Cogent Social Sciences

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/oass20

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To cite this article: Jozef Kučera, Emília Zimková, Juraj Nemec & Miroslav Nemec (2023) A comparative analysis of the efficiency of public funding policies for sports in the European Union, Cogent Social Sciences, 9:2, 2280335, DOI: 10.1080/23311886.2023.2280335

To link to this article: https://doi.org/10.1080/23311886.2023.2280335

Published online: 20 Nov 2023.

Kučera et al., *Cogent Social Sciences* (2023), 9: 2280335
https://doi.org/10.1080/23311886.2023.2280335

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SPORT | RESEARCH ARTICLE

A comparative analysis of the efficiency of public funding policies for sports in the European Union

Jozef Kučera[1]*, Emília Zimková[1], Juraj Nemec[2] and Miroslav Nemec[3]

Received: 30 August 2023
Accepted: 03 November 2023

*Corresponding author: Jozef Kučera, Faculty of Economics, Matej Bel University, Banská Bystrica, Slovak Republic
E-mail: jkucera2@student.umb.sk

Reviewing editor:
Mike Rayner, University of Portsmouth, United Kingdom

Additional information is available at the end of the article

Abstract: This study examines the technical efficiency of sports funding policies in the European Union countries. It aims to identify the efficiency of European countries in achieving two public policy objectives for sports: supporting the population's sporting activities and promoting sports representation, which is expressed by international sporting success. Additionally, the study aims to identify any statistical outliers within this group. Data envelopment analysis was chosen as the main method. The results indicate that most European Union countries are inefficient, and no statistical outliers were identified among the group of efficient countries. This study has the potential to support public policy decision-making related to funding sports.

Subjects: Political Economy; Economics; Finance; Sport and Exercise Science; Sport and Leisure Management

Keywords: comparative analysis; data envelopment analysis; cluster analysis; public funding; sports; efficiency

Jozef Kučera

ABOUT THE AUTHORS

Jozef Kučera is PhD. student in the field of Finance, who is focusing in his research on the topics of sport industry, financing sport from public sources, innovation policies and business environment in EÚ countries. Mr Kučera is also a senior policy counsellor in The Chief Sports Auditor dep. of The Ministry of Education, Science, Research and Sport of The Slovak Republic.
Emília Zimková is Professor in Finance at the Faculty of Economics Matej Bel University in Banska Bystrica, Slovakia. She devotes herself to the issues of central banking, macroeconomic performance and in recent years also to the efficiency and productivity measurement.
Juraj Nemec is Professor of Public Finance and Public Management at the Faculty of Economics and Administration, Masaryk University in Brno, Czech Republic and at the Faculty of Economics, Matej Bel University Banska Bystrica, Slovakia. He served and serves in different positions in international organisations in the public administration area.
Miroslav Nemec is Associate Professor of Sports Sciences at the Faculty of Arts of the Matej Bel University in Banska Bystrica, Slovakia.

PUBLIC INTEREST STATEMENT

This study examines the technical efficiency of sports funding policies in the European Union countries. It aims to identify the efficiency of European countries in achieving two public policy objectives for sports: supporting the population's sporting activities and promoting sports representation, which is expressed by international sporting success. Data envelopment analysis with various radial and non-radial models was chosen as the main tool for efficiency identification. The results are partly unique, as an analysis covering all European Union member countries has not been conducted previously. The most technically efficient financial systems operating under constant returns to scale are those of Latvia, Luxembourg, Malta, and Slovenia. The most technically efficient financial systems operating under variable returns to scale are technically efficient units under constant returns to scale plus Denmark, Germany, Estonia, Hungary, Netherlands, Slovenia, Slovakia, and Finland. Portugal has the least efficient public funding for sports, followed by Spain and Greece.

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1. Introduction

Financing (co-financing) sports using public funds is typical for all developed (and most developing) countries and is connected not only to the allocative function of public finances but also partly to the redistributive function of public finances (Stiglitz, 1989). In sports, market failure is indicated by the ratio of the volume of public and private financial resources allocated to mainly financing organized and professional sports. Without public funds, the functioning of organized sports would hardly be possible. Governments allocate large sums of public resources to sports, appreciating the various positive externalities resulting from sports activities, such as better health in the case of mass sports or promoting a country's reputation through winners at the Olympic Games (Howard & Crompton, 2018).

Downward et al. (2009) concluded that externalities are the basic starting points for public sports policymaking. From a societal viewpoint, the positive externalities of mass sports are connected, particularly with the fact that people who exercise and play sports reduce public spending on healthcare and improve the overall health of the population. Orviská et al. (2014) regarded a good health profile as an important part of a country's overall well-being. Rosenthal and Wolfson (2013), Bouckaert et al. (2008), and Johnson et al. (2021) also highlighted the political affiliation of policymakers, which influences their support for welfare activities. Specifically, Morgan et al. (2019) highlighted social inclusion as an important element of sports, which is another positive externality.

According to the European Commission's physical activity guidelines (*Recommended Policy Actions in Support of Health-Enhancing Physical Activity, 2008*), regular physical activity significantly reduces the risk of cardiovascular disease, cancer, stress, and other ailments (European Commission, 2008). In addition to the positive effects of sports and exercise on the population's health, healthcare savings are also significant. Otarbaevich and Dlimbetovich (2021) noted that the beneficial effect of 30 minutes of physical activity improved not only a person's physical health but also their mental health and consequently, the well-being of society as a whole.

