CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Economic Studies

Jan Bílek

Gender differences under competitive pressure: Evidence from skittles

Bachelor thesis

Prague 2019

Author: Jan Bílek

Supervisor: PhDr. Václav Korbel, Ph.D.

Academic Year: 2018/2019

Bibliographic note

BÍLEK, Jan. Gender differences under competitive pressure: Evidence from skittles, Prague 2019, 46 p. Bachelor thesis. Charles University, Faculty of Social Sciences, Institute of Economic Studies. Supervisor PhDr. Václav Korbel, Ph.D.

Abstract

Nowadays, performance in stressful situations has become essential in everyday lives. Moreover, many of these situations happen under competition. Recent literature suggests that there might be a gender gap in behavior under such competitive pressure. This paper studies this phenomenon in the previously unexplored field of skittles. We investigate whether men and women players score differently when facing better players, i.e. are put in higher competitive pressure. Based on our results, we cannot reject the hypothesis that men and women react similarly under competitive pressure. The alternative specifications provide a suitable evidence for existence of gender differences in reaction to the actual score of an opponent in the game, although the limitation of these specifications is an endogeneity problem and thus the results have to be interpreted with caution.

Abstrakt

Stresové situace se staly nedílnou součástí každodenního života většiny populace. Velká část těchto situací zahrnuje jistou formu soupeření. Nedávná literatura naznačuje existenci mezipohlavních rozdílů v chování pod tímto tlakem. Tato práce zkoumá jev v dosud neprobádaném prostředí kuželkářského sportu. Práce měří rozdíly ve výsledcích mužů a žen, když hrají proti lepším soupeřům, neboli když jsou vystaveni vyššímu tlaku. V souladu s výsledky nelze zamítnout hypotézu, že ženy a muži reagují stejně pod vyšším tlakem. Alternativní specifikace poskytují evidenci, že mezipohlavní rozdíly existují v reakci na aktuální výsledek (formu) soupeře v daném zápase, nicméně kvůli přítomné endogenitě je třeba tyto výsledky interpretovat s notnou dávkou obezřetnosti.

Klíčová slova

Tlak, stres, mezipohlavní rozdíly, soutěž, kuželkářský sport

Keywords

Competitive pressure, gender differences, stress, competitiveness, skittles

Range of thesis: 54,398 symbols, 32 pages

Declaration of Authorship

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

2. The author hereby declares that all the sources and literature used have been properly cited.

3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague, May 9, 2019

_____

Jan Bílek

Acknowledgments

I am greatly indebted to PhDr. Václav Korbel, Ph.D., the supervisor of this bachelor thesis, for his valuable comments and prompt responses to my numerous questions. Further, I am grateful for the support provided by my family.

Bachelor's Thesis Proposal

Institute of Economic Studies
Faculty of Social Sciences
Charles University in Prague

Author's name and surname: Jan Bílek

E-mail: bilekjan@seznam.cz

Phone: +420724085870

Supervisor's name: PhDr. Václav Korbel

Supervisor's email: vaclav.korbel@fsv.cuni.cz

Notes: Please enter the information from the proposal to the Student Information System (SIS) and submit the proposal signed by yourself and by the supervisor to the Academic Director ("garant") of the undergraduate program.

Proposed Topic:

Influence of gender on competitiveness and reactions in stressful situations

Preliminary scope of work:

Research question and motivation

An important line in research has recently provided a possible explanation of gender imbalances across various fields. Multiple studies have concluded (e.g. Niederle, Vesterlund, 2011) that men react more favourably to competition than women, are more inclined to compete and therefore are more likely to undergo stressful situations. Women, on the other hand, tend to avoid these situations as their competitiveness seems not to be as high. In practice, women often do not win competitions, because they do not enter them in the first place. As another study shows (Buser, Niederle, Oosterbeek, 2014), although boys and girls in secondary schools in the Netherlands show similar abilities, boys choose much more ambitious fields of study. This is considered as one of possible reasons of the female wage gap (Cahlíková, Cingl, Levely, 2017). Another subject of researchers is whether people react differently to stress across gender once they appear in these competitive situations. In my thesis, I will aspire to investigate these relationships and focus on examining the following questions:

- Does behavior in stressful environments differ across gender?
- Does a difference in approach to competition across gender influence their participation in stressful situations?

Contribution

This thesis should further the knowledge on the topic of gender differences in competition and behavior in stressful situations. It should contribute to better understanding of these phenomena while at least partly filling the existing gaps in the field. This will be done by analyzing a dataset from a unique and slightly unusual field of bowling.

Methodology

In my thesis, I will use data from the top bowling league in Czech Republic, which is played by both men and women. Since each of the games is played against an opponent of different skillset, the pressure under which people have to play is different. In addition to that, in bowling the pressure is purely exogenous due to no direct interaction between the players. I will analyze how performance of a player changes based on the opponent they are currently playing against in two scenarios. First, when the results are accumulated over multiple games and second, when each game counts separately. The data are available at https://www.kuzelky.cz/archivy/.

Outline

1. Introduction
2. Overview of existing literature
3. Model
4. Data analysis
5. Results
6. Conclusion

List of academic literature:

Bibliography

Buser, Thomas, Muriel Niederle, and Hessel Oosterbeek. "Gender, competitiveness, and career choices." *The Quarterly Journal of Economics* 129.3 (2014): 1409-1447. Available at: https://academic.oup.com/qje/article/129/3/1409/1817134

Flory, Jeffrey A., Andreas Leibbrandt, and John A. List. "Do competitive workplaces deter female workers? A large-scale natural field experiment on job entry decisions." *The Review of Economic Studies* 82.1 (2014): 122-155. Available at: https://academic.oup.com/restud/article/82/1/122/1545901

Jurajda, Štěpán, and Daniel Münich. "Gender gap in performance under competitive pressure: Admissions to Czech universities." *American Economic Review* 101.3 (2011): 514-18. Available at: http://www.jstor.org/stable/pdf/29783799.pdf

Cahlíková, Jana, Lubomír Cingl, and Ian Levely. "How Stress Affects Performance and Competitiveness across Gender." Max Planck Institute for Tax Law and Public Finance Working Paper (2017). Available at: http://www.tax.mpg.de/RePEc/mpi/wpaper/TAX-MPG-RPS-2017-01.pdf

Niederle, Muriel, and Lise Vesterlund. "Gender and Competition" Annual Review of Economics 2011. 3:601–30. Available at: https://www.annualreviews.org/doi/full/10.1146/annurev-economics-111809-125122

Contents

1. Introduction

In today's society, performance in stressful situations is a fundamental part of everyday life of most people. Understanding whether a gender gap in behavior under those situations exists is necessary in furthering the analysis of gender inequality, which has become an important topic in numerous fields, including economics. Most of life's important milestones happen under pressure with a significant portion of those, i.e. job interviews produce such pressure by happening in competitive environments.

Many existing studies examine the gender differences under competitive pressure. Azmat, Calsamiglia, and Iriberri (2016) show that a gender gap in how competitive pressure influences performance, exists. One of the main factors driving that gap might be the different reactions to stress (Cahlıkova, Cingl, and Levely, 2017). The gender differences could also partly be caused by stereotype threat, an area studied by Gneezy, Niederle, and Rustichini (2003). Men also seem to be more willing to compete and are more likely to be more confident than women (Dreber, von Essen, and Ranehill, 2014). Moreover, men exhibit lower risk aversion and higher risk tolerance as shown by Crosson and Gneezy (2009).

The factors influencing behavior under competitive pressure are not only caused by society and the environment shaping one's actions. They also partly originate in the biological differences between genders. One of those factors; particularly the menstrual cycle; does not influence performance and risk aversion but indeed has an impact on competitiveness as Buser (2010) shows. Higher levels of testosterone seem to induce increased competitiveness as found by Crewther and Cook (2018) as well as Eisenegger et al. (2017)

One of the most natural environments where competitive pressure exists is the field of sports. Athletes seem to successfully mediate stress by using a set of superstitions and rituals (Jackson and Baker, 2001). Gender differences in competitive anxiety were studied; with contradicting results; by Bebetsos and Antoniou (2012) on Greek badminton players and on endurance sports athletes (Hammermeister and Burton, 2004).

This thesis tries to partly fill the existing gaps in the field by studying gender differences in behavior under competitive pressure in the slightly unorthodox environment of skittles. It aspires to help to answer the question whether behavior in stressful environments differ across genders. In addition to that, the studied environment is unique since it involves only single sex competitions.

