

RESEARCH ARTICLE

Rules in International Tennis Tournaments: A Game Theoretic Perspective

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Abstract

This article presents a comprehensive analysis of the evolving rules in international tennis tournaments, focusing on the sport's adaption to technological advancements, shifts in playing styles, and the increasing need to enhance global spectatorship. Tracing the progression from the historical "Jeu de paume" to modern play, the strategic depth of its scoring system and potential future implications are examined. Reviewing statistical analysis and recent research, this study documents modifications to the scoring system, including the no-ad game and proposed "short games," designed to shorten match lengths while simultaneously boosting competitiveness and spectator involvement. These innovations seek to balance tradition with modern audience expectations. Central to the analysis is the game-theoretic perspective, which offers insights into the trade-off between game complexity and spectator satisfaction. Through an extensive review, the article discusses the adaptability and continuous evolution of the rule system. This is shown by an examination of the strategic significance of the serve and potential rule changes such as single-service games or granting starting advantages to lower-ranked players.

Keywords: Tennis, Scoring System, Game Theory.

1. Introduction

In the dynamic world of a sport enriched with centuries of traditions, meaningful changes have unfolded in recent years. This article explores how contemporary trends and rule modifications are influencing these traditions, with a specific focus on their future implications. Technological advancements - such as the introduction of Hawk-Eye for line calls, shifts in athletic styles, and enhanced global spectatorship - have all contributed to this transformation (Sheridan, 2006). Through a detailed examination of the scoring system, from the first point up to winning the entire match, this work dissects the strategic depth of the scoring structure.

Driven by the recognition of the subtle yet significant shifts within the sport, this transition is marked by the development of scoring systems at the levels of

individual points, games, sets, and ultimately entire matches. Analysing the critical role of the serve and the impact of rule adaptations across various international tournaments, the evolution from the ancestral "Jeu de paume" (Nanteuil et al., 1898) to modern tennis is outlined. The examination offers a comprehensive overview of the sport's progression. It critically explores how these developments reflect broader trends in sports innovation aiming at enhanced competitiveness and spectator engagement.

Moreover, this article reviews statistical analysis and recent research to examine the impact of rule changes on the scoring system. It delves into the relevance of both historical context and modernisation, including analyses of strategy and game theory. By quantifying the balance between game complexity and spectator enjoyment, this study assesses various scoring systems and their sophistication. Game refinement theory, as

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defined by Iida et al. (2004), provides a mathematical framework to evaluate how well a game maintains excitement and engagement over its duration (Dinh & Hiroyuki, 2016). This exploration seeks to bridge the gap between the sport's history and its potentially revolutionary future, providing a comprehensive perspective on the sport's adaptability.

2. Point

In the game of tennis, securing points is the primary objective, with players employing a wide array of tactics to achieve this goal. The International Tennis Federation (2024) rulebook states that points can be lost in several ways, including two consecutive faults by the server, failure to return the ball before it bounces twice, and infractions involving the ball, racket, or court boundaries. These rules in scoring emphasise the strategic depth required for every point, setting the stage for a deeper exploration of how these dynamics influence overall match outcomes.

The scoring method is notably unique, starting each game from a baseline of zero, known as "Love." A player's score progresses to 15, 30, and then 40 with each successive point won (ITF, 2024). This system, rooted in the sport's rich tradition, introduces a complex layer of strategy unlike any other sport. In contrast, sports like basketball and soccer have a more straightforward point counts where each goal or basket immediately increases the team's score, reflecting a continuous and linear scoring progression.

The origins of the modern tennis scoring system trace back to "Jeu de paume," an early form of tennis that was played using hands instead of rackets and featured different court dimensions (Manévioux, 1783). While "Jeu de paume" did not transform directly into "Lawn Tennis," its principles and gameplay influenced the development of the contemporary game. Notably, one of the key evolutions was the adjustment of the scoring transition from 45 to 40, among other modifications, that have shaped modern sport as we know it today (Nanteuil et al., 1898).

