Incentive Effects: Assessing Effort and Heterogeneity in Professional Tennis

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ABSTRACT

This study explores the impact incentive effects have on the level of effort exerted by professional men and women tennis players. Understanding what impact incentives have on tennis players can allow for greater understanding of the impact incentives have in the workplace and how employees react to different incentive schemes.

The study makes use of data from both the ATP and WTA tour of every tournament played during the 2016 season. This includes player statistics, tournament statistics and in-game statistics from the quarter-finals, semi-finals and finals of each tournament in an attempt to account for initial seeding effects. This provides a total of 440 ATP matches and 389 WTA matches for an overall sample size of 829 professional tennis matches.

The findings from this study illustrate in the last three rounds of all the tournaments played, for both male and females, money is not considered to be a key motivator for players. The ATP and WTA results suggest that competitors do not alter their effort levels depending on the level of the tournament. This illustrates that players exert similar effort levels regardless of the amount of money or ranking points available.

The outcome of the findings supports that of the capability effect of heterogeneity on players' performance. This means that the outcome of a match is linked more to the abilities of the competitors involved as opposed to the incentives available. Thus, players will adjust their effort levels according to their opponent and not because there are more money or ranking points available. This suggests that both the ATP and WTA should aim to reduce the differences in abilities amongst the players in an attempt to raise the attractiveness of the sport. Overall, the findings from this study illustrate that the capability effect outweighs that of the incentive effect.

DECLARATION

Except where explicitly stated otherwise and acknowledged, this thesis is wholly my own work and has not been submitted to any other University, Technikon or College for degree purposes.

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CHAPTER 1

INTRODUCTION

1.1 Research Context

Tournament theory was developed on the observation that in some cases, employees in a company are paid a lower amount at the beginning of their careers and then a larger amount as they reach the end of the careers. This is opposed to paying them on the basis of the value of the marginal product which they offer (Ivankovic, 2007).

Basic theoretical framework of tournament theory states that compensation for a given position in the hierarchy of a firm is fixed and proceeds to rise with the tiered level of job. Employees then compete for a promotion in order to move up the hierarchal ladder in the company in an attempt to obtain the higher salary of the relevant position (Sunde, 2009). The best performing worker wins this competition or tournament and gets the promotion. This means that the prize of larger pay, as well as the possibility to earn a further promotion in the future, are considered to be the main drivers inducing maximum effort for workers in their current positions. Tournament theory on elimination style tournaments predicts that the total amount of effort exerted is highest when contestants have similar abilities going into the event i.e.: contestants are homogenous. As a result, uneven tournaments results in lower levels of effort being exerted as the stronger competitor is aware of the advantage and can lower effort levels while still being confident of success (Sunde, 2003).

Traditionally, managers in the corporate world seek to find ways to introduce worker productivity. In an attempt to raise productivity, many organisations increase incentives through prizes such as promotions or bonuses. This approach is based on relative or rank performance in order to foster employees' effort (Lallemand *et al*., 2008). A compensation scheme that is based on an individual's relative position within the firm, as opposed to the absolute level of output, will sometimes be the preferred outcome of a competitive economy (Silverman and Seidel, 2011). Optimal prizes or rewards are therefore selected in order to encourage workers to maximize their effort and investment activities as efficiently as possible.

Developed by Lazear and Rosen (1981), tournament theory states that given an ideal pay dispersion scheme, position-based compensation in the firm can be just as effective as compensation based on output. Rosen (1985) expanded Lazear and Rosen's (1981) theory and claimed that the prizes in a tournament must be disproportionately large in the final rounds. The possibility of promotion then drives agents to a higher position and, therefore, an increase in pay. This is done in order to determine the best contestant via survival of the fittest and to maintain an optimal quality of play throughout the tournament. Rosen (1985) advocated disproportional payment structures in sport to ensure high quality of performance. According to Maloney and McCormick (2000), tournament theory suggests that competitors choose to enter a tournament based on the expected prize available, but once they have started competing, effort is exerted based on the difference between prizes. It can be assumed that a rise in financial incentives provided for work will result in greater performance (Lazear, 2000). The rationale behind this is that greater incentives increase a person's motivation, which in turn causes improved behavioural output and performance.

Sports provide more measures regarding worker performance compared to any other labour market. One has access to a variety of information on all competitors; such as an athlete's experience, demographic information and salary as well as performance statistics. Performance can be difficult to measure for workers as it is often subjective in nature. This, however, is not true with sports as every outcome resulting from a competitor's action is a measurable event (Kahn, 2000). A tournament model is usually characterized by three key features. Firstly, the prize structure is fixed ahead of time, known to all competitors and the winner receives the same pay regardless of the margin of victory. Secondly, relative performance is critical as opposed to absolute performance. Lastly, a competitor's effort is reliant on the size of the prize difference between winning and losing. Greater effort is induced by a larger spread (Lazear and Rosen, 1981). Tennis tournaments obtain the first two features as well as exhibiting prize structures which are theoretically consistent with the third feature. A typical tennis tournament can be described as a set of elimination matches where the winner of a match advances to a higher round and the loser is eliminated. The prize structure is set in advance, known to all competitors, depends solely on relative performance, and is highly skewed at the top (Gilsdorf and Sukhatme, 2008a). Given these characteristics, this study investigates the efficiency of several incentives schemes implemented by the Association of Tennis Professionals (ATP) for the men and the Women's Tennis Association (WTA) for the women. The idea behind the study is that tennis players that are more highly motivated are willing to exert an increased amount of effort, which in turn leads to more games being played, tighter matches between competitors and overall a more attractive competition for sponsors, fans, and players.

A specific tournament model which can be applied in a tennis context is that of the Lazear-Rosen model. In this model two players compete in a match for what is considered to be first and second place prizes (Lazear and Rosen, 1981). Competing in a tennis match requires effort, so each player will undertake a decision-process. The competitors will only participate if the expected reward is large enough to offset the expected cost of the anticipated effort (Ehrenberg and Bognanno, 1990a). Players will attempt to maximize their utility subject to some effort level constraint and as their effort level increases, so do the costs associated with it. By equating the marginal benefit to the marginal cost of additional effort supply, which is a higher prize that they can obtain, they would maximize utility (Ivankovic, 2007). In order for equilibrium to be reached the organiser is forced to set prizes to an efficient level, which causes the players to exert maximum effort (Maloney and McCormick, 2000). Once equilibrium is reached, players exert maximum effort in an attempt to progress as far in the tournament as possible and in return earn a higher amount of prize money.

Previous empirical studies of tournament theory in sport (Silverman and Seidel, 2011; Lallemand *et al*., 2008; Rousseva, 2014) have produced mixed results. The theory has been tested both indirectly (using non-experimental data) and directly (using experimental data). The majority of the studies that utilised non-experimental data have found a relationship consistent with tournament theory (Ehrenberg and Bognanno, 1990b). They used non-experimental data from the 1984 men's Professional Golf Association (PGA) tour to investigate whether tournaments actually elicit effort responses from competitors. The main finding of the Ehrenberg and Bognanno (1990b) study illustrated that higher prize levels do in fact lead to lower scores in golf tournaments. This shows strong support for the proposition that the structure and the level of prizes in professional golf tournaments influence players' performance and effort exertion levels.

Studies using experimental data in tennis, such as Silverman and Seidel (2011), Lallemand *et al*. (2008) and Rousseva (2014), have found evidence that both support and contradict the predictions made by tournament theory. Silverman and Seidel's (2011) findings support the theory in that when monetary incentives are increased, players exert more effort and this effort is maximized when the marginal pay spread varies directly with the position in the tournament. Rousseva (2014) and Lallemand *et al*. (2008) have a slightly more opposing view: the results show that the performance of players with an ex-ante disadvantage is not sensitive to the magnitude of the marginal prize spread. Lallemand *et al*. (2008) also analysed the impact of heterogeneity on players' ability on players' performance. The findings support the capability effect of heterogeneity on players' performance: the final outcome of a match is linked more to players' abilities than to players' incentives, which suggest that effort levels will be adjusted according to the difference in abilities between competitors as opposed to the difference in incentives. This is in accordance with the findings of Nieken and Stegh (2010) and Rousseva (2014) in that organisers should attempt to design matches as homogeneous as possible in order to ensure more tightly contested matches.

Empirical results from Rousseva (2014), Lallemand *et al*. (2008) and Ehrenberg and Bognanno, (1990)a all show that increases in monetary rewards will induce individuals to perform better, both in the workplace and on the sports field. However, it is necessary to explore whether the capability or the incentive effect is more prominent and how competitors' effort levels adjust accordingly. Results from Sunde (2003) and Ivankovic (2007) have shown that monetary incentives had a significant effect on player effort as the incentive effect outweighs the capability effect. In contrast, findings from Lallemand *et al.* (2008) and Rousseva (2014) support the capability effect of heterogeneity on players' performance. This means that the final outcome of a match is more linked to players' abilities than to players' incentives. Thus, it is important to identify which effect is more prominent in a competitor's decision on how much effort to exert as to identify if it is driven by monetary rewards or differences in skill level.

1.2 Goals of the Research

The goals of this research are to explore the impact of incentives of professional tennis players in a tournament setting and to test whether player effort levels increase as monetary rewards rise.

1.3 Methods, Procedures and Techniques

These goals will be achieved using a positivist research paradigm. The data to be used are based on the information provided by Jeff Sackman (2017) and comprise of both male and female player statistics as well as tournament statistics of every tournament played in 2016 on the ATP (men) and WTA (women) tours. The data includes the quarter-finals, semi-finals and finals of each tournament in an attempt to account for initial seedings affects. For the ATP, this sees each tournament level represented, namely the ATP 250, ATP 500, ATP 1000 and the Grand Slams. Grand Slam matches which were played over four or five sets in the men's tournaments have also been excluded as these macthes would skew the results for the duration of the match as well as total games played. Thus, only the male Grand Slam matches which were played over three sets have been included. For the WTA, the International, Premier, Premier 5, Premier Mandatory and the Grand Slams tournament levels are included. This provides a total of 423 ATP matches and 389 WTA matches for an overall sample size of 812 professional tennis matches.