The main hypothesis of this thesis would be that women react to stress more than men. However, since measuring stress directly is impossible, the following hypothesis is investigated: Women perform worse than men under competitive pressure. To test this hypothesis, data from the Czech first league of skittles for both men and women and seasons from 2012/2013 to 2015/2016 are used. The dataset consists of 6064 observations of player's name, their gender, team, player's score, opponent's name, opponent's score, long-term average of the opponent, group, and season. The analysis includes five models, each one examining the phenomenon from a slightly different perspective. The main model is based on the long-term average of the opponent, seasons, groups, and fixed-effects for each player.

The results show that we cannot reject the hypothesis that there is no gender gap under competitive pressure. Women seem to perform better under competitive pressure than men but the results are not statistically significant. However, alternative specifications of the competitive pressure with the score of the opponent and the difference of the actual score and the opponent's long-term average show significant differences between women and men. Namely, women improve less than men when their opponent scores higher in a given match or when their opponent scores higher than their long-term average (more than expected). Nevertheless, those two approaches do involve endogeneity problem. Thus, the long-term average of opponent model is used as the main specification.

This thesis contributes to the existing literature in three ways. First, it furthers the knowledge on gender differences in behavior under competitive pressure. Second, the uniqueness of the data enables for analyzing only same sex competitions. Gneezy, Niederle, and Rustichini (2003) suggest that the gender differences in competitiveness disappear in single sex environment. This is further examined in this thesis. Third, to

our best knowledge the topic has been studied in the field of sports but not specifically on skittles. Broadening the researched area should provide better understanding of the phenomenon in sports.

The remainder of the thesis is organized as follows. Section 2 provides an overview of existing literature on gender differences in behavior under competitive pressure from three fields relevant to the topic; economics, biology, and sports. Brief background in the sport of skittles is introduced in Section 3. In Section 4, the dataset analyzed in the models is specified and descriptive statistics are provided. Section 5 defines the hypothesis and the methodology used in the thesis. Results for individual models are presented in Section 6. These results are summarized and its implications briefly discussed in Section 7. Section 8 provides conclusion of the thesis.

2. Literature Review

Literature Review consists of a summary of findings of researches regarding the topic of this thesis. The structure of this part is following: Subsection 1.1 presents results of economic papers related to the subject. Subsection 1.2 focuses on review of biological papers. Lastly, subsection 1.3 summarizes papers relevant to the topic from the field of sports.

2.1. Economic papers

There have been many studies in the field of economics conducted with the purpose to discover whether a difference across genders in behavior under competitive pressure exists. Dreber et al. (2014) show in their study of 16-18 year olds, that women are less likely to enter mathematical tasks under competition. Furthermore, Cahlıkova, Cingl, and Levely (2017) also found that women are significantly less likely than men to invest in tournament scheme rather than piece rate regime, when given the choice. Subjects in stress were less willing to compete as well. Flory, Leibbrandt, and List (2015) studied almost 9000 job seekers who they randomize into different compensations regimes. They discovered that women disproportionally shy away from competitive settings.

However, it is important to note that other factors like whether the job is performed in teams, age of job-seekers, or if their desired position has any gender related preconceptions influenced the results.

Therefore, a gender gap regarding situations under competitive pressure exists and it can be partially explained by several mechanisms.

2.1.1. Stress and pressure

There are multiple studies; conducted by Zhong et al. (2018), Esopo et al. (2019), and Halko and Sääksvuori (2017); suggesting that gender differences in reaction to stress could be one of the mechanisms accounting for gender gap in competitiveness. Cahlıkova, Cingl, and Levely (2017) support that hypothesis in their research. Subjects were divided into control and stress treatments and they manipulated stress levels following standardized protocol. Cortisol levels were measured to ensure that desired stress levels were achieved. They found that stress indeed has a gender specific effect on reaction to competition. However, stress alone does not affect performance as no difference between groups was found in a piece-rate regime. When competitive pressure is introduced via tournament scheme payments, both men and women improve their performance. Combining stress and competition results in a decrease of performance for women whereas men achieved the similar results in both the control and the stress groups.

2.1.2. Competitive pressure

Such findings are supported by the literature on competitive pressure. This literature does not exactly measure stress but explores (exogenous or quasi-exogenous) changes in competitive pressure and its effect on performance. Azmat, Calsamiglia, and Iriberri (2016) conducted a study on high-school students and their performance in multiple tests. Incentives for students varied as the tests accounted for different parts of the final grade. When the stakes were low, females significantly outperformed males but the more important the test was the more the gender gap decreased. In fact, the difference in performance across gender disappeared in the end-of-high-school test which was worth

50% of university entry grade; hence the pressure was the highest amongst the studied examinations.

Another study on high school students was done by Jurajda and Münich (2011). They followed the performance of students in university entry exams. The results show that women achieved worse scores than men when the admission rate to their chosen university was below 19% and therefore they were facing higher pressure. If the admission rate was higher, no gender gap was discovered.

There also seems to be a difference in how much stress the same situation produces for both genders. Lu, Shi, and Zhong (2018) found in their research that in the same situation, namely college admission exams, women were more likely than men to report extreme levels of stress.

Interaction of competition and two pressure sources, namely time constraints and task stereotypes, was studied by Shurkchov (2012). In her research, men under higher time pressure significantly outperformed women in the mathematical task whereas in the verbal task and high pressure, performance across genders reached similar levels. Different results in different tasks might lead to a conclusion that men and women are more talented in various fields.

2.1.3. Stereotype threat

That idea is the core of stereotype threat. It occurs when someone's performance is affected due to conforming to a stereotype about their social group (Spencer, Steele, and Quinn, 1999). In this case, even if a woman does not believe she is less skilled than men in a given task, her performance might still be affected as stated by Gneezy, Niederle, and Rustichini (2003). Similar explanation for part of their findings offer Cahlıkova, Cingl, and Levely (2017) who argue that a counting or mathematical task is perceived as a male task and therefore women might find themselves subject to stereotype threat. The stereotype that men are inclined to perform better in mathematical tasks under no competition is contradicted by researches by Shurkchov (2012) and Dreber, von Essen, and Ranehill (2014).

2.1.4. Willingness to compete and confidence

As van Veldhuizen (2017) writes, gender differences in tournament choices are usually explained by three factors; overconfidence, risk preferences and competitiveness. Several studies, such as Dreber, von Essen, and Ranehill (2014), Flory, Leibbrandt, and List (2015) or Cahlıkova, Cingl, and Levely (2017), conclude that women are less willing to compete. Apicella, Demiral, and Mollerstrom (2017) show, that women are less willing to enter competitive environments than men of similar ability when competing against other people. However, there is no difference across genders in willingness to compete against one-self. In addition to that, self-competition leads to similar performance boost as other-competition.

Research by Kamas and Preston (2018) provides important implications regarding the relationship of gender differences in competitiveness and confidence with labor market pay gap. They measured college seniors' confidence and competitive preferences in lab experiments and later followed their labor market experience in the early years after graduating when family responsibilities are less likely to affect the gender pay gap. The study finds that competitive women earn substantially more than non-competitive women while also reaching the same earning levels as men. These results hold even after controlling for college major and labor market effects.

When participants in research by Gneezy, Niederle, and Rustichini (2003) had the option to choose difficulty of mazes they were about to solve, men chose significantly harder ones showing that they feel more confident in their abilities and therefore more competent.

Different results are offered by van Veldhuizen (2017). Contrary to most other studies, he finds that competitiveness does not influence the gender gap in tournament choices as it can be fully explained by overconfidence, risk preferences and their mutual interaction.

Another view on willingness to compete is offered by Esopo et al. (2019). They studied the relationship of acute stress and competitiveness in men and found that stress decreases their competitiveness. This implicates that stress from high-stakes environments might not contribute to men's higher willingness to compete relative to women's. The relationship of stress and competitiveness is also described in a study by Zhong et al. (2018) which shows that exogenous stress does not influence competitiveness.

2.1.5. Risk preferences

There might also be a difference across genders regarding risk preferences. Women seem to be more risk averse than men with three main factors influencing their behavior. There may be an affective reaction to risk based on different emotional reactions by men and women. As mentioned above, men tend to be more confident, leading to a different estimate of their probability to win in a specific situation which affects the risk they are facing. Lastly, men view risk-involving situations as challenges rather than threats; which appears to be the perspective of women. This results in higher risk tolerance in men (Crosson and Gneezy, 2009).

Another research concerning gender gap in risk preferences was done by Lu, Shi, and Zhong (2018). They found that previous competitive experience makes women more risk averse towards both gains and losses. This topic was also studied by Cahlíková and Cingl (2017). They show a gender difference in changes of risk aversion under acute stress. In their paper, men exposed to a stressor and exogenously induced psychological stress exhibit significantly increased risk aversion. Women's reaction goes in the same direction but is not significant.