Statistical analysis serves as a foundational tool in exploring the dynamics of winning points in tennis, particularly highlighting the fundamental role of the "first serve." Research conducted by Carboch (2017) demonstrates that a well-executed first serve significantly boosts the probability of winning a point. The data shows that men secure 72.70% of points initiated with a successful first serve, whereas in women's tennis, the advantage is more subtle, with players winning 65.15% of points off their first

serve. This disparity not only points out the strategic importance across genders but also suggests the need for differentiated tactical considerations in men's and women's matches. This variation highlights the critical importance of the serve determining match outcomes, emphasising the need for customised strategies to maximise serving effectiveness in competition.

Additionally, the strategic impact of a good first and second serve is quantified through data revealing that 64.40% of points in men's matches and 56.10% in women's matches are won during service games (Klaassen & Magnus, 2000). While a strong first serve is essential for gaining an immediate advantage, maintaining pressure and accuracy on the second serve is equally important for securing points and controlling the match. The second serve often becomes a player's safety net, minimising the risk of a double fault while keeping the opponent in the defensive. Effective second serves can disrupt the returner's rhythm and prevent aggressive returns, thus playing an important role in match dynamics and overall strategy.

Moreover, data compiled from various sources shows the importance of the quick pace and the decisive nature of points in professional tennis. Remarkably 50% of points, regardless of gender, are concluded within the first four shots, demonstrating the importance of early point dominance (Cui et al., 2019). During the Australian Open, the average duration of a point was measured at 5.93 seconds (± 0.67), further illustrating the sport's quick exchanges.

Further complexity in the game is illustrated through the variance in rally lengths, as documented by Cui et al. (2019). Their study reveals that rally lengths can vary significantly, ranging from an average for men's matches of 2.2 shots per point to as many as 16.7 shots, with the mean rally length recorded at 8.2 shots. This variability shows the complex strategies and necessary endurance in competition, indicating that players need to be ready for both swift exchanges and extended rallies.

Additionally, the type of court surface, whether clay, grass, or hard court, profoundly affects these dynamics. Grass, where the ball tends to bounce lower and faster, is considered as a faster surface in comparison. Thus players often adopt aggressive serve-and-volley tactics, where they rush to the net immediately after serving to volley the return. Hence grass courts favour players with powerful serves and quick reflexes at the net (Cross & Pollard, 2009). Conversely, slower surfaces like clay promote longer rallies and reward

baseline play, requiring players to exhibit patience, endurance, and the ability to construct points more strategically. On clay, players rely on heavy topspin shots, which cause the ball to rotate forward rapidly and bounce higher, making it more difficult for opponents to return (O'Donoghue & Ingram, 2001). Consistent groundstrokes are also important on clay, as the high bounce allows for greater recovery time and extended rallies. Hard courts, offering a balance between the extremes of grass and clay, require a flexible approach where players need to adapt at both baseline and net play. This variety demands adaptability and a well-rounded game to effectively handle the medium-pace conditions and moderate bounce (Lees, 2003).

3. Game

Winning four consecutive points results in winning a game. However, when both players reach three points each, resulting in a 40:40 tie, the situation is termed "deuce" (ITF, 2024). At this juncture, scoring methodologies diverge into either the standard scoring system or a newer method often used in doubles play.

In singles, the traditional scoring method remains predominant, as noted by the Association of Tennis Professionals (ATP, 2024). This classic approach requires that a game must be won by a margin of two points following deuce. Securing the first point after reaching deuce awards the player the "advantage," placing them one point away from winning the game. If the opponent counters by winning the next point, the score returns to deuce, requiring one player to achieve two consecutive points to win the game (ITF, 2024). Introduced in 2006, the scoring system for doubles matches underwent a significant modification with the implementation of the "no-ad" game rule (Pollard et al., 2007). At deuce, the receiving team chooses the side for the server to start. Once this decision is made, the subsequent point becomes a decisive game point for both teams. Thus, if one team secures the point following deuce, they win the game outright (ITF, 2024). This change, discussed as an alternative scoring method, adds a layer of strategy and unpredictability to doubles play, potentially reducing the match durations, intensifying competition at crucial moments, and resulting in fewer points played (Pollard et al., 2007). The reduction in points is significant as it helps to maintain the player's endurance and keeps the matches more engaging for spectators.

