



Section B

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## 90 Years of Italian Penalties: Trends, Importance, VAR, and Adjusting the 12-Yard Mark

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### Abstract

This article discusses an alternative to Video Assisted Refereeing (VAR) in football. An alternative option of positively adjusting the distance from the penalty spot to the goal, leading to a decrease in penalty scoring probabilities is suggested. 90 years of empirics from Serie A in Italy is used to discuss the suggested method. The article concludes by an example illustrating the proposed method.

**JEL classification:** Z20, Z21

**Keywords:** Serie A, penalty kicks, VAR, Football, 12-yard mark.

### Introduction

*“In the beginning there was football, then came the penalty kick...”* (Unknown football fan).

Most people with some interest in the game of football are quite aware of the significance of the penalty kick. This single kick on the ball has the power of making individual heroes and forever losers, making nations World Champions, or teams Champions League winners.

The fact that football was played for several decades without penalty kicks<sup>1</sup>, may come as a little surprise for most football fans. The rule set from 1863 contains no notion of the penalty kick whatsoever (see Alcock, 1906). Actually, it took close to 30 years before this

construct entered the rules of football. According to Peterkin (2007), a mill owner and goalkeeper in Ireland, Mr. McCrum invented the penalty kick around 1890 after observing the unthinkable; deliberate kicks from defenders against opposing strikers.

In those days, the penalty kick was quite different from today's version. No exact 12-yard penalty spot was defined, neither was today's 18-yard box (see International Football Association Board, 1892). By 1902, this fairly necessary prerequisites became integrated in the rules.

Although several minor changes related to goalkeeper movement as well as player positioning, (Wikipedia, 2019a), have been introduced, the penalty kick remained more or less unchanged both in the rule book as well as its usage for the next 70 years.

<sup>1</sup> If not professional so at least rule based.

Around 1970, an important change related to the usage of penalty kicks in football was introduced – the penalty shoot-out. Up to that point, matches that ended in a draw and needed a decisive result were resolved by replays. Alternatively, if time made replays impossible, simple randomizing (drawing lots) was applied. Although several experiments in various European countries had been conducted with penalty shoot-outs, (Wikipedia, 2019b), several years before, the Israeli, Yosef Dagan, is often given the credit for inventing the shoot-out as a decisive mechanism in football. It was formally adopted by the International Football Association Board (IFAB) in June 1970, (Wikipedia, 2019b), although the recommendation included the term “not entirely satisfying”.

With the introduction of the penalty shoot-out, the significance of the penalty-kick grew. Primarily because it was used in the most important matches, but also as the number of penalties awarded has shown a significant growing tendency over a long time period<sup>2</sup>.

An alternative example may support the growing significance of penalties even more. According to a Bleacher Report (2012), the 29-year period from 1984 to 2012 of European Cup and Champions League finals included 10 penalty shoot-outs. That is more than 34%. A number clearly indicating the importance of the penalty kick in modern football.

Lately, an event with great potential for making penalties even more important has been established. Video Assisted Refereeing (VAR) was implemented in the FIFA World Cup in Moscow in 2018 and has been used in major European leagues since the 2017-18 season. Bundesliga (Germany) and Serie A (Italy) were pioneers, but both La Liga (Spain) and Premier League (UK) followed within the next 2 years. See (Wikipedia, 2019d).

The VAR system has been (and still is) a change in football causing high controversy. It's potential impact on game flow (slower), adverse team/player incentives (aiming for the hand of the opposing defender instead of the

goal inside the 18-yard area), number of awarded penalties (increase) and uncertainty of outcome (decrease) have perhaps been the most well debated potential negative consequences of VAR. (Haugen, 2019; Niiler, 2019).

In our setting, it is the potential impact VAR<sup>3</sup> may have on the number of awarded penalties that will be of particular interest. It seems logical to assume that improving the referee quality in awarding penalties may lead to an increase in awarded penalties. This is caused by the fact that referees (typically) should have incentives to overlook these situations due to their significance and hence their potential for negative personal feedback to the referee. So far, the empirical observations are too sparse to test such a hypothesis, and what has been done indicate mixed results (see Skiver, 2018; “VAR increases refereeing accuracy,” 2018). Still, it seems logical to assume that VAR may lead to more awarded penalty kicks.

When importance of penalties grows to unacceptable levels<sup>4</sup>, it is not surprising that referees and clubs may shout for more justice. When a single match may be the difference between zero and millions of dollars, it is easy to understand that a wrongly awarded penalty, deciding the match, may cause intense controversy. As such, a phenomenon such as VAR is understandable, as VAR guarantees better and more fair treatment of penalty allotment. However, understandability does not necessarily guarantee optimality.

If penalties become too important, there are (at least) two ways of attacking the problem:

1. The complex solution – introduce technology and/or systems that improve the ability to make a better decision on the

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<sup>3</sup> We have of course not forgotten that VAR also has other dimensions than handling penalty decisions. Both offside as well as yellow and red cards are a part of the system. However, as the topic here is penalties, we leave these dimension out of the discussion.

