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DETERMINANTS OF A NATION'S SPORT PERFORMANCE AT DIFFERENT MEGA SPORT EVENTS[1]

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This paper presents the initial results of a significant research conducted under the IOC PhD Student Research Grant Programme with the support of the Hungarian Olympic Committee. A macro- and meso-level analysis were conducted within the framework of this research; this paper presents the macro model, with the aim of capturing important features of the economic, political and institutional environments which affect the productivity of a nation's sport performance and growth; with this the paper contributes to an understanding of the key elements of high-performance sport development. The macro model divides sport into two groups – individual and team sports – in order to determine if there are any differences at the macro level. The influence of the economic factors which were included in the models shows a decreasing effect on the market share of nations, which means that other factors must also play a significant role in a nation's international sporting success. The responsibility of national sport governance will become even more important in elite sport success in the future, which shows that the efficient utilisation of recourses will also become a key factor, along with an appropriate structure, organisation and integrated coordination.

Keywords: sport, Olympics, competitiveness, panel Tobit model

JEL-codes: C24, L83

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1. INTRODUCTION

In recent years there has been a large amount of literature exploring the correlations between Olympic successes and different macroeconomics determinants such as GDP, population, economic performance, or the resources dedicated to competitive sports as well as the number of people involved in leisure-time sporting activities (De Bosscher et al. 2008; Houlihan – Zheng 2013). In previous studies Hungary appeared as an exception among the examined countries because its victories at the Olympics cannot be explained with macroeconomic determinants such as population or GDP. In all of the post-Soviet countries, including Hungary, the government played a large role during the 1960-1992 period. In fact, each Soviet satellite state was able to perform better than the models predicted, but this effect is no longer important in determining country medal counts (Bernard 2008). Although the performance of Hungary is still outstanding in Summer Olympics, but at the same time the performance of its commercialised global team sports have been decreasing radically in the last decades. Despite the strong political and social will to have successful professional team sports, the trend has not changed (see Figures 1 and 2).

The key objective of the paper is to take a similar model used in previous studies, but to apply it separately to professional team sports and other sports and identify the differences in terms of the applied macro determinants. In addition, our aim is to determine to which degree various factors influenced sporting success regarding these two groups of sports. It is also examined how the obtained result of the model prevail in the case of Hungary.

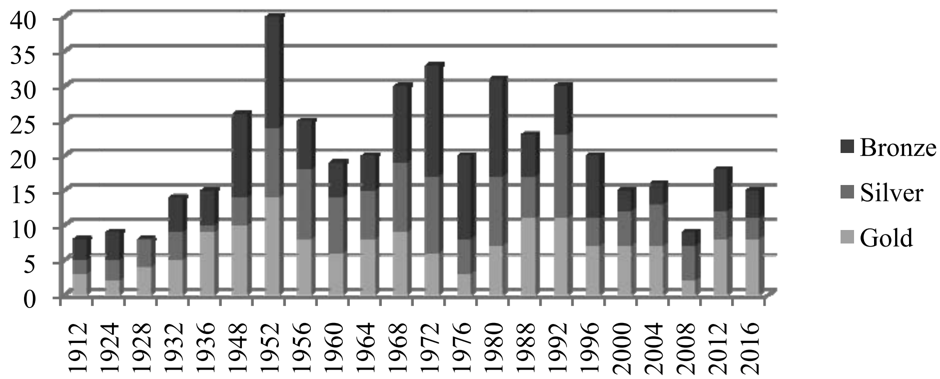

Figure 1. Number of medals won by Hungary at Summer Olympic Games in individual sports (1912-2016)

Source: authors, based on Infostrada Sports database

The following macro model was not created with the intention of generating another prediction model for medal winning, but rather to capture important features of the economic, political and institutional environments which affect the productivity of elite sport performance and growth and, with this, contribute to the understanding of the key elements of elite sport development. The novelty of this paper is that in comparison with previous studies, the sports have been categorised into two groups – professional team sports and individual sports. In the case of professional team sports, main world and continental events were also taken into consideration as in many cases it is not the Olympics which are considered to be the most important event.

First, the conceptual framework based on the related literature will be introduced, followed by a short overview of how the Olympic Games have changed during the years, what trends can be identified and what the characteristics of the "medal market" are in the case of team sports and the other sports. Before disclosing the results of the model, the profile of the data and the applied methods will be presented.

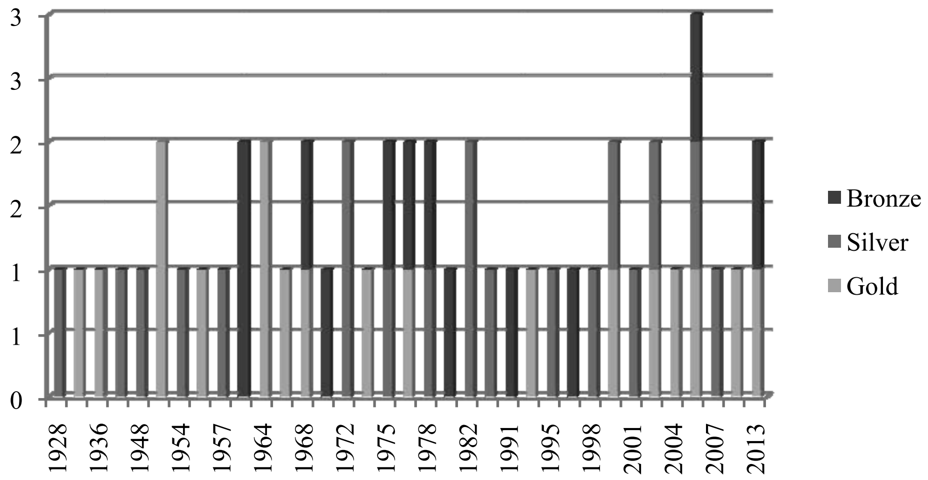

Figure 2. Number of medals won by Hungary at Olympic Games and world championships in team sports (1912-2016)

Source: authors, based on Infostrada Sports database

2. CONCEPTUAL FRAMEWORK

It is important to note that our research methods are based on the problem which we identified in the case of Hungary, namely, that it has a long and successful history in terms of the Summer Olympics, though most of its popular spectacular sports are struggling in terms of inefficiencies or declining international competitiveness. Therefore, a distinction was drawn between *individualistic* (such as swimming, kayaking, judo) and *team* (e.g. football, basketball) sports in the study, which rests on the unit of competition and the nature of the demand for the contest (Symanszki 2003; Dénes 2015), which in turn determines the amount of resources available from the private sector. In team sports the players act as agents on behalf of the team – which may be an actual employer (e.g. a club) or some delegated authority (e.g. a national team); in individualistic sports the player acts as a sole trader. Team sports are able to produce continuously and generate saleable product week-by-week for the spectators while individualistic sport events occur on a more infrequent basis.

