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Jack McCullar

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“How has the foreign substance ban implemented by the MLB affected
MLB Pitcher Spin Rate and Opponent Batting Statistics in 2021? Was it effective?”

Jack McCullar

The University of Puget Sound, Tacoma, WA, USA

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Abstract

This study analyzes the effects of the MLB foreign substance ban on pitcher spin rates and batting averages with different pitches. During the 2019-2020 and 2020-2021 MLB seasons, pitchers throughout the league were accused of putting pine tar, Spider Tack, and other banned substances onto baseballs in order to create an artificially high spin rate. A higher spin rate makes hitting much harder and batters tend to strike out much more often. These factors contributed to a reduction in runs scored per game and generated frustrated fans. Consequently, the MLB implemented a substance ban in 2021 over concern that interest in the sport was declining. This study was conducted to determine if spin rates decreased on specific pitches such as fastballs, curveballs, sliders, and change-ups after the substance ban was implemented and if the increase in pitched ball spin rates correlated with a decline in opponent hitting statistics. To determine the answers, 12 regressions were run, first on opponent batting average before and after the implementation of the foreign substance ban, pitcher spin rates before and after the implementation of the ban, and lastly, on regressed spin rates on a collection of hitting statistics to determine if there is any correlation. Four types of pitches were selected to provide a more comprehensive analysis to determine how the ban affected the spin rates and batting averages against each pitch type as well as if the ban was effective. It was discovered that average spin rates experienced a statistically significant drop in every pitch after the implementation of the foreign substance ban, however, batting averages only had a statistically significant change against fastballs after the foreign substance ban was implemented, which is not the increase that was expected. However, it appears that the foreign substance ban is doing its job to deter pitchers from utilizing foreign substances.

1. Introduction

In Major League Baseball (MLB), pitchers have been utilizing foreign substances to their advantage since the game was invented. According to Lindberg (2021), about 70 percent of pitchers were using something illicit, in reference to the persistent problem occurring in Major League Baseball long before the foreign substance ban in 2021. Pitchers use substances such as sweat, saliva, rosin, sunscreen, and pine tar on their throwing hand to create more spin on the pitch, particularly on their fastballs and breaking balls. These substances help to generate more friction on the ball as it leaves the hand of the pitcher, increasing the spin rate of the thrown ball.

Why does increasing the spin rate on pitches matter? When a pitch has a high spin rate, it is more difficult for a hitter to hit in two significant ways. First, when a pitch has a high spin rate, the ball will appear to move abnormally in the eyes of the hitter. When a fastball has a higher spin rate, the pitch will appear to rise, and a breaking ball will have a sharper bite to its break or “curve” when pitched. These differences make hitting more difficult because pitches with abnormally high spin rates move in a way that hitters are not familiar with. One way a hitter is able to discern which pitch is being thrown at them is by recognizing the specific spin on the pitch. A hitter discerns the spin on a pitch by being able to read the way the seams on the baseball are moving in the air. This leads to the second rationale for desiring higher spin rates: when the ball is spinning faster, it is more challenging to recognize the spin on the pitch, making it more difficult for hitters to predict where the ball will be when it enters the hitting zone. This can be reflected in lower batting statistics, such as batting average. Pitchers want to increase their spin rates because it gives them an advantage over hitters by making it harder for them to hit the

ball. Consequently, the increase in spin rate is believed to have contributed to a record high number of strikeouts and record low batting averages across Major League Baseball.

In the past, the strategy for success in baseball was for a team to generate consecutive hits and walks in order to score and win games. Today however, we observe a different style of game play. Pitchers are dominating hitters, recording the most strikeouts and no-hit games on a per season basis in MLB history, and hitters have been recording some of the worst batting averages on a per season basis in MLB history. Due to today's pitchers being undeniably dominant, a large share of hitters approach the plate with one goal in mind: swing as hard as they can, hope to make solid contact, and try to hit a home run. This strategy has led to decreased interest in the sport because viewers tend to enjoy when more balls are put into play. Today, spectators often observe a home run or a strikeout, which can be unappealing when hitters are consistently dominated.

