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RESEARCH ARTICLE

The Real Sabermetrics: A Game Theoretic Analysis of Women's Saber[1]

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Abstract

This paper analyzes real-world data on the fencing discipline of saber, applying a game theoretic framework and developing implications for saber actions, strategies, and mental training. This is the first paper to use competitive fencing data combined with a game theoretic approach to derive recommendations for strategic improvement. Results show that Olympic-level athletes systematically under utilize certain actions, such as initial movements that include retreats. I explore behavioral biases that might explain this and offer suggestions for training methods to address it.

1. Introduction

Fencing is one of the oldest Olympic sports, appearing in the inaugural modern Olympic games in 1896, and has its roots in real swordplay. The sport relies on strategy and quickness as vital components of a competitive bout and has been compared to physical chess.[2] Fencing, much like other sports, has a referee that calls the action. Each bout pits two opponents against each other. At the start of each point, the opposing fencers position themselves on their respective "en garde" lines, which are four meters apart on a surface known as "the strip," and wait for the referee's command to begin. On the referee's call of "allez," the point begins. The point ends when one fencer scores a touch.[3]

Within the sport of fencing, there are three weapons: foil, epee, and saber. Each weapon has its own target areas and strategies. In foil and epee, fencers can only score a point by hitting the opponent with the tip of their weapon, while in saber, fencers can use either the tip or the side of the weapon to score. In my analysis, I focus on saber, specifically women's saber. Saber is the most aggressive of the three weapons, and quickness is paramount to ensure success. Because saber's fast initial actions must be decided in advance of the referee's call to start fencing, the initial saber move lends itself to analysis as a simultaneous move game.

In this paper, I perform a game theoretic analysis of initial saber footwork grounded in the 2024 Olympic finals for women's saber. The goal is to analyze and understand, through the application of game theory and game theoretic thinking, the most effective initial moves to maximize the probability of winning the point. A key result of the analysis is that fencers appear to underappreciate the value of initial footwork that incorporates a retreat and instead overuse an initial action involving a full advance. Looking at the data in aggregate, there are clear moves that competitors can attach value to which will be more predictive of success. My methodology

[1] I thank Alex Beguinet, Aidan Cusack, Jacek Huchwajda, Leslie Marx, Stacey Swiantek, and Jeff Wilcox for helpful comments.

[2] See, e.g., "FITNESS: Fencing? Touché" by Cynthia Werthamer in The Washington Post, December 31, 1979 ("It's like playing physical chess"), p. D5.

[3] Double touches, whereby both fencers score, are possible in the discipline of epee, but not in saber, which is the focus of this paper.

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suggests a way for competitors to analyze and prepare for upcoming matches. Additionally, teams can use the methodology to analyze tendencies and prepare their own strategies and responses. Using my data, I identify a mixed strategy Nash Equilibrium for the teams competing in the 2024 Olympic final.

The approach of this paper has parallels to the "sabermetrics" used to evaluate player performance in baseball (James and Henzler, 2002)—but with metrics that are literally applied to saber. Other literature has examined mixed strategy equilibria in a sports context, including tennis (Bailey and McGarrity, 2012; Tea and Swartz, 2023; Walker and Wooders, 2001), and soccer (Monstad, 2023). Broadie (2012) performs an empirical analysis of golf that highlights the importance of the long game. These analyses focus on single components of a sport. For instance in tennis, the literature examines the serve, which initiates the point, to understand how game theory applies to it. In soccer, the focus is on the penalty kick, which is not as vital and more rare but lends itself to analysis through game theory. Fencing has been studied by Guerss and Ibrahimi (2024), but only in the abstract and without connecting with data from actual matches. They model the decision to attack or defend as a prisoner's dilemma, with attacking as the unique Nash equilibrium. As a result, their basic conclusion that being on the attack is preferential is not grounded in data and is overly stylized. To my knowledge, my paper is the first game theoretic analysis of fencing that draws from Olympic performance data. Some aspects of saber have been likened to a game of rock-paper-scissors, which is analyzed in Loertscher (2013).[4] This comparison has been made mainly because both games require the players to make choices simultaneously upon the start of the action, and also because there are multiple rounds, so there is opportunity for the players to learn and make changes to their overall strategy.