In the past decade many papers have provided economic predictions of medal distribution per nation for the Olympic Games (Bernard 2008; Bernard – Busse 2004; Johnson – Ali 2004; 2008). Existing studies have applied mostly reduced-form statistical methods and have examined the determinants of Olympic performances, combining socio-economic variables with the nutrition and protein consumption of the athlete, and the athlete's home country's weather, mortality rate, religion, colonial past, newspaper supply, urban population, life expectancy, geographical surface area, military expenditure, judicial system and sport disciplines taught at school. These apply various measures for Olympic success as some focus on medal counts or points, while the most recent studies use the *market share* of a country as an explanatory variable. The application of market share provides a standardised measure of performance, with which it is possible to make a more accurate time series diagnosis. As the number of medals which can be won in a given sport and the number of events contested at each Games has varied over time (and to a lesser extent, the number of points per event – for example, two or more nations "tying" for the same medal), the number of points available at each Olympic Games has also varied (De Bosscher et al. 2008). In order to convert points won into a standardised measure, SIRC (2002) introduced the principle of computing "market share", that is, points won as a proportion of points available to be won.

As Bernard (2008) concluded based on his previous study (Bernard – Busse 2004), that over the last forty years, national Olympic medal totals have been driven by four distinct factors: population, per capita income, past performance and a host effect. He also notes in his study that during the Soviet era there was a substantial additional boost for the Communist bloc, an effect which had completely dissipated by the Sydney games. In all the post-Soviet countries, like Hungary, the governments played a large role from 1960-1992. In fact, each Soviet satellite state was able to perform better than the models predicted. This effect is no longer important in determining country medal counts.

Andreff and Andreff (2015) highlight that the increase in the number of medals won by one nation leads, logically, to an equivalent decrease in medal wins for other nations participating in the Olympics, as the supply side is fixed. Therefore, if one wants to understand the Olympic performance of one specific nation, all other participating nations must be taken into account within the overall constraint of the total medals awarded at one Olympics.

To understand the determinants of Hungarian sport success, we have completed a macro-level analysis with the aim of revealing if there are any differences between individual and team sports with regard to macroeconomic factors. In this respect our purpose is not to forecast a medal table as most studies have, but rather to add to an understanding of the characteristics of these two groups of sports. With this segmentation we expect a different insight and a yielding of valuable information.

2.1. Characteristics of the Olympic "medal market"

The economic and political significance of the Olympics, and especially the Summer Olympics, is increasing, as is clearly shown by the steadily growing number of participating countries, which reached a record in London in 2012. At the same time, there is a distinct decrease in a country's chances of winning a medal or reaching a better position on the medal table. Almost sixty per cent of the participating countries do not win any medals and, as Table 1 shows, only about ten per cent of these countries were able to move to a higher category, which means that they were able to earn at least one medal in the next event. Similar changes can be found regarding the other categories, which highlight the fact that the countries have remained broadly stable over the last six Olympics.

As the aim of the paper is to determine if individual and team sports have shown any differences in terms of macroeconomic variables determining sporting success, in the following section the last six Olympic Games were analysed with respect to this.

Figure 3 shows how the number of medals per participant varies regarding different sports.[2] It can be seen that if a country has successfully qualified for a team

[2] A team is considered as one participant in our analysis.

sport event, than it has a much greater chance of getting a medal despite the fact that, in the case of an individual sport, an athlete can compete in more than one event.

In the next step, in order to present the differences between individual and team sports, concentration ratios were calculated and illustrated with Lorenz curves. Figure 4 provides an overview of the Lorenz curve for the Olympic Games in

Table 1. Transition in frequency distribution of total awarded medals for Summer Olympics (1992-2012)

	1992 → 1996		**1996 →2000**		**2000 →2004**		**2004 →2008**		**2008 →2012**	
Number of medals	Rate of staying in the same category	Rate of reaching a higher category	Rate of staying in the same category	Rate of reaching a higher category	Rate of staying in the same category	Rate of reaching a higher category	Rate of staying in the same category	Rate of reaching a higher category	Rate of staying in the same category	Rate of reaching a higher category
0	80%	20%	89%	11%	91%	9%	86%	14%	89%	11%
1-5	63%	16%	62%	9%	48%	15%	66%	18%	57%	14%
6-15	67%	11%	61%	17%	61%	11%	58%	11%	55%	14%
16-25	50%	13%	38%	25%	60%	20%	17%	67%	40%	20%
>25	67%	0%	100%	0%	91%	0%	82%	0%	90%	0%

Source: authors, based on Infostrada Sports database

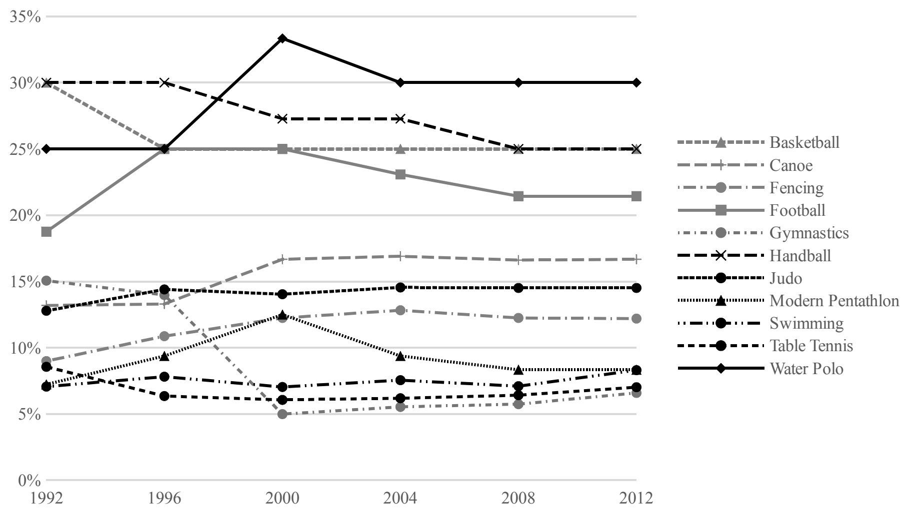

Figure 3. Number of medals per participant in selected sports in the Summer Olympic Games

Source: authors, based on Infostrada Sports database

1992 and 2012. In every Olympic cycle, countries are ranked according to their ratio of medal shares in individual and team sports. The *x*-axis presents the cumulative relative frequency of countries; the *y*-axis shows the cumulative frequency of countries by number of medals won. The proportional distribution represented by the 45º line can be considered as the default just distribution: every participating country has the same chance of success. The further the curve lays from the diagonal, the greater the degree of disproportional medals shares.

Clearly, there is a modest but steady inward shift of the Lorenz curve over time in the case of individual sports, which suggests that the distribution of medal shares in it has become less concentrated and more countries are able to win a medal; but this is still more concentrated than team sports. However, the trend in team sports runs counter to that of individual sports, and in 2012 fewer countries were able to go home with a medal, and thus the distribution of medals has become more unbalanced. It can be summarised that both markets are heavily concentrated; over fifty per cent of participating countries do not win any medals, and, as the Lorenz curve shows, there is just a modest positive change in the case of individual sport. In contrast, more than half of all medals are collected by 10% of the countries, which has not changed over time.

