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Modelling the impact of star player transfers on results in the case of European football

Doctoral (Ph.D.) thesis

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1. Introduction and objectives

In recent decades, the sport has undergone rapid development, as a result of which the expansion of sports and the sports industry has attracted a growing mass of scientific research. In Hungary, two significant events contributed to the development of the sports industry. On the one hand, the 2010 Prime Minister's announcement, which declared sport a strategic sector in Hungary, and on the other hand, the law on corporate tax relief introduced in 2011. As a result of the measures, an unprecedented source is now available to the sports industry, forcing sports science research in Hungary.

The interdisciplinary nature of sports science covers many fields, of which my dissertation is related to the sports economy. According to Krisztina András[1], Hungarian sports economics research can be divided into two main areas (spectacular sports and leisure sports) and three analysis levels. Macro-level research examines the effects of sports on the national economy (e.g., world events in sport), while meso-level research focuses on analysing individual sports and leagues. Micro-level research deals with the operation of sports organisations and the behaviour of the players in the market.

Although the dissertation touches on all three levels, its field of examination is the micro-level of spectacular sports. The most important participant in spectacular sports (from now on professional sports) is the professional athlete who produces the service with their sports performance and other abilities (stardom, brand value, merchandising, contract, etc.), which their sports organisation sells. As a result, the athlete contributes to the economic and, of course, their club's sports performance, both directly and indirectly. I aim to examine the extent and mode of this contribution and model it with statistical and econometric tools.

Although my original idea was to examine star athletes' transfer, the lack of available data limited my analysis to European football stars only. My dissertation examines the impact of a star player transfer on a football club's effectiveness. Thus, it identifies the athlete as an "investment" and seeks to answer the main question of what it means for a club to acquire a star athlete. Since for a professional sports organisation, even though with different preferences, effectiveness means both sports and economic efficiency, my dissertation examines both phenomena.

The dissertation's main goal was to find a causal relationship between star transfers and their effectiveness. I examined the direct impact of purchasing a star player on the transfer market balance. Of course, the transfers' aggregate was analysed, so I did not examine the effect of a

[1] András, K. (2003). A sport és az üzlet kapcsolata - elméleti alapok. 34. sz. Műhelytanulmány. Budapesti Közgazdaságtudományi és Államigazgatási Egyetem.

transfer but the given club's total performance for almost 15 years. I analysed whether the news of signing a star at a particular moment (official announcement) changes the stock market's perception, the capital value ("intrinsic value") of a club. Finally, I examined whether a player transfer leads to a change in sports performance through competitive balance (CB). Therefore, my research's basic idea is that purchasing a star player is a cause, while various performance factors are effects.

2. Data and methodology

From the point of view regarding the "subject" of the thesis, it is important to define both the star players and their sports clubs. In the most relevant study on stars, Brandes and co-authors examined the impact of superstars and local stars on demand through the example of German football[2]. Based on their results, it can be stated that superstars, unlike local stars, increase attendance. Following the usual outlier filtering in statistics, the thesis defines superstars through empirical data. Therefore, players in the top 2% of players' market value are defined as outliers (superstar).

In the main (modelling) chapters of my doctoral thesis, I follow the procedure used in the mentioned study; thus, stars in the "upper 2%" are the research subjects. The data contains 9,017 football player transfers between 2005 and 2019. The source of the data is www.transfermarkt.com, a site widely used for academic research.

Since the form of a given sports organisation is irrelevant regarding the research's main goal, the generally used "club" word was applied.

Regarding the methodology, first, social network analysis was used. During the analysis, the European transfer market was examined as a complex network, where clubs represents its nodes and transfers represent edges. I investigated whether differently structured networks result in different transfer balances.

The most commonly used network types are the Erdős-Rényi random model, the Watts & Strogatz small-world model and the Barabási-Albert scale-free network. Graph theory developed by mathematicians provides the methodological basis of research using social network analysis[3]. The theory of random networks formed the earliest by Pál Erdős and Alfréd Rényi. However, this assumption was soon questioned, as random networks do not fully cover the nature of real networks. Real networks are built in such a way that certain local nodes are cre-

[2] Brandes, L., Franck, E., & Nüesch, S. (2008). Local heroes and superstars: An empirical analysis of star attraction in German soccer. *Journal of Sports Economics*, *9*(3), 266–286.

[3] A good summary can be read in: Sebestyén, T. (2011). Hálózatelemzés a tudástranszferek vizsgálatában - régiók közötti tudás-hálózatok struktúrájának alakulása Európában. *Statisztikai Szemle, 89*(6), 667-697.

ated within the network. These are the so-called hubs (Watts and Strogatz' small-world network). However, according to the Barabási-Albert model, the distribution of degrees in real networks does not follow a normal but a power function distribution. In this case, there are nodes with an exceptionally high degree (popular participants with many connections), while most have relatively few connections. In order to identify the structure of each European transfer network, the appropriate small-world index was applied.

Then, the central actors of each network were identified by computing the most frequently used betweenness centrality measure.

$$sw = \frac{ac}{ad}$$

$$bc(i) = \sum_{i \neq j \neq k} \frac{g_{jk}(i)}{g_{jk}}$$

The small-world index (sw) is the quotient of the clustering coefficient and the average path length, while $bc(i)$ is betweenness centrality regarding the *i*-th club, calculated by the number of the shortest paths (g_{jk}). The closer the value of the indicator is to 1, the more important the given club is; thus, the higher index means that a given club is able to control the network.