During the 2016 Grand Slam tournaments (Australian Open, French Open, Wimbledon, and US Open), a

comprehensive analysis of 18'074 men's games and 10'879 women's games revealed that men averaged 6.29 points per game, while women's matches averaged slightly higher at 6.54 points per game. This data, drawn from studies on match play differences between men and women in tennis, demonstrates that both men's and women's tennis matches typically revolve around six points per game, often culminating in game-deciding scores like 40:30. Such statistical insights shed light on the competitive nature of the sport, highlighting the tight contest and strategic play that characterise matches at the highest levels (Carboch, 2017).

Carboch's (2017) study reveals a notable distinction in the likelihood of winning a "break," across genders in Grand Slam tournaments. A break is associated with winning a game as the returning player. In men's matches, the probability of securing a break stands at 20.94%, which contrasts with women's matches, where the chance of winning a break rises to 33.68%. This disparity not only shows the strategic and competitive differences between men's and women's tennis at the Grand Slam level but also emphasises the varying approaches to service games and return strategies, as evidenced by the contrast in break probabilities. This finding implies that women's matches may be more dynamic and unpredictable, requiring players to be particularly adaptive and strategic during critical points. Conversely, in men's tennis, the lower break percentage highlights the importance of a strong serve and effective service game strategies to maintain dominance. Both scenarios show the need for flexible tactics and strong mental focus making the ability to secure breaks an important factor in determining the flow and outcome of matches.

Research aimed at reducing service dominance, suggests that securing a break during a set often presages winning the set itself, given the comparatively lower likelihood of losing while serving. The dynamics of service advantage and the fluctuating probabilities of winning points from various game scores can be mapped using a Markov chain, as illustrated in Figure 1. This model effectively captures the complex interplay of service advantage and point-winning probabilities at different stages of the game, providing a visual representation of the probabilities at each score (Sim & Choi, 2020). The Markov chain highlights how each point influences the server's probability of retaining the service game or the receiver's chance of breaking the game.

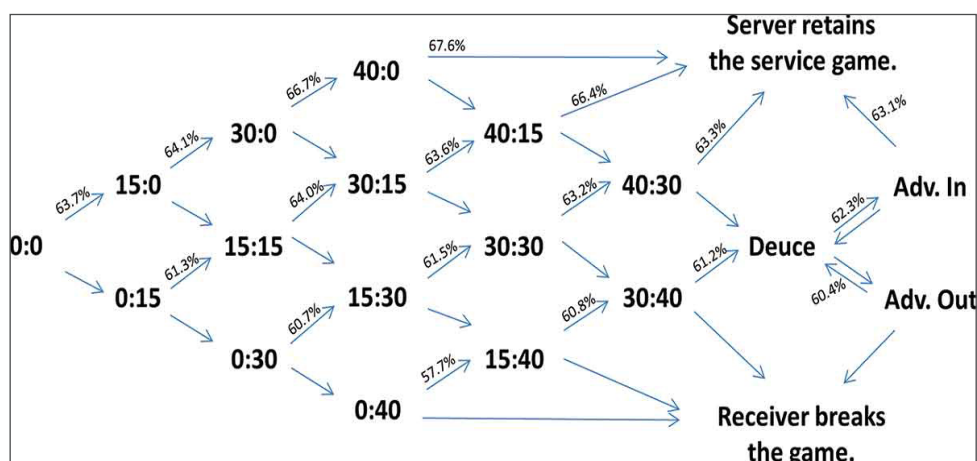


Figure 1. Markov chain diagram for a regular game – The point-winning probabilities for servers are marked (Sim & Choi, 2020).