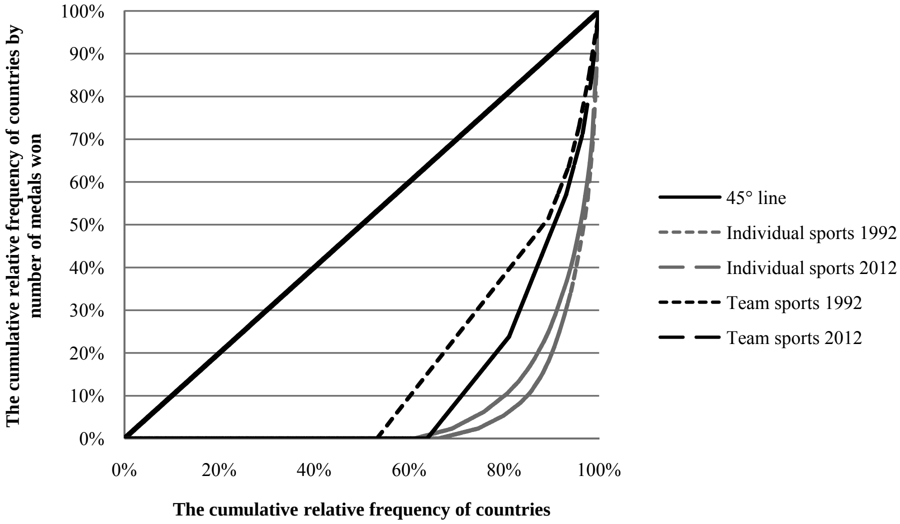

Figure 4. Lorenz curve

Source: authors, based on Infostrada Sports database

3. DATA AND METHODS

Our aim was to capture important features of the economic, political and institutional environments that affect the productivity of sport's performance and growth and, with this, contribute to an understanding of key elements of high-performance sport development. Therefore, we created a macro model in which we divided sports into two groups – individual and team sports – in order to determine if there are any differences at the macro level.

The model was built based on the results of the latest studies (Forrest et. al. 2015; Andreff – Andreff 2015; Bernard 2008), which examine the determinants of a nation's sport performance at the Summer Olympics, but with a different objective. As previous studies mainly focused on predicting the results of upcoming mega-sport events, our aim was to identify tendencies and possible differences in explanatory variables between individual and team sports. Individual sports in this analysis include only Summer Olympic disciplines, excluding team sports. In team sports we included the following disciplines: baseball; basketball; beach volleyball; cricket; football; handball; hockey; ice hockey; rugby; softball; volleyball; and water polo. We focused our analysis on the six Summer Olympic competitions from 1992 to 2012, years which can be characterised by more stable participation, with country-level information on medal counts and number of athletes. Results of the data analysis may be sensitive to the inclusion of certain time periods because before this time, the Games were affected by political actions (for example, the Soviet Union did not participate in 1984) or changes in political regimes (the dissolution of the former Soviet Union in the early 1990s; German reunification in the early 1990s; and state succession in Yugoslavia in the 1990s).

Countries with a minimum of one medal won in the modern Olympic Games are included in the modelling. Country-level information on medal counts, medal share and number of athletes come from Infostrada Sports,[3] a firm which collects and provides sport performance data. Medal counts include all of the medals won at the Summer Olympics in the case of individual sports and all of the medals won at the Summer and Winter Olympic Games, continental championships and world championships regarding team sports.

Since total medal winnings might be influenced by the growing number of sports and also by the growing number of events within each sport, we use the market share of the nations as a dependent variable in modelling the successive Olympics.

[3] Infostrada Sports is now Gracenote, which offers unique data, media, analytics and event services to the sports industry. It manages the world's largest sports database, covering over 250 sports worldwide, both historical and current.

Table 2. Analysis inclusion criteria

	Individual sports	Team sports
Year	1992-2012	1989-2012
Sports	Only Summer Olympic disciplines without team sports.	baseball, basketball, beach volleyball, cricket, handball, water polo, football, rugby, softball, volleyball, hockey, ice hockey
Competition	Summer Olympics	World championships, Continental championships, Summer Olympic Games, Winter Olympic Games,
Medal share	Podium	Podium

Source: authors

For the years 1988, 1992, 1996, 2000, 2004, 2008, and 2012, GDP per capita and population data come from World Bank and United Nations data sources. Our final estimation sample includes 135 countries for a total of 1,576 country/year observations.

Using Andreff and Andreff's works (2010; 2015) as a starting point, we have elaborated a model with a few recommendations for improvement. We use the same independent variables for the models, the same method and partly similar model specifications as Andreff and Andreff (2010; 2015), but the main difference is that we estimate separate models for individual and team sports and include new explanatory variables (such as *athlete share* or *youth market share*).

Table 3 shows the continuous variables used with their descriptive statistics. Two previously used primary explanatory variables are *GDP per capita* in purchasing power parity dollars (constant 2011 international dollars) and *population*. Both variables are four-year lagged (t–4), with the assumption that four years are required to create, build up, train and prepare an Olympic team to be its most competitive.

In addition, two new variables are included in the analysis. *Athlete share* measures the relative size of the given country's Olympic team compared to total Olympic participants. *Youth*[4] *Market Share* shows the market share of medals won at youth continental and world championships within a two-year period of the given Olympic Games. This data is available only between the 2006-2012 time period.

We used country classification variables which refer to the previous political regime of the country and also the result of its institutional transformation (Andreff 2004). Several categories are distinguished. The first is Central Eastern

[4] Youth means the last age category below adult level.

Table 3. Descriptive statistics

Variable	Definition		Mean	Overall Stand. Dev.	Between Country Stand. Dev.	Within Country Stand. Dev.
Market Share	Market Share of medals won	Individual sports	0.008	0.0184	0.021	0.006
		Team sports	0.007	0.015	0.014	0.004
Youth Market Share	Market Share of medals won at Youth Continental and World Championships within two years of the given Olympics	Individual sports	0.008	0.017	0.017	0.002
		Team sports	0.008	0.018	0.017	0.005
Athlete share	Number of country's athletes per number of total athletes		0.007	0.010	0.010	0.003
GDP per capita	Real GDP per capita PPP, 2005		8.884	1.268	1.248	0.213
Population	Total population		16.049	1.821	1.819	0.123

Source: calculations of the authors

European countries (CEEC), which gave up their Soviet-style centrally planned economies in 1989 or 1990 and transformed into democratic political regimes running market economies such as Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia (and Czechoslovakia until its 1993 split), Slovenia, and the GDR (until German reunification in 1990). Another commonality of this group is that these countries all joined the European Union in 2004 or 2007. The second country group (TRANS) consists of new independent states (former Soviet republics) and some former Council of Mutual Economic Assistance (CMEA) member states which started a transition similar to the one in the CEEC, but are lagging behind in terms of transforming into democratic regimes, with some stalling on the path toward market economies: Armenia; Azerbaijan; Belarus; Georgia; Kazakhstan; Kyrgyzstan; Moldova; Mongolia; Russia; Tajikistan; Turkmenistan; Ukraine; Uzbekistan and Vietnam. None of them have joined the EU so far or really have the option of doing so. The next two groups have not been Soviet regimes, properly speaking, in the past, although they were both communist regimes and planned economies. In the first one, NSCOM, we sample those countries which started a transition process in the 1990s: Albania; Bosnia-Herzegovina; China; Croatia; Laos; Macedonia; Montenegro; and Serbia (and the former FSR Yugoslavia before the 1991 break-up). Two countries have not yet engaged in a democratic transformation or have progressed towards a market economy: Cuba and North Korea, who must still be considered communist regimes (COM). All other countries are considered as capitalist market economies (CAPME), the reference group in our econometric estimations.

