The Predicted Effect of Torpedo Bats in the MLB

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1. Introduction

To begin the 2025 Major League Baseball (MLB) season, a major controversy has caught league-wide headlines, the torpedo bat. Former MIT physicist Aaron Leanhardt is credited with driving the new bat design. Still adhering to MLB dimension rules, the atypical design shifts the largest section of the bat, the barrel, downwards towards the shaft (figure 1). The benefit of the torpedo-like shape is increased bat speed and a higher rate of swings resulting in contact with the barrel. The implications of this emerging technology on the MLB are not well understood. Some players have been quick to adopt the new bat, citing up to 3mph of free velocity without changing swing mechanics. Others are calling for it to be banned. With the future of its adoption uncertain, this project will aim to identify players that will benefit most from the bat's benefits. These insights may inform and alter the perception of player potentials moving forward.

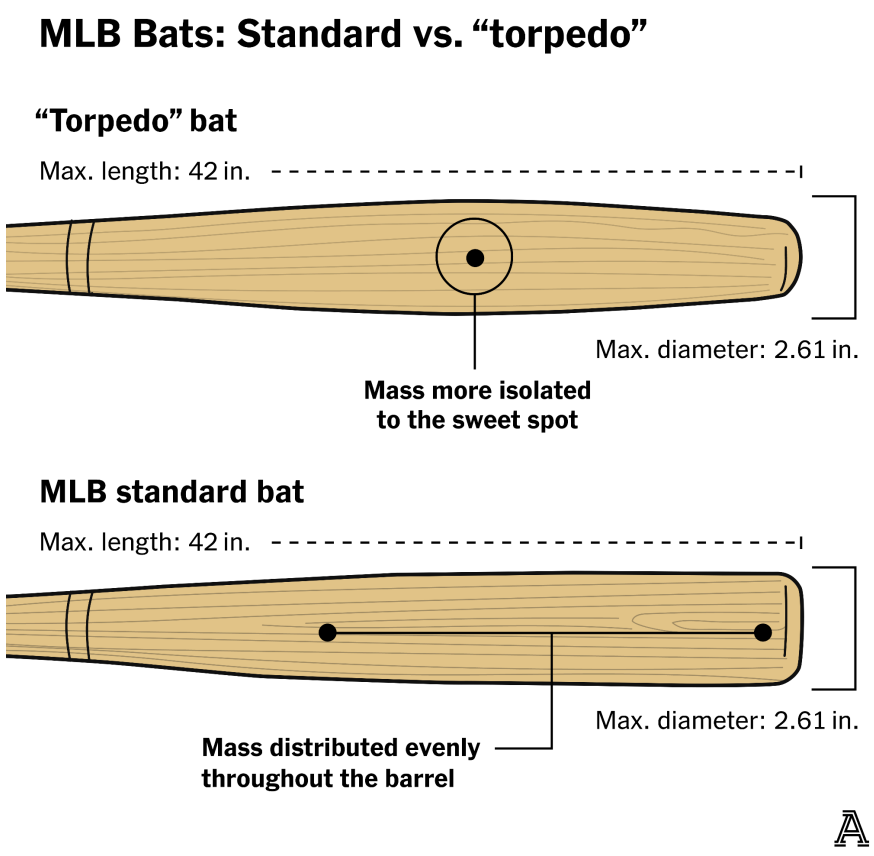

Figure 1: Torpedo bat versus standard (Kuty, 2025)

2. Methodology

Major League Baseball has comprehensive, publicly available data of player performance metrics and outcomes. The website Baseball Savant is a comprehensive database powered by Statcast, a Google project that utilizes triangulation through high-speed cameras to provide real-time data on dozens of metrics. In 2024, player bat speed was added to the measured outcomes, unlocking numerous statistics regarding hitting success. This data can be evaluated to find correlations between player metrics and overall success, feeding into training approaches and team strategy. In the baseball world, this is referred to as sabermetrics. This project will utilize sabermetrics available through Baseball Savant's Custom Leaderboards to analyze which players will experience the most improvement from torpedo bats.

Torpedo bats can increase squared-up rate and swing speed, leading to an increase to a player's batting success. Batting success will be defined as xwOBA. The "x" in xwOBA stands for expected, which normalizes batted ball outcomes using machine learning algorithms to factor out luck and better represent player skill. Weighted on-base average (wOBA) is calculated as:

"wOBA: (unintentional BB factor x unintentional BB + HBP factor x HBP + 1B factor x 1B + 2B factor x 2B + 3B factor x 3B + HR factor x HR)/(AB + unintentional BB + SF + HBP), where 'factor' indicates the adjusted run expectancy of a batting event in the context of the season as a whole." (MLB).