Additionally, research indicates that not all points are created equal, particularly when it comes to winning points on serve. The likelihood of securing a point varies depending on the score of the game, such as 40:00, 30:15, 15:30, or 00:40 (Sim & Choi, 2020). Breakpoints, where the return player is one point away from breaking the server’s game, are moments loaded with game-changing potential. During the analysed matches at Wimbledon in 2016, the effectiveness was lower on breakpoints than on any other point (Meffert et al., 2018).

Implementing the no-ad rule alters the dynamics for both the server and return player, elevating the pressure experienced during each point and intensifying the excitement by approximately 5% (Pollard & Barnett, 2018). The no-ad rule ensures that each point played at deuce becomes a decisive game point, thus heightening the stakes and strategic considerations for both players. From an organisational standpoint, this rule simplifies match duration predictions, resulting in more consistent and reduced variability compared to matches played under traditional scoring systems. This efficiency in match timing benefits tournament scheduling as well as viewer engagement.

Moreover, the adoption of the no-ad rule could encourage more aggressive play styles and increased risk-taking, as players are aware that each point holds significant weight. This potential shift in playing style may lead to more dynamic and entertaining matches, aligning with the evolving preferences of spectators and the broader objectives of modernising the sport.

4. Set

Since 1877, the foundational rules for winning a set in tennis have remained remarkably consistent. Originally, the format required a player to win a minimum of six games leading by two games to gain a set, a structure known as the advantage set. In cases

where the game score reached 6:6, players were tasked with winning two consecutive games to secure the set, leading to potential set scores such as 9:7. The rule of winning by two games has long been a fundamental aspect of tennis, demonstrating the sport’s dedication to tradition and ensuring competitive fairness (Pollard & Meyer, 2010).

The introduction of the tie-break system transformed the traditional approach to resolving tennis sets tied at 6:6. With this change, rather than extending the match by requiring a player to win by two clear games, a decisive 12-point tie-break game is played. The winner of the tie-break is awarded the set with a score of 7:6. This innovation has streamlined matches, reducing their duration while maintaining competitive intensity (Croucher, 1982). In the tie-break, the server starts at 0:0 on the deuce side, serving only one point before switching every two points. After every six points, they change sides of the court to equalise any potential environmental conditions (Dilworth, n.d.).

The International Tennis Federation’s (2024) Rules and Regulations consist of two different formats for concluding tennis sets: the traditional “advantage set” and the “tie-break set.” The tie-break set, pioneered by James Van Alen, was first introduced at the Philadelphia Indoor Tournament in 1970, representing a significant evolution in tennis scoring aimed at expediting match conclusions (Pollard & Meyer, 2010). Initially, the tie-break used a best-of-nine points format, where a 4:4 score line triggered a “sudden death” situation, giving both players a match point. This format favoured the server, placing immense pressure on the return player (Pollard & Meyer, 2010). This inherent bias towards the server led to criticism of the format’s fairness, prompting discussions about the need for adjustments to ensure a more balanced competition.

However, this early iteration of the tie-break was soon replaced by the more widely adopted 12-point system,

also known as the tie-break to 7 points, requiring a two-point advantage. This method gained favour for its balance and fairness, reducing the server's advantage at critical points and adding depth to the game's strategic dimensions (Pollard & Meyer, 2010).

The average number of games played per set in the 2016 Grand Slam matches was 9.82 for men and 9.32 for women (Carboch, 2017). This statistic indicates that most sets in these high-stakes tournaments tend to be highly competitive, resulting in longer and more engaging sets. While the first games in a set might progress relatively quickly as players hold serve, the later stages, especially when the score nears 6:6, become crucial and more captivating for spectators. These final games, filled with tension, are vital in determining the momentum and outcome of the set.

