

# Analyzing the effects of VAR on English Football

Football is a way of life for many people across the world, and the English Premier League (EPL) is heart and center of it all. With global support, people from entirely different backgrounds all come together to pledge their undying allegiance to a team of eleven players. But to the supporters, it is so much more than just eleven players.

According to a paper titled “The Hooligans’ Death List” (Alsiö, n.d.), England has the joint third highest number of incidents relating to football hooliganism. That is falling just behind Brazil and Argentina, who’s passion for football is essentially engraved in their DNA, with a multitude of footballing legends hailing from those two countries alone. Not only that, but a study found (Kirby et al., 2013) “the risk of domestic abuse rose by 26 percent when the English national team won or drew, and a 38 percent increase when the national team lost.”

These numbers are not just stats, they are serious problems. While players and teams are not responsible for these events, the footballing officials must ensure that each game is officiated with integrity, because so much rides on the shoulders of these football matches. Football’s integrity has—unfortunately, been tainted with the introduction of VAR. With almost daily controversy, inconsistent decision-making, and constant discussion over whether it makes the game better.

So I set out to find... **HOW much has VAR had an effect on the English Premier League?**

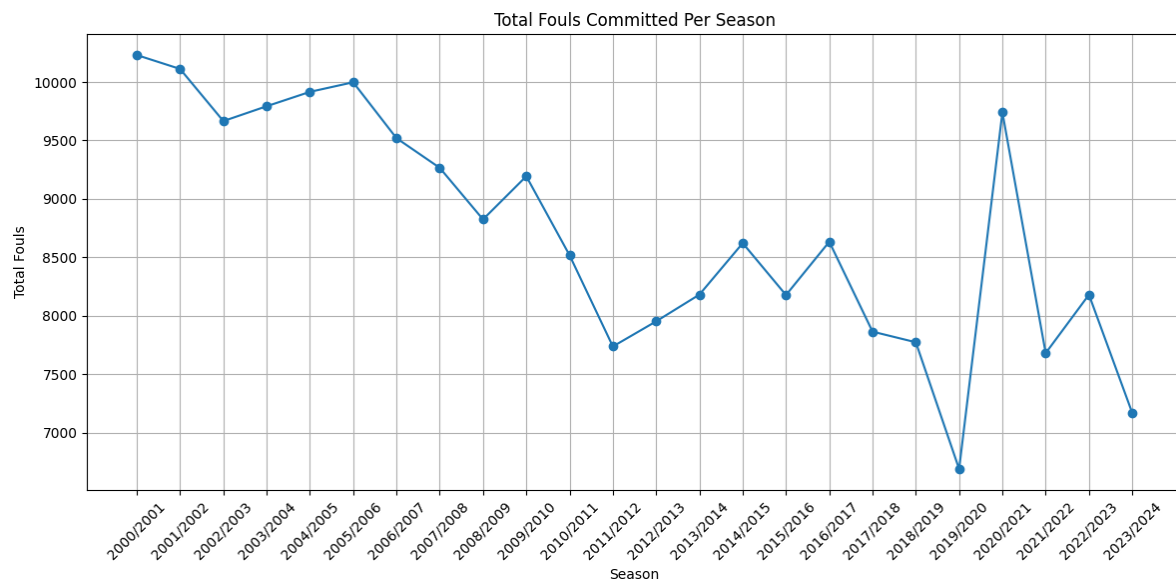
## Fouls

Video Assistant Referee (VAR) corrects on-field officiating mistakes. On the surface this seems like a great idea to reduce controversy, but in reality it has multiple negative effects on the game like interrupting the flow of the game, which can be game changing. Not only this, but VAR is usually utilized when fouls are made in dangerous areas, and has led to a lot of key decisions on whether a goal should be allowed or if a penalty should be awarded.

VAR was first introduced in the 2019/2020 season, and has had a lot of rule changes since that date.

The first question we will answer is; How has VAR affected the amount of fouls committed? To address this question I have used data from each premier league season (*England Football Results Betting Odds | Premiership Results & Betting Odds*, n.d.). The data starts from the 2000/01 season, so we have access to all of the data since then until the writing of this blog post (April 2024). Please note that the current season is not finished as of writing this blog, so expect the 2023/24 stats to change by the season’s end.