The aim of this study is to use historical bat tracking data to determine what profile of player would gain the most from using a torpedo bat.

Assumptions:

- Torpedo bats will improve quality of contact without impacting strikeouts or walks.
- The use of the bats will increase bat speed without impacting the quantity of contact between bats and balls.

Given that the perceived benefit of torpedo bats in increased bat speed without alteration of contact quality, average bat speed and squared up per swing percentage will be used. Average bat speed is calculated by averaging the speed of all competitive swings over the course of a season, which omits outliers from events such as bunts or check-swings. Squared up percentage

is a metric that can be used to represent quality of contact. According to the MLB, “a swing’s squared-up rate tells us how much of the highest possible exit velocity available (based on the physics related to the swing speed and pitch speed) a batter was able to obtain – it is, at its simplest, how much exit velocity did you get as a share of how much exit velocity was possible based on your swing speed and the speed of the pitch”. Any ball that is at least 80% squared up is considered a squared up ball. It is important to use squared up percentage since it normalizes bat speed and allows for a multiple regression with increased bat speed.

2.1 Research Questions

- How much would increased bat speed improve batter success?
- Would torpedo bats make a noticeable impact on batter success?
- What types of players would benefit the most from adoption of the torpedo bat?

2.2 Prototyping and Development

If squared up rate and bat speed are correlated with xwOBA**,** then the bats should have a positive effect. The positive effect will not be universal among hitters, though. By running a predictive model, increasing average swing speed by three miles per hour, a predictive xwOBA can be calculated. Players can then be sorted by predicted xwOBA improvement. Analysis of the most positively impacted players will reveal the profile of batters that will gain the most from torpedo bat use.

2.3 Hypothesized Relationships and Considerations

Torpedo Bats → Increase Bat Speed and Maintain Squared-Up Rate → Increase xwOBA

Correlations:

Bat Speed and xwOBA

Squared-Up Rate and xwOBA

To check for multicollinearity:

Bat Speed and Squared Up Rate

Regression to test:

xwOBA = b1Bat_speed + b2Squared_Rate + error

3. Results

The multiple regression of bat speed and squared up rate show a strong correlation between the two variables and xwOBA. This graph is shown in figure 2. Once bat speed was increased by three miles per hour, the expected change in xwOBA was calculated for all players. The top ten risers are shown in figure 3 and the top ten fallers are shown in figure 4. From the top ten risers, additional peripheral stats were compared to league average to investigate what the profiles of these players look like. The findings from this investigation are shown in figure 5.

