厦門大學

本 科 毕 业 论 文

（主修专业）

豪门得利？——探究换人新规对足球比赛结果的影响

Favoring the Super?

--The Impact of the New Substitution Rule on Football Match Results

姓　　名：　王微明

学　　号：　15220182202676

学　　院：　王亚南经济研究院

专　　业：　经济学

年　　级：　大四

校内指导教师：　祝嘉良　　助理教授

二〇二二年五月三日

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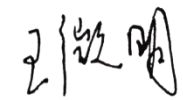
学生声明（签名）： 

2022 年　5 月　26 日

致谢

随着这篇论文的完成，我在厦门大学四年的生活也即将画上句号。

感谢祝嘉良老师、孟磊老师、叶仕奇学长。你们的支持给了我将自己感兴趣的领域作为研究方向的信心与动力。在论文撰写过程中，也是你们的悉心指导帮助我最终完成了这篇文章。

感谢与王亚南经济研究院对我的培养。不论今后是否会从事经济学相关的工作，我都将铭记这四年之所学，抱着严谨、求是、胸怀天下的态度面对今后的生活。

还要感谢 WISE2018 级的各位同学。大家共同营造出的包容、友善的班级氛围让我受益匪浅。四年间收到的每一份帮助、收获的每一段友谊我都将牢记于心，永远珍藏。祝大家今后前程似锦，谱写出属于自己的人生篇章！

摘要

本文研究了新冠疫情后实施的足球比赛换人新规对比赛结果的影响，并探究了资金更雄厚、资源更丰富的豪门球队是否会因换人的增加而受益更多。本文使用了 2018-2019 赛季（新规前）与 2020-2021 赛季（新规后）意大利足球甲级联赛的相关数据，先通过双样本 t 检验与方差分析排除了主场因素与对手强弱对新规实施后球队换人数量的影响，从而得出换人新规若使豪门球队受益更多，其潜在原因并非换人数量差距，而在于换人质量差距；此后将主队的表现（具体体现在净胜球，即进球数减失球数）与主队换人数进行回归分析，并在加入衡量豪门球队的虚拟变量及相应交叉项后进行了二次分析。该研究将新规实施前与实施后的比对贯穿始终，并将球员能力、主教练能力作为控制变量。回归结果显示：1.与 2018-2019 赛季相比，2020-2021 赛季中换人名额的增加将对净胜球增加起到显著促进作用。2.与普通球队相比，豪门球队受益于新规更多。此外，本文还发现豪门球队的净胜球优势与换人名额的利用率有关。当球队换人数小于 4 时，豪门球队在净胜球方面的表现不甚理想。潜在的原因包括相对较小的未完全利用换人名额场次以及样本选择偏差。

关键词：足球；换人规则；球队表现；意大利足球甲级联赛；双样本 t 检验

Abstract

This paper examines the effect of the new substitution rule implemented after COVID-19 on football match results. Moreover, it sheds light on whether super clubs with more resources will take advantage of this new rule that increasing total substitutes allowed from 3 to 5. Using the data of season 2018-2019 (pre-new rule) and season 2020-2021 (after new rule) of Serie A, I first conducted Welch two sample t-tests and ANOVA to rule out factors like being the home or away team and opponents' strength that could influence substitute numbers after the new rule, and concluded that the super clubs' advantage from this new rule, if exist, does not hinge on quantity of substitutes, but quality of substitutes. Then I related team performance of the home teams (in terms of goal difference, that is goals scored minus goals conceded) to number of substitutes made by the home teams. Then I analyzed this problem with a binary variable measuring super clubs and a corresponding interaction term added. The whole research is carried out with a comparison of before and after the new rule, together with players' abilities and managers' abilities controlled. The regression results indicate that: (i) compared to season 2018-2019, increased substitutes have a significant effect in increasing goal difference in season 2020-2021. (ii) super clubs indeed benefit more from this new rule than inferior clubs. Besides, the result shows that super clubs' goal difference dominance may have a bearing on the substitutes utilization rate. When making less than four substitutes, they may indeed experience worse performance in the way of goal difference, which could be explained by small size of substitutes-underutilized cases and sample selection bias.

Key Words: Football; Substitution Rule; Team Performance; Serie A; Two sample t-test

目录

Table of Contents

Chapter 1 Introduction

As the COVID-19 swept the whole world, football as a worldwide sport was also severely affected. Most football leagues were temporarily shut down in May 2020, and resumed several months later. As the season must end as scheduled so that the next season would not be affected, the remaining fixture were extremely tight. Most teams experienced a two to three matches per week schedule, which would generate heavy burdens for the players as they would have much less time to rest. To relief the players' fatigue and decrease the chances of injuries, FIFA carried out a new substitution rule: instead of the former three allowed substitutions, a maximum of five substitutions (with an additional allowed in extra time, where applicable) could be made in official matches.

Supporters of the new rule claim that it is a necessary change because modern football is totally different from football several decades ago as it is getting more and more intense. As players nowadays cover much more distance in ninety minutes than they used to do, increased substitution is a good chance to switch tired players off and bring new impulse to the match, so that the match can keep its fast pace and thus keep attracting audiences' eyeballs.