We can visualize how fouls have been affected by measuring the amount of fouls committed per season:



There seems to be a somewhat downward trend in fouls committed over time, which is consistent with the increase in quality over time, as teams improve their game, and tactics are refined.

However, the huge spike in the 2020/2021 season seems to be a deviation from the standard volatility. The first question I had after seeing this was; “why did VAR increase fouls so much, but only the year after being implemented?”

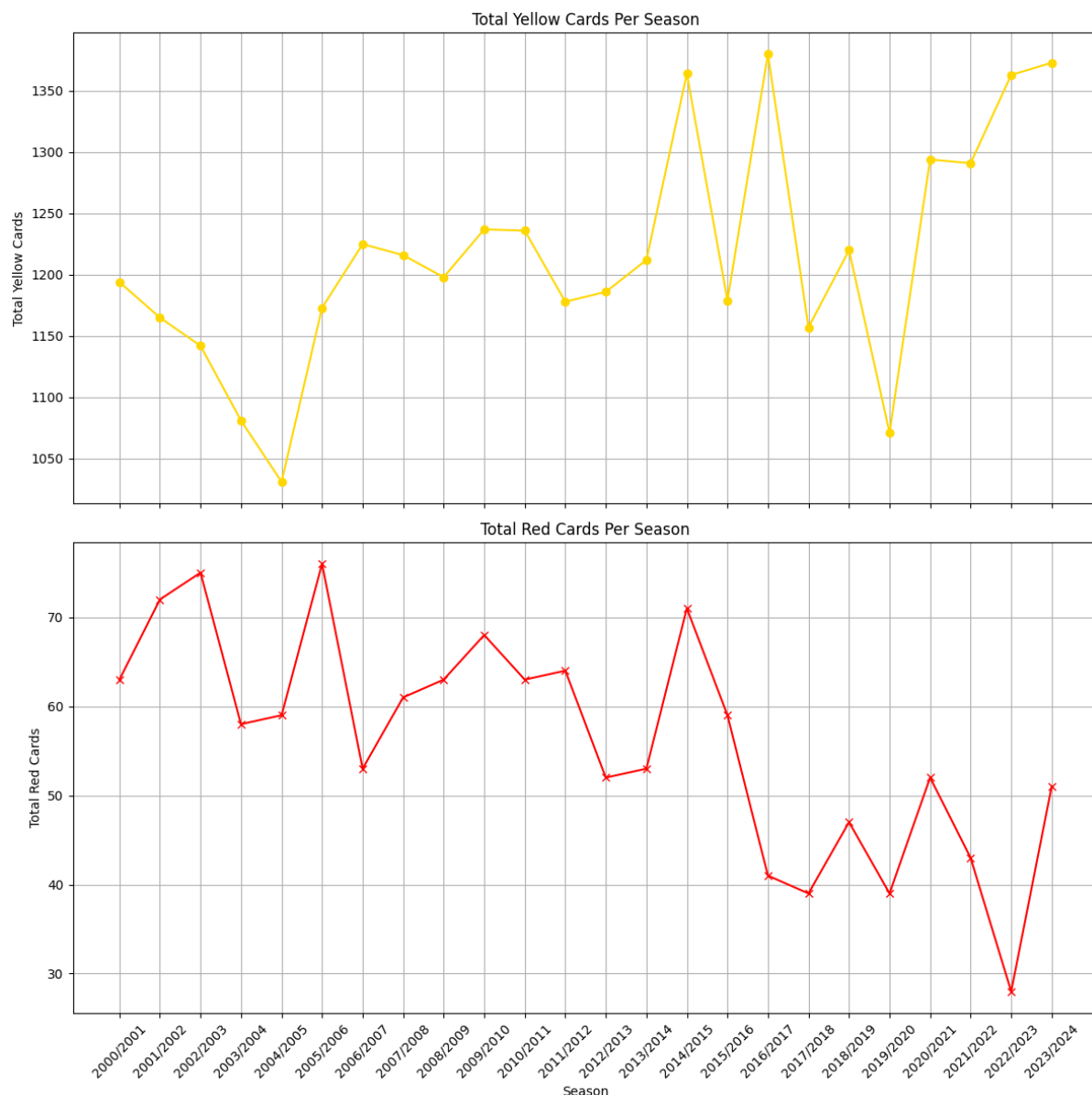
It is hard to say whether VAR was the sole reason for this, but VAR did go through major changes after its first season. Let’s examine...