<sup>4</sup> See the Empirics section for a more comprehensive discussion of the term unacceptable in this setting.

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<sup>2</sup> See the forthcoming Empirics section.

correctness of the penalty. VAR is one example of such a solution.

2. The simple solution – decrease the importance of penalties. For instance, by moving the 12yard spot to some point more than 12-yards from the goal line.

Instead of solving the 'penalty importance problem' by making better (more fair) decisions, one could turn it around and make penalties less decisive – for instance simply by making it harder to score on them. After all, VAR costs and, as discussed above, it has some potential added negative consequences. Adjusting the penalty spot from 12-yards is most certainly a very cheap solution.

This defines our motivation for writing this article. In forthcoming sections, we will by the aid of empirical examples from Italian Serie A, discuss and arrive at conclusive support for the above arguments, and finally arrive at a mechanism for adjusting the penalty spot – typically moving it in a direction making it harder to score. Obviously, we are aware of the fact that limiting such an analysis to a single European league (in principle) disrupts representativity. Still, we would be extremely surprised if the trends we have identified in forthcoming paragraphs are structurally different between Serie A and other major European football leagues.

### **Empirics**

This section contains empirical analyses aiming to support the main hypothesis discussed in the previous section. The penalty kick has shown a continuous trend of growing importance in European football. We have chosen Italian Serie A over a period of 90 years (1929-2019) as our case. The reason is mainly out of convenience, as data for a long period of time was readily available, at open Internet sources as transfermarkt.com (2019) and worldfootball.net (2019).

### **Goal Scoring Frequency**

Given an assumption of a constant penalty awarded frequency, as well as a constant scoring success rate on penalties, a time series with a significant negatively sloped goal scoring frequency would indicate an increasing share of goals scored on penalties and hence a growing (relative) importance of

penalties. As Figure 1 indicates, such a negatively sloped trend in goal scoring frequency is not present in the goal scoring frequency data from Serie A<sup>5</sup> for the given horizon. On the contrary, the goal scoring frequency shows (by visual inspection) a relatively clear U-shaped development. That is, from the start up to around 1980-85, a clear downward sloping pattern is observable, while

**[Please place Figure 1 about here]**

**[Please place Figure 2 about here]**

after that period, the trend shifts and gets positive. A closer inspection confirms these findings as observed in Figure 2<sup>6</sup>.

Consequently, we cannot claim that a total reduction in goal score can be taken as an argument for increased penalty kick importance in Serie A for the given time horizon.

The fact that total goal score frequencies show such a clear U-shaped pattern could of course be regarded as interesting in itself. What did happen and why? As our focus here is not such questions, we will limit this discussion to just mention that the transition from the original 2-1-0 to today's 3-1-0 system took place in all European football between 1981 and 1993 (Wikipedia, 2019c). It's potential impact for goal scoring as well as other relevant dimensions has been thoroughly analyzed in previous research. (See for instance Haugen, 2008; Haugen & Heen, 2019; Varela-Quintana, del Corral, & Prieto-Rodriguez, 2018; Dilger & Froböse, 2018).

### **Penalty success rates**

The previous subsection indicated no possible explanation of penalty kick importance by reduced goal scoring frequencies over time in Serie A. Alternatively, penalty kick

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<sup>5</sup> Observe that data for the three WWII-years, 1943-45 are missing due to obvious reasons.

<sup>6</sup> Simple linear regressions performed with *R* (R Core Team, 2017) produce highly significant estimates of the regression coefficients with significance probabilities both >> 99.9%.

importance can grow if the success rate of awarded penalties shows a significant growth over time. That is, if penalties in the old days either missed the target (bad executors) or got saved by the keeper (good keepers) while today indicates a turnaround. This is not necessarily a completely implausible hypothesis, but there are also obvious good reasons for a reverse causality. Anyway, as Figure 3 indicates, the situation is quite opposite.

**[Please place Figure 3 about here]**

Figure 3 indicates clearly that the keeper/executor game has evolved in favor of the keeper, not the executor. Again, the linear trend shown is clearly significant<sup>7</sup>. Hence, based on the data it is reasonable to conclude that over the years, fewer penalties give goals than before.

It is perhaps easier to observe the magnitude by partitioning the time horizon into 4 relatively equally spaced 22-year periods and plotting the average penalty scoring frequency as indicated in Figure 4.

Figure 4 indicates, for instance, that in the first (oldest) 22-year period around 95 out of hundred penalties resulted in a goal. However, for the 'newest' 22-year time period, only around 75 out of hundred penalties gave goals. This is a huge difference, actually a more than 20% reduction over the time horizon.

