Master's degree thesis

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Video Assistant Referee´s impact on competitive balance in elite football

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Preface

With submission of this master´s thesis I complete my two-years master´s degree in Sport Management at Molde University College.

I want to thank my classmates and professors for making my time both educational and enjoyable.

Special thanks to my supervisor, Kjetil Kåre Haugen for his guidance and support throughout the whole process of writing the thesis.

Football has always been a big part of my life, and I am grateful for the opportunity to conduct my thesis on my greatest passion. I hope the reader(s) will enjoy it as much as I did.

Vegard Valaker

Molde, 2020

Summary

This study investigates Video Assistant Referee´s (VAR) impact on competitive balance in elite football. The background for the study is an article by Haugen (2019), who claims that VAR will make the game more predictable as the best teams will benefit from an increased number of penalties.

Based on this, the following hypothesis was tested:

H1: The implementation of VAR has a negative impact on the leagues competitive balance

H2: The implementation of VAR increases the number of penalties given

H3: There is a negative correlation between number of penalties and the league´s competitive balance

As sub-hypothesis to H3, the study also explores:

H4: Stronger teams are given more penalties

H5: Stronger teams are more efficient penalty shooters

Relevant theory for the thesis is mainly Rottenberg´s (1956) Uncertainty of Outcome-hypothesis, and Michie & Oughton´s (2004) different measures of competitive balance. *The Herfindahl Index of Competitive Balance (HICB),* and an adapted *Four-Club Index of Competitive Balance (C4ICB)* was used in this study.

All statistics are retrieved from Transferfmarkt.com, and includes league tables and penalty statistics from Serie A and Bundesliga. The sample size is stretching from the 2009/10 season until the 2018/19 season in order to illustrate the general development over time as well as check for potential differences before and after implementation of VAR. The statistics were analysed in Microsoft Excel and Jamovi.

The findings indicate that stronger teams get more penalties than weaker teams, but no significant difference in penalty efficiency. The study finds no evidence of a significant impact on number of penalties or competitive balance by VAR. There might be a weak negative correlation between penalties and competitive balance, but not sufficient proof due to high p-values. Further research is needed to make strong conclusions.

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1.0 Introduction

This master thesis` topic of interest is Video Assistant Referee in football. More specifically the thesis investigates its impact on competitive balance in elite football. Video Assistant Referee (VAR) is a technology that let the referee take a second look at specific situations during a match to help improve his decisions. The referee can review four different types of situations: *goals*, *penalty decisions*, *direct red cards*, and *mistaken identity when sending off players*. In order to keep the flow of the game and avoid lengthy stoppages, the philosophy of VAR is "*minimum interference – maximum benefits*", and for a decision to be overturned by VAR, it must be regarded as a "*clear and obvious mistake*" by the referee (Premier League, 2019).

1.1 Background

VAR was introduced in world cup for the first time in the FIFA World Cup 2018 in Russia. According to Robinson (2018), through the 48 games in the group stages, 335 incidents were checked and 14 were reviewed on the field. According to FIFA in Robinson (2018), the right call was made in the first place in 95% of these incidents, but VAR bumped the number up to 99.3%.

After the World Cup, VAR was recognized as a big enough success to be implemented in Europe's biggest leagues. Although Bundesliga (the German top tier division) and Serie A (the Italian top tier division) had been using VAR since 2017, it wasn't until after the World Cup 2018 the rest of the "Big Five"[1] and the UEFA Champions League made the decision to follow. The English Premier League, the Spanish La Liga, the French Ligue 1, and the continental Champions League introduced VAR for the 2019/20 season.

According to Aftenposten (2019), the referees of the Norwegian top division, Eliteserien, have already begun their VAR-training. This is both because it is used internationally, but also because it is expected to be implemented in Norway in the near future.

[1] " Big Five" is a term used to describe five leagues (Premier League, La Liga, Bundesliga, Serie A, Ligue 1) that dominates European football in terms of popularity and revenue (Deloitte, 2019)

Recently, VAR has been a heavily discussed topic by both fans and media. The most obvious argument pro VAR, and the official reason for its implementation, is that it reduces the number of mistakes, and makes the game fairer. (FIFA, 2017)

The most typical cons are that is *slows down the game* and *removes the spontaneity.* Haugen (2019) points out that VAR introduce new stops to a game that already has enough of just that. This might impact viewers interest, and football migh eventually be full of time-outs and commercial breaks.

Another example pointed out by Goal (2019), is if your team of preference score a goal, the fans and players will potentially have to wait several minutes before they finally can celebrate the goal. By this time, the instant joy of scoring might have passed.

An argument that has gained less attention by fans and media, but might be of equal importance, is raised by Haugen (2019). He claims that by making the game fairer, it further increases the best teams' chances to win, and thereby makes the game more predictable and reduce the uncertainty of outcome. By first glance, this looks obvious to me as well. A stronger commitment to the rules, and less mistakes made by the referees will reduce their impact on the game, and let the outcome of the game be decided by the actual football side of things. In this case the best football team will obviously have an increased chance of winning.

This perspective seems to be shared by the biggest clubs in Premier League. According to The Athletic (2019), they were the ones who pushed hardest for VAR in the meetings preceding the decisive vote for its implementation. They argued that VAR would benefit them because of the "injustices" they were suffering.

Furthermore, Haugen (2019) backs up his argument by predicting that VAR will lead to more penalties, since the replays will detect more shirt pulling and other fouls inside the penalty box. This will benefit the best teams the most, since they are more likely play their way into the oppositions area and find themselves in a position to be fouled. An interesting prediction, and still, the logic behind it seems reasonable.

However, the problem with Haugen`s article is that it (so far) does not have the empirical data to back it up. As a great admirer of Levitt & Dubner`s *Freakonomics* series (2005, 2009 & 2014), a certain quote "*Assume nothing – question everything*" comes to mind.

This leads to my first question; What if VAR actually leads to *less* penalties? A possible impact of VAR is that since the referees knows that they have a video assistant to fall back on, they might be more reluctant to award a penalty if they are not 100% sure. At the same time, the VAR who is only supposed to overturn the referees' decision if it is a "*clear and obvious mistake*", will let most of these decision go. We might end up with a situation where both referees push the responsibility on the other, and every 50/50 (or even 60/40) situation will be let go.

Another hypothesis is that referees are more likely to award a free kick to the defending team (most likely the weaker team) than a penalty to the attacking team (most likely the stronger team). Examples of this is Sokratis Papastathopoulos of Arsenal versus Crystal Palace (Sky Sports, 2019) and Yerry Mina of Everton versus West Ham (Liverpool Echo, 2019), where both goals were disallowed after consultation with VAR, for a rather soft foul made by an attacking player, while the decision might as well have been a penalty if the ball did not end up in the net. If this becomes the norm, we might end up with less penalties, and in general less goals from attacking set pieces. By Haugen`s (2019) logic, this would benefit the *weaker* teams and *increase* uncertainty of outcome.

I also want to question *if VAR reduces the referees bias towards higher ranked teams.* Research done by Lago-Peñas & Gómez-López, (2016) suggests that referees could be more likely to favour the higher ranked teams in close games. With the implementation of VAR, it is a possibility that this bias could be reduced. This would obviously benefit the lower ranked teams, and thereby contribute to restore competitive balance.

Of course, we cannot exclude the possibility of the opposite effect. VAR might also *increase* the referees bias towards a higher ranked team or the home team. A longer decision making process might let him feel the pressure more from an impatient crowd, causing him to let 50/50 decisions go in a direction where he will face the least abuse.

It is worth keeping in mind that VAR is not a technology that *replaces* the referees decision (e.g. like the goal-line technology does). It merely gives them an opportunity to rewatch the situation. Thus, psycological factors might still impact the final decision.

1.2 Research question(s)

Inspired by Haugen`s (2019) article I have therefore decided to test the following hypotheses:

H1: The implementation of VAR has a negative impact on the leagues competitive balance

H2: The implementation of VAR increases the number of penalties given

H3: There is a negative correlation between number of penalties and the leagues competitive balance

As sub hypothesis to H3, I will also explore:

H4: Stronger teams are given more penalties

H5: Stronger teams are more efficient penalty shooters

1.3 Thesis outline

The thesis is structured in six chapters. In Chapter 2, relevant academic literature will be provided. This includes explanations of the aforementioned terms *Uncertainty of Outcome* and *competitive balance*, as well as their alleged impact on spectator demand. A literature review will also be presented to give an overview of previous research on the topic, and identify a research gap that this thesis will seek to fill.

In Chapter 3 the methodology will be presented. Different approaches will be explained and discussed, and the selected methods will be justified in order to ensure the study´s reliability and validity.

In Chapter 4, the results will be presented and described, followed by a discussion of the findings and their implications in Chapter 5. In Chapter 6, a conclusion will be made by providing answers to the hypotheses, as well as recommendations for further research.

2.0 Theoretical framework

2.1 Uncertainty of outcome

The uncertainty of outcome (UO) hypothesis was first introduced by Rottenberg (1956, p.246), who claimed that "*Uncertainty of Outcome is necessary if the consumer is to be willing to pay admission for the game*". In other words, who would want to spend their time and money to watch a game, if the outcome is predetermined?

Even though the hypothesis is rejected by some – Jespersen & Pedersen (2018) rejects UO hypothesis in four major European football leagues – the hypothesis is generally supported within the academia. Szymanski (2009), points out that despite the lack of documented risk-loving spectators, the market for old football matches (DVDs etc.) are rather small, which indicates that they are not a substitute for new matches. At the same time, he acknowledges that customers might prefer new matches for the same reason that they prefer new football shirts.

However, research that support the UO hypothesis exist. According to Humphreys and Miceli (2016), audiences prefer matches with an uncertain outcome even if club preferences exist. Also, more pop-science authors like Tifo Football (2016), makes arguments for the UO-hypothesis when they explain Bayern Munich`s financial glass ceiling. They argue that a low uncertainty of outcome in Bundesliga is the reason why the broadcasting revenues are lower than in more competitive alternatives like the Premier League (their interpretation of "competitive" seems to be based on number of different title winners). One would assume that a club's income is somewhat proportional with their sporting success. However, the low UO leads to a paradox where Bayern Munich`s total domestic dominance is hurting the club`s own broadcasting revenue.

This speaks to the peculiar economics of the sport industry based on the UO hypothesis. As pointed out by several authors, among them, Gossens (2005) and the references therein (Topkis, 1949; Neale, 1964; Janssens & Kasenne, 1987), in most industries, firms will try to dominate and outperform their competitors. In sports however, teams do want to win, but not all the time. If only one team survives, no games could be played, and the sport ceases to exist.

2.2 Competitive Balance

A league`s Uncertainty of outcome is often expressed as *competitive balance.* According to Michie & Oughton (2004, p. 4) "*Competitive balance refers to the balance between the sporting capabilities of teams*". The more balanced a league is in terms of the team's capabilities, the more uncertain the outcome is for each match. By extension, this leads to a higher uncertainty when competing for league titles or fighting against relegation.

Based on the UO hypothesis, a high competitive balance would be beneficial both for the league and the competing teams, because of a more attractive product and consequently higher revenues. This is illustrated by Michie & Oughton (2004) with a basic demand curve:

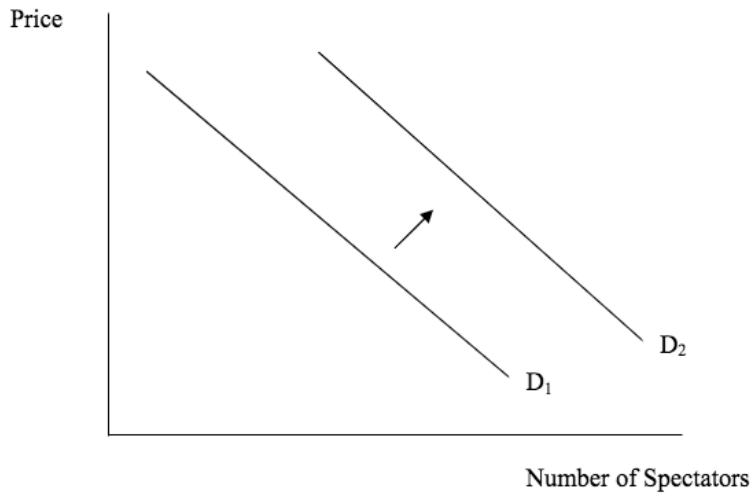

Figure 2.1: *The impact of competitive balance on spectator demand, (Michie & Oughton, 2004, p. 5)*

Figure 2.1 illustrate that an increased competitive balance causes a positive shift in the products demand curve (From D1 to D2). This means that the number of spectators (consumers) will increase at a given price. Equally, if the competitive balance decreases, the demand curve will make a negative shift. Different measures of competitive balance, and the chosen approaches for this thesis will be explained and discussed in chapter 3.

2.3 Literature review

Despite the topic´s popularity, and the heated discussions in blogs, newspapers and pre- and post match shows, very little academic literature exist on VAR.