In the first season of VAR (2019/2020), we see the lowest amount of fouls ever recorded. This is surprising since we would expect to see fouls increase as VAR would remove the ‘benefit of the doubt’ decisions, however the first season saw a very restrained use of VAR. It only reviewed “clear and obvious errors” (*Premier League Rule Changes and VAR in the 2019/20 Season*, n.d.), and had many controversial decisions where the VAR officials decided to make lenient decisions, or decide not to intervene. But, teams could have also been more risk averse as they were cautious of VAR calls.

On the other hand, the 2020/2021 season changed the rules to be less subjective (*VAR Is Back in the Premier League! How It’s Changed for 2020-21*, 2020), and instead provided clear instructions as to what was, and wasn’t, a foul. This was a change to make VAR less polarizing, but it would have also affected the on-field refereeing. Many of football’s subjective fouls became objective, and many more fouls were given, especially in the penalty box. Remember this for later, as there is a similar spike related to goals scored in the 2020/2021 season.

## Cards

VAR can only be used in four scenarios; goals and the incidents leading to them, penalties, red cards, and mistaken identity (*Premier League Rule Changes and VAR in the 2019/20 Season*, n.d.). Unexpectedly, when looking at red cards awarded per season, it is hard to see a trend at all:



If anything, red cards seem to have decreased since the introduction of VAR, with an all-time low in the 2022/2023 season; only 28 red cards were awarded over the course of the season. This could be due to the nature of VAR itself. Being able to review a red card offence could take away the initial intensity and shock of the moment, allowing the officials to make a more level-headed decision. However the amount of red cards per season is naturally a hard statistic to find a trend in, because they have a small sample size- a classic example of the law of small numbers.

Now, while yellow cards are not part of the list of situations where VAR can involve itself, they can still be awarded after a VAR call, and often when a decision is overturned, a yellow card may be issued.

We can see a lot of volatility, even more than the amount of red cards awarded. This is surprising as there are twenty-four times more yellow cards than red cards (56.25 mean red cards vs 1215.25 mean yellow cards), which significantly increases the sample size. It seems VAR had little to no effect on the severity of punishments.

## Goals

At the end of the day football is a game of goals. If you score more than the other team, you win. Simple. Everyone loves a game with a lot of goals. Not only do goals provide a fantastic measure of how dull a season has been, or whether fans are getting their money's worth, it also provides a great way to measure VAR's impact, as most of the important decisions are to do with whether goals should be allowed or not.