Although the causes for such a time development is irrelevant for this article, it may also here be tempting and enlightening to speculate on why. One very obvious and simple explanation may be keeper height. After all, the size of the goal is unchanged over the time period, but maybe the keepers are not? According to NCD Risk Factor Collaboration (2016), the average height of European men (including keepers) have increased significantly over the 90-year period, and 'bigger' keepers defending the same goal size should logically lead to higher saving probabilities. Furthermore, the fact that

Italians started out as quite short<sup>8</sup> and the growing imports of foreign (most probably taller) keepers to Serie A, would enhance this effect. Similar arguments are introduced in recent work by Pedersen, Aksdal, & Stalsberg (2019).

**[Please place Figure 4 about here]**

An alternative and perhaps more probable explanation could simply be that if penalties have become more important, increased pressure involved in taking them could lead to decreased success rates. See for instance Moll, Jordet, & Pepping (2010) and Jordet (2011) for more on this interesting topic.

***Number of penalties***

None of the two previous hypothetical causes for increasing penalty importance gave reasons for constructive conclusions. Still, the final obvious case remains. That is, what about the development of penalties. Could it be that defenders have grown more clumsy, or strikers acquired better acting skills? Or could it simply be that quality of referees both absolute as well as 'incentive-wise' has improved; leading to more penalties given? An alternative explanation could be that the enormous increase of TV-coverage makes it far harder for 'incentivized' referees to overlook the penalties they used to overlook? A reasonable way of measuring this is by looking at the ratio between penalty goals and total goals. If this fraction is increasing, it seems very reasonable to assume that the penalty as such has become a more important part of football teams' "production function". If more goals are achieved on penalties than before, the impact of getting a penalty means more for a club, especially as football is a team sport with relatively few goals (points) compared to other team sports like basketball or handball. This holds for normal league situations, as in our empirical examples. In addition, the increased importance due to the fact that penalty shoot-outs increase in number and are hence used more frequently in

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<sup>7</sup> Using R (R Core Team, 2017) with a significance probability for the slope estimate >> 99.9%

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<sup>8</sup> Compared to most other European nations, according to (NCD Risk Factor Collaboration (NCD-RisC), n.d.).

the most significant matches, adds to the argument.

As can be observed from Figure 5, the data, as well as the simple regression<sup>9</sup>, clearly indicate support for such a hypothesis. So, neither a highly variable (U-shaped) development in total goal score, nor a significant decreasing trend in penalty executor success are big enough to overshadow a steady increasing pattern of the penalty over total goal ratio. Surely, the explanation then must be strong growth in awarded penalties which is readily confirmed in Figure 6, based on the estimated trend, around 250% increase in awarded penalties is observed.

**[Please place Figure 5 about here]**  
**[Please place Figure 6 about here]**

This steady increase in Figure 5 is also quite large. Based on the estimated regression line from Figure 5, it is in fact more than doubled<sup>10</sup>. Hence, it seems reasonable to assume that the importance of penalties has increased for the teams playing in Serie A.

#### **Adjusting the 12-Yard Mark**

As the empirics in the previous section indicated huge and significant increase in the penalty kick importance, it is not hard to understand why VAR was introduced. The high uncertainty related to a single referee and a linesman's ability to make correct decisions in steadily pace-increasing football matches, had to lead to consequences. Our main point, as discussed in the introduction, was that there is at least one totally different way of solving a problem of penalty importance. Either, one could put resources (and in this case quite large resources) into improving both fair- and correctness or one could do as we suggest; make the penalty kick less important – for instance back to a period in time which was acceptable. The data we have

gathered makes such a strategy operationally feasible.

Suppose (for some reason) that the Italian Football Federation<sup>11</sup> has come to the conclusion that Serie A in 1950 had a reasonable mix between “normal-play-goals” and penalty-goals. Then, as our empirics indicate, if we want to time shift back to the 1950-situation, we would need far less penalty goals in the 2018/19 season. If we examine the actual underlying data, the number of awarded penalties in 1950 was 73<sup>12</sup>. Now, in order to achieve less penalty goals in the 2018/19 season, we could achieve this by making it harder to score such goals, or as we suggest, reduce the scoring probability by adjusting the penalty spot to a achieve only 73 penalty goals. The number of awarded penalties in the 2018/19-season was 122<sup>13</sup>. This means, that we would like to achieve a penalty scoring probability of  $\frac{73}{122} = 0.5984$  as opposed to the observed one of 0.7951. So, our suggestion is simple. If (for one reason or the other), the mix between penalty and “normal-play goals” was acceptable in 1950, we could achieve such a mix by changing rules such that the probability of scoring on a penalty should be reduced from its present level of 0.7951 to 0.5984<sup>14</sup>. The simplest and most obvious way to achieve this change would be to move the penalty spot further away from the goal.

Then, let us address this final part. How many yards is necessary to achieve such a change? Obviously, we need some kind of functional relation between the probability of scoring on a penalty and the distance to the penalty spot. Luckily, John Wesson's excellent book

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<sup>11</sup> The technique we introduce here is general, and not restricted to Italy. However, analyses similar to those we have executed should perhaps be repeated if our proposed strategy is to be operationalized in other leagues.

