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Working Paper

Coach characteristics and their impact on substitution decisions

Diskussionspapier des Instituts für Organisationsökonomik, No. 6/2024

Provided in Cooperation with:

University of Münster, Institute for Organisational Economics

Suggested Citation: Vischer, Lars (2024) : Coach characteristics and their impact on substitution decisions, Diskussionspapier des Instituts für Organisationsökonomik, No. 6/2024, Universität Münster, Institut für Organisationsökonomik, Münster,
<https://doi.org/10.17879/46988526636>

This Version is available at:

<https://hdl.handle.net/10419/300580>

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Diskussionspapier des
Instituts für Organisationsökonomik

6/2024

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Discussion Paper of the
Institute for Organisational Economics

**Diskussionspapier des
Instituts für Organisationsökonomik
6/2024**

Juni 2024

ISSN 2750-4476

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Lars Vischer

Abstract

This study analyses the factors influencing coaching decisions when substituting players, particularly in light of the rule change from three to five permitted substitutions. To this end, 161 coaches and their decisions are analysed in 1,836 Bundesliga matches from 2017/2018 to 2022/2023, whereby the tactical components, timing and age structure of the substitutions are examined. A total of 13,363 substitution situations are therefore analysed at the level of individual decisions. The main influencing factors are the age of the coach, professional experience and the length of time spent working with the team. Spectator numbers and goal difference hardly play a role.

JEL Codes: D81, D91, L83, M50, Z20, Z21

Keywords: Coach, Decision, Leadership, Rule Change, Substitution

Trainereigenschaften und ihr Einfluss auf Auswechselentscheidungen

Zusammenfassung

Diese Studie untersucht die Einflussfaktoren auf Trainerentscheidungen bei Spielerwechseln, insbesondere vor dem Hintergrund der Regeländerung von drei auf fünf erlaubte Wechsel. Dazu werden 161 Trainer und deren Entscheidungen in 1.836 Bundesligaspielen von 2017/2018 bis 2022/2023 analysiert, wobei die taktische Komponente, der Zeitpunkt und die Altersstruktur der Wechsel untersucht werden. Insgesamt werden somit 13.363 Wechselsituationen auf Ebene der individuellen Entscheidungen betrachtet. Wesentliche Einflussfaktoren sind das Alter des Trainers, die Berufserfahrung und die Dauer der Zusammenarbeit mit der Mannschaft. Zuschauerzahlen und Tordifferenz spielen hingegen kaum eine Rolle.

Im Internet unter:

http://www.wiwi.uni-muenster.de/io/forschen/downloads/DP-IO_06_2024

DOI: 10.17879/46988526636

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Coach Characteristics and Their Impact on Substitution Decisions¹

1. Introduction

Football is not just a game, but a complex dynamic sport characterised by tactics, strategy and teamwork. Due to the COVID-19 pandemic, there have been various rule changes in the sport that have changed the dynamics of the game and the decisions in the game and that have already been analysed in numerous studies (including Reade/Singleton 2022 and López/Refoyo 2023). The COVID-19 pandemic has also meant that the number of substitutions during a match has been increased from three to five, with three substitution periods remaining the same. This allows coaches significantly more influence during a match than before the rule change. While Meyer/Klatt (2024) and Dilger/Vischer (2023) analyse the impact of additional substitutions on the game in general, there has not yet been a study that focuses on coaches as decision-makers for substitutions.

Particularly in today's football business, coaches are often replaced in the event of failure and a newly installed coach is seen as a source of inspiration and sporting hope. For managers of football clubs, the installation of a coach is therefore not only highly relevant in sporting terms, but also economically. It is therefore crucial to be able to identify the characteristics of coaches and draw conclusions for the strategic direction of the club. This results in the research question of this paper:

What characteristics of coaches influence substitutions?

To answer this question, this study analyses a total of 161 coaches and their decisions in six Bundesliga seasons from 2017/2018 to 2022/2023. This includes 836 games with three permitted substitutions and 1,000 games with five permitted substitutions, resulting in a total number of 13,363 substitutions out of a total of 15,016 possible substitutions. With the help of this data, I attempt to close the identified research gap with regard to the increased possibility of substitutions and to answer the research question of this paper.