To secure relevant literature, the SportDiscus database was used as a search engine. The filter was set to only include peer-reviewed articles. My first strategy was to search for any research done in the field of VAR in football and then manually screen for articles that was relevant for my topic. Therefore, I started out with a search consisting of *"video assistant referee" AND (football OR soccer).* Only 2 academic papers came up. One of them was found irrelevant, and the other one was a quantitative study that compared statistics from Serie A and Bundesliga before and after the implementation of VAR. Therefore, I decided to expand my search further to see if similar research had been done in other sports. A new search of simply *"Video Assistant Referee"* was done, however, no additional articles was found.

One alternative could have been to change the search to *("competitive balance" OR "Video assistant referee") AND (football OR soccer).* This way, research done to investigate competitive balance in football would also be included. However, I was only interested in research done to find the impact VAR has had on football. Research that merely looked into competitive balance in football without any relation to VAR was therefore considered irrelevant. Hence, my final search ended up to be *"video assistant referee" AND (football OR soccer).* As mentioned, this lead to two academic articles found, and after a manual screening only one of them were considered relevant for my topic. Haugen (2019) did not show up in the SportDiscus database, but will be included in the literature review because of its relevance for this thesis.

This article by Lago-Peñas, Rey & Kalen (2019) looked into how VAR has modified the game in elite football. More specifically they measured the statistics *Fouls, Goals, Offsides, Penalties, Playing time in the first half, Playing time in the second half, Total Playing time, Red cards* and *Yellow cards.* Then they looked at the differences before and after the implementation of VAR.

The sample consisted of 1024 matches played in the Italian Serie A (544 matches, 272

without VAR and 272 with VAR) and the German Bundesliga (480 matches, 240 with VAR and 240 without VAR) during the 2016/17 and 2017/18 seasons. The VAR was introduced for the 2017/18 season, and therefore the season before and after where analysed. Match statistics where retrieved from “whoscored.com”.

The article concluded that overall, VAR does not modify the game in elite football. However, the main findings were that:

(1) there was a significant decrease in the number of offsides, fouls and yellow cards after the implementation of the VAR.
(2) there was an increase in number of minutes added to the playing time in the first half and the full game, but not in the second half.
(3) individual differences were found when comparing seasons without and with VAR in the Italian Serie A and the German Bundesliga.

#	Full reference (Author, title, journal, year)	Research Question (RQ)	Concept / theory	Design and methods	Main findings
1.	Haugen, K. K. *Video-Assisted Refereeing in Association Football – Possible Adverse Effects on Uncertainty of Outcome*, OA Sports, 2019	VAR´s possible effect on uncertainty of outcome	Uncertainty of outcome	Establishing a link between VAR and uncertainty of outcome, based on simple logic and observations	-VAR reduce uncertainty of outcome. -Stronger commitment to rules → More penalties given→benefitting for the best teams. -Lower uncertainty of outcome might be harmful for the sports future demand → VAR might be harmful for the sports future demand.
2.	Lago-Peñas, C., Rey, E., & Kalen, A., *How does Video Assistant Referee (VAR) modify the game in elite soccer? International Journal of Performance Analysis in Sport, 2019.*	How does VAR modify the game in elite soccer/football?	Previous research that explains what factors that can influence a referees' decisions	-Statistical analysis of one season before and after implementation of VAR in Bundesliga and Serie A. -Measured changes in Fouls, Goals, Offsides, Penalties, Playing time in the first half, Playing time in the second half, Total Playing time, Red cards and Yellow cards	-There was a significant decrease in the number of offsides, fouls and yellow cards after the implementation of the VAR. -There was an increase in number of minutes added to the playing time in the first half and the full game, but not in the second half. -Individual differences were found when comparing seasons without and with VAR in the Italian Serie A and the German Bundesliga. -Overall not enough changes to say that VAR modifies the game in elite soccer.

Figure 2.2: *Literature review – Typography table*

3.0 Methodology

3.1 Previous methods

One weakness with the research of Lago-Peñas et al. (2019) is that it only looks into one season in two leagues before and after VAR. The statistics will usually vary from a year to the next anyway and the fact that VAR was implemented between the two seasons does not have to be the reason why. If both of the 2017/18 seasons (Bundesliga and Serie A) shows the same development it might suggest that it has to do with VAR, however the sample is still a bit small to conclude anything. It is hard to say exactly how many seasons that is necessary to provide a sufficient sample for conclusion, but arguments will be made later in this chapter.

3.2 Sample size & collection strategy

For my research I will also use Serie A and Bundesliga as my study objects. Similar to most other domestic leagues in Europe, Serie A and Bundesliga follow a "double round-robin" system. This means that all teams play against each other twice. One game at home, and one game away. They also follow the regular 3-1-0-point system, which means that each team is rewarded 3 points for a win, 1 point for a draw, and 0 points if they lose. Both Italy and Germany operate with an open league system, which is the standard in European football. This means that teams can move between divisions through promotion and relegation. According to Franck (2014) this contributes to a self-regulating competitive balance, because it leads to the most competitive allocation of teams every season. Serie A and Bundesliga consists respectively of 20 and 18 teams. This has not changed during the period this study´s sample size is based on.

Serie A and Bundesliga are so far the only two of the Big Five who is yet to complete at least one full season of VAR. They have now completed two seasons each after implementation of VAR, which doubles my post VAR sample size from the previously mentioned research by Lago-Peñas et al (2019) from two seasons to four seasons.

If both leagues are showing the same development two seasons in a row, it might be an indicator of which direction VAR is affecting the sport. Even if it is still a bit to small

sample size to be make strong conclusions. However, if part of the purpose of the research is to support or disprove an argument in the debate around VAR, it might be a bit late to let the biggest leagues in Europe be turned into experiments for several years before attempting to reach a conclusion.

An alternative, in order to further expand the sample size could be to include half of the 2019/20 seasons in order to include Premier League, La Liga and Ligue 1 as test objects. However, since the teams have only played against each other once, factors related to a possible home advantage may or may not have had an impact on the results. It is also a possibility that factors related to the increased (or decreased) importance of games towards the end of each season can have an impact on the statistics. Therefore, I consider it essential that only fully completed seasons are included in the study.

I will perform a longitudinal study where I use the league tables from the last ten years. Eight seasons pre VAR and two seasons post VAR implementation. In other words, stretching from the 2009/10 season until the 2018/19 season. In this way I will find out of how the competitive balance has developed the last years regardless of VAR, and then see if VAR have made an impact on this. As an example, if the competitive balance is reducing by an average of X each year and continues to do so after VAR, we cannot say that VAR has a negative impact on the competitive balance.

In the same way that it is hard to say how many seasons that is necessary in the post VAR implementation sample, it is difficult to tell the optimal period for the pre VAR sample. In this case, it is considered fundamental to look at several seasons in the past in order to look at the development in recent years, but at the same time keep the pre VAR sample to a period that is comparable to the post VAR sample in terms of context and circumstances. In this way, I seek to keep the other variables with a possible impact on competitive balance without severe changes.

The most noteworthy occurrence in the two leagues in recent years was a corruption scandal in Serie A in 2006. This caused the dominating club in Italian football, Juventus, to be relegated to Serie B (Italian second tier division) for the 2006/07 season (Hafez, 2019). Even though Juventus were promoted to Serie A for the 2007/08 season, this might have had an impact on the leagues competitive balance for more than just the season they

were down. Consequently, a round number of 10 seasons, dating back to the 09/10 season were included in the study.

Contrary to the previous research by Lago-Peñas et al (2019), this study will retrieve all its statistics from the website "Transfermarkt.com" (Transfermarkt, 2019a-d). The rationale behind this, is mainly that they provide the necessary statistics in a straightforward and uncomplicated manner. It is also used in previous research (Hussinki, 2017; Pieters, 2018; Perez-Gonzalez, Fernandez-Luna, Vega & Burillo, 2018), and are therefore accepted as a reliable source within academia. The statistics will be analysed in Microsoft Excel (2016) and Jamovi (2020).

3.3 Methodical approach – in general

Because this is a testing of hypotheses, it is regarded as a *deductive* research. Contrary to an *inductive* research as Lago-Peñas et al (2019) performed, where they went into the study without any hypotheses proposed beforehand. (Veal & Darcy, 2014). As explained, this will be a statistical analysis of historical data. This seems like the obvious approach, as qualitative approaches like observation already has been done. However, in a hope to obtain the hard proof, we need to look into the actual statistics.

According to Veal & Darcy (2014), most statistical analyses results in a *probabilistic statement.* This is because it is impossible to be 100% sure that the samples represent the reality. In this case we are not looking into every game in history played with and without VAR, and can therefore not be 100% sure about VARs impact on football in general. These statements can only be probable within certain confidence intervals.

According to Johannessen, Christoffersen & Tufte (2011), p-values are used to indicate how certain we can be in our statement, or in other words, the probability of rejecting a correct null hypothesis. The smaller the p-value, the more significant is our findings. There are three levels of significance; $p<0.001$ often represented by ***. $p<0.01$ represented by ** and $p<0.05$ represented by *. As an example, if we find a correlation between penalties and competitive balance with the p-value of 0.05, we can be 95% certain that the result represents the reality.

According to Johannessen et al (2011), the most common practice is to set the minimum requirement for statistically significance to $p<0.05$. However, Kim (2020), argues that it is not always optimal to use $p<0.05$ or other conventional p-values such as 0.01 or 0.001, in every context. Furthermore, he emphasizes the importance of considering sample size (statistical power) and losses/consequences of an incorrect decision.

Because p-values are highly dependent on sample size, and our sample size is rather small, the chances of getting the sufficient p-values will be accordingly. The statistical significance will be set to $p<0.05$, since this is the most common minimum requirements within academia. However, insignificant p-values close to 0.05 will be discussed and found worthy of attention.

However, *correlation* does not imply *causality*. Correlation simply proves that two variables are associated. It does not necessary mean that one causes the other (Veal & Darcy, 2014). In this study I will first and foremost find out if there is a correlation. It is hard to prove any causality because penalties and the competitive balance in a league are affected by so many different factors. If a correlation is found, new measures should be taken to further investigate causality.

Some of the results will include a linear regression. According to Johannessen et al. (2011), this is way to show the linear relationship between two variables, and to predict the dependent variable when knowing the independent variable. In the result chapter the linear regression will be used to show the general development of penalties and competitive balance in the recent years, and also as a supplement to different correlation analyses to illustrate the relationship between the two variables in question.

3.4 Measures of competitive balance

There are several ways to measure competitive balance. According to Ramchandani, Plumley, Boyes & Wilson (2018), one can either measure competitive balance *between seasons* (if it is the same teams competing for the title every year) or *within seasons* (how balanced the points are distributed between the teams during each season). Both measures are obviously an extension of the results in individual matches, but the latter is closer linked due to the fact that it takes points gained from matches into account, rather than just

league positions. Therefore, this approach will be used, as the purpose is to measure uncertainty of outcome when going in to individual games.

According to Fort & Maxcy (2003) one way to measure competitive balance within a season is to calculate the *standard deviation of winning percentage*. However, this approach is developed with American sports in mind, where a draw is rare or non-existent. In European football however, a draw is both possible and normal.

Another way to measure competitive balance is according to Mitchie & Oughton (2004), cited in Ramchadani et al (2018) the *Herfindahl Index of Competitive Balance* (HICB). Furthermore, they argue for several reasons why this is an appropriate method for European football. The two main reasons are that:

1. it is an accepted method within the academia that has been used in several previous academic research focusing on football leagues.
2. It allows comparisons between leagues, with a different number of teams and, within leagues when the number of teams' changes over time. This makes it possible to compare Bundesliga and Serie A, even though the leagues consist respectively of 18 and 20 teams.

HICB is adapted from the Herfindahl-Hirschman Index (HHI), which according to Mitchie & Oughton (2004), is used to measure markets competitiveness, and is calculated by squaring each actors market share, and then summing the resulting numbers. In this case the league table can be seen as the market, and points gained in percentage of the leagues total points will be the market share of each team. According to Mitchie & Oughton (2004), the HICB is calculated by first finding the leagues HHI and then divide it by (1/N) where N is the total number of teams in the league. Finally, you multiply this number by 100. This gives you the following formula:

$$\boldsymbol{HICB = \frac{HHI}{1/N} * 100}$$

In a perfectly balanced league, the index would take the value of 100, and as the value rises, the less competitive the league is.
As an example, the Serie A 2018/19 season would look like this:

18/19		Points	Market share	HHI	
1	Juventus	90	8,72 %	0,007605462	
2	Napoli	79	7,66 %	0,005859962	
3	Atalanta	69	6,69 %	0,004470322	
4	Inter	69	6,69 %	0,004470322	
5	AC Milan	68	6,59 %	0,004341686	
6	AS Roma	66	6,40 %	0,004090049	
7	Torino	63	6,10 %	0,003726677	
8	Lazio	59	5,72 %	0,003268471	
9	Sampdoria	53	5,14 %	0,002637499	
10	Bologna	44	4,26 %	0,001817799	
11	Sassauolo	43	4,17 %	0,001736111	
12	Udinese Calcio	43	4,17 %	0,001736111	
13	SPAL	42	4,07 %	0,001656301	
14	Parma	41	3,97 %	0,001578368	
15	Cagliari Calcio	41	3,97 %	0,001578368	
16	Fiorentina	41	3,97 %	0,001578368	
17	Genoa	38	3,68 %	0,001355838	
18	FC Empoli	38	3,68 %	0,001355838	
19	Frosinone	25	2,42 %	0,000586841	
20	Chievo Verona	20	1,94 %	0,000375578	**HICB:**
	Total:	1032	100,00 %	0,055825972	**111,651944**

Figure 3.3: *HICB – Example: Serie A 18/19*

$$HICB = \frac{0{,}055825972}{1/20} = \underline{\underline{111{,}651944}}$$

Even if we know that the HICB starts at 100, the value does not tell you when it stops. This means that looking at one season isolated won´t make much sense, as it is not a good indicator of to which extent the league is competitive without comparing it to other seasons/leagues. However, the purpose of this study is to compare different seasons over time, and look for an increase/decrease after implementation of VAR. The HICB is therefore considered sufficient for this purpose.

