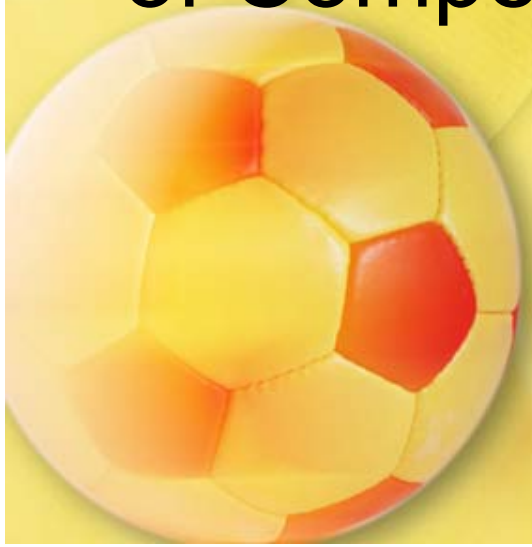
Η ομάδα *STArT Thinking* παρουσιάζει:

"Αβεβαιότητα, Αγωνιστική ισορροπία και Επαγγελματικό Ποδόσφαιρο"

Ομιλητές: Ιωάννης Ντζούφρας, Βασίλειος Μανασής

Uncertainty, Competitive Balance and Professional Team Sports

Part A: The Concept and Quantification of Competitive Balance



Ιωάννης Ντζούφρας, Τμήμα Στατιστικής,
Οικονομικό Πανεπιστήμιο Αθηνών

The Concept of Competitive Balance

"*The nature of the industry (of baseball) is such that competitors must be of approximate equal size if any are to be successful*" (Rottenberg, 1956).

Competitive Balance is literally the balance between the sporting capabilities of teams (Michie & Oughton, 2004).

Why Competitive Balance?

Competitive Balance is an important concept for professional team sports

⇩

Creates an uncertainty of outcome

⇩

Instigates the interest of sport fans

⇩

Increased demand for sport events

(El-Hodiri & Quirk, 1971; Rottenberg, 1956).

Quantification of Competitive Balance

Quantification of Competitive Balance is a complicating issue (Downward, Dawson, & Dejonghe, 2009; Zimbalist, 2003).

- Multidimensional concept
- A variety of different indices exist
- Econometric studies testing the relative significance of the indices is an area of research relatively undeveloped (Borland & MacDonald, 2003).

Why Competitive Balance in European Football?

"the heartland of football, the only truly global team sport" (Gerrard, 2004).

- Competitive Balance is an important issue for the viability of European football (Michie & Oughton, 2004).
- Any optimal index may differ from sport to sport (Zimbalist, 2003).
- European football leagues are complex in structure.

Dimensions of Competitive Balance

- Match

  Measures the strength difference in match level.

- Seasonal

  Measures the relative performance of teams within a season.

- Between-seasons

  Captures the relative performance of teams across seasons.

Dimensions of Competitive Balance

Units of Measurement

Match level

1. % of Points difference of the two teams
2. % of Wins difference
3. Betting odds (taken from bookies) difference
4. Probability odds or difference calculated by a “well-fitted” prediction model

Not found significant, max-attendance when home team has 0.6 win probability.

Seasonal

Dispersion (or concentration) of **points** or **win** percentage (%) of all teams at the end of the season (we use the final league table).

Between-seasons

Correlation or variance of the difference of **ranking** or **point** or **win** percentage **(**%) across seasons.

Quantification of Seasonal Dimension

- Existing Seasonal Indices:
  - *Ratio of Standard Deviation* (*RSD*) (Noll, 1988; Scully, 1989).
  - *National Measure of Seasonal Imbalance* (*NAMSI*) (Goossens, 2006).
  - *Herfindahl-Hirschman Index* (*HHI**) (Owen, Ryan, & Weatherston, 2007).
  - *Gini Coefficient* (*Gini*) (Utt & Fort, 2002).
  - *Relative Entropy* (Horowitz, 1977).
  - *Concentration Ratio*.
- They have not been developed in the context of complex structure in Europe.
- They refer to the North American unitary structure with a single prize.

Stadard deviation of win percentages divided by Standard deviation of win percentages divided by the Complete Imbalance (WSD) to account for different N.

$$WSD = \left[\frac{(N+1)}{2(N-1)}\right]^{1/2} \times ISD = 0.5\sqrt{2(N-1)}$$

The area of industrial organization theory offers a wide range of indices measuring the relative industry competitiveness. If we consider a professional football league as industrial sector, the industrial output can be measured by the win percantage, winning share or total points.

Issues Measuring Competitive Balance in European National Leagues

Standardization from zero to one => to make comparable leagues with differ number of teams (across different countries and/or seasons/years).

Promotion-relegation rule => a large number of between-seasons indices should be excluded or modified.

Multiple levels of Competition => Teams are competing not only for the first place but also for other positions leading to European competitions

Σύνθετη Δομή Τριών Σταδίων

(Manasis, Avgerinou, Ntzoufras, & Reade, 2011b)

1ο Στάδιο: Τίτλος του πρωταθλητή → NCR_1

2ο Στάδιο: Ευρωπαϊκές διοργανώσεις → ACR_K

3ο Στάδιο: Υποβιβασμός → NCR^l

SCR_K^I

O Normalized Concentration Ratio for the Champion (NCR_1) ερμηνεύει τον βαθμό επικράτησης του πρωταθλητή

O Adjusted Concentration Ratio (ACR_K) ερμηνεύει τον βαθμό επικράτησης των πρώτων *K* ομάδων αλλά και το επίπεδο ανταγωνισμού μεταξύ των ομάδων αυτών

O Normalized Concentration Ratio for relegated teams (NCR^l) ερμηνεύει τον βαθμό υστέρησης των *l* υποβιβασθεισών ομάδων

O Special Concentration Ratio (SCR_K^l) ο οποίος είναι περιεκτικός δείκτης, αναφέρεται δηλαδή και στα τρία στάδια με ανάλογη ερμηνεία

Development of Specially Designed Indices

- The design of the new indices is inspired by the necessity:
  - Quantify the level of competition in each level.
  - Weight ranking positions according to their significance for fans.
- For the development it is employed the NCR_K, which can be easily adapted to capture any of the three levels.

Normalised Concentration Ratio (NCR_K)

- NCR_K is the normalization of the widely used *CR* index.
- It ranges from 0-1 and is relatively robust to variation in *N* and/or *K*.
- It captures the level of domination by the top *K* teams.

$$NCR_K = \frac{\sum_{i=1}^{K} P_i - 2K(N-1)}{2K(N-K)}, K \le N/2$$

- Here we use two points for every win but the index can be easily adjusted for the 3-point system.

Why NCR_K ?

$\sum_{i=1}^{K} P_i$ ⇒ Captures the number of points for the top-K teams

Under perfect imbalance ⇒ Every team in i-th position wins the following N-i teams. This is multiplied by 2 times playing to each other and 2 (or 3) the number of points for each win

$$CR_K = \frac{\sum_{i=1}^{K} P_i}{2K(2N-K-1)} \Leftarrow \max = 2\times 2\times \sum_{i=1}^{K}(N-i) = 4\times\left(NK - \frac{K(K+1)}{2}\right)$$

Under perfect imbalance ⇒ All teams gain the same number of Points

Total Number of points = **2N(N-1)**

Each team wins 2(N-1) points

Top K-teams win 2K(N-1)

$$\min = 2K(N-1)$$

$$NCR_K = \frac{\sum_{i=1}^{K} P_i - \min}{\max - \min} \Leftarrow$$

$$NCR_K = \frac{\sum_{i=1}^{K} P_i - 2K(N-1)}{2K(N-K)}$$

Normalised Concentration Ratio for the Champion (NCR_1)

