Testing semi-strong efficiency in a fixed odds betting market: Evidence from principal European football leagues.

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Testing semi-strong efficiency in a fixed odds betting market: Evidence from principal European football leagues.

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Abstract

In this paper, we try to measure the semi-strong efficiency of the sports betting market. In particular, we aim to understand whether the efficiency of the market is realized in the case of fixed odds provided by bookmakers on the four major European football championships. By examining the trends of odds in the event of some major change in expectations about the teams' results, i.e. when a team's coach is replaced, we attempt to verify the argument that a profitable betting strategy for the bettor is likely possible. In this case, the market that we are taking into account will be inefficient.

1 Introduction

This paper fits in with a wide but comparatively recent area of research, which is about measuring the performance of regulated gambling markets. Our goal is to look into the sports betting industry, with a focus on bookmakers' odds in Europe's four key football championships, the British Premier League, the Spanish Liga, the Italian Serie A, and the German Bundesliga. Drawing a parallel with the concept of information efficiency in financial markets, Vaughan Williams (2005) splits the performance of gambling markets into a weak, a semi-strong and a strong form (Fama E., 1970). In this paper, we will only cover **semi-strong information efficiency**, which happens when current share prices encompass all publicly-available information. In other words, if a market meets such requirement, no extra return may be achieved on the basis of public information. Semi-strong (or strong) efficiency means that the return of a bet or of a type of bet based on public (or private) information must be the same, in terms of cost/risk, as that of a bet that has not been based on public (or private) information (Vaughan Williams L., 2005).

The first few research works on the efficiency of public gambling markets have focussed on totalizer-based horserace betting. Many authors did find evidence of the inefficiency of such markets by singling out profitable betting strategies: they include Bolton and Chapman (1986), Hausch et al. (1981), Hausch and Ziemba (1995), and lastly Lo (1995). Quite the opposite of the conclusions drawn by Asch et al (1984), Ali (1998), and Swindler and Shaw (1995), who found that totalizer-based betting markets seem to resemble a weak form of efficiency.

As to the kind of bets we are interested in, i.e. fixed-odds bets, Dixon and Coles (1997) found evidence of market inefficiency by applying trading strategies to the 1995/96 British Premier League matches. Similar results were found by Rue and Salvesen (2000), Kuypers (2000), and Dixon and Pope (2004). In addition, Goddard and Asimakopoulos (2004) found that market inefficiency is more apparent at the end of the football season than in the first few stages of a championship. Forrest et al. (2005) proved that market inefficiency increases along a five-year span

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of time, but it is difficult to find a predictive model to get positive returns. By implementing an *ordered probit* model, normally used to properly estimate the likelihood of the outcome of a football event, they conclude that no profitable returns may be achieved from bookmakers. Recently, Graham and Stott (2008) submitted two predictive models, one based on football results, the other on past odds, to compare rankings based on bookmakers' opinions with rankings based on sports results. Such work found that, even if affected by systematic errors, bookmakers' odds cannot be profitable, using the results of predictive models. As opposed to the results of such papers, Constantinou et al. (2013) built a model of a Bayesian network that can generate profitable strategies from bookmakers' odds, through a combination of market odds, subjective information and historical data.

The analysis of semi-strong information efficiency, which this paper is focussed on, is much less widely discussed in the literature, and major results are less frequent. Most of such papers focussed on horserace betting, often with mixed results [see Edelman (2003), Hausch and Ziemba (1990), Smith (2003) and Cain et al. (2000)]. As to football, one line of research looks into experts' predictions on the main national media (Andersson (2005), Song et al. (2007), Forrest and Simmons (2000)). Above all, Forrest and Simmons (2000) engaged in a review of the suggestions of three professional tipsters' columns, *The Times*, the *Daily Mail* and *The Mirror*. Despite such predictions being more accurate than those based on a random process, the authors concluded their review by claiming that the experts' predictive process fails to properly estimate the publicly-available information.

The goal of our paper is to find a profitable betting strategy, using public information. We will try, in particular, to find out whether a midseason change in technical staff may improve the sports results, and therefore whether such information may be used to reap extra profits. Part of sports business literature tried to answer such a question. In particular, Fabianic (1994) and McTeer, White & Persad (1995) found that a change of coach has a favourable impact on a team's performance, while Brown's conclusions are quite the opposite (1982). Recently, DePaola & Scoppa (2012) looked into the Serie A championship between 1997 and 2009: at first, the results seemed to corroborate the favourable impact of a change of coach on the team's performance, although they pointed out that comparing the results before and after a change of coach is not methodologically correct. Audas, Dobson & Goddard (2002) reviewed changes of coaches in the last 25 years in England: the results found a negative performance in the following three months and increased variance in the results. The authors concluded that changes are mainly made to take advantage of such increased variance in performance: the team owners would therefore try to gamble by giving such a shock.