This is the leading concern for Major League Baseball since their revenue is based upon the number of fans who follow the sport. If baseball is unappealing to watch, the sport will have fewer fans, resulting in less revenue. In an effort to make baseball less “boring” and increase the popularity of the sport, the MLB implemented a substance ban midway through the 2021 season, which included more aggressive monitoring and enforcement procedures. This ban prevents pitchers from using foreign substances when they pitch in an effort to level the playing field between hitter and pitcher, as well as bring back a more attractive and exciting form of baseball for fans. The MLB imposed this ban and monitoring procedures on June 21, 2021, requiring that after every inning a pitcher pitches, umpires must check pitchers gloves, hands, and belts for foreign substances. If caught, pitchers shall be immediately ejected and suspended for ten games.

The goal of this ban was to lower MLB pitcher spin rates and raise batting averages up to a normal level, in an effort to increase popularity in the sport. The MLB has had foreign substances like pine tar banned since 1920, but the ban of any foreign substance was not strictly enforced until 2021.

Did this ban make a significant difference in spin rates and batting averages in Major League Baseball? Katz, Quealy, and Kepner (2021) provide evidence of a decrease in fastball spin rate subsequent to the substance ban in 2021. This study examines this finding and, in addition, aims to determine if spin rates of multiple pitch types exhibit a statistically significant change, as well as if batting statistics have a negative correlation with MLB pitcher spin rates.

This study expands the scope of the literature to determine if the substance ban actually made a difference in MLB spin rates by finding how opponents' batting statistics were affected by the foreign substance ban. The pitches included in this study are fastballs, curveballs, sliders, and change-ups. This study estimates 12 regressions, three per pitch. This differs from current literature because current literature does not find the effects of the foreign substance ban on spin rates of multiple pitches and opponents' batting statistics.

This gap in current literature leads to the question of how the foreign substance ban implemented by the MLB in 2021 affected MLB Pitcher Spin Rate and Opponent Batting Statistics and if the ban was effective, meaning that the foreign substance ban was able to lower pitcher spin rates and in turn lead to the increase of batting averages. In answering these questions, this study determines if the substance ban was effective or not, and subsequently finds supportive evidence for spin rates being negatively correlated with hitting statistics. In order to determine if the foreign substance ban had an effect on spin rates, this study looks at average

Major League Baseball spin rates of different pitches from before and after the ban was implemented during the 2021 season. The null hypothesis of this study is that the foreign substance ban has no effect on spin rates or batting averages.

2. Literature Review

What is spin rate and how do higher spin rates affect pitches?

In order to determine if the foreign substance ban implemented by the MLB has made a difference in pitcher spin rates and opponent batting statistics, we must first understand what spin rates are. Knuppel (2021) defines spin rate as the rate of spin on a baseball out of the pitcher's hand measured in revolutions per minute (RPM). Why does it matter if a pitcher has high spin rates?

There are two main reasons that explain the importance of having a high spin rate. Prewitt and Apstein (2021) assert that fastballs with high spin rates will maintain their plane of trajectory as they approach the batter and appear to move more in the eyes of the hitter due to the pitch not dropping as much in mid-air. In addition, high spin rate pitches are more difficult for the hitter to distinguish what type of pitch is being thrown at them. In other research, Baumgaertner (2021) makes the claim that certain pitches such as curveballs already have high spin rates and move very abnormally compared to a fastball with a lot of vertical movement. So, when pitchers are able to create more spin with illegal substances, the ball will move more and disadvantage the hitter.

Hitters can discern what pitch is being thrown at them by reading the way the seams on the baseball are moving. Essentially, when a pitch has more movement and the hitter is unable to discern what pitch is being thrown at them, it becomes more difficult to predict where the pitch