¹ I thank our student assistants for their help in building the dataset, especially Tim Christoph, Claas Glindemann, Alexandra Michels and Rebecca Staubach, as well as Prof. Dr. Alexander Dilger for valuable suggestions.

2. Theoretical Background

While the coach can usually put together the starting line-up without any major time pressure, substitutions during a match are subject to precisely this pressure. Furthermore, substitutions are the only direct way for coaches to influence the game, their teams' tactics and the course of a match. The coach's ability to make the right decisions regarding substitutions is therefore crucial to the success of a team. The ability to analyse the current situation in a pressure situation, depending on the specific score, and to decide on an appropriate reaction makes a good coach.

Gomez et al. (2016), Kröckel (2017), Myers (2011) and Wittkugel et al. (2022) describe this situation and attempt to generate decision-making aids from empirical evidence to support coaches in their decisions during the game. In order to answer the research question, the empirical model must include the tactics of the substitution (offensive versus defensive), the time of the substitution (minute and score) and the player used (age). In terms of tactics, Wittkugel et al. (2022) find that offensive substitutions are favoured over defensive substitutions and that this also depends on the score at the time of the substitution. Rey et al. (2017) show that substitutions to the back are delayed when the own team is leading. The point of age is particularly interesting in light of the study by Meyer/Klatt (2021), as they identify an increased opportunity for younger players to play as a result of the rule change. Dilger/Vischer (2023) show that the rule change from three to five substitutions has changed the behaviour of coaches in terms of the number of substitutions made and, in some cases, the timing of substitutions. They also identify a fundamentally positive effect on player performance as a result of more substitutions.

For club managers, their characteristics are the most important factor when looking for a coach. Similar to the research conducted by Acet et al. (2017), Shehu (2019) and Molan (2016) in the field of sports economics, the aim is to find out which leadership characteristics make a good coach. The existing studies focus primarily on age, experience and attitudes towards leadership. Fonti et al. (2023) note that sport contexts are increasingly being used in management research, among other things to test and further develop theories and to research management-relevant phenomena. Sport generally offers an ideal environment for testing economic theories (Bradbury 2019). For this reason, transfers between the scientific sub-disciplines are frequent and implications between the research fields are possible. Management theory is therefore also used to identify the characteristics of coaches. Oshagbemi (2004) finds that, among other things, age influences the way managers lead. In addition to

age, Bell et al. (2015) identify other demographic factors such as education and gender as influences on leadership styles. Many different studies can be found on the characteristics of managers, but many studies like Marconatto et al. (2022) focus on gender, age or experience depending on the object of measurement and education. Since only male coaches were employed in the Bundesliga during the data collection period, gender differences will not be analysed in the following.

It should be noted that coaches have to make decisions under pressure when substituting players, which are crucial for the success of the team, whereby factors such as the score, tactics and player age play a role. Studies show that the characteristics of a good coach, such as age and experience, are also relevant in management theory and that these findings help to make optimal decisions and improve match performance.

3. Hypothesis Development

With the help of the conceptual background and own considerations, three hypotheses are formulated. The aim is to analyse the characteristics of coaches. Age, experience and, in some cases, nationality are identified as the main characteristics of coaches. These are also characteristics that can be easily identified by club managers without psychological assessors. Analogous to Wittkugel et al. (2022), it is expected that there are differences in the tactics of moving between offence and defence. The first hypothesis is therefore that the characteristics of coaches influence the tactics of substitution.

H1: The characteristics of coaches influence the tactics of a substitution.

Rey et al. (2017) show that the timing of substitutions also has a tactical component and that leading teams in particular delay substitutions until later in the game. I also expect the characteristics of coaches to have an influence on this.

H2: The characteristics of coaches influence the timing of a substitution.

Meyer/Klatt (2021) identify that with the increased possibility of substitution, there is also the possibility of using more younger players and I also suspect a connection to the characteristics of a coach here.

H3: The characteristics of coaches influence the age of substituted players.