- Captures first stage
- Interpretation: The degree of Champion's domination

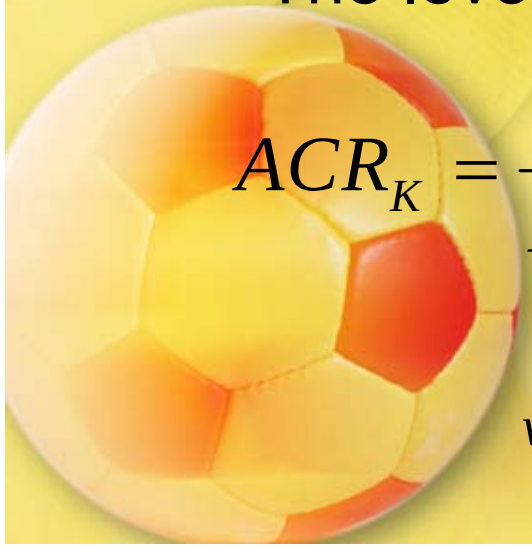
$$NCR_K = \frac{\sum_{i=1}^{K} P_i - 2K(N-1)}{2K(N-K)} \Rightarrow NCR_1 = \frac{P_1 - 2(N-1)}{2(N-1)}$$

First & Second Stage

Team Ranking	*League A:*	*League B:*
1	36	30
2	24	30
3	20	20
4	18	18
5	16	16
6	16	16
7	14	14
8	14	14
9	12	12
10	10	10
NCR_1	*1*	*0.667*
NCR_2	*0.75*	*0.75*
Average (NCR_1, NCR_2)	*0.875*	*0.708*

Adjusted Concentration Ratio (ACR_K)

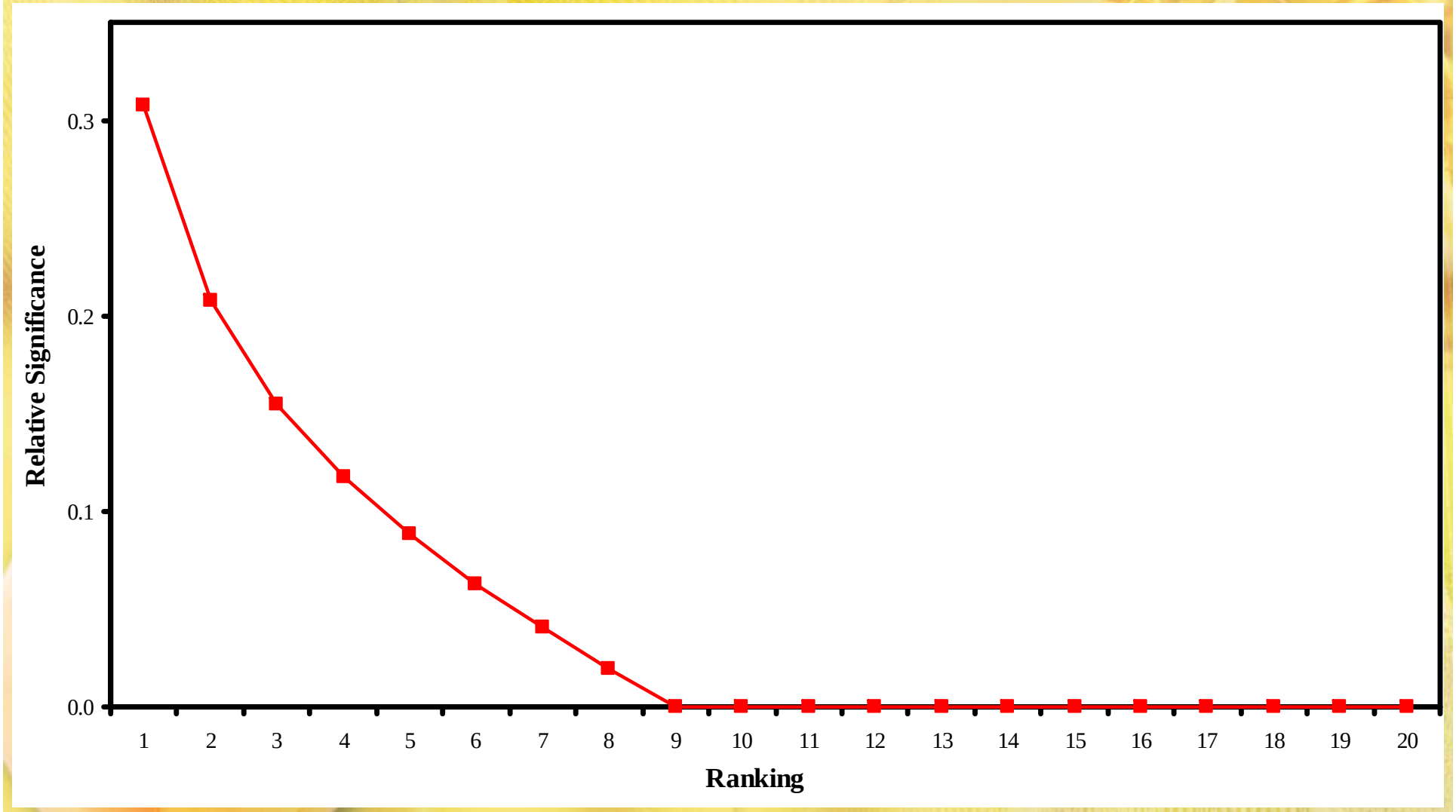
- Average of NCR_K for top-K teams
- Captures first & second stage
- Interpretation:
  - The level of domination by the top *K* teams
  - The level of competition among the top *K* teams



$$ACR_K = \frac{1}{K}\sum_{i=1}^{K} NCR_i = \frac{1}{K}\left[\sum_{i=1}^{K} w_i P_i - C_K\right],$$

$$w_K = \sum_{i=1}^{K} \frac{1}{2i(N-i)} \qquad C_K = (N-1)\sum_{i=1}^{K} \frac{1}{N-i}$$

Relative Significances in ACR_K for K=8



Concentration Ratio for Relegated Teams (NCR^I)

- Captures third stage
- Interpretation: The degree of weakness of the *I* relegated teams