On the contrary, critics of this new rule are worrying about equity. They suspect that stronger clubs may take advantage of this new substitution rule by switching on and off more players with good quality to influence the trend of the match. The intuition behind this conjecture is clear. Compared with normal or inferior clubs, super clubs have more resources, more money, and thus deeper benches. With the implementation of the new substitution rule, they can now more efficiently utilize their resources, which is to bring more of their football stars on to the field and make a difference of the match, while the normal or inferior clubs may only switch on players less desirable compared with the starting lineup. Moreover, in the long term, the new rule may also induce the Matthew Effect to the football world. To be more

specific, more substitutes allowed would lead to more player hoarding behavior for the super clubs, as they have the capacity and would be excellent choice for players chasing those trophies. More hoarding behavior would further result in better options from the bench, and thus bring more advantages to super clubs. As for those inferior clubs, due to the limited budget constraint together with the low marginal benefits of investing on the bench players who may not be able to play on the pitch, their optimal choice would be focusing on the line-up eleven. As a result, it would be possible that in the long run, stronger teams become stronger, while weaker team become weaker.

However, whether the super clubs will benefit more from the new substitution rule are not that obvious. As a matter of fact, four of the five defending champions failed to retain the title in season 2020-2021, and in the 2020 European Cup, which was postponed to 2021 and carried out the new substitution rule, the champion Italy did not seem to have a deeper bench than the teams they have beaten in their way out. Thus, a simple glimpse at the title owner would not help. More rigorous studies need to be conducted.

This paper relates team performance on number of substitutes, focusing on the effect of increased substitutes on match results, and whether super clubs will benefit more from the new rule than inferior clubs with regression models. Due to the relatively short period after the implementation of the new rule, this paper may have problems such as small dataset, and covering one tournament only, but should play a pioneering role in the investigation of the new substitution rule, and generate insights on the effect of substitutes on match results.

Chapter 2 Literature Review

As this paper is discussing the effect of increased substitutions on team performance, before entering this specific question, we should first see what previous studies have done about the determinants of team performance. Generally, previous research could be divided into macro level and micro level in terms of the determinants. As for studies of the macro level determinants, researchers focused on the factors outside the field, or beyond the ninety minutes match in other words, to see in what significance of those factors could influence match results, and furtherly have an impact on team performance. Up to now, the most discussed factor was the home effect. Carlos (2020) examined the home team advantage in terms of crowd size. According to him, the exogenous increase in attendance did not increase home team advantage, which means that the match performance of home team would not become better if the number of audiences increase. Fischer and Haucap (2021) also wrote a well-designed paper about the relation between crowd support and home advantage. They cleverly made use of the COVID-19 pandemic, which brought the so called “ghost game” at the end of the 2019/2020 season. Due to the empty field restriction, a unique “natural experiment” could be conducted. The authors found that there is a reduced home advantage in the first divisions, but not the lower divisions. Besides, they also concluded that the psychology reasons are of higher importance on the home advantage. Other aspects are also investigated. Winfree (2020) analyzed how the importance and characteristics of the previous match could influence the outcome of the game. In accordance with him, if the match between one team and its previous opponent are close, the team would be adversely affected in the next match, and the location of the previous game, or whether the team travelled a lot for the next game would not have a bearing on the next game’s result. Scoppa (2013) investigated the role of fatigue in football matches. Using data of all the tournaments of World Cup and European Football Championship played by national teams, Scoppa successfully related team performance, including points gained and goals scored, to the respective days of rests that teams have had after their previous

match. He showed that there are no relevant effects of enjoying different days of rest on team performance under the current structure of major tournaments, however, before 1990s days of rest had a positive impact on performance, presumably because athletic preparation of players was less effective.

Previous works focused on micro level of determinants laid stress on the on-field factors, which could influence the game during the ninety minutes. Weimar and Wicker's study (2014) related football team performance to a baseball theory called *Moneyball*, which shed light on player's efforts (running distance in this case) versus match results. They used data of three consecutive seasons of the German Bundesliga, and applied two measures: total distance run and number of intensive runs. In their ultimate model, running distance has a positive effect while the intensive runs have a negative effect. The finding is inspiring because it calls for the decision makers of clubs to pay more attention to players' statistics on field. Meier, Flepp, Ruedisser, at el. (2020) scrutinized the effect of scoring a goal just before the half-time. Checking the top five European leagues, they managed to show that in the case of a goal being scored just before halftime, the scoring team benefits more from the half-time break than the conceding team. An interesting research conducted by Hlasny and Kolaric (2013) even focused on the referee's preference. One of their conclusions is that distances between referees' hometowns and stadiums appear to play a role in his decision-making process, which might lead the game to an opposite result. Moreover, the influence increases with the referee's experience with the specific teams.

The above factors, both micro and macro level, are regarded as parallel relationship with this paper's focus, which revolves around substitutions. Though not directly correlated with this paper, the studies done by others share the same theme with this one: to see how on-field and off-field factors could impact team performance. Undoubtedly, their analyzing methods gave me insights to do this research, including the leagues selected as data sample, the selection of variables depicting team performance, etc.