It is also difficult to set an ideal level of HICB. Based on the UO hypothesis it is reasonable to assume that it is close to 100. However, a league where all games end in a draw, or where the home team always wins, can doubtfully be an ideal situation.

The HICB also doesn't take into account the concentration of points among the top teams compared to the rest. It merely gives an indicator of how equal the points are distributed between all of the teams, regardless of league position. This is aligned with the main purpose of the research, as we are looking to find out if VAR increases the higher ranked teams' chances to win, regardless of any of the teams are top teams.

As an example it is just as interesting to find out if number 16 in the league is more likely to beat number 18, as number 1 is to beat number 3. However, it would also be interesting to find out if VAR have an impact on the gap between the top teams and the rest of the league table. To do this, Mitchie & Oughton (2004) suggests *The Five-Club Concentration Ratio (C5)* and *Index of Competitive Balance (C5ICB)*.

Similar to the HHI, the C5 is developed as a tool to measure the competitiveness of a market based on the different actor's market shares. The C5 indicates to which extent a market is dominated by their five biggest firms. When applied to football, the C5 represents the inequality between the top five teams and the rest of the league, and may be calculated by the following formula (Mitchie & Oughton, 2004):

$$C5 = \frac{\text{Total points won by top 5 clubs}}{Total\ points\ won\ by\ all\ clubs}$$

The C5 ratio will be presented as a percentage of the total points won by all clubs. The higher the percentage, the more dominant is the top 5 clubs. By extension, this represents a low competitive balance.

The problem with this method is that it is sensitive to leagues number of teams. As an example, if Serie A (20 teams) and Bundesliga (18 teams) is equally (un)balanced, Bundesliga will show a higher C5 ratio, because 5 out of 18 makes up a higher percentage than 5 out of 20.

In order to find a standardised index adjusted for number of teams, Mitchie & Oughton (2004) suggests *The C5 Index of Competitive balance (C5ICB)*, which may be calculated

by the following formula:

$$\boldsymbol{C5ICB = \left(\frac{C5}{5/N}\right)*100}$$

Just like the HICB, the C5ICB will take the value of 100 in a perfectly balanced league, and rise according to the top five club's domination (Mitchie & Oughton, 2004).

In both Serie A and Bundesliga, the *top four* teams qualify for UEFA Champions League. It is reasonable to assume that the revenues generated through this competition is contributing to a gap between the top four clubs and the rest of the league. Consequently, an adapted *C4ICB* will be used instead of the C5ICB. The formulas used is therefore:

$$\boldsymbol{C4 = \frac{\text{Total points won by top 4 clubs}}{Total\ points\ won\ by\ all\ clubs}}$$

$$\boldsymbol{C4ICB = \left(\frac{C4}{4/N}\right)*100}$$

Eventual point deductions will be added back to the teams point score, and league positions will be changed accordingly. The same data will be used when checking for correlations related to league positions. The rationale behind this is that total points gathered through victories and draws, is what tells the real story of how the games have played out.

3.5 Methodical approach - Hypothesis 1

When the HICB and C4ICB is calculated for each season, simple line charts, supplied with a linear regression will be done to show the development over time, as well as look at potential differences in the development post implementation of VAR.

When calculating the differences between pre and post VAR, a possible way could be to do a regression from the 09/10 season until 16/17 season (last season of VAR), and another one from 16/17 until 18/19, and then check for differences in the development in the two periods.

However, as the sample size consist of eight seasons before VAR, and only two seasons after, the results could be a bit misrepresentative. Consequently, a t-test consisting of two seasons pre VAR, and two seasons post VAR was considered to be the most fitting way.

3.6 Methodical approach - Hypothesis 2

When testing the second hypothesis if *VAR increases the number of penalties*, I will count how many penalties where given in each season from 2009/10 and until 2018/19 in the Bundesliga and Serie A. In this way I can illustrate the development regarding penalties as well as look for potential differences after VAR was implemented. There is a possibility that the trend is to tolerate more and more for each season, or the other way around, that the referees are protecting the players more for each year. If the number of penalties after VAR implementation increases in a way that breaks with the development trend before VAR, it might suggest that VAR has made an impact.

A t-test alone would not encapsulate the development of recent trends regarding penalties. However, like hypothesis 1, a t-test consisting of two seasons pre VAR, and two seasons post VAR, supplied with a graph to show the ten-year development, was considered to be the most fitting way, because of the small post VAR sample.

3.7 Methodical approach - Hypothesis 3

The third hypothesis is to check for *correlation between number of penalties and competitive balance*. The idea is that a high value in number of penalties should correlate with a low competitive balance. This is what according to Veal & Darcy (2014) is called a *negative correlation*. However, a high HICB and C5ICB represent a low competitive balance. Therefore, this would in the result chapter be presented as a positive correlation between penalties and HICB or C5ICB. According to Veal & Darcy (2014) the correlation is measured by the means of the correlation coefficient, usually represented by the letter *r*. The coefficient goes from +1.0 to -1.0. +1.0 shows a perfect positive correlation, and -1.0 shows a perfect negative correlation. -0.8 is regarded as a strong negative correlation. 0 represents no correlation.

3.8 Methodical approach - Hypothesis 4

Could a possible correlation between competitive balance and penalties be explained by the assumption that the stronger teams are more likely to be given a penalty?

In this case, the *highest* position in the league will be set to **LP (League Position) =1**. The *lowest* position in the league will have the value **LP=20** in Serie A and **LP=18** in Bundesliga. In other words, when checking for correlation between number of penalties and league position, a *negative* correlation between penalties given and LP would support the hypothesis.

The results will be presented both as a scatter plot supplied with a linear regression line, and by a correlation matrix.

Because of the different number of teams in the two leagues, the leagues will only be checked for correlation individually. As an example, LP=18 in Bundesliga cannot be compared to LP=18 in Serie A. Thus, putting values from both leagues in the same scatter plot would not make much sense.

In order to investigate the gap between top four and the rest, an independent t-test will be used. A dummy variable where **LP≥5 = 0** and **LP≤4 = 1,** was created.

3.9 Methodical approach - Hypothesis 5

Are stronger teams more efficient penalty shooters?

If we choose not to accept the hypothesis that stronger teams are awarded more penalties than weaker teams, it is still possible that stronger teams can benefit from increased numbers of penalties in general.

If all teams get more penalties, but the strongest teams are more likely to score, then the strongest teams will benefit from a general increase in penalties given.

Again, this would need a negative correlation between goal% of penalties given and LP since the top of the league will be set to **LP=1**.

To secure that the results are not skewed because teams with a low number of penalties often have a goal% close to 100% or 0%, teams with fewer than 5 penalties were excluded from the data set.

As in H4, we also want to investigate the gap between top four and the rest, an independent t-test will be used. A dummy variable where **LP≥5 = 0** and **LP≤4 = 1,** was created.

3.10 Ethical considerations

According to Johannessen et al. (2011), ethics revolves mainly around the relationships between humans, and what we can and cannot do to each other. In research, ethical challenges might occur when the study directly touches upon people. Usually, when collecting data. In this study, the research will not directly touch upon people as the data will only consist of historical data that does not expose individual people. Veal & Darcy (2014, p.107-108) provides a list of ethical principles of research, where most of them revolves around how to treat people, especially the informants of the study. However, some of them are also relevant to studies without human informants or that directly touches upon individuals. The general principles of research ethics are:

- The research should *benefit the society*
- The researchers should be suitably *qualified* and/or *supervised* to conduct the research
- Subjects should take part *freely*
- Subjects should take part only on the basis of *informed consent*
- *No harm* should befall the research subjects
- Data should be *honestly* and *rigorously analysed*, *interpreted* and *reported*

The society would probably not benefit significantly from my research. However, if the results could somehow help decision making when it comes to implementation of VAR, the sport would at least benefit to a small extent. Other than that, the research is partly

conducted for educational purposes as a part of a Master degree, which it can be argued that the society benefits from. On the other hand, it is hard to find any reason why the research should be costly for the society.

When it comes to researchers' competence, I would probably not be qualified to conduct the research without supervision as my personal experience with quantitative research is little to non-existent. However, the research is supervised by Kjetil K. Haugen, professor of Logistics and Sport Management at Molde Universty College, who is experienced within the field of sport and football economics. Thus, the requirement regarding suitable supervision should not be an issue.

The last principle says that data should be *honestly* and *rigorously analysed, interpreted* and *reported.* It is important that I am not getting creative and start playing around with the statistics in order to get the results that I want. According to Veal & Darcy (2014) researches are often concerned about reporting negative findings or non-findings. As my research builds on hypotheses inspired by the article of Haugen (2019), it is important that I don't decide beforehand that I am going to disprove him with my research, or contrary support his arguments. As I am a huge fan of football myself it is also difficult not to have an opinion on the implementation of VAR. It is crucial that this opinion does not lead to any personal bias or in any way impacts the study.

4.0 Results

4.1 VAR`s impact on competitive balance

As explained in chapter 3, in a perfectly balanced league, the HICB will take the value of 100. The more the value rises, the less balanced the league is.

The results will be presented both as line charts and as t-tests. The line charts will contain a full drawn graph which represents the HICB for each season, and also a dotted regression line which represents the average development over time.

As the 16/17 season was the last season without VAR, there will be a stapled vertical line to represent the change from pre VAR to post VAR implementation. What we are after is to see if there is a significant break from the pattern after this, and then test the difference in a t-test.

4.1.1 HICB Serie A

After calculating HICB for each season, this were the results for Serie A:

Serie A	
Season	**HICB**
09/10	107,66
10/11	107,75
11/12	107,82
12/13	109,62
13/14	113,04
14/15	112,84
15/16	110,35
16/17	114,30
17/18	114,36
18/19	111,65

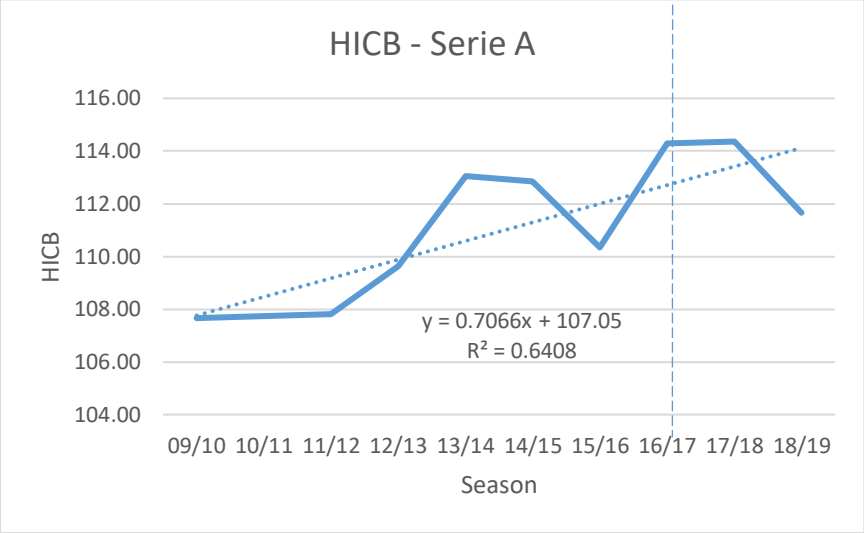

Figure 4.1: *Development of HICB over time in Serie A*

The graph in Figure 4.1 show that there is a general increase in the HICB-value over time. According to the slope of the regression, the HICB is expected to increase with 0,707 each season. This means that in general, Serie A has become a less balanced league the last 10 years. However, after the implementation of VAR, the HICB have stagnated and even reduced. This may indicate that Serie A has become a more balanced league after the implementation of VAR.

The two last seasons before VAR (15/16 and 16/17) were compared with the two seasons after VAR (17/18 and 18/19) in a t-test. The hypothesis was set to Measure 1 < Measure 2, because a higher HICB after VAR would support H1, that *VAR reduce competitive balance*.