$$NCR^I = \frac{2I(N-1) - \sum_{i=N-I+1}^{N} P_i}{2I(N-I)}, I \leq N/2$$

Special Concentration Ratio $\left(SCR_K^I\right)$

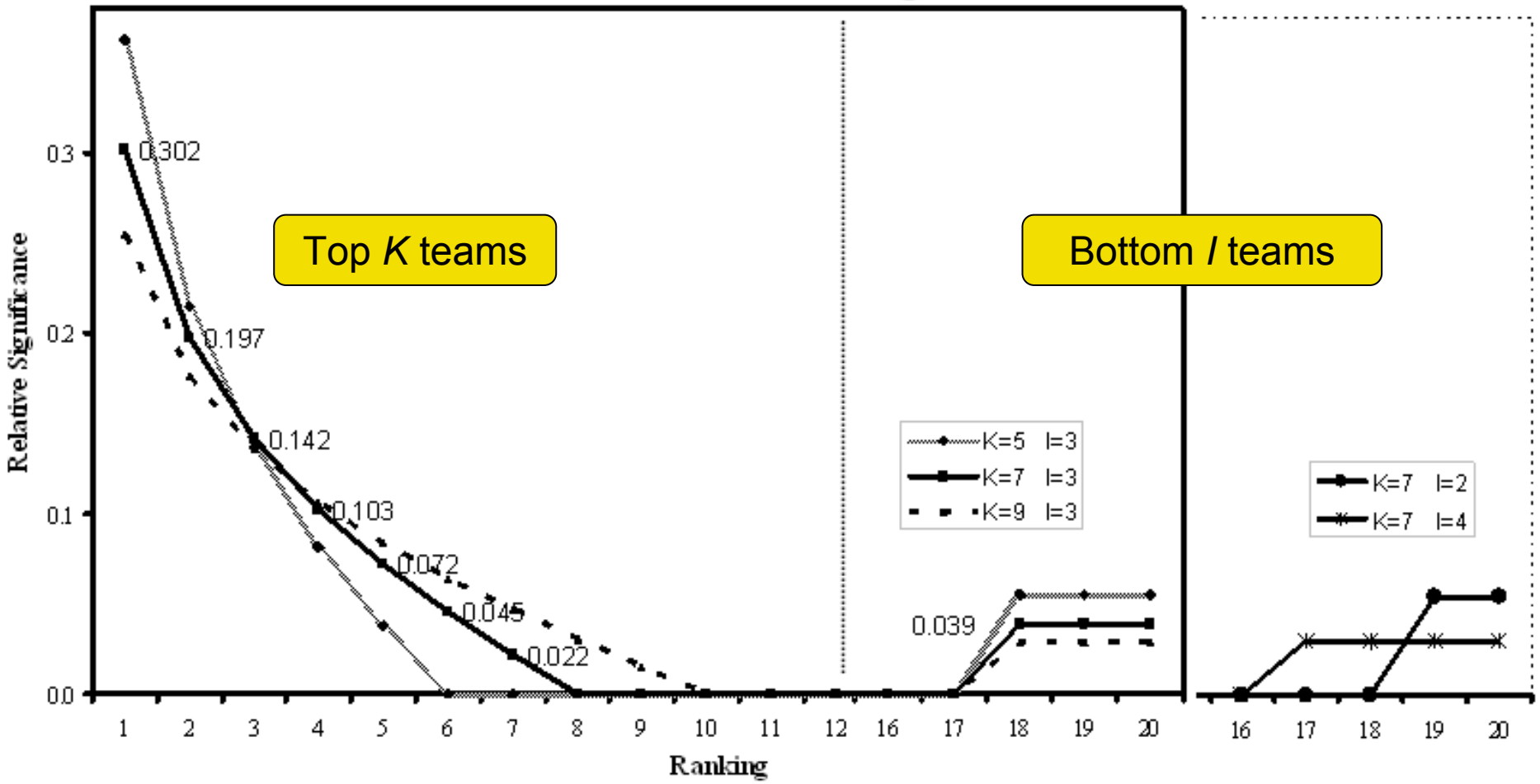
- Captures all three stages
- Interpretation:
  - The level of domination by the top *K* teams
  - The level of competition among the top *K* teams
  - The degree of weakness of the *I* relegated teams

$$SCR_K^I = \frac{\sum_{i=1}^{K} NCR_i + NCR^I}{K+1} = \frac{1}{K+1}\left[\sum_{i=1}^{K} w_i P_i - \sum_{i=N-I+1}^{N} w_I P_i - C_K + C_I\right]$$

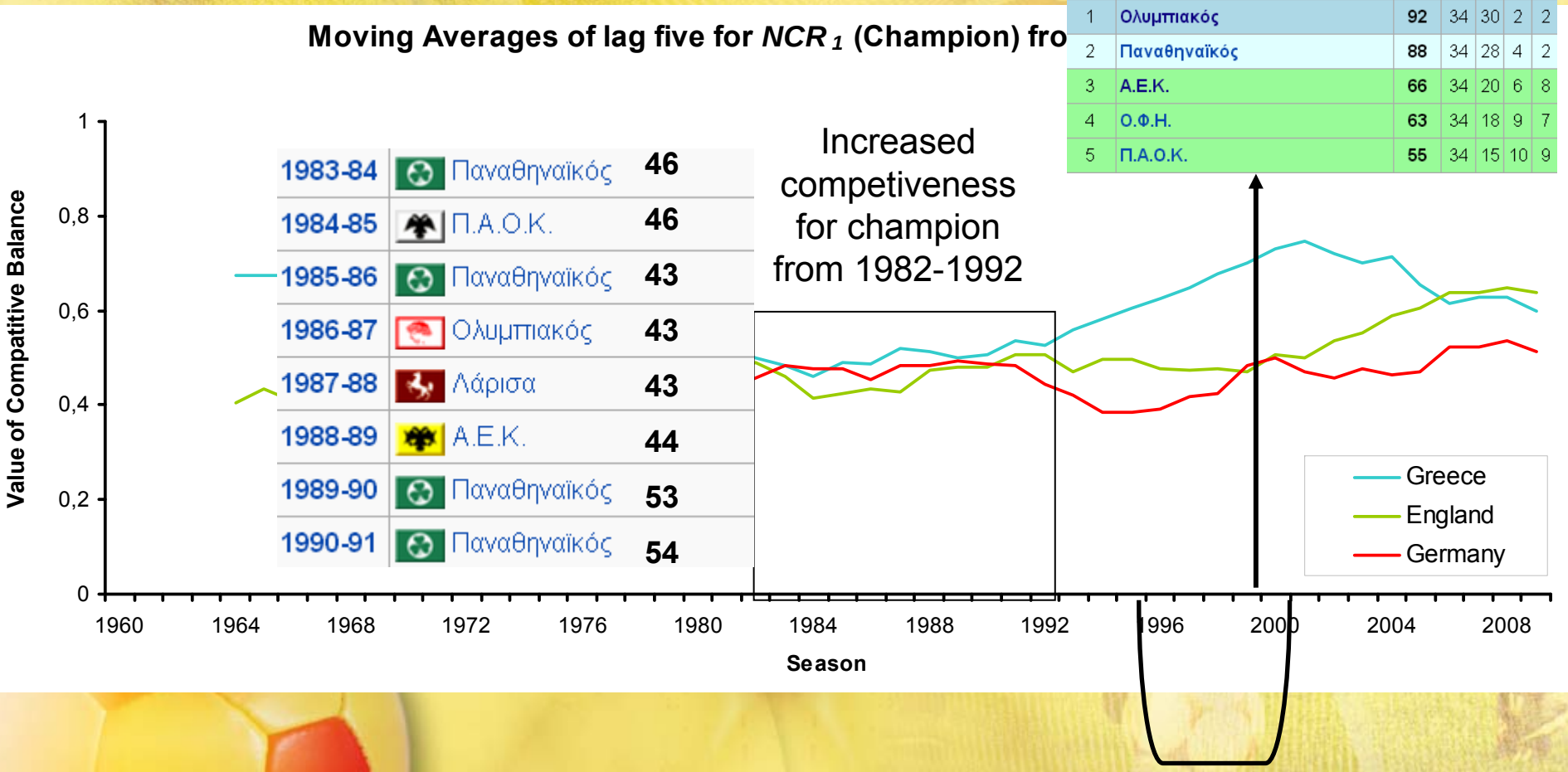
$$K < N/2, \quad I < K, \quad w_I = \frac{1}{2I(N-I)}$$