However, there may be negative externalities associated with sports, such as the construction of sports infrastructure, and hosting of competitions in protected natural areas. Hou and Liu (2020) also noted the possible negative environmental impact of organizing sporting events. Montolio and Planells-Strusse (2019) cited football hooliganism and crimes committed by club ultras as another significant negative externality arising from passive engagement in sports.

One of the main tasks in financing sports using public funds is to spend these funds efficiently. Achieving this requires that public resources be allocated transparently in accordance with public interest. There are still limited studies connected to this topic, and the aim of this study is to contribute additional comparative knowledge about the technical efficiency of public grants for sports in the European Union.

This study aims to identify the technical efficiency of public funding policies for sports in European Union countries in fulfilling two selected public policy objectives: supporting the public's sporting activities and promoting sports representation. Moreover, this study aims to benchmark (rank and compare) efficient sports funding policies using public funds across European Union countries to identify potential outliers.

The related research questions are as follows:

(1) How efficient is the public funding of sports in European Union countries in supporting the public's sporting activities and promoting sports representation?

(2) Are there any statistical outliers that can be identified in the case of efficient public funding of sports in European Union countries?

Most authors (f. e. Škoric & Hodak, 2011) are using regression models for efficiency identification between inputs and outputs on the national level which does not provide a comprehensive answer for inputs reduction or are also using same method for efficiency identification as this study but only on the national level—between sports federations with limited variety of efficiency models used (f. e. Murat et al., 2023) and between only sports clubs (f. e. Guzmán-Raja & Guzmán-Raja, 2021).

Taken this into the account, the specific value added of this study is the use of various efficiency models (radial and also non-radial) of the data envelopment analysis (DEA), a linear programming-based method for assessing the efficiency of operating units, which can also be used as a suitable tool for measuring the technical efficiency of the use of public resources in sports. In addition to identifying the technical efficiency of individual systems, the specific benefit of using this method is the fact that this method may serve to design specific input optimization measures, based on its results.

Employing available sports data from European Union countries, sports databases of The International Olympic Committee, and strategic public policy publications in the field of sports, it was possible to construct sets of main inputs and outputs representing the essential components for the efficiency analysis. This study is the first one that is focusing on the efficiency of all public funding systems of sports in the European Union by using the variety of the DEA efficiency models and especially the slack based models (SBM) by Tone (2001) which has not been applied yet in the field of sports.

2. Efficiency of public grants to sport and its measurement

The need for using public funds to finance sports can be justified based on the theory provided by the academic literature and within the framework of national or international sports policies. Regarding the international sport policies, the main strategy outlined in the European Union's White Paper on Sport (2007) suggests the following public policy objectives: promoting healthy lifestyles, supporting grassroots sports development, promoting social inclusion and the development of volunteering, preventing negative phenomena in sports (for example, match fixing or doping), and supporting professional sports and the representation of countries in sports. Another strategic document of The EOC EU Office (representation of the European Olympic Committees to the European institutions)—Guide to EU Sport Policy (2017) is reflecting the White Paper on Sport goals for public policies while highlighting the specific areas of social inclusion such as gender equality. Some of the acts covering the sports topic in The European Union countries reflected those sports policies—f. e. the Act No. 440/2015 Coll. on Sport (adopted by the Slovak Republic in 2015) aims to contribute to the development of positive externalities of sport—representation and promotion of the country, development of physical competencies, supporting healthy lifestyle and well-being of the population.

There exist many studies, identifying the value of sport from a public policy and public economics perspective. Brookes and Wiggan (2009) pointed out the need to consider sports funding as financing for the "higher good". Parnell et al. (2019) argued that public funds are an important tool for promoting social inclusion, facilitating the public's leisure activities, and improving their quality of life. Brown et al. (2016) made similar arguments, indicating that using public sources allocated by state administrative bodies could serve as a way to finance sports and sports organizations. In their study on financing major sporting events, Groothuis and Rotthoff (2016) analyzed public opinion, which is in line with that of many economists, in that public funding of big sport events (f. e. Olympic Games) is inappropriate, particularly because it generates neither positive economic benefits nor positive impressions of the organizing entity. Misener and Schulenkorf (2015) in their study on the social value of sport events identified a need for deeper involvement of the local communities in all of the organizational stages of the sports events. Pil Lee et al. (2013) used a variety of models and tools for measuring the social impact of sport and identified a high positive effect of the frequency exposure to community-oriented sports on the social capital, collective identities, and health literacy.

In addition to the arguments for co-financing sports with public funds, researchers have also highlighted that financing sports in this manner may lead to problems associated with certain aspects of the public choice theory (see Mueller, 2012 or Johnson et al., 2021). Sam (2009) identified the dependence of sports organizations on state subsidies, and thus public funds, as a main problem in sports development, particularly because of its high reliance on the will of currently powerful politicians.

Wilson (2011) distinguished two main types of sports organizations from the viewpoint of entities that receive state support: profit-generating organizations, such as professional sports clubs, and organizations that focus primarily on providing services to their members. Sports associations provide members, who may be natural or legal persons, with services and expertise in organizing national and international competitions and ensuring participation in these events. Lowther et al. (2016) also considered national sports associations as entities that fulfill the tasks of strategic management and sports administration, demonstrating a top-down sports management structure.