A slightly different perspective is offered by Sarin and Wieland (2016). They study risk aversion under uncertainty and even though they do report women to be more risk averse than men in objective probability gambles, they do not find similar results when uncertainty is introduced. Instead, when the probabilities of each outcome are not known which seems to be the case in most real life situations, they find men and women equally risk averse. However, their results might be affected by several biases such as

the home bias (French and Poterba, 1991). This bias suggests that people assign lower risk to things about which they deem themselves to have extensive knowledge.

2.2. Biological papers

There are two possible explanations for existing gender gaps in all the above mentioned phenomena. They can be either caused by society and the environment that shapes an individual or there might be biological factors generating these differences. It is hard to disentangle them because the differences are typically shaped by both factors and moreover they interact with the development. Crosson and Gneezy (2009), however, show that gender differences in risk preferences exist and are sometimes substantial across genders. Nonetheless, they also find that among managers that the difference disappears. Similar concept is developed by Gneezy, Niederle, and Rustichini (2003). They claim that women's lower willingness to compete compared to men might be caused by them not being socialized to compete.

Nevertheless, there seem to be biological causes that can impact one's behavior under competitive pressure and competitiveness overall. Buser (2010) studied the impact of the menstrual cycle and hormonal contraceptives on competitiveness and found that while it did not influence performance or risk aversion, it did affect competitiveness. He shows that women are less competitive on two occasions. First, when a woman is taking contraceptives containing estrogen and progesterone and second, during phases of the natural menstrual cycle when production of those two hormones is high.

This is supported by the findings of Crewther and Cook (2018). They analyzed salivary testosterone levels and competitiveness in both elite and non-elite women athletes. Their research revealed that competitive desire and salivary testosterone levels indeed do vary throughout the menstrual cycle, with both peaking around ovulation. The hypothesis that higher testosterone levels lead to higher willingness to compete in men was the subject of a research conducted by Eisenegger et al. (2017). They found evidence that with higher basal testosterone, the subjects were more likely to compete even after controlling for task-related skills, actual performance, confidence in one's abilities and

risk-taking behavior. The results also show that increased levels of basal testosterone lead to higher self-confidence.

Another study on how testosterone levels, in this case salivary testosterone, affect behavior was conducted by Sapienza, Zingales, and Maestripieri (2009). According to their research, high levels of salivary testosterone induce lower risk aversion in women but not in men. On the other hand, when concentrations of salivary testosterone are low, the gender gap concerning risk aversion disappears.

The relationship of levels of cortisol and competitiveness is described in a paper by Zhong et al. (2018). They show that subjects produce higher response of cortisol under tournament regime than under piece-rate scheme. Furthermore, more competitive subjects exhibit higher stress responses regardless of the payment scheme.

A slightly different view is offered by Halko and Sääksvuori (2017). They examine whether gender differences in responses to competitive stress explain gender gap in competitiveness. Their results show that individual variation in autonomic nervous system activity and psychological responses to competitive stress partly predict self-selection into competitive environments. Nonetheless, it does not explain gender differences in willingness to compete.

2.3. Sport papers

Multiple studies regarding performance under competitive pressure were also conducted in the field of sports. Important factors in mediating psychological tension seem to be superstitions and rituals that each athlete undergoes before each game or even before each important part of their performance. Jackson and Baker (2001) studied an elite goal kicker in rugby with the ambition to discover how consistent his rituals are across different difficulties of the kicks. They discovered that the athlete put a lot of emphasis on his routines but they were nonetheless slightly longer when the kick was of higher difficulty.

Another study regarding rituals was conducted by Brevers et al. (2011). They calculated the “index of superstition” based on three factors; number and kind of superstitious rituals, degree of superstitious feeling, and ritual commitment. They studied 7 different sports on 3 competition levels and found that the level of ritual commitment increases with importance of the game and uncertainty. In addition to that, women were more likely to engage in superstitious rituals while also experiencing higher levels of pre-game tension.

There are several other factors influencing sports performance related to stress. Bebetsos and Antoniou (2012) studied Greek badminton players and found that women reported lower levels of competitive anxiety shortly before their games. That is contradicted by Hammermeister and Burton (2004) who show that men and women in endurance sports experience same levels of competitive anxiety as well as the type of a threat perceived. Furthermore, men state to have higher control over those threats.

A study by Kaiseler, Polman, and Nicholls (2009) focuses on mental toughness of athletes. It seems to be connected with stress intensity and control appraisal rather than the type of the stressor. Hence, men who scored higher on emotional control than women, reported lower stress. Lastly, Ong (2017) examined reactive stress tolerance in elite athletes. He found that women had faster and more accurate reactions under competitive stress than men. However, with increasing competitive level, athletes across genders had faster and more accurate reactions under stress.

3. Basic Background of Skittles

This thesis studies an unusual environment of skittles. Since the uniqueness and thus probable unfamiliarity of the reader with this sport, a brief overview of where and how the sport is played as well as other topics from skittles relevant for this study are presented in this part of the thesis.

The general objective of skittles is to knock down the skittles with a rolling ball. Skittles are played on an alley which is 19.5 m long. At the end of the alley, 9 skittles, attached by strings are positioned in the shape of a square. They are positioned in such a way that

one of the diagonals, which are both 1 m long, of the square is on the axis of the alley, with the other one being orthogonal. The alley continuously connects to the approach which is 6.5 m long and 1.7 m wide. The middle part of the approach is designated for rolling the ball and is 5.5 m long and 0.35 m wide. This is the part on which the player has to roll, not throw the ball in order for the roll to be legal. The ball for adult categories is 2.880 kg with a diameter of 0.16 m.

Once the ball is rolling, there are several options how a skittle can be scored. It can be either hit directly by the rolled ball, by any other skittle, or by the strings of other skittles.

There are several possible game modes. In the first mode, all 9 skittles are put up before each roll. In the second mode, the player rolls to the remaining standing skittles until none are left. After hitting all skittles, 9 skittles are reset. However, the most frequently used version of skittles, including the leagues examined in this thesis, is a combination of the previous two. In this game mode, a player rolls exactly one half of their rolls to the full 9 skittles with the other half to the ones that remain standing after the first roll.

There are also multiple options regarding the number of rolls in each match. In both men's and women's Czech first leagues, which are subjects of this research, the number of rolls each player takes in a game is 120. The game happens on 4 alleys, on each of which the player rolls 30 times, 15 times to the full 9 skittles and 15 times to the remaining ones.

The Czech first leagues are played in a team of six players. This means that 6 pairs of players are created. The order of the players is set before the match. Since most of the alleys have 4 lanes, this leads to 3 groups of four where each group consists of two competing pairs. The players compete in those pairs throughout the whole match. After the 30 rolls one on alley is finished, whoever from the pair scored more skittles wins a point. The player with more scored skittles after 120 throws wins a point for their team. If the number of points is drawn (2:2), the player with higher overall score wins. Therefore, six points; one from each pair; are at stake. When all the 12 players finish, their scores are summed. The team that overall scored more skittles wins extra 2 points. This means that the maximum number of points a team can score in a single match is 8.

Logically, a match can draw (4:4). The winning team gets two points into the table for match won and one point for match drawn.