$$for \ \ I > K/3 \quad w_{K-1} < w_I < w_K$$

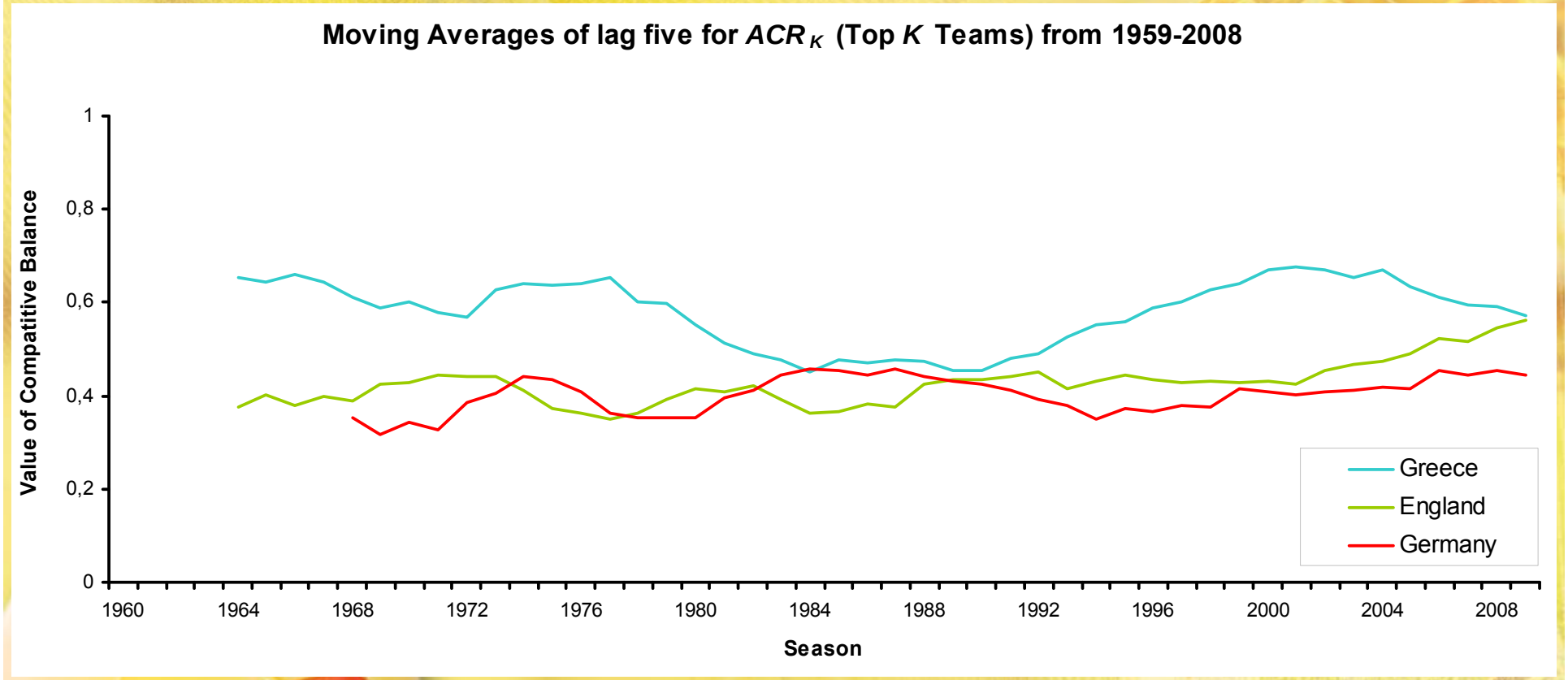
Figure 4.6: Relative Significance in SCR_K^I for K=5, 7, 9 and I=2, 3, 4 in a 20-team League



		Βαθ.	Αγ.	Ν	Ι	Η
1	Ολυμπιακός	92	34	30	2	2
2	Παναθηναϊκός	88	34	28	4	2
3	Α.Ε.Κ.	66	34	20	6	8
4	Ο.Φ.Η.	63	34	18	9	7
5	Π.Α.Ο.Κ.	55	34	15	10	9



Points adjusted for 16 teams and 2-1-0 system: 51, 52, 51, 55, 53


Moving Averages of lag five for ACR_K (Top K Teams) from 1959-2008
Value of Compatitive Balance
1
0,8
0,6
0,4
0,2
0
1960
1964
1968
1972
1976
1980
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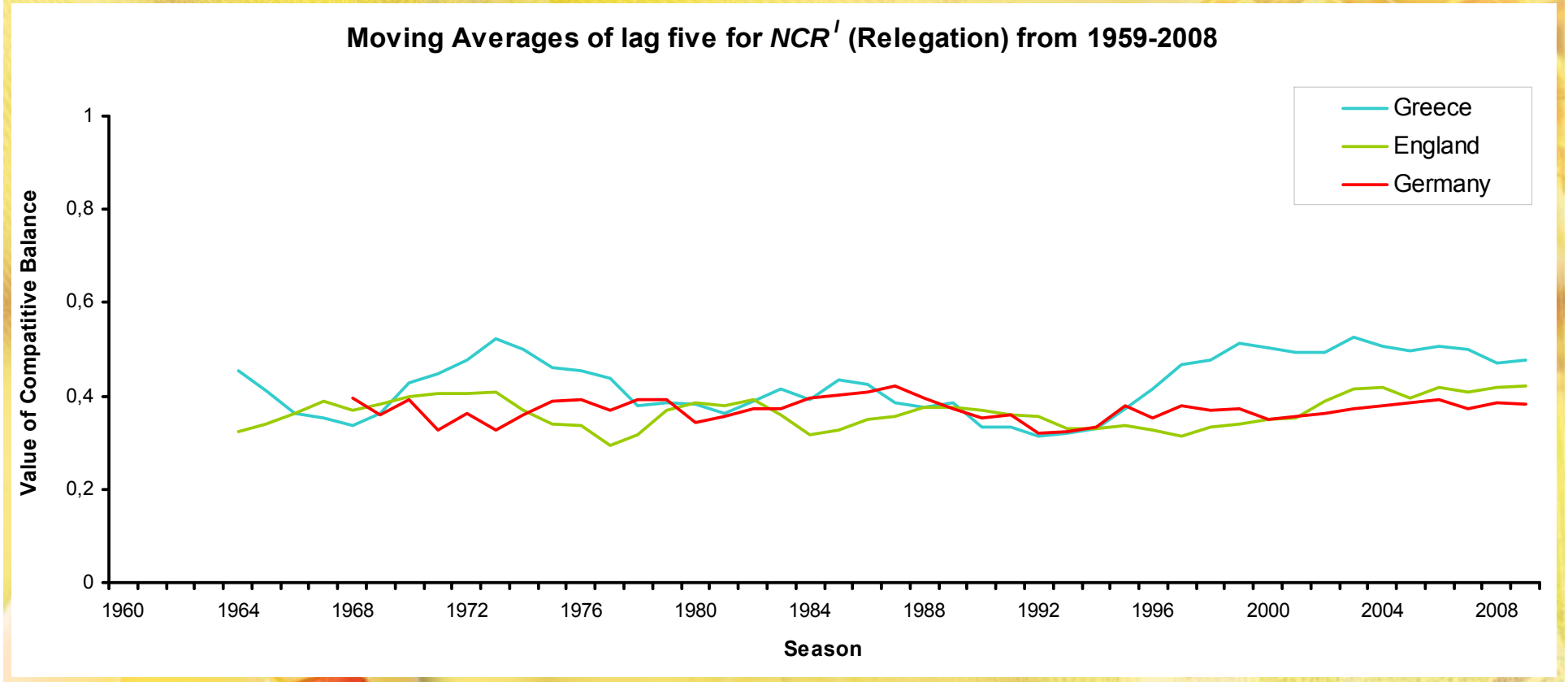
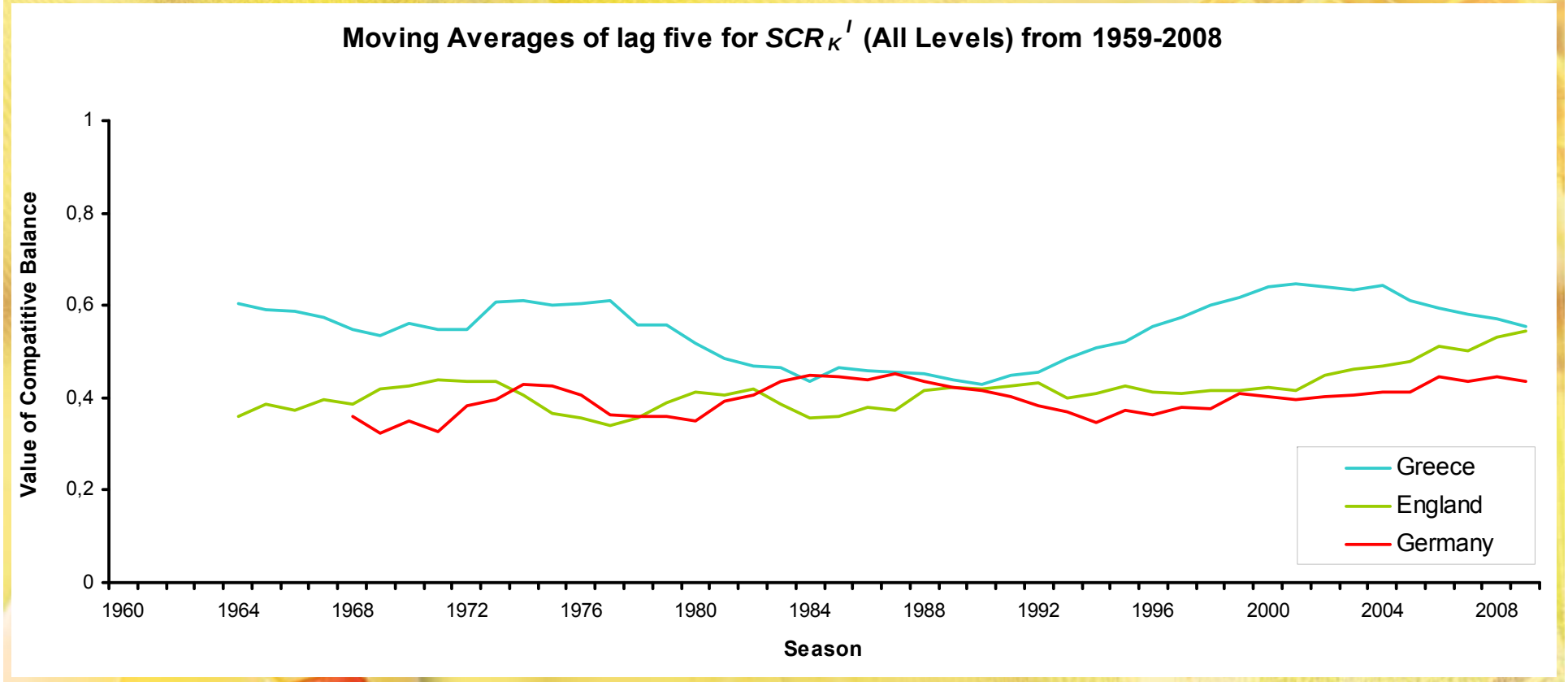


