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A COMPARISON OF GERMANY, HOLLAND AND TURKEY FOOTBALL LEAGUES WITH CRAMÉR–VON MISES TEST

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ABSTRACT

Football, which is assumed to be played with more than 250 million players in more than 200 countries all around the world, is a sports activity that appeals to the masses. In this respect, football, apart from the sports structure, with its fan communities, sponsors, social media applications and social responsibility projects has turned into an inseparable part of our daily lives. Different football leagues show differences in regards to the sponsor connections and financial powers they have. In this study, Germany, Holland and Turkey premier football leagues, all of which are in European leagues, have been discussed because each have 18 teams. The competitiveness structure of the leagues has been compared by making comparisons based on the points scored throughout the season by the teams that rank among the top three in the league. The results have been interpreted by comparing the above-mentioned three leagues with the fundamental principle that the score increase rate of the teams ranking among the top three in leagues, where there is less competitiveness, will be high.

Keywords: Cramér–von Mises test, Football, Competetiveness

1. INTRODUCTION

Football is a team sport that is played between two teams made up of eleven players each, with a distinctive spherical ball. As of the 21st century, it is being played in more than 200 countries with more than 250 million players and it is the most popular sports in the world. *Cuju*, which emerged in China in 300-200 BC and had some similarities with today's football, has been acknowledged as the first game that resembles football with regard to the way it was played. Even though games similar to football have been played around the world throughout the years, modern football rules were first systemized by Football Association in 1863 and has undergone many changes to this day [1].

It is known that football was first started to be played in the last quarter of the 19th century in Turkey. The wick that was first ignited in Thessaloniki in the Ottoman Empire spread all the way to Bornova meadows in time. The time when football began to settle into our culture in Turkey is between 1908 and 1923. After the foundation of Turkish Training Society Alliance (Türk İdman Cemiyetleri İttifakı), which is the first organisation of Turkish sport, the first Turkish Football Federation was founded with the name "Futbol Heyet-i Müttehidesi" during the meeting which took place in Letafet Apartment in Şehzadebaşı in 1923. Later, an application was made to FIFA and Turkey became the 26th member of FIFA in May 21, 1923 [2].

Turkish Football League, which is now called Süper Lig, has been founded in 1959. The matches that took place in the first season of Turkey Premier League in 1959 were played in two groups called "*Beyaz"* and *"Kırmızı"* (Red and White), each made up of 8 teams. The group system was cancelled following the 1959-1960 season and Turkey Premiere League began to be played as it is played today. While the league, whose name was changed to *Turkey Süper Lig* in the 2002-2003 season, was called "Turkcell Süper Lig" between the 2005-2006 and 2009-2010 seasons, "Spor Toto Süper Lig" name has been used since the 2010-2011 season. While 2 points were given for a victory until the 1987-1988

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season in Spor Toto Süper Lig, which has undergone changes in terms of the number of participants and format in time, 3 points have been started to be given for a victory since that season. With the end of the 2015-16 season, the league is in the 11th place UEFA country ranking and sends two teams to UEFA Champions League and three teams to UEFA Europa League. A team that wins the Turkish Cup but cannot make it to the top 4 can take part in UEFA Europa League. Up until now, including the 2015-2016 season too, five teams; Galatasaray (20) Fenerbahçe (19), Beşiktaş (14), Trabzonspor (6) and Bursaspor (1), have earned the champion title in Süper Lig, in which 68 teams compete [3].

Spor Toto Süper Lig consists of 18 teams. The season starts in August and ends in May. The teams meet each team twice throughout the season. One of these matches is played in the team's own home and the other match is played in the opponent's home. Thus, a team plays 34 matches at the end of a season. With the other teams taken into account, a Spor Toto Süper Lig season consists of 306 matches in 34 weeks. In the case that a match ends with the victory of one of the parties, the winning team earns three points. The losing team cannot earn any points. If the match doesn't end up with the victory of one of the parties, meaning it is a draw, each team earns one point each. At the end of the season, the teams are ranked in accordance with the points they have earned. The team that ranks first at the end of 34 weeks becomes the league champion and directly joins UEFA Champions League groups in the following season. The team that ranks second goes to UEFA Champions League 3rd qualifying round, the team that ranks third goes to UEFA Europa League 3rd qualifying round and the team that ranks fourth goes to UEFA Europa League 2nd qualifying round. Teams that rank in the last three go down to "1. Lig". 3 teams from 1. Lig go up to Spor Toto Süper Lig. If two teams have the same points at the end of the season, point superiority of the matches they played against each other is checked. If the points are equal, the goal average between the teams is checked (If the goals scored in matches they played with each other are equal, the team that scores more goals in the visiting game isn't deemed more superior). If the equality continues, the general average is checked. If that's equal too, the team that has scored more goals is superior. If the equality still continues, the team that hasn't lost by default is superior. If the equality continues despite all these conditions, a final outcome is reached by determining the superior team based on which team wins the single elimination match played between the two teams. If three or more teams have the same points at the end of the season, the matches they played against each other are checked. If the results are the same, the general average is checked. The team that is superior to its rivals ranks higher [4].