Paired Samples T-Test

			statistic	df	p	Mean difference	SE difference	Cohen's d
HICB pre VAR Serie A	HICB post VAR Serie A	Student's t	-0.205	1.00	0.436	-0.681	3.33	-0.145

Note. H_a Measure 1 < Measure 2

Descriptives

	N	Mean	Median	SD	SE
HICB pre VAR Serie A	2	112	112	2.79	1.98
HICB post VAR Serie A	2	113	113	1.91	1.35

Figure 4.2: *T-Test - HICB in Serie A – Before and after VAR implementation*

Plots

HICB pre VAR Serie A - HICB post VAR Serie A

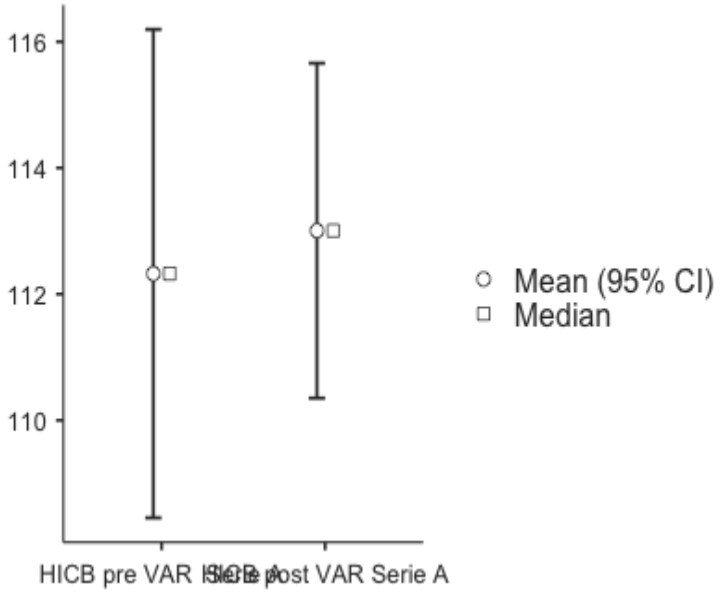

Figure 4.3: Plots – HICB Serie A - Mean and median before and after VAR

According to Figure 4.2, the mean difference (calculated by **mean HICB pre – mean HICB post**) shows -0,681. This indicates that the HICB post VAR is on average 0,681 higher than pre VAR. This is lower than the expected rise 0,707. However, the p-value of 0.436, is too high to conclude with anything.

4.1.2 C4ICB Serie A

When looking into the C4ICB of Serie A, this was the result:

Serie A	
Season	**C4ICB**
09/10	144,03
10/11	140,94
11/12	140,91
12/13	147,03
13/14	146,54
14/15	145,58
15/16	153,11
16/17	158,49
17/18	158,47
18/19	148,74

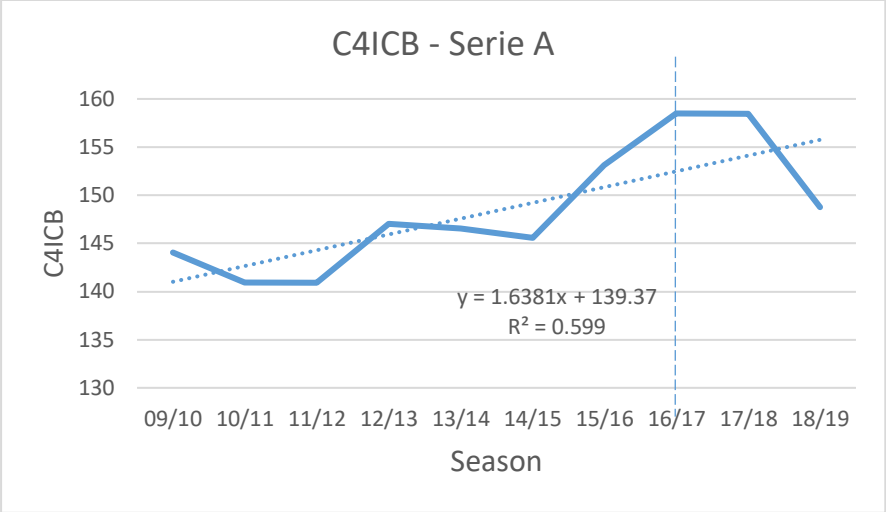

Figure 4.4: *Development of C4ICB over time in Serie A*

The C4ICB in Figure 4.4 shows a similar development as the HICB, with a general increase the recent years. According to the function of the regression the C4ICB is expected to rise with 1,64 each season. Similar to the HICB there has been a stagnation and reduction of the C4ICB after implementation of VAR. This might suggest that the top four in Serie A is less a dominant force than before VAR.

Again, the two last seasons before VAR were compared with the two seasons after VAR in a t-test. The hypothesis was set to Measure 1 < Measure 2, because a higher C4ICB after VAR would support H1, that *VAR reduce competitive balance*.

Paired Samples T-Test

			statistic	df	p	Mean difference	SE difference	Cohen's d
C4ICB pre VAR Serie A	C4ICB post VAR Serie A	Student's t	0.291	1.00	0.590	2.20	7.55	0.206

Note. H_a Measure 1 < Measure 2

Descriptives

	N	Mean	Median	SD	SE
C4ICB pre VAR Serie A	2	156	156	3.80	2.69
C4ICB post VAR Serie A	2	154	154	6.88	4.86

Figure 4.5: T-Test C4ICB Serie A – Before and after VAR

Plots

C4ICB pre VAR Serie A - C4ICB post VAR Serie A

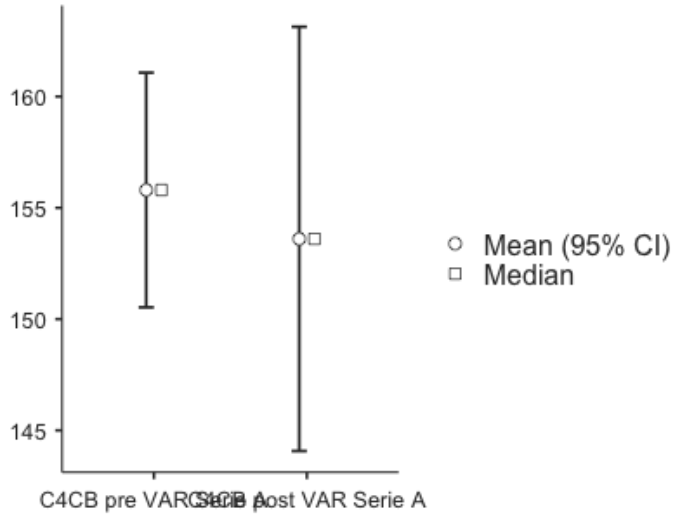

Figure 4.6: Plots – C4ICB Serie A – Mean and median before and after VAR

Figure 4.5 shows a mean difference of 2,20. This indicates that the C4ICB post VAR is on average 2,2 lower than pre VAR, despite an expected rise of 1,64. However the p-value of 0.590, is too high to conclude with anything.

4.1.3 HICB Bundesliga

The results for HICB in Bundesliga is as follows:

Bundesliga	
Season	**HICB**
09/10	107,9
10/11	106,6
11/12	109,98
12/13	111,15
13/14	112,71
14/15	108,08
15/16	110,45
16/17	108,35
17/18	108,59
18/19	112,4

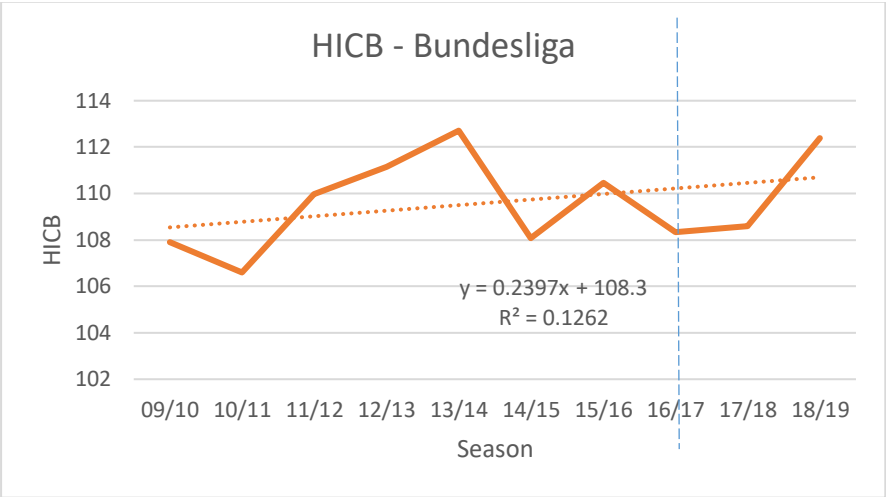

Figure 4.7: *Development of HICB in Bundesliga over time*

Like Serie A, Bundesliga seems to have developed into a less balanced league the last 10 years, with an expected rise of 0,24 HICB each season, asshown in Figure 4.7. However, after the HICB peaking in 13/14 it actually seems like the league was on its course to restore competitive balance, until VAR was implemented. After the implementation of VAR, the HICB changed its course and Bundesliga may have become a less balanced league.

When comparing the two seasons before and after in a t-test, this was the result:

Paired Samples T-Test

			statistic	df	p	Mean difference	SE difference	Cohen's d
HICB pre VAR Bundesliga	HICB post VAR Bundesliga	Student's t	-0.371	1.00	0.387	-1.10	2.96	-0.262

Note. H_a Measure 1 < Measure 2

Descriptives

	N	Mean	Median	SD	SE
HICB pre VAR Bundesliga	2	109	109	1.48	1.05
HICB post VAR Bundesliga	2	110	110	2.69	1.91

Figure 4.8: T-Test HICB Bundesliga – Before and after VAR

Plots

HICB pre VAR Bundesliga - HICB post VAR Bundesliga

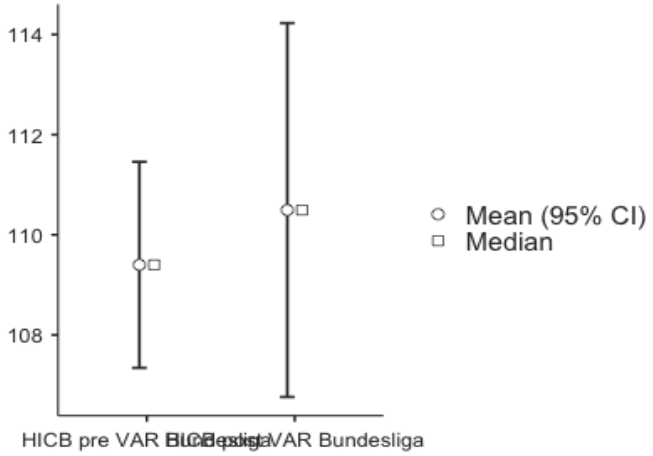

Figure 4.9: Plots – HICB Bundesliga – Mean and median before and after VAR

The mean difference in Figure 4.8 shows -1.10, which suggest that the HICB has increased with an average of 1,10 after VAR. This is higher than the expected rise of 0,24 HICB, but the p-value of 0,387 is too high to conclude.

4.1.4 C4ICB Bundesliga

When calculating the C4ICB for Bundesliga this was the results:

Bundesliga	
Season	**C4ICB**
09/10	137,92
10/11	141,05
11/12	149,12
12/13	148,39
13/14	151,05
14/15	148,03
15/16	149,29
16/17	146,62
17/18	138,50
18/19	148,05

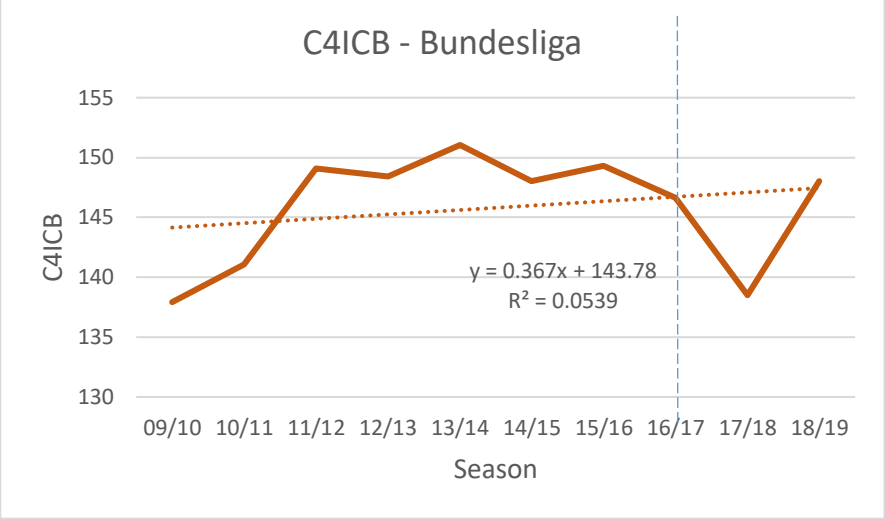

Figure 4.10: Development of C4ICB in Bundesliga over time

According to Figure 4.10 the C4ICB shows a slightly different development than the HICB, although with some similarities. Just like the HICB the graph shows an increase until peaking in 13/14, and then a decrease until the implementation of VAR. However, after the implementation of VAR, it drops significantly before bouncing back up for the 18/19 season. Regression predicts an increase of 0,367 C4ICB each season.