Μικρότερες τιμές εν σχέση με τους άλλους δείκτες, άρα μεγαλύτερος ανταγωνισμός για τον υποβιβασμό.



Βρέθηκε ότι η τάση είναι σημαντική:
Α) Για την Ελλάδα, δευτέρου βαθμού με χαμηλότερο σημείο το 1986.
Β) Για την Αγγλία, γραμμική αυξητική τάση που φτάνει το 36%.

Quantification of Between-seasons Dimension

- Teams' identity matters
- Two units of measurement:
  - Ranking mobility or change
  - Change in winning percentages or shares
- Scarcity of applicable indices to European football (Buzzacchi et al., 2003).
  - Due to the promotion – relegation rule (open leagues)

Indices not applicable to European football

- Indices of ranking mobility over long periods
  - Relative HHI (Hirfindahl-Hirchman index; Eckard, 1998)
  - Adjusted HHI (Gerrard, 2004)
  - Gini coefficient (Fizel, 1997; Quirk & Fort, 1997)
  - Markov-based approach (Hadley, Cieka, & Krautman, 2005)
  - Hope statistic (Kaplan, Nadeau, and O'Reilly, 2011)
- Indices of winning percentage change across seasons
  - Correlation coefficient (Balfour & Porter, 1991)
  - ANOVA-based measure (Eckard, 1998)
  - Competitive Balance Ratio (Humphreys, 2002)
  - Linearised Turnover Gain Function (Lenten, 2009)

Indices that can be applied in European football

- *G* index (Buzzacchi et al., 2003)
  - The modified Adjusted G Index (aG) is developed with range from 0 to 1.
- Index of Dynamics DN_t^* (Haan, Koning, & van Witteloostuijn, 2002)
- Kendall's tau coefficient (τ) (Groot, 2008)
- Spearman's rho (r_s) (Daly & Moore, 1981)

Development of specially designed indices

- A similar process for the seasonal dimension is followed
- For the development it is employed the Dynamic Index (DN_K) which is a modification of the widely used DN_t^* index (Haan, Koning, & van Witteloostuijn, 2002).

$$DN_K = 1 - \frac{\sum_{i=1}^{K} \left| r_{i,t} - r_{i,t-1} \right|}{K(N-K)}, K \leq N/2$$

r: ranking position

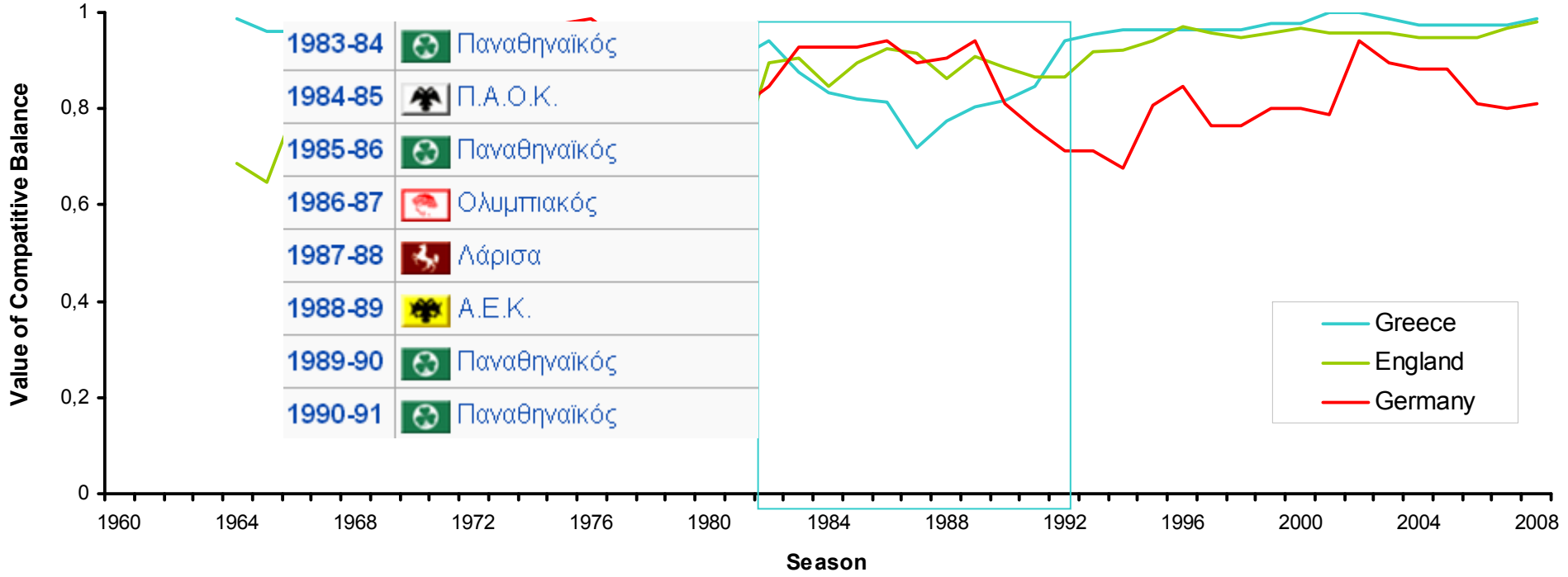
  - It captures the ranking mobility of the top K teams in two adjacent seasons.
  - It can be correctly adapted to capture any of the levels.

