significant differences in time preferences when looking at a more general population with a larger number of observations. To the best of my knowledge there is only one paper looking at time inconsistency across gender. Ashraf et al. (2006) found that women are more time inconsistent by showing that they are more prone to accept commitment savings as a means to avoid consuming more in the short run than they would like to do in the long run. Thus, their result is in line with the findings of this paper. Their paper and the present study nicely complement each other as they tackle the question from different perspectives. Ashraf et al. (2006) examine whether women *consider* themselves to be more time inconsistent while this paper measures the behavior ex post. More research on the subject is necessary but if it turns out that one of the sexes is more time inconsistent than the other, then the behavior could create gender differences in long-term savings, for instance, in pension plans for retirement.

With the increasing popularity of online chess tournaments on the Internet, it might be possible in the near future to be able to observe the exact amount of time spent on each single move. That could give rise to some interesting further research which would be more precise than what is offered in this paper. The data on international chess games is very rich in variation and easy to quantify and there are still variables other than those used here. I think that this data could and should be further exploited by economists. After all, with concepts like *rational choice* and *optimization*, chess probably has more in common with economics than with any other discipline.

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Table 1
Descriptive statistics for game durations in moves for different subgroups.

Duration in moves	All		Amateurs, Elo<2300		Professionals, Elo>2300	
	men	women	men	women	men	women
Mean	**39.07**	**41.97**	**39.06**	**41.52**	**39.09**	**42.91**
Stand dev	16.73	16.86	15.98	16.37	17.34	17.81
No. of obs	1,423,567	125,369	646,273	84,552	777,294	40,817

Table 2
Descriptive statistics for wins and losses per period in absolute numbers and as shares.

WINS	***37***	***38***	***39***	***40***	***41***	***42***	***43***	***44***
No. of male games	12,952	13,123	13,634	16,804	14,871	11,765	10,591	9,711
Males/ total males	.0102	.0103	.0107	.0132	.0117	.0093	.0083	.0082
No. of fem. games	1,084	1,171	1,223	1,267	1,227	1,034	967	959
Females/ total fem	.0093	.0101	.0105	.0109	.0105	.0089	.0083	.0076
LOSSES	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**
No. of male games	11,448	11,617	12,062	15,114	13,300	10,504	9,449	8,674
Males/ total males	.0090	.0091	.0095	.0119	.0105	.0083	.0074	.0068
No. of fem. games	1,171	1,214	1,281	1,439	1,379	1,138	1,052	1,003
Females/ total fem	.0101	.0104	.0110	.0124	.0119	.0098	.0090	.0086

Table 3

Game duration in moves regressed with OLS on the female dummy and controls.

Dep var: game length in moves	*all*	*Amateurs Elo<2300*	*Professionals Elo>2300*
Female	**2.4491**	**1.5615**	**3.5431**
	(.1305)***	**(.1181)*****	**(.2832)*****
Elo	.0010	.0025	.0031
	(.0003)***	(.0004)***	(.0009)***
Elo difference	-.0003	-.0015	.0009
	(.0001)***	(.0001)***	(.0001)***
Age	-.1288	-.0416	-.1989
	(.0161)***	(.0146)***	(.0341)***
Age-squared	.0013	.0004	.0019
	(.002)***	(.0002)**	(.0004)***
Teenage	.3024	.3205	.4127
	(.1165)***	(.1159)***	(.1854)**
Number of observations	1,548,936	726,681	818,111

Notes: Additional controls: number of games and nationality controls. Robust standard errors in parentheses, clustered at player level. *** significant at 1%, ** significant at 5%.

Table 4

Coefficients, standard errors and significance level for the results displayed in Figure IV.

Female dum.	***10-14***	***15-19***	***20-24***	***25-29***	***30-34***	***35-39***
Win	-.0003	-.0017	-.0038	-.0053	-.0047	-.0002
	(.0001)***	(.0003)***	(.0004)***	(.0006)***	(.0007)***	(.0007)
Loss	-.0004	-.0016	-.0044	-.0049	-.0028	.0018
	(.0001)***	(.0003)***	(.0005)***	(.0007)***	(.0008)***	(.0008)**
Draw	-.0099	-.0104	-.0055	-.0023	-.0001	.0011
	(.001)***	(.0008)***	(.0008)***	(.0007)***	(.0006)	(.0006)*

40-44	**45-49**	**50-54**	**55-59**	**60-64**	**65-69**	**70-74**
.00003	.0019	.0022	.0019	.002	.0021	.0013
(.0007)	(.0006)***	(.0006)***	(.0005)***	(.0004)***	(.0003)***	(.0003)***
.0039	.0038	.0042	.0041	.0027	.0026	.0014
(.0009)***	(.0006)***	(.0006)***	(.0005)***	(.0005)***	(.0004)***	(.0003)***
.0028	.0032	.0026	.0027	.0015	.0019	.0016
(.0007)***	(.0006)***	(.0005)***	(.0005)***	(.0004)***	(.0003)***	(.0003)***

Notes: Control variables are: Elo, Elo difference, age, age-sq, age 0-20 years old, number of games and nationality controls. Robust standard errors in parentheses, clustered at player level. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5

Female dummy coefficients and standard errors for wins and losses in periods 37–43.