German football leagues is named as Bundesliga that means National League. Bundesliga is considered one of the 5 highest quality leagues in Europe. Bayern Munich, which has won 25 championships since 1963, is the most successful club in the league that has been called Bundesliga since 1963. Borussia Dortmund and Borussia Mönchengladbach follow Bayern Munich with 5 championships each [5]. Bundesliga, like Spor Toto Süper Lig, consists of 18 teams and the teams have matches with each team twice, one in their home and one away game. Thus, a team plays 34 matches at the end of a season. With the other teams taken into account, a Bundesliga season consists of 306 matches in 34 weeks. The score system, ranking according to the scores at the end of the season, determining the champion team and the team that goes down to the lower league are the same as Spor Toto Süper Lig.

Holland Premier Football League is called Eredivisie. Ajax has won 33 championships in the league that was founded in 1956. PSV Eindhoven follows Ajax with 22 championships and Feyenoord follows it with 14. Eredivisie, like Spor Toto Süper Lig, consists of 18 teams and the teams have matches with each team twice, one in their home and one away game. Thus, a team plays 34 games at the end of a season. With the other teams taken into account, a Bundesliga season consists of 306 matches in 34 weeks. While the score system, ranking according to the scores at the end of the season, determining the champion team are the same as Bundesliga Spor Toto Süper Lig, determining the teams that go down to the lower league is different from other leagues. The team that ranks 18th at the end of the season drops from the league and goes to Eerste Divisie, the lower league. The team that ranks 1st in Eerste Divisie goes up to Eredivisie. The teams that rank 16th and 17th in Eredivisie go to play-offs with

teams that rank 2nd, 3rd, 4th, 5th, 6th, 7th, 8th and 9th in Eerste Divisie. Two play-off groups are formed. Each team in play-off play four games, two games in their home and two games away. Teams that rank first in the groups earn the right to play in Eredivisie while the teams that rank lower in the groups play in Eerste Divisie [6].

In this study, Turkey Spor Toto Süper League has been compared to Germany's Bundesliga and Holland's Eredivisie League by using Turkey Spor Toto Süper League season finale cumulative score status. With this purpose, comparisons of the weekly cumulative scores of the teams that rank the first, second and third in the mentioned leagues have been made. The main purpose of this study is to compare the weekly cumulative score distribution of the teams that rank in the top three in the studied football leagues. While making the comparisons, three different seasons have been taken into account. These are the 2004-2005, 2009-2010 and 2014-2015 seasons. The fundamental philosophy of the study is that the cumulative scores of a very strong team that may be in any league rapidly increase because the team always earns victories for the most part of the season. If the league is more competitive, it is expected to have a slower rate of scores increase. The main question here is that a strong team in a weak league will have a rapid score increase according to the weeks as it will end the matches with victory. However, in leagues where there are teams that are equal to each other, the teams will slow down the score increase rate of the leader teams as all the teams will likely to defeat each other. In this study, the consistence of the cumulative score distribution of the leagues has been tested via Cramér–von Mises test.