For substitutions, existing literatures have not paid too much attention on substitutions, especially after the new rule has been carried out. Corral, Barros and Rodriguez (2007) analyzed determinants of football substitutions with an inverse Gaussian hazard model, and concluded that the score mostly explain the timing of substitutions, and defensive substitutions come later than offensive substitutions, together with home teams make more half time substitutions than away teams. As for the paper's hypothesis, that top clubs benefit more from the new rule, though not directly digging into substitution-directed consequences, previous paper did lay a foundation for this topic in terms of the so-called Matthew Effect after some policy changes in the football world and the aftermath of it. Pawlowski, Breuer and Hovermann (2010) have researched about the impact of increased payouts in the Union of European Football Associations Champions League in 1999-2000. The article indeed found a significant decrease in competitive balance after the modification of the CL payout system. The main author Pawlowski (2013) later revealed that around 70% of fans do care about competitive balance in the German Bundesliga, which is one of the top European Leagues. Those indicate that the existing balance of a series of football leagues have been somewhat broke by the implementation of new policies, and may have hurt the fans well-being. A much more far-reaching change of rule was also investigated. Binder and Findlay (2016) studied the aftermath of Bosman Ruling, which allowed soccer players to move more freely between clubs in Europe. While their main finding concentrates on the effect of national teams that do not involve shareholders' investment, they also found that in the Champions League the top clubs appear to have become noticeably stronger due to the Bosman Ruling.

In short, no research in sports economics is closely related to this paper's theme, which is the increased substitution and its effect, however, both articles concentrating in parallel determinants of team performance and studies revolving around substitutions and the widening gap between big and small clubs are instrumental to this paper, empirically and methodologically.

Chapter 3 Data

The data source of this paper is Transfermarkt (Transfermarkt.de), which is literally the most prestigious football websites and also one of the biggest sport websites nowadays. Transfermarkt contains world-wide football information such as scores, results, statistics, transfer news and fixtures, and has 39 million unique monthly visitors and 680,000 registered users. For the data content, I built two datasets, containing all matches of the season of 2018-2019 and 2020-2021 of Serie A, the Italian top vision football league. Serie A consists of twenty clubs, each playing against the other 19 clubs twice; once at home and once away. So, there are in total 38 games for each team by the end of the season, and altogether 380 matches played in one whole season. In all, 760 matches' data are included in this paper. Apart from match results, which include goals scored by home teams and away teams, I also collected the number of substitutes from both sides made in each game, which should be the most direct independent variable in this analysis. Further, control variables are also needed, and for the moment I have chosen total team value and average coaching terms of managers as control variables, controlling team's ability and managers' ability, which are two instrumental factors for match results as well as substitution behavior. As previous football-related paper did not pay much attention to substitution behavior, none have added managers' coaching terms as a variable. So the consideration of coaching term is an originality of this paper. Then I calculated the difference of goals scored by both sides (which is goal difference), the difference of total team value between home team and away team, and the difference of average coaching terms between home team's manager and away team's manager, in purpose of taking both sides' information into account when doing regression. The three differences are calculated in single-match bases. To summarize, there are 380 observations in each season, each observation consists of goals scored and conceded by the home team (goals conceded by the home team are exactly goals scored by the away team), number of substitutes made by both sides, total team value of both sides, and average coaching terms of both sides' managers, together with the

differences of goals, total team value and average coaching terms.

There are multiple strengths of this dataset. First, it is convincing in the way of league selection. Serie A is one of the top five European football leagues, which are Premier League (English football league), Bundesliga (German football league), La Liga (Spanish football league) and Ligue 1 (French football league) respectively. Representing the top level of football, Serie A is definitely an appropriate league for research regarding impact of new football rules. Second, clear distinguishment of super clubs is available in Serie A. According to the total team value of past ten years, 6 of the 20 clubs: Juventus, Inter, Milan, Napoli, Roma, Lazio are the leading clubs. Besides, these six are also the leading Italian clubs in the UEFA 5-year rankings of all European clubs. Moreover, the gaps of these six clubs are small while the gulf between the Big-6 and other Italian clubs is much larger. As a result, the derivation of the six-club-list is indubitable, and in this study they will be regarded as super clubs, while other teams will be deemed as inferior clubs. In fact, the most desirable league would be Premier League in terms of super clubs' selection, as there is even larger gulf between their Big-6 and the other clubs, both in performance and in prestige. However, as Premier League has reverted to the old substitution rule by the end of 2020, that is, Premier League only used the 5-maximum substitution rule for a few months, their data is unfortunately not applicable for this analysis. As for the other top football leagues, the classification process is not such an easy thing: Bundesliga and Ligue 1 share the same problem: the monopoly of the biggest club: Bayern Munich and Paris Santa Germain, are so powerful that people could only think of those two clubs as the super club in their country. The situation in La Liga is better, but the long reign of Real Madrid and Barcelona in the past decades can hardly remind people of other clubs defined as the super compared with these two. Third, the selection of season 2018-2019 and season 2020-2021 could provide a clear comparison of before-new-rule and after-new-rule. As COVID-19 stroke in 2020, these two seasons are the nearest complete seasons before or after the implementation of the new substitution rule. So, with data of these two seasons, it is advisable to use season 2018-2019 as the control group and season 2020-2021 as the

treatment group to test the effect of the increased substitutes by clear comparison.

On the other hand, there is a potential pitfall of this dataset, which is the relatively small sample size. Afterall, the new rule has only been implemented for one year, which generates only one complete season in which the new rule has been carried out thoroughly. Compared with other literature investigating determinants of match results, one season's sample size is relatively small.

Chapter 4 Empirical Analysis

4.1 Summary Statistics and Empirical Model

In this chapter, we will first see the variable definitions, some summary statistics and subsequent data analysis, and then the regression model.