<sup>12</sup> The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

<sup>13</sup> See footnote 12.

<sup>14</sup> We approximate to 4 digits after the comma to simplify.

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<sup>9</sup> Again, the slope is highly significant >> 99%.

<sup>10</sup>  $2(0.0005439 \cdot 1929 - 0.9898) < 0.0005439 \cdot 2018 - 0.9898$ .

(Wesson, 2002) provides the necessary information.

**[Please place Figure 7 about here]**

Figure 7 contains Wesson's original figure with some red arrows and numbers added by the authors for the given example. As can be observed (roughly), the penalty spot should be moved 2 yards out from 12 to 14 yards.

Now, this is just a thought experiment kept at a very simplified level. If one really would do this in practice, a bit more accuracy is probably needed.

Firstly, by changing the penalty spot's distance, the question on the 18-yard box arises. This box serves two functions. It defines the area where penalties are given, but it also serves an important function in the execution of the penalty kick – where the rest of the players could locate in case of a rebound. Increasing the box based on the relocation of the penalty spot is clearly not a good idea, as increasing its size would lead to more awarded penalties, potentially killing the whole argument. As a consequence, we suggest introducing a new 'box' in addition to the original 18-yard box adjusted according to the adjustment of the penalty spot. This new box is only used for player positioning during the penalty execution while the penalty awarding is kept within the original 18-yard box.

Secondly, our example does not correspond with reality as it is made with information not available when the decision must be made. If FIFA, UEFA or any football federation was to test this, the statistical knowledge used in our example lacks some information pieces. If we investigate the argument closer, we will see that a prediction of awarded penalties for the upcoming season is needed. Let us formalize this a little bit by defining necessary parameters. Let:

$P_t$ : Number of goals scored on penalties in season  $t$

$T_t$ : Total number of goals scored in season  $t$

$A_t$ : Number of awarded penalties in season  $t$

The first part of the argument leading to Figure 7 uses historical data –  $\frac{P_t}{T_t}$  is available.

The second part however involves  $\frac{P_t}{A_t}$ . The value of  $P_t$  is picked on the previous step, but the upcoming  $A_t$  needs to be predicted for the upcoming season or seasons. Of course, the naive forecast in Figure 6 could be used, but a more thorough forecasting model could definitely be developed.

Thirdly, equilibrium effects are not taken care of. If rules are adjusted, either by introducing VAR or adjusting the penalty spot, teams will react. Making penalties less important by making it harder to score on them will have equilibrium effects. Hopefully, in the manner underlying this argument with less penalty-goals, but other effects may also evolve. For instance, defender's anxiety for committing fouls within the 18-yard box will decrease, which again could lead to more penalty kicks, which again must lead to more spot adjustment. Still, VAR also have effects. For instance, both the value of "acting" to receive a penalty as well as aiming for a defender's hand within the 18-yard box might increase dramatically.

Finally, Wesson's model is surely extremely simplified. Both the number of experimental penalty kicks involved as well as the settings underlying the experiments could be improved a lot. This is however most probably a matter of adding resources for improvement. Still probably much cheaper than introducing the VAR system.

### Conclusions

Many football purists<sup>15</sup> would, much like the anonymous football fan at the very beginning of this article, claim that the penalty kick itself is the problem. After all, the introduction of the concept created a lot of debate, so did the decisive use of the shoot-out. One could claim that football, a team sport, is not meant to have decisive elements of individual sports, which the sub-game of a penalty kick clearly is. In all other situations in football, including free-kicks, corners and throw ins, the team plays an import role.

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<sup>15</sup> See for instance (Staley, 2018).

However, in a penalty kick, the executor and the keeper involve in a sub-game most certainly of individual nature, just like a boxing match. The team is set aside, the flow of play is stopped, and the individuals decide. Some purists would argue that one should keep these elements in football at an absolute minimum.

Our goal by writing this paper has not been to claim the correct answer. Still, we have a feeling that the alternative options to an introduction of the VAR-system may have been (if not overlooked) at least not judged sufficiently. Here, we point on a totally opposite option. Clearly there are many in-between possibilities, perhaps not studied, analyzed and judged enough. It is sometimes too easy to let technology that evolves be used too fast. In most situations, thinking of the consequences and studying the potential trade-offs, new games arising as well as equilibrium consequences, needs carefulness and time. Some of us are quite uncertain on whether FIFA and UEFA have spent the necessary amount of time judging alternatives to VAR.

