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The effect of an additional substitution in association football. Evidence from the Italian Serie A

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THE EFFECT OF AN ADDITIONAL SUBSTITUTION IN ASSOCIATION FOOTBALL. EVIDENCE FROM THE ITALIAN SERIE A

KEYWORDS: Football, Substitutions, Discrete choice model, Coaching behavior.

ABSTRACT: The substitution of players during a match has been one of the most significant changes in the Laws of the Game of the association football. FIFA regulated its application in the 1970 World Cup by establishing two replacements, which were expanded to three in 1995. The experimental introduction in 2016 of a fourth replacement during the extra time of several tournaments (the Olympic Games, the FIFA U-20 Women's World Cup and the FIFA Club World Cup) as a previous step to a possible application in next 2018 World Cup makes advisable to study how coaches reacted to an additional substitution in past situations. The present research examines coaches' behavior before and after the FIFA regulatory reform in 1995 that authorized the third replacement. For this, substitutions made in the Italian Serie A during the seasons 1994-95 and 1995-96 are analyzed. Our hypothesis is that teams made more physiological substitutions than tactical ones, which would reflect in a higher proportion of neutral substitutions (replacements of players who belong to the same positions). The results from the estimated discrete choice models found evidence of a change in the coaches' behavior giving preference to neutral replacements over tactical substitutions, probably to maintain the game intensity and prevent injuries.

The possibility of replacing players during a match was one of the most significant reforms in the regulation of association football made in the second half of the twentieth century. English football introduced the substitution for injury reasons in the season 1965-66, and the system was spread to other competitions in the following years, especially after FIFA regulated its application in the 1970 World Cup. The new regulatory framework allowed two substitutions, which were left to the discretion of the coaches. In 1994, FIFA added one extra substitution for an injured goalkeeper through the 2+1 rule. This restriction was removed a year later for setting the substitution system as we know it nowadays: three substitutions at any position.

The increase in the number of substitutions offers a large range of possibilities of influencing the match. Coaches cannot only replace injured players, but also correct tactical errors, compensate the fatigue of the team, adapt to the evolution of the result, or retire players cautioned with a yellow card. This influence can be achieved throw two variables: timing of the substitution and kind of player.

Literature has proposed several explanations about how coaches select players, which can be summarized in four types of factors: (1) tactical factors, (2) physiological factors, (3) psychological factors, and (4) target factors. Tactical factors refer to changes in the balance of offensive and defensive pressure established at the beginning of the match. They are related to the score (del Corral, Pestana-Barros and Prieto-Rodriguez, 2008; Rey, Lago-Ballesteros and Padrón-Cabo, 2015) and can appear either because the attack plan is not working out or because you are ahead in the score and you decide protect this advantage adding more defenders. In addition to this, substitutes transfer information from the manager to the team, which is related to a minor home advantage in Spanish indoor football (Sampedro and Prieto, 2012). Sabotage strategies, such as making a substitution only to lose time, could also be included in this factor. Physiological reasons are those related to choosing players in the best physical condition for a given offensive-defensive strategy. In so far as fatigue and a lower intensity are present in the second half of the game (Bradley, Sheldon, Wooster, Olsen, Boanas and Krustrup, 2009; Mohr, Krustrup and Bangsbo, 2003; Reilly, Drust and Clarke, 2008) and certain positions are more physically demanding (Di Salvo, Baron, Tschan, Calderon Montero, Bachl and Pigozzi, , 2009; Lago-Peñas, Rey, Lago-Ballesteros, Casais and Domínguez, 2009), coaches are forced to make substitutions in order to keep the previously chosen strategy. The replacing of harmed players by an injury or yellow card can be included in this group. Psychological reasons are associated to a non-rational thinking of coaches. It would include well known behavior biases such as the heuristic of not changing a winning team (Nüesch and Haas, 2012), social pressure of the crowd (Nevill, Balmer and Williams, 2002; Garicano, Palacios-Huerta and Prendergast, 2005), confidence of playing at home (Waters and Lovell, 2002) or senses of territoriality (Pollard, 2006). Related to behavior biases, del Corral et al. (2008) found that local managers made the first substitution before, in the halftime interval, probably to avoid that fans show their dissatisfaction. Likewise,

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Myers (2012) reported that coaches tended to overvalue starters on the field and undervalue the role of substitutes. Finally, the target factor would consist on satisfying aims not related to winning the match. Discriminatory tastes (Schroffel and Magee, 2012), or disciplinary measures could be included in this group.