Nemec et al. (2014) distinguished among the three levels of public funding by which sports are financed: the state budget level, budgets of higher territorial units, and budgets of cities and municipalities. Andreff and Szymanski (2006) characterized the satellite account as a set of national statistical reporting techniques covering specific areas. Some of the first satellite accounts for sports originated in France and Germany. Therefore, sports satellite accounts represent a standardized approach in compiling and subsequently evaluating selected indicators for measuring the impact of sports on the economy, specifically the proportions of sports within the gross domestic product, employment, and total expenditure. Shoji et al. (2018) understood satellite accounts as measuring a defined set of sports goods and services that should reflect the specifics of national economies.

2.1 Measuring efficiency of public grants to sports

There are a relatively limited number of studies with a direct focus on the efficiency of public sports funding. Andreff and Szymanski (2006), Downward et al. (2019), Wilson (2011) and King (2009) offered a basic insight into the issue of public sports funding and its connection with public policy creation. Andreff (2009) also highlighted the importance of the effective use of public funds during crises. De Carlos et al. (2017) focused on the effective use of all financial sources within the Spanish federations representing Olympic sports, while Kasale et al. (2018) adopted a holistic approach to measure the performance (and thus the effectiveness) of selected national sports federations. De Bosscher et al. (2019) were focusing on the prioritization of funding in elite sport across the 16 countries with conclusion that the level of prioritization depends on the level of available funds (bigger countries prioritize less).

Lowther et al. (2016) presented a framework and possible tools that could be adopted by national sports federations in the EU, which could possibly improve the effectiveness of the public funds used. Škoric and Hodak (2011) focused on the complex approach of measuring the efficiency of the sports public funding system in Croatia. Groothuis and Rotthoff (2016) and Ivaškovič and Čater (2018) partially focused on sports clubs' performance and their assets. Winand et al. (2012) developed the tool for financial management of sports federations which is based on ratios—f. e. between the structure of public and private funds.

The issue of mechanisms for allocation public resources in sport was addressed by several authors—e.g. (Andreff, 2009; De Carlos et al., 2017; Downward et al., 2019; Groothuis & Rotthoff, 2016; Kasale et al., 2018; King, 2009; Lowther et al., 2016; Mitchell et al., 2012; Škoric & Hodak, 2011). The issue was also addressed by Czech and Slovak authors such as (Nemec et al., 2014; Pavlík & De Vries, 2013) and (Novotný et al., 2011). The main issues of allocation of public resources identified by the authors may be summarized as follows: i) identification and appreciation of the value of sport for the public, ii) efficiency of the use of public funds in sport, iii) fair and transparent distribution of public funds based on achieved results in sport and iv) high dependence of sports organisations on public funds.

Some studies have applied the DEA in sports research. For example, Ren and Liu (2021) applied a three-stage DEA model to evaluate the efficiency of China's public sports services. Murat et al. (2023) used a DEA-based Malmquist productivity index to evaluate Turkish sports federations. DEA techniques in the field of sports have also been employed by Niu and Zhang (2021) on the example of universities´ sports facilities with the identification of significant differences in the effectivity, Guzmán-Raja and Guzmán-Raja (2021) identified relatively acceptable performance levels of all clubs, Miragaia et al. (2016), and Meza et al. (2015) were comparing the results of different DEA models used for evaluation of the Olympic federations.

Bhat et al. (2019) further reviewed various articles about DEA use in sports. However, the different DEA models and approaches have not been fully used in interstate comparisons of sports funding systems, and we also did not indicate the use of SBM DEA models.

3. Methodology

To answer the first research question (efficiency of funding), we employ non-parametric radial-oriented DEA models by Charnes et al. (1978) and Banker et al. (1984), and a non-radial-oriented slack-based measure by Tone (2001), applied under constant and variable returns to scale. In our optimization procedure, the decision-making unit (DMU) is the public funding policy for sports activities in individual EU countries. Non-radial DEA models (in contrary to radial DEA models known as CCR and BCC DEA models) allow to optimize both side of the model, inputs and outputs at the same time. The outcome reveals the level of inefficiency of inputs and outputs, an information about economy of scale (increasing, decreasing, non-increasing, non-decreasing) of analyzed decision-making units (DMUs), and individual benchmarks of DMUs. The cluster analysis is used to group countries with similarities. We employ public spending on sports (2011–2020 data; total sum) and the population count of EU countries (2022 data, as this figure is almost stabile) as inputs, while the percentage of the population engaged in sports (measured and published in 2022 by Eurobarometer 525 Sport and physical activity) and Olympic medal count (2012–2022; total sum) represent the outputs of our analysis (Table 1). The fact that for the engagement in sports the input and output data do not cover identical periods should not be a problem, as the conversion of inputs into outputs in real life does not occur at the same time.

To answer the second research question (identification of outliers), we use an innovative super-efficient slack-based measure by Tone (2002). What is now called super-efficiency in scientific papers was first suggested as a means of differentiating among frontier units. In many applications, several decision units are ranked as fully efficient, and it may be interesting to consider ways of ranking them (Bogetoft & Lars, 2011). The optimal performance of DMUs (funding systems) is in ordinary DEA models indicated by an efficiency score of one. As there is always more than one DMU with this efficiency score, by super efficiency we compare efficient units to rank them and identify statistical outliers (for example, the super-efficiency score more than 3.5 would be considered as statistical outlier e.g., the DMU with such score is incomparable to other DMUs). The idea of super-efficiency was proved crucial to regulation and contracting applications of DEA.