will be when it enters the hitting zone making it more difficult to hit, or even determine if the pitch will be in or out of the strike zone. For fastballs with high spin rates, JajaBojangles (2018) states that these fastballs, "...seem to 'rise,' as in they stay up higher than the aforementioned average spin fastballs." This "rise" in the pitch from backspin leads to more swings and misses by batters, which is an obvious benefit to pitchers. However, this is only for fastballs. Curveballs have a spin that looks like the ball's seams are tumbling forward (topspin). Sliders have a spin that rotates with almost a sideways spin and comes out of the pitcher's hand in a manner where the hitter will see a tiny dot created by the seams of the baseball on the axis it is rotating around. Lastly, per Brooks (2022), change-ups have a spin that is very difficult to detect because not only is the spin not the same as the rotational spin of breaking balls (curveballs and sliders), the seams look like the seams of a fastball but the pitch is not as fast and drops out of the strike zone at the last second. This is due to how the pitcher throws the ball with the ball wrapped up deep in the pitcher's hand as they throw it. Especially for offspeed pitches (curveball, slider, change-up), increased spin rates can make it difficult for a hitter to be able to discern which pitch is being thrown. So, it is clear that higher spin rates should be negatively correlated with lower opponent batting averages, since higher spin rates make it immensely more difficult for hitters to make consistent hard contact. Since there is an obvious motivation for pitchers to increase spin rate, how can pitchers increase their spin rate?

What can be used to increase spin rate?

Neiswender (2021) finds that there are only four ways a pitcher can increase spin rate. First, is to gain velocity. If a pitcher can throw the ball harder, then the ball will go through more

rotations, thus increasing spin rate. Second is adjusting one's spin axis when releasing a ball. If a pitcher is able to release a ball correctly then they will be rewarded with a higher spin rate. The last two ways to increase spin rate are finger strength and friction. It is important to note that although finger strength and friction have some effect on spin rate, it is not much of an effect unless aided by something else. McGinty and Beaton (2021), assert that substances such as sunscreen, rosin and Spider Tack (sticky tar substance used by pitchers) can enhance a pitcher's grip in turn helping pitchers generate more spin. At the MLB level, most pitchers do not see a large increase in velocity and already have elite mechanics so it can be inferred that if spin rates were to drop from an imposed ban of foreign substances, these high spin rates can be attributed to foreign substances.

Why did the MLB implement a substance ban?

Kelly (2021) states that in 2021, more than half of the teams managed to increase the average spin rates of their pitchers versus the prior year. Additionally, Young (2021) estimates that anywhere between 75 and 100 percent of pitchers in the MLB used some type of foreign substance before the substance ban was implemented. Due to this influx of high spin rates and pitchers who use foreign substances, the MLB decided to implement this substance ban for a couple of reasons. First, due to suspected foul play and second, as an attempt to “even the playing field” for hitters in the midst of a record high strikeouts, as mentioned by Prewitt and Apstein (2021). For the MLB, the substance ban would be effective if it successfully lowered the average spin rates and in turn, caused a rise in batting averages. In doing so, the MLB aims to even the playing field for hitters with lower spin rates making it easier to hit pitches, hopefully

leading to increased popularity in the sport. Westerbeek (2016) questions if the spirit of sport can be maintained, its integrity kept safe, and what basic principles should underpin and regulate sports. He suggests that spectators need to feel confident that their cheers are part of a real contest, that the outcome remains unpredictable, and that those who use sport to meet and congregate will decide if sport remains worthy of such prominence in society. MLB efforts to save baseball from losing popularity due to the spin rate scheme appears to be a worthy objective.

It is interesting to note that the substance ban was implemented two months into the season. Gonzales (2021), found that the MLB wanted to gather data before punishments were issued. Essentially, the MLB was aware of the usage of foreign substances at the beginning of the season, however they wanted to collect a small sample of data to determine if the use of these substances was a problem. Ultimately, did MLB spin rates change after the substance ban?

How has MLB spin rate changed after the substance ban?

Katz, Quealy, and Kepner (2021) assert that pitchers do not experience a drastic change in spin rate over the course of a typical season. When drastic increases in MLB spin rates for multiple types of pitches were observed, MLB fans and employees became concerned. This concern was warranted since there was a significant drop in average spin rates, specifically after the implementation of a substance ban. Lindbergh (2021), provides evidence of a noticeable decrease in average MLB pitcher fastball spin rates subsequent to the substance crackdown. In this study, Lindbergh (2021) illustrated that when comparing the average fastball spin rates of MLB pitchers a few weeks before the substance ban to a few weeks prior, 78.9% of the 277

pitchers under examination experienced a drastic decrease in average spin rate. Janes et al. (2021) found that around 70% of pitchers experienced notable decreases in average fastball spin rates, specifically between April 1st and June 23rd. Foley (2022) asserted that after the implementation of the substance ban, fastball spin rates reverted back to near 2015 levels, and breaking ball spin rates fell to near 2017 levels. Also, according to Cowart (2021) although many pitchers experienced a decrease in spin rates, Gerrit Cole and Trevor Bauer are the most prominent pitchers that demonstrated decreases in pitched-ball spin rates following the foreign substance ban. These examples provided strongly suggest usage of foreign substances based on decreased spin rates after the substance ban.