It is considered that the two first ones, the tactical factor and the physiological factor, are the most relevant. It is unclear, however, which factor gain weight in the reasoning of the manager when it is increased the number of replacements. Our hypothesis to test is that teams make more physiological substitutions than tactical ones, which would reflect in a higher proportion of neutral substitutions (i.e., replacements of players who belong to the same positions). The present research examines coaches' behavior before and after the FIFA regulatory change in 1995, which increased, from two to three, the number of substitutions. To do this, substitutions made in the Italian Serie A during the 1994-95 and 1995-96 seasons are analyzed. The Italian league provides the advantage that the introduction of the third substitution (in the season 1994-95) did not match up with the rule of the three points for a win (1995-96), allowing to test the hypothesis free of the effect of other changes.

Methods

Database

The database consists of 2623 substitutions carried out in 612 matches (306 per season) played in the Serie A during the 1994-95 and 1995-96 seasons. In each season, 18 teams faced each other twice, once at home and once away. The use of two consecutive seasons provides the advantage of having a sample with similar teams and players. Implicitly, the supposition that coaches quickly updated their behavior to the new regulation is assumed.

Information on substitutions has been obtained from the websites www.footballdatabase.ue, and http://www.worldfootball.com. Additionally, depending just on their positions, a defensive value is attached to each player. We collected these values as the average for each position at http://www.pointafter.com for the season 2014-15 (the only available). In summary, we assign a defensive value of 64.26 points to all defenders, 49.43 to midfielders and 32.0 to forwards. We consider that the average values of the season 2014-15 are a reasonable approximation in the absence of individual data for the years studied.

Analysis of Data

To investigate the effect of the increase in the number of substitutions, an exploratory analysis is presented, which compares values from games that used the 2+1 rule (season 1994-95) with those from games that used the three substitutions (season 1995-96). Hypothesis testing is used to evaluate the significant of the differences. We consider as statistically significant values those with a p-value of less than .10. Unless otherwise stated, all tests are two-tailed.

In order to obtain more robust results, we estimated two models, an ordered logit with random effects and a multinomial logit with fixed effects, whose dependent variable takes value 0 if the substitution is defensive, 1 if it is neutral and 2 if it is offensive. The character of the substitution was set according to del Corral et al. (2008) definition: a replacement is defensive when the player entering is more oriented to protect the net than the player leaving (i.e., defender for a midfield, defender for a forward, and midfield for a forward); neutral substitution is one in which the roles of both players are the same (defender for a defender, midfield for a midfielder, and forward for a forward); and the replacement is offensive when the coach chooses a player more oriented to scoring goals (forward for a defender, midfielder for a defender, forward for a midfield).

As independent variables we use eleven aspects that are supposed to influence the substitution election: (1) ability difference respect to the opponent (which comes from the difference in the ranking in the previous five seasons, in log terms); (2) matches between direct competitors (those with a difference of ±3 points); (3) round of the season (which takes values from 1 to 34); (4) home team, expressed with a dummy variable; (5) the three substitutions rule, collected with a dummy; (6) timing of the substitution (minute) and (7) its square (minute2); (8) be winning at the moment of the substitution (dummy), (9) difference between teams in the number of players (due to dismissals) at the time of replacing; (10) defensive value of the starting line-up, which was obtained by adding the average defensive values of defenders, midfielders and forwards (these average defensive values come from season 2014-15 and were collected at http://www.pointafter.com); (11) the substitution order (with values from 1 to 3).

Results

Descriptive analysis

Table 1 shows how the third substitution modified the timing of the replacements for all games (2623 observations) excluding games in which goalkeepers were substituted (132). Four conclusions can be drawn from the data. First, as we expected, managers decided to distribute the substitutions along the 90 minutes, bringing forward the first and second substitutions ($P<0.01$). Second, most of the replacements occurred in the second half of the match since, on average, the first two substitutions only were moved 4.2 and 4.9 minutes respectively, and the third one was made in the 78.7th minute. Third, surprisingly, the average number of minutes of all substitutions of the match (two in 1994-95 and three in 1995-96) did not experience a significant variation between seasons (65.8 and 65.9 respectively). Fourth, the average number of minutes of all substitutions remained the same regardless of whether teams were winning, losing or drawing.

Using the same sample than Table 1, the strategy of substitution is analysed in Table 2. The results indicate that coaches tended to choose more neutral substitutions when the third substitution was possible (difference = 3.6, $p < .10$). However, there are no significant differences in the minutes played by players in defensive, neutral and offensive replacements.