A last variable is introduced that captures the influence of a specific sporting culture on Olympic performance in a region. For example, Afghan women are not used to participating much in sport or attending sport shows, let alone being part of the Olympic team. As a result of these cultural (and sometimes institutional) disparities, some nations are more specialised in one specific sport discipline, such as weight-lifting in Bulgaria, Turkey and Armenia, marathon and long distance running in Ethiopia and Kenya, cycling in Belgium and the Netherlands, table tennis, judo and martial arts in Asia, and the sprint in the Caribbean islands and the USA. It is not easy to design a variable that would precisely capture such regional sporting culture differences, but it is assumed here that regional dummies may reflect them. For model estimation, the world is divided into nine 'sporting culture' regions: AFS, sub-Saharan African countries; AFN, North African countries; NAM, North American countries; LSA, Latin and South American countries; EAST, Eastern European countries; WEU, Western European countries (used as the reference region in our estimations); OCE, Oceanian countries; MNE, Middle East countries; and ASI, (other) Asian countries.

Table 4. Frequency table of category variables

Category of variables	Definition	**1992**	**1996**	**2000**	**2004**	**2008**	**2012**
	Political Regime						
CAPME	Capitalist market economies	100	99	99	98	100	100
TRANS	New independent states	13	13	13	13	13	13
CEEC	Central Eastern European countries	10	10	10	10	10	10
NSCOM	Communist regimes which started a transition process in the 1990s	4	4	4	4	3	3
COM	Communist regimes	2	2	2	2	2	2
	Sporting culture region						
WEU	Western Europe	18	18	18	18	18	18
AFN	North African countries	5	5	5	5	5	5
AFS	sub-Saharan African countries	23	23	23	23	23	23
NAM	North America	11	11	11	11	11	11
LSA	Latin and South America	16	16	16	16	16	16
ASI	Asian countries	22	22	22	22	22	22
EAST	Eastern Europe	18	18	18	17	18	18
MNE	Middle East	15	14	14	14	14	14
OCE	Oceania	3	3	3	3	3	3

Source: calculations of the authors

Table 5. Number of athletes and medals won by host countries

	Olympics before Hosting		Hosted Olympics		Olympics after Hosting	
	Number of athletes	Number of medals won	Number of athletes	Number of medals won	Number of athletes	Number of medals won
Spain	229	4	422	22	289	17
USA	545	108	646	101	586	93
Australia	417	41	617	58	470	50
Greece	140	13	426	16	152	4
China	383	63	600	100	386	88
United Kingdom	304	44	559	65		

Source: calculations of the authors

Table 4 shows the number of countries by year and political regime as well as by sporting culture region.

A host dummy variable was used to capture the host country effect, that is, the observed surplus of medals usually won by the national team of the host country. One specific advantage for the host country comes from it being able to field a relatively large number of competing athletes. Table 5 illustrates that each country substantially boosted the size of its contingent when serving as host, only to reduce its size at the subsequent Olympics. We include a variable indicating whether the country served as the host for the previous games (last host variable).

In the past six Olympics between 36 and 58 per cent of the countries analysed have not won any medals. To provide a more detailed description, Figure 5 shows

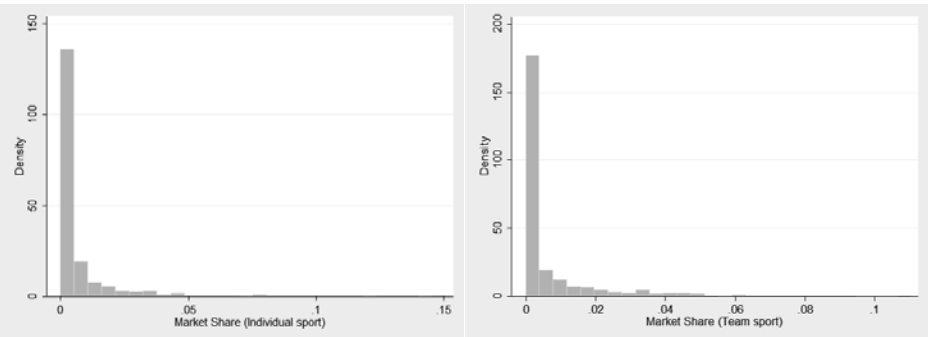

Figure 5. Market share (podium) of medals distribution

Source: calculations of the authors

frequency distributions by individual and team sports. The numbers highlight the significant concentration among zero-medal winners.

Modelling market shares using simple linear regression methods is problematic because distributions of market share show a large mass at zero, which is inconsistent with normality. Therefore, we fit random-effects Tobit models to the data. The Tobit model, also called a censored regression model, is designed to estimate linear relationships between variables when there is either left- or right-censoring in the dependent variable. Due to the panel data structure, we used a special form of the Tobit model with random effects to take into account unobserved heterogeneity, which was shown to be present in our data. The model summary includes ρ, which is the percentage contribution to the total variance of the panel-level variance based on the overall and panel-level variance components.

$$\rho = \frac{\sigma_v^2}{\sigma_\epsilon^2 + \sigma_v^2}$$

When ρ is zero, the panel-level variance component is unimportant, and the panel estimator is not different from the pooled estimator. A likelihood-ratio test of this is included in the regression results table. This test formally compares the pooled estimator (Tobit) with the panel estimator.

We define three types of model specifications. Based on the work of Andreff and Andreff (2010; 2015), Type I includes the lagged dependent variable, lagged population, lagged GDP per capita and further covariates (such as host country dummy, last host country dummy, year dummy, etc., depending on the actual model).

The first type of specification (Type I) is the following:

$$MS_{k,i,t}^* = c + \beta_1 MS_{k,i,t-4} + \beta_2 \ln N_{i,t-4} + \beta_3 \ln\left(\frac{GDP}{N}\right)_{i,t-4} + \sum_{j=1}^{p} \alpha_j O_j + u_j + \varepsilon_{i,t}$$

where $\varepsilon_{i,t} \sim N(0, \sigma^2_\varepsilon)$ and $u_i \sim N(0, \sigma^2_u)$

$MS_{k,i,t}$ observation is defined by $MS_{k,i,t} = \begin{cases} MS_{k,i,t}^* \text{ if } MS_{k,i,t}^* > 0 \\ 0 \text{ if } MS_{k,i,t}^* \leq 0 \end{cases}$

The dependent variable is each (i) nation's market share of medal wins in the Olympics t (k means individual or team sports): $MS_{k,i,t}$; $N_{i,t}$ is the population of country i in the Olympics t; $\left(\frac{GDP}{N}\right)_{i,t}$ is GDP per capita of country i in the Olympics t; O_j is one of the further explanatory variables (such as host country dummy, last host country dummy, year dummy, etc., depending on the actual model).