Paired Samples T-Test

			statistic	df	p	Mean difference	SE difference	Cohen's d
C4ICB pre VAR Bundesliga	C4ICB post VAR Bundesliga	Student's t	0.767	1.00	0.292	4.68	6.11	0.542

Note. H_a Measure 1 > Measure 2

Descriptives

	N	Mean	Median	SD	SE
C4ICB pre VAR Bundesliga	2	148	148	1.89	1.33

Descriptives

	N	Mean	Median	SD	SE
C4ICB post VAR Bundesliga	2	143	143	6.75	4.77

Figure 4.11: T-Test C4ICB Bundesliga – Before and after VAR

Plots

C4ICB pre VAR Bundesliga - C4ICB post VAR Bundesliga

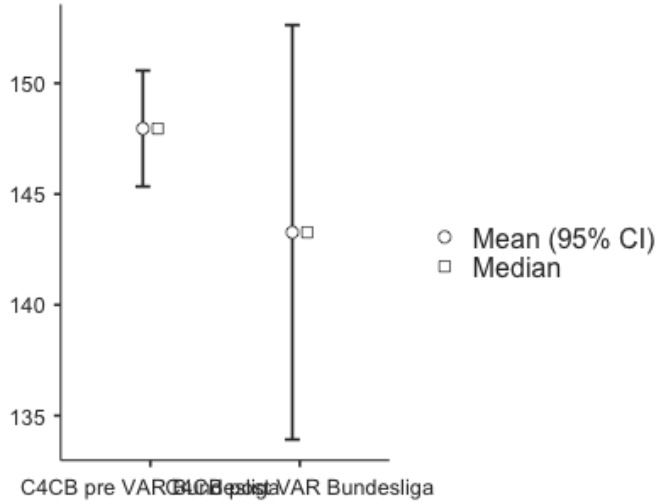

Figure 4.12: Plots – C4ICB Bundesliga – Mean and median before and after VAR

The mean difference in Figure 4.11 shows a decrease of 4,68 C4ICB after the implementation of VAR, despite the predicted increase of 0,37. However, the p-values are too high to conclude.

4.2 VAR increase the number of penalties

The results in this paragraph will also be presented both as a line chart and a t-test. The line chart will contain a full drawn graph which represent the actual number of penalties for each season, and a dotted regression line. The vertical stapled line represents the change from pre to post VAR-implementation.

4.2.1 Total penalties given – Serie A & Bundesliga

Season	Penalties	
	Serie A	Bundesliga
09/10	116	55
10/11	109	83
11/12	135	76
12/13	132	83
13/14	128	87
14/15	117	71
15/16	118	86
16/17	133	98
17/18	120	93
18/19	122	91

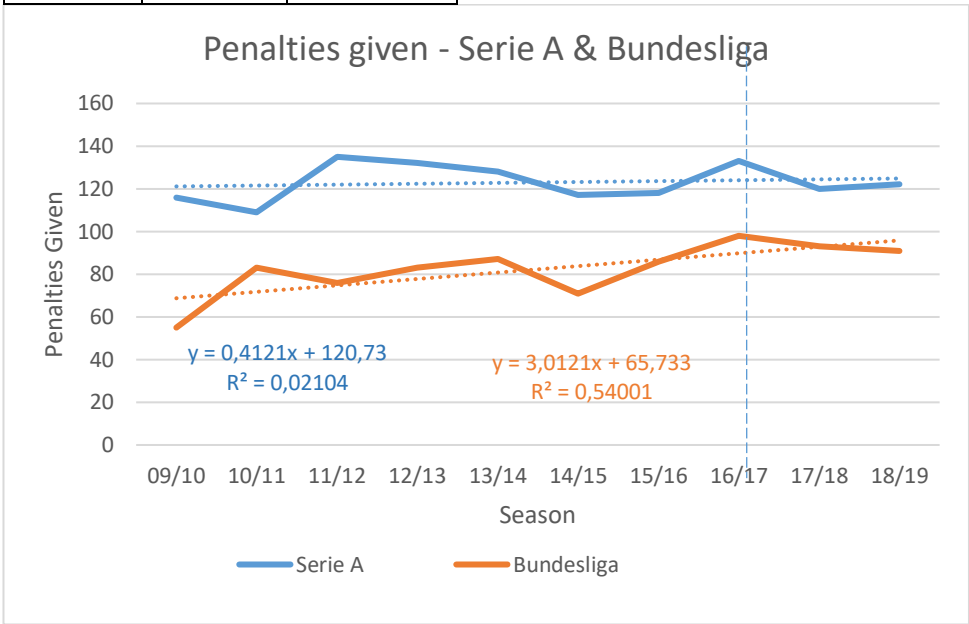

Figure 4.13: Development over Total Penalties Given in Serie A & Bundesliga

As shown in Figure 4.13, the number of penalties given in both Serie A and Bundesliga have been increasing slightly the last 10 seasons. The regressions predict an increase of 0,4 penalties per season in Serie A, and an increase of 3 penalties each season in Bundesliga After the implementation of VAR, the number of penalties seem to have decreased slightly.

Just like with the competitive balance, the two seasons before and after implementation of VAR were compered in a t-test. The hypothesis was set to Measure 1 > Measure 2 because the graph may indicate a slight decrease after implementation of VAR.

4.2.2 Difference Serie A

Paired Samples T-Test

			statistic	df	p	Mean difference	SE difference	Cohen's d
Penalties pre VAR Serie A	Penalties post VAR Serie A	Student's t	0.692	1.00	0.307	4.50	6.50	0.490

Note. H_a Measure 1 > Measure 2

Descriptives

	N	Mean	Median	SD	SE
Penalties pre VAR Serie A	2	126	126	10.61	7.50
Penalties post VAR Serie A	2	121	121	1.41	1.00

Figure 4.14: T-Test Total Penalties Given Serie A – Before and after VAR

Plots

Penalties pre VAR Serie A - Penalties post VAR Serie A

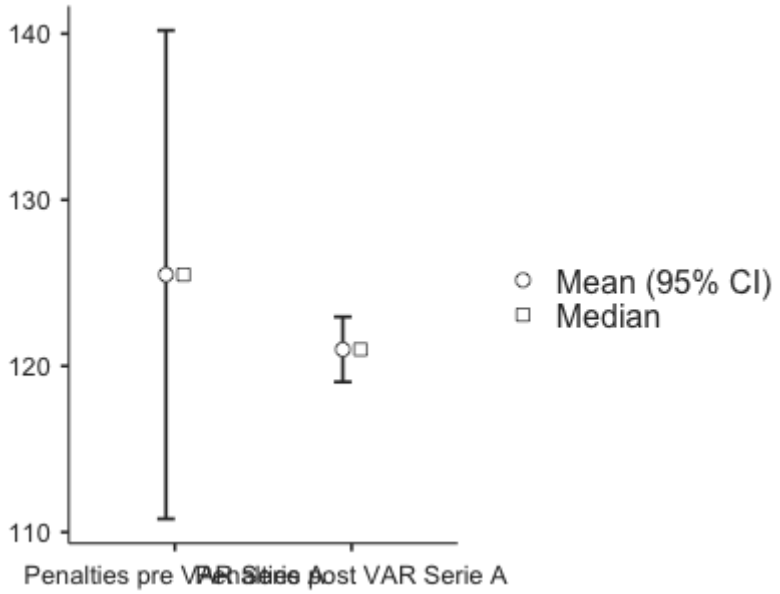

Figure 4.15: Plots – Penalties Given Serie A – Mean and median before and after VAR

In Serie A, the t-test in Figure 4.14 shows a reduction of 4,5 penalties after VAR, despite the general increase of 0,4 penalties per season. However, the p-values are too high to conclude.

4.2.3 Difference Bundesliga

Paired Samples T-Test

			statistic	df	p	Mean difference	SE difference	Cohen's d
Penalties pre VAR Bundesliga	Penalties post VAR Bundesliga	Student's t	0.00	1.00	0.500	0.00	7.00	0.00

Note. H_a Measure 1 > Measure 2

Descriptives

	N	Mean	Median	SD	SE
Penalties pre VAR Bundesliga	2	92.0	92.0	8.49	6.00
Penalties post VAR Bundesliga	2	92.0	92.0	1.41	1.00

Figure 4.16: T-Test Penalties Given Bundesliga – Before and after VAR

Plots

Penalties pre VAR Bundesliga - Penalties post VAR Bundesliga

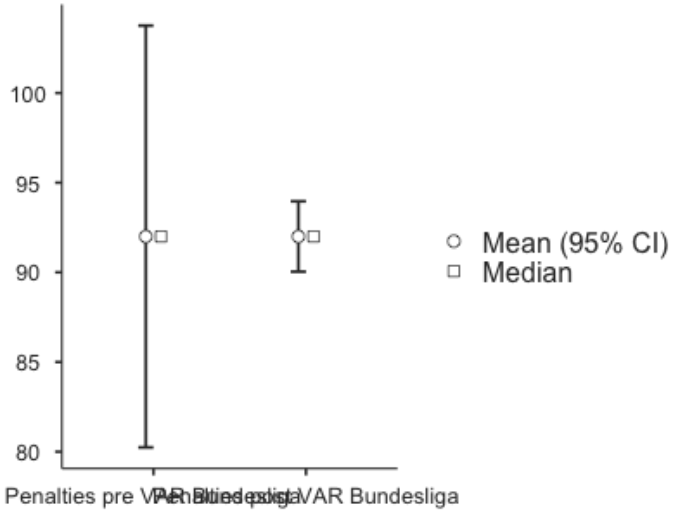

Figure 4.17: Plots – Penalties Given Bundesliga – Mean and median before and after VAR

In Bundesliga, the t-test in Figure 4.16 shows no difference between pre and post VAR, despite an expected increase of 3 penalties per season. However, the p-values are too high to conclude.

4.3 Correlation between penalties and competitive balance

The hypothesis claims that a higher number of penalties benefits the stronger teams, and therefore reduces the competitive balance. Since a high value in HICB or C4ICB represents a low competitive balance, there should be a positive correlation between penalties given and HICB/C4IBC in order to support the hypothesis.
The results will be presented as a scatter plot with a regression line, and also as a correlation analysis.

4.3.1 Penalties & HICB Serie A

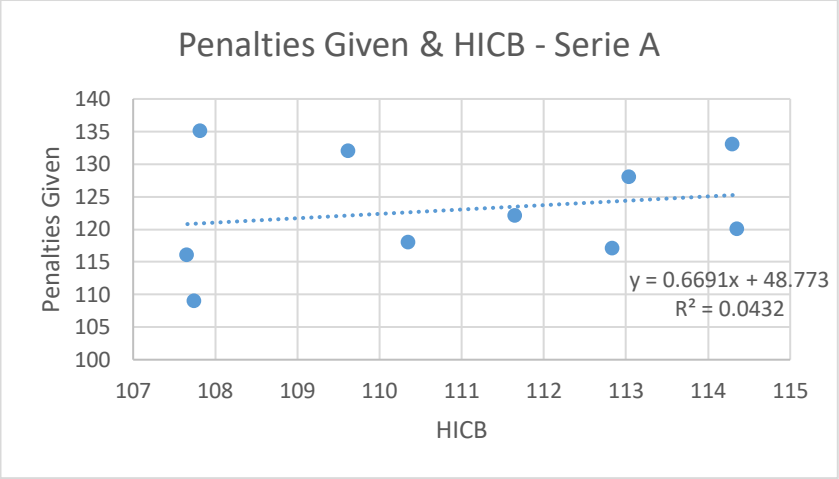

Figure 4.18: Relationship between penalties given & HICB in Serie A

Correlation Matrix

		HICB Serie A	Penalties Given Serie A
HICB Serie A	Pearson's r	—	
	p-value	—	
	N	—	
Penalties Given Serie A	Pearson's r	0.208	—
	p-value	0.282	—
	N	10	—

Note. H_a is positive correlation

Figure 4.19: Correlation between penalties given & HICB in Serie A

In Serie A, the Pearson`s r in Figure 4.19 shows a correlation of 0,208, which represents a weak correlation. However, a p-value of 0,282 is too high to conclude.