Let us first see the variable definitions. The key variables of the whole analysis are as follow. *GoalDiff* is the dependent variable, measuring the difference between home teams' scored goals and home team's conceded goals; *HomeSubs* is the number of substitutes made by home teams, while *AwaySubs* is the number of substitutes made by the away teams. Those two are the main dependent variables and range from 0 to 3 in season 2018-2019, from 0 to 5 in season 2020-2021. *HomeSuper* and *AwaySuper* are the dummy variables which equal to 1 if home teams or away teams are of those six super clubs, and equal to 0 if not; *ValueDiff* and *YearDiff* are the two control variables. *ValueDiff* represents the difference between the total team value of the home team and the away team, which is to control for team's ability, or players' ability; *YearDiff* is the difference between the average coaching term of managers of the home team and away team.

Table 1: Variable definitions

Variable	Definition
GoalDiff	Difference between home teams' scored goals and home team's conceded goals
HomeSubs	Number of substitutes made by the home team
AwaySubs	Number of substitutes made by the away team
HomeSuper	Equals to 1 if the home team belongs to "super clubs"; equals to 0 if not
AwaySuper	Equals to 1 if the away team belongs to "super clubs"; equals to 0 if not
ValueDiff	Difference between the total value of the home team and the away team
YearDiff	Difference between the average coaching term of the home team manager and the away team manager

Table 2: Variable means and standard deviations

Variable	18-19	20-21
GoalDiff	0.29	0.21
	(1.67)	(1.84)
HomeSubs	2.91	4.29
	(0.30)	(0.91)
AwaySubs	2.90	4.34
	(0.37)	(0.86)
HomeSuper	0.30	0.30
	(0.46)	(0.46)
AwaySuper	0.30	0.30
	(0.46)	(0.46)
ValueDiff	0.00	0.00
	(285.29)	(249.20)
YearDiff	0.00	0.00
	(0.70)	(0.70)

*Note: ***, **, * respectively represents significance level at the 1%, 5%, 10% level*

Then comes the summary statistics of those variables. As shown in Table 2 above,

GoalDiff is positive in both seasons, which reflects the famous home advantage; *HomeSubs* and *AwaySubs* both increased from 2.9 to 4.3, due to the increasing total substitutes allowed. The increment also reflects that clubs are indeed utilizing this new rule, but comparing to season 2018-2019, substitutes are more flexible: the numbers 2.9 and 4.3 indicate that previously most clubs will make full use of the allowed substitutes, but now an unused substitute is common. *HomeSuper* and *AwaySuper* equal to 0.3 all the time because of fixed proportion of super clubs and all Serie A clubs: 6 out of 20. *ValueDiff* equals to 0 all the time, because the home-and-away round-robin will automatically offset the value difference of home teams and away teams. On the contrary, *YearDiff* is not absolutely 0, but actually 0.002. That is because when collecting the average coaching term of managers, I made targeted adjustments in accordance with managers' sacking and signing. Thus, there is no symmetry, but actually small discrepancies for home teams and away teams, as there could be changes in manager from two teams' first match to second match.

Next, I took a further look into those data. To see whether clubs will benefit from the new substitution rule, it is necessary that we figure out whether clubs are indeed utilizing those increased substitutes. These efforts are also some preliminary works that try to explore what might have accounted for the potential advantage of super clubs with these extra substitutes, if any.

The main focus here is to figure out if there is any difference between number of substitutes used in different circumstances. I classified those different circumstances into three categories: 1. home sides versus away sides; 2. super clubs versus inferior clubs; 3. the combination of super/inferior and home/away.

Getting a better understanding of whether number of substitutes used would be different under these three conditions are important: for home sides and away sides difference, if whether being the home team is a factor that will determine number of substitutes, then totally distinct results of home-teams' data and away-teams' data are foreseeable; for super clubs and inferior clubs difference, it is exactly the area this

article aims to probe into, and if super clubs indeed tend to make more substitutes than inferior clubs, the utilization rate of substitutes may largely speak for the underlying advantage of super clubs in terms of the new rule; the combination of super/inferior clubs and home/away sides may induce more specific area to dig into.

First, for whether there is significant difference in substitutes between home teams and away teams, I summarized all 20 Serie A teams' average number of substitutes both as home teams and as away teams. With data in hand, I did the Welch two sample t-test. According to the result in table 3, the p-value is 0.7158, larger than the cutoff value 0.05, then I reached the conclusion that being the home side or away side does not make a significant difference regarding number of substitutes. The possible explanation is that with the new rule implemented, all teams tend to utilize those increased substitutes, and deem them as merits to their tactical arrangements no matter they play at home or away.