For each tournament, the data will include tournament-, match-, and player-specific variables. Tournament specific characteristics include the tournament level, the court surface, the ranking points and the prize money that players can expect to earn from losing in a specific round as well as the difference between the ranking points and prize money from advancing one round further. Match specific data will include the number of aces and double faults served by each player, and the percentage of break points saved by both competitors. Lastly, player-specific statistics will include the players' ages, the difference in abilities in the two competitors, measured using the difference in absolute rankings between players, as well as the number of Grand Slam titles won by each player (which can be considered to be a reputational variable).

The estimation strategy to be used was originally put in place by Sunde (2003); Rousseva (2014); Lallemand *et al*. (2008); Silverman and Seidel (2011), and the estimation strategy which will be used is an OLS regression for both the men and the women.

The dependent variable, effort, represents the effort exerted by a single player in a specified match of a particular tournament. This study will employ various alternative dependent variables as proxies for player effort. These include the total number of games won by a given player (Sunde, 2003; Rousseva, 2014; Lallemand *et al*., 2008), the percentage of games won which is total games won by the victor divided by the total games played in a match (Silverman and Seidel, 2011), and the duration of the match, based on the assumption that a longer match has seen a larger amount of effort exerted (Ivankovic, 2007). A measurement of heterogeneity in capability between the two players is also used and is measured by the rank difference. Rank Difference is included as a control variable in order to separate out the capability effect, which in turn allows player incentives to be isolated. It is a measure of the difference in ranking between the two competitors in a specific match. A separate measure of heterogeneity which is included, is the difference in career Grand Slam wins between players in order to obtain a reputational difference between competitors. This is included as a player with a large amount of Grand Slam titles may have a different motivation as compared to someone with zero Grand Slam titles. The prize money variable estimates the expected monetary incentive of a specific player in a certain match, measured as the differential of prizes between winning and losing a match. It can, therefore, be viewed as the marginal monetary incentive of advancing one round further. The model also includes tournament specific characteristics such as the surface and level of the tournament, match specific variables such as the round in which the match was played, and lastly, player-specific characteristics including the ages of both players in a match.

1.4 Organisation of the Study

The remainder of the study is as follows. Chapter two introduces the concept of tournament theory, specifically within a tennis context. The discussion will elaborate on a specific tournament theory model that can be applied to the sport, which will then be followed by the concept of relative and absolute effort and finally why the structure of tennis tournaments plays such a big role in the study. Chapter three provides empirical evidence on the topic. The chapter is broken into two main sections. The first section focuses on empirical evidence in sport as a whole while the remainder looks at evidence in tennis specifically. This allows for a more general view of the theory initially and then moves onto a more detailed view of existing studies in the tennis environment.

Chapter four will give a brief understanding of the background of the men’s and women’s associations of tennis, which is then followed by outlining the data and method used in order to achieve the objectives of the study. Chapter five will then analyse the results found. This will entail a report on the findings of the regressions run and this will be followed by a discussion on the implications of the findings. Finally, chapter six provides the conclusion of the study. It summarises the study as well as outlining possible areas of further research.

CHAPTER 2

TOURNAMENT THEORY WITH RESPECT TO TENNIS

2.1 Introduction

The previous chapter identified that optimal prizes should be selected in order to encourage workers to maximize their effort activities as efficiently as possible. This is where tournament theory can be applied in a sporting and a tennis context in order to ensure that maximum effort is produced during every available match. As described, tournament theory states that given an ideal pay dispersion scheme, position-based compensation in the firm can be just as effective as compensation based on output and due to the fact that sports provide a number of measures regarding worker performance, actual performance can be quantified as every outcome resulting from a competitor's action is a measurable event (Kahn, 2000). This chapter will describe how tournament theory can be applied in a tennis context and why the structure of tennis tournaments lends itself as a comparative measure for firms to identify whether incentive schemes are inducing more effort from workers, based on how tennis players react to incentive schemes in a tournament setting.

2.2 The Lazear-Rosen Tournament Model

A typical tennis tournament can be described as a set of elimination matches where the winner of a match advances to a higher round and the loser is eliminated. The prize structure is set in advance, known to all competitors, depends solely on relative performance, and is highly skewed at the top (Gilsdorf and Sukhatme, 2008b). There are three key features of a tournament model. Firstly, the prize structure is fixed ahead of time, the prize is known to all competitors and the winner receives the same pay regardless of the margin of victory. The second feature is that relative performance is critical as opposed to absolute performance due to the fact that despite a player's ability, what matters is that a player performs well enough to win. The third feature is that a competitor's effort is reliant on the size of the prize difference between winning and losing. Greater effort is induced by a larger spread (Lazear and Rosen, 1981). Based on these three key features, it can be said that tennis tournaments obtain the first two features of a fixed and known prize structure as well as relative performance being more important than absolute performance. With regard to the last feature, tennis tournaments exhibit prize structures which are theoretically consistent with the third feature in that greater effort is induced by a larger spread.

A specific tournament model that can be applied in a tennis context is the Lazear-Rosen model. This model sees two players compete in a match for what is considered to be first and second place prizes (Lazear and Rosen, 1981). The model assumes that both competitors and the organiser are risk-neutral and identical. Due to the fact that each player undertakes a decision process in order to decide what effort levels they will exert, players will attempt to maximize their utility subject to some effort level constraint (Maloney and McCormick, 2000). As their effort level increases, so do the costs associated with it. By equating the marginal benefit to the marginal cost of additional effort supply, which is a higher prize that they can obtain, they would maximize the utility (Ivankovic, 2007).

The decision-making process undertaken by the competitors has two aspects. Initially, the competitors determine the level of effort that they are willing to exert during the match to maximize the probability of winning. This effort level is shown to be a function of the prize spread. That is if the top prize is P_1 (winning the match) and the lower prize P_2 (losing the match), then effort can be described as a function of $[P_1 - P_2]$ as opposed to the average level of the prizes. The larger the marginal spread between prizes, the more effort each player will be forced to exert. On the other hand, however, after determining the amount of effort required, the player will then decide whether the expected prize, which is the average of P_1 and P_2 when competitors are identical, is sufficient to compensate for the effort exerted. The player will, therefore, decline to participate if the expected share of the purse is insufficient to offset the pain. In order for equilibrium to be reached the organiser is forced to set prizes to an efficient level, which causes the players to exert maximum effort (Maloney and McCormick, 2000). Once equilibrium is reached, players exert maximum effort in an attempt to progress as far in the tournament as possible and in return earn a higher amount of prize money.

If the marginal gap in prizes between the rounds of a tennis tournament is not large enough, elite players will not participate, which in turn may see sponsors leave and fans lose interest (Shmanske, 2004). This can be illustrated using professional golf as an example. The prize structure in golf tournaments is constant across all tournaments where prize differentials between finishing positions increase proportionately with the purse. Therefore, when performance between tournaments is compared, a larger purse sees greater differentials between finishing positions. One can conclude from this that larger purses should result in better performance because initially higher ranked players are attracted to compete and following this, greater spreads between prizes encourage individuals to perform better (Maloney and McCormick, 2000). This is in line with Rosen (1985) who advocates disproportional payment structures in tournament theory.

2.3 Relative vs. Absolute Effort

Tennis, unlike golf, is a sport in which each action taken is in response to a reaction from the opponent. Therefore, a player's effort in a match cannot be observable independently from the opponent. This sees an issue arise when it comes to testing for effects of prizes on absolute performance as opposed to relative performance. Each point played can, therefore, be classified as a zero-sum game between the two competitors (Sunde, 2003). Klaassen and Magnus (2001) show that the probability of winning a certain point is not independent of who won the previous point, as well as some points being more important to players than others. However, both the relative and absolute efforts of the competitors affect the observed outcomes in terms of points. A player is able to alter their probability of winning a match by choosing how much effort to exert, and thus the probability is a function of relative and not absolute effort.

Although it is believed that relative effort plays more of a part than absolute effort, in Sunde's (2003) study, the main assumption of the analysis was that the number of games won by a player in a given match also depends positively on the players' absolute exertion levels. The thinking behind this assumption can be rationalized by considering the method for producing points. Each game is directly contested between the two players and every game reflects the outcome of this direct competition. Essentially, the probability of winning a game can be described as a process with both players' effort as inputs. The probability of winning a specific game then directly depends on the propensity of errors from both players. As a player increases their effort exertion levels, the likelihood of them making an error rises since they are playing harder, which in turn involves riskier play. An increased amount of effort then involves more games won by each competitor on the basis that the respective opponent makes more errors. Thus, as seen before, by taking both players as a whole, the probability of winning a point depends solely on relative effort. However, it should be noted that the total number of errors, both forced and unforced, increases as the absolute effort levels of both players increase. Therefore, according to Sunde (2003), if the hypothesis about the incentive effects of prizes is true, the prize variable should increase the number of games won by a player in a given match as well as the effort exerted, while the effect on the difference in games won by the match favourite is ambiguous as it depends on whether the incentives set by prizes are stronger for the favourite or the underdog.

2.4 The Structure of Tennis Tournaments

The structure of tennis tournaments determines the way in which the prize money is distributed to players (Jordan, 2013). The best way to reveal the structure of a tennis tournament is by analysing a statistical pairwise comparison structure (David, 1969). The tournament begins with players starting in round one and then sequentially proceeds through N stages with each stage being a set of pairwise matches (Rosen, 1985). Losers are eliminated from the tournament while the winners continue onto the next round. This results in half of all eligible contestants from the previous round surviving to the next, where another pairing is drawn (David, 1969). This process continues until a final is reached and only two players remain.