The paper is organised as follows: section 2 will go deeper into the goals of the research. Section 3 will discuss the methodological aspects and the main results of our analysis. Finally, section 4 will try to draw some conclusions.

2 Semi-strong information efficiency

2.1 Scope

This research work revolves around the idea of a similarity between the betting world and what happens in listed share prices. Think for instance of a listed company that announces an unplanned distribution of dividends, a leading company's interest in a takeover, or a merger with a competitor: the market will respond to such new information by changing its expectations. As expectations change, the share prices will increase or decrease depending on whether the operation is rated as positive or negative by market players. Likewise, sports betting odds may be adjusted based on public information, such as an injury suffered by the strongest player, a referee's decision to have the match played behind closed doors, or the replacement of a coach.

Rather than to an extra distribution of profits, the kind of information we are going to use herein can be compared to an extra financial operation, since it consists of a structural change in the company's organisation that may not improve the company's future profits. In football clubs, there are few instances in which such information basically includes a change in the players' squad or in the technical staff. For the sake of consistency and objectivity, we decided to take the second instance, i.e. the replacement of the technical staff, in particular the change of coach. Actually, estimating a change in the squad is much more complicated, since one should check every match, one by one, to see whether the new players were involved in the match, the minute count and the physical fitness.

To achieve our goal, it is important that we tackle the investigation in small steps. Therefore, our work will be split into the following logical steps:

1) Univocal definition of a 'change of coach';
2) Measurement of the average impact of changes;
3) Strategy-based efficiency analysis.

2.2 Univocal definition of 'change of coach'

For the sake of consistency, we will take a stricter definition of a 'change of coach', which must meet the following requirements:

- ✓ The change takes place in the midst of a sports season;
- ✓ The dismissed coach has trained the team for at least five matches;
- ✓ The new coach is not just a temporary replacement until a new team manager steps in;
- ✓ This is the first change of the season.
- ✓

The first requirement is key, because otherwise our research would be impaired by other factors that could change the team's structure before the start of the season (transfers, promotions, relegations, etc.). The second and third requirements help properly understand the structural change as well as comparing the sporting results before and after the change in the technical staff. The fourth point is definitely a more artful requirement than the others, but it helps make our sample somewhat more consistent. We do not think that the first change should be compared with the subsequent ones, since they happen in very critical circumstances and often result in the first dismissed coach being brought back in. Finally, one last requirement lays down that the new team manager must have had the chance to train at least four matches[4], because otherwise the time horizon would not be wide enough to estimate the impact of the change.

Our sample consisted of the eight football seasons of Europe's four leading football championships, the Italian Serie A, the Spanish Liga, the German Bundesliga and the British Premier League, from 2006/2007 to 2013/2014. In these 32 championships, 203 midseason changes of coach fulfilled our requirements. The following Table lists the distribution of the sample by football season and by championship.

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[4] Changes made after the 30th match by Bundesliga and after the 34th match by the other championships were therefore left out of this analysis.

	Serie A	Liga	P. League	Bundesliga	Tot X Season
2006/07	8	5	3	3	19
2007/08	9	7	8	4	28
2008/09	6	9	5	4	24
2009/10	11	8	5	3	27
2010/11	10	7	4	9	30
2011/12	8	8	4	7	27
2012/13	7	7	5	5	24
2013/14	10	3	7	4	24
Tot X Champ	69	54	41	39	203

Table 1 (source: www.transfermarkt.com)

The Serie A championship is the one in which managers turned over most frequently, 69 in eight years, followed by the Liga with 54; in the Premier League and in the Bundesliga, the turnover of coaches was much less frequent, instead, 41 and 39, respectively.

2.3 Measurement of the average impact of change

The purpose of this section is to measure the impact of a change of coach. We will try to understand whether the new coach can or cannot improve a team's performance in terms of scores[5]. So, we want to answer the following question: "On average, does a change of coach have a positive or a negative impact on the team's performance?".

By putting together the scores made with the dismissed coaches and those made with the new coaches, and then weighting them by the number of trained matches, we found how often a change increased the average value of the team's score. As suggested by the following diagrams, the cases in which a change of coach has had a positive impact are the majority. Actually, in 72% of cases, a change of coach led to a rise in the team's scores. The championship with the highest number of wins is the Liga, with 47 changes of coach out of 54 resulting in an increase in the team's performance. The Premier League is the championship in which a change ended up with a lower number of wins, even if it is still positive in 63% of cases.

[5] Based with the available data, we are unable to measure the value of each coach/team pairing; in other words, we are unable to find whether for Team X it would be preferable to have coach Alfa or Coach Beta.