	37	*38*	*39*	*40*	*41*	*42*	*43*
Elo<2300							
Loss female	-.0006	.00004	-.0001	-.0014	-.00002	-.00002	.00036
	(.0003)*	(.0004)	(.0004)	(.0004)***	(.0004)	(.0004)	(.0003)
Win female	-.0002	.0008	.0004	.0001	.0015	.0004	.0010
	(.0004)	(.0005)*	(.0005)	(.0005)	(.0005)***	(.0004)	(.0004)**
Elo>2300							
Loss female	-.0005	.0004	.0003	-.0011	-.0002	.00003	-.0001
	(.0006)	(.0006)	(.0006)	(.0006)*	(.0006)	(.0005)	(.0005)
Win female	-.00066	-.0002	.0010	-.0010	-.0002	.0005	.00003
	(.0005)	(.0005)	(.0005)**	(.0005)*	(.0005)	(.0005)	(.0005)

Notes: Additional controls are: Elo, age, age-squared, teenager, number of games played and nationality controls. Robust standard errors in parentheses, clustered at player level. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 6
Female coefficients estimated by ordered logit for the total performance (win, loss and draw).

	36	*37*	*38*	*39*	*40*	*41*	*42*	*43*	*44*
Elo<2300									
Female	-.0228	-.0550	-.0555	-.0424	**-.1082**	-.0775	-.0120	-.0243	-.0187
	(.0458)	(.0472)	(.0472)	(.0477)	**(.0437)****	(.0420)*	(.0472)	(.0473)	(.0499)
No of obs	19,351	18,520	18,603	18,970	23,075	22,355	18,371	16,376	15,321
Elo>2300									
Female	.0684	-.0014	.0165	-.0820	.0166	-.0096	-.0686	-.0337	-.0306
	(.0629)	(.0674)	(.0643)	(.0664)	(.0627)	(.0596)	(.0581)	(.0698)	(.0722)
No of obs	20,208	19,979	20,223	20,475	25,154	24,951	20,232	18,248	16,802

Notes: Additional controls are: Elo, Elo difference, age, age-squared, teenager, number of games played and nationality controls. Robust standard errors in parentheses, clustered at player level. * significant at 10%; ** significant at 5%; *** significant at 1%

Figure 1

Descriptive statistics: number of ended games (vertical axis) for wins/losses, draws and total for different game durations in moves (lateral axis) divided into five-move intervals.