The secondly applied model family is the event study analysis. The event study analysis makes it possible to determine, using empirical data from the stock market, whether a transfer of star player impacts the stock prices of the purchasing club.

As a first step, the event and the analysis periods have to be determined (Figure 1).

Figure 1. Timeline of the event study

where *T* denotes the time of the event; τ_1 is generally the same length of the post- and pre-window, and τ_2 is the length of the estimation period.

Besides the event's specifying, it is also important to select the pre-event window (the period before the event) and the so-called post-event window (the period after the event). The normal return is determined from the estimation period's data, while the abnormal return is determined in the post-window. Several models are used in the literature to generate normal returns.

During the analysis, the partially adjusted GARCH (1,1) model proved to be the most efficient, so it was applied to determine the estimated returns. The form of the model is the following

$$r_{it} = \alpha_0 + \alpha_1 r_{i,t-1} + \beta r_{mt} + \varepsilon_t$$
$$\varepsilon_t \sim N\left(0, \left(\sigma_\varepsilon^2\right)_t\right)$$
$$\left(\sigma_\varepsilon^2\right)_t = \gamma_0 + \gamma_1 \left(\sigma_\varepsilon^2\right)_{t-1} + \gamma_2 \varepsilon_{t-1}^2 + u_t$$

where ε_t and u_t denote the errors; $\left(\sigma_\varepsilon^2\right)_t$ represents the error variance, and $\alpha_0, \alpha_1, \beta, \gamma_0, \gamma_1, \gamma_2$ are the parameters. Following the estimation, the difference between the normal- and estimated return gives the abnormal returns (AR). The abnormal return observations have to be aggregated to get the cumulative abnormal return (CAR), which depends on the length of the pre- and post-window.

$$car_i^{(-\tau_1, \tau_1)} = \sum_{t=T-\tau_1}^{T+\tau_1} ar_{it}$$

where ar_{it} is the normal return of *i*-th stock in the period of *t*.

In order to identify the effect of 100 transfer examined, the following cumulative abnormal returns variations were distinguished.

0. the news generated abnormal returns not at all
1. there were no abnormal returns before the event; then
   1.1. the event resulted in a positive abnormal return for some time
   1.2. the event resulted in a negative abnormal return for some time
2. abnormal returns were generated before the event, which
   2.1. did not change on the occurrence of the event
      2.1.1. was positive all the time
      2.1.2. was negative all the time
   2.2. its sign reversed after the event
      2.2.1. after rising, it turned negative
      2.2.2. after a decline, it became positive

To determine whether the cumulative abnormal return affected by an event can be considered significant (i.e., significantly different from zero), the original parametric test, proposed by MacKinlay, and the non-parametric test of Kolari and Pynnonen's study were used.[4]

Another crucial point of event study analysis is the identification of the event window length. Considering the methodological recommendations and the practice of sports economics, the 20-

[4] MacKinlay, C. A. (1997). Event Studies in Economics and Finance. *Journal of Economic Literature*, *35*(1), 13-39., illetve Kolari, J., & Pynnonen, S. (2011). Nonparametric Rank Tests for Event Studies. *Journal of Empirical Finance*, *18*(5), 953-971.

day event window was preferred in the empirical analysis, which can correspond to approximately one calendar month.

In the last empirical analysis of the thesis, I examined the "two-step effect" in which the total value of a given club's players changes due to purchasing a star player. First, the relationship between club player value and sports performance was investigated by assuming a linear relationship (based on linear correlation coefficients). Since the methodology used oversimplifying the relationship between wealth and profit, I further applied a more complex model. I assumed that as a result of purchasing a star, the wealth concentration between the clubs would also change. This change would also lead to a change in a given league's CB. Due to these assumptions, the star player transfer can be identified as a cause in this chapter as well, while the effect is a change in CB. During the modelling, panel regression was applied. Besides, three methodological innovations were performed.

- To calculate CB, a realistic measure for the football scoring system (3-1-0) was developed, which is the normalised Herfindahl-Hirschman ratio[5]:

$$HRCB = \frac{HHI - HHI_{\min}}{HHI_{\max}^{(3-1-0)} - HHI_{\min}}$$

- Based on the assumption of an oligopoly for the concentration of club wealth, the following measure was performed:

$$HRV^{olig} = \frac{k\left(nHHI - 1\right)SumV^2}{\left(n-k\right)\left(SumV - nv_{\min}\right)^2}$$

- To examine the relationship a partial adjusted model was applied:

$$CB_{i,t} = \beta_0\lambda + \left(1-\lambda\right)CB_{i,t-1} + \beta_1\lambda HRV_{i,t}^{olig} + \lambda\varepsilon_{i,t}$$

$$CB_{i,t} = \beta_0' + \beta_1' CB_{i,t-1} + \beta_2' HRV_{i,t}^{olig} + \varepsilon_{i,t}'$$

The applied methods form the standard methodology of mathematical statistics and econometrics, but - to my knowledge - they are still not widespread in sports economic analyses. The results of the dissertation are presented in the next chapter.