In order to make progress analyzing key aspects of a fencing bout, I set aside much of the complexity of the game and consider one small aspect of the game, the initial footwork at the beginning of a point. While this is, of course, a massive simplification, the aspect that I study remains an important part of the game and one worthy of independent study. My focus on saber in particular aims to build on this simultaneous choice because the resolution of the point is often determined very quickly after the initial actions.

The remainder of the paper is as follows: In Section 2, I describe the data and methods, and I provide some basic statistics. In Section 3, I provide a game theoretic analysis and results. In Section 4, I discuss implications, and then in Section 5, I conclude.

2. Data and Methods

I use publicly available video of the 2024 Olympic team final for women's saber between Ukraine and South Korea to hand collect data on the first and second footwork actions for each point in the team final. The team final involved 87 points, with Ukraine winning with a score of 45-42. For each point, I record the first and second footwork action of each fencer, as well as which fencer won the point. The data table is provided in the appendix.

I identify four initial movements: advance (A), retreat (R), small-advanceadvance (SAA), and small-advance-retreat (SAR). Note that for my analysis, I consider SAA and SAR as single movements and not two independent movements. This is because the SAA involves a quick stutter step forward that combines with a subsequent additional advance, and the SAR involves a quick "check step" forward with the one foot followed by a retreat. In both cases, the underlying footwork movements combine to make one action, and so are naturally analyzed as being one choice by the athlete.

It is notable that the fencers almost never use R as their first movement. As a result, in the analysis of Section 3, I omit the action R. As shown in Tables 1 and 2, both Ukraine and South Korea employ a full advance as their initial footwork approximately 75% of the time, with the remainder roughly equally split between SAA and SAR.

Table 1. *Counts of initial actions.*

	A	R	SAA	SAR
UKR	64	1	10	12
KOR	66	0	11	10

[4]Loertscher (2013) analyses a setup in which uniform randomization, i.e., 1/3–1/3–1/3, across rock, paper, and scissors, is an evolutionarily stable strategy, which roughly speaking, reinforces the need to randomize and be unpredictable in that game.

Table 2. *Percentages of initial actions*

	A	R	SAA	SAR
UKR	74%	1%	11%	14%
KOR	76%	0%	13%	11%

3. Analysis and Results

I employ two approaches for my game theoretic analysis. In the first approach, I pool the data from both of the teams to construct a game table showing the probability of winning the point based on the initial footwork action chosen by each player. This pooled approach treats all fencers equally and looks at their initial footwork choices. This data allows for the calculation of optimal mixed strategies. In the second approach, I maintain the separation of the two teams' data and provide an analysis of optimal randomization by each side.

3.1 Pooled data

Analysis of the pooled data shows that the small-advance-retreat (SAR) is the dominant strategy. Both players using SAR achieve the unique Nash Equilibrium. This is evident in the game table shown in Figure 3. If fencer 1 chooses SAR, then fencer 2 maximizes its probability of scoring by also choosing SAR, and vice versa.

To analyze the relative advantage of SAR, note that when facing an opponent that is randomizing according to 75% A, 12.5% SAA, and 12.5% SAR, then the choice of A scores with probability 43.5%, the choice of SAA scores with probability 67.5%, and the choice of SAR scores with probability 71.4%.

Table 3. *Payoff table based on pooled data.*

		Fencer 2		
		A	SAA	SAR
Fencer 1	A	(0.5, 0.5)	(0.25, 0.75)	(0.231, 0.769)
	SAA	(0.75, 0.25)	(0.5, 0.5)	(0.4, 0.6)
	SAR	(0.769, 0.231)	(0.6, 0.4)	(0.5, 0.5)

Thus, the two actions beginning with a small advance outperform the full advance.