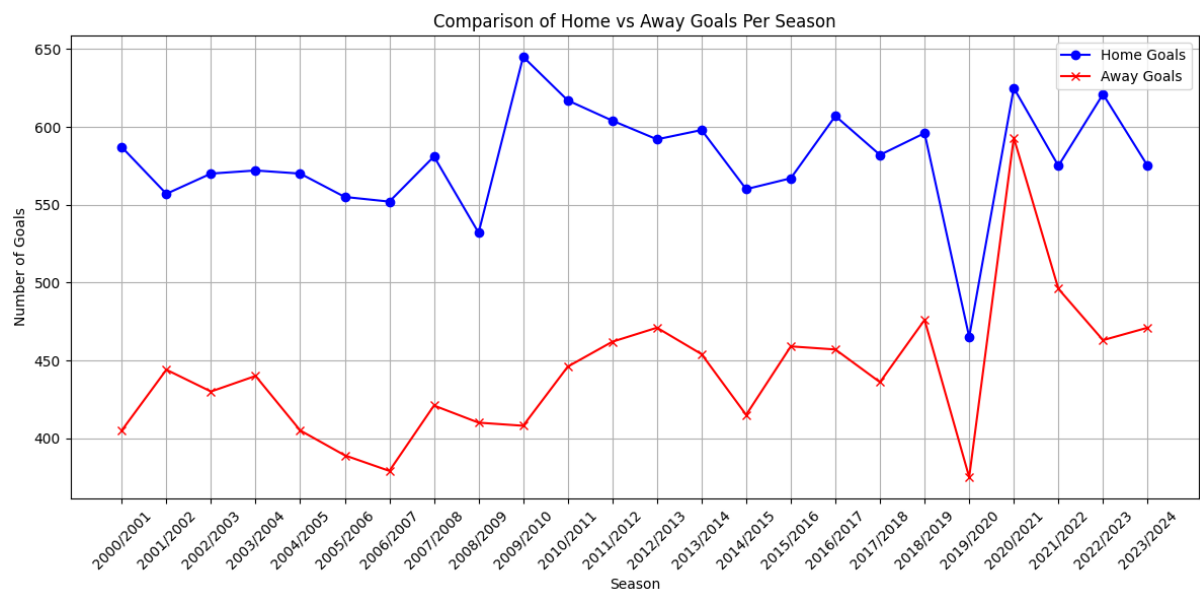
There are two main ways a goal may be disallowed by VAR; a handball by an attacker leading to a goal, or an offside attacking player influencing the play. In each of these cases VAR has and will always check whether the goal may stand.

Let's look at the number of goals scored per season:

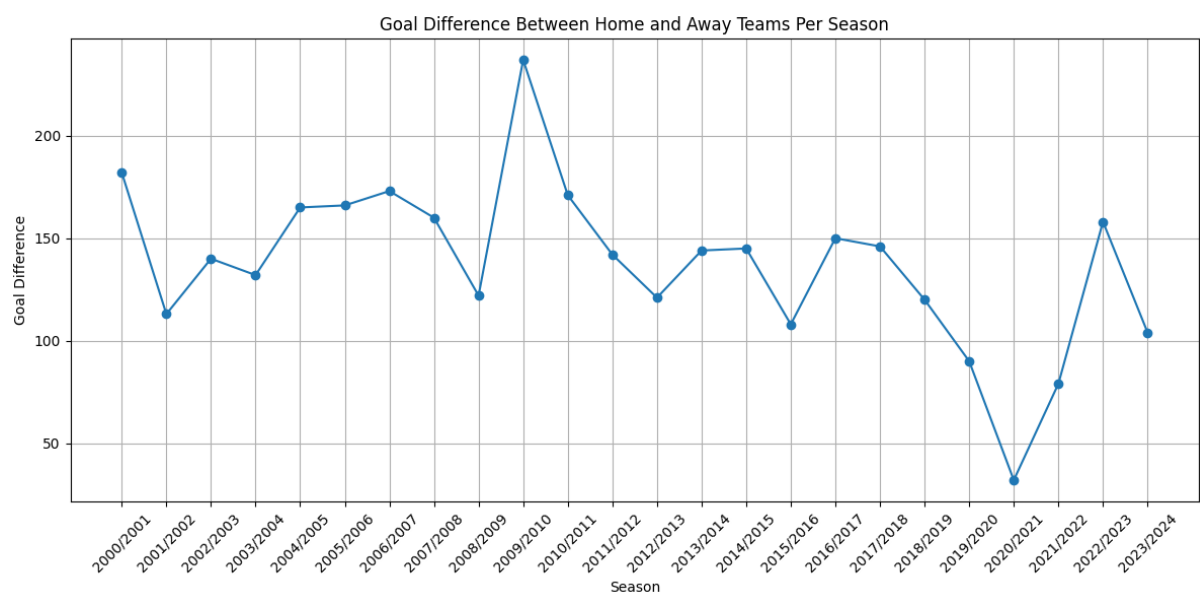


Once again we can see a general consistent trend of goals scored until the introduction of VAR in 2019/2020. The shape shows a relatively consistent level of goals of around 1000, with some amounts of fluctuation around that, but once again as we saw with the fouls, the introduction of VAR in the 2019/2020 season has caused a more dramatic volatility in the goals scored. The first two years of VAR saw the least goals (840) and most goals (1218) since the 200/2001 season.