A number of country's athletes per number of total athletes is a possible key explanatory variable because Olympic participation is dependent on success in the pre-Olympic tournaments. Therefore, in Type II a new variable, the country's measured participation level (athlete share), is added to the models.

A second type of specification (*Type II*) is therefore:

$$MS^*_{k,i,t} = c + \beta_1 \ln N_{i,t-4} + \beta_2 \ln\left(\frac{GDP}{N}\right)_{i,t-4} + \\ +\beta_3 \ln\left(Athlete\ share\right)_{i,t} + \sum_{j=1}^{p} \alpha_j O_j + u_j + \varepsilon_{i,t}$$

where $\varepsilon_{i,t} \sim N(0,\sigma^2_\varepsilon)$ and $u_i \sim N(0,\sigma^2_u)$

$MS_{k,i,t}$ observation is defined by $MS_{k,i,t} = \begin{cases} MS^*_{k,i,t} \ if \ \ MS^*_{k,i,t} > 0 \\ 0 \ \ if \ \ MS^*_{k,i,t} \leq 0 \end{cases}$

A country's measured participation level is expected to be highly correlated with observable variables like the country's GDP per capita and population size. Therefore, we modified the model specification in such a way that these variables are eliminated from models in Type III, and a supplementary fixed-effects regression model with athlete share, as a dependent variable, and GDP per capita and population, as independent variables, are estimated.

A third type of specification (Type III) is therefore the following (Trivedi – Zimmer, 2014):

$$MS^*_{k,i,t} = c + \beta_1 MS_{k,i,t-4} + \beta_2 \ln\left(Athlete\ share\right)_{i,t-4} + \sum_{j=1}^{p} \alpha_j O_j + u_j + \varepsilon_{i,t}$$

where $\varepsilon_{i,t} \sim N(0,\sigma^2_\varepsilon)$ and $u_i \sim N(0,\sigma^2_u)$

$MS_{k,i,t}$ observation is defined by $MS_{k,i,t} = \begin{cases} MS^*_{k,i,t} \ if \ \ MS^*_{k,i,t} > 0 \\ 0 \ \ if \ \ MS^*_{k,i,t} \leq 0 \end{cases}$

The supplementary regression for the Type III specification:

$$\ln\left(Athlete\ share\right)_{i,t} = c + \beta_1 \ln\left(Athlete\ share\right)_{i,t-4} + \\ +\beta_2 \ln N_{i,t-4} + \beta_3 \ln\left(\frac{GDP}{N}\right)_{i,t-4} + \beta_4 \ln\left[\left(\frac{GDP}{N}\right)_{i,t-4}\right]^2 + u_j + \varepsilon_{i,t}$$

where $\varepsilon_{i,t} \sim N(0,\sigma^2_\varepsilon)$ and $u_i \sim N(0,\sigma^2_u)$

Table 6 gives an overview of three types of models.

Table 6. Specifications of models

	TypeI	**TypeII**	**TypeIII**
Dependent variable	Ln(Market Share)$_t$	Ln(Market Share)$_t$	Ln(Market Share)$_t$
Independent variables			
MODEL1			
	Ln(Market Share)$_{t-4}$		
	Ln(Population)$_{(t-4)}$	Ln(Population)$_{(t-4)}$	Ln(Population)$_{(t-4)}$
	Ln(Population)$_{(t-4)}$ square	Ln(Population)$_{(t-4)}$ square	Ln(Population)$_{(t-4)}$ square
	Ln (GDP per capita) $_{(t-4)}$	Ln (GDP per capita) $_{(t-4)}$ Ln(Athleteshare)$_t$	Ln (GDP per capita) $_{(t-4)}$
	Host	Host	Host
	LastHost	LastHost	LastHost
MODEL2	MODEL1 +	MODEL1 +	MODEL1 +
	Political regime	Political regime	Political regime
	Regions	Regions	Regions
	Years	Years	Years
MODEL3	MODEL2 +	MODEL2 +	MODEL2 +
	Ln(Youth Market Share)$_t$	Ln(Youth Market Share)$_t$	Ln(Youth Market Share)$_t$

Source: authors

4. RESULTS

With reference to Andreff and Andreff (2015), the Type I models include the lagged dependent variable, lagged population, lagged GDP per capita and further covariates (such as host country dummy, last host country dummy, year dummy, etc., depending on the actual model). Table 7 shows the results of Type I models by individual and team sports. In all of the models the coefficient of the lagged dependent variable is positive and significant at a 1% threshold; that is, past performance significantly determines the current outcome. The effect of GDP per capita and population size is not different for individual and team sports; both variables positively correlate with market share. In Model 1, the square is added for the population size variable in order to control for possible decreasing returns of population in terms of performance in the Olympics. In this case the population size variable is not statistically significant.

The host country effect is statistically significant and relevant, but the level of its coefficient for team sports is lower than for individual sports. Being the previous host country has a questionable effect on the market share of individual sports. In a short time period (2008-2012), year dummies did not have a significant effect. In the case of individual sports, all political regime categories have a statistically significant effect on market share. These effects are not detectable for team sports.

Since Western Europe is the reference, a significant coefficient with a positive (negative) sign means that a region performs relatively better (worse) than Western Europe in terms of medal wins. Asian countries and the Middle East perform worse, and Oceania performs better than Western Europe in both sport groups. Others are not different from Western Europe.

Table 7. Panel Tobit estimation of market share (podium) at the Olympics – Type I

Independent variables (std.err.)	Individual sports Model 1	Team sports Model 1	Individual sports Model 2	Team sports Model 2	Individual sports Model 3	Team sports Model 3
Log Market Share$_{(t-4)}$	0.1029*** (0.0280)	0.1736*** (0.0307)	0.1101*** (0.0285)	0.1769*** (0.0308)	0.8908*** (0.0359)	0.7635*** (0.0486)
Log population$_{(t-4)}$	–0.0148* (0.0078)	0.0009 (0.0082)	0.0072*** (0.0007)	0.0076*** (0.0007)	0.0009*** (0.0003)	0.0025*** (0.0005)
Log population$_{(t-4)}$square	0.0007*** (0.0002)	0.0002 (0.0003)				
Log GDP per capita$_{(t-4)}$	0.0047*** (0.0009)	0.0052*** (0.0009)	0.0062*** (0.0012)	0.0065*** (0.0013)	0.014*** (0.0005)	0.0027*** (0.0008)
Host	0.0271*** (0.0036)	0.0064** (0.0032)	0.0269*** (0.0036)	0.0059* (0.0032)	0.0351*** (0.0037)	0.0077 (0.0052)
LastHost	0.0056 (0.0037)	0.0083** (0.0032)	0.0068** (0.0028)	0.0081** (0.0032)	–0.0156*** (0.0038)	0.0104** (0.0052)
Youth Market Share$_t$					0.0452 (0.0346)	0.0286 (0.0391)
Political Regimes (ref. CAPME)						
COM			0.0247** (0.0117)	0.0242** (0.0105)	–0.0029 (0.0034)	–0.0005 (0.0049)
TRANS			0.0185*** (0.0045)	–0.0087* (0.0052)	0.0047*** (0.0014)	–0.0057** (0.0026)
CEEC			0.0153** (0.0068)	–0.0076 (0.0062)	0.0041** (0.020)	–0.0071** (0.0030)
NSCOM			0.01839** (0.0074)	0.0020 (0.0067)	0.0065** (0.0027)	–0.0036 (0.0039)
Regions (ref. WEU)						
AFN			–0.0057 (0.0063)	–0.0009 (0.0058)	0.0019 (0.0019)	0.0019 (0.0029)
AFS			0.0005 (0.0052)	0.0037 (0.0051)	0.0010 (0.0017)	0.0022 (0.0027)
NAM			0.0063 (0.0043)	0.0045 (0.0041)	0.0014 (0.0014)	0.0014 (0.0021)
LSA			–0.0028 (0.0040)	0.0013 (0.0040)	0.0011 (0.0013)	0.0007 (0.0020)