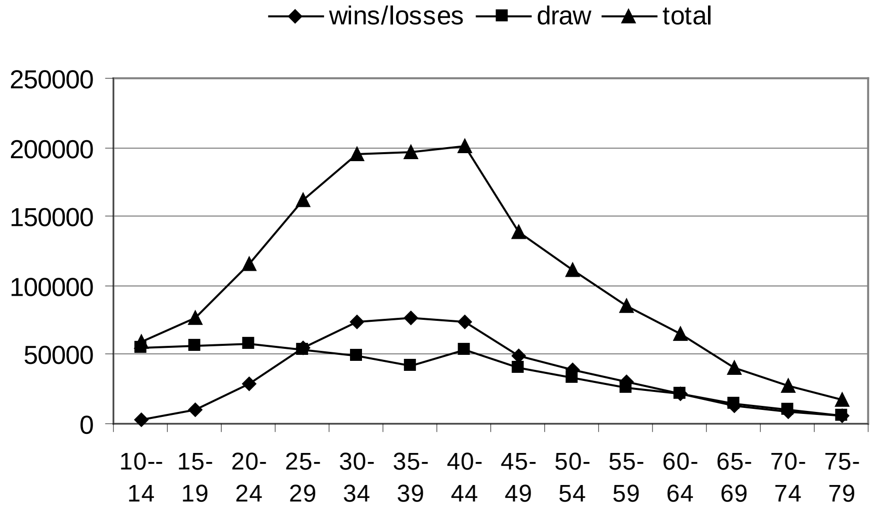
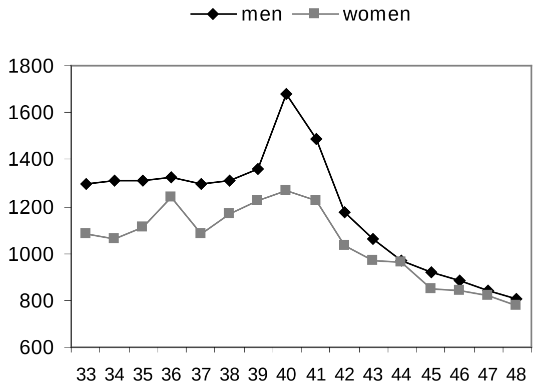
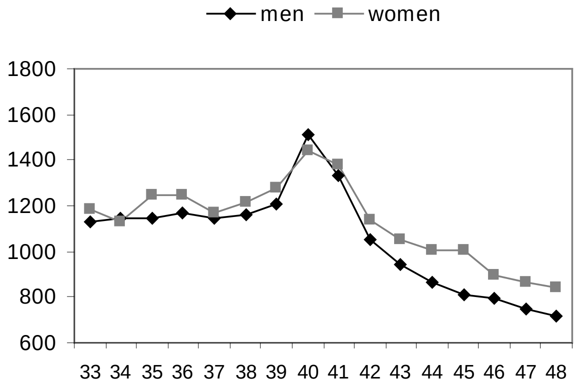


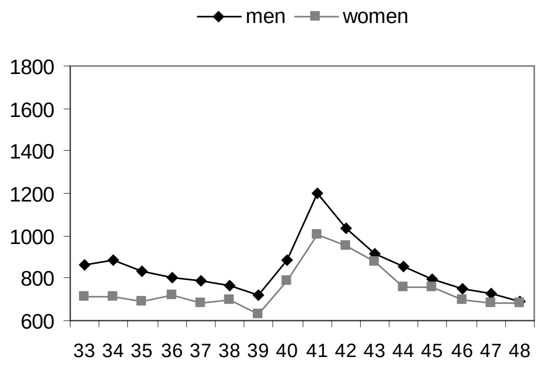
Figure 2
a) the number of wins, b) the number of losses, c) the number of draws. The number of male games has been divided by 10.



a) No. of wins at each game length (in moves)



b) No. of losses at each game length (in moves)



c) No. of draws at each game length (in moves)

Figure 3
Female dummy coefficients from separate regressions for each five-move interval for wins, draws and losses. LPM estimated with OLS.

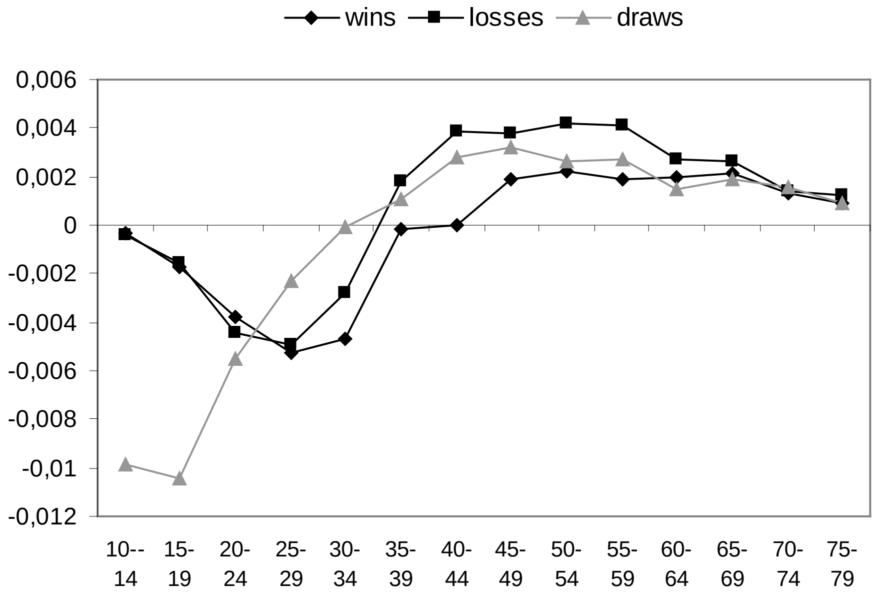


Figure 4
Female dummy coefficients from separate regressions for each five-move interval. LPM estimated with OLS for amateurs and professionals.