3.2 Team-Based Data

Maintaining the separation of the teams' data, one can formulate the game played by the two teams. In this case, as shown in Table 4, the payoffs are not symmetric, reflecting that the Ukrainian and Korean teams have slightly different skills.

Table 4. *Payoff table for team-based data.*

		KOR		
		A	SAA	SAR
UKR	A	(0.52, 0.48)	(0.67, 0.33)	(0.14, 0.86)
	SAA	(1, 0)	(0, 1)	(1, 0)
	SAR	(0.67, 0.33)	(0.75, 0.25)	(0, 1)

In this game, there is no pure-strategy equilibrium. There is a mixedstrategy equilibrium in which UKR uses the strategy of A with probability 65% and SAA with probability 35% (and never uses SAR). As a best-response to this, KOR uses a strategy of SAA with probability 56% and SAR with probability 44% SAR (and never uses A). In this mixed-strategy equilibrium, UKR has expected payoff of 0.44 and KOR has expected payoff of 0.56. This equilibrium suggests that UKR should focus on more aggressive forward-motion strategies, while KOR should emphasize actions beginning with a small advance.

To see that we have a Nash equilibrium, note that under their Nash equilibrium strategies, UKR wins the point with probability 44% with A, 44% with SAA, and 42% with SAR. As required, UKR's payoffs are the same for the two actions over which it mixes and lower for action not employed in the equilibrium.

Analogously, under the Nash equilibrium strategies, KOR wins points with the following probabilities: 31% with A, 56% with SAA, and 56% with SAR. Again, KOR's payoffs are the same for the two actions over which it mixes and lower for the other action.

Based on this analysis, the advice to UKR would be to focus on A and SAA. And the advice to KOR would be to always start with a short advance. KOR should be using the large advance much less often than they are.

This type of analysis could provide a framework for team preparation, allowing, say UKR, to employ a more aggressive strategy and KOR to make a more defensive minded approach. This type of analysis could help teams to identify tendencies and strengths of opponents, as well as potential counter responses.

3.3 Effects of the Second Movement

Analyzing fencers' second movements, we learn that an aggressive quick follow up advance can win points, but a retreat can also yield good results as well. Looking beyond the initial movement, it is interesting to look at the winner's second move (M2). In 57 out of the 87 points (66%), the winner's M2 was an advance. Of these 57 points, 28 were won by Fencer 1, with 23 of those preceded with an initial action of advance. The other 29 were won by Fencer 2 with 21 of those preceded with an initial advance. This suggests that once a fencer commits to an aggressive first step, with both footwork and body language, continuing with another advance remains a highly effective strategy. In 19 of the 87 points (22%), the winner's M2 was a retreat. While less common, retreating as a second move can also win points, when used selectively.

This analysis of the second move suggests that an aggressive follow up, particularly as the second advance tends to be successful. However, the data also demonstrate that a retreat as a second move is not disadvantageous when well-timed. The retreat can be effective to win points, challenging a common belief that saber should always be played in a forward manner.

4. Strategic and Training Implications

In this section, I discuss implications for how saber fencers can productively adjust strategies, mental attitudes, and training methods.

After analyzing the fencers' movements, there are also multiple practical lessons that can be gleaned for both individual fencers and teams. While the data reveal advantages to aggressive sequences, the value of a retreat or a small-retreat combination is also shown. Translating these insights into practice spans at least three areas: strategic choices during competition, mental approaches to risk and defense, and training methods that contribute to both. The following outline provides guidance for how fencers and coaches could productively incorporate these findings into preparation and competitive bouts.

4.1 Adjust Strategies

- Reduce overuse of Advance and focus more on Small Advance sequences (SAA or SAR).
- Increase SAR use.
- Examine results based on initial strategies and adjust.
- Understand more clearly that aggressive M2 strategies win more points.

4.1 Mental Attitudes

- Accept the idea of a small advance as an initial move and value it.
- Overcome a fear of defense and utilize a SAR strategy more.
- Focus on first and second movements jointly rather than each individually.