As discussed above, there is no quick fix. Any alternative choice has its ups and downs, just like VAR. However, the real problem with VAR is its potential dramatic adverse effects on the team-game of football. We feel certain that an adjustment of the penalty spot has far less potential adverse incentive effects. One thing is obvious. Starting the new season with a presentation of all new penalty spots in all leagues would be much more of a tasteful event for the European football audience than a presentation of the new VAR referee teams. Obviously, we have not discussed the question of team reactions. Our suggestion of making it harder to score on penalties may implicate the teams' playing style. A reasonable assumption to make would perhaps be to speculate on tougher defensive actions from the defending teams, as the probability of scoring on a possible penalty is lower. On the other hand, the attacking teams would also realize this, and probably put more effort in preparing for long-distance penalties. The actual equilibrium outcome is hard to predict, without engaging in quite complex

game theory. Still, our main focus here is more to offer an alternative to VAR, as VAR itself also has obvious (unanalyzed) equilibrium effects. As such, we feel that our suggestions, if not clearly dominant, deserves some thought – as we have demonstrated in this article.

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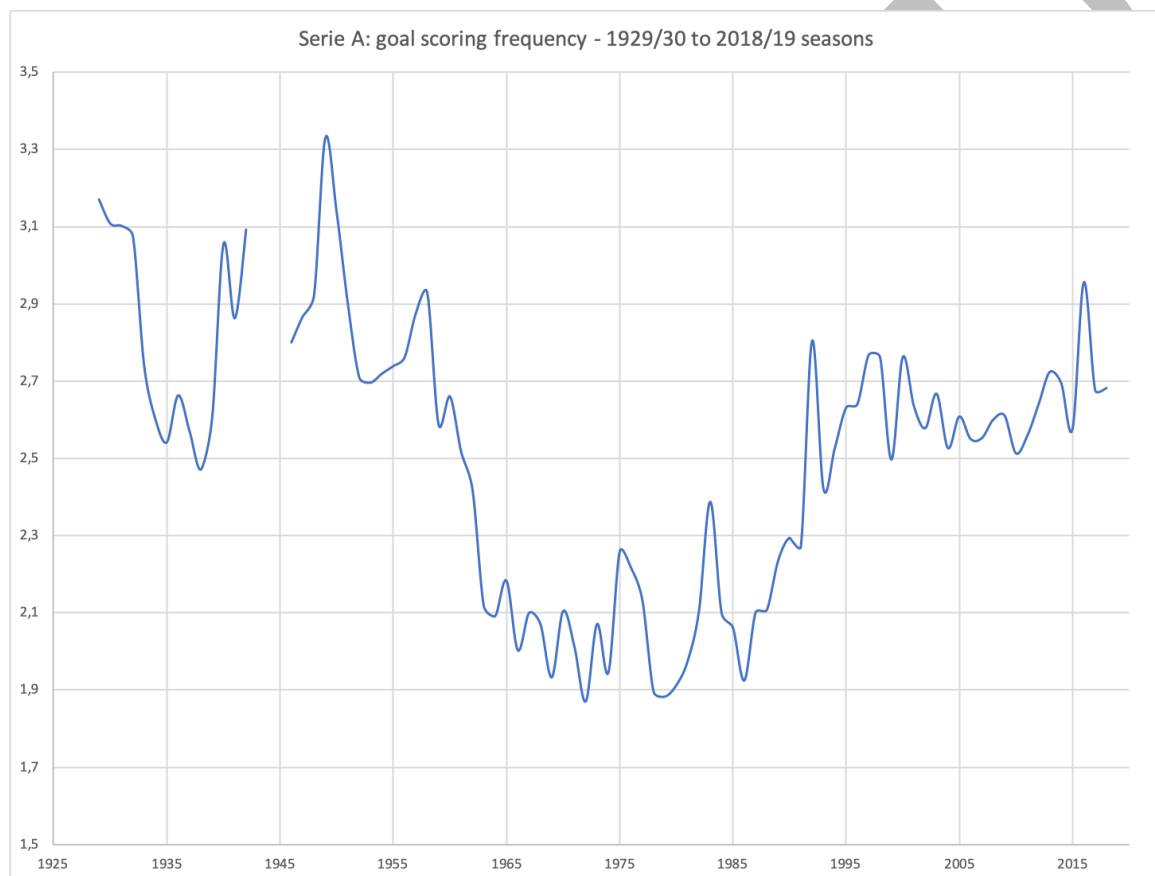


Figure 1: Serie A – Time series of goal scoring frequency (per match).

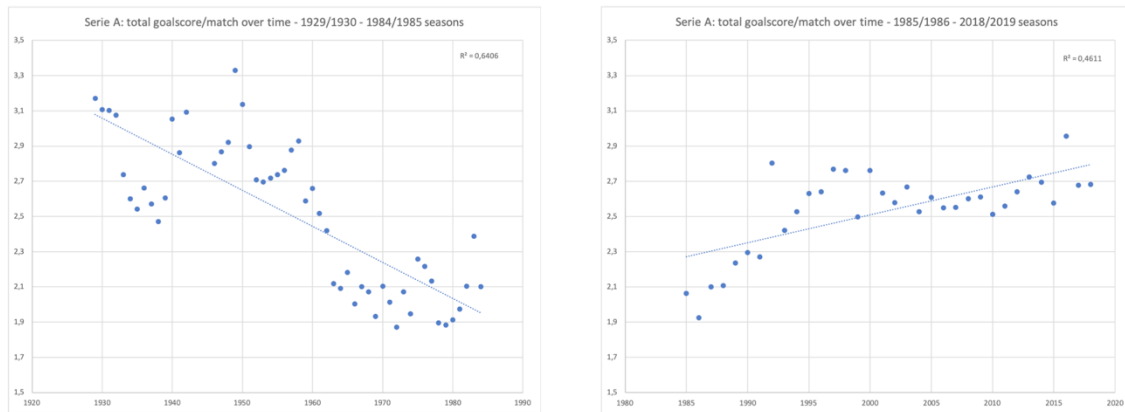


Figure 2: Serie A – total goal score per match broken in two parts.