4. Data

This article examines the role of the coach in substitutions based on 1,836 games in six seasons of the German Bundesliga in the period 2017 to 2023. The period under consideration not only has the special feature of ghost matches in the data set, but also of a rule change from previously three to five permitted substitutions with a constant number of three substitution periods. In contrast to Dilger/Vischer (2023), this article does not consider the level of games, but the level of substitution situations. This results in a total of 13,363 substitutions out of a total of 15,016 possible substitutions. The data set primarily contains data from www.football-data.co.uk for fixtures and results as well as manually collected data on the changes and goal times from www.dfb.de. This data was then randomly checked for accuracy. Due to the size of the biographical database, the data of the 161 coaches used was collected manually from the German specialist magazine kicker.de, randomly checked and then matched with the respective substitutions. By analysing 13,363 substitutions, there are corresponding rows of data in the data set, which were adjusted to the respective perspective with regard to the game result and consider the substitutions in isolation from each other while Dilger/Vischer (2023) consider the substitutions cumulatively per game situation. The player data comes from the platform footystats.org (see Shahriar et al. 2019). Due to, for example, almost 60 duplicate surnames, such as the twins Lars and Sven Bender or the names Müller or Schmidt, which are frequently used in German-speaking countries, the identification strategy did not correctly capture all players, which means that some observations are lost in the regression. Holding a coaching licence was also considered as an experience indicator for coaches at first. However, since, with the exception of some interim coaches, all coaches have the highest coaching licence and therefore no differentiation can be made here, this is not considered further. I identified coaches as interim coaches if they were in the position for less than two match days or 14 calendar days. All 161 coaches analysed are male, meaning that, as already mentioned, gender is not taken into further consideration in the analysis.

5. Results

5.1. Descriptive Statistics

Table 1 shows the data on the coaches, players and other match statistics in the 13,363 substitutions. The first variables from `coach_age` to `years_of_coaching` relate to the coach. Here I consider the age of the coach (`coach_age`) and the years as a coach in professional football (`years_of_coaching`) as classic characteristics. Furthermore, due to the large number of

	Mean	SD	Min	Max
coach_age	47.40	7.97	30.00	73.00
entry_until_exit_days	1,028.30	1,077.07	6.00	4,931.00
germany01	0.65	0.48	0.00	1.00
years_of_coaching	14.78	6.57	4.00	40.00
subst_pos_in	2.17	0.73	0.00	3.00
subst_pos_out	2.13	0.72	0.00	3.00
subst_age_in_years	25.69	4.33	16.00	41.73
subst_age_out_years	26.11	3.89	14.92	40.43
subst_min	70.18	14.54	3.00	97.00
subst_H_goals	1.28	1.22	0.00	8.00
subst_A_goals	0.99	1.08	0.00	7.00
Spectator	28,511.61	23,492.01	0.00	81,365.00
rulechange01	0.64	0.48	0.00	1.00
<i>N</i>	13,363			

N = sample size, *SD* = standard deviation, *Min* = minimum, *Max* = maximum.

Table 1: Descriptive Statistics of the Full Sample

German coaches, a dummy variable for German nationality was created. 117 coaches in the data set have German citizenship. As nationality is considered in some studies, it is included here as a variable for the description of the coach. With a few exceptions, the remaining coaches come from other European countries. In contrast to the players in the data set, the internationality of coaches is low. The variable *entry_until_exit_days* classifies the interim coaches.

To test the hypotheses, need data on the players used are needed, too. I use *subst_pos_in* and *subst_pos_out* to identify the positions of the players used and adopte the categorisation of footystats.org platform. This is divided into goalkeepers (coded as 0), defenders (1), midfielders (2) and attackers (3). The coding therefore leads to negative values in the later analysis if there is a defensive substitution, to positive values for an offensive substitution and to a value of 0 for a positional substitution. The variables *subst_age_in_years* and *subst_age_out_years* describe the age of the players at the time of the substitution.

For hypothesis testing and as control variables, I also collected information on the specific game situation and the game in general. The variable *subst_min* indicates the minute of the substitution and *subst_H_goals* and *subst_A_goals* the respective goals scored by the home and away team at the time of the substitution. I also consider the spectators, as their influence on the action on the pitch has been demonstrated in several studies (including Nevill et al. 2002 and Dilger/Vischer 2022). In addition, I analyse whether the rule change from three to five substitutions has an influence in the following models. The variable is coded as a binary variable.