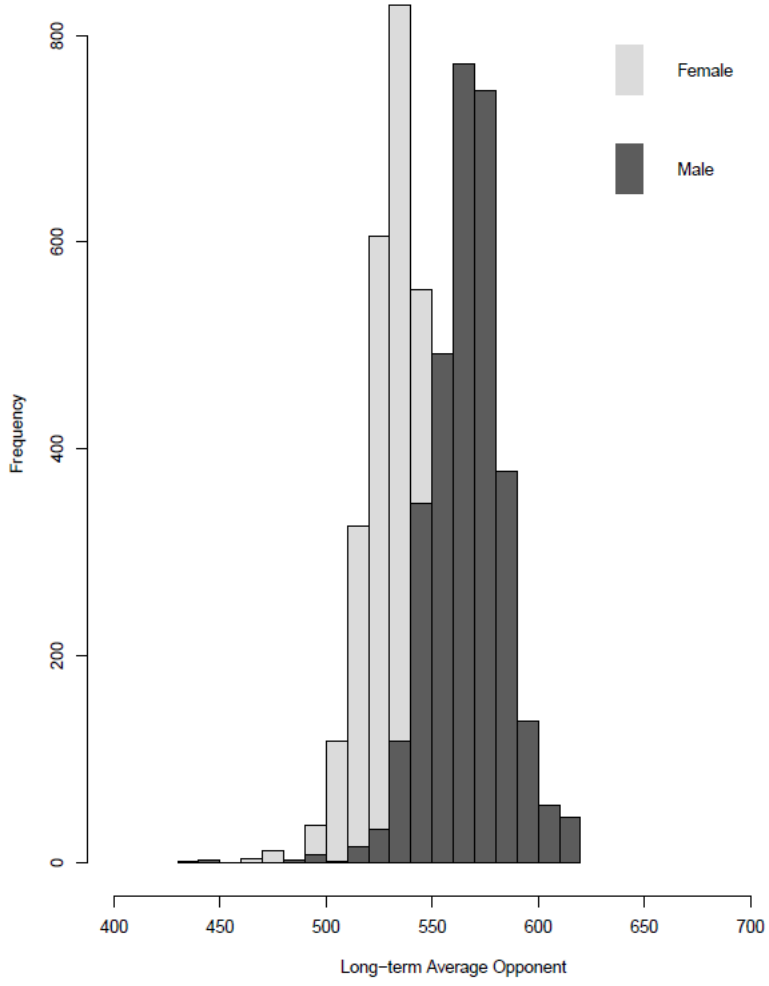
4. Data

Data used for this study was collected from four seasons; 2012/2013 – 2015/2016; of both men's and women's top Czech league in skittles. These leagues were chosen because the available data allow for the best comparison. Each season consists of 22 rounds with 6 matches in each round. In each round two teams play a match against each other and in total, each team faces each opponent once at the home skittle alley and once away. Below, I describe the main variables influencing the score of players. Namely, I analyze the long-term average score, gender, season, position in the match and skittle alleys.

These variables were chosen because they could possibly influence the performance of a player in a given game. A higher long-term average of an opponent indicates that such player's expected performance is higher and therefore added pressure is put onto a player competing against them. The long-term averages of opponents were calculated as their average score from the previous season and if that was not available, for example due to the opponent not playing the previous season, then an average score from the current season was used in the calculation. In addition to that, each season the last team is demoted into the second league as well as the winner of the second league being promoted into the first league. For such teams, the long-term average calculation is based on the players' performances in the second league in the previous season.

There is a significant variation in the averages across both genders, as displayed in following histograms.

Figure 1



Notes: Figure 1 depicts a histogram of opponent's long-term average for both genders.

The histograms also indicate the overall gender gap in achieved score. Men tend to score higher than women, as the following table confirms.

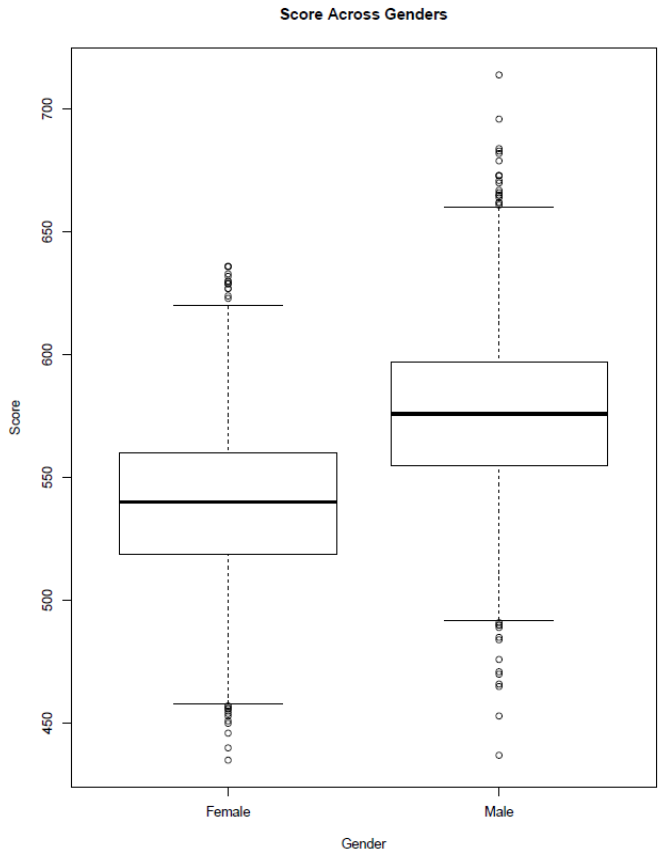
Figure 2

	Male	Female
Minimum	437	435
Maximum	714	636
Mean	576.6	540
Median	576	540

Notes: Figure 2 depicts a brief summary of scored skittles for both genders.

These numbers are important, however might be slightly deceiving as for example scores close to both the maximum and the minimum are achieved rarely. For more accurate understanding of the distribution of scores a boxplot is provided.

Figure 3

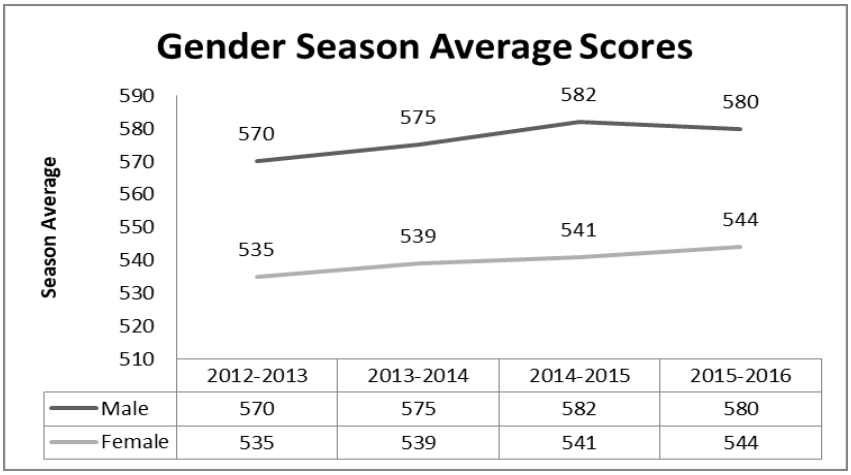


Notes: Figure 3 depicts a boxplot of achieved scores across genders throughout the examined seasons. Scores are represented by number of scored skittles. The boxplot consists of the median; borders of the box are the 1st quartile (25th percentile) and 3rd quartile (75th percentile), respectively. The outer lines represent the expected minimum

and maximum calculated based on the inter-quartile range. The small circles outside of those lines show outliers.

Furthermore, the overall average score for each season is also developing. As the line-chart shows, both men and women improve their average scores across the examined seasons. This is due to multiple factors, the most important being the overall improvements of playing alleys.