In recent years, the ITF (2024) has authorised modifications in the format for concluding matches, particularly in doubles, juniors, and qualifying rounds of lower pro tournaments (ITF Futures). This adjustment introduces the final set as a match tie-breaker, diverging from traditional formats. Unlike the standard 12-point tie-break system at 6:6, which typically requires a player to reach 7 points with at least a two-point advantage, the match tie-breaker extends this threshold. In this format, players or teams compete to be the first to reach 10 points, again a minimum lead of two points is necessary to secure victory (Pollard, 2017). This format not only lessens the physical demand on players by shortening the match duration but also enhances tournament scheduling efficiency, ensuring that events proceed smoothly without extended delay. Shorter matches reduce the likelihood of scheduling conflicts, allow for more matches to be played in a day, and provide a more predictable timetable for broadcasters and spectators.

The ITF (2024) has introduced an innovative format known as "short sets," designed to accelerate the pace of tennis matches and to facilitate smoother tournament scheduling. The first player to win four games wins the set. In scenarios where competitors are at 4:4, a tie-break is deployed to determine the set victor. This tie-break, aptly termed the "short set tie-break," mirrors the original tie-break system established in 1970. The "short set" format can be explained as a normal set starting from 2:2, which makes the first few games already more critical to win. This approach emphasises the importance of every game from the beginning.

5. Match

To win a match, a player must secure the last point. According to the rules of the ATP (2024) men's singles are typically decided by the best of three tie-break sets, where a player needs to win two sets to secure victory. Similarly, in doubles matches, victory goes to the team that wins two sets. The Women's Tennis Association follows the same rules for winning matches in singles and doubles (WTA, 2024).

In Grand Slam events overseen by the ITF, matches may follow either a best-of-three-sets format or a more demanding best-of-five-sets structure. The best-of-five-sets match, which requires a player to win three sets to secure victory, is exclusive to the four men's Grand Slam tournaments. Until 2002, all Grand Slams, as well as Davis Cup and Fed Cup matches, were decided with an advantage set in the final set, which did not employ a tie-break. This format often led to exceptionally long matches, as winning required a clear two-game lead, sometimes resulting in marathon sessions on the court (Pollard & Meyer, 2010).

A notable example of this was the 2010 match between Nicolas Mahut and John Isner at Wimbledon, which became the longest match in tennis history. The marathon match concluded with Isner prevailing 6:4 / 3:6 / 6:7 / 7:6 / 70:68 after 11 hours and 5 minutes of play (O'Donoghue, 2013). Reflecting a broader trend towards modernisation and ensuring fair competition while maintaining viewer engagement, Wimbledon modified its rules in 2019 to institute a match tie-breaker to 10 points if the final set reaches a 12:12 deadlock (Clarke, 2018).

In 2022 all Grand Slam events further adjusted their approach by implementing a match tie-break at the score of 6:6 in the deciding set, starting with the French Open that year (Grand Slam Tennis, 2022). This adjustment aims to streamline match durations and accommodate scheduling constraints. Notably, this change included Wimbledon, a tournament known for its adherence to tradition. With an adoption to all Grand Slams this marked a significant shift, showing the importance of evolving rules to meet contemporary needs and expectations.

The recent changes in match structure signify a central moment in the sport's evolution. These modifications not only aim to streamline match durations and improve scheduling efficiency but also have broader implications for the future of tennis. By reducing the number of points played, changes

can lessen the physical load on players, potentially extending their careers and enhancing overall player welfare. Moreover, the emphasis on decisive points, such as those in tie-breaks, increases the intensity and excitement of matches, making the sport more engaging for spectators. This shift towards shorter, more dynamic matches align with the preferences of modern audiences, who favour fast-paced and unpredictable sporting events. Ultimately, the ongoing modernisation of match formats promises to maintain the sport's competitive integrity while making it more accessible and appealing to a global audience.