4.2 Training Methods

- Practice SAR and SAA drills.
- During practice, use mixed strategies to see how your opponent responds without consequences.
- Utilize video analysis not just for technique but for strategy.
- Develop advanced scouting on opponents to understand which strategies they are likely to employ and then make a plan based on that.
- Track individual results based on sequences that are used in a given bout.

5. Conclusion

In summary, this paper collects data and analyzes Olympic level fencing data within a game theoretic framework and develops implications for saber strategy, mental training, and preparation. This is also the first paper to apply game theoretic analysis to actual fencing data rather than hypothetical play, consequently resulting in recommendations for strategic improvement.

The results could, of course, be extended to larger data sets. Future research might examine matches with larger score differentials (blowouts) to see which strategies consistently drive dominant victories, as well as what strategies teams or individuals can use to shift prospective outcomes.

By treating fencing as a simultaneous move game, this paper demonstrates the value of game theoretic

analysis for one of the oldest Olympic sports. The framework developed here not only sheds light on the dynamics of saber but also shows a model for how strategy and analytics can inform preparation, decision making, and performance in high level competition.

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A. Appendix

Data were hand collected based on the 2024 Women's Team Saber Olympic Final, which is available at https://www.olympics.com/en/video/kor-ukr-womens-sabre-team-gold-medal-match-fencing-olympic-games-paris-2024 (accessed August 31, 2025).

Table 5. *2024 Women's Team Saber Olympic Final: UKR vs KOR*

Bout	Point	Fencer 1	Fencer 2	Winner of Point	F1 M1	F2 M1	F1 M2	F2 M2
1	1	O. Kharlan	Jeon E.	Fencer 1	Advance	Advance	Small Adv Advance	Small Adv Retreat
1	2	O. Kharlan	Jeon E.	Fencer 2	Advance	Advance	Small Adv Retreat	Small Adv Retreat
1	3	O. Kharlan	Jeon E.	Fencer 1	Advance	Advance	Small Adv Retreat	Small Adv Advance
1	4	O. Kharlan	Jeon E.	Fencer 1	Advance	Small Adv Retreat	Advance	Retreat
1	5	O. Kharlan	Jeon E.	Fencer 1	Small Adv Retreat	Small Adv Advance	Retreat	Advance
1	6	O. Kharlan	Jeon E.	Fencer 2	Advance	Small Adv Retreat	Advance	Retreat
1	7	O. Kharlan	Jeon E.	Fencer 2	Advance	Small Adv Retreat	Advance	Advance
1	8	O. Kharlan	Jeon E.	Fencer 1	Small Adv Advance	Advance	Retreat	Small Adv Retreat
2	1	Y. Bakastova	Jeon H.	Fencer 1	Small Adv Retreat	Small Adv Advance	Advance	Retreat
2	2	Y. Bakastova	Jeon H.	Fencer 2	Small Adv Retreat	Small Adv Retreat	Advance	Advance
2	3	Y. Bakastova	Jeon H.	Fencer 2	Small Adv Retreat	Small Adv Retreat	Small Adv Advance	Advance
2	4	Y. Bakastova	Jeon H.	Fencer 2	Advance	Advance	Advance	Advance
2	5	Y. Bakastova	Jeon H.	Fencer 1	Small Adv Retreat	Advance	Retreat	Advance