2. MATERIAL AND METHOD

In this study, Germany, Holland and Turkey Premiere Football Leagues end of the season score status has been used. This study has been limited to three seasons as the mentioned three football leagues have been going on for many years. These are 2004-2005, 2009-2010 and 2014-2015 seasons. The statistics that were published by the football federations of the said leagues were used while collecting data. The points the teams which rank in top three in the league have got as a result of the games they have played throughout the season have been cumulatively compiled according to the weeks. Therefore, the data set used in the study consists of 27 (3 different season values of the top 3 teams from each league) cumulative score series. Cramér–von Mises test, which is an alternative of Kolmogorov-Smirnov test and can be used in the comparison of distribution functions, has been used in order to compare the cumulative score increase among the top three teams of the countries. Cramér–von Mises test has been briefly discussed further in the study. Also in this study a simple linear regression without intercept analysis of the data is investigated. A comparison of the beta coefficient for each season and three countries are given in detail. Simple linear regression provides an extra knowledge how the steady increase of the data points from week to week differs from the arithmetic mean points per week in each season.

2.1. Cramér–von Mises Test

Cramér–von Mises test, which is an alternative of Kolmogorov-Smirnov test in statistics, is a test that is used in deciding the goodness of fit test of a F^* cumulative distribution function that is compared to a given F^n experimental distribution or two experimental distribution functions. Also, it is a part of other algorithms such as minimum distance estimation and is described as

$$w^2 = \int_{-\infty}^{\infty} \left[F_n(x) - F^*(x) \right]^2 dF^*(x). \qquad (1)$$

In the one sample case, F^* is theoretical distribution and F^n is experimental observed distribution. Additionally, a two samples case where the two distributions can both be estimated can be possible. This criteria was first proposed by Harald Cramér and Richard Edler von Mises in 1928-1930. Its generalisation for two samples was proposed by Anderson [7].

In order for Cramér–von Mises test to be applied for one sample the following steps are applied. Let's say $x_1, x_2, \cdots, x_n$ are the observed values of the problem that is sequenced with increasing value. In this case, Cramér–von Mises test statistic is calculated as follows: [7,8]

$$T = nw^2 = \frac{1}{12n} + \sum_{i=1}^{n}\left[\frac{2i-1}{2n} - F\left(x_i\right)\right]^2 . \quad (2)$$

If the calculated test statistic is greater than the table value that will be determined according to a certain significance level, the hypothesis that the data comes from the said F distribution is rejected.

In order for Cramér–von Mises test to be applied for two samples the following steps are applied. Let's say $x_1, x_2, \cdots, x_N$ and $y_1, y_2, \cdots, y_M$ are the observed values of the problem that is sequenced with increasing value in the first and second sample. Let $r_1, r_2, \cdots, r_N$ represent the x line in the unified sample and $s_1, s_2, \cdots, s_M$ represent the y line in the unified sample. Anderson has showed that if U is written as

$$U = N\sum_{i=1}^{N}\left(r_i - i\right)^2 + M\sum_{j=1}^{M}\left(s_j - j\right)^2 , \quad (3)$$

then it is

$$T = Nw^2 = \frac{U}{NM\left(N+M\right)} + \frac{4MN-1}{6(M+N)} . \quad (4)$$

If the T value is greater than the table value that will be determined according to a certain significance level, the hypothesis that the two samples come from the same distribution is rejected [7].

The number (4) equation assumes that since the place of x_i is i and is uneven in the $x_1, x_2, \cdots, x_N$ lined list, there are not any even values in the x, y and r sequences. If even values are in question, a general approach is the "mid-rank method" that assigns $\left(i+j\right)/2$ line to each even value. The even values that are in the $\left(r_i - i\right)^2$ and $\left(s_j - j\right)^2$ statements in the number (3) equation can change the r_i, i, s_j and j variables [7,8].

3. RESULTS

Cramér–von Mises test operations have been carried out for the compiled cumulative score series. The cumulative score graphics of the teams that were the champions of the 2004-2005, 2009-2010 and 2014-2015 football seasons in Turkey, Germany and Holland football leagues are shown in Figure 1.