6. Game Refinement Theory

In any competitive game, each player must devise their strategy to secure victory. However, the outcome is not solely determined by individual choices but also by the actions and reactions of their opponent. This interplay of decisions creates a complex and dynamic environment where the primary objective for both players is to win.

Game theory, a mathematical framework for analysing strategic interactions, provides valuable insights into this process. The origins of game theory trace back to 1928 when John von Neumann introduced the concept of mixed strategy equilibria (von Neumann, 1928). This foundational work laid the groundwork for understanding how players can optimise their strategies in situations where their actions depend on the choices of others. Since its inception, game theory has been applied to a wide range of fields, including economics, politics, and biology (Osborne & Rubinstein, 1994). In sports, particularly tennis, game theory offers a richness of strategic opportunities. Tennis is a prime example of a game where players constantly adjust their strategies based on their opponent's moves. Whether planning serves, choosing shot placement or deciding when to play aggressively or defensively, players use game theory principles to outplay their opponents.

By analysing the strategic interactions in tennis through the lens of game theory, we can gain a deeper understanding of how players make decisions under pressure. This approach helps to explain why certain strategies are more successful than others and how players can adapt their tactics. The inclusion of game theory analysis allows us to appreciate the complexity and sophistication of the tennis sport.

Game refinement theory sets out to explain the attractiveness and sophistication of games. Iida et al. (2004) delved into the application of game refinement

theory to the board game "Mah Jong" exploring its outcome and measurement. This theory is not only significant in board games but also in sports, where strategic adjustment can enhance the competition's appeal for spectators. In tennis, for example, while many potential rule changes are possible, determining which ones genuinely increase the sport's attractiveness presents a compelling challenge.

Game sophistication, defined as the level of excitement experienced by spectators, is quantified by assessing the relationship between a game's duration and its decision-making complexity (Iida et al., 2004). This concept stems from the idea that the enjoyment and engagement of a game are closely linked to how unpredictable and dynamic it is. A game that is too predictable or lacks strategic depths may not hold the audience's attention, while a game with too much complexity or excessive duration can become exhausting and lose its appeal.

To better understand game sophistication, we can analyse the speed of the game, which is an important factor influencing excitement. The speed of the game is denoted by x (Dinh & Hiroyuki, 2016):

$$x = \frac{G}{T} \tag{1}$$

- G total points made by the winner of the game
- T total points played in the game

Since G and T are unknown variables during gameplay, Sutiono et al. (2014) proposed a model for game information progress, $x(t)$, as follows, where n is a parameter that characterises the rate of game information progress over time:

$$x(t) = G \left(\frac{t}{T} \right)^n \tag{2}$$

To evaluate the game's progress dynamics using Equation(2), the acceleration of game progress is calculated by taking the second derivative of $x(t)$ and solving it at $t = T$, leading to Equation(3) (Sutiono et al., 2014):

$$x''(T) = \frac{G}{T^2} n(n - 1) \tag{3}$$

The greater the value of $\frac{G}{T^2}$, the more exciting the game is due to the increased uncertainty of its outcome (Sutiono et al., 2014). Dinh and Hiroyuki (2016), along with Sutiono et al. (2014) suggest that game sophistication can be further quantified by the variable R in Equation(4) below.

$$R = \frac{\sqrt{G}}{T} \tag{4}$$

Based on previous research, the optimal game refinement measurement for the most captivating games falls within the range of 0.07 to 0.08. For instance, games such as chess, basketball, and soccer fall within this range (Hiroyuki et al., 2003; Iida et al., 2004; Sutiono et al., 2014; Takeuchi et al., 2014)

Table 1. Game refinement value of no tie-break and tie-break final set tennis scoring system for male and female tournaments. Based on data from Dinh and Hiroyuki (2016).