The elimination design of a tennis tournament requires an extra prize or reward for the overall winner in order to maintain performance incentives throughout the game (Silverman and Seidel, 2011). The economics behind this is derived from survival aspects (Lazear and Rosen, 1981). The value of continuation incentivises a competitor's performance at any stage in a tournament and can essentially be described as an option value (Rosen, 1985). At the current stage, the player is guaranteed the loser's prize, but a win will provide the player with the option to continue in the tournament. As the event proceeds, there are fewer achievements left to be attained and the option value plays out

(Rosen, 1985). In the final, the difference in prize money between winning and losing is the solitary instrument available to encourage a player to exert maximum effort and as a result must incorporate the equivalent of the option value that maintained incentives at previous stages (Lazear and Rosen, 1981). The extra weight of rewards at the top extends the horizon of players surviving to the final stages. It makes the game appear infinite and as if there is always more to achieve, despite any past achievements (Rosen, 1985).

2.5 Conclusion

This chapter provided an overview of the underlying theory utilised in this study and then proceeded to identify a specific tournament model that can be applied in a tennis context, namely the Lazear-Rosen model. This then allowed for a discussion regarding the structure of tennis tournaments and how this structure allows for effort analysis for each competitor due to the fact that tennis is classified as a zero-sum game. It was found that a player is able to alter their probability of winning a match by choosing how much effort to exert as the probability of winning is a function of relative as opposed to absolute effort. Chapter 3 will extend on this theory as well as examining the empirical results found in other studies conducted regarding sport in general and then focussing more specifically on a tennis context. This allows for a more complete idea about what has already been found about tournament theory and what areas there are for improvements in further studies.

CHAPTER 3

LITERATURE REVIEW

3.1 Introduction

This chapter seeks to first analyse the results from previous studies in sport, as this will provide a general idea about how tournament theory can be applied in a sporting context, followed by an analysis of empirical studies in tennis. The previous chapter identified the importance of the structure of sport, which allows for effort exertion levels to be accurately measured. The studies found in this chapter have all looked at the importance of this structure and have arrived at various conclusions on how incentive effects affect effort levels in all aspects of life, both in sports and in the workplace. These studies then provide a benchmark when comparing the results of this study to *a priori* information and to other studies conducted in a similar field.

3.2 Review of Empirical Studies in Sport

3.2.1 Studies Investigating Financial Incentive Effects

It can be assumed that a rise in financial incentives provided for work will result in greater performance (Lazear, 2000). The rationale behind this is that greater incentives increase a competitor's motivation, which in turn causes improved behavioural output and performance. Previous empirical studies of tournament theory have produced mixed results. Tournament theory has been tested indirectly using non-experimental data, such as Ehrenberg and Bognanno (1990a), who examined the structure of compensation relative to job hierarchies. Most of these studies have found a relationship that is consistent with tournament theory. Studies, however, making use of experimental data, such as Silverman and Seidel (2011), have found evidence that both support and contradict the predictions made by tournament theory.

Nalebuff and Stiglitz (1984) investigated the role competitive compensation schemes have on both work incentives and performance in sport. They asserted that contests as an incentive device can result in competitors abandoning their natural risk aversion in favour of riskier, more profitable behaviour. They concluded that individualistic pay schemes, such as piece-rate schemes, are inferior to schemes that base compensation on relative performance. This is due to people's loss aversion behaviour as they will generally work harder in an attempt to avoid being a "loser" than they will work to become a "winner". A piece rate scheme allows everyone who works hard to do well. When people are competing with their peers for a fixed purse, however, they will undertake any actions possible to avoid coming in last place. Nalebuff and Stiglitz's (1984) findings suggested that due to social considerations such as one's work environment, the use of competitive compensation schemes is less widespread than what their advantages would suggest.

Ehrenberg and Bognanno (1990b) conducted a study on a concentrated data set. A 1987 European Men's PGA Tour dataset was used in an attempt to determine whether the overall score of professional golfers is affected by increased prize money in later rounds. Ehrenberg and Bognanno (1990b) were able to construct a linear model using a player's final score as the dependent variable. The findings revealed that a player's performance varied directly with the tournament's total monetary prizes as well as the proportion of money awarded in the final rounds of the tournament. These results illustrate that competitors will increase effort in a tournament in which marginal payoffs increase in later rounds, which strongly supports Rosen's (1985) tournament theory hypothesis. Payoffs rising in later rounds will again ensure a high quality of performance at the elite end of the tournament and will encourage lower ranked golfers to maximize effort in order to finish one place higher.

According to Maier *et al.* (2016), an important objective for sports managers of elite sports clubs is to create an ideal environment that enables athletes to perform at their best. Therefore, Maier *et al*. (2016) aimed to test the relationship among monetary incentives, organizational support, and athletic performance in elite team sports. This investigation calculated the relative effects of non-monetary incentives of organizational support as well as monetary incentives on individual performance through job satisfaction. Additionally, an innovative measurement approach of player performance was implemented by using individual performance ratings of coaches. Questionnaires were collected from 34 coaches and 315 athletes of 19 professional ice hockey, football, and handball clubs in Germany. The findings were such that two variables of organizational support, namely integration of family and private problem support, reveal strong positive effects on athletes' job satisfaction. These results confirm a strong relationship between player satisfaction and individual performance.

The implications of Maier *et al*.'s (2016) results mean that sports managers need to recognize that not only monetary incentives play a part in motivating players or employees. The relevance of non-monetary incentives is crucial and thus, should be integrated in order to improve job satisfaction and, consequently, facilitate top performance of their players (Maier *et al*., 2016). This is in accordance with Tshube *et al.* (2012), who found that athletes in Botswana placed significant value on both tangible and social non-monetary incentives regardless of gender and age. Tshube *et al*. (2012) provide an account of how monetary, non-monetary, and social events are significantly valued as motivational tools among competitors in Botswana. These results echo those of Maier *et al.* (2016) and suggest that monetary incentives alone may not be sufficient and non-monetary incentives are seen as a useful supplement in motivating competitors. This can be applied particularly in Africa where economies are struggling (Tshube *et al.* 2012).

3.2.2 Studies Investigating the Effects on Effort Levels

Maloney and McCormick (2000) investigated whether workers respond to their wages through their effort levels, by focussing on foot racing i.e.: running performances. The results describe two aspects based on Rosen's (1985) tournament model. Firstly, an entry effect exists in that higher wages attract higher skilled runners to participate, i.e. higher prizes attract a faster field. Secondly, the marginal spread between prizes incites individual runners to exert more effort. This means that higher prizes are associated with faster times for individuals already in the race. The results confirm a priori expectations that more pay produces more performance. The findings, however, are not mirrored by other research in labour and managerial economics as researchers outside of the tournament literature rarely find individual supply effects. An explanation for this according to Maloney and McCormick (2000) is that diversity in research outcomes is due to the performance elasticities observed which are conditioned on the tournament nature of sports competition. Lastly, it was found that markets and individuals respond to price when competition is free and open and the implication of this is that the tournament creates the response.

It should be noted, however, that according to Ariely *et al.* (2009) when a competitor is performing skilled activities, the individuals' performance increases as the level of incentive increases but only up to a point. Once this point is reached, increased incentives then have a negative effect on performance. This is echoed by Chib *et al.* (2012) who investigated the neural processes underlying behavioural responses to performance-based pay. The results were such that an individuals' performance increased when incentives increased; however, extremely high levels of incentives led to worse performance, which is the opposite of what larger incentives aim to achieve. These results suggest that initially, competitors focus on the potential gain of successful task completion but when the actual task is being undertaken, individuals instead encode the potential loss that would arise from failure, i.e. loss aversion behaviour.

Ehrenberg and Bognanno (1990a) conducted a second study and used non-experimental data from the 1984 men's Professional Golf Association (PGA) tour in order to investigate whether tournaments actually elicit effort responses from competitors. The study chose to focus on professional golf tournaments due to the fact that information is readily available on both the prize distribution as well as on the players' scores. Under appropriate assumptions, it can be said that a player's score is related to their effort levels and implications for scores thereafter can be drawn. In addition, data were available to control for factors that should affect output other than the incentive structures. These may include player quality, course difficulty and the quality of the rest of the field as well as weather conditions. This allows for implications to be drawn for how a player will perform during the entire tournament and how they will perform in the last round, depending on the marginal return to effort faced in the tournament after the third round, *ceteris paribus*.

One of the most prominent findings made was that during the first two rounds, the total tournament prize money did not appear to influence players' performance. This is, however, consistent with the hypothesis that a competitor has difficulty in maintaining concentration during the later rounds of a tournament when fatigue is more likely to have set in. Ehrenberg and Bognanno (1990a) also found that the level of prize money in tournaments influences who enters the tournaments, with higher prize money attracting better players, which is consistent with the findings of Maloney and McCormick (2000).

The main finding of the study illustrated that higher prize levels do lead to lower scores, other factors kept constant. This effect does, however, occur primarily in the later rounds of a tournament when fatigue has set in and it is more difficult for players to maintain concentration. Therefore, the results show strong support for the proposition that the structure and the level of prizes in professional golf tournaments influence players' performance and effort exertion levels.

Nieken and Stegh (2010) investigated the impact of heterogeneity on effort provision in the German hockey league. The study utilised a large dataset from the German Hockey League spanning over three seasons from 2006/2007 to 2008/2009. The number of two-minute penalties was used as a proxy for effort in the study under the assumption that a more intense game will result in more infractions as the players are more likely to act against the rules. Heterogeneity was measured by the absolute difference between the winning probability of the home team and the winning probability of the visiting team, which was calculated using betting odds. If one examines a tournament with perfectly homogeneous agents, it is clear that the ex-ante chances of winning are equal for all participants. This leads to the incentives to work being higher, as there is no pre-determined advantage. In real-world tournament situations, however, contestants are mostly heterogeneous.