Furthermore, how did this decrease in spin rates affect opponents batting averages? Given the prediction that spin rate and opponent batting averages are negatively correlated, a general increase in opponent batting averages should be detected. Acknowledging that the usage of foreign substances was prevalent during the 2021 season leading up to the ban, it is important to question how the spin rate of fastballs in the MLB affected opponents batting averages before and after the substance ban. This study hypothesized that there would be an increase in opponent batting averages after the implementation of the substance ban, that the average spin rate of each pitch would drop after the implementation of the ban, and that there would be evidence that the spin rate of a pitch affects the hitting statistics against that pitch.

3. Data

This study utilizes data from BaseballSavant.mlb.com. This source includes data on every pitch from every MLB pitcher from the 2015 MLB season to the present day. This data is

recorded through a software called HitTrax, that calculates different metrics of each pitch in real time through a device placed behind home plate. This device reads each pitch and records a plethora of metrics per pitch such as velocity and spin rate, as well as batted ball metrics from hitters. Baseballsavant.com provides less in-depth data from seasons before 2015, and not with the same specificity as the data collected with HitTrax after 2015. For the study data, four data sets that consist of four pitches: fastball, curveball, slider, and change-up are provided. Not every pitcher in the MLB throws the same pitch, so the number of pitchers per data set differs. However, there are more than enough observations per each type of pitch. The fastball dataset consists of 970 pitchers, the curveball dataset consists of 117 pitchers, the slider dataset consists of 347 pitchers, and lastly the changeup dataset consists of 174 pitchers. All pitchers in each dataset pitched during the 2021 season. The entities in my data reflect each pitcher. Each column reflects the amount of pitches per month, the average spin rate of the pitcher per month, the hitters batting average per month, all per type of pitch per month of the 2021 season, as well as if the ban was implemented or not by a binary. The hitting statistics (batting averages) were selected because they provide insight into how well hitters and pitchers are performing. Batting average loosely captures the performance of the batter and is calculated by dividing number of hits by the number of at-bats taken. Batting average can also determine how well a pitcher is performing based on how high or low batting averages are against them. These hitting statistics are great measures of hitter and pitcher performance. The datasource, Baseballsavant.com, has the best data currently available. The only downside of this source is that it was created in 2015, and has no in-depth Trackman data leading up to its creation. Additionally, the only feature in the data that may affect the results would be the existence of foreign substances, which abnormally

increase spin rate on many pitches and may cause variations in the data. Since this study addresses the spin rates of multiple pitches and opponent batting averages, the exclusion of data such as other irrelevant metrics that have nothing to do with spin rates or opponent batting averages was needed. Also, this study only utilizes data from pitchers that threw over 100 pitches in the 2021 season, in order to have a larger set of data per pitcher.

4. Model and Estimation Technique

This study utilized 12 distinct models fitted with Ordinary Least Squares (OLS) Regressions with three regression for each of the four pitches: curveball, fastball, slider, and change-up. These regressions aim to discover if in fact, there was a foreign substance problem in the MLB, determine the effects of the foreign substance ban, as well as evaluate if there was a need for the substance ban. First, the MLB believed that there was an issue for hitters connected to pitcher's use of foreign substances. This occurrence is considered one of the leading reasons why the MLB sought to implement the ban. Therefore, the first regression of each pitch determines how opponent batting averages were affected by the foreign substance ban. This data serves as partial evidence to validate that there was an uneven playing field between the pitcher and the hitter in the MLB. Consequently, if batting averages rose on average after the ban, this suggests that foreign substances were a factor. The removal of foreign substances would lead to better batter performance meaning that the foreign substance allowed for pitchers to possess an unfair advantage over hitters before the ban was implemented. The information provided by the first regression then leads the study to evaluate if the foreign substance ban makes a difference in pitcher spin rates. This information serves as affirmation that the MLB was correct in