Association	Rule	Tournament	Surface	Avg. G	Avg. T	R- Value
ATP (Men’s)	5 sets by tie-break	US Open	Hard	105.4	193.3	0.053
	No T/B final	Australian Open	Hard	119.8	218.9	0.05
	No T/B final	French Open	Clay	119.5	217.9	0.05
	No T/B final	Wimbledon	Grass	122.8	226.6	0.049
WTA (Women’s)	3 sets by tie-break	US Open	Hard	77.9	138	0.064
	No T/B final	Australian Open	Hard	77.53	139.4	0.063
	No T/B final	French Open	Clay	77.4	139.4	0.063
	No T/B final	Wimbledon	Grass	77.96	140.8	0.062
Masters1000 (Men’s)	3 sets by tie-break	(all)	(all)	82.37	141.8	0.064

Thanks to the comprehensive analysis by Dinh and Hiroyuki (2016), Table 1 presents a wide-ranging overview of scoring systems used in Grand Slam and Masters 1000, which are the most important tournaments beside the Grand Slams. In men’s Grand Slam, matches are decided by a best-of-five format, whereas women’s matches adhere to a best-of-three rule. During the study period, all Grand Slam events, except the US Open, did not utilise a tie-break in the final set. This absence may influence the average total points per match.

The average total points in men’s US Open are notably lower compared to the other three Grand Slams, likely due to the presence of a tie-break in the final set. In contrast, the difference in average total points between the two final set styles in women’s tournaments is relatively minor. Specifically, R-values for women’s matches range between 0.062 and 0.064, while men’s matches show significantly lower R-values, from 0.049 to 0.053, indicating a lower level of predicted interest in men’s matches.

Table 1 also includes data from Masters 1000 tournaments, where matches are played in a best-of-three format with a tie-break in the final set. Interestingly, this format demonstrates a higher R-value of 0.064, compared to the lower R-values in the best-of-five-sets format of Grand Slam events. This suggests that the best-of-three format with a tie-break in the final set may offer a more engaging and

Dinh and Hiroyuki (2016) analysed a dataset of 9’616 matches from various tournaments, including 5’080 Grand Slam matches and 4’536 Masters tournament matches, to assess the appeal of tennis across different scoring systems. Their findings highlight the importance of optimising game speed and decision-making complexity to maintain a high level of spectator engagement.

dynamic experience for spectators, aligning with the optimal game refinement range of 0.07 to 0.08.

These findings show the impact of different scoring systems on the game’s sophistication and spectator engagement. This insight can be valuable for tournament organisers and governing bodies considering rule adjustments to enhance the sport’s appeal.

7. Discussion

Recent years have witnessed significant shifts in the tennis scoring system, particularly in doubles matches and exhibition tournaments. For example, the implementation of the no-ad rule in all doubles matches make a departure from traditional scoring conventions (Pollard & Pollard, 2010). Similarly, singles competitions have undergone modifications, as seen with the introduction of the Fast4 format at the Next Gen ATP Finals. In this format, matches are played with best-of-five sets, each played up to four games with a sudden death point at 40:40 (NEXT GEN ATP Finals, 2023). This format is specially designed to enhance the spectator experience by showcasing fast-paced matches and innovative scoring systems. The tournament aims to appeal to modern audiences who prefer shorter, more dynamic contests by implanting these changes, the Next Gen ATP Finals emphasises quick play and high-stakes points. This approach reflects a broader trend in sports to adapt to the evolving preferences of spectators.

These developments highlight a growing recognition of the need to adapt and refine the sport's scoring mechanisms. While these adjustments represent initial steps toward modernisation, there remains considerable room for further innovation to elevate the game's sophistication. This discussion explores various options for refining the international tennis scoring system, focusing on enhancing competitiveness, captivating spectators, and enriching the overall experience.

A critical aspect of strategy is the advantage of having two serves, allowing players to be more aggressive on their first serve, often resulting in easier points. The importance of the server is evident, as, on average only 0.28 ± 0.18 service breaks occur per game (Knight & O'Donoghue, 2012). One proposed solution to reduce this dominance is the elimination of the second serve (Sheridan, 2006). With only one serve permitted, players would need to balance the risk associated with their first serve, likely leading to longer rallies as powerful first serves become less frequent. This change could increase the quality of rallies and give the return player a greater opportunity to win points, fundamentally altering practice and strategy by shifting the focus from power to precision and reliability. Moreover, this adjustment could make matches more unpredictable and engaging, providing a more balanced and exciting contest.