Due to the fact that effort comes at a cost, the competitor who is least favourite to win, the ‘underdog,’ will reduce their level of effort as compared to the homogeneous case. This is because their probability of winning is smaller due to their handicap of being the ‘underdog’. The higher the underdog’s disadvantage, the stronger the effect. The competitor who is expected to win the match, the ‘favourite,’ will anticipate this behaviour from the underdog and will consequentially reduce their effort levels without jeopardising the favourable position. Nieken and Stegh (2010) concluded that in a heterogeneous tournament both agents will exert lower effort levels as compared to the homogeneous case. Thus, if the teams involved in a match contain very different abilities, lower effort levels will be observed. It can be said that this observation holds true especially for the favourite. The results of Nieken and Stegh’s (2010) study can be applied to other sporting events in that the organisers should attempt to design matches as homogeneous as possible in order to ensure more tightly contested matches.

3.3 Review of Empirical Studies in Tennis

3.3.1 Studies Investigating Financial Incentive Effects

Silverman and Seidel (2011) investigated the incentives of professional tennis players in a tournament setting. The study focused only on the four Grand Slam events as well as the Davis Cup matches during the period under investigation. This period ranged from 2005 to 2008 for the Grand Slams and 2005 to 2010 for the Davis Cup matches. The percentage of games won in a match was used as a proxy for effort and the results were such that the coefficient of prize expectations was positive and significant, as tournament theory would suggest. This illustrates that the expected monetary reward provides a more comprehensive measurement of a player's option value of possible future earnings. It was also found that when monetary incentives are increased, competitors exert more effort and this effort is maximized when the marginal pay spread varies directly with the position in the tournament. It was found that an increase in prize expectation of $100 000 could provide a competitor with sufficient motivation to exert the effort necessary to win as many as 5% more of the total games played in a match. Given that the margin of victory in many tennis matches in terms of games is so small, a 5% change can have a large effect on the outcome of the match. Silverman and Seidel's (2011) study is in line with tournament theory and confirms the findings of both Ehrenberg and Bognanno (1990a) and Rosen (1985) in that when the monetary incentives are increased per round, players will exert more effort in order to get through that round successfully and progress further in the tournament where the monetary incentives are larger.

As arguably the main determinant of effort levels in tennis, the structure of a tennis tournament is such that prize money roughly doubles per round furthered in the tournament. This means that the marginal monetary increase from round to round can become large and this will, therefore, play an important role in the amount of effort used by each player (Jordan, 2013). Silverman and Seidel (2011) also found that effort is maximized when the marginal pay spread varies directly with the position in the tournament. This translates to more money being awarded to those players who progress the furthest in the event. This can be illustrated using the prize money from Wimbledon in 2016 where both males and females earned the same prize money. A player who lost in the first round earned $30 000, while the runner-up of the tournament won $1 000 000 and the eventual winner received $2 000 000 (ATP, 2016). Therefore, the spread between the last round and the first round is extremely large, which means that players will exert maximum effort in order to progress as far as possible. This spread may cause players to exert maximum effort but it also leads to large differences in earnings between professional players (Fort, 2003).

Ivankovic (2007) explored marginal pay spreads in professional tennis tournaments and the impact of such spreads on the efforts of players in the tournament. The study focused on the 1992 and 1993 seasons, in which data was collected from 169 professional tennis tournaments played on the ATP tour. The study’s findings contradicted the theory and suggested that spread levels in ATP tennis tournaments are not structured in an efficient manner as tournament theory would suggest. This is due to the fact that spread levels increase but at a decreasing rate. Even though poorly structured spread levels exist, it was still found that the duration of a tennis match was both significantly and positively correlated with the spread (Ivankovic, 2007). As a proxy for effort, the time of the match was used as the main dependent variable under the assumption that the longer the match lasts, the more effort each player is exerting. The findings suggested that due to the increased monetary reward available to a player for advancing further, it will result in more effort exerted by a player in the match. This confirms the findings of Sunde (2003) and is in line with Lazear and Rosen’s (1981) tournament theory in that the incentive effect outweighs the capability effect (Rosen, 1985).

Gilsdorf and Sukhatme (2008a) investigated match outcomes and tournament incentives in women's professional tennis. The study examined the effect of differentials in prize money on the probability that the favoured player wins the match in women’s tournaments. Using a detailed dataset comprising of information on player characteristics, prize money and match outcomes for all tournaments played during the 2004 WTA tour, Gilsdorf and Sukhatme (2008a) estimated a standard probit model. The results of the study support the predictions of Rosen (1985) in that increased prize money differentials have a positive, statistically significant effect on the probability of the favoured player winning the match. The study, therefore, illustrates that the favoured player exerts an increased amount of effort, which in turn increases her probability of winning the match. Under tournament theory, however, the underdog would also increase her effort, which partially offsets the favourite player’s higher effort levels. The overall effect of this would be a reduced marginal increase in the probability that the favourite wins the match, despite both participants having increased their respective effort levels.

Gilsdorf and Sukhatme (2008b) then conducted an identical study on men's professional tennis using a large, unique, and complete data set from the 2001 men's professional tennis circuit. The study chose to focus on relative rather than absolute measures of output. The results were identical to that of the women's study as larger prize money differentials generally have a positive, statistically significant effect on the favoured player's probability of winning the match. They found a 0.02 percentage point rise in the probability of the favoured player winning the match for every $1 000 increase in the prize money differential. Gilsdorf and Sukhatme (2008b) note that this increase in percentage points is not a direct measure of the additional effort exerted by the favourite player, but the prize differential variable was found to have a statistically significant effect on the probability of winning, suggesting an effort response did, in fact, take place. Thus, the results indicate that the net increase in the probability of winning will be smaller than the overall effort response. Gilsdorf and Sukhatme's (2008a, 2008b) results, therefore, support the predictions associated with Rosen's (1985) match play, elimination-type tournament model.

Lallemand *et al.* (2008) studied professional female tennis players and examined how the competitors react to prize incentives as well as ex-ante heterogeneity in players' abilities. The data set used ranges from 2002 to 2004 and encompasses all professional female tennis players who participated in at least one of the two final rounds of an official WTA tournament. It contains detailed information on both players and tournaments and in total includes 1 004 observations for individuals playing 502 matches. The method used is consistent with that of Sunde (2003) and also uses an indicator built by Klaassen and Magnus (2001) to control for the pyramid structure of players' quality. As an indicator of heterogeneity in the strength of contestants, the difference in WTA ranks is utilised and the prize spread is measured by the difference in prizes between winning and losing a match.

The initial part of the Lallemand *et al.* (2008) study investigated how professional female tennis players react to prize incentives in tournaments. The empirical findings reveal a positive and significant relationship between prize spread and women's performance, as suggested by tournament models. The results, however, indicate that the performance of players with an ex-ante disadvantage is not sensitive to the magnitude of the marginal prize spread. The authors went on to then analyse the impact of heterogeneity in players' ability on players' performance. The descriptive statistics indicate that there is heterogeneity in players' ability despite strategies from the WTA to limit uneven matches. Empirical findings show that the favoured player wins more games than the underdog in uneven contests, confirming expectations. The findings do, however, support the capability effect of heterogeneity on players' performance. This means that the final outcome of a match is more linked to players' abilities than to players' incentives, which indicate that effort levels will be adjusted according to the difference in abilities between competitors as opposed to the difference in incentives. The conclusions drawn from this study is that the WTA should attempt to reduce the ability differential among players in order to increase the attractiveness of female tennis competition (Lallemand *et al.,* 2008). This is in accordance with the findings of Nieken and Stegh (2010) in that organisers should attempt to design matches as homogeneous as possible in order to ensure more tightly contested matches.

Rousseva (2014) conducted a similar study to that of Lallemand *et al.* (2008), but focused on male professional tennis and analysed two hypotheses. Firstly, the effects of player heterogeneity on the players' performance were assessed and secondly, it was tested whether competitors possibly value the prize money differently by looking at how this contributes to changes in effort exertion. The data used in the study comprised of male professional tennis player statistics and tournament characteristics, ranging from 2003 to 2013 and looks only at the final and semi-final rounds of the four Grand Slam tournaments, i.e. the Australian Open, the French Open, Wimbledon, and the U.S. Open. The results were consistent with *a priori* expectations as well as the findings of Lallemand *et al* (2008), in that effort exertion is highest when contestants are homogeneous. Thus, the ATP should also attempt to reduce the ability differentials between players in order to ensure more tightly contested matches and more entertaining tournaments. Regarding the second hypothesis, it was found that previous Grand Slam title victories were the most important determinant as compared to the various measures of heterogeneity used of how much effort players exert during the match. These results are consistent with the fact that previous Grand Slam wins increases confidence (Rousseva, 2014). This can also be linked to the results of Lallemand *et al* (2008) in that the findings support the capability effect as the outcome of a match is linked more to a player's abilities as compared to incentives.

3.3.2 Studies Investigating the Effects on Effort Levels

Sunde (2003) conducted a study in which he applied tennis data from professional tennis tournaments to tournament theory. Sunde (2003) investigated whether increased heterogeneity levels, reflected by players of different abilities, could lead to lower amounts of effort exerted as well as if a higher amount of tournament prize money could lead to greater effort exerted. Data from 1990 to 2002 were utilised, which included 156 men's singles tournaments which comprised of both Grand Slam and Master Series tournaments. Data were compiled from the semi-finals and finals for each tournament with the total number of games played during a match used as a proxy for effort. Sunde (2003) constructed a linear specification and found that a player's ranking going into the match had an influence on the number of games won through both incentive and capability effects, in that the initial relative strength between two opponents has been found to influence the match outcomes through affecting effort exertion. The results also showed that monetary incentives had a significant effect on player effort as incentives were found to promote performance in terms of the dependent variable which was the number of games won and this saw greater total effort exerted during a match. Thus, larger marginal monetary incentives encourage players to exert maximum effort as the aim is to progress as far in the tournament as possible.