In Figure 1, it is shown the evolution of the average defensive power of 279 team formations during the 90 minutes of the match. In order to compare both seasons, we only considered teams with a 4-4-2 starting line-up (i.e., 4 defenders, 4 midfielders and 2 forwards) since it was the most common one in Italy during these seasons. Formations in which the goalkeeper was substituted were excluded. We also removed line-ups from those matches that involved an ejection in order to exclude the influence of the unequal number of players on the election of the coach. The defensive power of the line-ups was generated by adding the average defensive values that http://www.pointafter.com assigns to the role of the defenders (64.26), midfielders (49.43) and forwards (32.0).

	1994-95 2 subst.	1995-96 3 subst.	Diff.	*p*-value	*N*†
Overall substitutions According to the order	65.8	65.9	0.1	.924	2491
1st substitution	58.9	54.8	-4.2***	.000	1154
2nd substitution	74.4	69.5	-4.9***	.000	985
3rd substitution		78.7			352
According to the scoreboard					
Winning (all substitutions)	71.9	73.2	1.2	.193	832
Drawing (all substitutions)	62.7	62.1	-0.6	.671	793
Losing (all substitutions)	62.9	62.2	-0.6	.524	866

*, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.
† Note: Substitutions involving goalkeepers have been excluded.
Table 1. The timing of the substitutions. Seasons 1994-95 and 1995-96 from Italian Serie A

	1994-95 2 subst.	1995-96 3 subst.	Diff.	p-value	N†
Strategy					
Defensive	26.6%	25.1%	-1.4	0.420	2491
Neutral	46.6%	50.1%	3.6*	0.079	2491
Offensive	26.9%	24.7%	-2.1	0.229	2491
Minutes involving each strategy					
Defensive	22.9	21.6	-1.3	0.332	641
Neutral	25.7	25.9	0.1	0.901	1212
Offensive	26.5	27.2	0.7	0.589	638

*, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively
† Note: Substitutions which involved goalkeepers have been excluded
Table 2. Strategy of substitution in Seasons 1994-1995 and 1995-1996 from Italian Serie A

It can be seen that, on average, teams under the 3 substitutions rule were less defensive just in the middle of the regulatory time to becoming much more defensive at the end of the match.

Econometric models

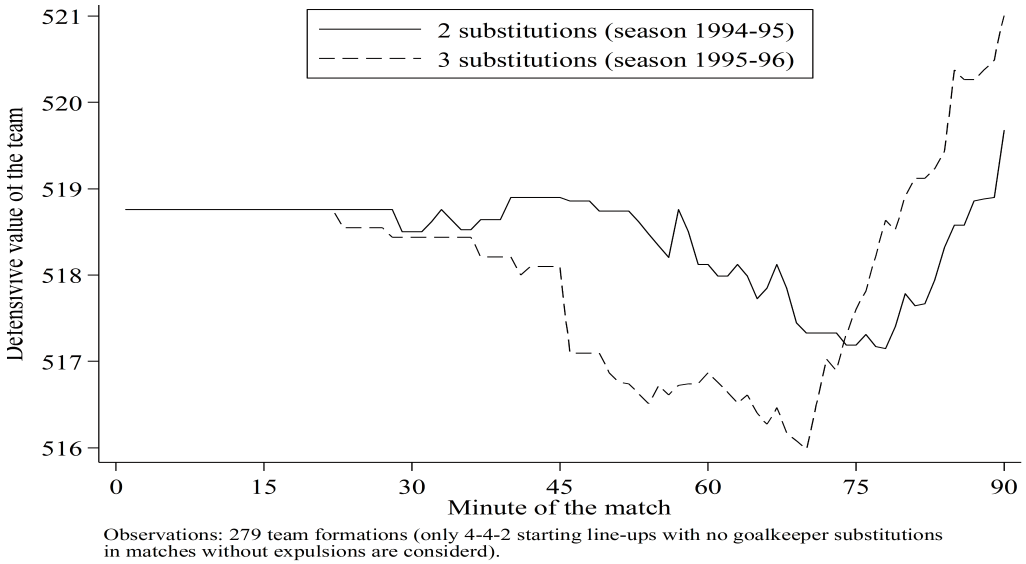
Table 3 presents the results of the econometric models using the whole sample of 2623 substitutions carried out in the 612 matches played in the Serie A during the 1994-95 and 1995-96 seasons. The ordered logit, estimated with random effects, used as dependent variable an ordered discrete variable that takes value 0 if the substitution was defensive, 1 if it was neutral and 2 if the substitution was offensive. It found a positive and significant relationship of the offensive strategy with the quality difference and with going behind in the scoreboard, so confirming the findings of Rey et al. (2015). Additionally, it is also detected a positive relationship with playing at home, with the players difference and with having a starting line-up of high defensive value. All this relationships are significant at $p < .01$. On the other hand, the league round, playing against a direct rival, and the three substitutions rule are not significant variables.