The data for the comparative analysis were obtained mainly from the secondary empirical data in the EUROSTAT datasets (general government expenditures for sports available between 2011 and 2020 and latest population statistics in the EU, valid as of 31 December 2022). Additionally, we obtained data from the Eurobarometer 525 sport and physical activity statistical databases—data

Table 1. Selected indicators for DEA analysis

Countries	Inputs		Outputs	
	Government expenditures in mil. EUR (I)	Population (P)	% of the populations´ sports participation (PA)	Medals won at Olympic Games (M)
Belgium	16857.4	11631136	64	11.14
Bulgaria	1104.2	6838937	33	6.65
Czechia	7645.1	10516707	58	28.1
Denmark	10972.3	5873420	79	18.62
Germany	79238	83237124	62	126.63
Estonia	1059.5	1331796	64	2.82
Ireland	2974.3	5060005	49	6.48
Greece	6093	10603810	31	7.65
Spain	44271	47432805	38	32.1
France	125604	67842582	53	90.49
Croatia	1970.3	3879074	48	16.98
Italy	42869	58983122	33	71.14
Cyprus	656.9	904705	39	0.5
Latvia	691.5	1875757	65	5.81
Lithuania	826.9	2805998	61	4.98
Luxembourg	2602.4	645397	68	0.01
Hungary	9586.4	9689010	50	37.27
Malta	164.9	520971	26	0.01
Netherlands	38141	17590672	88	84.68
Austria	9816.6	8978929	59	33.43
Poland	18936.5	37654247	39	25.93
Portugal	5992.9	10352042	17	0.83
Romania	5032.5	19038098	27	9.99
Slovenia	1262.5	2107180	62	17.63
Slovakia	1434.4	5434712	67	11.15
Finland	11039	5548241	81	12.29
Sweden	25031.5	10452326	78	45.94

Source: compiled based on the Eurobarometer 525 sport and physical activity statistical databases, EUROSTAT datasets—general government expenditures for sports and population statistics in the EU and International Olympic Committee statistics—available at: https://olympics.com/en/olympic-games/olympic-results

pertaining to sporting activity within the EU population between 2018 and 2022, and data in the International Olympic Committee registers of medals awarded to individual countries in the winter and summer Olympic Games held during 2012–2022.

Since 2012, data regarding the sporting activity of countries have been periodically gathered and published through Eurobarometer surveys focusing on this topic; therefore, data on countries' sports participation are obtained from the Eurobarometer 525 sport and physical activity survey. The second output is the number of Olympic medals won from the 2012 Olympic Games held in London to the 2022 Olympic Games held in Beijing. This includes both summer and winter games.

The resulting indicator for the number of medals awarded is a composite indicator, in which each individual medal award is allocated a unique value. The value of the gold medal is 1, that of the silver medal is 0.5, and that of the bronze medal is 0.33. The authors estimated the average value of medals on the basis of prize money rewards for athletes, based on existing public data. Owing to computational constraints of the DEA Solver, a value of 0.01 was assigned to countries that did not win any medals during the study's timeframe.

3.1. Detailed methodology

Before performing the DEA, we identify the basic statistical features of the data. An important part of the statistical overview is the cluster analysis based on Ward's procedure (Rabušic et al., 2019). This is a variance method that generates clusters that minimize the within-cluster variances. The means of the variables are computed for each cluster. Next, the squared Euclidean distance from the cluster means is calculated for each object. These distances were summed for all objects.

In our DEA, based on Thanassoulis (2001) and Zimková (2016), we consider a set of homogenous production units $DMU_1, DMU_2, \ldots, DMU_n$. Let a random production unit $DMU_o, o = 1, \ldots n$ produced from m inputs represented by vector $\vec{x}_o$ together with s outputs represented by vector $\vec{y}_o$. We assume that X_{mxn} is a representative matrix of all m inputs of n production units, and $\mathbf{Y}_{mxn}$ is a representative matrix of all their s outputs. For a given decision-making problem, there exists a production possibility set (PPS), that, for a given technology of production, comprises the permissible combinations of all inputs and outputs. Assuming constant returns to scale, the PPS has the following form:

$$PPS_{CRTS} = \left\{(\vec{x}, \vec{y}) | \vec{x} \geq X\vec{\lambda}, \vec{y} \leq \mathbf{Y}\vec{\lambda}, \vec{\lambda} \geq \vec{0}\right\}, \quad (1)$$

Assuming variable returns to scale:

$$PPS_{VRTS} = \left\{(\vec{x}, \vec{y}) | \vec{x} \geq X\vec{\lambda}, \vec{y} \leq \mathbf{Y}\vec{\lambda}, \vec{\lambda} \geq \vec{0}, \vec{e'}\vec{\lambda} = 1\right\}, \quad (2)$$

where $\vec{e'}$ denotes the corresponding unit vector in the form of $\vec{e'} = (1, \ldots, 1)^{'}$, and $\vec{\lambda}$ represents the corresponding vector of weights in the form of $\vec{\lambda} = (\lambda_1, \ldots, \lambda_n)^{'}$. Technically, the most efficient DMUs determine the efficient frontier, also referred to as the production possibility frontier (PPF). A mathematical programming problem is solved for each $DMU_o, o = 1, \ldots, n$, while searching for such a combination of inputs and outputs, to maintain the DMU_o within the PPS and ensure technical efficiency.