Table 7. continued

Independent variables (std.err.)	Individual sports Model 1	Team sports Model 1	Individual sports Model 2	Team sports Model 2	Individual sports Model 3	Team sports Model 3
ASI			–0.0097** (0.0042)	–0.0088** (0.0041)	0.00001 (0.0013)	0.0002 (0.0021)
EAST			–0.0078 (0.0063)	0.0071 (0.0059)	–0.0029 (0.0019)	0.0068** (0.0029)
MNE			–0.0086** (0.0044)	–0.0075* (0.0042)	–0.0013 (0.0014)	–0.0024 (0.0021)
OCE			0.0156** (0.0073)	0.0282*** (0.0066)	–0.0004 (0.0024)	0.0119*** (0.0035)
Year dummies (ref. 2004)						
1992			–0.0008 (0.0012)	–0.0006 (0.0012)		
1996			0.0020 (0.0012)	0.0012 (0.0011)		
2000			0.0014 (0.0012)	–0.0005 (0.0011)		
2008			–0.0001 (0.0012)	–0.0008 (0.0011)		
2012			–0.0014 (0.0012)	–0.0025** (0.0012)	–0.0002 (0.0006)	–0.0007 (0.0010)
Constant	0.0266 (0.0640)	–0.1052 (0.00676)	–0.1697*** (0.01953)	–0.1804*** (0.0194)	–0.0292*** (0.0082)	–0.0678*** (0.0127)
Rho	0.7190*** (0.0356)	0.7556*** (0.0357)	0.6472*** (0.0429)	0.6478*** (0.0466)	$8.05*10^{-32}$ $(8.37*10^{-17})$	$1.14*10^{-45}$ $(1.26*10^{-18})$
Number of observations	763	763	763	763	256	256
Left-censored observations	314 (41.15%)	370 (48.49)	314 (41.15%)	370 (48.49)	89 (34.77%)	109 (42.58%)
Log-likelihood value	1269.2747	1154.3458	1289.4138	1182.307	621.7292	486.099
LR Chi^2	150.81	112047***	191.09***	168.39***	344.79	219.085***
Correlation between observed and predicted values	76.0%	77.9%	83.8%	85.7%	98.0%	94.8%

Notes: *** Significant at 1% threshold; ** at 5%; * at 10%. Standard errors in parenthesis. Model 3: Reference year = 2008

Source: calculations of the authors

In Type II models the country's level of athletic participation is added to the models as an explanatory variable. In all of the models the athlete share variable has a positive and statistically significant coefficient. On the whole, the effect of other variables does not change significantly compared to Type I models, with the exception of youth market share and the host country variable. The youth market share coefficient is positive and significant at a 5% threshold. In the case of team sports, the host country effect cannot be detected.

Since a country's measured participation level is expected to be highly correlated with observable variables like the country's GDP per capita and population

Table 8. Panel Tobit estimation of market share (podium) at the Olympics – Type II

Independent variables (std.err.)	Individual sports Model 1	Team sports Model 1	Individual sports Model 2	Team sports Model 2	Individual sports Model 3	Team sports Model 3
Log population$_{(t-4)}$	–0.0214*** (0.0071)	–0.0032 (0.0086)	0.0054*** (0.0008)	0.0077*** (0.0009)	0.0025** (0.0010)	0.0071*** (0.0013)
Log population$_{(t-4)}$square	0.0008*** (0.0002)	0.0003 (0.0003)				
Log GDP per capita$_{(t-4)}$	0.0022*** (0.0008)	0.0046*** (0.0010)	0.0056*** (0.0013)	0.0068*** (0.0015)	0.0034** (0.0015)	0.0073*** (0.0021)
Host	0.0253*** (0.0029)	0.0046 (0.0031)	0.0257*** (0.0057)	0.0046 (0.0031)	0.0315*** (0.0040)	0.0068 (0.0057)
LastHost	0.0069** (0.0029)	0.0080*** (0.0031)	0.0068** (0.0028)	0.0078** (0.0031)	0.0016 (0.0039)	0.0123** (0.0056)
Log Athlete share$_t$	0.0069*** (0.0009)	0.0028*** (0.0009)	0.0054*** (0.0010)	0.0019* (0.010)	0.0045*** (0.0644)	0.0020 (0.0017)
Youth Market share$_t$					0.4900*** (0.0644)	0.1142** (0.0591)
Political Regimes (ref. CAPME)						
COM			0.0193 (0.0122)	0.0258** (0.0119)	0.0078 (0.0097)	0.0092 (0.0115)
TRANS			0.0162*** (0.0048)	–0.0100* (0.0060)	0.0091** (0.0044)	–0.0088 (0.0062)
CEEC			0.0072 (0.0070)	–0.0116* (0.0070)	0.0101* (0.0057)	–0.0124* (0.0068)
NSCOM			0.0193** (0.0077)	0.0049 (0.0076)	0.0274*** (0.0068)	–0.0014 (0.0082)
Regions (ref. WEU)						
AFN			0.0002 (0.0064)	0.0004 (0.0065)	0.0069 (0.0052)	0.0036 (0.0065)
AFS			0.0097* (0.0052)	0.0064 (0.0056)	0.0109** (0.0052)	0.0095 (0.0065)
NAM			0.0100** (0.0045)	0.0064 (0.0046)	0.0129*** (0.0037)	0.0089** (0.0045)
LSA			0.0010 (0.0042)	0.0029 (0.0044)	0.0041 (0.0035)	0.0063 (0.0043)
ASI			–0.0028 (0.0044)	–0.0077* (0.0046)	0.0048 (0.0037)	–0.0026 (0.0048)
EAST			–0.0018 (0.0065)	0.0100 (0.0066)	–0.0071 (0.0052)	–0.0022 (0.0050)
MNE			–0.0011 (0.0046)	–0.0054 (0.0048)	0.0028 (0.0039)	–0.0054 (0.0048)
OCE			0.0158** (0.0075)	0.0317*** (0.0074)	0.0112* (0.0068)	0.0378*** (0.0071
Year dumies (ref. 2004)						
1992			0.0010 (0.0011)	–0.00001 (0.0012)		
1996			0.0015 (0.0010)	0.0013 (0.0011)		
2000			0.0012 (0.0010)	-0.0003 (0.0011)		