4.3.2 Penalties & HICB Bundesliga

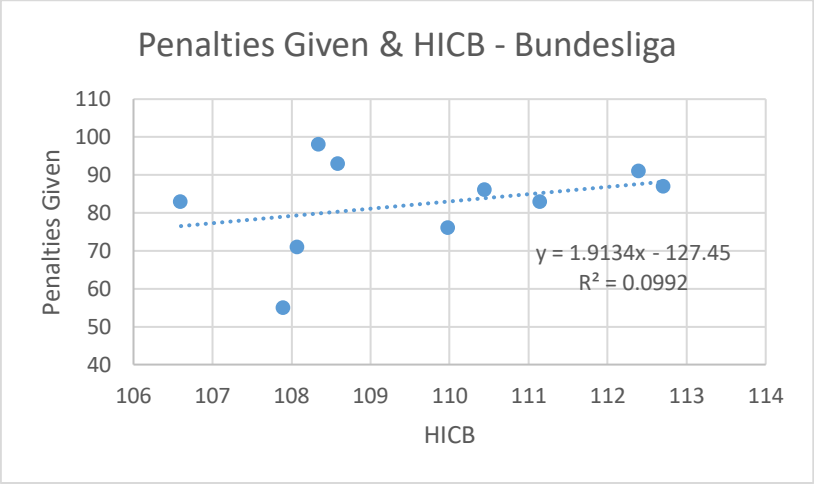

Figure 4.20: Relationship between penalties given & HICB in Bundesliga

Correlation Matrix

		HICB Bundesliga	Penalties Given Bundesliga
HICB Bundesliga	Pearson's r	—	
	p-value	—	
Penalties Given Bundesliga	Pearson's r	0.315	—
	p-value	0.188	—

Note. H_a is positive correlation

Figure 4.21: Correlation between penalties given & HICB in Bundesliga

For Bundesliga, presented in Figure 4.21, the Pearson`s r shows 0,315. This represents a weak correlation. However, the p-value of 0,188 is too high to conclude.

4.3.3 Penalties & HICB Bundesliga & Serie A

In order to increase the sample size in a hope to get the sufficient p-values, data from both leagues were included in one correlation analysis. When investigating the relationship between penalties given and competitive balance in both leagues together, penalties per team will be used instead of total penalties. This is because of the different number of in the two leagues, which again leads to a different number of games played.

The average penalties given per team for each season is found by the following formula:

$$\boldsymbol{Penalties\ per\ team = \frac{Total\ penalties}{Number\ of\ teams}}$$

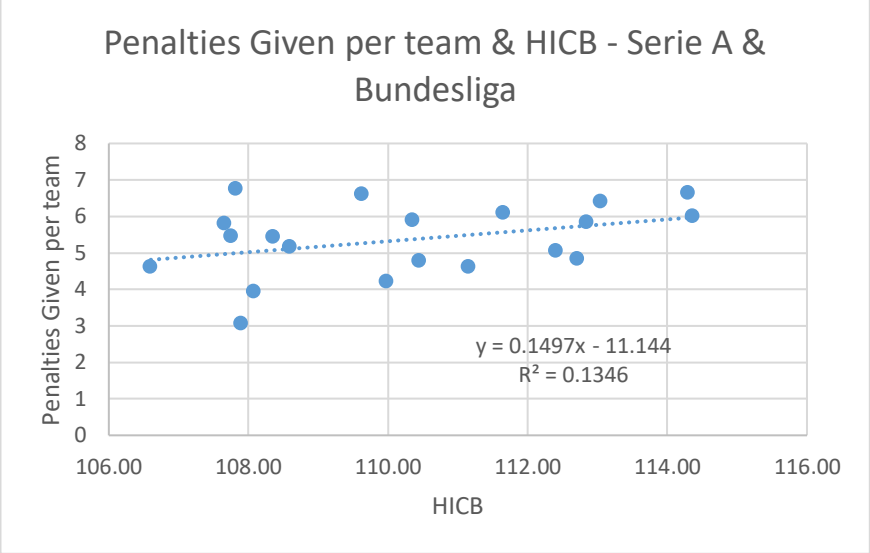

Figure 4.22: Relationship between penalties given & HICB in Serie A & Bundesliga

Correlation Matrix

		Pen per team BL&SA	HICB SA & BL
Pen per team BL&SA	Pearson's r	—	
	p-value	—	
	N	—	
HICB SA & BL	Pearson's r	0.367	—
	p-value	0.056	—
	N	20	—

Note. H_a is positive correlation

(SA=Serie A, BL=Bundesliga)

Figure 4.23: Correlation between penalties given & HICB in Serie A & Bundesliga

When including data from both leagues, in Figure 4.23, the Pearson`s r shows **0,367** which is a weak correlation. However, the p-value of 0,056 is still too high to conclude.

4.3.4 Penalties & C4ICB Serie A

The same procedure is followed when checking for correlation between penalties given and C4ICB.

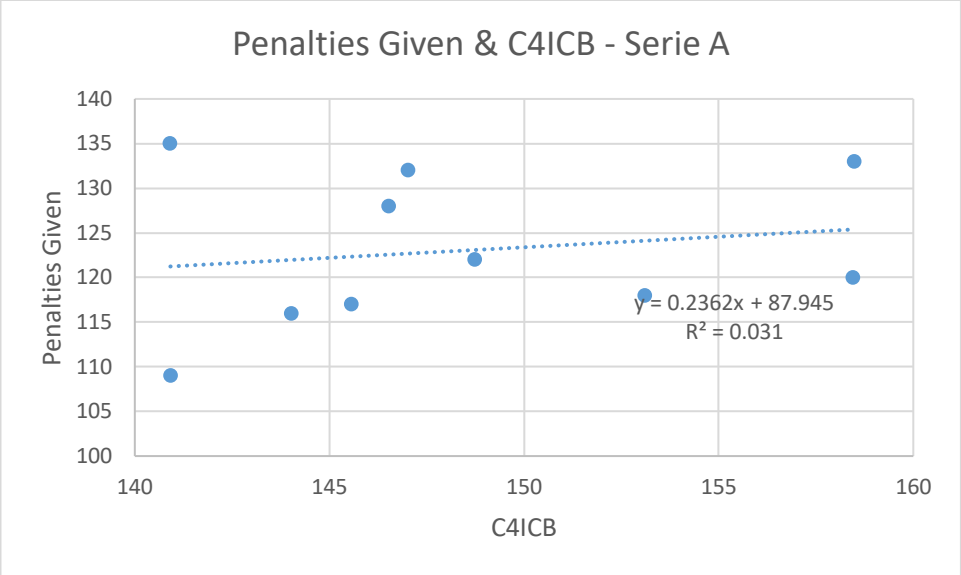

Figure 4.24: Relationship between penalties given & C4ICB in Serie A

Correlation Matrix

		Penalties Given Serie A	C4ICB Serie A
Penalties Given Serie A	Pearson's r	—	
	p-value	—	
	N	—	
C4ICB Serie A	Pearson's r	0.176	—
	p-value	0.313	—
	N	10	—

Note. H_a is positive correlation

Figure 4.25: Correlation between penalties given & C4ICB in Serie A

For Serie A, the Pearsons r in Figure 4.25, shows 0,176, which is a very weak correlation. The p values are also too high to conclude.

4.3.5 Penalties & C4ICB Bundesliga

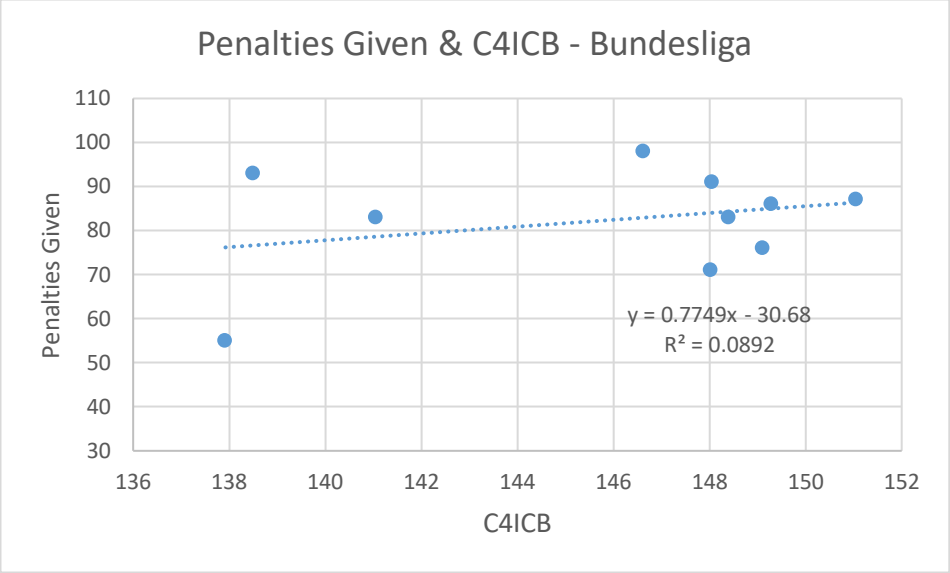

Figure 4.26: Relationship between penalties given & C4ICB in Bundesliga

Correlation Matrix

		Penalties Given Bundesliga	C4ICB Bundesliga
Penalties Given Bundesliga	Pearson's r	—	
	p-value	—	
	N	—	
C4ICB Bundesliga	Pearson's r	0.299	—
	p-value	0.201	—
	N	10	—

Note. H_a is positive correlation

Figure 4.27: Correlation between penalties given & C4ICB in Bundesliga

For Bundesliga, the Pearson`s r in Figure 4.27, shows 0,299, which is a weak correlation. However, the p-value of 0,201 is too high to conclude.

4.3.6 Penalties & C4ICB Serie A & Bundesliga

In an attempt to reach sufficient p-values, data from both leagues were included in one analysis.

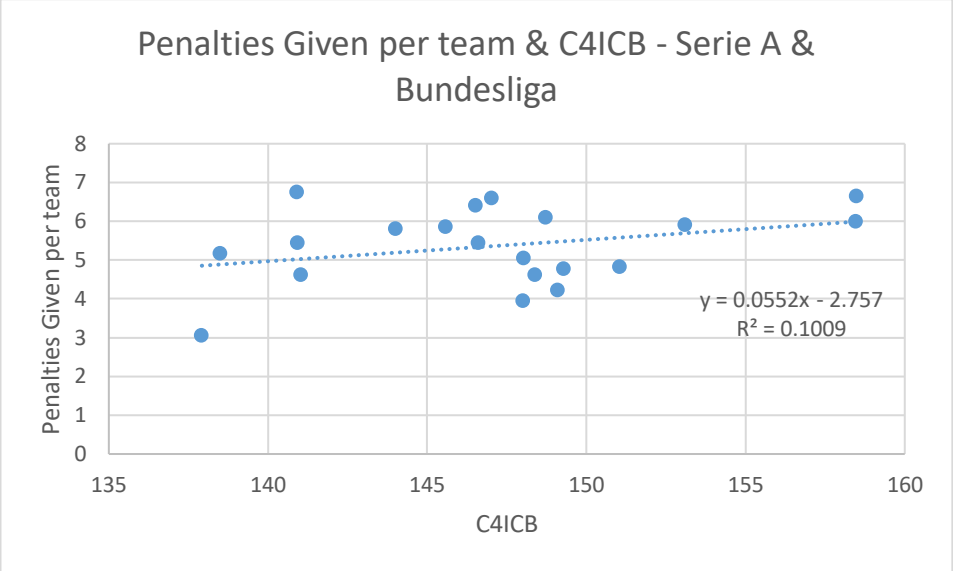

Figure 4.28: Relationship between penalties given per team & C4ICB in Serie A & Bundesliga

Correlation Matrix

		C4ICB SA&BL	Pen per team BL&SA
C4ICB SA&BL	Pearson's r	—	
	p-value	—	
	N	—	
Pen per team BL&SA	Pearson's r	0.318	—
	p-value	0.086	—
	N	20	—

Note. H_a is positive correlation

Note. * p < .05, ** p < .01, *** p < .001, one-tailed
(SA= Serie A, BL= Bundesliga)

Figure 4.29: Correlation between penalties given & C4ICB in Serie A & Bundesliga

When including data from both leagues in Figure 4.29, the Pearsons r shows 0,318. This is a weak correlation. However, the p-value of 0,086 is still too high.

4.4 Stronger teams benefit the most from increased number of penalties

Due to the insufficient p-values, it is hard to conclude that there is a correlation between number of penalties and competitive balance. But for the sake of the argument; could a possible correlation be explained by the assumption that the stronger teams are more likely to be given a penalty?

Again, the results will be presented as a scatterplot with a regression line, and as a correlation matrix. The leagues will only be investigated individually, because of the different number of teams. Because a high league position would take a low numerical value (closer to 1), a negative correlation would support the hypothesis.