In analyzing the fulfillment efficiency of selected objectives of public sports policies by individual European Union countries, we employed both radial and non-radial DEA models to benchmark the efficient use of public fund volumes provided for the funding of sports, considering individual countries' populations. We focused on input-oriented models.

For a radial model operating under constant returns to scale, we used the input-oriented Charnes, Cooper, and Rhodes model (CCR-I model) (Charnes et al., 1978). The result of the first phase of the optimization problem is the rate of technical efficiency θ^*_{CCR}, or θ^*_{BCC}, which produces values from the interval $(0, 1]$. A value of one represents the overall Farrell's efficiency of inputs, using the CCR-I model.

Assuming that we have an optimization problem, the first phase of the CCR-I model takes the following form:

$$\min_{\theta, \vec{\lambda}} = \theta_o \quad (3)$$

under conditions:

$$\theta\vec{x}_o \geq X\vec{\lambda} \tag{4}$$

$$Y\vec{\lambda} \geq \vec{y}_o \tag{5}$$

$$\vec{\lambda} \geq \vec{0}_{nx1} \tag{6}$$

The second phase of the optimization takes the following form:

$$\max_{\vec{\lambda},\vec{s}^-,\vec{s}^+} = \vec{e'}\vec{s}^- + \vec{e'}\vec{s}^+ \tag{7}$$

under conditions:

$$\vec{s}^- = \vec{x}_o - \sum_{i=1}^{n} \lambda_i \vec{x}_i \geq \vec{0}_{mx1} \tag{8}$$

$$\vec{s}^+ = \sum_{i=1}^{n} \lambda_i \vec{y}_i - \vec{y}_o \geq \vec{0}_{sx1} \tag{9}$$

For a radial model operating under variable returns to scale, we use the input-oriented Banker, Charnes, and Cooper model (BCC-I model) (Banker et al., 1984). The first phase of the optimization problem takes the following form:

$$\min_{\theta,\vec{\lambda}} = \theta_o \tag{10}$$

under conditions:

$$\theta\vec{x}_o \geq X\vec{\lambda} \tag{11}$$

$$Y\vec{\lambda} \geq \vec{y}_o \tag{12}$$

The second phase of the optimization takes the following form:

$$\max_{\vec{\lambda},\vec{s}^-,\vec{s}^+} = \vec{e'}\vec{s}^- + \vec{e'}\vec{s}^+ \tag{13}$$

under conditions:

$$\vec{s}^- = \vec{x}_o - \sum_{i=1}^{n} \lambda_i \vec{x}_i \geq \vec{0}_{mx1} \tag{14}$$

$$\vec{s}^+ = \sum_{i=1}^{n} \lambda_i \vec{y}_i - \vec{y}_o \geq \vec{0}_{sx1} \tag{15}$$

For a non-radial model, we use the slack-based measure (SBM) and the super-efficient slack-based measure (super-efficient SBM) of Tone (2001, 2002). We consider both constant and variable returns to scale versions of the non-radial SBM models.

The input-oriented non-radial SBM model under constant returns to scale (SBM-I-C model) takes the following form:

$$\min_{\vec{\lambda},\vec{s}^-} \rho_o = 1 - \frac{1}{m} \sum_{i=1}^{m} \frac{s_i^-}{x_{io}} \tag{16}$$

$$\max_{\vec{\lambda},\vec{s}^-,\vec{s}^+} = \vec{e'}\vec{s}^- + \vec{e'}\vec{s}^+ \tag{17}$$

under the conditions:

$$\vec{s}^- = \vec{x}_o - \sum_{i=1}^{n} \lambda_i \vec{x}_i \geq \vec{0}_{mx1} \quad (18)$$

$$\vec{s}^+ = \sum_{i=1}^{n} \lambda_i \vec{y}_i - \vec{y}_o \geq \vec{0}_{sx1} \quad (19)$$

The input-oriented non-radial Super-SBM model under constant returns to scale (Super-SBM-I-C model) takes the following form:

$$\min_{\vec{\lambda},\vec{s}^-} \rho_o = 1 - \frac{1}{m} \sum_{i=1}^{m} \frac{s_i^-}{x_{io}} \quad (20)$$

under the conditions:

$$\vec{s}^- = \vec{x}_o - \sum_{i=1, i \neq o}^{n} \lambda_i \vec{x}_i \geq \vec{0}_{mx1} \quad (21)$$

$$\vec{s}^+ = \sum_{i=1}^{n} \lambda_i \vec{y}_i - \vec{y}_o \geq \vec{0}_{sx1} \quad (22)$$

The input-oriented non-radial SBM model under variable returns to scale (SBM-I—V model) takes the following form:

$$\min_{\vec{\lambda},\vec{s}^-} \rho_o = 1 - \frac{1}{m} \sum_{i=1}^{m} \frac{s_i^-}{x_{io}} \quad (23)$$

under the conditions:

$$\vec{s}^- = \vec{x}_o - \sum_{i=1}^{n} \lambda_i \vec{x}_i \geq \vec{0}_{mx1} \quad (24)$$

$$\vec{s}^+ = \sum_{i=1}^{n} \lambda_i \vec{y}_i - \vec{y}_o \geq \vec{0}_{sx1} \quad (25)$$

$$\overrightarrow{e'} \vec{\lambda} = 1, \vec{\lambda} \geq \vec{0}_{nx1} \quad (26)$$