Figure 4

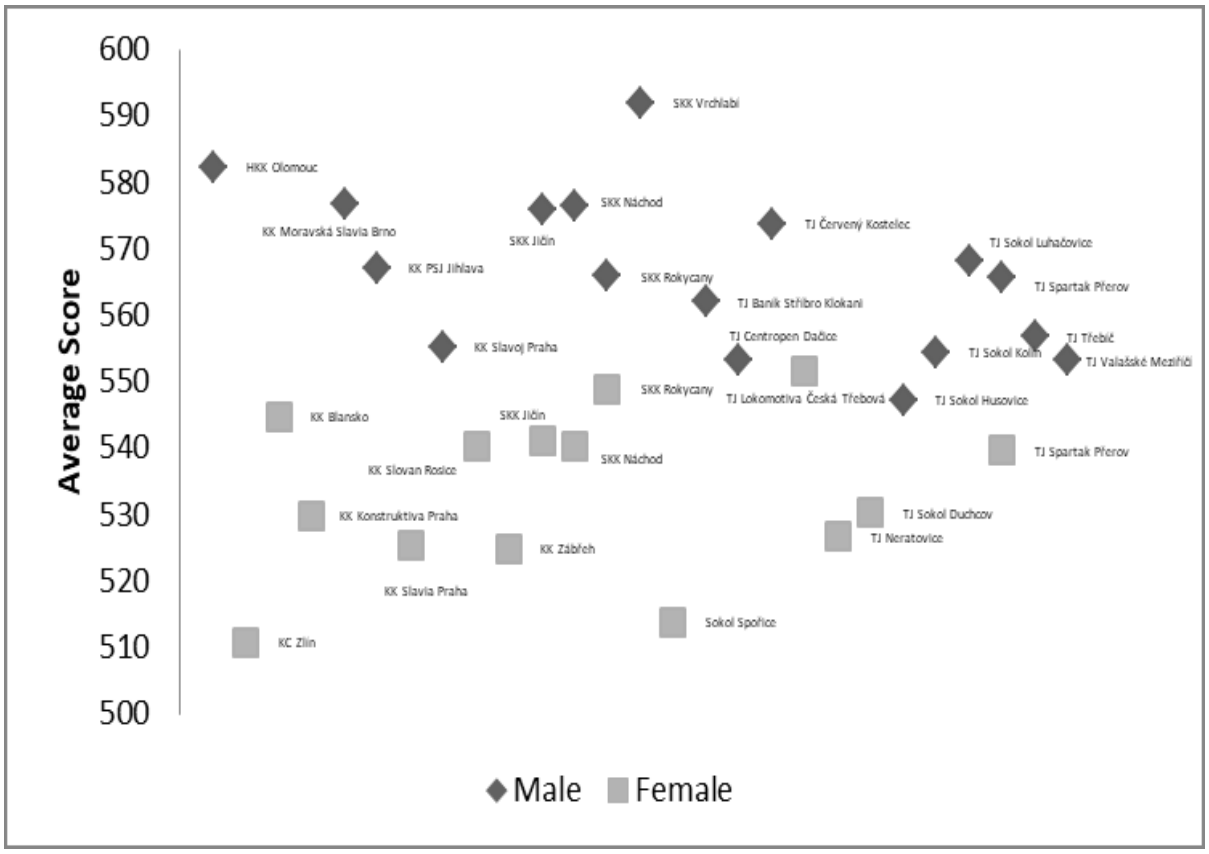


Notes: Figure 4 depicts season average scores for men and women.

The line-chart also supports the notion that men achieve higher scores than women. The difference has to be interpreted with caution because one possible factor is not examined. Since men's and women's leagues do not include the same teams, they are not played on the same alleys. It could be the case that the alleys in one league are of a different quality than in the other. That would make the comparison of achieved scores slightly inaccurate.

The varying quality of the alleys causes substantial differences of the average scores achieved in each alley as shown in the graph below. To overcome this issue, only home games are studied. Further reasons for this decision are provided in methodology.

Figure 5



Notes: Figure 5 depicts average scores across genders at each examined alley.

5. Hypothesis and Methodology

5.1. Hypothesis

The main hypothesis is that women react to stress more than men. However, we cannot measure stress directly; therefore we investigate the following hypothesis: women perform worse than men under competitive pressure. Similar results were achieved by Cahlıkova, Cingl, and Levely (2017), as well as Azmat, Calsamiglia, and Iriberri (2016), and Jurajda and Münich (2011). However, this paper examines the phenomenon in a completely different environment with unique data.

5.2. Methodology

The variables specified in the previous section were chosen because they could possibly influence the performance of a player in a given game. A higher long-term average of an opponent indicates that such player's expected performance is higher and therefore additional pressure is put onto a player competing against them.

An important note has to me made here. As mentioned above, the analysis includes only scores from home games. There are several reasons why including away games would be problematic. First, the alleys are of a different quality and therefore the scores that players achieve could be influenced by those factors. When taking into account only the home games, each player performs on their home alley. Second, if away games were added to the sample, each performance would be counted twice.

Last, there is an important part of the team strategy connected with whether a game is played at home or away. The home team has to announce its lineup first and based on that information the away team can modify the order in which its players will perform. The order is important because the players compete in pairs. Hence, the away team could manipulate the competitive pressure under which each member would play based on the expected quality of their opponent. For example, if a stronger player competes against a weaker one, the point is more probable to go to the former. The team could also employ a riskier strategy and put their best player against the best player of their opponents. In this regime, the home team cannot influence who will compete against whom in any of the 3 groups and therefore cannot control the stress under which each of their players will play.

5.2.1. Main Specification

The first studied model can be expressed by the following equation:

$$Y_{im} = \alpha + \beta_1 LTAO_j + \beta_2 G_i + \beta_3 G_i * LTAO_j + \mu_{im}$$

It measures the relationship between the score (Y_{im}) of a player (i) in the match (m) facing an opponent (j) with the long-term average of the opponent ($LTAO_j$) represented by their average score from the previous season. It is controlled for gender of the player (G_i) as well as for interaction of the gender and the long-term average of the opponent (G_i*$LTAO_j$) with μ_{im} being the error term. However, the model has several limitations. Most importantly, it does not take into account the opportunity of the away team to set the order of players based on opponent. Hence, the groups in which the players compete are not randomly created.

The effect of sorting could be limited by introducing fixed-effects for each player in the next model. It is represented in the form of the next equation:

$$Y_{im} = \alpha + \beta_1 LTAO_j + \delta_i + \mu_{im}$$

In this case, the fact that each player reacts to stress, based on the opponent's perceived quality, differently is considered. Therefore, this model examines the relationship between the score (Y_{im}) of a player (i) in the match (m) facing an opponent (j) with the long-term average ($LTAO_j$), represented by their average score from the previous season, and the fixed effects of each player (δ_i) with μ_{im} being the error term. The desired gender difference is studied by creating two versions of the same model, one with the male subset, and the other with the female subset of the original data.

However, there are other important variables not included in the previous model. Considering the previously mentioned team strategy in managing the order of players, and consequently the specific opponent against whom a given player will compete, dummy variables for groups are added. To control for an improving overall trend in

scores across different seasons, the dummy variables for each season are also part of this model which can be expressed by the following equation:

$$Y_{im} = \alpha + \beta_1 LTAO_j + \delta_i + \beta_2 G_2 + \beta_3 G_3 + \beta_4 S_{2013/2014} + \beta_5 S_{2014/2015} + \beta_6 S_{2015/2016} + \mu_{im}$$

In this equation, the score (Y_{im}) of a player (i) in the match (m) facing an opponent (j) is regressed on the long-term average of opponent ($LTAO_j$), fixed-effects of each player (δ_i), and dummy variables for groups and seasons with μ_{im} being the error term. As with the previous model, the analysis was performed separately on male and female subset of the original data.

5.2.2. Alternative Specifications

A different perspective is offered by the next model. It is possible that a given player does not follow the long-term averages of their competitors. Instead, they know the best players in the league; as well as the worst; but do not differentiate between the rest of the players in terms of the amount of stress competing against such player would cause. Hence, one's performance could be affected by the current score of the opponent. In other words, one might not experience higher level of stress when competing against a good player based on their long-term average but rather when the opponent is achieving high scores in the current game. This is represented by the score of the opponent in the following model which was performed in two versions for both gender subsamples and is represented by the following equation:

$$Y_{im} = \alpha + \beta_1 SO_j + \delta_i + \beta_2 G_2 + \beta_3 G_3 + \beta_4 S_{2013/2014} + \beta_5 S_{2014/2015} + \beta_6 S_{2015/2016} + \mu_{im}$$

In this model, the score (Y_{im}) of a player (i) in the match (m) facing an opponent (j) is regressed on the score of the opponent (SO_j), fixed-effects of each player (δ_i), and dummy variables for the groups and seasons with μ_{im} being the error term.

Nevertheless, there is an important limitation of this model. The score of an opponent could be endogenous to the score of the player. For example, if a player plays great this

could stress the opponent and thus affect their score. Moreover, the score of opponent variable mixes two effects; ability of the player and performance on the given day. Precisely for these reasons, this model is not used as the preferred specification of this thesis. Nonetheless, it is interesting to analyze it in this way.

Last model combines the previous two. The idea is that additional stress could be created if an opponent performs differently from what was expected. The expected performance is captured by the long-term average from the previous season. Based on this and the score in the current game, the variable representing the difference of the actual score of the opponent and the long-term average of the opponent is created. Thus, if a player scores one more skittle than is their long-term average, value of the newly created variable for this particular player is 1.

This approach helps to disentangle the two effects; ability of a player and performance on a given day; from the previous model. However, the limitation of endogeneity created by including the score of an opponent in the model applies here as well. Hence, this specification was also not used as the main one in this analysis. Nevertheless, the model can be represented by this equation:

$$Y_{im} = \alpha + \beta_1 D_j + \delta_i + \beta_2 G_2 + \beta_3 G_3 + \beta_4 S_{2013/2014} + \beta_5 S_{2014/2015} + \beta_6 S_{2015/2016} + \mu_{im}$$

In this model, the score (Y_{im}) of a player (i) in the match (m) facing an opponent (j) is regressed on the difference of the actual opponent's score and their long-term average (D_j), fixed-effects of each player (δ_i), and dummy variables for the groups and seasons with μ_{ims} being the error term.

Since the models; excluding the first one; were conducted on separate female and male subsamples, a cross-model t-test to compare the coefficients for corresponding variables was done for each of the concerned models.

6. Results

In this section, we examine the results of the above mentioned models. As in the previous section, this part is divided based on the specification used in the individual models.