3. Summary of new findings

The new results of the dissertation are organised around three topics:

- I examined the transfer market, which is the labour market of football players;
- I analysed the impact of purchasing star players on the intrinsic value of sports clubs; and

[5] Fűrész, D. I., & Rappai, G. (2018). Koncentrációs mérőszámok „sportos" szerepkörben. *Statisztikai Szemle*, *96*(10), 949-972.

- I investigated the complex effect of a transfer, which ranges from purchasing a star to sports results changes.

At the end of the thesis, I intend to present a complex model that includes both the direct and indirect effects of star player transfers.

3.1 Impact of star player transfers on transfer balance

Using social network analysis, the direct impact of the acquisition or sale on a given football club's transfer balance was investigated. The data contains 18,775 transfers of 37 European countries between 2005 and 2018. During the analysis, the "real sales" were taking into account, so loans and transfer-free transactions were not analysed. Among the transfers, there were 6,659, in which both clubs participated in the 37 European leagues. Thus, these transfers provided the sample with a total value of almost € 27.8 billion.

Examining countries (leagues), striking differences were discovered in transfer balance within Europe; therefore, the player market was divided into two parts:

- On the one hand, the "rich Western Europe", namely England, Germany, Italy and Spain, have a negative balance. Besides them, Turkey and Russia, the two leagues that constantly buy a significant number of valuable players, thus trying to compete with the wealthier leagues to stand out from the other countries;
- On the other hand, the clubs in Eastern Europe and Western Europe outside the top leagues are closing with positive, in some places, very significant balance.

As a next step, the European transfer market was further divided based on geographical location and transfer balance, so the following four clusters (groups) were identified (Table 1).

Table 1. The four clusters of the European transfer market based on geographical location and transfer balance (2005-2018)

Western Europe		Eastern Europe	
Negative balance	**Positive balance**	**Negative balance**	**Positive balance**
England	Austria	Russia	Belarus
Germany	Belgium	Turkey	Bosnia-Herzegovina
Italy	Denmark		Belarus
Spain	Finland		Bulgaria
	France		Croatia
	Greece		Czech
	Island		Republic
	Netherlands		Estonia
	Island		Hungary
	Norway		Latvia
	Portugal		Lithuania
	Scotland		Macedonia
	Sweden		Montenegro
	Switzerland		Poland
	Sweden		Romania
	Wales		Serbia
			Slovakia
			Slovenia
			Ukraine

Source: www.transfermarkt.com; own creation

An interesting result is that the French "League 1", a member of the top 5 leagues, is separated from the other four leagues regarding the transfer balance. (Hereinafter, the following abbreviations were used to name the clusters: Western Europe with a negative balance: WE–, Western Europe with a positive balance: WE +, Eastern Europe with a positive balance: KE +, Eastern Europe with a negative balance: KE–.)

Examining the development of transfer balances, it is clear that there are huge differences between the western and eastern regions of Europe and within the clusters. A difference like this in the transfer market is partly due to the club managers' distinct possibilities and motivations (the number of domestic and global consumers and the owners' resources) and partly due to the different transfer strategy and policy. The top clubs in Europe are willing to pay a significantly higher price for short-term success. They can pay for the best players, consequently typically overspending and losing money in the transfer market. In contrast, Eastern European clubs' transfer strategy with much more modest financial opportunities is motivated by the replacement of the resources needed for their professional success from the transfer market. In addition to sporting success, they are also motivated by transfer market benefits. Due to different strategies, each transfer network has a different structure, and the actors within it occupy different positions.

Teams in the first group (WE–) can sign star players from anywhere; thus, they have an almost identical role in the network. Consequently, there are no hubs in the network, as players are transferred from many places, expensively and "randomly". Therefore the network of these clubs behaves like a random network. In contrast, the network of clubs in the other group is much more interesting, as there are key actors among the profit-oriented teams, as they collect and then sell the players. As a result of this activity, hubs are formed; therefore, their network shows small-world characteristics. The four clusters were identified as separate networks in the European transfer market to detect the transfer market activity differences. During forming networks, as a dominant link, the sales were taking into account. Due to the relevant hypothesis, it is worth mentioning that unweighted and binary networks were performed.

In the next stage of the investigation, the normalised small-world indicators were calculated. Table 2 shows the main characteristics of the networks formed based on European transfers between 2005 and 2018.

Table 2. Main characteristics of transfer networks (2005-2018)

Network	**Nodes**	**Edges**	sw^{norm}
WE−	158	1,912	5.975
WE+	325	2,815	6.947
EE+	427	1,728	15.083
EE−	86	204	5.554

Source: www.transfermarkt.com; own calculation

The most small-world feature (the most marked hubs) is shown by Eastern European clubs' network with a positive transfer balance. Although we obtained significantly lower indicator values for the other three networks, we cannot rule out central actors' existence in this network either. Indeed, they are presumably significantly less decisive. It can be clearly shown that the Western European network with a positive balance (WE+) shows a small-world characteristic to a greater extent than the two networks with a negative transfer balance. Thus, it can be stated that in transfer networks, there is a relationship between the transfers balance and the small-world feature. The stronger the central actors dominate a given network, the more likely the transfer balance of a given network will be positive. This is likely due to the ability to sell players with additional profits by "stepping in" among central players within the network, smaller sellers and richer customers, which means their added value in the supply chain.