Next we will evaluate the home and away advantage. To do this, we will look at the amount of home goals scored, vs the amount of away goals scored. Below, we can see this visualized.



We can see there is a fairly consistent separation between home and away goals. This is because the home team will almost always have the advantage- they have louder fans and are at their home stadium. But momentarily, VAR reduced the home team advantage, and shrunk the gap between home and away goals. We can visualize this by calculating the home vs away goal difference (home goals – away goals):



It seems that since the introduction of VAR, the EPL has had much fairer games, with away sides being able to score more goals than before. However I would like to point out that the dip seen between 2019/2020 and 2021/2022 was probably due to the COVID-19 pandemic, which saw teams play behind closed doors in empty stadiums. Therefore, I think this is more of a comment on how much of an advantage home support gives to a team, than how VAR has affected the league. You can see that with the return of fans since that point, the goal difference seems to be widening once again.

So in order to see a more novel method of measuring the impact of VAR on goals scored, we can use the causal forests method to estimate the extra amount of goals scored since its introduction to the EPL. To do this we must pick our variables.

The treatment variable was 'VAR'. We can mark each match with a value; '1' for a game which used VAR, and '0' for a game which did not use VAR. Our outcome variable is 'TotalGoals' which is a variable used to calculate the amount of goals scored in each match. Finally, we can use a bunch of covariates as the variables we will train our model on, allowing it to find patterns in the data.

We used these covariates as these were the only variables with no missing data from the dataset used, in order to make the testing as fair as possible. Below is the Conditional Average Treatment Effect (CATE) of VAR on goals scored. I have taken a mean of multiple CATE results, as there can be some variation:

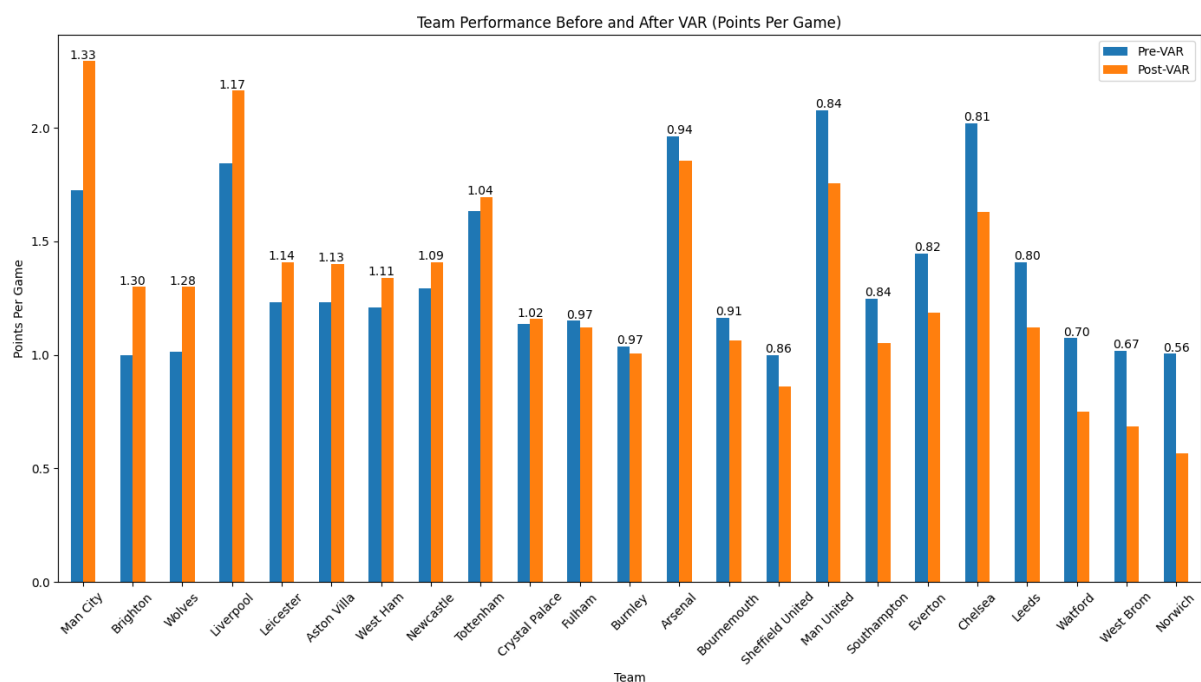
Statistic	Value
Number of Valid Data Points	50
Mean Value	0.1836
Standard Deviation	0.0416
95% Confidence Interval	(0.1721, 0.1952)
Min/Max CATE	0.1007 / 0.2893
Percentiles (25%, 50%, 75%)	0.1475, 0.1834, 0.2155
Interquartile Range (IQR)	0.0679
Skewness	0.1508
Kurtosis	-0.4820