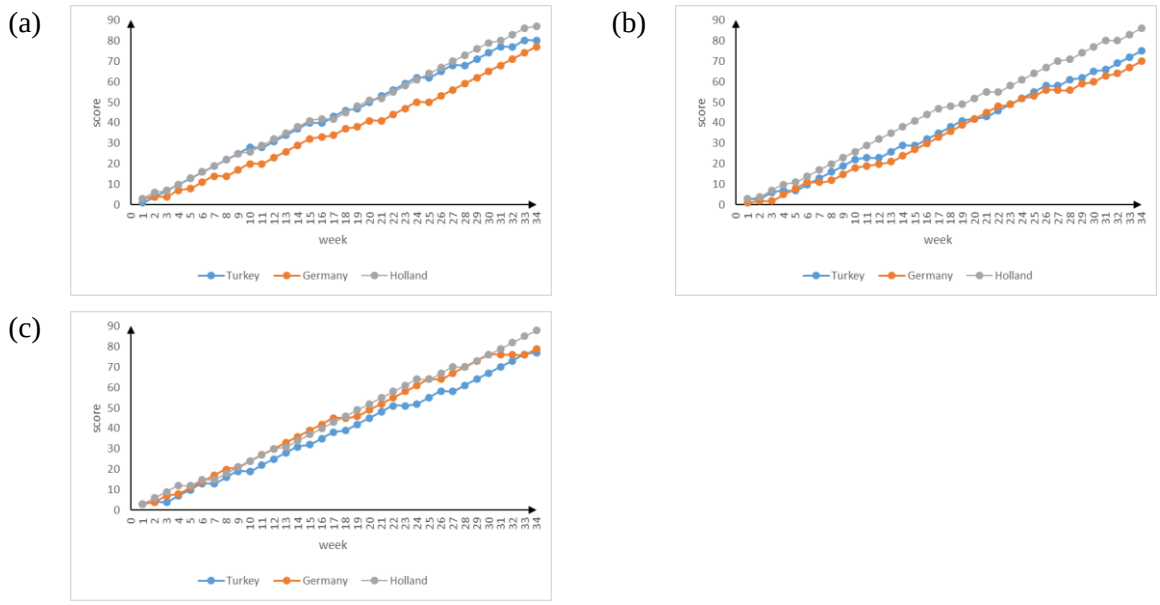

Figure 1. The cumulative score graphics of the teams that were the champions of the **(a)** 2004-2005 football season, **(b)** 2009-2010 football season and **(c)** 2014-2015 football season in Turkey, Germany and Holland football leagues.

In Table 1, Table 2 and Table 3 are shown the comparisons of 36 cumulative series for each of the three different seasons. An "*" mark has been put next to the probability values for the pairs that statistically show a significant difference within the scope of Cramér–von Mises test. In this study, 5% has been used as the significance level.

Table 1. The comparison of the first, the second and the third teams in Turkey Football League, Germany Football League and Holland Football League in the 2004-2005 season.

			TURKEY			**GERMANY**			**HOLLAND**		
			1st	**2nd**	**3rd**	**1st**	**2nd**	**3rd**	**1st**	**2nd**	**3rd**
TURKEY	**1st**	**cvm**		35.7059	39.3089	37.3971	38.6029	34.9412	40.2353	34.7500	35.8088
		p		0.6753	0.9111	0.2987	0.0989	0.0160*	0.9980	0.3756	0.3766
	2nd	**cvm**	-		37.7794	34.5882	33.6029	30.2206	39.0588	35.8088	39.5882
		p	-		0.9960	0.7902	0.3716	0.0669	0.4825	0.9361	0.8042
	3rd	**cvm**	-	-		34.0294	35.2647	29.0882	38.3824	38.3971	34.2059
		p	-	-		0.6918	0.2632	0.0350*	0.7043	0.8252	0.7602
GERMANY	**1st**	**cvm**	-	-	-		31.8382	30.6029	36.4853	34.9118	32.4706
		p	-	-	-		0.7622	0.2498	0.2338	0.9990	0.6474
	2nd	**cvm**	-	-	-	-		29.0588	37.0441	34.5588	36.0882
		p	-	-	-	-		0.4785	0.0579	0.6833	0.5140
	3rd	**cvm**	-	-	-	-	-		34.6912	31.6618	30.7059
		p	-	-	-	-	-		0.0080*	0.1938	0.0879
HOLLAND	**1st**	**cvm**	-	-	-	-	-	-		36.0441	39.2353
		p	-	-	-	-	-	-		0.2967	0.2507
	2nd	**cvm**	-	-	-	-	-	-	-		37.1765
		p	-	-	-	-	-	-	-		0.7912
	3rd	**cvm**	-	-	-	-	-	-	-	-	
		p	-	-	-	-	-	-	-	-	

Table 2. The comparison of the first, the second and the third teams in Turkey Football League, Germany Football League and Holland Football League in the 2009-2010 season.