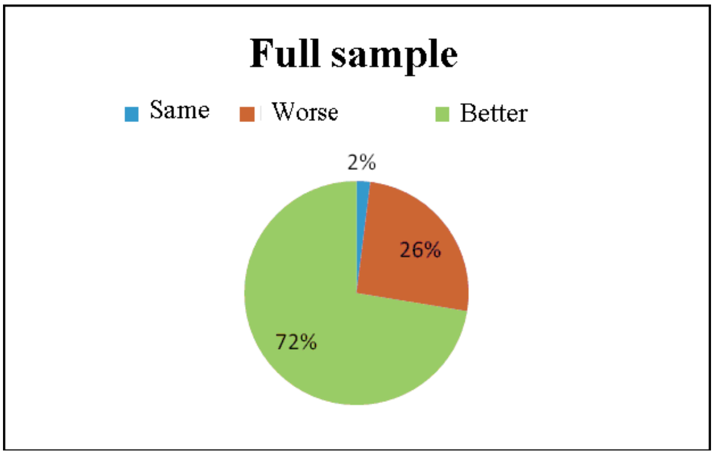


Figure 1 – Source: www.football-data.co.uk

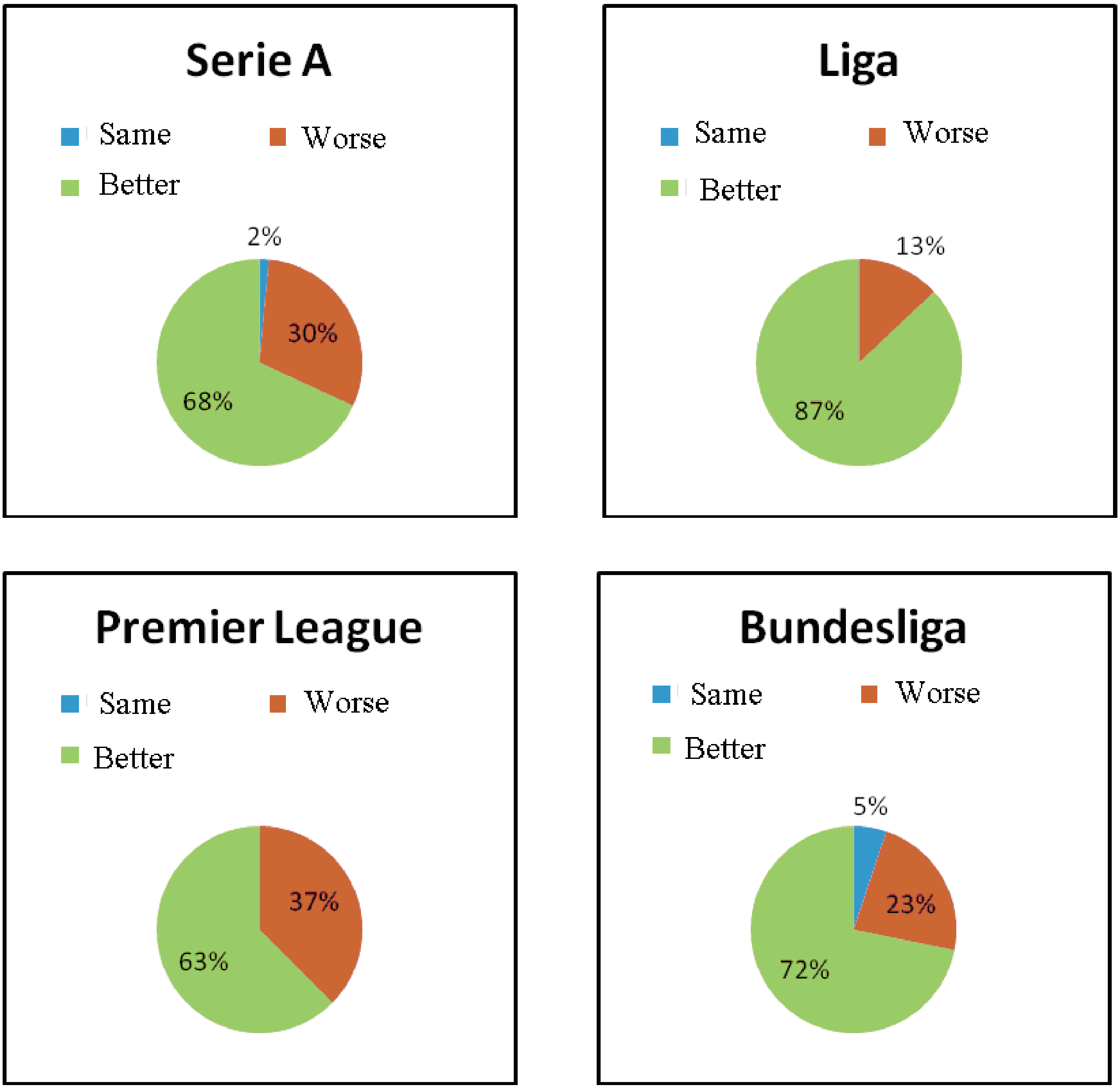


Figure 2 – Source: www.football-data.co.uk

The total number of matches trained by the coach before the change was 3431 and generated 1,023 points each. 3509 matches were trained by a new manager, and in such matches the teams performed much better: 1,272 points per match. On average, in this wide sample, the change resulted in a 24% improved performance. The figures listed in the table below suggest that, on average, in each one of the four championships and in each one of the eight years, the team's scores increased after the change. In addition, the team's performance got worse in just two cases in the 32 championships (Serie A 2008/09 and Liga 2013/14).

So, we can conclude that, insofar as it meets the above requirements, a change of coach has a positive impact on the team's performance. 72% of the 203 changes resulted in an improvement in the team's performance, with a 24% increase in the average score of the whole sample. Based on such evidence, we can move on to the third logical step of this research, i.e. outlining a strategy to understand whether the sports betting market is efficient in taking up the information of a change 'in the bench'.

		Serie A	Liga	P. League	Bundesliga	