5.2. Characteristics of Coaches

Table 2 shows the influence on the tactic of substitution in various models. I therefore consider the difference in the positions as described in 5.1. as an independent variable. With days_since_entry I include an experience variable, as every team and every sporting situation can theoretically be seen as a new world of experience for the coach. However, the longer he trains with the specific team, the more experience he has with regard to the strengths and weaknesses of the individual players. As an additional component, I also consider days_until_exit to find out whether a possible imminent cancellation has an influence on the substitutions made. The two variables are generated from entry_until_exit_days and the underlying data.

In Model 1, only the identified experience variables of the trainers are considered. In Model 2, further variables are included in the model with the age difference of the changed players as the difference of (subst_age_out_years - subst_age_in_years) and the rule change. In Model 3,

	(1)	(2)	(3)	(4)	(5)
coach_age	-0.00191 (0.321)	-0.00202 (0.294)	-0.00247 (0.199)	-0.00294 (0.133)	-0.00585** (0.006)
days_since_entry	-0.0000271* (0.044)	-0.0000286* (0.035)	-0.0000299* (0.028)	-0.0000347* (0.013)	-0.0000290 (0.056)
days_until_exit	0.000000903 (0.960)	0.00000182 (0.920)	-0.000000485 (0.979)	0.00000802 (0.679)	0.0000188 (0.345)
germany01	0.0115 (0.576)	0.0112 (0.584)	0.0111 (0.587)	0.00780 (0.707)	-0.0273 (0.245)
years_of_coaching	0.00543* (0.022)	0.00582* (0.014)	0.00621** (0.009)	0.00684** (0.005)	0.00814** (0.002)
subst_age_diff		0.0000144*** (0.000)	0.0000142*** (0.000)	0.0000152*** (0.000)	0.0000132** (0.004)
rulechange01		0.00542 (0.755)	-0.00539 (0.783)	-0.00738 (0.707)	-0.0166 (0.406)
subst_min			0.00355*** (0.000)	0.00370*** (0.000)	0.00358*** (0.000)
subst_goals			-0.00298 (0.537)	-0.00295 (0.544)	-0.00420 (0.456)
Spectator			-0.000000266 (0.506)	-0.000000324 (0.421)	0.000000435 (0.402)
_cons	-0.0148 (0.840)	-0.0158 (0.832)	-0.234** (0.006)	-0.228** (0.008)	-0.117 (0.223)
N	9,872	9,872	9,865	9,729	7,268
F	2.358	3.536	6.424	7.013	5.290
R ²	0.00119	0.00250	0.00648	0.00716	0.00724

*p-values in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; (1) only coach characteristics, (2) coach characteristics with further controls, (3) coach characteristics with all controls, (4) sample without interim coaches, (5) sample without ghost games.*

Table 2: Linear Regressions with Difference in Positions as Dependent Variable

the time of the substitution, the spectators and the score are considered from the point of view of the substituting team. Variable `subst_goals` is a difference variable that subtracts the goals received from the goals scored by the substituted team and is positive if the substituted team is ahead. In Model 4, interim coaches are not considered, as they may have different objectives due to their predetermined status as a temporary solution and could distort the picture. In Model 5, ghost matches are excluded, as some studies consider them to be experiments that could also potentially distort the picture. Analogous to Dilger/Vischer (2023), a match with less than 10 % stadium utilisation is classified as a ghost match. The age of the coach only has a significant effect when ghost games are excluded. It can be seen that the variable `days_since_entry` has a significant negative influence on the dependent variable, with the exception of Model 5. The experience variable `years_of_coaching` is significant in all models. The same applies to the control variables of the age difference of the players and the time of substitution in all models.

Table 3 uses the same structure as Table 2 and therefore no detailed explanation is provided