Extension for multi-prized league

- First level (champion) $DN_1 = 1 - \frac{\left| r_{1,t} - r_{1,t-1} \right|}{(N-1)}$
- First & second level $ADN_K = \frac{1}{K} \sum_{i=1}^{K} DN_i$
- Third level (relegation) $DN^I = 1 - \frac{\sum_{i=N-I+1}^{N} \left| r_{i,t} - r_{i,t-1} \right|}{I(N-I)}$
- All three levels => Special concentration index

$$SDN_K^I = \frac{\sum_{i=1}^{K} DN_i + DN^I}{K+1}$$

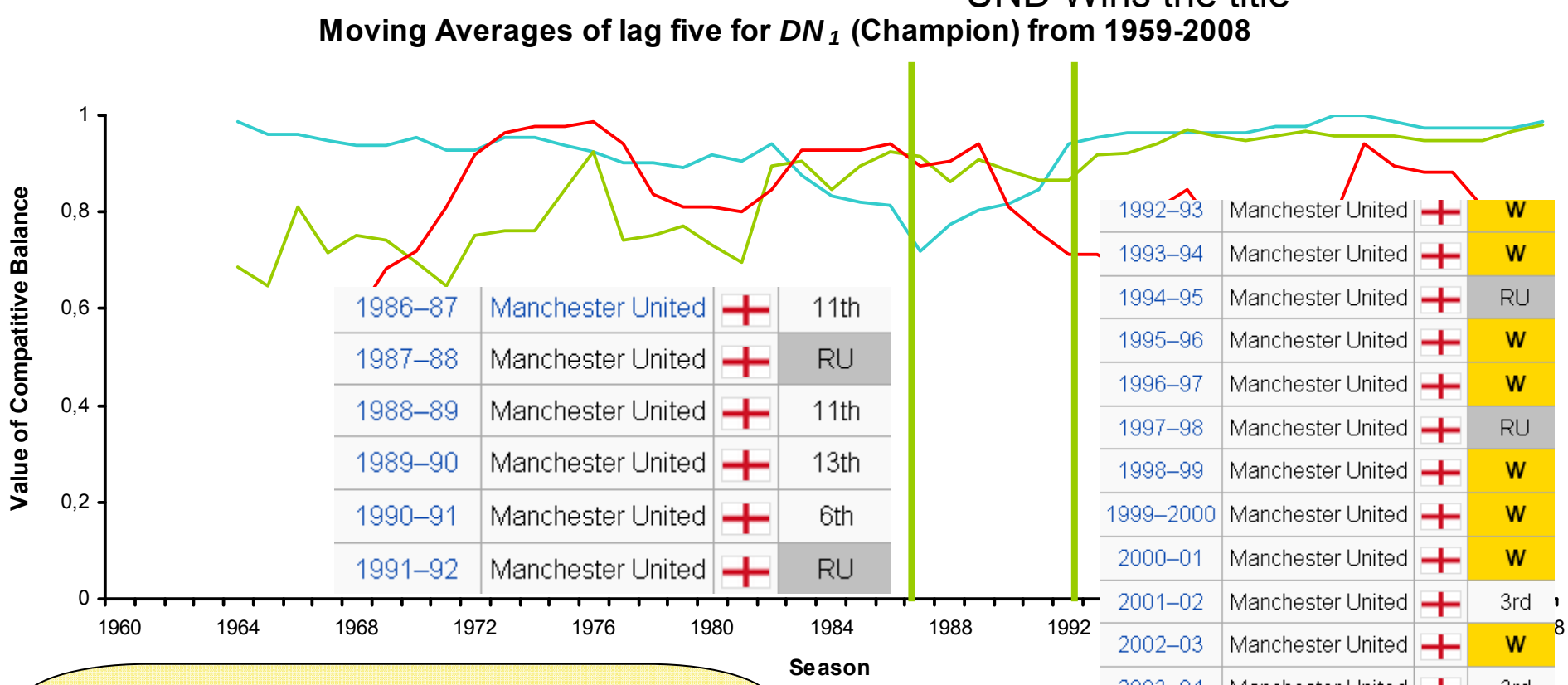
Moving Averages of lag five for DN_1 (Champion) from 1



1991-92	Α.Ε.Κ.	2000-01	Ολυμπιακός
1992-93	Α.Ε.Κ.	2001-02	Ολυμπιακός
1993-94	Α.Ε.Κ.	2002-03	Ολυμπιακός
1994-95	Παναθηναϊκός	2003-04	Παναθηναϊκός
1995-96	Παναθηναϊκός	2004-05	Ολυμπιακός
1996-97	Ολυμπιακός	2005-06	Ολυμπιακός
1997-98	Ολυμπιακός	2006-07	Ολυμπιακός
1998-99	Ολυμπιακός	2007-08	Ολυμπιακός
1999-00	Ολυμπιακός	2008-09	Ολυμπιακός

Eric Cantona from Leeds United for £1.2 million

UND Wins the title



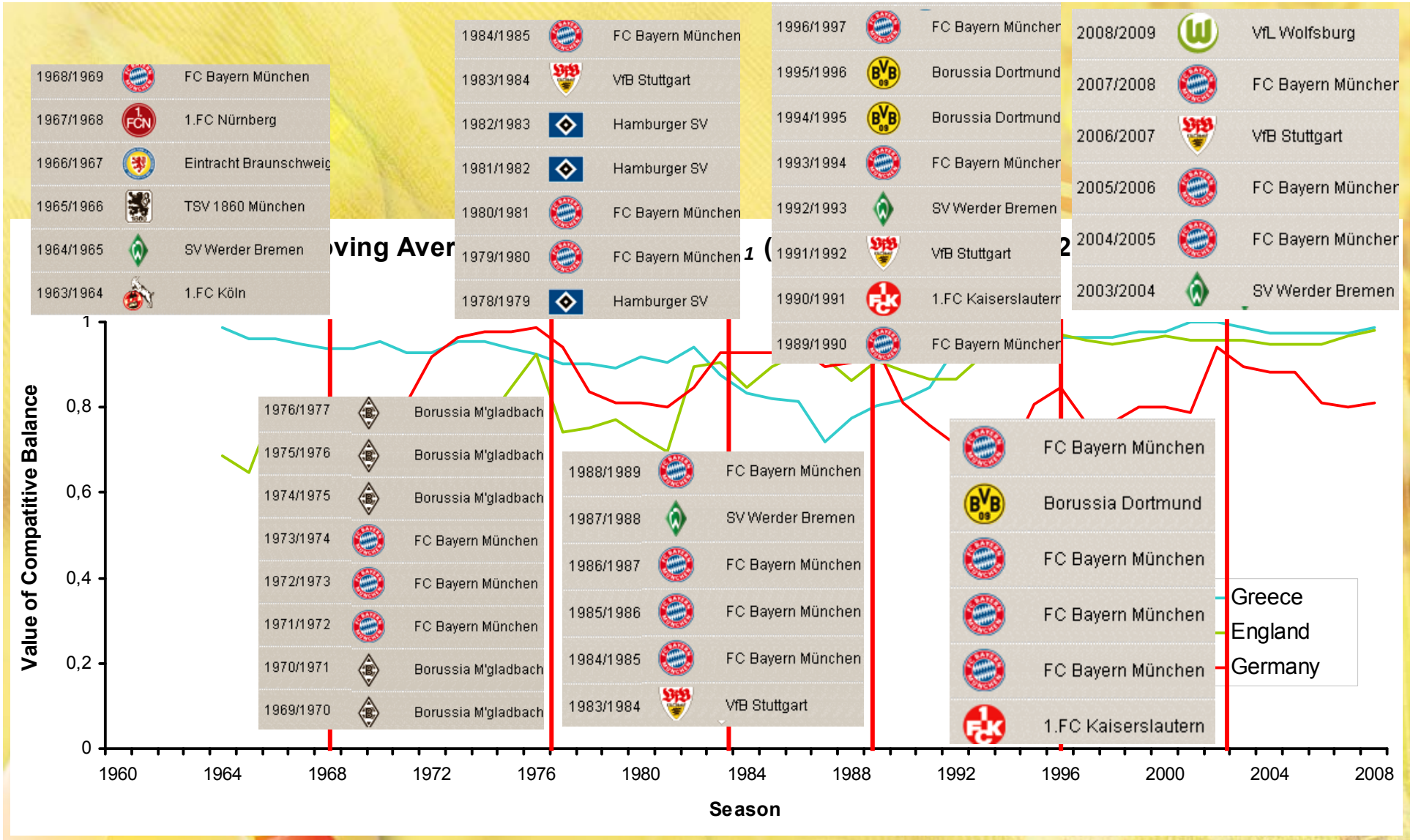
1986–87	Manchester United		11th
1987–88	Manchester United		RU
1988–89	Manchester United		11th
1989–90	Manchester United		13th
1990–91	Manchester United		6th
1991–92	Manchester United		RU