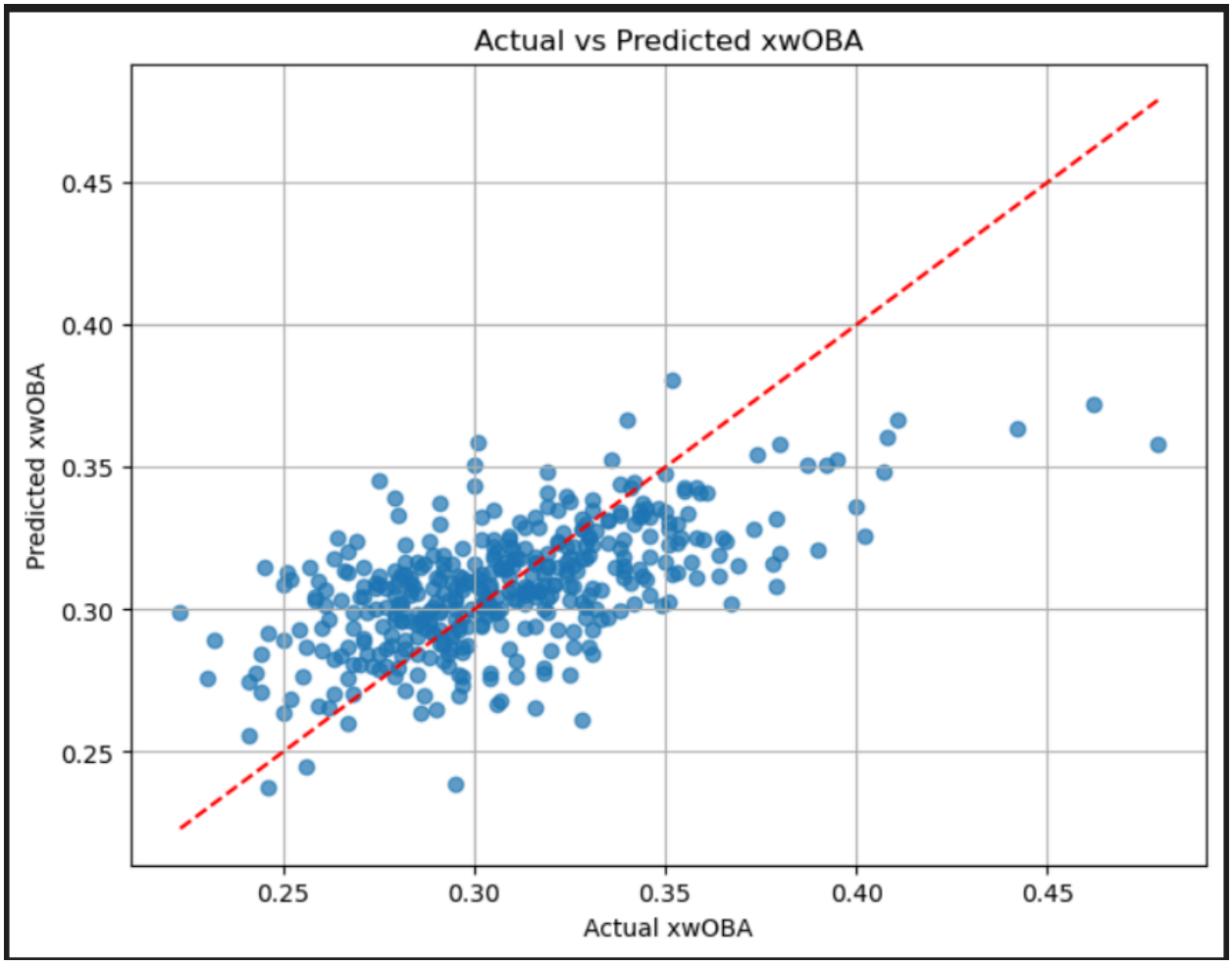

Figure 2: Predicted xwOBA from Regression vs Actual xwOBA from MLB season

	last_name, first_name	# xwoba	# xwoba_gain_3mph
138	Jackson, Alex	0.223	0.10342632930901643
281	Walker, Jordan	0.275	0.0980668374831295
240	Fortes, Nick	0.245	0.0975716686866614
33	Ramírez, Harold	0.251	0.08981495513746768
46	Báez, Javier	0.264	0.08909255177700987
373	Hayes, Ke'Bryan	0.279	0.08809182231755436
130	Rojas, Johan	0.25	0.08634198408015459
254	Duran, Ezequiel	0.252	0.08622509315945498
27	Caminero, Junior	0.301	0.08554941801530164
206	Rosario, Eddie	0.257	0.08529118910476563

Figure 3: Ten players with most xwOBA added

	last_name, first_name	# xwoba	# xwoba_gain_3mph
408	Pederson, Joc	0.378	-0.03433316231707895
90	Tucker, Kyle	0.4	-0.03602301998569901
205	Freeman, Freddie	0.367	-0.03750309754314912
327	Turner, Justin	0.328	-0.03879581589751713
238	Seager, Corey	0.39	-0.0413075224128428
298	Carpenter, Kerry	0.379	-0.04314701740653559
159	Ozuna, Marcell	0.402	-0.048508863427855986
45	Ohtani, Shohei	0.442	-0.05091394356715245
212	Soto, Juan	0.462	-0.06209439698263308
188	Judge, Aaron	0.479	-0.09337414710507336