4.4.1 Penalties & League Position Serie A

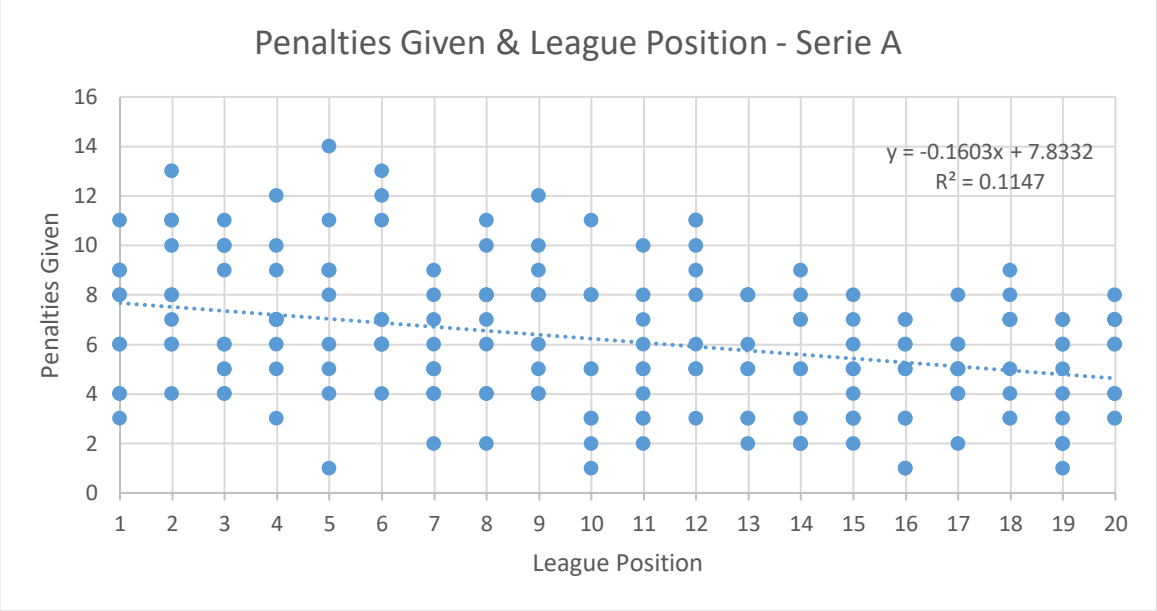

Figure 4.30: Relationship between penalties given & league position in Serie A

Correlation Matrix

		League Position Serie A-team	Penalties Given Serie A-team
League Position Serie A-team	Pearson's r	—	

Correlation Matrix

		League Position Serie A-team	Penalties Given Serie A-team
	p-value	—	
	N	—	
Penalties Given Serie A-team	Pearson's r	-0.339 ***	—
	p-value	< .001	—
	N	200	—

Note. * p < .05, ** p < .01, *** p < .001

Figure 4.31: Correlation between penalties given & league position in Serie A

In Serie A, the Pearson`s r in Figure 4.31, shows -0,339, which is a weak negative correlation. The p-value of <0,001 shows that the result is statistically significant.

4.4.2 Penalties & League Position Bundesliga

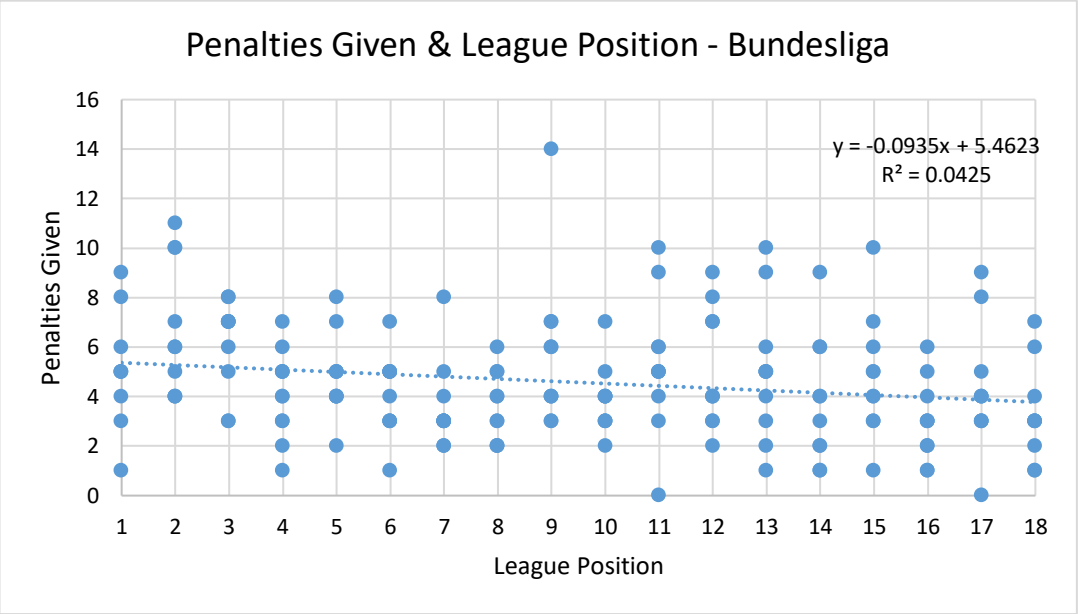

Figure 4.32: Relationship between penalties given & league position in Bundesliga

Correlation Matrix

		League Position Bundesliga-team	Penalties Given Bundesliga-team
League Position Bundesliga-team	Pearson's r	—	
	p-value	—	
	N	—	
Penalties Given Bundesliga-team	Pearson's r	-0.206 **	—
	p-value	0.005	—
	N	180	—

Note. * p < .05, ** p < .01, *** p < .001

Figure 4.33: Correlation between penalties given & league position in Bundesliga

In Bundesliga, the Pearson`s r in Figure 4.33, shows -0,206, which is a weak negative correlation. The p-value of 0,005 shows that the result is statistically significant.

4.4.3 Penalties & Top four Serie A

In an attempt to find the difference between top four teams and the rest of the league, a dummy variable was set to distinguish between top four and the rest. LP ≤4 = 1 and LP ≥5 = 0. In consequence, the hypothesis is that 0 < 1.

The results for each league will be presented in an independent sampled t-test.

Independent Samples T-Test

		statistic	df	p	Mean difference	SE difference	Cohen's d
Penalties Given Serie A-team	Student's t	-3.13	198	0.001	-1.47	0.469	-0.548

Note. H_a 0 < 1

Group Descriptives

	Group	N	Mean	Median	SD	SE
Penalties Given Serie A-team	0	159	5.85	6.00	2.69	0.213
	1	41	7.32	7.00	2.63	0.411

Figure 4.34: T-test – Penalties given –5-20 vs Top 4 – Serie A

Plots

Penalties Given Serie A-team

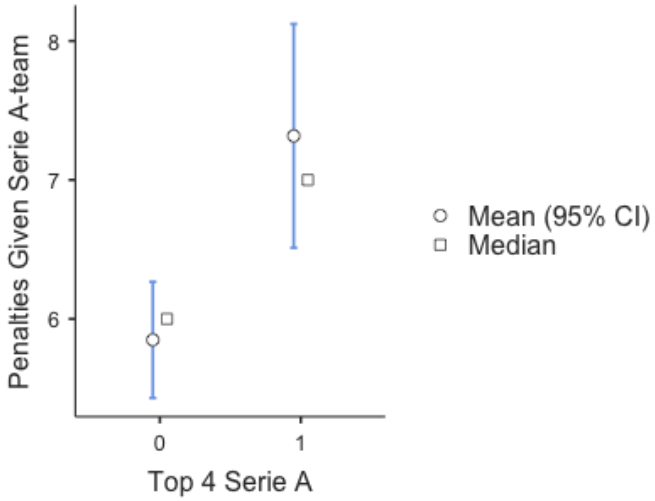

Figure 4.35: Plots – 5-20 vs Top 4 – mean and median in Serie A

In Serie A, the mean difference is -1,47, as shown in Figure 4.34. In other words, top four teams get on average 1,47 penalties more than the rest of the league each season. Top four teams get on average 7,32 penalties, while 5th-20th get on average 5,85 penalties per season. The p-value of 0,001 indicates that the results are statistically significant.

4.4.4 Penalties & Top four Bundesliga

Independent Samples T-Test

		statistic	df	p	Mean difference	SE difference	Cohen's d
Penalties Given Bundesliga-team	Student's t	-2.81	178	0.003	-1.16	0.413	-0.503

Note. H_a 0 < 1

Group Descriptives

	Group	N	Mean	Median	SD	SE
Penalties Given Bundesliga-team	0	140	4.31	4.00	2.29	0.194
	1	40	5.47	5.00	2.35	0.372

Figure 4.36: T-test – Penalties given –5-18 vs Top 4 – Bundesliga

Plots

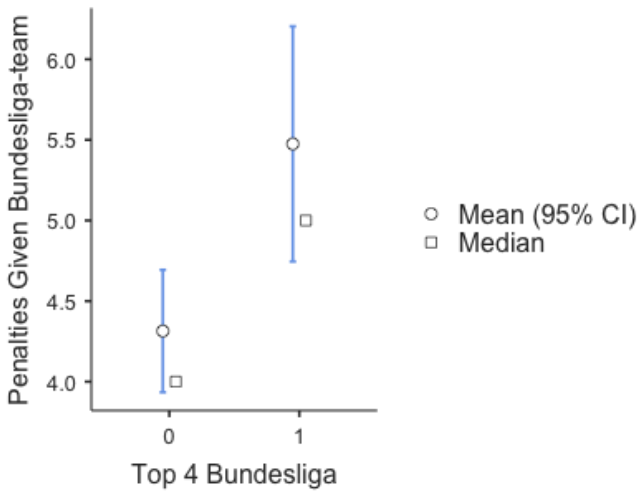

Figure 4.37: Plots – 5-18 vs Top 4 – mean and median in Bundesliga

In Bundesliga, the mean difference is -1,16, as shown in Figure 4.36. In other words, top four teams get on average 1,16 penalties more than the rest of the league each season. Top four teams get on average 4,31 penalties, while 5th-18th get on average 5,47 penalties per season. The p-value of 0,003 indicates that the results are statistically significant.

4.5 Are stronger teams more efficient penalty shooters?

In an attempt to further support the hypothesis that the best teams benefit from an increased number of penalties given, we take a look at the relationship between league position and goal% of penalties given. A negative correlation would support the hypothesis. The goal% of penalties given is calculated for each team by the following formula:

$$\textbf{Goal\% of penalties given} = \frac{\textbf{Penalties scored}}{\textbf{Penalties given}}$$

4.5.1 Penalty Efficiency & League Position - Serie A

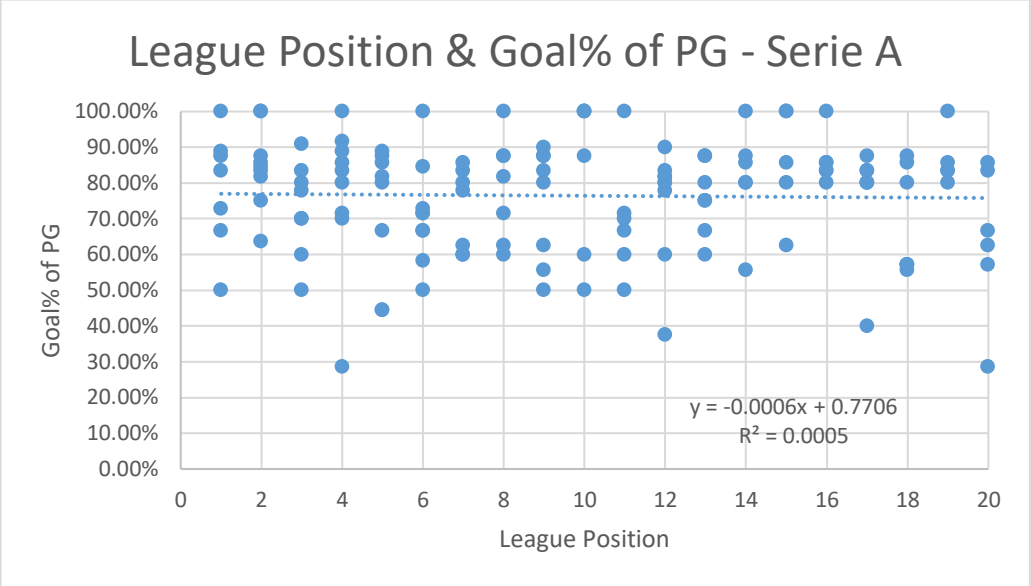

Figure 4.38: Relationship between penalty efficiency & league position in Serie A

Correlation Matrix

		Goal% from penalties Serie A	League position >4 Penalties Serie A
Goal% from penalties Serie A	Pearson's r	—	
	p-value	—	
	N	—	
League position (5+ Penalties) Serie A	Pearson's r	-0.023	—
	p-value	0.393	—
	N	142	—

Note. H_a is negative correlation

Note. * p < .05, ** p < .01, *** p < .001, one-tailed

Figure 4.39: Correlation between penalty efficiency & league position in Serie A

For Serie A, Figure 4.39 shows a Pearson`s r of -0,023, which represents no correlation. The p-value is also too high to conclude.