			TURKEY			GERMANY			HOLLAND		
			1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
TURKEY	1st	cvm		29.9706	32.7794	37.8824	32.5588	29.8088	36.4265	38.6912	36.0882
		p		0.8192	0.7767	0.9620	0.9336	0.1299	0.2767	0.8182	0.4096
	2nd	cvm	-		29.1765	30.8235	32.5882	27.3382	33.5735	34.1471	30.8824
		p	-		0.8911	0.4466	0.6144	0.0829	0.2138	0.6913	0.2677
	3rd	cvm	-	-		33.6324	33.8677	30.7059	33.4265	35.6765	34.5441
		p	-	-		0.6918	0.8811	0.1568	0.1074	0.3976	0.1678
GERMANY	1st	cvm	-	-	-		31.8824	31.0147	35.2647	36.1618	35.1177
		p	-	-	-		0.9770	0.2043	0.1099	0.4545	0.1943
	2nd	cvm	-	-	-	-		27.4118	35.3971	34.6471	37.0147
		p	-	-	-	-		0.2712	0.0949	0.3966	0.1489
	3rd	cvm	-	-	-	-	-		35.1765	30.7059	34.9559
		p	-	-	-	-	-		0.0070*	0.0350*	0.0050*
HOLLAND	1st	cvm	-	-	-	-	-	-		39.5882	41.7794
		p	-	-	-	-	-	-		0.7892	0.9760
	2nd	cvm	-	-	-	-	-	-	-		40.1471
		p	-	-	-	-	-	-	-		0.7757
	3rd	cvm	-	-	-	-	-	-	-	-	
		p	-	-	-	-	-	-	-	-	

Table 3. The comparison of the first, the second and the third teams in Turkey Football League, Germany Football League and Holland Football League in the 2014-2015 season.

			TURKEY			GERMANY			HOLLAND		
			1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
TURKEY	1st	cvm		35.7500	35.0588	40.0735	34.8677	33.4118	36.4559	32.1765	33.6765
		p		0.9990	0.9880	0.6898	0.9081	0.2827	0.5145	0.9970	0.1808
	2nd	cvm	-		32.1471	35.5294	33.0735	34.2794	38.2500	32.8677	31.4265
		p	-		0.9950	0.5325	0.9481	0.3107	0.3736	0.9990	0.1978
	3rd	cvm	-	-		38.2059	35.5000	34.0588	36.8529	33.4853	32.4118
		p	-	-		0.4615	0.9346	0.2662	0.3077	0.9985	0.1768
GERMANY	1st	cvm	-	-	-		35.1177	36.3382	40.2059	35.8382	34.6177
		p	-	-	-		0.2537	0.0420*	0.9950	0.4855	0.0180*
	2nd	cvm	-	-	-	-		32.6029	36.5000	37.0588	29.3235
		p	-	-	-	-		0.6154	0.1703	0.9560	0.3676
	3rd	cvm	-	-	-	-	-		32.5588	30.5147	28.2647
		p	-	-	-	-	-		0.0220*	0.2977	0.8996
HOLLAND	1st	cvm	-	-	-	-	-	-		36.2059	38.2941
		p	-	-	-	-	-	-		0.3736	0.0170*
	2nd	cvm	-	-	-	-	-	-	-		31.4559
		p	-	-	-	-	-	-	-		0.2118
	3rd	cvm	-	-	-	-	-	-	-	-	
		p	-	-	-	-	-	-	-	-	

A summary table of the comparison between Turkey league and Germany and Holland leagues for the 2004-2005. 2009-2010 and 2014-2015 seasons have been presented in Table 4. Those that show a statistically significant differences are shown as (+) and those that do not show a statistically significant differences are shown as (-).

Table 4. Cramér–von Mises test statistical significance level of the football leagues

		2004-2005 Football Season			2009-2010 Football Season			2014-2015 Football Season		
		TURKEY			TURKEY			TURKEY		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
GERMANY	1st	-	-	-	-	-	-	-	-	-
	2nd	-	-	-	-	-	-	-	-	-
	3rd	+	-	+	-	-	-	-	-	-
HOLLAND	1st	-	-	-	-	-	-	-	-	-
	2nd	-	-	-	-	-	-	-	-	-
	3rd	-	-	-	-	-	-	-	-	-

A summary table of the comparisons between the first team in Turkey and the first teams in Germany and Holland. the second team in Turkey and the second teams in Germany and Holland. and the third team in Turkey and the third teams in Germany and Holland in the 2004-2005. 2009-2010 2014-2015 seasons has been presented. Those that show a statistically significant differences are shown as (+) and those that do not show a statistically significant differences are shown as (-).