Figure 4: Ten players with most xwOBA lost

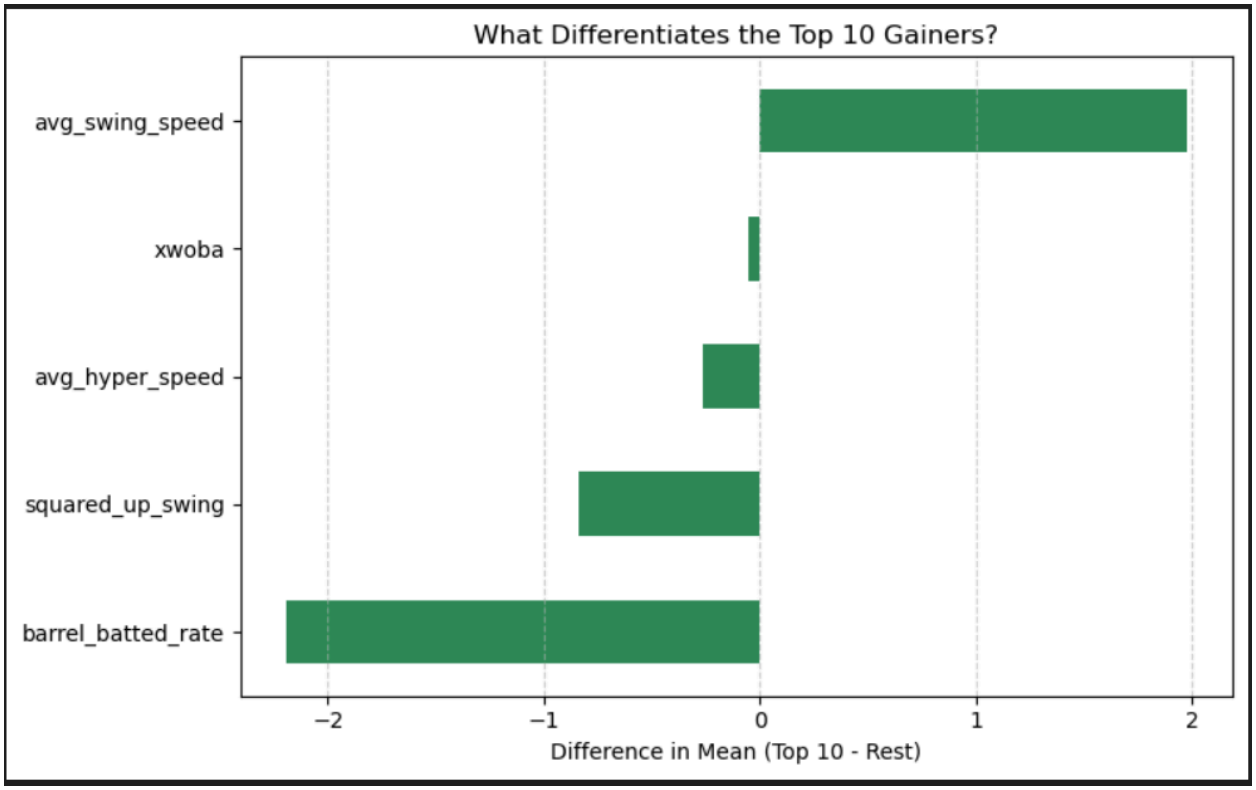

Figure 5: Average profile of the ten players with most xwOBA added compared to League Average

4. Discussion

The findings of the model indicate that players who swing close to as hard as they can, often, but lack above average top bat speed have the most to gain from using torpedo bats. The top ten risers have better average bat speed than most MLB players. However, the 90th percentile swing speed, i.e. how fast their fastest swing is, is below league average. Furthermore, the squared up rate and barrel rate of these players is well below league average. These players are sacrificing quality of contact to swing aggressively, with little success. The implementation of the torpedo bat will improve average wing and may allow these players to ease off their swing aggression, leading to better contact and improved success.

The conclusion of this project could be used for teams to decide which players they should encourage to use torpedo bats to increase production and wins, drawing more value out of their players and rosters. Identifying players with the aforementioned profile could prove useful in improving performance of rostered players or signing players to below-market contracts based on the production that could be generated from torpedo bat implementation.

There were a few limitations and recommendations for future improvements of the model. The model assumed that there would be no change to the quality of contact given the improvement in bat speed. In the real world, this is unlikely to be true. Any change would likely result in altered batted ball outcome, especially if the increase in speed changes batter approaches. Furthermore, the regression was assumed to be linear. Based on observation of the scatterplot, the data is likely logarithmic with a plateau of diminishing returns for increased bat speed and xwOBA. This would explain why excellent batters, like Aaron Judge, are projected to decrease xwOBA with increased bat speed. The model believes that they are already too good at making consistent, quality contact given how hard they swing the bat. Adjusting the model should more accurately reflect player outcomes. Further refinement can be done once a larger sample size is created during the current season. Player performance with and without torpedo bat usage will demonstrate their effectiveness and can be analyzed to see if their profile corresponds to what the model predicts.

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