Sunde (2009) investigated whether greater heterogeneity of participants leads to lower effort exertion in elimination tournaments. The data comprise of the semi-finals and finals of 156 tournaments from the Grand Slams and the Master Series for professional men's tennis. The framework used in the study illustrates how the incentive effects arising from the monetary prize and the player heterogeneity rely on the assumption that players are able to affect their winning probability through their absolute effort choice. Sunde (2009) measured heterogeneity inability by the difference of the players' ATP ranking before the match and used a simple empirical model to carry out the analysis. Tournaments where one contestant is ex-ante stronger than the other results in lower effort exertion of the contestants, which is in accordance to Nieken and Stegh (2010). The larger the initial disadvantage faced by the underdog, the costlier it is in terms of effort in an attempt to compensate for the handicap. The favourite is then aware of the advantage and as a result is able to reduce effort levels without endangering the prospects of success. The empirical results support the *a priori* expectations that effort exertion is highest for homogeneous contestants in a tournament setting. These results, in particular, provide evidence for an adverse incentive effect. This is due to heterogeneity that offsets the capability effect for favourites, while both effects reinforce each other for underdogs.

Lastly, Malueg and Yates (2010) analyse how players exert effort during a best-of-three contest between equally skilled players. This study takes a different approach than Sunde (2003), Lallemand *et al.* (2008) and Rousseva (2014) when accounting for the difference in abilities. For the test of contest theory, Malueg and Yates (2010) use betting odds to identify equally skilled players as opposed to controlling for ability differences. Economic theory predicts that tennis matches have an increased likelihood to end in two sets than in three. If, however, a contest does reach the third set, then each player has an equal chance to win. This is due to the fact that the study looks at equally skilled players, thus theoretically, each player has an equal chance to win the third set. This study tests these predictions with data from professional tennis matches. The findings suggest that tennis players of an equal skill level allocate effort across sets in accordance with economic theory. The competitor who wins the first set exerts an increased amount of effort in the second set than the loser of the first set does. If the match then progresses to a third set, competitors exert equal efforts (Malueg and Yates, 2010).

3.4 Conclusion

A review of empirical studies in sport and in tennis allows for a background to what the current situation is regarding the theory about effort exertion levels in various situations. The main finding from this chapter is that the capability effect generally outweighs that of the incentive effect. This means that the final outcome of a match is linked more to players' abilities than to players' incentives, which suggests that effort levels will be adjusted according to the difference in abilities between competitors as opposed to the difference in incentives. This translates in encouraging organisers to attempt to design matches as homogeneous as possible in order to ensure more tightly contested matches. The following chapter sets out the method to be used as well as the data that will be utilised when carrying out the study.

CHAPTER 4

DATA AND METHOD

4.1 Introduction

The main purpose of this chapter is to describe the data and analytical methods used in the study. This chapter will provide an overview of the men's and women's tennis tournaments. This will include the different tournament categories as well as the prize structure for distributing both prize money and ranking points. A description of the data utilised in the study then follows, including how many matches have been included for both men and women and how many tournaments have been included. Finally, the chapter sets out the econometric methods employed.

4.2 Tournament Background

4.2.1 The Association of Tennis Professionals

The Association of Tennis Professionals (ATP) was founded in 1972 and is the official organisation of the men's professional circuit. In 1990 the first official tournament of the ATP tour was played and currently, there is a total of 66 tournaments played across the world. The size of the draw varies depending on the type of tournament being played. The smallest draw has 32 players, for example, an ATP 250 tournament such as the ASB Classic in Auckland. The largest draw has 128 players, which include the Grand Slams such as Wimbledon and the US Open (ATP, 2015). The bigger tournaments often require the lower ranked players to play in qualifying rounds, while the higher ranked players are seeded and will have a preferable draw. This structure sees the seeded players become the favourites and allows them greater opportunity to progress further in the tournament.

Each tournament is divided into different categories, namely ATP 250, ATP 500, ATP 1000 and Grand Slams. Each category represents how many ATP ranking points the winner of the tournament will receive. For example, the Western and Southern Open in Cincinnati is an ATP 1 000 tournament, which sees the winner of the event receive 1 000 ATP ranking points. The prize money follows a similar pattern and increases at each tournament level. The least amount of prize money available is found at an ATP 250 event and the highest at the Grand Slams with the ATP 500 and ATP 1 000 falling in-between.

The Australian Open, Wimbledon, French Open (Roland-Garros) and U.S. Open are the four Grand Slam tournaments. These are the most prestigious and carry the highest prize money and ATP ranking points.

The ranking system was established in 1973 and provides a fair analysis of a player's performance throughout their career. It also provides an objective means to determine entries and seeding into tournaments (ATP, 2015). The ranking points are awarded based on the round in which a player exits the tournament. These points are roughly doubled for each additional round a player progresses in a tournament. This system is also used for the distribution of the prize money and sees those players who lose in the early rounds of a tournament receive little to no money, while those who progress further receive most of the available prize money.

4.2.2 The Women's Tennis Association

In 1973 the Women's Tennis Association (WTA) was founded, which united all of women's professional tennis into one tour. The tour is currently made up of tournaments with different levels, which include Grand Slams, Premier Mandatory, Premier 5, Premier, and International tournaments (WTA, 2016). The Grand Slams are once again the Australian Open, Wimbledon, French Open and U.S. Open as the men and women compete for the same prize money at all the same Grand Slams. Currently, there are over 2 500 players registered with the WTA and the 2016 season included 61 events, spanning from the Olympic Games to the four Grand Slams across 33 countries (WTA, 2016). The ranking points system differs slightly from the men's tournaments in that the winners of a Premier Mandatory event receive 1000 points, Premier 5 winners obtain 900 points while the winner of a Premier tournament gets 470 points. This compares to the 2 000 points for winning a Grand Slam. The prize money follows the same pattern as the ATP in that it increases at each tournament level. The least amount of prize money available is at the International events and the highest are at the Grand Slams with the Premier, Premier 5 and Premier Mandatory falling in-between.

4.2.3 Section 8 of the ATP Rulebook

Due to the fact that this study focuses on effort in tennis, the rules regarding effort should be noted. In the ATP rulebook, it states that: "A player shall use his best efforts during the match when competing in a tournament. Violation of this section shall subject a player to a fine up to $20,000 for each violation" (ATP, 2018). An example of a player violating this rule is that of the Australian Nick Krygios, during a second-round loss at the Shanghai Masters to Mischa Zverev (Fuller, 2016). Kyrgios lost 6-3, 6-1 to Zverev and during the match was deemed to have disrespected the game by playing with little effort, which was seen in one instance where he walked to his chair before the point was over. The ATP announced that due to Kyrgios showing a "lack of best efforts" he would be stripped of his first-round prize money and receive a fine of $10,000, which is the maximum fine for a breach of this nature (Donati, 2016).

4.3 Data

The data used in this study is based on the information provided by Sackman (2017) and comprise of both professional male and female player and tournament statistics of every tournament played in 2016 on the ATP and WTA tour. For the ATP, each tournament level is represented, i.e. ATP 250, ATP 500, ATP 1000 and the Grand Slams. The fourth highest tier is the ATP 250 tournaments in which 39 events took place in 2016. In this category, 250 rankings points are awarded to each champion with the total prize purse ranging from $500 000 to $1 000 000. Following this is the ATP 500 category, which included 13 tournaments, with 500 rankings points awarded to the winners. The second highest tier in male tennis is that of the ATP 1000 in which 9 tournaments were played and total prize money in the region of $5 000 000 to $7 500 000. Results in these events earn players more ranking points than regular tournaments but are still below those earned in the Grand Slams.

The women's tour includes the following tournament levels: International, Premier, Premier 5, Premier Mandatory and the Grand Slams. The lowest tier of the WTA tour is that of the International tournaments, where 33 events took place in 2016. Most events had a purse of $250 000 with Shenzhen, Monterrey, Prague, Seoul and Tianjin's prize total increased to $500 000. The Premier Tournaments were implemented in 2009 and as of 2016, included four Premier Mandatory events with prize money of $4.5 million, five Premier 5 tournaments with a prize purse of $2 million and twelve Premier events with prize money ranging from $600 000 to $1 million. The ATP and WTA tours then both compete for the same prize money at the Grand Slam events. These events can range from winners earning approximately $2.3 million up to $3.5 million.

In the tournaments included, male competitors play best-of-three sets in all the events apart from the four Grand Slams where it is the best-of-five sets, whereas all of the women's events are contested in a best-of-three set format. In order to avoid the initial seeding effects of competitors, only the last three rounds (quarter-finals, semi-finals and finals) of the tournaments are used. In an attempt to keep the results consistent, all matches were removed where a player retired or there was a walk-over, i.e. no match was played. Lastly, all male Grand Slam matches which were four or five set matches have been omitted as these matches skew the results as they naturally have a longer match duration and result in more games being played. Thus, only Grand Slam matches that ended in three sets have been used. The final sample consisted of 812 professional tennis matches, with 423 ATP matches and 389 WTA matches.

The variables included are surface and tournament level dummy variables. The surface dummy variable indicates which surface each tournament is played on i.e. Grass, clay or a hard surface and the tournament dummy variable indicates what level the specific tournament is i.e. for the men it could be an ATP 250, ATP 500, ATP 1000 or Grand Slam. The ages of both players are also included as well as the ages squared as this accounts for a possible decrease in stamina among older players. The spread between the competitors' current overall ranking or the rank difference is also controlled for. The rank difference coefficient is expected to be negative as this would indicate that the favoured player won the match. Also included are the ranking points and prize money that the players can expect to earn from losing in a specific round as well as the difference between the ranking points and prize money from advancing one round further. Furthermore, in-game statistics such as the number of aces, double faults and the percentage of break points saved by each player are included. Lastly, the number of Grand Slam titles won by each player is included as a 'reputational' variable (Rousseva, 2014) in that certain players compete for different reasons. For instance, Roger Federer (who has won 19 Grand Slam titles) may have different incentives as compared to someone like Kevin Anderson (who has not won any Grand Slam titles).