Table 8. continued

Independent variables (std.err.)	Individual sports Model 1	Team sports Model 1	Individual sports Model 2	Team sports Model 2	Individual sports Model 3	Team sports Model 3
2008			–0.0001 (0.0010)	–0.0007 (0.0011)		
2012			–0.0015 (0.0010)	–0.0025** (0.0011)	–0.0008 (0.0006)	–0.0018** (0.0009)
Constant	0.1617*** (0.0594)	–0.0458 (0.0722)	–0.1082*** (0.0254)	–0.1736*** (0.0287)	–0.0520 (0.0320)	–0.1724*** (0.0446)
Rho	0.7764*** (0.0290)	0.8042*** (0.00283)	0.7687*** (0.0294)	0.7263*** (0.0364)	0.8670*** (0.0316)	0.7913*** (0.0506)
Number of observations	763	763	763	763	256	256
Left-censored observa-tions	315 (41.28%)	353 (46.26%)	315 (41.28%)	353 (46.26%)	89 (34.77%)	109 (42.58%)
Log-likelihood value	1382.6485	1162.0292	1392.0278	1187.8369	557.3933	445.212
LR Chi^2	227.81***	92.40***	246.56***	144.01***	216.12***	138.08***
Correlation between observed and predicted values	79.7%	72.0%	82.7%	81.8%	91.6%	86.4%

Notes: *** Significant at 1% threshold; ** at 5%; * at 10%. Standard errors in parenthesis. Model 3: Reference year = 2008

Source: calculations of the authors

Table 9. Fixed-effects (within) regression estimation of Log Athlete share

Independent variables	Value (std.err.)
Log Athlete share$_{(t-4)}$	0.0881*** (0.0177)
Log population$_{(t-4)}$	0.0224 (0.1180)
Log GDP per capita $_{(t-4)}$	1.6790*** (0.4727)
Log GDP per capita$_{(t-4)}$square	–0.0885*** (0.0265)
Rho	0.9108
Number of observations	725
R^2 within	0.0614
R^2 between	0.5375
R^2 overall	0.4902
Corr(u_i, Xb)	0.5641

Source: calculations of the authors

size, we modified the model specification: the GDP per capita and population size variables were eliminated from the models in Type III, and a supplementary fixed-effects regression model with athlete share, as a dependent variable, and GDP per capita and population size, as independent variables, was estimated. Table 9 shows the result of the fixed-effect regression estimation. In contrast to expectations, population size did not have a significant effect on participation levels. Squares are added for the GDP per capita variable [*GDP/cap*^{2}] in order to control for the possible decreasing returns of GDP per capita in terms of Olympics performance. GDP per capita has a positive effect on participation level, but this positive effect decreases the returns of GDP per capita.

In Type III models the host and last host country effects are similar as in previous model specifications. An interesting finding is that the lagged dependent

Table 10. Panel Tobit estimation of market share (podium) at the Olympics – Type III

Independent variables (std.err.)	Individual sports Model 1	Team sports Model 1	Individual sports Model 2	Team sports Model 2	Individual sports Model 3	Team sports Model 3
Log Market Share$_{(t-4)}$	0.0088 (0.0238)	0.1591*** (0.0296)	0.0049 (0.0243)	0.1568*** (0.0303)	0.8592*** (0.0353)	0.7944*** (0.0472)
Host	0.0242*** (0.0030)	0.0043 (0.0031)	0.0240*** (0.0030)	0.0037 (0.0031)	0.0342*** (0.0036)	0.0075 (0.0052)
Last Host	0.0065** (0.0030)	0.0082*** (0.0030)	0.0065** (0.0030)	0.0080*** (0.0031)	–0.0153*** (0.0037)	0.0104** (0.0052)
Log Athlete share$_t$	0.0090*** (0.0009)	0.0053*** (0.0009)	0.0093*** (0.0010)	0.0063*** (0.0010)	0.0024*** (0.0004)	0.0030*** (0.0006)
Youth Market Share$_t$					0.0435 (0.0339)	0.0428 (0.0387)
Political Regimes (ref. CAPME)						
COM			0.0085 (0.0117)	0.0080 (0.0091)	–0.0012 (0.0024)	–0.0043 (0.0035)
TRANS			0.0034 (0.0057)	–0.0179*** (0.0053)	0.0015 (0.0012)	–0.0104*** (0.0025)
CEEC			0.00001 (0.0057)	–0.0143** (0.0068)	0.0021 (0.0020)	–0.0091*** (0.0030)
NSCOM			0.0158 (0.0098)	0.0048 (0.0078)	0.0064** (0.0027)	–0.0046 (0.0040)
Regions (ref. WEU)						
AFN			–0.0017 (0.0081)	–0.0002 (0.0065)	0.0019 (0.0017)	0.0020 (0.0026)
AFS			–0.0004 (0.0081)	–0.0033 (0.0045)	0.0015 (0.0014)	0.0013 (0.0020)
NAM			0.0068 (0.0059)	0.0028 (0.0047)	0.0028* (0.0014)	0.0020 (0.0020)
LSA			–0.0037 (0.0051)	–0.0013 (0.0042)	0.0007 (0.0012)	0.0003 (0.0018)
ASI			0.0010 (0.0053)	–0.0012 (0.0043)	0.0019 (0.0012)	0.0038** (0.0018)

Table 10. continued

Independent variables (std.err.)	Individual sports Model 1	Team sports Model 1	Individual sports Model 2	Team sports Model 2	Individual sports Model 3	Team sports Model 3
EAST			–0.0017 (0.0077)	0.0049 (0.0062)	–0.0023 (0.0018)	0.0061** (0.0028)
MNE			0.0067 (0.0058)	–0.0039 (0.0048)	0.0009 (0.0014)	0.0009 (0.0022)
OCE			0.0071 (0.0099)	0.0172** (0.0077)	–0.0012 (0.0024)	0.0083** (0.0033)
Year dummies (ref. 2004)						
1992			–0.0008 (0.0010)	–0.0025** (0.0011)		
1996			0.0003 (0.0010)	–0.0001 (0.0011)		
2000			0.0004 (0.0010)	–0.0014 (0.0011)		
2008			0.0007 (0.0010)	0.0004 (0.0010)		
2012			0.0004 (0.0010)	–0.0002 (0.0010)	–0.00001 (0.0006)	–0.0004 (0.0009)
Constant	0.0537*** (0.0054)	0.0289*** (0.0050)	0.0534*** (0.0060)	0.0379*** (0.0053)	0.0111*** (0.0024)	0.0147*** (0.0035)
Rho	0.8666*** (0.0216)	0.8159*** (0.0317)	0.8557*** (0.0238)	0.7995*** (0.0412)	3.85*10–32 (5.55*10–17)	6.61*10–33 (2.88*10–17)
Number of observations	765	765	765	765	262	262
Left-censored observations	307 (40.13%)	367 (47.97%)	307 (40.13%)	367 (47.97%)	93 (35.50%)	113 (43.13%)
Log-likelihood value	1367.3524	1173.4372	1373.0104	1191.8175	638.9411	488.230
LR Chi^2	174.10***	69.07***	185.41***	105.83***	368.38***	213.71***
Correlation between observed and predicted values	75.2%	83.2%	77.7%	82.2%	98.1%	94.8%

Notes: *** Significant at 1% threshold; ** at 5%; * at 10%. Standard errors in parenthesis. Model 3: Reference year = 2008

Source: calculations of the authors

variable did not have a significant effect in the case of individual sports (with the exception of Model 3). The athlete share's coefficient is positive and significant at a 1% threshold.