Table 3: Average home substitutes and away substitutes for 20 clubs

Team	*HomeSubs*	*AwaySubs*	*Average*
Lazio	5.000	4.947	4.974
Sassuolo	4.737	4.737	4.737
Spezia	4.632	4.842	4.737
Benevento	4.684	4.684	4.684
Genoa	4.632	4.737	4.684
Atalanta	4.789	4.474	4.632
Bologna	4.316	4.789	4.553
Verona	4.474	4.474	4.474
Napoli	4.263	4.632	4.447
Parma	4.316	4.526	4.421
Cagliari	4.316	4.316	4.316
Inter	4.526	4.000	4.263
Florentina	4.105	4.211	4.158
Milan	4.211	4.000	4.105
Roma	4.105	3.947	4.026
Sampdoria	4.158	3.895	4.026
Torino	3.789	3.947	3.868
Udinese	3.579	4.105	3.842
Juventus	4.000	3.579	3.789
Crotone	3.263	4.000	3.632

From Table 3, we can also compare each teams' overall substitutes utilization. At the first glance, we can see that there is some difference between teams. Lazio has an average 4.974 substitutes, leading all other teams, while Crotone only made 3.632 substitutes on average, which is the lowest in Serie A. Moreover, it is noticeable that in general, the six super clubs did not make more substitutes than inferior clubs. Apart from Lazio who has the highest utilization rate among all clubs, and Napoli ranked 10th, the rest 4 super clubs all lie in the last 50 percent, and have number of substitutes lower than the average number of all 20 teams.

But only looking at the average is not enough for comparing team-level substitution. Therefore, I summarized each team's substitutes in all their 38 games, that is 760 piece of substitute numbers classified by teams, and with the established definition of super clubs and inferior clubs, I classified those substitute numbers by those made by super clubs (228 piece of data) and those made by inferior clubs (532 piece of data). With those in hand, I did ANOVA test with number of substitutes regressed on category (super or inferior). According to the result, the p-value is 0.3, larger than the cutoff value 0.05, then the conclusion is that super clubs and inferior clubs did not have a significant difference in the way of number of substitutes.

The below Table 4 would be a good supplement clearly showing that in terms of number of substitutes used after the implementation of the new rule, there is no apparent difference between super clubs and inferior clubs. As shown in the following table, in the total 380 matches in season 2020-2021, 308 of the home teams have used the extra substitutes (the fourth or the fifth), which account for 81.1% of the total. Within those home teams, 91 are super clubs, which account for 79.8% of all the super home teams. In other words, the percentage of super clubs in all the home teams (30%), and the percentage of super clubs using extra substitutes in all the home teams using extra substitutes (29.5%), is almost the same. In short, the new substitution rule does not generate any discrepancy between super clubs and inferior clubs, in terms of quantity of substitutes.

Table 4: Club numbers and percentage on different substitutes

Substitutes	All clubs	Super clubs	Percentage of super clubs
All	380 (100.0%)	114 (100.0%)	30.0%
4 and 5	308 (81.1%)	91 (79.8%)	29.5%
4	103 (27.1%)	23 (20.2%)	22.3%
5	205 (53.9%)	68 (59.6%)	33.2%

As a further attempt, I did another ANOVA to test the difference between all teams, to see that whether the number of substitutes made by difference between teams are significantly different. From the result we can see that this time the p-value is smaller than 0.05, which means that different teams do have significant difference in substitute numbers. To look further into those difference, I used the TukeyHSD function in RStudio to make pairwise comparisons of all teams' substitutes. As there are 190 pairs of comparison in total, I only counted the number of pairs whose p-value is smaller than the cutoff value 0.05, which is 40 out of 190. As this paper aims at analyzing super clubs and inferior clubs but not each specific club, I did not furtherly delve into those data.

Having shown that home/away and super/inferior factors do not make a significant difference on number of substitutes, now let us further divide all 380 matches into 4 sub datasets, based on 'super clubs versus super clubs', 'super clubs versus inferior clubs', 'inferior clubs versus super clubs', 'inferior clubs versus inferior clubs' standard. It should be noted that home sides are always placed in front of away sides. By doing such division, can we further analyze number of substitutes under different circumstances such as playing against opponents with different level as different status, namely home side or away side. The table below shows the average substitute numbers of the four sub divisions.

Table 5: Average number of substitutes of different divisions

	Matches	Home teams' average number of substitutes	Away teams' average number of substitutes
Super vs. Super	30	3.933	4.233
Super vs. Inferior	84	4.500	4.512
Inferior vs. Super	84	4.274	4.167
Inferior vs. Inferior	182	4.269	4.363

To explore whether there is difference in substitute numbers when a specific category (that is, super or inferior) of teams, standing as the home sides, playing against different kinds of teams; or the specific category of teams playing against another specific category of teams, on home sides or away sides, I did Welch two sample t-tests with number of substitutes accordingly. To be more specific, teams with different status were further divided into 8 categories, which are shown in the following table. The capital 'S' or 'I' represents super clubs or inferior clubs; 'H' or 'A' represents being the home teams or the away teams; the subscript 'S' or 'I' represents facing super clubs or facing inferior clubs. Each category should be paired with other two categories: with the same sides or facing the same opponents. For example, the number of substitutes made by super clubs when facing inferior clubs as home sides, should be respectively paired with number of substitutes made by super clubs facing inferior clubs as away sides, and number of substitutes made by super clubs when facing other super clubs as home sides. With all circumstances accordingly paired, I did the t-tests and calculated the corresponding p-value. In accordance with the results, except the pair 'IH_SIA_S' (and also IA_SIH_S), that is, the number of substitutes made by inferior clubs facing super clubs as home sides and the number of substitutes made by inferior clubs facing super clubs as away sides, are significantly different with $\partial = 0.1$, all other pairs do not have significant difference. Hence, I concluded that generally, teams tend to deploy the same substitution strategy regarding substitute numbers no matter what kind of teams they face and where they play.