4.5.2 Penalty Efficiency & League Posistion – Bundesliga

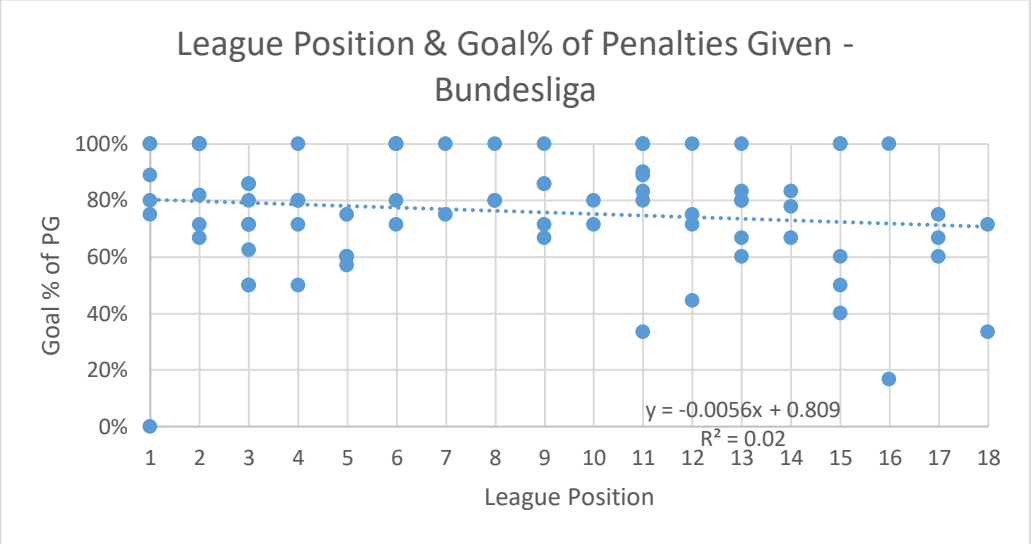

Figure 4.40: Relationship between penalty efficiency & league position in Bundesliga

Correlation Matrix

		Goal% from penalties Bundesliga	League position (5+ Penalties) Bundesliga
Goal% from penalties Bundesliga	Pearson's r	—	
	p-value	—	
League position (5+ Penalties) Bundesliga	Pearson's r	-0.142	—
	p-value	0.105	—

Note. H_a is negative correlation

Figure 4.41: Correlation between penalty efficiency & league position in Bundesliga

For Bundesliga, Figure 4.41 shows a Pearson`s r of -0,142, which represents a weak negative correlation. However, the p-value of 0,105 is too high to conclude.

4.5.3 Penalty Efficiency & Top four – Serie A

In an attempt to find the difference between top four teams and the rest of the league, a dummy variable was set to distinguish between top four and the rest. LP ≤4 = 1 and LP ≥5 = 0. In consequence, the hypothesis is that 0 < 1. The results for each league will be presented in an independent sampled t-test.

Independent Samples T-Test

		statistic	df	p	Mean difference	SE difference	Cohen's d
Goal% from penalties Serie A	Student's t	-0.885	140	0.189	-0.0275	0.0311	-0.176

Note. H_a 0 < 1

Group Descriptives

	Group	N	Mean	Median	SD	SE
Goal% from penalties Serie A	0	109	0.758	0.800	0.156	0.0149
	1	33	0.786	0.833	0.157	0.0274

Figure 4.42: T-test: Penalty efficiency – 5-20 vs Top 4 – Serie A

Plots

Goal% from penalties Serie A

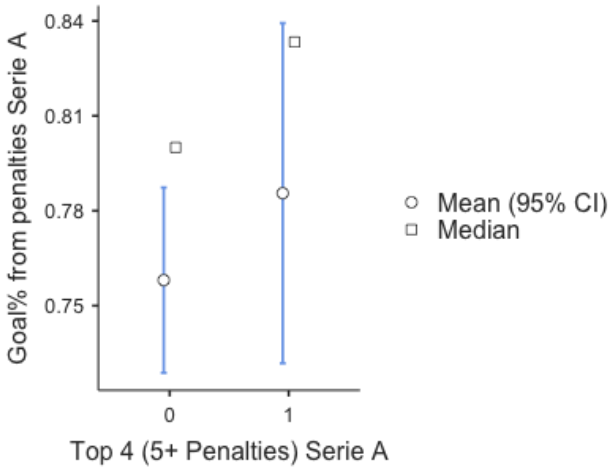

Figure 4.43: Plots – Penalty efficiency – 5-20 vs Top 4 – Mean & median in Serie A

For Serie A, the mean difference in Figure 4.42 shows -0,0275. This means that top four teams score on average 2,75% more of their penalties. However, the p-value of 0,189 is not statistically significant.

4.5.4 Penalty Efficiency & Top four - Bundesliga

Independent Samples T-Test

		statistic	df	p	Mean difference	SE difference	Cohen's d
Goal% from penalties Bundesliga	Student's t	-0.336	78.0	0.369	-0.0164	0.0489	-0.0794

Note. H_a 0 < 1

Group Descriptives

	Group	N	Mean	Median	SD	SE
Goal% from penalties Bundesliga	0	53	0.757	0.778	0.199	0.0274
	1	27	0.773	0.800	0.221	0.0425

Figure 4.44: Figure 4.44: T-test: Penalty efficiency – 5-18 vs Top 4 – Bundesliga

Plots

Goal% from penalties Bundesliga

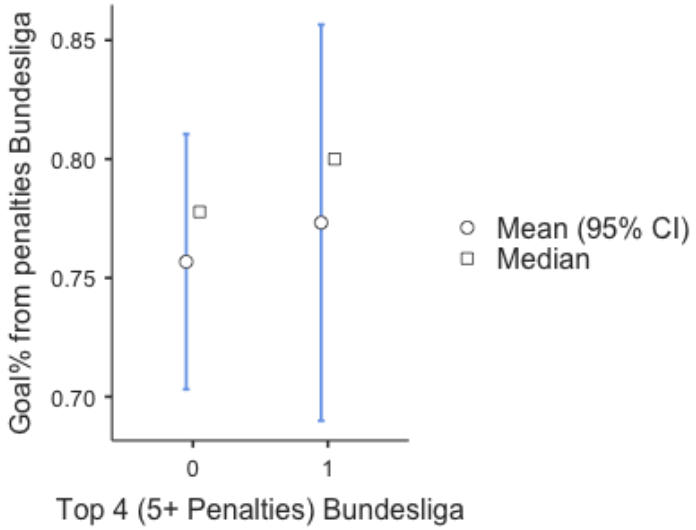

Figure 4.45: Plots - Penalty efficiency – 5-18 vs Top 4 – Mean & median in Bundesliga

For Bundesliga, the mean difference in Figure 4.44 shows -0,0164. This means that top four teams score on average 1,64% more of their penalties. However, the p-value of 0,369 is not statistically significant.

5.0 Discussion

5.1 VAR`s impact on competitive balance

When looking at HICB and C4ICB in both leagues over the last ten seasons, they all show a steady increase. This means that both league´s competitive balance is on a general decrease, and that the gap between the top four teams and the rest are generally getting bigger.

After the implementation of VAR, the HICB in Serie A seems to have stagnated. It has continued to rise, but slightly less than what was expected. The C4ICB in Serie A have had a slight reduction, suggesting that the gap between the top four and the rest have shrunken. However, due to high p-values it is not possible to make strong conclusion about these findings. In other words, the results fail to prove any significant change in competitive balance after implementation of VAR.

In Bundesliga, the HICB have actually had a higher increase after VAR than what was expected, which might suggest that VAR have impacted the leagues competitive balance negatively. The C4ICB tells a different story, with a slight reduction. This might suggest that just like in Serie A, the top four have become a less dominant force. However, since also these findings are insignificant, the results fail to prove any changes on the leagues competitive balance after VAR.

With insignificant results, it is impossible to make strong conclusions, but the early signs seem to speak against Haugen`s (2019) hypothesis about VAR`s negative impact on competitive balance. This research does not look into the relationship between competitive balance and customer's willingness to pay, and how much the demand curve will potentially shift at a given change in competitive balance. However, it is questionable that, even with significant results, slight changes in competitive balance would be noticeable enough among the average spectator to affect their willingness to pay. It is worth keeping in mind that the Average Joes, the Otto Normalverbrauchers and the Mario Rossis of the football universe usually refrain from in-depth statistical analyses before renewing their season tickets or streaming subscriptions.

It is however, possible that a small change in competitive balance might lead to a bigger impact in the long run. If the gap between top four and the rest of the league is reduced, it might cause a more frequent change in which teams the top four includes. This will lead to a more balanced distribution of revenues gained from Champions League, which might be reflected in more balanced sporting capabilities in the long run.

Equally, if the gap gets bigger, and it is the same clubs qualifying for Champions League every year, the barriers might be stronger for each season, because of the financial disparity.

5.2 VAR`s impact on penalties

The development of total penalties given in the two leagues, shows that both leagues have had an increasing number over the last ten seasons. However, after implementation of VAR, the numbers seems to have reduced slightly in Serie A, and stagnated/remained unchanged in Bundesliga. Also in these findings, the p-values showed to be insignificant, which makes it hard to conclude with anything. The early signs however, seems to contradict Haugen´s (2019) assumption that VAR would lead to an increased number of penalties.

We cannot exclude the possibility that there are some psychological and tactical factors related to VAR and penalties, that might take time to settle. If teams find out that attacking set pieces are more likely to lead to penalties, then tactical specialization and the players mind set inside oppositions penalty area might slowly change over time, and the effect will not be visible yet. Also, both leagues are still in a learning phase when it comes to VAR. Potential cultural and institutional differences between leagues might lead to different practices when the technology fully finds its feet. These potential differences are also a reason why we have to be careful with generalizing the findings to elite football in general, before having investigated other leagues.

5.3 Correlation between penalties and competitive balance

When investigating the correlation between penalties and competitive balance in the two leagues, both Serie A and Bundesliga shows a weak correlation. Both when checking for correlation between HICB and penalties, and when checking for correlation between C4ICB and penalties. However, the results when investigating the leagues individually was insignificant. When checking the leagues together, the results turned out to be what the optimistic researcher would describe as "*trending towards significance*". This is still some way from proving correlation, but it is at least an indicator that there might be some truth to parts of Haugen´s (2019) hypothesis, and enough to encourage further research.

As mentioned in chapter 3, a potential correlation does not necessarily imply causality. Both penalties and the measures for competitive balance seems to have had a steady rise in recent years. The rise of HICB and C4ICB might be caused by an increasing financial disparity. The increasing number of penalties might be caused by the referees increasing protecting of players, or that players simply improve their abilities to construct certain types of situations.

5.4 Do stronger teams get more penalties?

When checking for correlation between penalties and league position, it was found a significant weak correlation in both leagues. It was also a significant difference between top four teams and the rest of the league. This suggests that stronger teams get more penalties than weaker teams, and might help to explain a potential correlation between penalties and competitive balance.

However, it is questionable exactly how strong impact it has on competitive balance. The t-test shows that top four teams in Serie A get on average 1,47 penalties more than the rest each season. In Bundesliga, the difference is on average 1,16 penalties. In other words, between 1-2 penalties more. Let´s imagine that the team that finishes as number 4 in Serie A is statistically lucky and get 2 penalties more than number 5 in the league. If both of the penalties are given at the perfect timing, this will give 4 extra points (given that both are scored). Will this be enough to make the difference between qualifying for Champions League or not? Perhaps. But how likely is this to happen? After all the extra penalty is

more likely to be 1 than 2, and the extra penalty is not guaranteed to lead to any extra points.

In Bundesliga, the number of extra penalties for a top four-team are even more likely to be 1 than 2. This would in best case scenario give 2 extra points. Still, it is possible that this is the difference between 4 and 5. But how noticeable is it on the uncertainty of outcome? Of course, it is reasonable to assume that *if* VAR indeed makes a strong impact on the total number of penalties, the gap between top four and the rest will move accordingly. But so far it is questionable if the potential impact would be strong enough.

5.5 Are stronger teams more efficient penalty shooters?

The results show a is a *very* weak correlation between league position and penalty efficiency. It also finds a slight difference between top four and the rest of the league. However, the p-values are too high to support the hypothesis.

6.0 Conclusion

6.1 H1 – VAR have a negative impact on a leagues competitive balance

Study **fail** to support the hypothesis.
Early signs are that the leagues have become more competitive after VAR, but too high p-values to conclude.

6.2 H2 – VAR increase a leagues number of penalties

Study **fail** to support the hypothesis.
Early signs are that the penalties have reduced, but p-values too high to conclude.

6.3 H3 – There is a negative correlation between VAR and Competitive balance

Study **fail** to support the hypothesis.
Early signs are that there might be some truth to it, but more research needed to strongly conclude.

6.4 H4 – Stronger teams are awarded more penalties

The study **supports** this hypothesis.
A significant weak correlation is found between number of penalties and league position in both leagues. The study also finds a small difference between top four teams and the rest.

6.5 H5 – Stronger teams are more efficient penalty shooters

Study **fail** to support this hypothesis
No proven correlation is found between goal% of penalties given and league position.
No proof of difference between top four and the rest.

6.6 Suggested interpretation of study

The study finds that stronger teams get more penalties than weaker teams, but no significant difference in penalty efficiency. There might be a correlation between penalties and competitive balance, but no sufficient evidence. If the number of penalties should increase, the study suggest that this might benefit the stronger teams, and impact the competitive balance. However, the research finds no evidence of VAR´s impact on penalties. Although video has been accused of killing the football star, they are still innocent until proven guilty. Further research is needed to make strong conclusions.

6.7 Further research

The study shows some interesting results, but insufficient p-values makes it difficult to make strong conclusions. A larger post-VAR sample size in the future would be interesting to look into.

There are also some aspects of VAR this study does not touch upon. There is a possibility that a potential VAR related increase/decrease in red cards might have an impact on competitive balance. The study also does not actually look into exactly how many points VAR can take credit for. The timing of potential extra penalties, and match statistics in games between higher and lower ranked teams could be a possibility for further research.

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