2	6	Y. Bakastova	Jeon H.	Fencer 1	Advance	Advance	Advance	Advance
2	7	Y. Bakastova	Jeon H.	Fencer 2	Advance	Small Adv Advance	Advance	Retreat
2	8	Y. Bakastova	Jeon H.	Fencer 2	Small Adv Retreat	Small Adv Advance	Retreat	Advance
2	9	Y. Bakastova	Jeon H.	Fencer 2	Advance	Advance	Advance	Advance
2	10	Y. Bakastova	Jeon H.	Fencer 2	Small Adv Retreat	Advance	Retreat	Advance
2	1	A. Komashchuk	Choi S.	Fencer 1	Small Adv Retreat	Small Adv Advance	Retreat	Advance
2	2	A. Komashchuk	Choi S.	Fencer 1	Small Adv Advance	Advance	Advance	Retreat
3	3	A. Komashchuk	Choi S.	Fencer 1	Advance	Advance	Advance	Advance
3	4	A. Komashchuk	Choi S.	Fencer 2	Small Adv Advance	Small Adv Advance	Advance	Advance
3	5	A. Komashchuk	Choi S.	Fencer 1	Small Adv Advance	Small Adv Retreat	Advance	Advance
3	6	A. Komashchuk	Choi S.	Fencer 1	Small Adv Retreat	Advance	Retreat	Advance
3	7	A. Komashchuk	Choi S.	Fencer 2	Advance	Advance	Advance	Advance
3	8	A. Komashchuk	Choi S.	Fencer 2	Advance	Advance	Advance	Advance
3	9	A. Komashchuk	Choi S.	Fencer 2	Advance	Advance	Retreat	Advance
3	10	A. Komashchuk	Choi S.	Fencer 2	Advance	Advance	Retreat	Advance
3	1	Y. Bakastova	Jeon E.	Fencer 2	Advance	Small Adv Retreat	Advance	Retreat
3	2	Y. Bakastova	Jeon E.	Fencer 2	Small Adv Advance	Small Adv Advance	Advance	Advance
4	3	Y. Bakastova	Jeon E.	Fencer 2	Small Adv Advance	Small Adv Advance	Retreat	Advance
4	4	Y. Bakastova	Jeon E.	Fencer 1	Advance	Advance	Advance	Retreat
4	5	Y. Bakastova	Jeon E.	Fencer 2	Advance	Advance	Advance	Small Adv Retreat
4	6	Y. Bakastova	Jeon E.	Fencer 2	Advance	Small Adv Retreat	Advance	Retreat
5	1	O. Kharlan	Choi S.	Fencer 2	Small Adv Retreat	Advance	Retreat	Advance
5	2	O. Kharlan	Choi S.	Fencer 1	Small Adv Advance	Advance	Advance	Retreat
5	3	O. Kharlan	Choi S.	Fencer 1	Advance	Advance	Retreat	Advance
5	4	O. Kharlan	Choi S.	Fencer 2	Advance	Advance	Advance	Advance
5	5	O. Kharlan	Choi S.	Fencer 1	Advance	Advance	Retreat	Advance
5	6	O. Kharlan	Choi S.	Fencer 1	Advance	Advance	Advance	Advance
5	7	O. Kharlan	Choi S.	Fencer 1	Small Adv Retreat	Advance	Advance	Advance
5	8	O. Kharlan	Choi S.	Fencer 2	Advance	Advance	Retreat	Advance
5	9	O. Kharlan	Choi S.	Fencer 1	Advance	Advance	Advance	Advance
5	10	O. Kharlan	Choi S.	Fencer 1	Advance	Advance	Advance	Small Adv Retreat
5	11	O. Kharlan	Choi S.	Fencer 1	Advance	Advance	Advance	Advance