Reflecting on the origins of the sport reveals an intriguing historical rule that provided a competitive advantage to lower-ranked players. As documented by Nanteuil et al. (1898), in the sport's early days, lower-ranked players received a scoring advantage based on their rankings. For example, a lower-ranked player might start certain games with a score advantage of 15:0, meaning they would only need to win three points to secure the game, while their higher-ranked opponent would need four. This system aimed to enhance fairness and complexity by levelling the playing field. Reintroducing such a rule today could offer lower-ranked players a better chance of defeating higher-ranked opponents, creating a narrative akin to the "David against Goliath" scenario and adding more excitement for spectators. This blend of tradition and contemporary gameplay could make early-round matches more engaging and unpredictable.

Pollard and Barnett (2018) explore innovative scoring systems designed to shorten the average match duration while enhancing the overall efficiency and excitement of each point. Their study proposes various new game structures that could revolutionise

the way matches are played and experienced. The no-ad game, an established scoring method, reduces match length but slightly diminishes the likelihood of the superior player winning compared to traditional scoring systems. Another innovative approach, the 30:00 advantage game, introduces deuce at 30:30, thereby further reducing the average points per match. Similarly, the 50:40 game, which requires the server to win one additional point than the receiver, helps to reduce the server's advantage (Pollard and Barnett, 2018).

Pollard and Barnett's (2018) research utilises both game theory and game refinement theory to evaluate new tennis scoring systems, focusing on metrics such as the average number of points played, scoring efficiency, and excitement per point. By applying game refinement theory, they highlight the importance of optimising the ratio between the average winning points and the total points played during the match (the speed of the game x). This theory posits that playing for fewer points, for example with the adoption of no-ad and 30:30 rules, heightens the stakes of each point, adding intensity and enhancing the match dynamics.

The evolving trends in scoring systems aim to introduce more critical moments into the game, effectively increasing the excitement and competitive tension. Game theory provides a robust framework for understanding these dynamics, offering insights into how rule changes can impact player strategies and match outcomes. By analysing the strategic interaction between players and the probabilistic outcomes to different systems, game theory helps to identify the most effective ways to balance fairness, excitement, and efficiency in matches.

Through comprehensive statistical analysis and the application of both game theory and game refinement theory, these innovations can be further developed to ensure the continued appeal and vitality of the sport in the future. Game refinement theory not only guides these developments but also provides a structured approach to optimising the spectator experience and enhancing the overall strategic depth of the sport. As the sport evolves, maintaining a balance between tradition and modernisation will be important in sustaining its global popularity and competitive spirit.

8. Conclusion

The analysis of international tournament rules through a game-theoretic perspective highlights a sport in a state of evolution, seeking to increase excitement while preserving tradition. Through our examination,

we identified the important role of the serve, the effects of rule adjustments on gameplay dynamics, and the promising potential of new scoring systems to elevate competitiveness and spectator engagement.

Future research should delve deeper into the statistical impact of these new rules, providing a clearer understanding of how they influence match outcomes and player strategies. Additionally, continued exploration of game refinement theory could offer future insights into optimising the balance between game duration and excitement, ensuring that tennis remains both challenging for players and captivating for fans.

As tennis continues to evolve, embracing innovation while honouring its heritage, it remains a captivating and dynamic sport at the forefront of athletic competition. This ongoing evolution not only shapes the future of the sport but also enhances its appeal to a global audience, making it increasingly accessible and enjoyable for fans around the world. By promoting an environment that values both tradition and modernity, tennis can maintain its prestigious status and continue to grow its fan base worldwide.

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ChatGPT was used to generate copy-editing suggestions for this article.

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