Table 6: Welch two sample t-tests of pairs of different categories

	SH_S	SA_S	SH_I	IA_S	IH_S	SA_I	IH_I	IA_I
SH_S		0.2391	0.1374					
SA_S	0.2391					0.7199		
SH_I	0.1374					0.1683		
IA_S					0.0618			0.1406
IH_S				0.0618			0.9696	
SA_I		0.7199	0.1683					
IH_I					0.9696			0.3133
IA_I				0.1406			0.3133	

Note: On the horizontal and vertical axis are super clubs or inferior clubs with different categories based on the division in Table 5. There are 8 categories in total. The capital 'S' or 'I' represents super clubs or inferior clubs; 'H' or 'A' represents being the home teams or the away teams; the subscript 'S' or 'I' represents facing super clubs or facing inferior clubs. Each category is paired with other two categories and a Welch two sample t-test was conducted for each pair, and the numbers are the corresponding p-values. Values symmetric to the diagonal are equal because of repetition.

To summarize, in regards of substitute numbers, teams in general prefer to utilize the increased substitutes, and there is no significant difference between home teams and away teams, and though each specific team may have different preference of substitute numbers, the super clubs and inferior clubs in a whole do not have significant difference in those numbers. Moreover, the combination of sides and opponents neither significantly influence teams' substitutes number preferences.

After all the data-analyzing process, we can finally turn to the regression models.

The regression analysis consists of two parts, and two corresponding models. The first part is to investigate the effect of substitutes on match results, and the second is to figure out whether super clubs would benefit from the increased substitutes more than inferior clubs. Let us first see the preliminary regression model. To avoid complexity in variables, I would only focus on the home side variables in the regression, as it is shown previously that overall being the home sides or away sides do not have a bearing on substitute numbers. The away side variables would be used for robustness check.

$$GoalDiff_{ij} = \beta_0 + \beta_1 HomeSubs_i + +\beta_2 ValueDiff_{ij} + \beta_3 YearDiff_{ij} + \mu_{ij} \quad [1]$$

The basic regression model is presented above, as i, j represents home teams and away teams. The basic regression pays attention to the effect of increased substitutes on goal difference. β_1 is thus the most notable coefficient here. A positive and significant β_1 would indicate that increased substitutes do enlarge the goal difference.

After figuring out the effect of increased subs on goal difference, further attempts of testing whether the new substitution rule favors the super clubs can be implemented. The second regression model will figure out in terms of goal difference, whether super clubs have benefitted more from the new rule. The model is as follow:

$$GoalDiff_{ij} = \beta_0 + \beta_1 HomeSubs_i + \beta_2 HomeSuper_i + \beta_3 HomeSubs_i * HomeSuper_i + \beta_4 ValueDiff_{ij} + \beta_5 YearDiff_{ij} + \mu_{ij} \quad [2]$$

Compared to the initial model, this time I included $HomeSuper_i$, the dummy variable indicating whether the home team is one of the six super clubs, and the interaction term $HomeSubs_i * HomeSuper_i$. β_3 should be the most notable coefficient, measuring the effect of substitutes made by a super club, on goal difference.

4.2 Empirical Results

Table 7: Estimated result 1

Variable	18-19	20-21
(Intercept)	-0.596	-0.524
	(0.258)	(0.398)
HomeSubs	0.303	0.170*
	(0.258)	(0.091)
ValueDiff	0.002***	0.004***
	(0.000)	(0.000)
YearDiff	0.305***	0.310***
	(0.112)	(0.700)
N	380	380
R^2 *within*	0.203	0.256

*Note: ***, **, * respectively represents significance level at the 1%, 5%, 10% level*

Let us first see the preliminary regression result. As shown above, the coefficients of *HomeSubs* are both positive in the two seasons and, compared with the season before the new rule, the coefficient of *HomeSubs* turns significant at 5% level in the season after the new rule. The positively significant coefficient in the second season indicates that increased substitutes do enlarge goal difference, as a team can now exert more influence on the match results by substituting more of their players onto the field.

As number of substitutes do have a bearing on match results, let us turn to the second part of this analysis, which is super clubs' advantages on this new rule. To get a broad view, I plotted a figure of average goal difference with different number of substitutes made by all the 760 home teams, and the 228 home teams which are super. As shown in the figure, the general trends of average goal difference and number of substitutes are both positive, which conforms with the previous regression result. Moreover, there is a decline between the third and fourth substitutes of both lines, which I cannot explain for the moment. But skipping that mysterious decline, between the fourth and fifth substitutes, we can see that the slope of the solid line is greater than the dotted line, which may reflect that, at least from the fourth substitutes to the

fifth substitutes, super clubs are indeed benefitting more.