The input-oriented non-radial Super-SBM model under variable returns to scale (Super-SBM-I—V model) takes the following form:

$$\min_{\vec{\lambda},\vec{s}^-} \rho_o = 1 - \frac{1}{m} \sum_{i=1}^{m} \frac{s_i^-}{x_{io}} \quad (27)$$

under the conditions:

$$\vec{s}^- = \vec{x}_o - \sum_{i=1, i \neq o}^{n} \lambda_i \vec{x}_i \geq \vec{0}_{mx1} \quad (28)$$

$$\vec{s}^+ = \sum_{i=1}^{n} \lambda_i \vec{y}_i - \vec{y}_o \geq \vec{0}_{sx1} \quad (29)$$

$$\overrightarrow{e'} \vec{\lambda} = 1, \vec{\lambda} \geq \vec{0}_{nx1} \quad (30)$$

As the assumption of convexity for DMU_o does not hold when using a super-efficiency model, the optimal solution for a super-efficient SBM model is $\rho_o^* \geq 1$.

The methodology used has some limitations, which are known to authors, but better options do not exist. Used input and output data (except for the number of inhabitants) represent proxies and not exact figures for several reasons. First, there is no chance to measure the amount of public spending on sport correctly. In our study, we use the EUROSTAT indicator "general government expenditures for sports". The EUROSTAT data do not cover all public resources, provided as direct and indirect subsidies for sport (and physical education), but better source is not available. There exist few national and comparative studies trying to estimate the full amount of public subsidies for sports, but these studies cannot be used for our purpose. Second, also the precise measurement of the engagement of populations in to sporting activities is impossible, however EUROBAROMETER data are based on the responses of statistically significant sample of inhabitants, and this allows to use them in our analysis. The last proxy is the number of medals won at the Olympic Games and its conversion into one value, with different weights of different medals. The allocation of weights was explained above, the other fact is that at the Olympic Games countries from the entire world participate and thus the EU countries compete for a limited number of ranks. However, this fact should not influence the validity of results, because the relative chance of the EU countries is similar.

4. Results

The Table 2 shows that according to the Pearson's correlation coefficient, there is a strong positive correlation between a country's population and the amount of public funds allocated to sports. This finding is consistent with the logical assumption that larger and more populous countries invest more in sports. There is also a substantial positive correlation between a country's population size and medal count; countries with larger populations have the potential for a greater number of sporting talent, allowing participation in a wider variety of sports. A substantial positive correlation was also discovered between the amount of public funding allocated to sports and medal count.

Surprisingly, a low level of positive correlation was observed between the amount of public funds allocated to sports and sports activities of the population. This suggests that the sports activities among the population do not depend on the amount of public funds allocated to sports (as determined by the EUROSTAT data) and that other factors (or sources not registered by EUROSTAT) influence the sports activity indicator more significantly. There is a low level of positive correlation between the outputs—sports activities of the population and medal count. Therefore, a larger sports-active population does not necessarily result in a greater possibility of winning medals, and vice versa.

Table 2. Descriptive statistics of inputs, outputs, and correlation coefficients

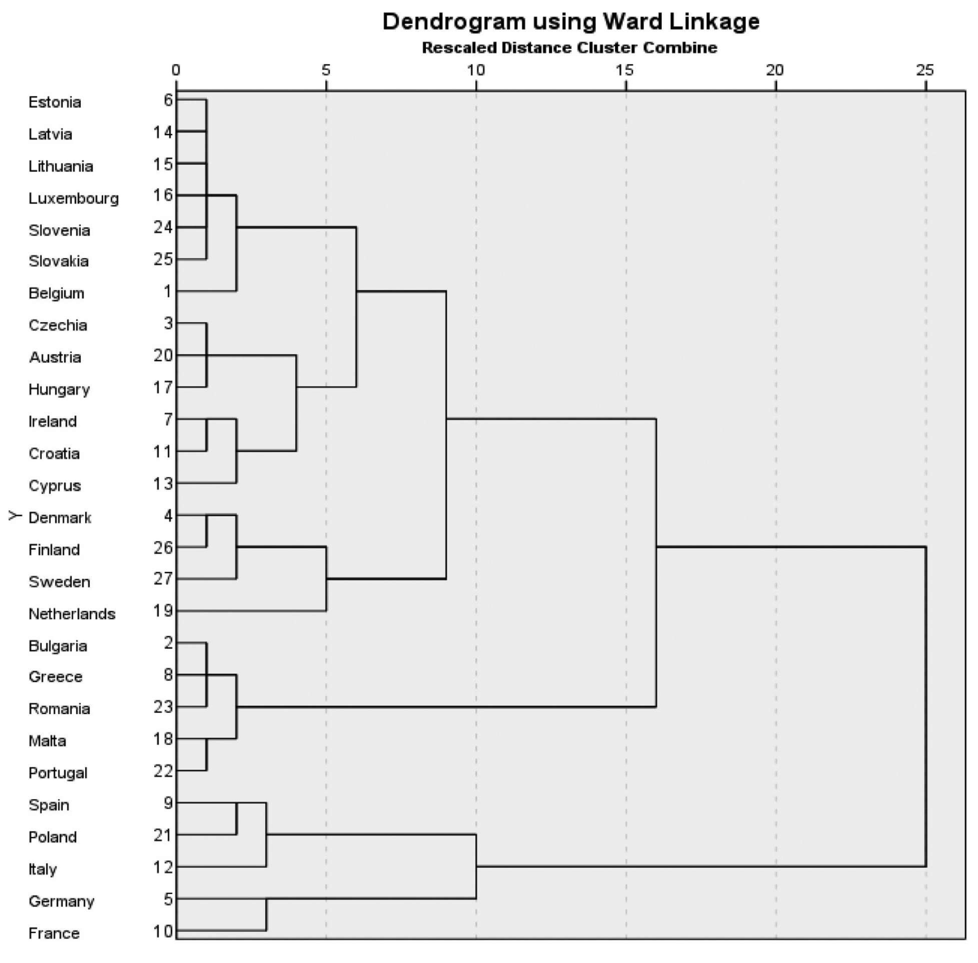
	Inputs		Outputs	
	(I)P	**(I)I**	**(O)PA**	**(O)M**
Min.	520971	164.9	17	0.01
Max.	83237124	125604	88	126.63
Median	8978929	6093	58	12.29
Average	16549214.93	17476.814	53.296	26.268
Std. deviation	22279312.1	28382.254	18.660	31.980
CORRELATION	**(I)P**	**(I)I**	**(O)PA**	**(O)M**
(I)P	1			
(I)I	0.878	1		
(O)PA	−0.143	0.083	1	
(O)M	0.832	0.846	0.238	1