5	12	O. Kharlan	Choi S.	Fencer 1	Advance	Advance	Advance	Advance
5	13	O. Kharlan	Choi S.	Fencer 2	Advance	Advance	Retreat	Advance
5	14	O. Kharlan	Choi S.	Fencer 2	Advance	Advance	Advance	Advance
6	1	A. Komashchuk	Jeon H.	Fencer 2	Advance	Small Adv Retreat	Advance	Retreat
6	2	A. Komashchuk	Jeon H.	Fencer 1	Advance	Small Adv Advance	Advance	Retreat
6	3	A. Komashchuk	Jeon H.	Fencer 2	Advance	Advance	Advance	Small Adv Retreat
6	4	A. Komashchuk	Jeon H.	Fencer 1	Advance	Advance	Retreat	Advance
6	5	A. Komashchuk	Jeon H.	Fencer 2	Small Adv Advance	Small Adv Advance	Retreat	Advance
6	6	A. Komashchuk	Jeon H.	Fencer 1	Small Adv Retreat	Advance	Advance	Advance
6	7	A. Komashchuk	Jeon H.	Fencer 2	Advance	Advance	Advance	Advance
6	8	A. Komashchuk	Jeon H.	Fencer 1	Small Adv Advance	Advance	Retreat	Advance
6	9	A. Komashchuk	Jeon H.	Fencer 1	Advance	Advance	Small Adv Retreat	Advance
6	10	A. Komashchuk	Jeon H.	Fencer 2	Advance	Advance	Advance	Advance
7	1	Y. Bakastova	Choi S.	Fencer 1	Advance	Advance	Advance	Advance
7	2	Y. Bakastova	Choi S.	Fencer 2	Retreat	Advance	Retreat	Advance
7	3	Y. Bakastova	Choi S.	Fencer 1	Advance	Advance	Advance	Advance
7	4	Y. Bakastova	Choi S.	Fencer 1	Advance	Advance	Advance	Advance
7	5	Y. Bakastova	Choi S.	Fencer 2	Advance	Advance	Advance	Advance
7	6	Y. Bakastova	Choi S.	Fencer 1	Advance	Advance	Advance	Advance
7	7	Y. Bakastova	Choi S.	Fencer 2	Advance	Advance	Advance	Retreat
7	8	Y. Bakastova	Choi S.	Fencer 2	Advance	Advance	Advance	Advance
7	9	Y. Bakastova	Choi S.	Fencer 1	Small Adv Advance	Advance	Retreat	Advance
7	10	Y. Bakastova	Choi S.	Fencer 2	Advance	Advance	Advance	Advance
8	1	A. Komashchuk	Jeon E.	Fencer 1	Advance	Small Adv Advance	Advance	Retreat
8	2	A. Komashchuk	Jeon E.	Fencer 1	Advance	Advance	Small Adv Retreat	Small Adv Retreat
8	3	A. Komashchuk	Jeon E.	Fencer 2	Advance	Advance	Retreat	Small Adv Advance
8	4	A. Komashchuk	Jeon E.	Fencer 2	Advance	Advance	Advance	Advance
8	5	A. Komashchuk	Jeon E.	Fencer 1	Advance	Advance	Small Adv Retreat	Advance
8	6	A. Komashchuk	Jeon E.	Fencer 2	Advance	Small Adv Retreat	Advance	Retreat
8	7	A. Komashchuk	Jeon E.	Fencer 1	Advance	Advance	Retreat	Advance
8	8	A. Komashchuk	Jeon E.	Fencer 2	Advance	Advance	Advance	Small Adv Retreat
8	9	A. Komashchuk	Jeon E.	Fencer 2	Advance	Advance	Small Adv Retreat	Advance
9	1	O. Kharlan	Jeon H.	Fencer 1	Advance	Advance	Advance	Advance
9	2	O. Kharlan	Jeon H.	Fencer 1	Advance	Advance	Advance	Advance

9	3	O. Kharlan	Jeon H.	Fencer 1	Advance	Advance	Retreat	Advance
9	4	O. Kharlan	Jeon H.	Fencer 2	Advance	Advance	Retreat	Advance
9	5	O. Kharlan	Jeon H.	Fencer 2	Advance	Advance	Advance	Advance
9	6	O. Kharlan	Jeon H.	Fencer 1	Advance	Advance	Advance	Advance
9	7	O. Kharlan	Jeon H.	Fencer 1	Advance	Advance	Advance	Small Adv Retreat
9	8	O. Kharlan	Jeon H.	Fencer 2	Advance	Advance	Advance	Small Adv Retreat
9	9	O. Kharlan	Jeon H.	Fencer 1	Advance	Advance	Advance	Small Adv Advance
9	10	O. Kharlan	Jeon H.	Fencer 1	Advance	Advance	Advance	Advance