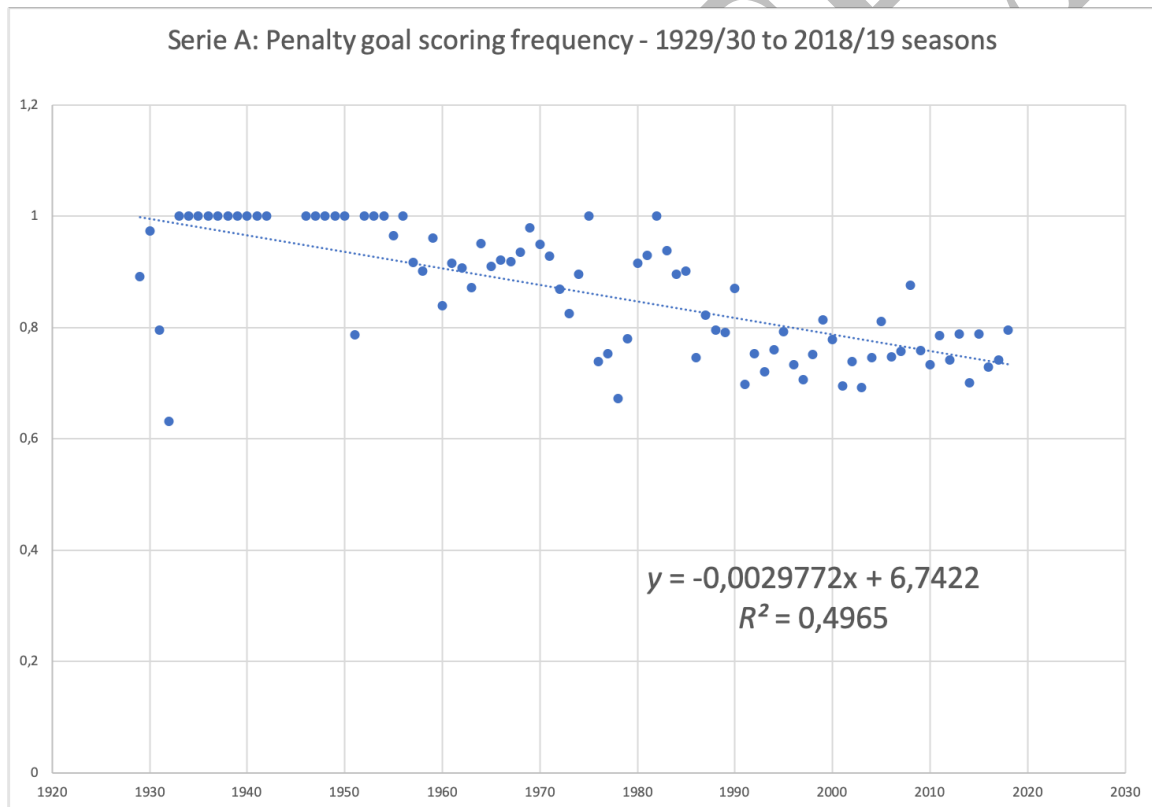


Figure 3: Serie A – Penalty success rates.