A summary table of the comparisons between the first team in Turkey and the first teams in Germany and Holland. the second team in Turkey and the second teams in Germany and Holland. and the third team in Turkey and the third teams in Germany and Holland in the 2004-2005. 2009-2010 2014-2015 seasons has been presented in Table 5. Those that show a statistically significant differences are shown as (+) and those that do not show a statistically significant differences are shown as (-).

Table 5. Cramér–von Mises test statistical significance level of Turkey football league with the other leagues

		2004-2005 Football Season		2009-2010 Football Season		2014-2015 Football Season	
		GERMANY	HOLLAND	GERMANY	HOLLAND	GERMANY	HOLLAND
1st	TURKEY	-	-	-	-	-	-
2nd	TURKEY	-	-	-	-	-	-
3rd	TURKEY	+	-	-	-	-	-

In Table 6 and Table 7 some statistical analysis of the football leagues are given. In table 6, a linear regression analysis without intercept of the leagues are calculated. The main idea here is that, the beta coefficient will show how steep the increase of the data points from one week to other week during the football season. The expectation is that if the number of points gained by the winner of the league follows a steady increase (ie a win every week), the beta coefficient will be exactly equal to the average points per week. In the extreme case where the winner wins all the games during the season the beta coefficient for a linear regression analysis will be equal to 3 points. If the season 2004-2005 is investigated, one can see that the beta coefficient for Turkish league winner is 2.49 whereas the average points during the season shown in Table 7 is 2.35. So the model suggests a bigger value than the average value. Similarly, for the Holland's champion team for 2014-2015 season. the beta coefficient 2.56 and the average point is 2.59. Therefore, it can be seen that for Holland's champion team the increase of the points during the season is very steady. When the table 6 and 7 are investigated in detail, ıt can be seen that almost for all seasons the champion teams of Holland's league shows similar results. But at the same time, it should be noted that the number wins for a champion team among these three leagues. Holland stays at the top for these three seasons. Also from the table 7 it can be seen that the Hollands average goal per week statistic is higher than the other two leagues.

Table 6. The value of Beta coefficients for the linear regression without intercept

	TURKEY	**GERMANY**	**HOLLAND**
2004-2005 Football Season	2.49	2.11	2.58
2009-2010 Football Season	2.14	2.02	2.57
2014-2015 Football Season	2.22	2.46	2.56

Table 7. Some descriptive statistics about the football leagues

		Average of Goals	**Average points**	**The number of wins**
2004-2005 Football Season	**TURKEY**	2.26	2.35	26
	GERMANY	2.21	2.26	24
	HOLLAND	2.62	2.56	27
2009-2010 Football Season	**TURKEY**	1.91	2.21	23
	GERMANY	2.12	2.06	20
	HOLLAND	1.79	2.53	26
2014-2015 Football Season	**TURKEY**	2.26	2.26	24
	GERMANY	2.35	2.32	25
	HOLLAND	2.71	2.59	29

4. CONCLUSION / EVALUATION

In this study, where the differences between the weekly scores the teams that rank in top three during a season in Germany, Holland and Turkey premiere football leagues, no difference has been seen according to Cramér–von Mises test results. Cramér–von Mises test results have shown that the cumulative score status of the teams are similar to each other. Therefore, the competitiveness structures of those three leagues are similar, too. Upon close examinations, a statistically significant difference has been spotted only between Germany's third and Turkey's first and third in the 2004-2005 football season. Additionally, a statistically significant difference has been identified between Germany's third and Holland's first in the 2004-2005 football season; Germany's third and Holland's first, second and third in the 2009-2010 football season; and in the 2014-2015 football season Germany's first and Germany's third and Holland's third, Germany's third and Holland's first, Holland's first and Holland's third.

In this study, in order to expose the competitiveness structure of the leagues, the weekly scores the teams get are compiled in cumulative series and comparisons have been made. Cramér–von Mises test has been applied in order to show the consistence of the cumulative series. Although some statistically significant differences are seen in some cumulative series pairs when all analysis results are examined, generally the weekly scores of the teams that rank in top three in the leagues show consistency.

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