4.3.1 Descriptive Statistics

Table 1: Men's Descriptive Statistics					
Variable	**Mean**	**Median**	**Maximum**	**Minimum**	**Standard Deviation**
ATP 250	0.202	0.0000	1.0000	0.0000	0.403
ATP 500	0.143	0.0000	1.0000	0.0000	0.350
ATP 1000	0.017	0.0000	1.0000	0.0000	0.128
Grand Slam	0.550	1.0000	1.0000	0.0000	0.498
Grass	0.350	0.0000	1.0000	0.0000	0.478
Hard	45 575.820	15 122.230	87 5000.000	4 805.000	87 328.940
Clay	64.250	45.000	360.000	25.000	63.281
Expected Prize Money Spread ($)	7.510	6.000	97.000	0.000	6.890
Expected Ranking Points Spread	2.488	2.000	10.000	0.000	2.031
Winner Aces	0.601	0.667	1.000	0.000	0.352
Winner Double Faults	5.376	4.000	30.000	0.000	4.726
Winner Percentage Break Points Saved	2.871	2.000	14.000	0.000	2.230
Loser Aces	0.527	0.556	1.000	0.000	0.204
Loser Double Faults	28.190	28.768	37.654	18.280	4.220
Loser Percentage Break Points Saved	812.447	827.597	1 417.798	334.181	235.875
Winner Age	28.253	28.474	37.653	18.281	4.239
Winner Age Squared	816.140	810.749	1 417.798	334.181	236.802
Loser Age	-15.248	-10.000	1 012.000	-981.000	106.219
Loser Age Squared	1.521	0.000	19.000	0.000	4.083
Rank Difference	0.619	0.000	19.000	0.000	2.928
Winner Grand Slam Titles	0.202	0.0000	1.0000	0.0000	0.403
Loser Grand Slam Titles	0.143	0.0000	1.0000	0.0000	0.350

Table 2: Women's Descriptive Statistics					
Variable	**Mean**	**Median**	**Maximum**	**Minimum**	**Standard Deviation**
International	0.186	0.000	1.000	0.000	0.313
Premier	0.208	0.000	1.000	0.000	0.407
Premier 5	0.087	0.000	1.000	0.000	0.282
Premier Mandatory	0.072	0.000	1.000	0.000	0.259
Grand Slam	0.082	0.000	1.000	0.000	0.313
Grass	0.420	0.000	1.000	0.000	0.498
Hard	0.653	1.000	1.000	0.000	0.477
Clay	0.239	0.000	1.000	0.000	0.427
Expected Prize Money Spread ($)	39924.130	9120.000	875000.000	2384.305	92540.670
Expected Ranking Points Spread	79.023	50.000	520.000	30.000	78.267
Winner Aces	3.378	3.000	20.000	0.000	3.306
Winner Double Faults	2.856	2.000	12.000	0.000	2.201
Winner Percentage Break Points Saved	0.581	0.615	1.000	0.000	0.277
Loser Aces	2.288	2.000	17.000	0.000	2.350
Loser Double Faults	3.604	3.000	13.000	0.000	2.575
Loser Percentage Break Points Saved	0.455	0.500	0.818	0.000	0.164
Winner Age	26.117	26.177	36.085	16.931	3.761
Winner Age Squared	696.189	685.214	1302.118	286.654	204.796
Loser Age	25.447	25.191	36.107	16.931	3.748
Loser Age Squared	661.563	634.585	1303.700	286.654	196.482
Rank Difference	-17.954	-10.000	759.000	-692.000	80.805
Winner Grand Slam Titles	1.126	0.000	22.000	0.000	4.027
Loser Grand Slam Titles	0.411	0.000	22.000	0.000	2.318

From the descriptive statistics for the ATP data reported in Table 1, the average prize money spread is $45 575.82 with the maximum being $875 000 and the minimum $4 805. The average expected ranking points spread is approximately 64 points with a maximum spread of 360 points and a minimum spread of 25. Another noteworthy variable is that of rank difference, which illustrates the difference in the ranking positions of the two competitors in a match and is expected to be negative as this would indicate that the favoured player won the match. The average rank difference between players is -15, illustrating that in the quarter-, semi- and finals of a tournament, the matches are typically won by the higher ranked player. The maximum difference is 1 012 ranking positions and the minimum is -981.

Table 2 reports the descriptive statistics for the WTA data. The average prize money spread is $39 924.13 with the maximum being the same as the ATP level at $ 75 000.00 and the minimum level at $2 384.31. Looking at the expected ranking points spread, the average spread is approximately 79 points with the maximum being 520 points and the minimum spread being 30 points. Lastly, the average rank difference is around -18, which is similar to that of the ATP data also indicating that the matches are typically won by the higher ranked player. The maximum difference is 759 and the minimum at -692 ranking positions.

4.4 Method

Rosen's (1985) theoretical framework regarding two-player elimination tournaments with heterogeneous players provides the basis for the model used in this study, with elements of previous studies (Lallemand *et al.*, 2008; Sunde, 2003; Silverman and Seidel, 2011) incorporated as well. Tennis presents an ideal situation to apply this model, as it provides two heterogeneous players with separate capabilities as well as incentives (Rosen, 1985). The amount of effort a competitor will be required to supply will, however, depend on the ability he possesses as well as the ability of any possible opponents. In an attempt to test the incentive effect of prizes and to assess the impact of players' heterogeneity on individual effort, the following regression is estimated via OLS for both the ATP and WTA:

$$EFFORT_{kmi} = \beta_0 + \beta_1 HTG_{kmi} + \beta_2 PRIZEMONEY_{kmi} + \beta_3 X_i + \beta_4 Y_m + \beta_5 Z_k + u_i$$

The dependent variable, $EFFORT_{kmi}$, represents the effort exerted by player *k* in match *m* of tournament *i*, HTG_{kmi} is a measurement of the heterogeneity in capability between the two players and is measured by the rank difference between players. The rank difference is included as a control variable in order to separate out the capability effect, which in turn allows player incentives to be isolated. $PRIZEMONEY_{kmi}$ denotes the expected monetary incentive of player *k* in a specific match. It is measured as the differential of prizes between winning and losing a match, and can, therefore, be seen as the marginal monetary incentive of advancing one round further. X_i represents tournament specific characteristics such as the surface (grass, clay or hard surface) and level of the tournament (ATP 250, 500, 1000 or Grand Slam for the men and International, Premier, Premier 5, Premier Mandatory or Grand Slam for the women). Y_m represents a variety of characteristics specific to a given match, such as the percentage of break points won by the winner and by the loser, the number of aces hit by both players, the number of double faults served, and the ranking points a player can expect to earn should they exit the tournament at that specific stage. Lastly, Z_k denotes player-specific characteristics, including a player’s age and age squared, as well as the number of Grand Slam titles, won by each player.

There are a number of ways to measure player effort. Sunde (2003) made use of the total number of games won by a given player as a proxy for player effort. This measure is not considered to be the most accurate measure of a player’s overall performance, but still provides an indication of effort levels exerted. Silverman and Seidel (2011) modified Sunde’s (2003) study and made use of the percentage of games won, which is total games won by the loser divided by the total games played in a match. This, in turn, normalises the variable, allowing for an analysis of player-specific results within the context of a given match. This is undertaken under the assumption that the more effort a player exerts, the higher percentage of games they will win. Another option, as used by Ivankovic (2007), would be to use the duration of the match as a proxy for effort under the assumption that a longer match has seen a larger amount of effort exerted.

This study uses all three measures of player effort as dependent variables in separate models. This approach provides a more complete and accurate description of the effort exerted by each player. For example, if a match ended 6-0 6-0, the total number of games played indicates that the loser did not exert maximum effort as they were comprehensively beaten. However, this may not tell the full story as each game may have been extremely hard fought, which will, in turn, be reflected in the duration of the match. The opposite may also be true, where a match may have seen a result of 7-5 7-5 which, using the total number of games played and percentage of games won by the loser, would indicate large effort exertion levels. However, if each game was played extremely quickly then the duration of the match would indicate the opposite. Therefore, by including a variety of dependent variables for the same underlying measure, it accounts for all possible outcomes in any given match.

4.5 Conclusion

This chapter was able to illustrate how both the ATP and WTA tournaments are conducted and how the different tournament levels may lend itself to changing effort exertion levels by competitors as some tournaments have less prize money and ranking points available. This was built upon in the data section where the different variables to be used were set-out. The method section illustrated the need for a variety of dependent variables to be used as a proxy for effort as no single tennis match is the same and provides a more comprehensive idea of effort exertion levels applied in a given match. The following chapter will report and discuss the regression results within the context of existing theory and empirical research.

CHAPTER 5
RESULTS

5.1 Introduction

The purpose of this chapter is to report and discuss the regression results that predict player effort for both the male and female data for the 2016 season. The chapter is organised as follows: Section 5.2 and 5.3 report on the male and female results respectively in a table format. Section 5.4 then provides an interpretation of the results and discusses the possible implications it has on the sport as a whole. Finally, the last section provides a summary of the chapter and the results found.

5.2 Men's Regression Results

Table 3 reports the regression results for ATP tournaments. As discussed above, the four and five set Grand Slam matches have been omitted from the data set so it would have been expected that with these matches included that the results would have indicated that these matches are longer as more games are played. However, by only including the three set matches, one can accurately compare the Grand Slam matches to the other tournaments. When this is done, it can be seen that the majority of the tournament levels are insignificant under all three dependent variables with the only significant tournament level being the ATP 100 under the Total Games Played dependent variable. This coefficient indicates that the ATP 1000 tournament level matches play an average of two games less than the ATP 250 tournaments, *ceteris paribus*. This is interesting as these tournaments contain higher prizes and monetary incentives. A reason for this result could be that these tournaments attract both very high and very low ranked players and the difference in ability could result in slightly fewer games being played per match. It should also be noted that the Grand Slam results indicate that these three set matches are insignificant under all three dependent variables. This supports the capability affect as opposed to the incentive effect and suggests that matches are played on the merit of the opposition and not on the merit of the incentives.