2006/07		29,1%	39,9%	15,4%	26,4%	27,5%
2007/08		15,5%	18,0%	46,7%	6,2%	23,3%
2008/09		-11,0%	23,3%	9,7%	10,5%	9,8%
2009/10		33,2%	26,9%	2,2%	83,3%	30,0%
2010/11		31,0%	46,8%	22,5%	4,5%	24,4%
2011/12		22,0%	39,5%	1,5%	32,8%	24,2%
2012/13		18,3%	54,1%	27,7%	45,5%	35,1%
2013/14		48,1%	23,8%	23,5%	-1,8%	28,1%
		24,6%	33,2%	20,3%	21,0%	24,4%

Table 2 (source: www.transfermarkt.com and www.football-data.co.uk)

3 An empirical analysis

3.1 Sample

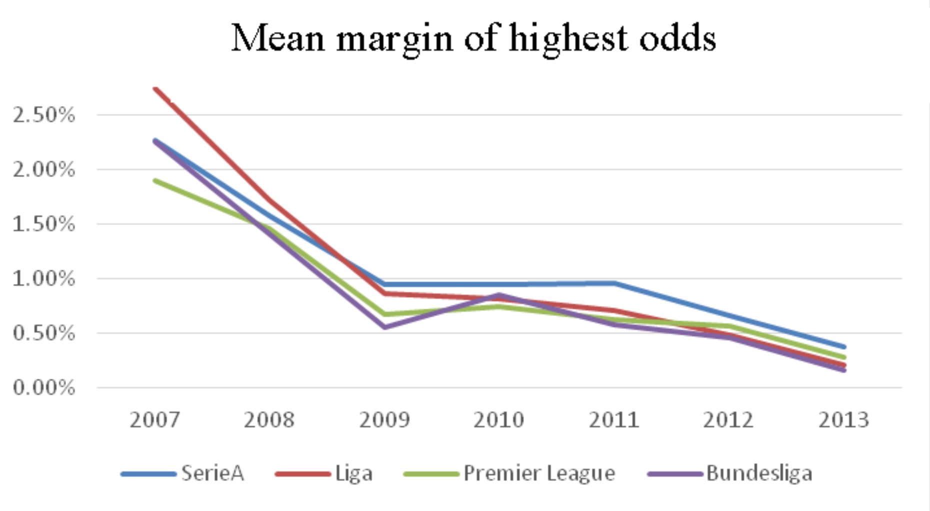
Our data, the source of which is: *football-data.co.uk*, include both the final results and the odds of the football matches of Europe's top four championships: the British Premier League, the Spanish Liga, the Italian Serie A, and the German Bundesliga. This paper covers the seven seasons between 2006 and 2013, a total of 10122 matches. 47.03% of such matches ended with the home side winning, 25.56% ended in a tie, and the remaining 27.42% ended with the away side winning. Odds of 1x2 per result were selected from *football-data.co.uk* based on two criteria, the highest and mean values of those listed at *betbrain.com*, a website that shows all odds in the British and European bookmaking markets. Odds are taken at a random time before the start of the sports event, with approximately 40 bookmakers per match.