1992–93	Manchester United		W
1993–94	Manchester United		W
1994–95	Manchester United		RU
1995–96	Manchester United		W
1996–97	Manchester United		W
1997–98	Manchester United		RU
1998–99	Manchester United		W
1999–2000	Manchester United		W
2000–01	Manchester United		W
2001–02	Manchester United		3rd
2002–03	Manchester United		W
2003–04	Manchester United		3rd
2004–05	Manchester United		3rd
2005–06	Manchester United		RU
2006–07	Manchester United		W
2007–08	Manchester United		W
2008–09	Manchester United		W

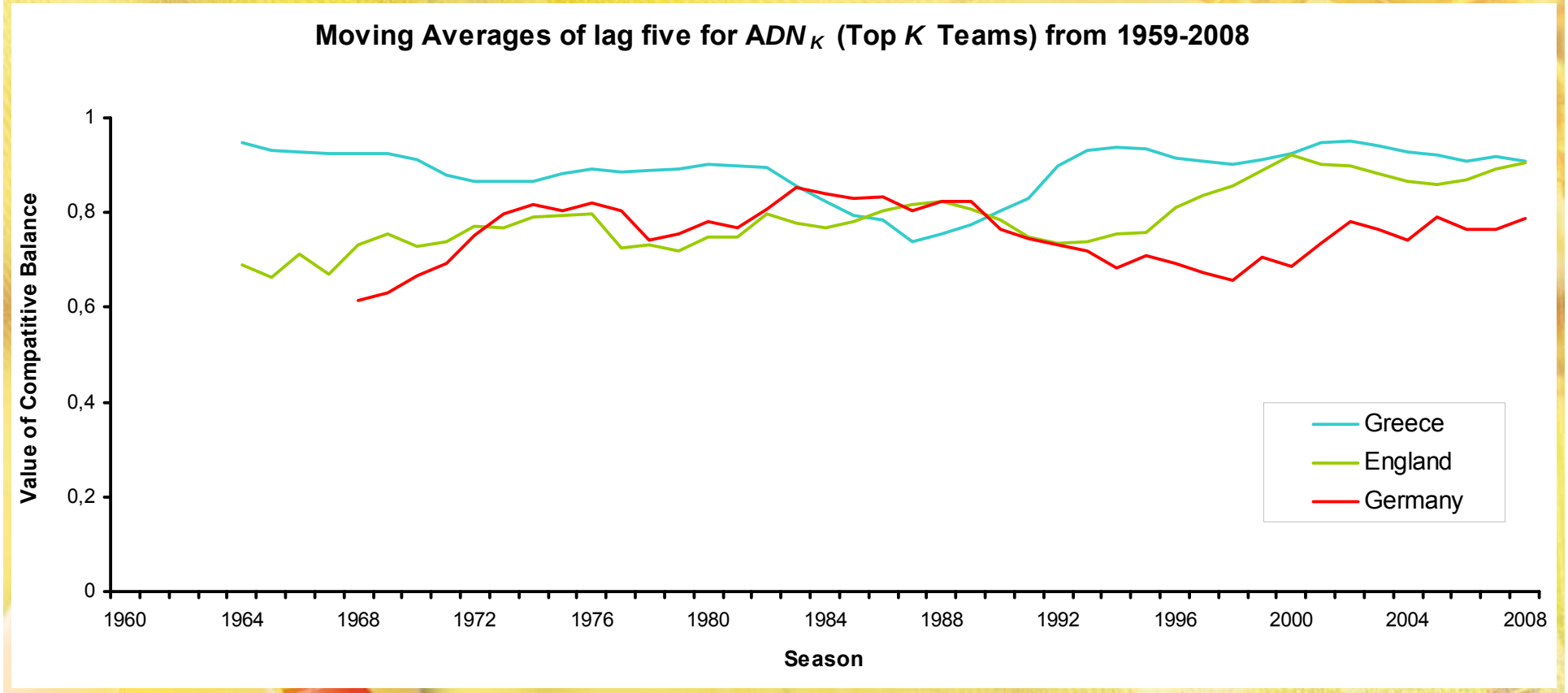
6 November 1986 (Ferguson Hired)

Η ManU κέρδισε τα 13 από τα τελευταία 22 πρωταθλήματα στην Αγγλία

Υπάρχουν δύο περιπτώσεις ομάδα που ανέβηκε από την 2η κατηγορία, κέρδισε το πρωτάθλημα. Η Ipswich το 1961 και η Nottingham το 1997