6.1. Main Specification

6.1.1. Long-term average without fixed effects

We will begin with the model where the long-term average of an opponent is used but the fixed effects of each player are not yet included. The results of the regression are shown in the following table:

Figure 6

	Whole sample
Long-term Average of Opponent	0.06
	(0.04)
Gender (Male)	78.59**
	(26.28)
Gender (Male) * Long-term Average of Opponent	-0.08
	(0.05)
Intercept	510.54***
	(19.23)
R-squared	0.26
Number of Observations	6064

*Notes: Figure 6 depicts the summary of results of the first model. The dependent variable is the score of a player in a given match measured in number of skittles. The regression was estimated with OLS. Long-term Average of Opponent measured in number of skittles, Gender is a dummy variable, Gender * Long-term Average of Opponent is an interaction of the variables. Significance levels are symbolized as follows: 0.01 (***), 0.05 (**), 0.1 (*).*

The results show that facing an opponent with on average ten skittles higher long-term average increases the score of a player by 0.6 skittles in the game. Furthermore, men score on average 79 more skittles than women. The interaction examines whether women react differently than men to opponents with higher long-term average. In this case, when men face an opponent with 10 skittles higher long-term average, they on average score 0.8 skittles less than women.

The only statistically significant variable at a 0.01 significance level in this model is the gender of the player, whereas the long-term average of opponent and the interaction of gender and the long-term average of opponent are not statistically significant.

6.1.2. Long-term average with fixed effects

The second model introduces fixed effects for each player and it is performed individually on subsets for each gender. Summaries of the results for both subsets are provided in the following table:

Figure 7

	Male	**Female**
Long-term Average Opponent	-0.003	0.05
	(0.03)	(0.03)
Player Fixed-Effects	YES	YES
Intercept	575.50***	515.48***
	(16.81)	(17.31)
R-squared	0.34	0.34
Number of Observations	2973	2739

Notes: Figure 7 depicts the summary of results of the second model performed individually on both gender subsets of the original data. The dependent variable is the score of a player in a given match measured in the number of skittles. Each regression was estimated with OLS. Long-term Average of Opponent is measured in number of skittles; player fixed-effects are included in the model. Significance levels are symbolized as follows: 0.01 (***), 0.05 (**), 0.1 (*).

The results show that facing an opponent whose long-term average is ten skittles higher; on average decreases the performance of a male player by 0.03 skittles but it increases the performance by 0.5 skittles for female players. The variable is insignificant for both gender, even though for women only slightly (p-value = 0.11).

This model does control for the individual reactions to stress among the players but omits important factors such as the difference of scores between seasons as well as between the groups.

6.1.3. Long-term average with fixed effects and additional variables

These important factors are included in this model in the form of dummy variables.
In this case, the results of the regressions are summarized in the following table:

Figure 8

	Male	**Female**
Long-term Average Opponent	-0.02	0.02
	(0.03)	(0.03)
Second Group	-5.51***	-1.79
	(1.46)	(1.42)
Third Group	-4.32***	-1.07
	(1.64)	(1.46)
Season 2013/2014	3.31**	9.64***
	(1.45)	(1.50)
Season 2014/2015	8.16***	7.48***
	(1.57)	(1.48)
Season 2015/2016	5.10***	9.46***
	(1.65)	(1.60)
Players Fixed-Effects	YES	YES
Intercept	581.60***	526.93***
	(16.99)	(17.39)
R-squared	0.35	0.36
Number of Observations	2968	2734

Notes: Figure 8 depicts the summary of results of the third model performed on both gender subsets of the original data. The dependent variable is the score of a player in a given match measured in number of skittles. Each regression was estimated by OLS. Long-term Average of Opponent is measured in number of skittles; Second Group,

Third Group, Season 2013/2014, Season 2014/2015, and Season 2015/2016 are dummy variables; player fixed-effects are included in the model. Significance levels are symbolized as follows: 0.01 (***), 0.05 (**), 0.1 (*).

The estimated coefficients for the long-term average of opponent are rather close to zero for both genders; negative for men, positive for women. This means, that if on average the opponent's long-term average is ten skittles higher, the performance of men decreases by 0.2 skittles, whereas women improve their score by 0.2 skittles. However, the variable is not statistically significant for either gender.

Furthermore, based on the results, there is a gender gap in reaction to the long-term average of opponent but it seems insignificant. To examine this, a t-test was run to discover whether the coefficients significantly differ across the models. The p-value of this test was 0.37; hence, the reactions of men and women to an opponent with higher long-term average are not significantly different.

The estimates for the groups lead to an impression that the strategy of putting the best players in the first group is most widely used as the expected score decreases in both the second and the third group. In addition to that, the worst performing players seem to play in the second group which also conforms to the generally used tactics, since the pressure in the second group should be the lowest.

Regarding the magnitude of the coefficients, there seems to be a common trend for both genders, but men show greater differences across the groups than women. In fact, the dummy variables for groups are not significant in the female regression.

All of the added dummy variables for seasons are significant at a certain level; with the highest being Season 2013/2014 for men at a 0.05 level, implicating that it is important to include them in the model. The coefficients conform to the idea that overall scores improve over seasons as they all show increases in scores relative to the first studied season 2012/2013. There also seems to be a gender difference as the greater magnitude of the coefficients for women indicates that women improved their performance throughout the seasons more than men.

Furthermore, the long-term average of the opponent is based on the average score of the opponent from previous season. However, if the player for whichever reason did not participate in either of the top 2 Czech leagues on the previous season, the average score from the current season is used. This enables for a robustness check. The model is estimated again but this time the average scores from the current season are not used if the average from the previous season is not available. The number of observations omitted due to unavailability of the average score is 230 for men and 587 for women. The results, summarized in the Appendix A1, show that the results are robust.

6.2. Alternative Specifications

6.2.1. Score of opponent with fixed-effects and additional variables

The fourth model reflects the possibility of players not following so closely the long-term averages of their opponents but rather their current score. Thus, the current score of the opponent was considered instead of their long-term average. The results for both genders are summarized in the following table:

Figure 9

	Male	Female
Score of Opponent	0.09***	0.03*
	(0.02)	(0.02)
Second Group	-4.87***	-1.42
	(1.45)	(1.35)
Third Group	-4.09**	-0.38
	(1.63)	(1.39)
Season 2013/2014	2.88***	8.58***
	(1.44)	(1.38)
Season 2014/2015	7.33***	7.56***
	(1.56)	(1.44)
Season 2015/2016	3.97**	9.54***
	(1.63)	(1.55)
Players Fixed-Effects	YES	YES
Intercept	522.65***	526.35***
	(10.70)	(9.88)
R-squared	0.36	0.35
Number of Observations	2986	2970

Notes: Figure 9 depicts the summary of results of the fourth model performed on both gender subsets of the original data. The dependent variable is the score of a player in a given match measured in number of skittles. Each regression is estimated with OLS. Score of Opponent is measured in number of skittles; Second Group, Third Group, Season 2013/2014, Season 2014/2015, and Season 2015/2016 are dummy variables; player fixed-effects are included in the model. Significance levels are symbolized as follows: 0.01 (***), 0.05 (**), 0.1 (*).

Regarding the score of opponent, the coefficients are positive for both men and women. This means that on average if the score of the opponent increases by ten skittles, men improve their score by 0.9 skittles, women by 0.3 skittles. This variable is statistically significant in both versions of the model, even though at different significance levels; 0.01 for men and 0.1 for women.

The gender gap in coefficients for the score of opponent suggests that men and women react differently to a higher current score of their opponents. This was tested with a cross-model t-test which produced a p-value of 0.0092 meaning that in this model, women indeed improve less than men.

As for the groups, this regression again points towards the best players performing in the first group, as both coefficients for the second and the third group are negative for both genders. Nevertheless, they are not statistically significant in the female version of this model and the magnitude is greater for men, suggesting that there are larger differences across the groups for men than for women.

The estimates for seasons confirm the previous results showing that there was a statistically significant improvement in scored skittles in each season relative to the season 2012/2013. The variables are all statistically significant with higher coefficients in the female version of this model. This shows that women improved more across seasons than men.