This data was taken from a list of 50 CATE values, and indicates an increase in 0.1836 Goals per match when VAR is used. The standard deviation (0.0416) is quite small, showing the values are fairly consistent. The negative skewness and kurtosis suggests the normal curve of these CATE values is slightly flatter and most of the values larger, with a flatter curve towards the smaller end. Overall, a small increase in goals scored.

## Which Teams Have Won or Lost?

Due to the nature of football, we cannot attribute the changing performances of teams solely on VAR, much like the rest of the measurements. But what we can do is see which teams have done proportionally better or worse since then. This can have a significant effect on people's view on VAR, especially if the team which you support is doing worse than before VAR.

In order to measure this we can take the number of points each tam has earned per match (on average), for the periods before and after VAR. I have excluded teams which have not participated in the EPL in both post and pre-VAR periods:



Each team has been assigned a VAR impact ratio. This number is the ratio of Average points per match for both periods. This effectively measures how each team has performed since the introduction of VAR. The graph was ordered from best performers to worst performers. We can see our three most improved teams are Manchester City, Brighton, and Wolves, who all have a VAR impact ratio of over 1.25. On the other side of the graph, our worst three performers Watford, West Brom, and Norwich all have VAR impact ratios below or equal to 0.70, which indicate a severe fall-off in performance, and all four of the bottom teams are not in the current season of the EPL, which should be no surprise.

The worst drop-off in performance for a team currently in the EPL is Chelsea. This should come as no surprise, with the club in turmoil following the forced sale of the club from Roman Abramovich to Todd Boehly and Co., which was a byproduct of the Russia-Ukraine war. This has caused much dissatisfaction from the Chelsea fans, as they have seen their club fall from consistent top three finishers, to mid table for the past two seasons. Manchester United, another huge club from the traditional “Big Six” is also not far behind. Both of these clubs have a VAR impact ratio of 0.81 and 0.84 respectively.

VAR may not have been responsible for this, but these teams have massive followings, and a drop-off in performance since VAR would not help fan sentiment towards VAR, in an already controversial environment. When these teams lose due to a close VAR call, the fallout lasts for days, even if the call was correct.

## VAR-ied Results...

While it is in no doubt that VAR has been a massive change to the English Premier League, the statistics show varied perspectives. Overall, the introduction has led to higher volatility in most metrics, and I would attribute that more to the technology ‘finding its feet’, rather than the technology being unfair. I would say the initial controversy was fair, as VAR calls were inconsistent and naïve, but the technology has been refined and improved since then.

There do seem to be many indications that VAR has changed the game minorly, whether it be the CATE of 0.1836 more goals due to VAR, and the massive change in fouls committed, but it is impossible to say with 100% certainty that VAR is the reason for these changes.

Of course, the COVID-19 pandemic would have affected the league while VAR was introduced, as well as many changes to Financial Fair Play, and situations like the forced auction of Chelsea FC due to the Russia-Ukraine war. These all would have had an effect. Teams are playing football very differently to twenty years ago.

With all of this in mind, VAR has undoubtedly had an impact on the game, but the extent of which it has changed the game and whether it has been negative or positive is somewhat uncertain, and may need more time and data to discern the full story.

## References

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