Υπάρχει και μια περίπτωση στην Γερμανία όπου ομάδα που ανέβηκε από την 2η κατηγορία, κέρδισε το πρωτάθλημα, η Kaiserslauten το 1998.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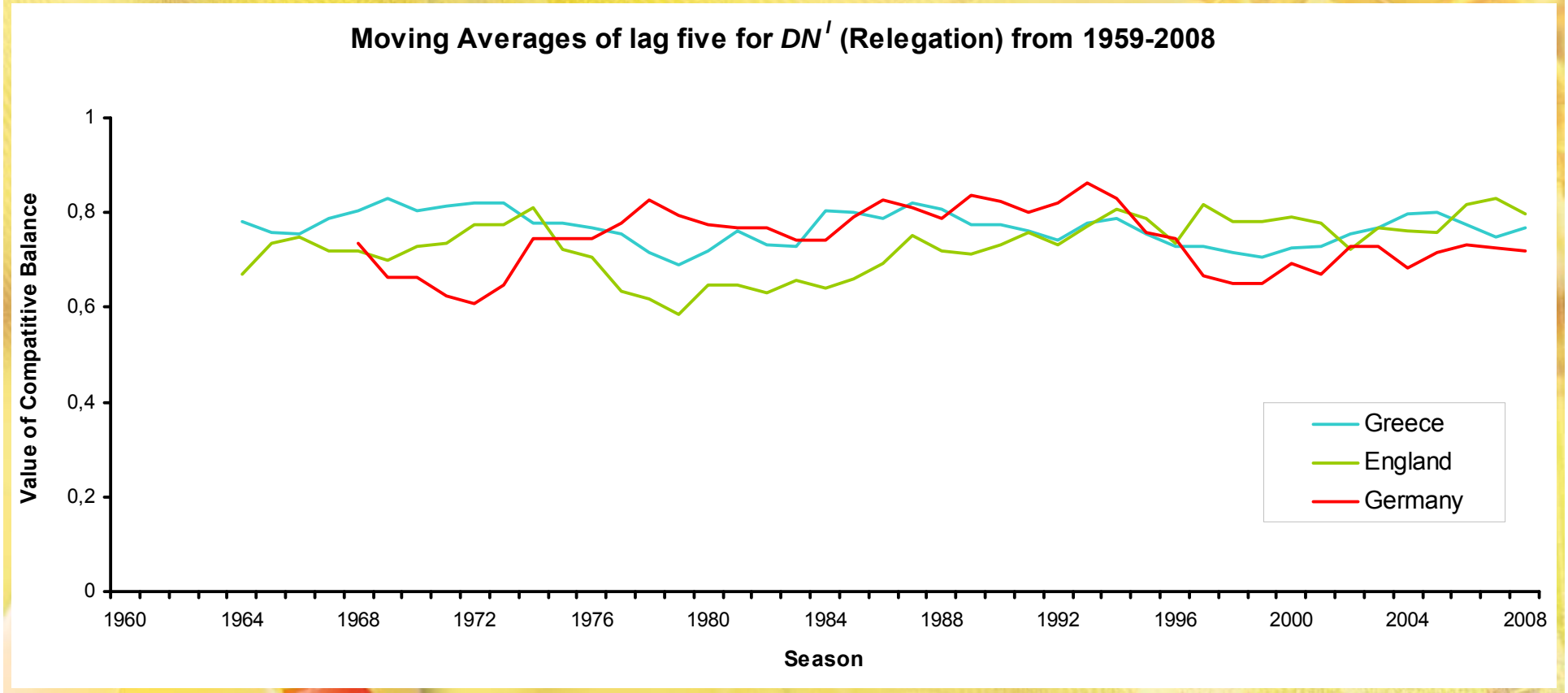
Moving Averages of lag five for DN' (Relegation) from 1959-2008
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0,8
0,6
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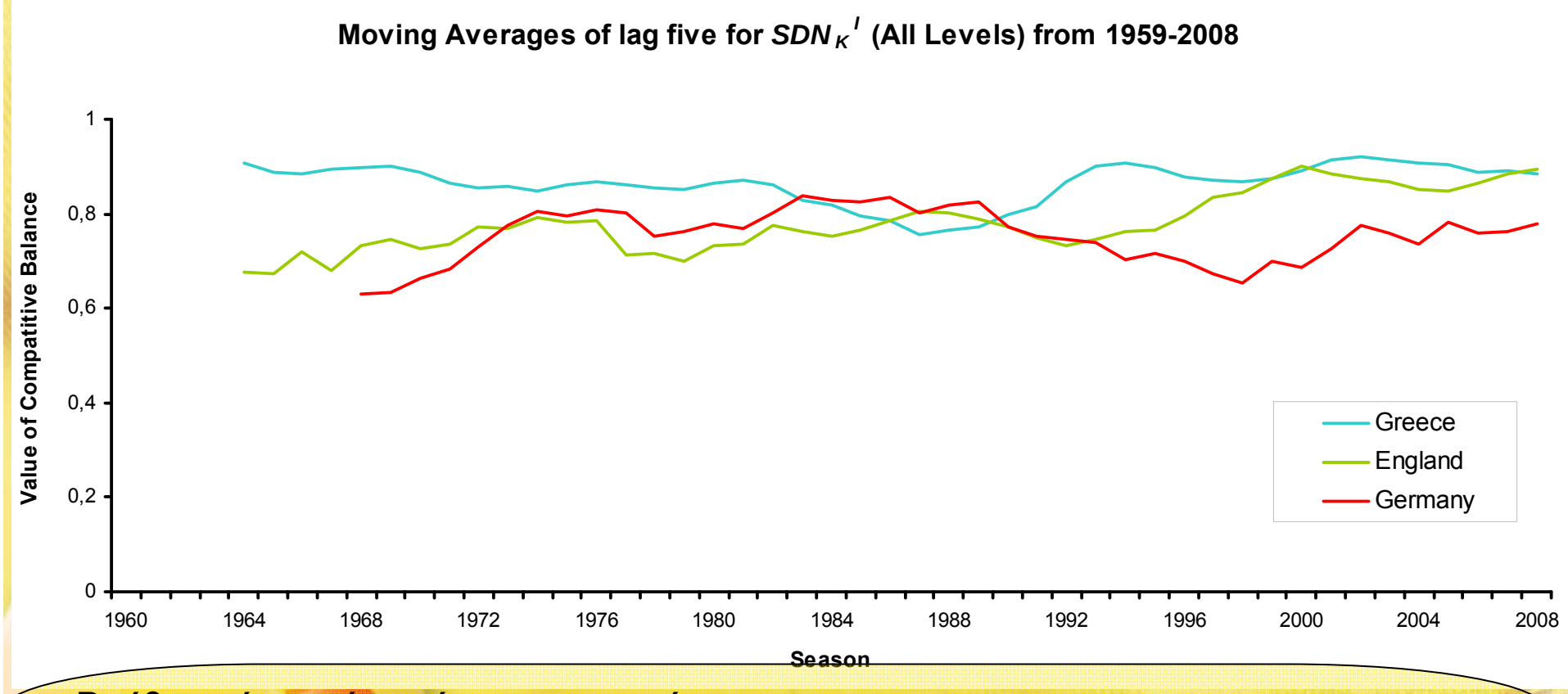

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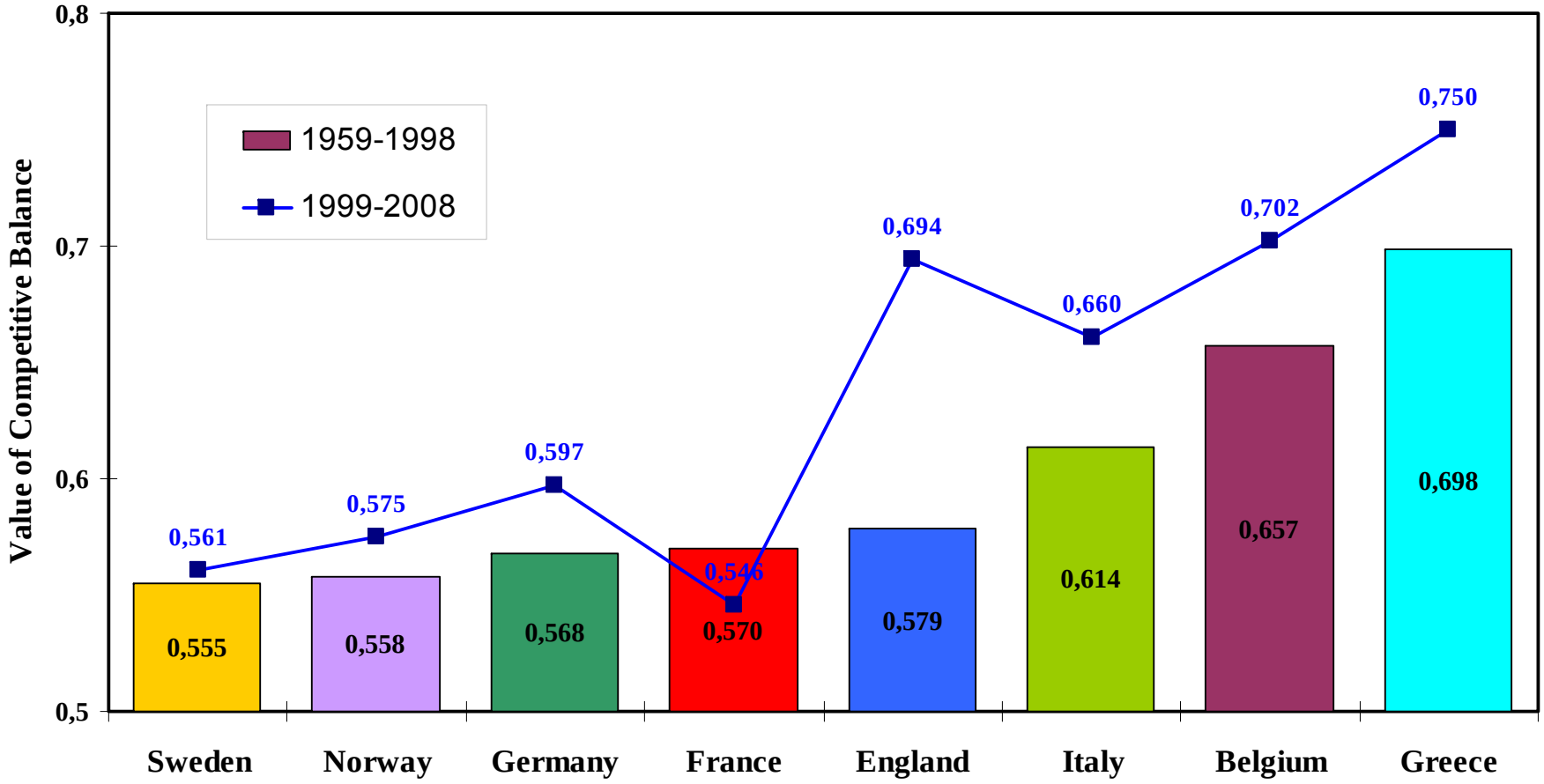
Γ) Για την Γερμανία, τάση τρίτου βαθμού με μεγάλη βελτίωση του δέικτη στο τέλος της δεκαετίας του 90.

Average competitive balance across Europe



THE 91ST MINUTE