According to social network analysis, the following conclusions can be stated about the European football transfer market: the Croatian Dinamo Zagreb and Hajduk Split, and the Czech Slavia Prague are the key actors of the EE+ network. Simultaneously, the Scottish Celtic Glasgow and the French and Dutch clubs are the central actors in Western European networks. It is

extremely remarkable that in addition to the 4 top leagues, the key actors in each region come from among the most successful and wealthy clubs. Among the few exceptions, we find the most successful Bosnian club, the Siroki Brijeg, the "big supplier" of the strongest Croatian clubs (Dinamo, Hajduk, Rijeka). The Swedish Djurgarden was mainly a major collector and educator club in the first decade of the 2000s, with intense transfer activity towards the top leagues.

Thanks to the results of the network analysis, the first thesis can be stated.

T1 Top clubs, which are the biggest market for star players, are not motivated by the transfer market's profit.

The network analysis was able to show the trends of the European football transfer market in recent years. Besides, the analysis's practical relevance is that by identifying regional winners and studying the transfer market strategy, we can set an example for Hungarian clubs that gain their main income source from the transfer profit. A further interesting investigation may be the characterisation of each network structure in a dynamic approach. However, it is no longer the subject of the dissertation.

3.2 Impact of star player transfers on clubs' stock prices

My hypothesis is that purchasing a star player not only affects the profitability of the club through the transfer market balance but also causes additional financial effects. Using the event study analysis, I examined whether the announcement of a star player transfer could cause an abnormal change in football clubs' stock prices listed on a regulated stock market. The transactions analysed took place between the summer of 2015 and 2019 in the European transfer market, and the transfer amount in each case reached the 98th percentile mentioned earlier, namely 10 million euros. During the transactions examined, 10 top European clubs were in a buyer position: Ajax Amsterdam, SL Benfica; Celtic Glasgow; Borussia Dortmund, Juventus FC, Olympique Lyon, Manchester United FC, FC Porto, AS Roma, and Sporting Lisbon.

During the analysis, the day of the official announcement regarding the transfer was considered an event. It is a common practice in the media (primarily in the electronic media and in the written press) to speculate, based on 'reliable information', before the official announcement. Therefore, the study aims to assess precisely their market-influencing role by analysing the returns during the pre-window.

It is assumed that the stock price fluctuations caused by transfers would have already subsided by the time the first few rounds of the next season (in case of winter transfers) occur. This is because the surprise element would have disappeared by that time, and additional revenue is

generated from potential merchandising opportunities. Consequently, during the analysis, the 20-day pre-, and post window was applied.

In the empirical analysis, the previously presented GARCH model parameters were estimated for each stock price. The estimation period always included 250 trading days, so it started on the 270th day preceding the event. The estimation results are presented in Table 4.

Table 4. Estimation results of the partial adjustment model with GARCH (1,1) specification

	R^2 values of the best models		Average values of
Club	**minimum**	**maximum**	**ß-coefficient**
Ajax Amsterdam	0.081	0.085	0.167
SL Benfica	0.021	0.022	0.324
Celtic Glasgow	0.008	0.011	0.107
Borussia Dortmund	0.195	0.202	0.609
Juventus FC	0.228	0.240	0.568
Olympique Lyon	0.129	0.177	0.293
Manchester United	0.114	0.119	0.500
FC Porto	0.165	0.214	-0.459
AS Roma	0.227	0.276	0.326
Sporting Lisbon	0.064	0.094	-0.101

Source: own calculation

The coefficient of determination (R^2) of the models ranged from 6 to 28%, which is broadly in line with financial econometrics's values. It is not surprising that a higher R^2 corresponds to a higher market cap for a given company; therefore, the best fit is found at Juventus, AS Roma, and Borussia Dortmund[6].

The ß-coefficients also show that European football clubs' shares are less risky than the average market risk. (A negative parameter in Porto and Sporting's case shows that the price of these shares moved in line with the market trend.)

Estimated parameters were used to construct expected returns ($\hat{r}_{it}$) for the entire period (20 days after the event). Considering each of the events for which the effect appeared to be significant according to one of the tests used, the cumulative abnormal return pattern could be recognised according to the previously introduced scheme. Table 5 provides a categorisation of the changes occurring in cumulative abnormal returns.

[6] The worst fit models are in the case of Benfica, Sporting, and Celtic.

Table 4. Runs of cumulative abnormal returns

Type of CAR-runs	Transfers
None	14
1.1	13
1.2	10
2.1.1	28
2.1.2	23
2.2.1	9
2.2.2	3

Source: own calculation

It can be seen that in the vast majority, in 86% of the cases, the time series altered significantly as a result of transfer events. Based on the results in Table 4, it can be stated that most of the transfer announcements caused positive changes in the stock market price of the listed clubs (cases 1.1, 2.1.1, and 2.1.2). However, in 23 cases, the stock prices were found to be lower than anticipated.

A more interesting result of this study is that about two-thirds of the 100 transfers examined (63 in the case of a 20-day event window) resulted in information leakage, so the cumulative abnormal returns showed a subtype of type 2 of such returns. It is important to note that investors generally have a good sense of the direction of stock market price movements; therefore, only a tiny number of the two-thirds (mentioned above) of the information leakages resulted in a car-run in which the announcement reversed the expectations (cases 2.2.1 and 2.2.2).