establishing the necessity to implement the ban. Results that reveal that spin rates on average decreased after the implementation of the foreign substance ban indicate that there is evidence of pitchers utilizing foreign substances. This is the goal of the second regression of each pitch type. The last level of analysis and the third regression of each pitch assesses how spin rate affects hitting statistics. This helps to recognize if spin rate directly affects hitting statistics in the MLB. The regression equations appear below. A similar approach was utilized for all four pitches:

$$\begin{aligned} \mathbf{BA}_i &= \beta_0 + \beta_1 \mathbf{Ban}_i + \beta_2 \mathbf{Pitcher_Name}_i \\ \mathbf{Spin_Rate}_i &= \beta_0 + \beta_1 \mathbf{Ban}_i + \beta_2 \mathbf{Pitcher_Name}_i \\ \mathbf{Hitting_Stats}_i &= \beta_0 + \beta_1 \mathbf{Spin_Rate}_i + \beta_2 \mathbf{Pitcher_Name}_i \end{aligned}$$

Variables:

Ban = the implemented ban (0 if before the ban and 1 if after)

BA= opponent batting average

Spin_Rate= the average MLB pitcher spin rate

Hitting Stats= batting average against specific pitch

Pitcher_Name= name of player

5. Results

The results of this analysis exhibit some effect on spin rates and batting averages across all included pitch types during the 2021 season. Each pitch exhibited a statistically significant decrease after the foreign substance ban was implemented, and two of the four pitches (curveballs and fastballs) had statistically significant increases after the implementation of the foreign substance ban. Therefore, we are able to reject the null hypothesis that the foreign substance ban implemented by the MLB had no effect on spin rates and batting averages. Overall, this study found that the foreign substance ban negatively affected the spin rates of the

four included pitches, the foreign substance ban caused an increase in the batting averages against curveballs and change-ups, and that the spin rates of curveballs and fastballs directly affect the batting averages against those pitches with a negative correlation, all supported by statistically significant evidence. Table 1 includes the twelve OLS regression results of the four pitches included in the dataset. Each regression is numbered one through twelve, starting with curveballs and ending with change-ups as labeled in the table. In the first regression of each type of pitch, the dependent variable is Batting Average which identifies the effect of the foreign substance ban on the pitcher's opponent batting averages. In the second regression of each type of pitch, the dependent variable is Spin Rate, which finds the effect of the foreign substance ban on the pitched-ball spin rate. Lastly, in the third regression, the dependent variables are the hitting statistics, which reflect the effect of MLB pitcher spin rates on those included hitting statistics (batting average, woba, BABIP, and whiffs). Under each value presented in each table, another value is introduced in parentheses. These values are the standard errors of the estimates for each variable before and after the foreign substance ban, as well as the respective p-values ($p=$) for each. Referenced on the left column of the table are Ban, Spin Rate, and the Constant. The Ban represents the implementation of the ban, Spin_Rate is used to see how spin rate affects batting averages against each pitch type, and the Constant is utilized to determine what the average of the dependent variables were before the ban was implemented. Regressions (1), (2), and (3) are the curveball regressions.

Table 1. Regression Results (All Pitches)