Source: own elaboration (2023)

The relatively high standard deviation also demonstrates the variance among the DMUs. The fact that the median is less than the arithmetic mean value for all inputs and outputs—medal count—indicates that there are a greater number of units in the set whose values are less than the mean value. The median is greater than the arithmetic mean in the case of the output—sports activities. Hence, there are more medal-winning countries with larger populations and greater government investment in sports. On the other hand, there are slightly more sports-active countries than the average for the European Union.

According to the cluster analysis outcomes summarized in and the descriptive statistical outcomes, substantial disparities exist between inputs and outputs across countries. Using the input and output data, the countries can be grouped into five clusters.

The first cluster consists of countries (Estonia, Latvia, Lithuania Luxembourg, Slovenia, Slovakia, Belgium, Czechia, Austria, Hungary, Ireland, Croatia, Cyprus) with relatively high participation of inhabitants in sport activities (average 58.81%) but not as high as it is in the second group (average 81.5%). The second cluster consists of Denmark, Finland, Sweden, and Netherlands and their unique feature is the largest participation of inhabitants in sport activities and better performance regarding the medals won in Olympic Games comparing to the group one. The



third cluster consists of countries with the lowest levels of participation of their inhabitants in sport activities (Bulgaria, Greece, Romania, Malta, Portugal) and poor performance during Olympic Games. The group four consists of three large countries (Spain, Italy, Poland) with relatively low participation of inhabitants in sport activities and solid performance during Olympic Games. The last, fifth cluster consists of Germany and France, with not so high levels of participation of their inhabitants in sport activities but with best performance during the Olympic Games.

Regarding the definition of DMUs, inputs and outputs, the connection between variables, and subsequent descriptive statistics, the technical efficiency of each country will be further analyzed. This involves a multi-criteria assessment of the non-parametric DEA and measures of the technical efficiency of the decision units.

Table 3 summarizes the outputs generated by the DEA Solver when various input-oriented DEA efficiency models were employed. To answer the first research question, input-oriented CCR-I, BCC, and SBM models operated under constant and variable returns to scale were used. We examine the efficiency of sports public funding in European Union countries in supporting their population's sporting activities and sports representations in situations of constant (CCR and SBM-C) and variable returns to scale (BCC and SBM-V). Technically efficient financial systems are observed when technical efficiency equals one. The most technically efficient financial systems operating under constant returns to scale are those of Latvia, Luxembourg, Malta, and Slovenia. By definition, the most technically efficient financial systems operating under variable returns to scale are technically efficient units operating under constant returns to scale plus Denmark, Germany, Estonia, Hungary, Netherlands, Slovenia, Slovakia, and Finland. Portugal has the least efficient public funding for sports, followed by Spain (under constant returns to scale) and Greece (under variable returns to scale).

To answer the second research question, super-efficient SBM operating under constant (super-SBM-I-C) and variable (super-SBM-I-V) returns to scale were used. We ranked and compared the efficient units to determine whether statistical outliers exist. As the highest technical super-efficiency score reached by Malta is 2.860, that is less than 3.5, we can conclude that none of the financial systems funding public sports in EU countries is a statistical outlier.

Table 4 presents the outputs of the DEA of each model and identifies the necessary input adjustment design (P: population, I: public funds invested in sports) for achieving technical efficiency in the six inefficient countries. The table also includes Latvia as an example of the efficient utilization of inputs. In Latvia, inefficient use of input resources was not identified.

Portugal was the least efficient country. All DEA models revealed the possibility of a substantial input reduction. Regarding population, the models suggest the necessity to increase the potential quality of a country's population. The individual models (radial and non-radial; variable and constant returns to scale) had no discernible impact on the analysis results. The untapped population potential of the country is apparent, and given its size, it should result in increased sporting activities and medal count. According to input-output correlations, a country's population size has a substantial effect on their medal count, but little effect on the sporting activities of the population.

Regarding the amount of public investment in Portuguese sports, given the outputs achieved, various DEA models suggest large cuts. The models recommended cut ranges from 96% to 97%, indicating a grossly inefficient use of public funds for achieving sporting activities through the public and Olympic medals. The individual models, whether radial or non-radial or variable or constant returns to scale, had no discernible impact on the results.