Based on the analysis of transfers over 10 million euro, it can be claimed that even before the announcement of transfers, some stock market participants had already reacted to the transfer. About two-thirds of the investigated transfers led to a significant change in the stock market price, even before the news was published. Because there are many news, public opinion, and journalistic analysis on the football transfer market, there is no way that information leakage can be equated with insider trading.

The above findings are the interesting recommendations for club leaders and managers, which were formulated in our study[6] published in the European Sport Management Quarterly, which is the basis of this chapter. Selling valuable players results in a positive abnormal return, meaning it allows the sport's leadership to make stock price gains on official announcements and negotiate with investors from a stronger position. It is also imperative that emotional investors with a predominantly fan-minded attitude are more satisfied and committed, thereby increasing the club's financial security. Therefore, if the management schedules the transfer well, it will reduce the purchase's financial risk on the one hand and provide additional sources of revenue on the other hand. An increase in the stock price rises the market value (capitalisation) of the

company, thereby generating a price gain depending on the number of shares acquired and improving the company's image in the eyes of investors. Summarising the results of the event analysis, I was able to state the second thesis.

T2 Signing a star player can cause an increase in stock prices in the capital markets, thus increasing the club's financial attractiveness and ability to attract capital.

In my opinion, the above statement should also be considered for Hungarian sports clubs, even though we do not currently find a joint-stock company behind a Hungarian sports club on either the domestic or international stock exchange. However, it can be seen that the above results can be identified as best practice. Furthermore, successful Western European sports clubs can also serve as a benchmark for Hungarian football (or other sports) clubs with increasingly high goals.

3.3 Effects of star player transfer on sports performance

It is evident in public opinion that purchasing a star athlete leads almost immediately to a better sports result. The linear correlation coefficients were calculated based on the top 5 football leagues results (2005/06 -2018/19) to see the relationship between the players' total value and points achieved. Although the coefficients, except two seasons, ranged from +0.7 to +0.9, the relationship cannot be called deterministic (the indicator's value is significantly lower than 1). Complementing my calculation results with my literature review related to the topic (which claims the relationship cannot be called linear), the following thesis can be stated.

T3a Purchasing star players usually leads to better sports performance, but the effect is not deterministic and not necessarily linear.

Based on the former train of thought, it can also be seen that a permanent increase in the players' value would only harm the CB if the increase was not evenly distributed among the teams, consequently, if the dominance of already stronger teams were to increase. Arnold and Benveniste have already shown that elite clubs' tendency to increase their dominance further harms the balance of competition. However, the relationship between player value and CB has not been studied in the literature so far. Applying fixed-effect panel regression, I investigated whether a correlation can be detected between player value concentration and CB. The parameter estimation results of the fixed-effect partially adjusted panel model are shown in Table 6.

Table 6. Estimation results of panel regression

Parameters	$Y_{i,t}$		
	WPCT	***HRCB***	***Gini***
β_0'	0,080 (0,017) [0,000]	0,088 (0,027) [0,002]	0,121 (0,023) [0,000]
β_1'	0,303 (0,113) [0,001]	0,303 (0,113) [0,001]	0,174 (0,075) [0,024]
β_2'	0,088 (0,038) [0,024]	0,220 (0,096) [0,026]	0,119 (0,049) [0,018]
R^2	0,399	0,394	0,369
F-stat	6,426 [0,000]	6,286 [0,000]	5,652 [0,000]
DW	2,175	2,181	2,148

Source: own calculation
Note: Standard errors in ( ) and p-values in [ ].

The estimation provided convincing results. The results of F-tests suggest that all models performed examining an existing relationship. Furthermore, the fixed-effect panel model's assumption is correct since the Durbin-Watson statistic values, used as a general diagnostic test, are around 2. The explanatory power of the models is higher than 30% almost in all cases. (This is higher than usual regarding panel regressions between stationary variables.)

In summary, regardless of the indicators used to measure competitive balance, it can be concluded that there is a relationship between player value concentration and CB. In the case of partially adjusted models, the HRV^{olig} variable is associated with positive regression coefficients. Based on the above results, the following thesis of the dissertation was stated.

T3b Acquiring a star player can also indirectly affect sports performance through competitive balance and wealth concentration changes.

Based on the previous results, it is obvious to ask to what extent purchasing a star player will change the CB. To answer the question, a relatively simple simulation was applied. I looked at what would happen to the wealth concentration (based on 2018/19 data) if one of the clubs acquired a star player worth € 110 million. (The oligopoly framework was used throughout the determination of the HRV indicator.)

Based on the simulation results, the main findings are as follows.

- The "poorer" club buy the star player, the more balanced the league become. The greatest impact can be achieved in France. In contrast, the smallest can be achieved in England with a star transfer: in the former case, if a "small team" bought (or could buy) a star player, CB could increase by more than 5%, however, in England, the maximum reduction in CB does not exceed 1%.
- It is worth mentioning that the assumed transfers have their effect in different "places" in each league: for example, in France, from the 4th wealthiest team, it almost does not matter where the player goes, while in England, if any of the first 7-8 teams sign a superstar, the CB will change significantly.

In summary, it is worth noting that according to the simulation, CB does not change significantly from a single star player. However, if a small team could gain significant wealth, the league's balance would increase perceptibly for the fans.