If participation level is added and GDP per capita and population size are eliminated from the models, the coefficients of the political regime and sporting culture region variables are not significant in comparison to their reference categories (expect for one or two cases in Team sports Model 2).

5. KEY FINDINGS AND CONCLUSIONS

The literature about the economic determinants of medal winnings at Olympic Games is broad. Although this article followed the same methodology which can be found in significant previous studies, a different, innovative approach was applied; namely, sports were divided into individual and team sports. We estimated separate models for these two segments, and new explanatory variables were included in the models, such as athlete share or youth market share. In order for team sports to be included in the model, we had to widen it to include the events and medals won at world championships and continental championships, in addition to those from the Summer and Winter Olympic Games.

The results show that in the case of individual and team sports, there are no significant differences in the effects of the tested explanatory variables, with the exception of the host country variable, whose effect is detected only in the case of individual sports. In the investigated period the political regime variable has an uncertain effect, but applies in the case of individual sports. This result confirms the findings of Bernard-Busse (2004) in that the effect of the political regime is no longer important in determining country medal counts. Finally, the sporting culture variable shows differences between some regions, but is not significant (OCE has always shown a positive effect compared to Western Europe).

The earlier market share of a country determines its current sporting results, unless the model of individual sports includes the athlete share variables, which refer to the number of a country's athletes per number of total athletes. Athlete share has a significant effect, but has a strong correlation to GDP, which means that the application of these two variables in the same model is not recommended. However, the positive effect of youth market share is only detected if the athlete share variables are involved in the models.

Overall, we can conclude that GDP, population and host/last host country effect is stable for any model specification, but the effect of political regime, region and youth market share is uncertain.

The main result of this analysis is that macro factors have a similar effect on international sporting success in the case of both individual and team sports, although we assumed that even some difference between individual and team sports should emerge with regard to macro factors as team sports are mostly highly commercialised and, in that respect, their sport development is quite different from publicly-funded elite sport systems (De Bosscher et al. 2015: 51). On the other hand, many individual sports are showing explosive growth in terms of the amount of commercial resources flowing into them.

The influence of the economic factors which were included in our models shows a decreasing effect on the market share of nations (De Bosscher et al. 2015: 105), which means that other factors must also play a significant role in a nation's international sporting success. The responsibility of national sport governance will be increasing in elite sport success in the future, which shows that the efficient utilisation of recourses will become a key factor, along with an appropriate structure, organisation and integrated coordination.

This tells us that in terms of understanding why a huge gap has emerged between successful elite sports and popular but underperforming spectacular team sports, further, deeper investigations are required.

REFERENCES

Andreff, M. – Andreff, W. (2010): Economic Modeling and Prediction of Summer Olympic Medal Wins and FIFA World Cup Semi-finalists. *IASE Working Paper Series* No. 10-08.

Andreff, M. – Andreff, W. (2015): Economic Prediction of Sport Performances from the Beijing Olympics to the 2010 FIFA World Cup in South Africa: The Notion of Surprising Sporting Outcomes. In: Rodriguez, P. – Késenne, S. – Koning, R. (ed.): *The Economics of Competitive Sports.* Edward Elgar: Cheltenham, pp. 185-215.

Andreff, W. (2004): Would a Second Transition Stage Prolong the Initial Period of Post-socialist Economic Transformation into Market Capitalism? *European Journal of Comparative Economics* 1 (1), 7-31.

Andreff, W. (2013): Economic Development as Major Determinant of Olympic Medal Wins: Predicting Performances of Russian and Chinese Teams at Sochi Games. *International Journal of Economic Policy in Emerging Economies* 6(4): 314-340.

Bernard, A. B. (2008): Going for the Gold: Who will Win the 2008 Olympic Games in Beijing? http://faculty.tuck.dartmouth.edu/images/uploads/faculty/andrew-bernard/Beijing2008.pdf, accessed 4 July 2017.

Bernard, A. B. – Busse, M. R. (2004): Who Wins the Olympic Games: Economic Resources and Medal Totals. *Review of Economics and Statistics* 86(1): 413-417.

De Bosscher, V. – Bingham, J. – Shibli, S. – van Bottenburg, M., – De Knop, P. (2008): *A Global Sporting Arms Race: An International Comparative Study on Sports Policy Factors Leading to International Sporting Success*. Aachen: Meyer & Meyer.

De Bosscher, V. – Shibli, S. – Westerbeek, H. – van Bottenburg, M. (2015): *Successful Elite Sport Policies. An International Comparison of the Sport Policy Factors Leading to International Sporting Success (SPLISS 2.0) in 15 nations.* UK: Meyer & Meyer Sports.

Dénes, F. (2015): *Sportközgazdaságtan [Economics of Sport]*. Debrecen: Campus Kiadó.

Forrest, D. – McHale, I. G. – Sanz, I. – Tena, J. D. (2015): Determinants of National Medals Totals at the Summer Olympic Games: An Analysis Disaggregated by Sport. In: Rodriguez, P. – Késenne, S. – Koning, R. (eds): *The Economics of Competitive Sports.* Edward Elgar: Cheltenham, pp. 185-215.

Houlihan, B. – Zheng, J. (2013): The Olympics and Elite Sport Policy: Where Will It All End? *International Journal of the History of Sport* 30 (4): 338-355.

Johnson, D. – Ali, A. (2004): A Tale of Two Seasons: Participation and Medal Counts at the Summer and Winter Olympic Games. *Social Science Quarterly* 85(4): 974-993.

Johnson, D. – Ali, A. (2008): Predictions for Medal Counts at Beijing Olympics, based on Economic Model. http://faculty1.coloradocollege.edu/~djohnson/Olympics/Beijing2008predictions.pdf, accessed 4 July 2017.

SIRC (2002): *European Sporting Success. A Study of the Development of Medal Winning Elites in Five European Countries. Final Report*. Sheffield: Sport Industry Research Centre.

Symanszki, S. (2003): The Economic Design of Sporting Contests. *Journal of Economic Literature* 41(4): 1137-1187.

Tha, M. (2004): The Color of Medals: An Economic Analysis of the Eastern and Western Blocs' Performance in the Olympics. *Journal of Sports Economics* 5(4): 311-328.

Trivedi, P. K. – Zimmer, D. M. (2014): Success at the Summer Olympics: How Much do Economic Factors Explain? *Econometrics* 2(4): 169-202.