Table 3 (Source: www.football-data.co.uk)

	Serie A	Liga	P. League	Bundesliga	Mean
2007	2.27%	2.74%	1.90%	2.25%	2.29%
2008	1.57%	1.72%	1.45%	1.41%	1.55%
2009	0.95%	0.87%	0.67%	0.56%	0.77%
2010	0.95%	0.81%	0.74%	0.85%	0.84%
2011	0.96%	0.71%	0.63%	0.58%	0.73%
2012	0.66%	0.49%	0.57%	0.46%	0.55%
2013	0.38%	0.21%	0.28%	0.16%	0.26%

As shown in Table 3, the marginal value of the highest odds on the bookmaking market remarkably decreased over the last seven years, due to the increased competitiveness of the supply side. Therefore, the expected value of the betters' stakes must have been definitely lower in the first seasons that in the last ones.

Figure 3 (Source: www.football-data.co.uk)



This clearly shows, therefore, that the expansion of the betting market, especially through the Internet, enables people to bet almost "on a par" with bookmakers when the highest odds are selected. Our review is therefore affected by margins, since in 2007 the average margin of the highest odds was 2.29%, while in 2013 it was just 0.26%.

In Costantinou & Fenton (2013), a betting simulation is always based on one and the same bet, i.e. one euro. Since our sample includes 10122 matches, betters would have spent 30,366 €[6] and, based on the actual results, their payoffs would have been 29,745.48 €, which is 97.95% of their stakes. In this paper, we discard this method and opt for the proportional betting method. Firstly, we believe that assuming that a better would put the same amount of money on odds of 30 and odds of 1.10 sounds unreasonable. In addition, opting for a proportional betting system will not produce false results should the odds be exceptionally high. From now on, our research will stick to the following betting principle: 1/q1 on the home team, 1/qx on a tie, 1/q2 on the away team. Such method will produce a one-euro payoff if the result is a positive one and zero if the result is a negative one. Using this setup, betters would have spent 10222,94€[7], while their payoff would have been just 10122€, i.e. the number of matches they would have betted on. In this way, the turnover would have amounted to 99.01%. The fact that the expected result of our strategy is different from that of Costantinou & Fenton's is in itself indicative of the fact the odds ratio in all ranges of probability is not perfectly balanced.

Table 4 (Source: www.football-data.co.uk)

[6]Number of matches multiplied by potential results: 10122*3=30366
[7] Which is precisely the number of matches multiplied by the bookmaking market's average margin.

Constantinou&Fenton’s strategy				Proportional strategy		
1	X	2		1	X	2
10122	10122	10122	Investment	4670.61	2700.11	2852.22
10352.36	9630.69	9762.43	Result	4760	2587	2775
2.28%	- 4.85%	- 3.55%	Payoff	1.91%	- 4.19%	- 2.71%
97.96%			Expected value	99.01%		

3.2 Testing semi-strong efficiency

To test the assumed semi-strong efficiency of the sports betting market, we will split this analysis into two parts. In order to make sure bookmakers’ odds regularly underestimate or overestimate the chance of winning when the coach changes, we will see whether a strategy, whereby the team whose coach has been changed would be the winner, may be profitable in the championships we have taken into account. Conversely, if the market has properly estimated the chance of winning, there should be no gain whatsoever. In the second part of our research, we will see whether the chosen strategy is more profitable than a randomly-selected betting choice.

First, we will engage in a short-term analysis, focussing our attention on the first few matches after a change in the technical staff, so both bookmakers and betters have fewer inputs to make a proper estimate of the teams’ chance of winning. So we selected a time horizon of four matches, which is the number of matches played in one month. Of the 203 changes of coach we took into account, only once did the new coach continue to train the new team for less than 4 matches. Therefore, the total number of matches is 811, i.e. approximately 7% of the total number of matches included in these championships[8].

To sum up the foregoing as well as our strategy:

- We will consider the first 4 matches trained by the new team manager;
- We will simulate betting on the team that changed its coach to win each match (both home and away);
- Stakes will be laid on the market’s highest and average odds and will be inversely proportional to such odds.
- We will compare the results with random betting choices.

[8] Note that two teams that have just replaced their coaches may, of course, happen to play against each other. In these cases, each match is addressed as if they were two different ones: one from the perspective of the home team, the other from the perspective of the away team.

3.3 The payoff of highest and average odds

Table 5 shows the profit margin of the aforesaid betting strategy. In this case, we selected the highest odds from our dataset.

	Serie A	Liga	P. League	Bundesliga		Season's total
2006/07	5.4%	0.3%	-17.0%	6.4%		1.1%
2007/08	1.4%	31.7%	-37.0%	-51.3%		-11.1%
2008/09	-67.4%	4.1%	55.7%	51.7%		14.2%
2009/10	18.7%	-14.0%	12.5%	24.9%		8.3%
Tot. Champ.	-2.4%	4.6%	3.4%	9.7%		3.1%

Table 5 (Source: www.transfermarkt.com and www.football-data.co.uk)

If we look at the season-championship pairings, we see that the strategy delivered a positive result in 11 cases out of 16 (69%). The only championship that delivered a negative payoff as a whole is the Serie A, deeply affected by the 2008/09 season; it is in Germany, instead, that we have the overall highest payoff, with a 9.7% profit margin.