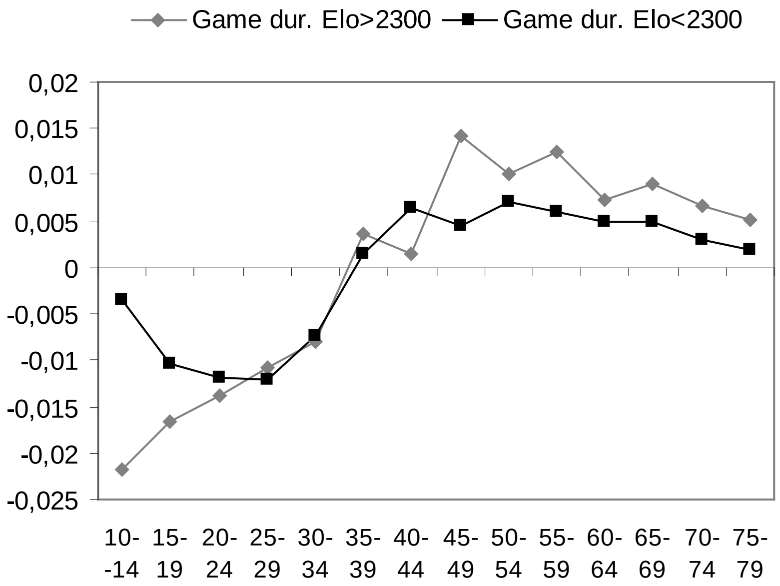
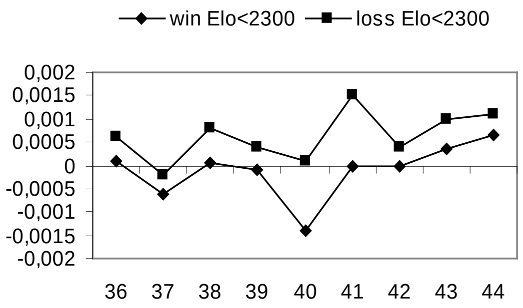
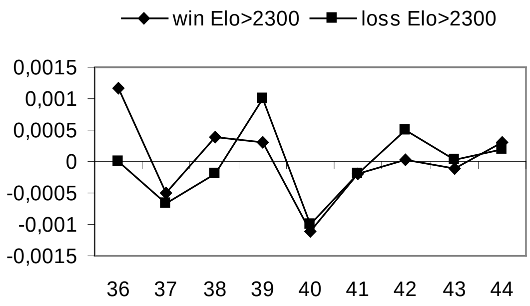


Figure 5
Wins and losses in periods 36–44, female dummy coefficients for amateurs and professionals.

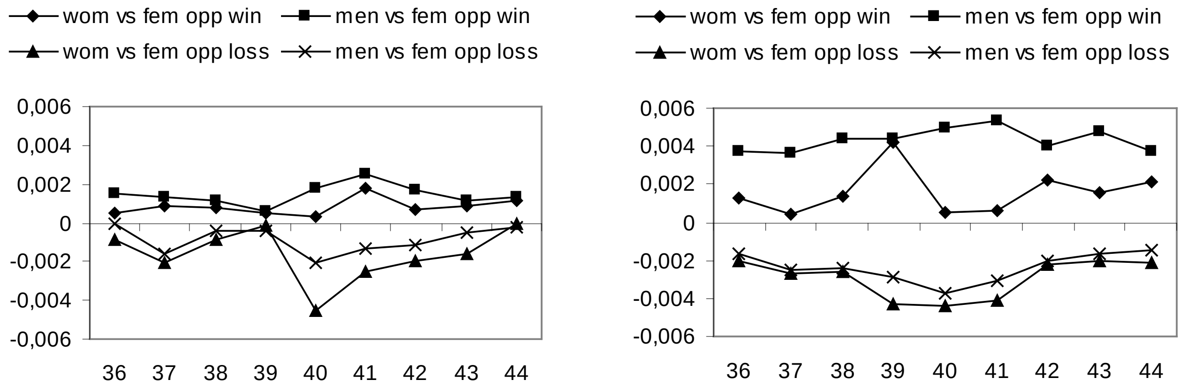


a) Amateurs: Coefficients for wins and losses at each game length. Female share: 15 percent.



b) Professionals: Coefficients for wins and losses at each game length. Female share: 5 percent.

Figure 6
Wins and losses in periods 36–44, female opponent coefficients with individual fixed effects.



a) Amateurs, Elo<2300 b) Professionals, Elo>2300

Figure 7
Ended games in periods 33–49, female dummy and MEN/WOMEN vs. female opponent coefficients with individual fixed effects.