The surface dummy variables are both insignificant, suggesting no difference in match duration of clay- and hard court matches relative to those on grass. This may suggest that the nature of grass court tennis is changing as longer rallies are introduced and less serve and volley, leading to longer points. In terms of the in-game variables, the number of double faults served by the winner and the loser as well as the number of aces served by the loser are all statistically significant and positively associated with match duration, as expected. Lastly, both the age of the loser and the age of the loser squared are significant at the 10% level. However, the loser's age coefficient is positive, and the loser's age squared coefficient is negative. Meaning that match duration increases with player age, but after a certain point, it increases at a decreasing rate or even drops. The loser's age squared variable was also significant meaning that the fatigue of the player had a significant and negative impact on the duration of the match. Thus, as the match went on, the losing player tired and this had a negative impact on the time of the match.

It is again expected that the in-game statistics will have a significant impact on the total number of games played as variables such as double faults, aces and break points saved have a direct impact on the total number of games played in a match as they effectively determine the outcome. This is shown as the number of double faults served by the winner and loser, the percentage of break points saved by the winner and loser as well as the number of aces served by the loser are all significant. The age of the loser and the age of the loser squared are again significant for the same reasons as above. Lastly, the number of Grand Slam titles won by the loser has a positive and significant impact on the total number of games played. This illustrates that players who have won previous Grand Slam titles tend to partake in matches with a larger number of games played, showing an increased amount of effort. This variable is able to capture some of the variation in the heterogeneity of the competitors and could indicate that the reputation of the loser sees them exert an increased amount of effort, as they do not want to lose to competitors that have not previously won a Grand Slam title and therefore, may be deemed to be the 'underdog' A possible explanation, according to Rousseva (2014), may be that the competitor deemed to be the underdog is more mindful of their disadvantage on a particular surface and attempts to compensate for the capability advantage of the favourite on that surface.

The results for the percentage of games won by the loser show that the majority of the significant variables are those in-game statistics, have a direct impact on the percentage of games won by the loser. This direct impact can be both positive and negative in that an increased amount of double faults by the winner will see a positive impact on the number of points and games won by the loser which in turn could result in more total games being played. Whereas, a larger amount of break points saved from the winner will result in fewer games being won by the loser and a lower total amount of games played. This is illustrated in Table 3 in that the coefficient for Winner Double Faults is both positive and significant and the coefficient for Winner Percentage Break Points Saved is significant and negative. It also shows that the number of Grand Slam titles won by the loser is once again significant, indicating that the reputational variable affects the amount of effort exerted in a match. This may again be attributed to players who have previously won Grand Slam titles tending to partake in matches with a larger number of games played, showing an increased amount of effort as they do not want to lose to players who may be deemed as the 'underdog.'

If one had to compare the results of all three dependent variables, it can be noted that the results are fairly similar throughout. In-game statistics such as double faults, aces and percentage of break points saved were significant in the majority of the dependent variables as well as the ages of the competitors having a significant positive and negative impact on the three dependent variables. The reputational variable of Loser Grand Slam Titles Won was significant in both the Total Games Played and Percentage of Games Won dependent variables suggesting that this variable has a significant and positive impact on these two dependent variables. The tournament levels were seen to be relatively insignificant when comparing it to the ATP 250 events. The Expected Prize Money Spread and the Expected Ranking Point Spread were however insignificant throughout all the dependent variables suggesting that these factors do not influence a competitor's effort levels during tournaments. This is confirming that the incentive effect is outweighed by the capability effect in that a match is determined by the skill levels of the competitors and not due to the incentives of winning or losing the match.

Table 3: Men's Results									
Independent Variables	**Dependent Variables**								
	Minutes			**Total Games Played**			**Percentage of Games Won**		
	Co-efficient	**Standard Error**	**Probability**	**Co-efficient**	**Standard Error**	**Probability**	**Co-efficient**	**Standard Error**	**Probability**
ATP 500	0.704	10.066	0.944	-1.022	0.819	0.213	-0.017	0.011	0.120
ATP 1000	2.239	13.578	0.869	-2.244**	1.105	0.043	-0.021	0.014	0.150
Grand Slam	16.571	26.604	0.534	3.219	2.165	0.138	-0.005	0.028	0.110
Hard	12.479	10.105	0.218	-0.668	0.822	0.417	0.002	0.011	0.864
Clay	14.587	10.844	0.179	0.733	0.882	0.407	0.004	0.011	0.757
Expected Prize Money Spread ($)	-6.890	6.869	0.316	0.430	0.559	0.443	0.006	0.007	0.383
Expected Ranking Points Spread	0.069	0.085	0.423	-0.003	0.007	0.669	-0.001	0.001	0.151
Winner Aces	-0.055	0.468	0.907	0.040	0.038	0.298	0.001	0.000	0.316
Winner Double Faults	5.795***	1.503	0.000	0.900***	0.122	0.000	0.008***	0.002	0.000
Winner Percentage Break Points Saved	-10.056	8.151	0.218	-1.381**	0.663	0.040	-0.023***	0.009	0.008
Loser Aces	1.314**	0.665	0.04	0.507***	0.054	0.000	0.006***	0.001	0.000
Loser Double Faults	3.362**	1.372	0.015	0.369***	0.112	0.001	0.002	0.001	0.156
Loser Percentage Break Points Saved	12.841	14.164	0.365	2.867**	1.153	0.012	0.060***	0.015	0.001
Winner Age	-1.014	5.874	0.863	0.027	0.478	0.955	0.007	0.006	0.272
Winner Age Squared	0.024	0.107	0.820	-0.001	0.009	0.865	0.000	0.000	0.252
Loser Age	9.509*	5.703	0.09	1.034**	0.464	0.030	0.012**	0.006	0.053
Loser Age Squared	-0.168	0.104	0.105	-0.019**	0.008	0.025	0.000**	0.000	0.082
Rank Difference	-0.001	0.027	0.965	-0.003	0.002	0.167	-0.002	0.003	0.408
Winner Grand Slam Titles	0.543	0.801	0.498	0.014	0.065	0.826	0.000	0.001	0.867
Loser Grand Slam Titles	1.323	1.013	0.193	0.176**	0.082	0.033	0.002**	0.001	0.033
Adjusted R-Squared	0.057			0.365			0.294		
Sample Size	423 Matches								
*, ** and *** indicate 10%, 5% and 1% significance levels respectively.									

5.3 Women's Regression Results

Table 4 reports the WTA tournament results for the various dependent variables. The first dependent variable is the duration of the match and it is in line with that of the ATP results in that the tournament levels are deemed to be insignificant in affecting the time of a match. This confirms theory in that all of the WTA tournaments, the Grand Slams included, are played as the best of three sets meaning that the average among all the tournaments should be similar. The in-game statistics are once again significant as they have a direct impact on the duration of the match. Thus, winner and loser double faults, loser aces and the percentage of break points won by the loser are all significant variables. The second dependent variable is that of total games played. None of the individual tournament levels is significant, with the clay surface coefficient once again being the largest, indicating that matches on clay surfaces tend to take longer than those matches played on a grass court.

The in-game statistics show similarities to that of the men's results in that the winner's and loser's aces, double faults and percentage of break points saved are all significant. They did not all, however, have the anticipated signs. Winner Double Faults, Winner Percentage Break Points Saved, Loser Aces and Loser Percentage Break Points Saved had the expected coefficient signs. The double faults served by the winner had a positive and significant impact on the total number of games played as double faults served by the winner, sees their opponent win more points which could lead to more games during the match. The percentage of break points saved by the winner has a significant, negative impact on the dependent variable which is again consistent as a larger number of break points saved by the winner results in fewer games won by the loser and a lower number of total games played. The number of aces served by the loser was significant and positive as this will result in more points being won by the loser which could then result in more games won by them and therefore, more total games played. Lastly, the percentage of break points won by the loser was also positive and significant which is again expected as this sees the loser win more points. The variables which did not display the expected signs was that of Winner Aces and Loser Double Faults. It would be expected that an increased number of aces served by the winner would result in more points won by them and less by the opponent which will, in turn, see a lower number of games played in the match. The same can be said for the number of double faults served by the loser. More double faults served results in more points won for the opponent which may mean less total games played. These two variables, however, do not display the expected sign and reasons may be that the games in which these aces and double faults were served did not actually result in the expected outcome of who won the specific games. It is not always the case in tennis where a competitor serves an ace in a game and wins the game or when an opponent serves a double fault that they also win the game and this is illustrated in this variables.

It should be noted that the rank difference, in this case, has a positive and significant impact at the 5% level, indicating that the difference in ranking between competitors has an impact on the total number of games played. This may be a significant finding in that the Rank Difference variable is expected to be negative as that would indicate that the favoured player won the match. In this case, however, it suggests that this is not always the case on the WTA Tour. The last dependent variable is that of the percentage of games won by the loser. These results are very similar to that of the other dependent variables in that the majority of significant variables are those of the in-game statistics, such as winner and loser aces and double faults, loser percentage of break points saved, loser age squared and rank difference.

Comparing the similarities and differences across the results of the three dependent variables, it can again be seen that the results are fairly consistent throughout. As seen above with the ATP results, the in-game statistics such as the number of aces and double faults served as well as the percentage of break points saved, are highly significant in all three dependent variables. The difference between the player's rankings before the match is seen to have a positive and significant impact on the Total Number of Games Played and the Percentage of Games Won dependent variables. Looking at the tournament levels, none of the levels is deemed to be significant when comparing it to the base group level, this is also seen with the dummy surface levels. Notably, as seen with the Men's results, the Expected Prize Money Spread and the Expected Ranking Points Spread are insignificant throughout which suggests that the incentive effect is once again outweighed by the capability effect in that a match is determined by the skill levels of the competitors and not due to the incentives of winning or losing the match.