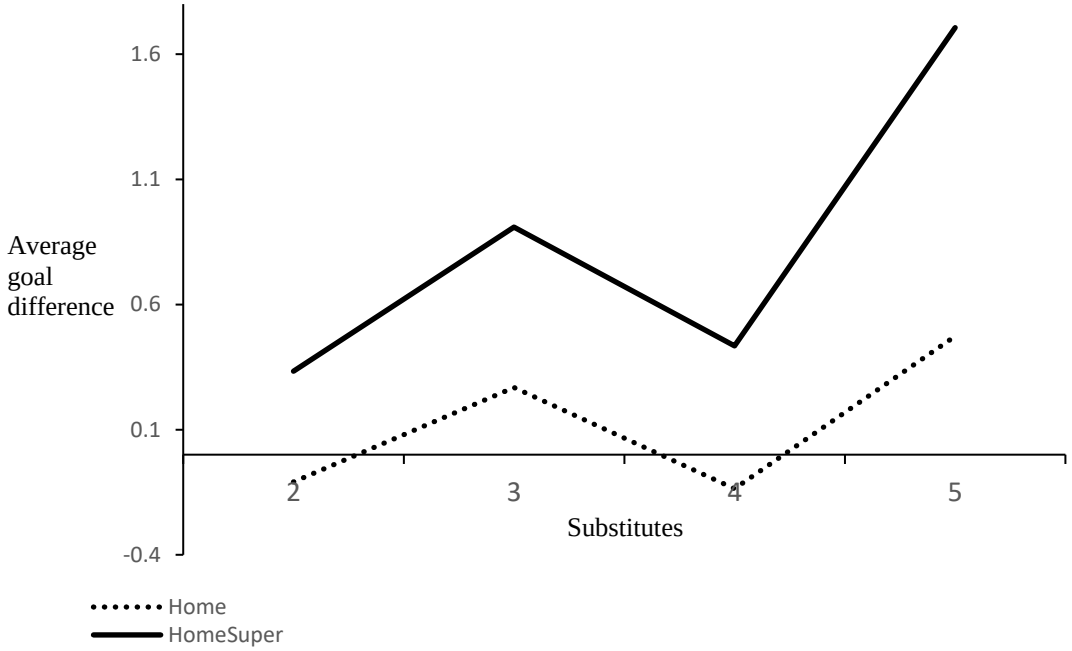


Figure 1: Average goal difference with different number of substitutes

In summary statistics I have shown that the gap between super clubs and inferior clubs in the way of the increased substitutes does not hinge on the quantity of substitutes but only lies in the quality of those extra substitutes. Thus, the hypothesis is that as super clubs have higher average value of players than inferior clubs, the increased number of substitutes will enlarge the value difference of on-pitch players, as super clubs could switch on players still competent enough compared to the line-up eleven, while normal or inferior clubs could only switch on players not that capable. This paper only focus on seeking the answer of whether super-inferior gap exists but rather delving into the potential cause of it.

Table 8: Estimated model 2

Variable	18-19	20-21
(Intercept)	-0.728	0.185
	(0.956)	(0.466)
HomeSubs	0.352	-0.017
	(0.326)	(0.106)
HomeSuper	0.348	-2.462***
	(1.565)	(0.866)
*HomeSubs*HomeSuper*	-0.131	0.638***
	(0.532)	(0.195)
ValueDiff	0.002***	0.003***
	(0.000)	(0.000)
YearDiff	0.305***	0.299***
	(0.112)	(0.117)
N	380	380
R^2 *within*	0.203	0.279

*Note: ***, **, * respectively represents significance level at the 1%, 5%, 10% level*

So now let us see the result of the second regression model. First and foremost, the coefficient of the interaction term turns significantly positive from season 2018-2019 to season 2019-2020, which means that super clubs also benefit from the new rule. Comparing the now insignificant coefficient of *HomeSubs* with the significant coefficient of the interaction term, I conclude that super clubs indeed benefit more from this new rule than inferior clubs, and the previous significant coefficient of *HomeSubs* in the first regression may largely come from the effects of super clubs. That is, it is the super clubs' deeper benches and higher quality substitutes that really makes a difference in the way of substitution; the effect of increased substitutes for inferior clubs, however, may turn out not that significant.

What is surprising at first is the negatively significant coefficient for *HomeSuper*. Afterall, if a team belongs to those super clubs, then intuitively, it should experience a higher goal difference because of its stronger comprehensive ability. Though this negatively significant coefficient may seem contradict to this intuition at first glance, it actually conforms with what we presume. Taking a closer look, if we take derivative of

GoalDiff and *HomeSuper* after adding the interaction term (as shown below), we will find out that β_2, β_3, and *HomeSubs* together determines the derivative. As a matter of fact, $\widehat{\beta_2} = -2.462$, $\widehat{\beta_3} = 0.638$, and are both significant, which means that, when *HomeSubs* is greater than or equal to 4, then we can confirm that being a super club indeed positively affect one team's goal difference.

$$\frac{\partial GoalDiff}{\partial HomeSuper} = \beta_2 + \beta_3 HomeSubs \quad [3]$$

For the cases that a team made less than four substitutes, the main reason why the positive effect turns in doubt is sample selection bias. First, there are only 72 matches that the home team only used three or less substitutes during the whole season 2020-2021, which only accounts for less than 20 percent of the 380 matches. This, together with Table 4, simply indicates that all clubs in Serie A are receptive towards the new rule. As more substitutes available, clubs tend to utilize the increased substitutes in most cases. Moreover, when furtherly digging into those substitutes-unutilized cases, I found that the ratio of super clubs' clash nearly doubled from the four or five substitutes case to the less-than-four substitutes case, from 7.9% to 15.2%. As we are discussing the effect of being a super club on goal difference, I further summarized the conditional probability of super clubs' clash conditional on the home team is a super club, the result is almost the same, that the probability increases from 26.3% to 48.3%, doubling also. This could probably explain why the coefficient was dragged down in the less-than-four substitutes' cases, as super clubs are tougher opponents than normal clubs. In fact, the average goal difference of all matches that have a super home team is 1.057, while it drops to 0.450 if only including the super versus super among those. So we can see that there is a huge goal difference decline when super clashes are predominant. And in the way of the different substitute utilization case, it is indeed the case. The average goal difference of super clubs using the fourth or fifth substitutes is 1.149, while the average goal difference of super clubs only using less than four substitutes is only 0.217.