Overall, this strategy results in a 3.1% positive payoff, despite the bookmakers' higher margin in the first four years[9]. This suggests, then, that the impact of a new coach on the team's performance is regularly underestimated.

When we repeat our test on the following time span, i.e. from 2010 to 2014, the results are:

	Serie A	Liga	P. League	Bundesliga		Season's total
2010/11	23.4%	30.2%	23.8%	3.4%		18.2%
2011/12	25.0%	16.4%	-7.0%	-27.4%		1.0%
2012/13	51.2%	9.5%	-27.4%	41.1%		20.9%
2013/14	34.3%	-55.9%	31.5%	32.7%		19.3%
Tot Champ	32.0%	8.2%	7.7%	4.9%		14.6%

Table 6 (Source: www.transfermarkt.com and www.football-data.co.uk)

Because of a decrease in the average margins and, above all, a highly underestimated impact of the change of coach in the Serie A, our strategy delivers an extremely positive payoff value. As

[9] Equal to approximately 2% of the highest odds.

we can see, only 4 cases out of 16 delivered negative results, and overall our strategy resulted in a 14.6% payoff.

The championship that had been most profitable before, the German one, now has a lower profit margin, which means that bookmakers made better estimates of the odds. All things considered, however, we can say that the sports betting market cannot efficiently counteract the positive impact of a change of coach, since our strategy would have ensured a 9.1% average margin in eight years, with just one negative observation, 2007/08.

	Serie A	Liga	P. League	Bundesliga		Season's total
2006/07	5.4%	0.3%	-17.0%	6.4%		1.1%
2007/08	1.4%	31.7%	-37.0%	-51.3%		-11.1%
2008/09	-67.4%	4.1%	55.7%	51.7%		14.2%
2009/10	18.7%	-14.0%	12.5%	24.9%		8.3%
2010/11	23.4%	30.2%	23.8%	3.4%		18.2%
2011/12	25.0%	16.4%	-7.0%	-27.4%		1.0%
2012/13	51.2%	9.5%	-27.4%	41.1%		20.9%
2013/14	34.3%	-55.9%	31.5%	32.7%		19.3%
Tot Champ	15.3%	6.3%	5.4%	6.8%		9.1%

Table 7 (Source: www.transfermarkt.com and www.football-data.co.uk)

The championship in which the strategy turned out to be most profitable, with a 15.3% payoff, is also the one in which the coach changed most frequently, i.e. the Italian championship. In the other three championships, the average value is similar and ranges between 5.4% and 6.8 %.

One of the objections that may be raised to this analysis is that it focuses on the highest market odds. Actually, the results might be affected by a bookmaker's mistake rather than market inefficiency. To answer this legitimate question, we will repeat our test on the market's average odds instead of the highest odds. Since in our sample the average odds have too high a margin to make a comparison (on average, approximately 7% versus 1% of the highest odds), we will weight the average odds on the margin, so that the intrinsic probability of the odds adds up to one. This is merely a linear weighting method, which is vastly used in the literature[10]. Firstly, we will calculate the margin (μ) using equation 1, with q being the average odds of each stake.

$$1) \qquad q(1)^{-1}+q(X)^{-1}+q(2)^{-1}=1+\mu.$$

Then, we will recalculate the weighted odds by multiplying the average odds by the margin. If for example we wanted to calculate the weighted odds of a home win, q'(1), we will have:

$$2) \qquad q'(1)= q(1)\cdot \mu.$$

[10] See, for example, "Online bookmakers' odds as forecasts: The case of European soccer leagues", E. Strumbelj, M. Robnik Sikonja, International Journal of Forecasting 26 (2010)

If the mean and highest odds were perfectly aligned, we would expect to have a higher payoff than before. This is because the highest odds we had used before had an overall margin of approximately 1%, while the average odds, which are weighted, do not include any bookmaker's margin.