The models have shown that an increase in the amount of money flowing into sports alone does not harm the balance of competition. For a drastic shift in the CB, wealth growth must not affect all clubs evenly for the league to become possibly boring. Empirical analyses and simulation have shown that the increase in wealth concentration leads to competitive imbalance.

In my opinion, the above-presented analysis provides not only valuable results for football top leagues but also contains important information for Hungarian sports leaders and regulators. Leagues are interested in the most balanced league to maintain or increase demand. Consequently, it can be said that domestic leagues can also aim to prevent the concentration of wealth. However, this can be achieved not only by restricting the richest clubs but also by providing the relatively "poorer" teams with additional resources and by expanding the number of richer clubs. Examples include the sharing of ticket and broadcasting revenue, the introduction of pay caps in major North American sports, or the introduction of progressive taxes.

3.4 A complex model of star player transfers

I consider the dissertation's main result that, despite several methodological applications with different backgrounds, I managed to set up a complex model that shows all the relationships between star transfer and club success (Figure 2).

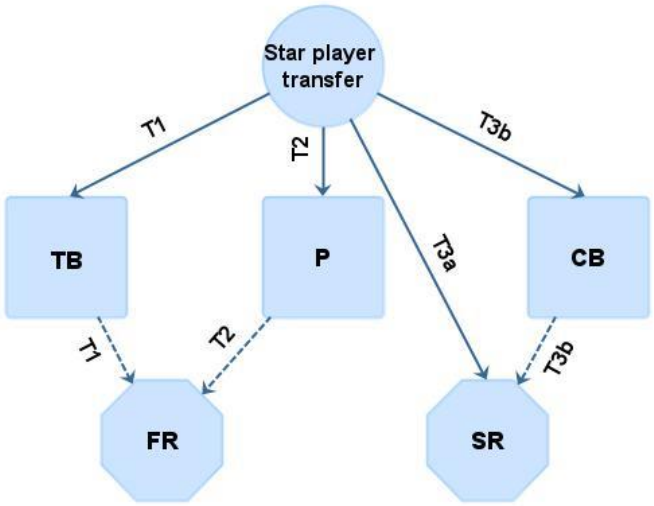

Figure 2. A complex model of star player transfers
Source: own creation

The meanings of abbreviations are: *TB* is transfer balance, *P* is stock prices, *CB* is competitive balance, *FR* is financial results, and *SR* is sporting results.

It is worth mentioning that I could verify all the relationships shown in the figure through empirical data. The direct relationships marked with a solid line and the indirect relationships marked with a dashed line are based not only on previous studies but also on my calculations. Based on the existence of the complex model, I stated the last thesis of the dissertation.

T4 Purchasing star players, directly and indirectly, affect their club's performance. These impacts can only be examined with a complex model.

In addition to the important and interesting empirical results, it is worth mentioning that stochastic methods (time series econometrics, network analysis, panel regression, event study analysis) widely applied in economics can be used in sports economics research. The use of these methods allows for deeper and more grounded results than intuition-based verbal analyses.

4. Discussion and further directions

In the dissertation, I examined the role of star football players from a new aspect. The effects of acquiring a high-value player on the club's performance with various mathematical-statistical and econometric modelling procedures were analysed through empirical data. Following the dual goal system of professional sports clubs, I examined both economic- and sports performance.

I found that

1. clubs that are considered to be central actors in a small-world transfer market are in the best position in terms of profitability;

2. purchasing a star player increases the stock prices of the listed club, which results in an increase not only in the market capitalisation but also in the investor satisfaction and investment attractiveness;
3. the wealth concentration is significantly important for the competitive balance, so some regulatory system changes may increase the leagues' excitement, thus increasing the attendance.

The complex model showing the impact of star transfers can also provide several useful lessons for Hungarian sports leaders. It can be used to identify foreign good practices and points of reference. I would like to emphasise that all my results are based on public data and validated by statistical methods. At the end of my dissertation, I would like to mention further possibilities for future analysis.

1. A clear indication of the "value" of stardom did not occur in all analysis. It is worth considering the threshold of 10 million euros set in the event study analysis in the case of examining the transfer network. However, on the one hand, it would significantly reduce the size of the existing network and, on the other hand, disturb the basic idea of the research since the European transfer market cannot be considered as a single network.
2. It is also worth examining whether there is a comparative advantage in the football transfer market, so whether, for example, it is possible to determine which players are typically signed by western star clubs.
3. Unfortunately, in the absence of adequate data, I did not have the opportunity to analyse the relationship between competitive balance and economic performance. This implementation would raise my dissertation to a new "dimension".

In my opinion, the different empirical analyses used in the research, both in terms of their depth and diversity, are suitable for formulating "best practice" recommendations properly applied to Hungarian football clubs. We can already see examples of all these suggestions in domestic studies on the subject (Fűrész & Rappai, 2018; Fűrész, 2020). The enrichment of these studies is also one of my plans. Nonetheless, I hope that the findings been described in this way has enriched sports economics research.

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Publications

Journal articles and book(s) related to the thesis

Fűrész, D. I. (2018). Correlation between profitability and transfer activity in European football. *Croatian Review of Economic, Business and Social Statistics 4*(2), 15-22.