Indeed, there is a huge difference between the goal difference under those two circumstances, and I conclude that one of the main reasons is that super clubs' clash occurs too often in the less than four substitutes' cases, which generates sample selection bias.

Table 9: Probabilities of super club's clash and average goal difference under substitutes

Substitutes	$P(super\ vs\ super)$	$P(super\ vs\ super \mid homesuper)$	Average goal difference of $homesuper$
4/5	7.9%	26.3%	1.149
1/2/3	15.2%	48.3%	0.217

Note: The first column presents the percentage probability of super clubs encounter super clubs under 4 or 5 substitutes case or 1/2/3 substitutes case; the second column is that probability conditional on the home team is one of the super clubs; the third column shows the average goal difference of home teams that are super clubs under the two circumstances.

4.3 Robustness Check

In the robustness check, I used away teams' data to test the models. For the first model, unfortunately, both coefficients for *AwaySubs* are insignificant. One possible explanation is the away matches' difficulty. We all know that there is a famous home advantage in many sports. That is, compared with away teams, home teams have some inbuilt advantages, due to factors like fans' support, less travelling distance, and familiarity with home stadiums' condition, etc. These objective factors or obstacles may strongly offset human's behavior, both manager's deploy and player's effort.

Table 10: Robustness check for Model 1

Variable	18-19	20-21
(Intercept)	-0.266	0.066
	(0.612)	(0.427)
AwaySubs	0.191	0.032
	(0.210)	(0.097)
ValueDiff	0.002***	0.004***
	(0.000)	(0.000)
YearDiff	0.327***	0.332***
	(0.112)	(0.118)
N	380	380
R^2 *within*	0.202	0.249

*Note: ***, **, * respectively represents significance level at the 1%, 5%, 10% level*

For the second model, related coefficients share the same pattern with the initial regression: *AwaySubs* and the interaction term have contrary significant coefficients with the initial regression, and that conforms with the intuition, because away matches are the opposite side of home matches. Likewise, according to the data, when the away team makes more than four substitutes, being a super club also has positive effect towards match results. However, the overall significance of key coefficients drops from 1% to 5%, which could also be explained by the uncertainty of away matches induced by home advantage.

Table 11: Robustness check for Model 2

Variable	18-19	20-21
(Intercept)	-0.654	-0.699
	(0.882)	(0.537)
AwaySubs	0.309	0.186
	(0.302)	(0.120)
AwaySuper	0.819	2.062**
	(1.220)	(0.874)
*AwaySubs*AwaySuper*	-0.235	-0.516**
	(0.418)	(0.198)
ValueDiff	0.003***	0.004***
	(0.000)	(0.000)
YearDiff	0.323***	0.309***
	(0.112)	(0.118)
N	380	380
R^2 *within*	0.204	0.261

*Note: ***, **, * respectively represents significance level at the 1%, 5%, 10% level*

Chapter 5 Conclusion

This paper is one of the first to investigate the role of substitutions in football matches, especially in the context of COVID-19 and the corresponding implementation of a new substitution rule. It is of great significance to figure out the impact of increased substitutes and whether it will break the balance between clubs and even equity of football tournaments. In this paper, I used the example of Serie A, first examined the utilization of increased substitutes under different circumstances, then tested the relation between number of substitutes and goal difference (which could represent team performance more accurately than a single win or loss), and further analyzing this relation with super club factors considered.

I found that there is no significant difference in regards of substitute numbers with different sides and opponents, and further concluded that the potential advantage of super clubs against after the new rule does not lie in quantity but rather quality of substitutes. From the regression I found that in season 2018-2019, which is the season before the new rule, number of substitutes could not significantly affect goal difference, while in season 2020-2021, the season after the new rule, the coefficient keeps positive but turns significant. It indicates that with total substitutes allowed increasing from 3 to 5, a team can now exert more benefiting influence on the match results by utilizing more substitutes. Moreover, from the second regression model, I concluded that super clubs do take advantage from this new rule, and made the assumption that thanks to their deeper benches, can they make substitutes with better players than inferior clubs. In other words, it is bench players' quality rather than substitution quantity that distinguish super clubs from inferior clubs, in terms of making full use of the new rule. I also found that super clubs' advantage may turn eclipsed when making less than 4 substitutes after the new rule, but it may largely because of sample selection bias and the small size of those underutilized cases.

The finding of this paper is inspiring in that it points out super clubs' advantage on

the increased substitutes in a quantitative way. The mathematical foundation of this analysis fortifies the claims that the new substitution rule is unfair and will lead to unbalance of super clubs and inferior clubs, or even ultimately result in the long run Matthew Effect. However, this paper has not dig deeper into the long run effect of the new rule, because it has been only less than two years after the new rule. Only providing the new rule keeps being implemented for longer periods, can people further explore the long run effect of it with larger datasets and more clear observation of the underlying Matthew Effect. For now, I leave these for future studies.

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