	Serie A	Liga	P. League	Bundesliga		Season's total
2006/07	6.2%	2.6%	-16.5%	16.8%		4.2%
2007/08	2.4%	32.2%	-36.7%	-47.0%		-9.4%
2008/09	-65.4%	-5.0%	57.7%	63.5%		13.9%
2009/10	18.6%	-13.1%	13.1%	33.9%		9.5%
2010/11	24.0%	30.3%	24.7%	-6.6%		14.4%
2011/12	23.2%	16.0%	-6.6%	-35.9%		-3.5%
2012/13	49.4%	9.0%	-28.1%	49.6%		21.6%
2013/14	25.9%	-55.9%	32.3%	33.5%		16.5%
Tot Champ	14.7%	4.9%	5.9%	5.4%		8.3%

Table 8 (Source: www.transfermarkt.com and www.football-data.co.uk)

Table 8 shows that payoffs have decreased from before, but are generally still positive. As there are no margins, we expected to see an approximately 1% increase in the total value; instead the payoff dropped from 9.1% to 8.3%. In addition, the championship/season pairings that had a negative payoff were 11 out of 32, instead of 9. Lastly, note that, while all four championships remained positive over the seven years' time span, the years in which the payoff was negative have doubled up, with the 2011/2012 season adding up to the 2007/08 season. All in all, even if the expected payoffs of the average odds are lower than those of the highest odds, this test confirms that, in the short term, bookmakers regularly underestimate the chance of winning of the teams that have changed their coaches.

3.4 Comparing payoffs with a Monte Carlo Experiment

Based on the definition of semi-strong efficiency, a betting strategy that relies on public information must have the same risk/return profile as any other betting strategy that uses no information at all. Therefore, what we are trying to understand here is whether the profit margin of our strategy is significantly higher than the one of a random betting choice. In this case, we would contradict such definition and would confirm this as a case of semi-strong market inefficiency.

The change-of-coach betting strategy may be equated to a set of bets on 811 results, selected according to specific criteria out of the total 35'520 results of the entire sample. Therefore, we want to randomly pick some sets from 811 bets out of the entire sample and calculate their overall payoff. As in the previous example, a cost of 1/q will be incurred for each one $_i$[11], and the return will be either 1 or 0, depending on whether the chosen result happens or not. If we calculate the

[11] Where q_i is the odds for the i-nth result.

ratio of total returns to total costs, we find the payoff of this set of random bets. We then repeat this algorithm a high number of times[12] to calculate the odds ratio of payoffs, for a comparison with the results of our strategy. The odds ratio, which is shown in Figure 5, has a mean value of 0.991517 and a variance of 0.002083. Assuming as a null hypothesis that the value obtained following our strategy (1,090615) belongs to this distribution, we carry out the test on the right-hand column. The result of the z-test is 2.1713 (p-value 0.017), which makes us reject the null hypothesis, with a 2.5% significance level.

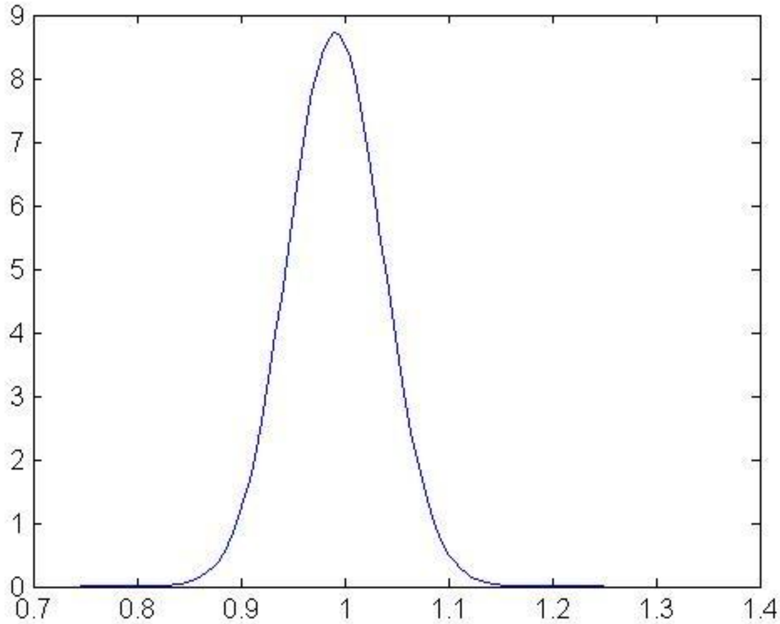


Figure 4 – Source: Simulation of data from: www.football-data.co.uk

Now, we repeat the simulation test we did on the average odds by testing the overall result of 1.082913. We get the following odds ratio, with a mean value of 0.999961 and a variance of 0.002125 (figure 6). In this case, the z-test delivers a lower result, i.e. 1.7995, and a p-value below the 5% significance level (0.036). In either case, we can conclude that there is an anomalous payoff, at least in the short term, for bets placed on the team that changes its coach, and so the hypothesis of market efficiency in the semi-strong sense is not, in fact, respected. In other words, bookmakers do not factor in this information in their forecasts, so they underestimate the market's odds.

[12] We made 10 million reiterations, taking efficiency/time as a principle.