	Dependent variable:											
	Batting Average (CB) (1)	Spin Rate(CB) (2)	Hitting Stats(CB) (3)	Batting Average(FB) (4)	Spin Rate(FB) (5)	Hitting Stats(FB) (6)	Batting Average(SL) (7)	Spin Rate(SL) (8)	Hitting Stats(SL) (9)	Batting Average(CH) (10)	Spin Rate(CH) (11)	Hitting Stats(CH) (12)
Ban	0.048 (0.018) p = 0.011**	-68.241 (16.837) p = 0.0002***		0.017 (0.006) p = 0.004***	-45.056 (4.221) p = 0.000***		0.009 (0.010) p = 0.352	-50.910 (7.069) p = 0.000***		0.019 (0.015) p = 0.207	-32.982 (15.588) p = 0.038**	
spin_rate			-0.00005 (0.00003) p = 0.050**			-0.0001 (0.00002) p = 0.000***			-0.00002 (0.00002) p = 0.135			-0.00002 (0.00002) p = 0.222
Constant	0.100 (0.065) p = 0.128	2,870.000 (59.727) p = 0.000***	0.319 (0.065) p = 0.00001***	0.250 (0.075) p = 0.001***	2,342.000 (54.360) p = 0.000***	0.494 (0.038) p = 0.000***	0.135 (0.030) p = 0.00001***	2,861.955 (20.649) p = 0.000***	0.261 (0.041) p = 0.000***	0.100 (0.074) p = 0.178	2,870.000 (77.967) p = 0.000***	0.263 (0.031) p = 0.000***
Observations	116	116	116	969	969	969	346	346	346	173	173	173
R ²	0.654	0.978	0.033	0.459	0.921	0.042	0.521	0.977	0.006	0.580	0.978	0.009
Adjusted R ²	0.290	0.955	0.025	0.151	0.877	0.041	0.122	0.959	0.004	0.129	0.953	0.003
Residual Std. Error	0.065 (df = 56)	59.727 (df = 56)	0.076 (df = 114)	0.075 (df = 616)	54.360 (df = 616)	0.080 (df = 967)	0.071 (df = 188)	49.834 (df = 188)	0.076 (df = 344)	0.074 (df = 83)	77.967 (df = 83)	0.079 (df = 171)
F Statistic	1.796** (df = 59; 56)	42.200*** (df = 59; 56)	3.940** (df = 1; 114)	1.488*** (df = 352; 616)	20.521*** (df = 352; 616)	41.994*** (df = 1; 967)	1.304** (df = 157; 188)	51.842*** (df = 157; 188)	2.245 (df = 1; 344)	1.287 (df = 89; 83)	40.598*** (df = 89; 83)	1.505 (df = 1; 171)

Note:

*p<0.1; **p<0.05; ***p<0.01

In the first regression (1), we can see that the introduction of the foreign substance ban significantly increased opponent batting averages against curveballs (F= 1.796, p=.011, R²= .654). After the implementation of the ban, the average batting average against curveballs increased by an average of .048 percentage points. In terms of spin rates (2), Table 1 shows that the introduction of the foreign substance ban significantly decreased fastball spin rates (F= 42.200, p=.0002, R²= .978). After the implementation of the ban, the average fastball spin rate decreased by an average of 68.241 percentage points. In examining the regression for curveballs, the data shows that there is a significant negative correlation between the spin rates of fastballs and the batting averages against them (F= 3.940, p<.050). For curveballs, this study exhibits statistically significant changes in batting average and spin rate after the implementation of the foreign substance ban, as well as provides statistically significant evidence that there is a negative correlation between spin rate of curveballs and the batting average against them.

The data for the three regressions for fastballs (4,5,6), illustrates that regression (4) tells us that the introduction of the foreign substance ban caused a statistically significant increase in opponent batting averages against fastballs (F= 1.488, p=.004, R²= .459). After the

implementation of the ban, the average batting average against fastballs increased by an average of .006. Regression (5) underscores that the foreign substance ban caused a statistically significant decrease in fastball spin rates ($F= 20.521$, $p<.001$, $R^2= .921$). After the implementation of the ban, the fastball spin rate decreased by an average of 45.056 RPM. In the last regression for fastballs (6), the regression shows us that there is a statistically significant negative correlation between the spin rate of fastballs and batting averages against them ($F=3.940$, $p<.001$). These results provide statistically significant evidence to support that the foreign substance ban affected opponent batting averages and spin rates, and that the hitting statistics against fastballs are affected by the spin rates of fastballs.

Regressions (7), (8), and (9) reflect slider data. Regression (7) tells us that the introduction of the foreign substance ban caused no statistically significant change to batting average against sliders ($F= 1.304$, $p=.352$, $R^2= .521$). After the implementation of the ban, the average batting average against sliders increased by an average of .009 percentage points. Regression (8), demonstrates that the foreign substance ban significantly decreased slider spin rates ($F= 20.521$, $p<.001$, $R^2= .921$). After the implementation of the ban, the average slider spin rate decreased by an average of 50.910 RPM. Regression (9) delineates that there is no statistically significant evidence to support that batting averages against sliders are affected by the spin rates of sliders. For sliders, there is statistically significant evidence to support that spin rates were affected by the foreign substance ban but not batting averages, and fails to provide evidence that the hitting statistics against sliders are affected by the spin rates of sliders.