6.2.2. Difference of actual and expected score with fixed-effects and additional variables

The fundamental idea behind the last model is that players follow both how good a player is over time, meaning their long-term average, as well as how well are they currently performing. Then, the added pressure is created when the opponent performs better than the player expected. To measure this unexpected difference, a new variable was included in this model. This created variable should disentangle the ability and actual performance. The results of this model performed on subsets for both genders are summarized in the following table:

Figure 10

	Male	Female
Difference of Actual and Expected Score	0.10***	0.03
	(0.02)	(0.02)
Second Group	-5.18***	-1.82
	(1.45)	(1.42)
Third Group	-3.95**	-1.00
	(1.64)	(1.46)
Season 2013/2014	2.79*	9.53***
	(1.45)	(1.50)
Season 2014/2015	7.45***	7.51***
	(1.57)	(1.48)
Season 2015/2016	4.71***	9.62***
	(1.63)	(1.58)
Players Fixed-Effects	YES	YES
Intercept	571.63	537.50***
	(5.47)	(6.19)
R-squared	0.36	0.35
Number of Observations	2968	2734

Notes: Figure 10 depicts the summary of results of the fifth model performed on both gender subsets of the original data. The dependent variable is the score of a player in a given match measured in number of skittles. Each regression estimated with OLS. Difference of Actual and Expected Score is measured in number of skittles; Second Group, Third Group, Season 2013/2014, Season 2014/2015, and Season 2015/2016 are dummy variables; player fixed-effects are included in the model. Significance levels are symbolized as follows: 0.01 (***), 0.05 (**), 0.1 (*).

We will begin the analysis with the crucial variable in this model; the difference of the actual score and the long-term average of an opponent. The estimated coefficients are positive for both genders meaning that if the opponent's actual performance is ten skittles higher than expected, both genders improve their performance; men by 1 skittle, women by 0.3 skittles. There is also a gender difference regarding statistical significance of this variable. Whereas it is significant for men, that is not the case for women, even though by a rather narrow margin (p-value = 0.100597)

.

Both the difference in significance and the magnitude of the coefficients imply that the coefficients might be significantly different across the gender versions of this model. To test this, a cross-model t-test was conducted and based on the p-value of 0.0051, it is evident that men and women do react differently when the actual score of an opponent differs to the score they expected based on the opponent's long-term average score. The significance of this variable for men shows that only the actual performance of the opponent, not the long-term average, has a substantial impact on the performance of players.

The coefficients for group dummy variables exhibit similar results as the previous models. The strategy of putting the best players in the first group, as well as the worst in the second group seems to be present in this model as well. The magnitude of the estimates is greater for men, once again indicating that the differences between groups are larger for men than for women. This is supported by the fact that the dummy variables for groups are statistically significant for men but not for women.

Previous findings regarding the season dummy variables are also supported by this model. All of the variables are statistically significant in both versions of the model, justifying their presence in the model. The coefficients are positive, meaning that there was an improvement in overall scores in the following seasons compared to the first studied one; 2012/2013. There is also a greater magnitude of the estimates in the case of women, showing that such improvement was of higher proportions for women than for men.

7. Discussion

In this part, we discuss the effect of the main variables of interest (competitive pressure) in each of the specifications; using the long-term average as the main benchmark for the comparison. We finish the discussion with the possible reasons why the results might differ.

The main specification uses the long-term average of an opponent as the core variable. There, the effect for each gender as well as their difference (gender gap) is insignificant.

That is not the case in the alternative specifications. In those, the score of the opponent and difference of the actual score and the long-term average of the opponent significantly influence the score of both men and women. In addition to that, the gender gaps in both models are significant as well as suggesting that women improve less than men when facing higher competitive pressure.

The difference between the effect of the long-term average of opponent and the actual score might be caused by several factors. First, it is possible that players either do not know the long-term averages of their opponents or they do not assign a substantial importance to them.

Second, it seems that the actual score of the opponent motivates men but stresses and in turn thus decreases the performance of women. That would conform to the idea presented by Azmat, Calsamiglia, and Iriberri (2016) that with increased stakes men significantly outperform women.

Third, the players possibly know the very best players in the league but do not distinguish between the rest of the opponents. To test this, the dataset is modified and two versions are created. First version includes performances played against an opponent with a long-term average equal or higher than the median of the long-term averages of opponents. Second version consists of performances against which the long-term average of the opponent is equal or lower than the median. The results, summarized in Appendix A2, do not show any significant evidence for men. However, the long-term average of opponent variable is significant in the version for opponents equal or above the median of their long-term averages which is not the case in the version conducted for opponents equal or below the median of their long-term averages. This suggests that women's performance indeed is affected when playing against the top players in the league more than when playing against weaker opponents.

8. Conclusion

This thesis presents new evidence on gender gap in behavior under competitive pressure. The analysis of the model shows that men and women do not react differently under competitive pressure based on the main specification of this thesis, i.e. the long-term average of their opponent. However, when the alternative specifications are introduced; meaning using the actual score of the opponent and the difference of the actual score and the long-term average of the opponent as the core variables; a statistically significant gender gap can be found. All three models are conducted separately on male and female subsets of the data because of the presence of fixed-effects of each player in the regressions.

The results show that the long-term average of the opponent does not seem to influence the performance of the player, regardless of their gender. On the other hand, when score of the opponent or the difference of the opponent's actual score and their long-term average are used as the main variable in the models, a statistically significant gender gap in its effect on the player's performance can be observed. Both men and women seem to improve when their opponent scores higher amounts of skittles in the game.

As for the difference of the actual opponent's score and their long-term average, the coefficients are positive for both genders, indicating that men and women improve their performance when their opponent plays better than expected. The gender gap in this case originates in the different magnitude of the coefficients. When the opponent scores more skittles than expected men seem to improve their performance considerably more than women. Moreover, the difference variable is statistically significant in the male version of the model which is not the case in the female version.

However, both of the models using the alternative specifications, meaning the score of the opponent and the difference of the actual score of the opponent and their long-term average as the core variables in the model, have to be interpreted with caution, as they include an endogeneity problem.

Results of this thesis cannot reject the hypothesis that men and women react similarly on competitive pressure based on our preferred specification. On the other hand, it seems that the actual scores matters for gender differences.

Further research could focus on resolving the endogeneity issue in the specific area of skittles. However, that might be quite challenging but it could be solved by devising a suitable instrumental variable. Overall in the field of skittles, future research could focus on the mixed sex environment present for example in the world championship where a tandem mix, meaning one man and one woman forming a team, is played. Moreover, studies focusing on this topic in different sports could be conducted. Lastly, papers examining the phenomena in similarly unique environments are recommended.

9. Bibliography

Apicella, Coren L, Elif E Demiral, and Johanna Mollerstrom. 2017. “No Gender Difference in Willingness to Compete When Competing against Self,” 39.

Azmat, G. (1), C. (2) Calsamiglia, and N. (3) Iriberri. 2016. “Gender Differences in Response to Big Stakes.” *Journal of the European Economic Association* 14 (6): 1372–1400. https://doi.org/10.1111/jeea.12180.

Bebetsos, Evangelos, and Panagiotis Antoniou. 2012. “Competitive State Anxiety and Gender Differences among Youth Greek Badminton Players,” 5.

Brevers, Damien, Bernard Dan, Xavier NoeL, and Frédéric Nils. 2011. “Sport Superstition: Mediation of Psychological Tension on Non-Professional Sportsmen’s Superstitious Rituals.” *Journal of Sport Behavior* 34 (1): 3–24.

Buser, Thomas. 2010. “The Impact of the Menstrual Cycle and Hormonal Contraceptives on Competitiveness.” In .

Cahlíková, Jana, and Lubomír Cingl. 2017. “Risk Preferences under Acute Stress.” *Experimental Economics* 20 (1): 209–36. https://doi.org/10.1007/s10683-016-9482-3.

Cahlıkova, Jana, Lubomır Cingl, and Ian Levely. 2017. “How Stress Affects Performance and Competitiveness across Gender,” 71.

Crewther, Blair T., and Christian J. Cook. 2018. “A Longitudinal Analysis of Salivary Testosterone Concentrations and Competitiveness in Elite and Non-Elite Women Athletes.” *Physiology & Behavior* 188 (May): 157–61. https://doi.org/10.1016/j.physbeh.2018.02.012.

Crosson, Rachel, and Uri Gneezy. 2009. “Gender Differences in Preferences” 2009.

Dreber, A. (1), E. (2) von Essen, and E. (3) Ranehill. 2014. “Gender and Competition in Adolescence: Task Matters.” *Experimental Economics* 17 (1): 154–72. https://doi.org/10.1007/s10683-013-9361-0.

Eisenegger, Christoph, Robert Kumsta, Michael Naef, Jörg Gromoll, and Markus Heinrichs. 2017. “Testosterone and Androgen Receptor Gene Polymorphism Are Associated with Confidence and Competitiveness in Men.” *Hormones and Behavior* 92 (June): 93–102. https://doi.org/10.1016/j.yhbeh.2016.09.011.