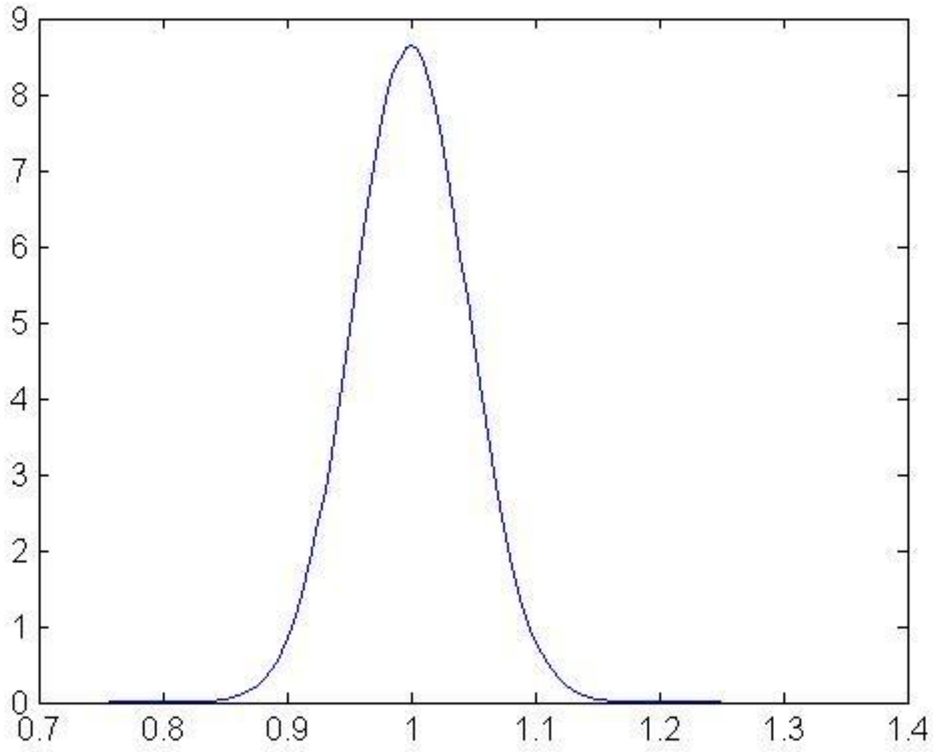


Figure 5 Source: Simulation of data from: www.football-data.co.uk

To complete this test, let's now calculate the payoffs that would have been achieved by repeating the betting strategy on the next four matches, i.e. from the fifth to the eighth match after the change of coach. The results (Tab. 9) buck the trend of those from the first four matches after the change. The only championship in which the strategy is still positive is the Liga, with a 4.7% payoff, while the championship in which such strategy results in the greatest losses is the Premier League, with a -17.1% payoff. In the eight years covered by our test, the average loss is 5.6%. Note also that, compared with the first four matches after the change, the proportion of wins drops from 35.4 % to 30.6%. We can say, therefore, that the payoffs of the strategy we opted for are not worthwhile over a longer time span. On one hand, bookmakers improve their estimates of the odds, adjusting their expectations of the chance of winning of the teams that changed their coaches. Actually, because of the positive results of the teams that changed their coaches, the market generally decreased its odds, thus increasing their chance of winning. In addition, the results are affected by the lower number of matches won by the teams that changed their coaches.

	Serie A	Liga	P. League	Bundesliga	Season's total
2006/07	-25.5%	15.2%	-100.0%	-5.6%	-17.2%
2007/08	-22.4%	-33.9%	3.2%	21.8%	-11.3%
2008/09	-47.4%	-13.1%	-30.0%	-39.3%	-28.4%
2009/10	4.7%	29.6%	-49.5%	45.4%	8.9%
2010/11	5.9%	32.2%	13.5%	-56.6%	-3.1%
2011/12	2.2%	-4.8%	-25.0%	24.9%	0.5%
2012/13	-5.9%	2.8%	4.3%	14.0%	3.3%

2013/14	5.2%	43.6%	-16.6%	-22.2%		-1.5%
Tot Champ	-7.2%	4.7%	-17.1%	-5.3%		-5.6%

Table 9 (Source: www.transfermarkt.com and www.football-data.co.uk)

4 Conclusions

In our research, we tried to measure the semi-strong information efficiency of the sports betting market. By looking at the trends of odds in the event of some major change in expectations about the teams' results, i.e. when a team's coach is replaced, we found evidence that contradicts the assumed semi-strong efficiency of the sports betting market. In addition, our analysis shows that a market that has made an incorrect underestimate will tend to raise its expectations. Finally, we found that, if we use the market's average odds instead of the highest ones, our estimate is more correct, but still wrong: based on such result, we can assume that underestimates are made by just part of the market, not all of it.

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