	(1)	(2)	(3)	(4)	(5)
<code>coach_age</code>	0.0963** (0.001)	0.124*** (0.000)	0.127*** (0.000)	0.120*** (0.001)	0.0883* (0.022)
<code>days_since_entry</code>	0.000532** (0.007)	0.000260 (0.277)	0.000247 (0.301)	0.000200 (0.417)	0.000125 (0.647)
<code>days_until_exit</code>	0.000553 (0.051)	0.000569 (0.076)	0.000589 (0.065)	0.000708* (0.038)	0.000482 (0.178)
<code>germany01</code>	0.202 (0.523)	0.0823 (0.820)	0.0997 (0.782)	0.0214 (0.953)	-0.234 (0.578)
<code>years_of_coaching</code>	-0.0829* (0.025)	-0.114** (0.007)	-0.120** (0.004)	-0.110* (0.010)	-0.0240 (0.619)
<code>subst_age_diff</code>		0.0000379 (0.592)	0.0000237 (0.737)	0.0000226 (0.750)	0.0000201 (0.809)
<code>rulechange01</code>		1.258*** (0.000)	0.881* (0.011)	0.887* (0.010)	1.063** (0.003)
<code>pos_diff</code>			1.100*** (0.000)	1.150*** (0.000)	1.151*** (0.000)
<code>subst_goals</code>			0.0191 (0.822)	0.0178 (0.835)	0.00673 (0.947)
<code>Spectator</code>			-0.0000164* (0.020)	-0.0000150* (0.034)	-0.0000222* (0.017)
<code>_cons</code>	66.15*** (0.000)	64.67*** (0.000)	65.38*** (0.000)	65.51*** (0.000)	66.29*** (0.000)
<i>N</i>	13,363	9,872	9,865	9,729	7,268
<i>F</i>	6.743	6.066	8.721	8.853	6.524
<i>R</i> ²	0.00252	0.00429	0.00877	0.00903	0.00891

*p-values in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; (1) only coach characteristics, (2) coach characteristics with further controls, (3) coach characteristics with all controls, (4) sample without interim coaches, (5) sample without ghost games.*

Table 3: Linear Regression with Minute of Substitution as Dependent Variable

here. In Table 3, the time of the substitution is the dependent variable. I can identify a significant influence of the coach's age on the time of the substitution in all models. The effect of the experience variable `days_since_entry` appears to disappear with increasing inclusion of control variables. The rule change, the difference in the positions of the substituted players and the spectators also have a significant influence.

Table 4 also uses the same structure as Table 2 and Table 3. For a better differentiation of the age difference between the players, the days are used as the unit of time, which must be taken into account when interpreting the results. The calculation of the age difference with the previously used time level of years makes no difference to the results, apart from the different unit. Here I can identify a positive influence of the experience variable `days_since_entry` and a negative influence of `years_of_coaching`. Furthermore, the control variable of position is significant.

	(1)	(2)	(3)	(4)	(5)
<code>coach_age</code>	6.938 (0.150)	6.691 (0.166)	7.056 (0.144)	8.156 (0.098)	4.435 (0.413)
<code>days_since_entry</code>	0.0756* (0.026)	0.0708* (0.037)	0.0709* (0.037)	0.0826* (0.019)	0.0507 (0.187)
<code>days_until_exit</code>	-0.0262 (0.564)	-0.0199 (0.662)	-0.0172 (0.706)	-0.0396 (0.418)	0.00545 (0.914)
<code>germany01</code>	29.95 (0.560)	32.32 (0.530)	33.50 (0.515)	42.76 (0.414)	0.0590 (0.999)
<code>years_of_coaching</code>	-22.86*** (0.000)	-22.06*** (0.000)	-22.57*** (0.000)	-24.17*** (0.000)	-22.00** (0.001)
<code>subst_min</code>		0.769 (0.592)	0.482 (0.737)	0.461 (0.750)	0.399 (0.809)
<code>rulechange01</code>		66.42 (0.128)	55.57 (0.259)	59.50 (0.229)	52.62 (0.298)
<code>pos_diff</code>			89.55*** (0.000)	96.45*** (0.000)	84.21** (0.004)
<code>subst_goals</code>			19.73 (0.104)	18.87 (0.123)	26.74 (0.060)
<code>Spectator</code>			-0.000516 (0.608)	-0.000429 (0.672)	0.000290 (0.825)
<code>_cons</code>	-205.0 (0.265)	-302.9 (0.146)	-264.3 (0.215)	-296.0 (0.170)	-153.2 (0.529)
<i>N</i>	9,872	9,872	9,865	9,729	7,268
<i>F</i>	5.066	4.001	4.360	4.615	3.573
<i>R</i> ²	0.00256	0.00283	0.00441	0.00473	0.00490

*p-values in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; (1) only coach characteristics, (2) coach characteristics with further controls, (3) coach characteristics with all controls, (4) sample without interim coaches, (5) sample without ghost games.*

Table 4: Linear Regression with Age Difference Between the Substitutes as Dependent Variable

It is also interesting to note that the control variable of goal difference at the time of the substitution does not appear to play a significant role, at least in these models.