Due to identification problems, 88 observations were removed in the estimation of the multinomial logit. This two-equation model confirms all the results obtained by the ordered probit with the exception of the quality difference. Regarding to our variable of interest, model 2 provided a significant evidence (at $p < .1$ level) that the rule is not related to an increase of defensive/offensive replacements, but related to neutral substitutions.

Discussion

Given the controversial introduction of a fourth substitution during the extra time of the 2018 World Cup, how it is expected that coaches react to the rule should be studied. The analysis of the introduction of the third substitution in the season 1995-96 of the Italian Serie A provides evidence that coaches gave on average preference to neutral replacements over tactical substitutions (offensive and defensive), probably to maintain the game intensity and prevent injuries. Moreover, a convergence of strategies is also observed under the 3-substitution rule, with a significant drop of both defensive and offensive substitutions, *i.e.*, a lower number of offensive and defensive changes in the second analyzed season. Therefore, we could expect that an extra substitution will not have on average a large strategic impact, however it could be very important the time path introduce for the new rule since it would take place only if the extra time is played.

Since we have limited the study to the Italian Serie A, this work could be enhance in further research by using data from other leagues. As we have mentioned above Serie A has the advantage of not introducing the 3-substitution rule together with other rule changes. Also, a more detailed analysis of the time patterns could be addressed.



Nota: *$p < .05$.

Figura 1. Modelo de relaciones causales.

	Model 1: Ordered logit		**Model 2: Multinomial Logit (reference value = neutral substitution)**			
			Defensive		**Offensive**	
	Coef.	***p*-value**	**Coef.**	***p*-value**	**Coef.**	**p-value**
Ability difference	0.1084	.001***	-0.123	.638	-0.121	.620
Home team	0.2475	.000***	-0.237	.035**	0.231	.037**
Round	0.0019	.627	-0.010	.129	-0.006	.383
Even matches	-0.0425	.601	-0.096	.521	-0.090	.547
3 substitutions	-0.0579	.471	-0.227	.096*	-0.251	.070*
Minute	0.0383	.001***	-0.013	.430	0.028	.100*
Minute2	-0.0004	.000***	0.000	.216	0.000	.143
Winning	-12.228	.000***	0.878	.000***	-1.194	.000***
Players difference	0.6658	.000***	-0.762	.000***	0.166	.345
Defensive starting 11	0.0230	.000***	-0.023	.000***	0.020	.000***
Substitution order	0.0492	.487	-0.008	.931	0.053	.585
N		2623	2535			
Pseudo-R2			0.086			
Log-likelihood			-1407.97			
Log pseudolikelihood	-2553.88					

*, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively

Table 3. Multinomial logit and ordered logit. Dependent variable: managers choose a defensive, neutral or offensive substitution

EL EFECTO DE UNA SUSTITUCIÓN ADICIONAL EN EL FÚTBOL PROFESIONAL. EVIDENCIA DE LA SERIE A ITALIANA

PALABRAS CLAVE: Fútbol, Sustituciones, Modelos de elección discreta, Comportamiento de los entrenadores

RESUMEN: La sustitución de jugadores durante un partido ha sido uno de los cambios más significativos en las Reglas de Juego de la FIFA. Ésta reguló su aplicación en el Mundial de 1970 mediante el establecimiento de dos cambios que fueron ampliados a tres en 1995. La introducción experimental en 2016 de una cuarta sustitución durante el tiempo extra de varias competiciones (Juegos Olímpicos, Copa Mundial Femenina Sub-20 y la Copa Mundial de clubes de la FIFA) como paso previo a su posible uso en la próxima Copa del Mundo de 2018 hace recomendable analizar cómo los entrenadores reaccionaron a una sustitución adicional en situaciones pasadas. La presente investigación examina el comportamiento de los entrenadores antes y después de la reforma del reglamento de la FIFA en 1995 que autorizó una tercera sustitución. Para ello, se analizan las sustituciones realizadas en la Serie A italiana durante las temporadas 1994-95 y 1995-96. Nuestra hipótesis es que los equipos hicieron más sustituciones de carácter fisiológico que de tipo táctico, lo cual se reflejaría en una mayor proporción de sustituciones neutras (sustituciones de jugadores que pertenecen a las mismas posiciones). Los resultados de los modelos de elección discreta estimados muestran, efectivamente, evidencia de un cambio en el comportamiento de los entrenadores que otorgaron preferencia a las sustituciones neutras, probablemente para mantener la intensidad del juego y evitar lesiones.

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