Table 4: Women's Results									
Independent Variables	**Dependent Variables**								
	Minutes			**Total Games Played**			**Percentage of Games Won**		
	Co-efficient	**Standard Error**	**Probability**	**Co-efficient**	**Standard Error**	**Probability**	**Co-efficient**	**Standard Error**	**Probability**
Premier	2.665	4.747	0.575	0.291	0.873	0.739	-0.002	0.016	0.893
Premier 5	-0.600	7.191	0.934	-0.075	1.326	0.955	-0.001	0.024	0.971
Premier Mandatory	-4.197	8.820	0.634	-0.907	1.626	-0.558	-0.021	0.029	0.461
Grand Slam	-2.515	10.906	0.818	-0.950	2.012	-0.472	-0.016	0.036	0.647
Hard	0.639	4.713	0.892	-0.773	0.861	-0.898	-0.01	0.015	0.217
Clay	4.934	5.238	0.347	0.295	0.959	0.308	-0.005	0.017	0.751
Expected Prize Money Spread ($)	1.710	2.985	0.567	-0.027	0.551	-0.054	0.001	0.010	0.999
Expected Ranking Points Spread	-0.032	0.046	0.4843	-0.000	0.008	-0.067	0.002	0.000	0.916
Winner Aces	0.215	0.446	0.630	0.253***	0.08	0.002	0.005***	0.001	0.002
Winner Double Faults	4.272***	0.651	0.000	0.717***	0.120	0.000	0.245***	0.002	0.000
Winner Percentage Break Points Saved	-2.631	4.956	0.596	-2.259**	0.910	0.014	-0.034	0.016	0.039
Loser Aces	2.329***	0.625	0.000	0.655***	0.115	0.000	0.009***	0.002	0.000
Loser Double Faults	1.883***	0.555	0.000	0.409***	0.102	0.000	0.004***	0.001	0.000
Loser Percentage Break Points Saved	30.863***	8.468	0.000	3.241**	0.102	0.039	0.082***	0.028	0.003
Winner Age	1.381	3.221	0.668	0.759	0.594	0.202	0.005	0.01	0.630
Winner Age Squared	-0.021	0.061	0.735	-0.013	0.011	0.232	-0.010	0.000	0.634
Loser Age	1.447	3.216	0.653	0.443	0.593	0.455	0.018	0.011	0.097
Loser Age Squared	-0.018	0.062	0.771	-0.007	0.011	0.528	0.000*	0.000	0.078
Rank Difference	0.026	0.017	0.128	0.006**	0.003	0.042	0.001**	0.006	0.071
Winner Grand Slam Titles	-0.602	0.503	0.232	-0.083	0.093	0.372	-0.001	0.002	0.329
Loser Grand Slam Titles	-1.031	0.781	0.188	-0.197	0.144	0.172	0.001	0.003	0.981
Adjusted R-Squared	0.2392			0.2821			0.2284		
Sample Size	389 Matches								

*, ** and *** indicate 10%, 5% and 1% significance levels respectively.

5.4 Combined Regression Results

Looking at the results for the effect of monetary incentives on effort exertion, none of the coefficients was statistically significant. This indicates that in the last three rounds of all the tournaments played, for both males and females, money is not considered to be a key motivator for players. This result is in line with those found by Rousseva (2014). The expected prize money spread coefficient is positive for the majority of the dependent variables, such as total games played and percentage of games won for the men and the duration of the match and the percentage of games won for the women. This positive sign is consistent with expectations and states that as the marginal spread of progressing to the next round rises, the player's average effort exertion per set rises. As noted, however, none of these coefficients is significant. These results, therefore, support the findings of the capability effect of heterogeneity on players' performance. This means that the outcome of a match is linked more to the abilities of the competitors involved as opposed to the incentives available. Thus, players will adjust their effort levels according to their opponent and not because there are more money or ranking points available. This is illustrated through the capability effect as the effort levels exerted by each player is linked more to the ability or perceived ability of the opponent as opposed to the prizes available. This can be illustrated through an example: if player A is a better than player B and both competitors give 100% effort than player A will win. If however, player A perceives player B to be weaker and drops their effort levels with player B giving 100%, this could result in player B beating player A. The practical implications of the findings illustrate that the tournament organisers may not have set correct prize incentives in order to induce an increased amount of effort, particularly at the lower end of the tournament levels. Theoretically, however, it shows that the competitors on both the ATP and WTA tours do not increase effort levels purely based on monetary incentives or rewards. This is an important finding as it means that there is more to the sport than just the rewards as intangible factors such as pride and desire therefore also play a part when it comes to tennis. These results can then be applied to other spheres of life such as the working world, in that monetary incentives may not be the only factor driving employees to want to do better but rather a variety of tangible and intangible factors which all managers need to be aware of in order to get the best out of their staff.

Rosen (1985) argues that there are incentives in competitions where rankings are involved for a competitor to give off signals that mislead the opponent regarding his or her abilities. Thus, it is in the interest of the favourite to make the other competitors think that his/her ability is greater than what it actually is. This will then have a direct effect on how the opponent devises their strategy before coming into the match as well as having an indirect effect, which is that mentally the underdog will have less confidence in winning the game if he or she believes that the favourite has a far superior ability to them. The opposite is then true for the underdog, in that if they give out signals that they are weaker than they actually are, then the favourite will exert less effort due to the capability effect. This strategy can then be implemented to an extent which may be socially costly and as a result, the correct incentive prize structure is needed to reduce these potential costs. This, therefore, requires weighting top prizes less heavily than in situations where such effects are not present.

Lallemand *et al.* (2008) state that the incentive hypothesis suggests that both competitors are encouraged to exert a lower amount of effort in highly uneven matches due to the fact that the chances of each player winning is uneven. In contrast, the capability hypothesis states that if all other factors are kept constant, then greater heterogeneity results in the favourite performing better, which sees the underdog win fewer games as their inferior ability reduces their probability of winning. The ATP and WTA results suggest that competitors do not alter their effort levels depending on the level of the tournament. This illustrates that players exert similar effort levels regardless of the amount of money or ranking points available. These results are consistent with those of Nieken and Stegh (2010). This is due to the fact that in real-world tennis tournaments heterogeneous players compete in matches. Due to the fact that effort comes at a cost, the competitor who is the least favourite to win, the 'underdog,' will reduce their level of effort as compared to the homogeneous case. This is because their probability of winning is smaller due to the handicap. The higher the underdog's disadvantage, the stronger will be the effect. The competitor who is expected to win the match, the 'favourite,' will anticipate this behaviour from the underdog and will consequentially reduce their effort levels without jeopardising the favourable position. Nieken and Stegh (2010) concluded that in a heterogeneous tournament both agents will exert lower effort levels as compared to the homogeneous case. Thus, if the teams involved in a match contain very different abilities, lower effort levels will be observed. The dataset used for this study examines the quarter, semi and final rounds of each tournament, which eliminates initial seeding effects and results in the majority of matches being played by competitors with more homogenous skills. This sees higher but constant effort levels throughout which is shown by the results as there are no individual cases where effort levels are significantly higher.

5.5 Conclusion

This chapter reported and discussed the regression results from all the 2016 ATP and WTA tours, with the purpose of studying player effort. The main finding was that the capability effect outweighs that of the incentive effect and that monetary incentives are not the only factors driving competitors to increase effort, which was in line with findings from Nieken and Stegh (2010) and Rousseva (2014). These results contribute to the small but ever-growing findings on tournament theory in sport and can be used when deciding what incentives to be applied in both the sporting and working world and whether they will ultimately have the desired effects on the participants.

CHAPTER 6

CONCLUSION

6.1 Summary and Conclusion

This study is similar to Sunde (2003) in that the data used is particularly suited for testing whether prizes affect the effort players exert during a tournament through the respective incentives on offer for winning matches in a tournament as well as testing whether differences in competitors' abilities, measured through rankings, decrease their efforts. The study seeks to examine the incentive effects in tennis and how these incentives affect effort exertion levels among professional tennis players. Using a unique data set that includes the quarter-finals, semi-finals and finals of all the tournaments played in 2016 on both the male and female tours, it is possible to identify how players react to heterogeneity in ability as well as prize incentives. This was done using comprehensive information on players, tournaments and in-game statistics.

Competition works best when all the participants are similar (Nalebuff and Stiglitz, 1984). The results from this study also confirm those found by Sunde (2009) and Nieken and Stegh (2010) in that it supports the theoretical implication stipulating that effort exertion in tournaments is highest for matches that involve homogeneous contestants. Hence, if two players with varying abilities compete against each other, then lower effort levels will be observed and this finding holds especially for the favourite. This was seen in this study as the matches used were only those from the quarter-finals, semi-finals and final of each tournament, meaning that initial seeding effect was accounted for. The results of this is that players making it into the last three rounds of a tournament are more likely to have a closer skill level. Thus, when there are homogenous contestants, matches compete at a closer level.

As reported in Rousseva's (2014) study, the heterogeneity coefficients were mostly insignificant, but the signs were consistent with the economic theory in that a competitor's effort exertion levels are highest when contestants are homogeneous, which is also indicated by Nieken and Stegh (2010). The outcome of the current study is therefore also in line with the findings of Lallemand *et al.* (2008) in that the findings support that of the capability effect of heterogeneity on players' performance. This means that the outcome of a match is linked more to the abilities of the competitors involved as opposed to the incentives available. Thus, players will adjust their effort levels according to their opponent and not because there are more money or ranking points available. This suggests that both the ATP and WTA should aim to reduce the differences in abilities amongst the players in an attempt to raise the attractiveness of the sport.

6.2 Areas for Further Research

Using sport as a proxy for the corporate environment provides a more general observation about the effect incentives have on individuals. Sunde (2009) believes that through the use of tournaments, it allows one to analyse how incentives play a part in the effort exerted by competitors and this illustrates the importance of identifying strategies which allow the tournament director to evaluate whether the intended incentives actually affects individual behaviour. Thus, the broader question that needs to be addressed is to explore to what extent tournament theory can provide an explanation for the structure of compensation observed in the corporate environment. Thus, formulating ways to address the relevance of tournament theory should be of the utmost importance of economists interested in compensation issues. This study is a contribution to tournament analysis. Attempting to understand how to use data from sports in order to apply it to the labour environment should be of major concern for future studies.

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