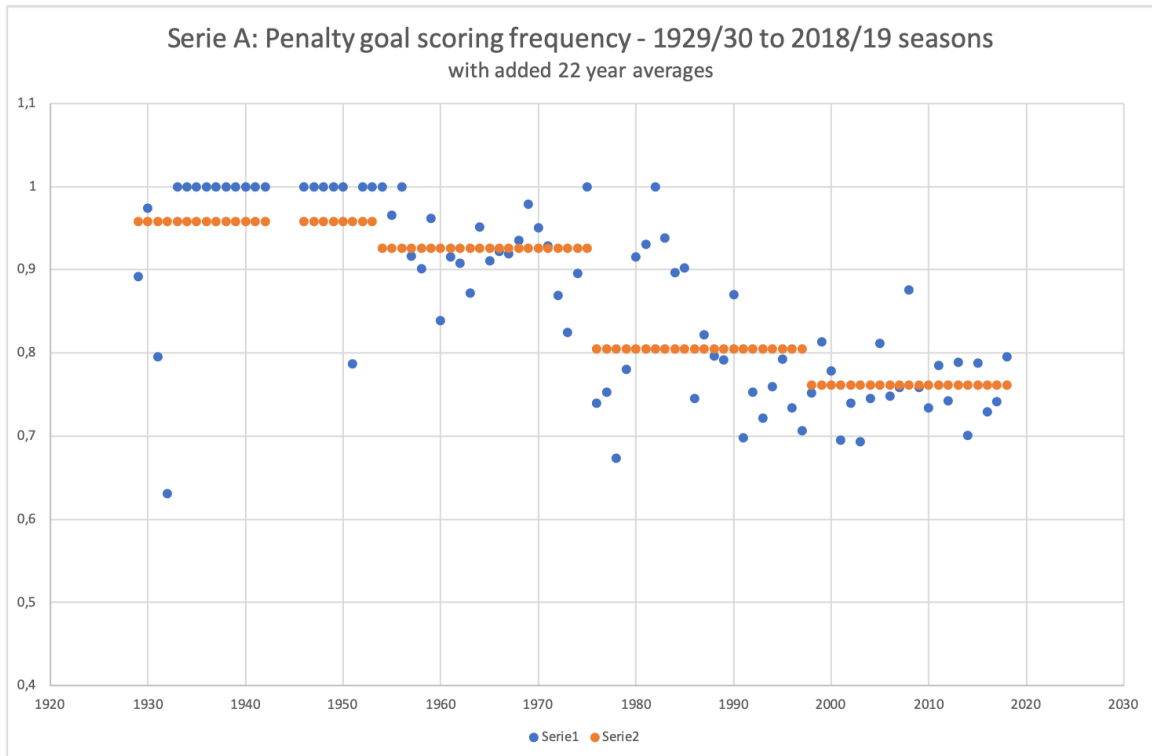


Figure 4: Serie A – Penalty success rates with 22-year averages.

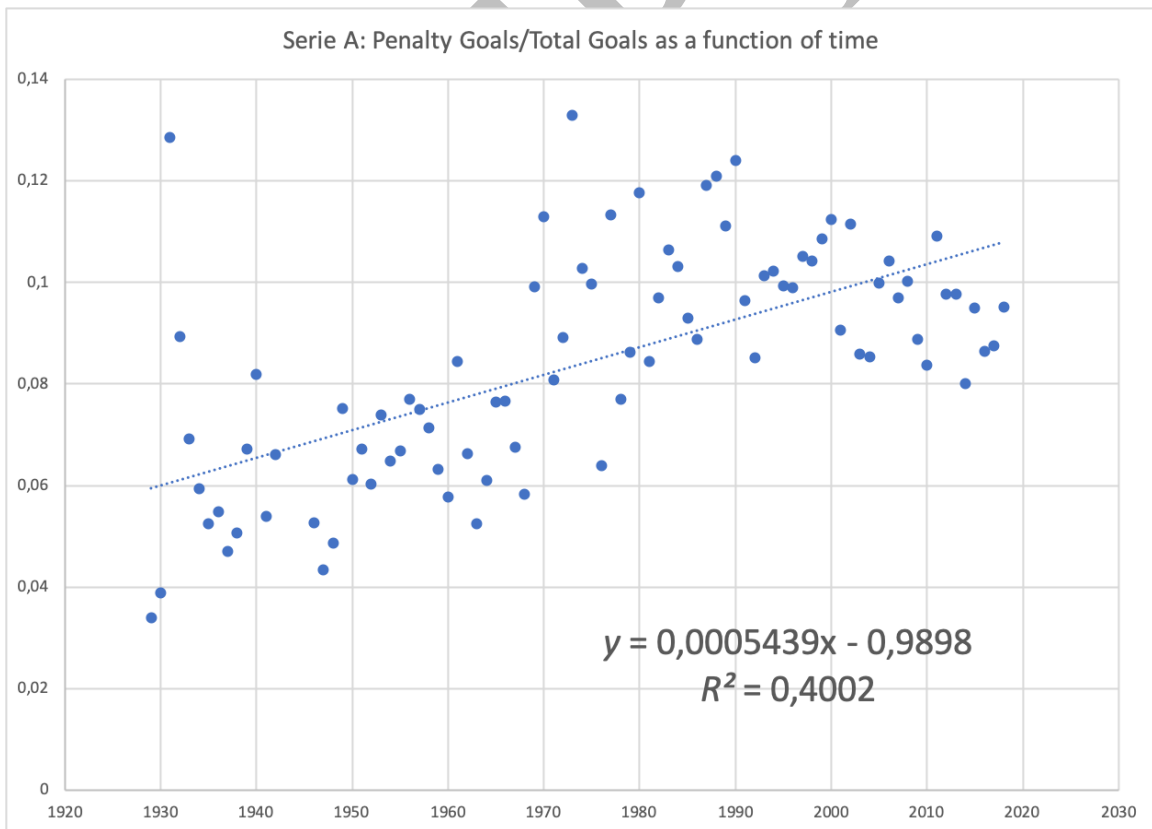


Figure 5: Serie A – Penalty goals over total goals for the time horizon.