Fűrész, D. I. (2018). Átigazolások és árfolyamok kapcsolata a labdarúgásban. *Egészség-Akadémia, 9*(3), 133-141.

Fűrész, D. I. (2020) Méltányos volt-e a magyar sportszövetségek világjárványra adott reakciója? Empirikus elemzés a kosárlabda példáján keresztül, *Magyar Sporttudományi Szemle, 21*(88), 11-21.

Fűrész D. I., & Ács, P. (2020). The relation between national competition and international competitiveness. *Management Issues, 18*(1), 11-26.

Fűrész, D. I., & Rappai, G. (2018). Koncentrációs mérőszámok „sportos" szerepkörben. *Statisztikai Szemle, 96*(10), 949-972. https://doi.org/10.20311/stat2018.10.hu0949

Fűrész D. I., & Rappai, G. (2019). *Ökonometriai modellek alkalmazása a sportgazdaságban*. Pécs, Magyarország: Pécsi Tudományegyetem Közgazdaságtudományi Kar (PTE KTK) (2019), 204 p.

Fűrész, D. I., & Rappai, G. (2020). Information leakage in the football transfer market. *European Sport Management Quarterly*. https://doi.org/10.1080/16184742.2020.1797847

Kovács, A., Paár, D., Welker, Zs., Fűrész, D. I., Elbert, G., Stocker, M., & Ács, P. (2016). Sportfogyasztási szokások alakulásának aktuális helyzete. *Magyar Sporttudományi Szemle, 17*(68), 17-22.

Articles and abstracts related to the thesis

Csurilla, G., Fűrész D. I., Rappai, G., Sterbenz, T. (2019). Túlértékeltek-e a makro tényezők? Az olimpiai eredményességgel foglalkozó tanulmányok kritikai összehasonlítása. *Magyar Sporttudományi Szemle, 5*(82), 50-50.

Fűrész, D. I. (2017). Capital concentration and the 'name of the game' In: Matevž, Rašković; Andreja, Jaklič (szerk.) 4th Aib-Cee Chapter Conference – Changing Global Landscape And Regional Cooperation: From Regional Value Chains To Chinas's One Belt One Road Initiative And Beyond: Conference Proceedings, 8-8.

Fűrész, D. I. (2017). Az olimpiák hatása a részvény-árfolyamokra. *Magyar Sporttudományi Szemle, 18*(70), 40-41.

Fűrész, D. I. (2017). Okozhatja-e a vagyonkoncentráció a verseny unalmassá válását?: Empirikus elemzés az európai labdarúgó bajnokságok paneljén. *Magyar Sporttudományi Szemle, 18*(72), 57-57.

Fűrész, D. I. (2018). A sportolók munkaerőpiaci mozgásainak elemzése. *Farkas Ferenc Nemzetközi Tudományos Konferencia Lektorált Tanulmánykötet*. 569-581.

Fűrész, D. I. (2018). Női sportolók részvétele az olimpiákon. In: Kehl, D. & Rappai, G. (szerk.) *PRIMUS INTER PARES: Tanulmánykötet Hoóz István 90. születésnapja tiszteletére,* Pécs, Magyarország: Pécsi Tudományegyetem Közgazdaságtudományi Kar, 195-204.

Fűrész, D. I. (2018). Network of transfers in European football. *Book Of Abstracts Of The Isccro: International Statistical Conference In Croatia, 2*(1), 31-31.

Fűrész, D. I. (2018). Az európai labdarúgópiac átigazolási sajátosságai. *Magyar Sporttudományi Szemle 19*(75), 42-42.

Fűrész, D. I. (2018)."Határ a csillagos ég?"– Avagy meddig tekinthető jó befektetésnek egy sportoló? In: András, Krisztina; Havran, Zsolt; Kajos, Attila; Kozma, Miklós; Kynsburg, Zoltán; Máté, Tünde (szerk.) *II. SKEOF (Sportgazdaságtani Kutatók és Egyetemi Oktatók Fóruma) Konferencia : Sikerényezők a globális sportgazdaságban – Absztraktkötet*, 50-52.

Fűrész, D. I., & Havran, Zs. (2018). Az európai labdarúgás átigazolási piacának regionális sajátosságai - "Nyílik, vagy záródik az olló?" Nyugat-európai bajnokságok és a közép-kelet-európai régió játékospiaci trendjeinek empirikus összehasonlítása. *Magyar Sporttudományi Szemle, 19*(77), 63-63.

Fűrész, D. I., Kehl, D., & Rappai, G. (2020). Measuring value of the national character. *Book of Abstracts of the ISCCRO: International Statistical Conference in Croatia, 3*(1).

Fűrész, D. I., Kehl, D., & Rappai, G. (2020). Nemzeti karakter értéke a sportban. *Magyar Sporttudományi Szemle, 21*(85).

Havran, Zs. & Fűrész, D. I. (2019) Regionális kereskedők és nevelők: kik a nyertesei a labdarúgás nemzetközi játékospiacának? *Magyar Sporttudományi Szemle, 2*(79), 50-50.

Kehl, D. & Fűrész, D. I. (2018). Hatással van-e az alapszakasz kiegyensúlyozottsága a végeredményre? *Magyar Sporttudományi Szemle, 19*(75), 52-52.