Finally, regressions (10), (11), and (12) provide data regarding change-ups. Regression (10), tells us that the implementation of the foreign substance ban caused no statistically

significant change to the batting average against change-ups ($F= 1.287$, $p=.207$, $R^2= .580$). After the implementation of the ban, the batting average against change-ups increased by an average of .019 percentage points. Regression (11), signifies that the foreign substance ban significantly decreased change-up spin rates ($F= 40.598$, $p=.038$, $R^2= .978$). After the implementation of the ban, the average change-up spin rate decreased by an average of 32.982 RPM. Lastly, regression (12) informs us that there is no statistically significant evidence to support that batting averages against change-ups are affected by their spin rates. Therefore, we can assert that there is statistically significant evidence to support that the spin rates of change-ups were affected by the ban, but not for batting averages against change-ups. Also, there is no evidence to support that the hitting statistics against change-ups are affected by the spin rates of change-ups.

6. Conclusions

This study aimed to discover if the foreign substance ban implemented by the MLB affected MLB pitcher spin rates and opponent batting averages during the 2021 season and if the ban was effective. The hypotheses of this study were: 1) That there will be an increase in opponent batting averages after the implementation of the substance ban, 2) That the average spin rate of each pitch will drop after the implementation of the ban, and 3) That there will be evidence to support that the spin rate of a pitch affects the hitting statistics against that pitch. 1) This study was able to provide statistically significant evidence that the batting averages against curveballs and fastballs increased, however could not provide the same significance for an increase in the batting averages of sliders and change-ups. 2) Additionally, this study was able to

provide strong statistically significant evidence that the spin rates of all four pitches (curveballs, fastballs, sliders, and change-ups) decreased after the implementation of the foreign substance ban. Furthermore, 3) This study established that there was statistically significant evidence to support that only the spin rates of fastballs affected the hitting statistics against fastballs, not curveballs, sliders, or change-ups. In summary, the foreign substance ban implemented by the MLB negatively affected the pitcher spin rates of all included pitches with strong significance and only affected the batting averages against curveballs and fastballs. Additionally, there is statistically significant evidence to support that for curveballs and fastballs, their spin rates affected the batting average against that pitch.

Another major component in this study was to determine whether the foreign substance ban was effective. As mentioned earlier in the article, the foreign substance ban would prove effective for the MLB if it successfully lowered pitcher spin rates and, in turn, increased batting averages. First, this study was able to validate that the spin rates of all pitches were negatively affected by the foreign substance ban. Given the research overviewed in the Literature Review section of this paper, this is very likely due to the removal of all foreign substance use in the middle of the 2021 season. It is known that foreign substances cause higher spin rates, and a ban of those substances followed by a massive reduction in spin rates provides ample evidence that there was a presence of said foreign substances. Therefore, the foreign substance ban proved effective in successfully lowering the spin rates of all four pitches. The successfully lowered spin rates of all the pitches affected the batting averages, yet the results were inconsistent because only two of the pitches were affected. Despite the fact that the ban only affected the batting averages of two pitches, that is still positive news for the MLB because the ban itself was mostly

effective. Ultimately, the ban was effective in lowering spin rates, which made the batting averages against at least two pitches increase. The MLB ban exposed the use of foreign substances with intent to improve the popularity of baseball and maintain loyal spectators. Unfortunately, the ban did not provide a complete significant difference in all aspects. Overall, the implementation of the foreign substance ban was a positive and effective undertaking for the sport. In future studies, it would be interesting to sort the pitchers by team to determine how the average spin rates and batting statistics differed before and after the ban on a per team basis. This would allow for the MLB and fans to be able to detect which team specifically benefited most from the use of foreign substances. This study provides just one example of a professional sports league inciting positive change in their sport in order to dispel and remedy controversy.

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