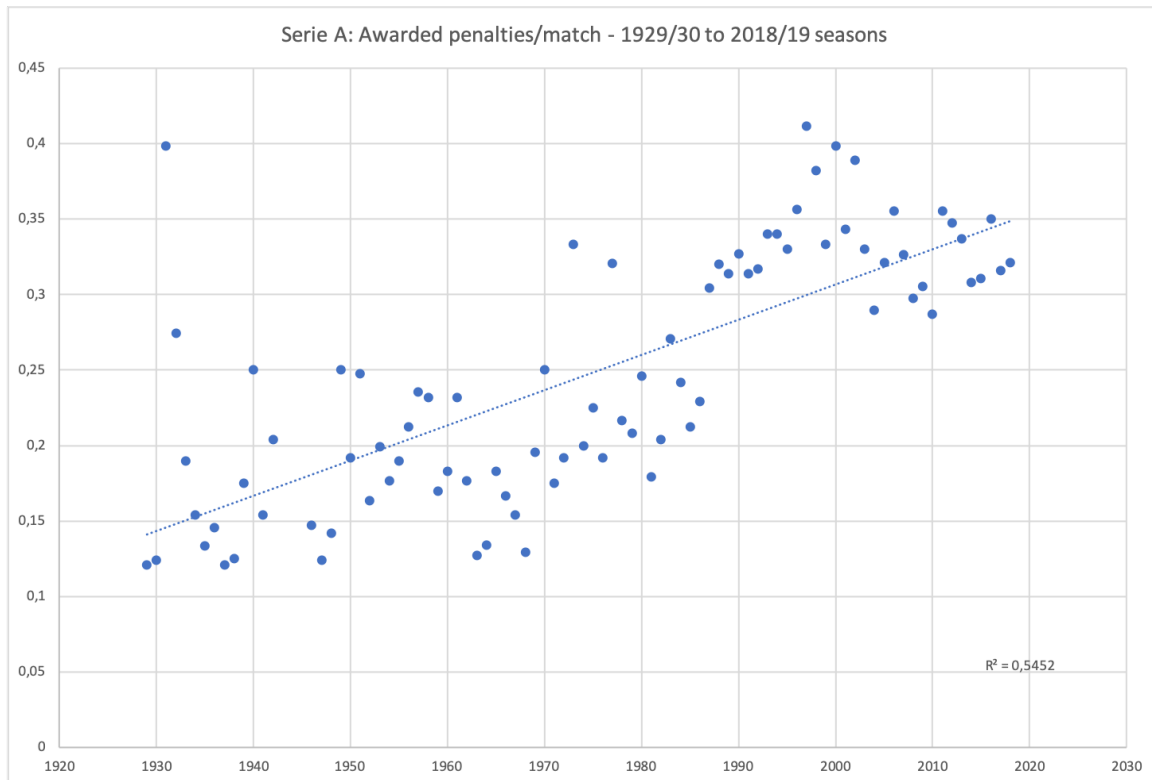


Figure 6: Serie A – Development of awarded penalties per match.

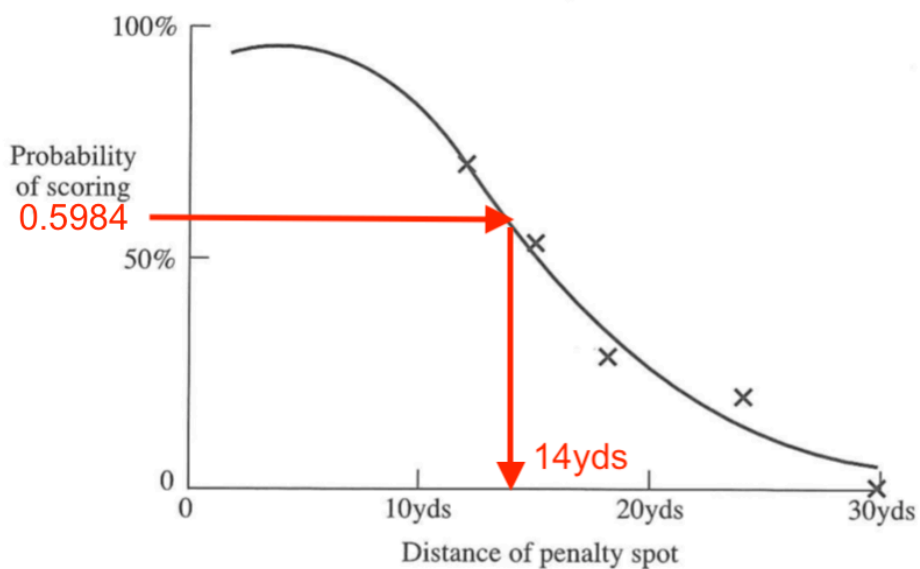


Figure 7: Probability of scoring on a penalty as a function of distance from the goal line to the penalty spot – from (Wesson, 2002).