6. Discussion, Implications, Limitations and Further Research

In the following, I will first address the hypotheses and then discuss a few more general points.

H1: The characteristics of coaches influence the tactics of a substitution.

The results confirm this hypothesis, which refers to Wittkugel et al. (2022) among others, with regard to the experience variables days with the team and years as a coach in the professional field. The age of the coach has a negative and the years as a coach a positive influence on the tactic of a substitution. I cannot find any significant influence for the other experience variables. The difference in the age structure of the substituting players as well as the time of the substitution have a positive influence on the tactics of the substitution.

H2: The characteristics of coaches influence the timing of a substitution.

This hypothesis, which is based on the work of Rey et al. (2017) among others, can be confirmed for the experience variable of years as a coach and a negative correlation can be identified. A positive correlation can be identified with the age of the coach. With the exception of the years as a coach in Model 5 in Table 3, this observation can be confirmed in all models. The rule change and the spectators also appear to influence the timing of the substitution.

H3: The characteristics of coaches influence the age of substituted players.

Meyer/Klatt (2021) find that with the increased possibility of substitution there is also the possibility of using more younger players. The results here show a negative correlation in all models for the variable years as coach and in 4 out of 5 models the days with the team as coach has a positive influence on the age difference of the substitution. Regarding the control variables, the tactical component of the substitution has a particularly positive influence.

It can therefore be concluded that nationality and the time until dismissal play no role in the decision-making process with regard to the tactics of the substitution, the time of the substitution and the age structure of the substitution. In the case of nationality, it cannot be ruled out that the available data set is not heterogeneous enough in this respect to be able to find differences. When leaving the team as its coach, self-imposed departures play a role in addition to

termination by the employer. In the termination scenario, the type of termination also varies from an open secret that the coach could soon be dismissed to a completely unexpected dismissal. Overall, the age of the coach, the years as a coach of a professional football team and the period of experience with the specific team seem to influence the decision of a coach with regard to the type of substitution. Influences were also identified for various control variables. It is interesting to note that, with the exception of the time of the substitution and, above all, the goal difference at the time of the substitution, the spectators play almost no role in the type of substitution. The rule change seems to influence the timing of the substitutions in particular.

In general, many factors can influence a coach's decision to make a substitution that I cannot control with the available data. For example, with regard to the fixture list, especially for international clubs, substitutions can also be made in order to protect players before important matches, for example in the Champions League. Sometimes the coach does not make the decision to make a substitution of his own accord, but is forced to do so by the injury of a player or a sending-off. I categorise players into four positions, but in modern football in particular, the boundaries and deployment options for players are blurred and players hold different positions during a season. For example, replacing an attacking midfielder with a defensive midfielder can have a tactical component that cannot be controlled here. Furthermore, I cannot analyse psychological factors in this study. Other leagues and sports could be analysed in order to exclude phenomena that is specific to the German Bundesliga.

7. Conclusion

The aim of this study was to answer the research question "What characteristics of coaches influence substitutions?" and thus fill an existing research gap, also against the background of the rule change regarding the increased possibility of substitutions from three to five permitted substitutions. I confirm that a coach's experience has a positive influence on tactics and timing of substitutions and that younger players are more likely to be substituted by experienced coaches. This study also finds that factors such as rule changes and spectators influence substitution decisions. However, nationality and time to dismissal do not play a significant role in substitution decisions.

Common findings and additional insights compared to the existing research projects in Chapter are the following: Overall, both theoretically and empirically, the importance of the coach's age and experience in decision-making can be emphasised, which influences both the

tactical and timing aspects of substitutions. Furthermore, the additional substitution quotas for the possibility of playing time for younger players are primarily utilised by experienced coaches. In addition, it can be recognised in some of the empirical models that external factors such as rule changes and spectators influence the strategies of coaches during a match.

Overall, the considerations of the studies analysed are in part empirically verified and additional factors, such as rule changes and spectator presence, are identified that also have an influence. Nevertheless, other factors remain that influence coaches' decisions and cannot be controlled for in my models.

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