Rappai, G., & Fűrész, D. I. (2018). Handling heteroskedasticity in labour demand functions of athletes. *Croatian Review Of Economic Business And Social Statistics, 4*(2), 47-56.

Rappai, G., & Fűrész, D. I. (2018). Special demand curves in the sports economy. *Book Of Abstracts Of The Isccro: International Statistical Conference In Croatia, 2*(1), 39-39.

Rappai, G., & Fűrész, D. I. (2019). Is There Information Leakage on the Football Transfer Market? In: Breitbarth, T; Bodet, G; Fernandez, Luna Á; Burilo, Naranjo P; Bielons, G (szerk.) *Connecting Sport Practice and Science: The 27th European Sport Management Conference: Book of Abstracts*, 36-38.

Journal articles under reviewing process

Fűrész, D. I., & Havran, Zs. (2021?). Small-world networks and regional traders on the European football transfer market. *International Journal of Sport Management and Marketing.*

Rappai, G., & Fűrész, D. I. (2021?). Relationship between player value and competitive balance under the assumption of oligopoly. *International Journal of Sport Finance.*

Journal article closely <u>not</u> related to the thesis

Fűrész, D. I., & Vörös, M. (2021). A részmunkaidős foglalkoztatás hatékonyságának empirikus vizsgálata. *Közgazdasági Szemle, 68*(2), 178-204. DOI: 10.18414/KSZ.2021.2.178

Presentations related to the thesis

Fűrész, D. I. (2018) "Határ a csillagos ég?"– Avagy meddig tekinthető jó befektetésnek egy sportoló II. SKEOF (Sportgazdaságtani Kutatók és Egyetemi Oktatók Fóruma) Konferencia: Sikerényezők a globális sportgazdaságban (Székesfehérvár, 2018.04.20.)

Fűrész, D. I., Kehl, D., & Rappai, G. (2020). Nemzeti karakter értéke a sportban. „Sporttudomány az egészség és a teljesítmény szolgálatában" XVII. Országos Sporttudományi Kongresszus (Győr, 2020.09.04.)

Fűrész, D. I., Kehl, D., & Rappai, G. Measuring value of the national character. ISCCRO: 3. International Statistical Conference In Croatia (Online, 2020.05.08)

Csurilla, G., Fűrész, D. I., Rappai, G., & Sterbenz, T. (2019). Túlértékeltek-e a makro tényezők? Az olimpiai eredményességgel foglalkozó tanulmányok kritikai összehasonlítása. Fiatal Sporttudósok VII. Országos Konferenciája (Budapest, 2019.11.29.)

Havran, Zsolt, & Fűrész, D. I. (2019). Regionális kereskedők és nevelők: Kik a nyertesei a labdarúgás nemzetközi játékospiacának? „Sporttudomány az egészség és a teljesítmény szolgálatában" XVI. Országos Sporttudományi Kongresszus (Nyíregyháza, 2019.06.05.)

Rappai, G., & Fűrész, D. I. (2019). Is There Information Leakage on the Football Transfer Market? The 27th European Sport Management Conference (Sevilla, 2019.09.06.)

Fűrész, D. I. (2018). Correlation between profitability and transfer activity in European football. International Statistical Conference in Croatia (ISCCRO'18) (Opatija, 2018.05.10.)

Fűrész, D. I (2018). A sportolók munkaerőpiaci mozgásainak elemzése. Farkas Ferenc Nemzetközi Tudományos Konferencia (Pécs, 2018.06.08.)

Fűrész, D. I., Havran, Zs. (2018). Az európai labdarúgás átigazolási piacának regionális sajátosságai - "Nyílik, vagy záródik az olló?" Nyugat-európai bajnokságok és a közép-kelet-európai régió játékospiaci trendjeinek empirikus összehasonlítása. Fiatal Sporttudósok VI. Országos Konferenciája (Budapest, 2018.12.08.)

Fűrész, D. I. (2018). Az európai labdarúgópiac átigazolási sajátosságai. XV. Országos Sporttudományi Kongresszus. (Szombathely, 2018.06.01.)

Kehl, D., & Fűrész, D. I. (2018). Hatással van-e az alapszakasz kiegyensúlyozottsága a végeredményre? XV. Országos Sporttudományi Kongresszus. (Szombathely, 2018.06.01.)

Rappai, G., & Fűrész, D. I. (2018). Special demand curves in the sports economy. International Statistical Conference in Croatia (ISCCRO'18) (Opatija, 2018.05.10.)

Fűrész, D. I. (2017). Az olimpiák hatása a részvény-árfolyamokra. Sporttudomány az Egészség és a Teljesítmény Szolgálatában: XIV. Országos Sporttudományi Kongresszus (Pécs, 2017.06.02.)

Fűrész, D. I. (2017). Capital concentration and the' name of the game'. 4TH AIB-CEE Chapter Conference – Changing Global Landscape and Regional Cooperation: From Regional Value Chains to Chinas' One Belt One Road Initiative and Beyond. (Ljubljana, 2017.09.29.)

Fűrész, D. I. (2017). Okozhatja-e a vagyonkoncentráció a verseny unalmassá válását? Empirikus elemzés az európai labdarúgó bajnokságok paneljén. Fiatal Sporttudósok V. Országos Konferenciája (Budapest, 2017.12.09.)