Esopo, Kristina, Johannes Haushofer, Linda Kleppin, and Ingvild Skarpeid. 2019. “Acute Stress Decreases Competitiveness Among Men,” 48.

Flory, Jeffrey A., Andreas Leibbrandt, and John A. List. 2015. “Do Competitive Workplaces Deter Female Workers? A Large-Scale Natural Field Experiment on Job Entry Decisions.” *The Review of Economic Studies* 82 (1): 122–55. https://doi.org/10.1093/restud/rdu030.

French, Kenneth R., and James M. Poterba. 1991. “Investor Diversification and International Equity Markets.” *The American Economic Review* 81 (2): 222.

Gneezy, U., M. Niederle, and A. Rustichini. 2003. “Performance in Competitive Environments: Gender Differences.” *The Quarterly Journal of Economics* 118 (3): 1049–74. https://doi.org/10.1162/00335530360698496.

Halko, Marja-Liisa, and Lauri Sääksvuori. 2017. “Competitive Behavior, Stress, and Gender.” *Journal of Economic Behavior & Organization* 141 (September): 96–109. https://doi.org/10.1016/j.jebo.2017.06.014.

Hammermeister, Jon, and Damon Burton. 2004. “Gender Differences in Coping with Endurance Sport Stress: Are Men From Mars...: Univerzity Karlovy - Fakulta Sociálních Věd.” 2004. http://eds.a.ebscohost.com/eds/pdfviewer/pdfviewer?vid=4&sid=b672e56d-881b-466b-b96c-0dda1fac2a55%40sdc-v-sessmgr04.

Jackson, Robin C., and Julien S. Baker. 2001. “Routines, Rituals, and Rugby: Case Study of a World Class Goal Kicker.” *Sport Psychologist* 15 (1): 48. https://doi.org/10.1123/tsp.15.1.48.

Jurajda, Štěpán, and Daniel Münich. 2011. “Gender Gap in Performance under Competitive Pressure: Admissions to Czech Universities.” *The American Economic Review* 101 (3): 514–18.

Kaiseler, Mariana, Remco Polman, and Adam Nicholls. 2009. “Mental Toughness, Stress, Stress Appraisal, Coping and Coping Effectiveness in Sport.” *Personality and Individual Differences* 47 (7): 728–33. https://doi.org/10.1016/j.paid.2009.06.012.

Kamas, Linda, and Anne Preston. 2018. “Competing with Confidence: The Ticket to Labor Market Success for College-Educated Women.” *Journal of Economic Behavior & Organization* 155 (November): 231–52. https://doi.org/10.1016/j.jebo.2018.08.025.

Lu, Yi, Xinzheng Shi, and Songfa Zhong. 2018. “Competitive Experience and Gender Difference in Risk Preference, Trust Preference and Academic Performance: Evidence from Gaokao in China.” *Journal of Comparative Economics* 46 (4): 1388–1410. https://doi.org/10.1016/j.jce.2018.05.002.

Ong, Nathanael C.H. 2017. “Reactive Stress Tolerance in Elite Athletes: Differences in Gender, Sport Type, and Competitive Level.” *Cognition, Brain, Behavior. An Interdisciplinary Journal* 21 (3): 189–202. https://doi.org/10.24193/cbb.2017.21.11.

Sapienza, P., L. Zingales, and D. Maestripieri. 2009. “Gender Differences in Financial Risk Aversion and Career Choices Are Affected by Testosterone.” *Proceedings of the National Academy of Sciences* 106 (36): 15268–73. https://doi.org/10.1073/pnas.0907352106.

Sarin, Rakesh, and Alice Wieland. 2016. “Risk Aversion for Decisions under Uncertainty: Are There Gender Differences?” *Journal of Behavioral and Experimental Economics* 60 (February): 1–8. https://doi.org/10.1016/j.socec.2015.10.007.

Shurkchov, Olga. 2012. “UNDER PRESSURE: GENDER DIFFERENCES IN OUTPUT QUALITY AND QUANTITY UNDER COM...: Univerzity Karlovy - Fakulta Sociálních Věd.” 2012. http://eds.b.ebscohost.com/eds/pdfviewer/pdfviewer?vid=2&sid=503f2829-5fac-4e82-843c-51c4fc02d96e%40pdc-v-sessmgr01.

Spencer, Steven J., Claude M. Steele, and Diane M. Quinn. 1999. “Stereotype Threat and Women’s Math Performance.” *Journal of Experimental Social Psychology* 35 (1): 4–28. https://doi.org/10.1006/jesp.1998.1373.

Veldhuizen, Roel van. 2017. “Gender Differences in Tournament Choices: Risk Preferences, Overconfidence or Competitiveness?,” 106.

Zhong, Songfa, Idan Shalev, David Koh, Richard P. Ebstein, and Soo Hong Chew. 2018. “COMPETITIVENESS AND STRESS: Stress and Competition.” *International Economic Review* 59 (3): 1263–81. https://doi.org/10.1111/iere.12303.

10. Appendices

A1

Figure 11

	Male	Female
Long-term Average Opponent	-0.03	-0.01
	(0.03)	(0.04)
Second Group	-5.88***	-2.51
	(1.52)	(1.60)
Third Group	-3.96**	0.11
	(1.70)	(1.63)
Season 2013/2014	3.35**	9.41***
	(1.49)	(1.63)
Season 2014/2015	8.18***	8.99***
	(1.63)	(1.71)
Season 2015/2016	4.91***	10.57***
	(1.71)	(1.89)
Players Fixed-Effects	YES	YES
Intercept	591.75***	543.32***
	(18.58)	(20.00)
R-squared	0.36	0.36
Number of Observations	2738	2147

Notes: Figure 11 depicts the summary of results of the third model performed on both gender subsets of the dataset adjusted for the robustness check. The dependent variable is the score of a player in a given match measured in number of skittles. Each regression was estimated by OLS. Long-term Average of Opponent is measured in number of skittles; Second Group, Third Group, Season 2013/2014, Season 2014/2015, and Season 2015/2016 are dummy variables; player fixed-effects are included in the model. Significance levels are symbolized as follows: 0.01 (***), 0.05 (**), 0.1 (*).

A2

Figure 12

	Male	**Female**
Long-term Average Opponent	0.03	0.07
	(0.06)	(0.07)
Second Group	-5.13**	-4.28**
	(2.14)	(2.03)
Third Group	-5.43**	-0.98
	(2.49)	(2.25)
Season 2013/2014	5.22***	8.73***
	(1.97)	(2.06)
Season 2014/2015	12.02***	3.97*
	(2.21)	(2.07)
Season 2015/2016	7.48***	8.62***
	(2.42)	(2.36)
Players Fixed-Effects	YES	YES
Intercept	560.10***	501.02***
	(33.27)	(35.26)
R-squared	0.41	0.39
Number of Observations	1409	1295

Notes: Figure 12 depicts the summary of results of the third model performed on the subset of data including only performances played against an opponent whose long-term average is equal or below the median. The dependent variable is the score of a player in a given match measured in number of skittles. Each regression was estimated by OLS. Long-term Average of Opponent is measured in number of skittles; Second Group, Third Group, Season 2013/2014, Season 2014/2015, and Season 2015/2016 are dummy variables; player fixed-effects are included in the model. Significance levels are symbolized as follows: 0.01 (***), 0.05 (**), 0.1 (*).

Figure 13

	Male	**Female**
Long-term Average Opponent	-0.003	0.13*
	(0.07)	(0.07)
Second Group	-6.10***	0.78
	(2.14)	(2.14)
Third Group	-3.94*	-1.47
	(2.33)	(2.01)
Season 2013/2014	2.02	11.35***
	(2.24)	(2.29)
Season 2014/2015	6.69***	10.95***
	(2.35)	(2.20)
Season 2015/2016	3.48	11.81***
	(2.37)	(2.28)
Players Fixed-Effects	YES	YES
Intercept	571.95***	466.27***
	(41.07)	(39.32)
R-squared	0.35	0.36
Number of Observations	1412	1289

Notes: Figure 13 depicts the summary of results of the third model performed on the subset of data including only performances played against an opponent whose long-term average is equal or above the median. The dependent variable is the score of a player in a given match measured in number of skittles. Each regression was estimated by OLS. Long-term Average of Opponent is measured in number of skittles; Second Group, Third Group, Season 2013/2014, Season 2014/2015, and Season 2015/2016 are dummy variables; player fixed-effects are included in the model. Significance levels are symbolized as follows: 0.01 (***), 0.05 (**), 0.1 (*).