Table 3. DMU efficiency according to input-oriented DEA models

CCR-I		BCC-I		SBM-C		SBM-V		SUPER SBM-C		SUPER SBM-V	
Latvia	**1**	Denmark	**1**	Latvia	**1**	Denmark	**1**	Luxembourg	**2.022**	Malta	**2.860**
Luxembourg	**1**	Germany	**1**	Luxembourg	**1**	Germany	**1**	Slovenia	**1.800**	Slovenia	**2.852**
Malta	**1**	Estonia	**1**	Malta	**1**	Estonia	**1**	Malta	**1.559**	Luxembourg	**2.455**
Slovenia	**1**	Latvia	**1**	Slovenia	**1**	Latvia	**1**	Latvia	**1.025**	Slovakia	**2.175**
Estonia	0.951	Luxembourg	**1**	Estonia	0.882	Luxembourg	**1**	Estonia	0.882	Netherlands	**1.959**
Cyprus	0.798	Hungary	**1**	Cyprus	0.651	Hungary	**1**	Cyprus	0.651	Latvia	**1.583**
Lithuania	0.757	Malta	**1**	Lithuania	0.643	Malta	**1**	Lithuania	0.643	Finland	**1.534**
Slovakia	0.676	Netherlands	**1**	Croatia	0.570	Netherlands	**1**	Croatia	0.570	Germany	**1.292**
Croatia	0.617	Slovenia	**1**	Slovakia	0.513	Slovenia	**1**	Slovakia	0.513	Hungary	**1.124**
Netherlands	0.575	Slovakia	**1**	Hungary	0.369	Slovakia	**1**	Hungary	0.369	Estonia	**1.089**
Sweden	0.525	Finland	**1**	Netherlands	0.367	Finland	**1**	Netherlands	0.367	Denmark	**1.052**
Bulgaria	0.485	Sweden	0.925	Austria	0.344	Sweden	0.856	Austria	0.344	Sweden	0.856
Hungary	0.459	Austria	0.896	Sweden	0.328	Austria	0.829	Sweden	0.328	Austria	0.829
Austria	0.445	Cyprus	0.836	Bulgaria	0.315	Cyprus	0.797	Bulgaria	0.315	Cyprus	0.798
Denmark	0.401	Czechia	0.785	Czechia	0.291	Lithuania	0.694	Czechia	0.291	Lithuania	0.695
Finland	0.329	Lithuania	0.771	Denmark	0.277	Czechia	0.667	Denmark	0.277	Czechia	0.667
Czechia	0.319	Italy	0.699	Finland	0.251	Croatia	0.574	Finland	0.251	Croatia	0.574
Ireland	0.249	Croatia	0.620	Ireland	0.234	Italy	0.479	Ireland	0.234	Italy	0.479
Germany	0.181	Bulgaria	0.523	Germany	0.148	France	0.371	Germany	0.148	France	0.371
France	0.159	France	0.393	Italy	0.131	Bulgaria	0.343	Italy	0.132	Bulgaria	0.343
Italy	0.144	Ireland	0.255	Belgium	0.107	Ireland	0.244	Belgium	0.106	Ireland	0.244

(Continued)

Table 3. (*Continued*)

CCR-I		BCC-I		SBM-C		SBM-V		SUPER SBM-C		SUPER SBM-V	
Romania	0.142	Poland	0.252	France	0.105	Poland	0.197	France	0.105	Poland	0.197
Belgium	0.135	Spain	0.167	Romania	0.102	Spain	0.161	Romania	0.102	Spain	0.161
Poland	0.098	Romania	0.156	Greece	0.094	Belgium	0.117	Greece	0.094	Belgium	0.117
Greece	0.094	Belgium	0.135	Poland	0.090	Romania	0.115	Poland	0.090	Romania	0.115
Spain	0.081	Greece	0.114	Spain	0.066	Greece	0.109	Spain	0.066	Greece	0.109
Portugal	0.035	Portugal	0.057	Portugal	0.031	Portugal	0.047	Portugal	0.030	Portugal	0.047

Source: own elaboration (2023)

Table 4. Comparison of analytical outputs of different DEA models in chosen countries

DEA Model	Indicators	Latvia	Portugal	Spain	Greece	Poland	Romania	Belgium
CCR-I	Data - P	1875757	10352042	47432805	10603810	37654247	19038098	11631136
	Projection - P	1875757	361107.52	3836669.2	998399.2	3099216	1194029	1566769
	Diff.(%) - P	0	−96.512	−91.911	−90.585	−91.769	−93.728	−86.53
	Data - I	691.5	5992.9	44271	6093	18936.5	5032.5	16857.4
	Projection - I	691.5	209.04873	2298.7096	573.685	1856.87	715.3928	1747.989
	Diff.(%) - I	0	−96.512	−94.808	−90.585	−90.194	−85.785	−89.631
BCC-I	Data - P	1875757	10352042	47432805	10603810	37654247	19038098	11631136
	Projection - P	1875757	594790.03	7693182	1208748	5311314	1419403	1568137
	Diff.(%) - P	0	−94.254	−83.781	−88.601	−85.895	−92.544	−86.518
	Data - I	691.5	5992.9	44271	6093	18936.5	5032.5	16857.4
	Projection - I	691.5	215.98014	7395.2308	640.8174	4780.238	786.5826	1743.84
	Diff.(%) - I	0	−96.396	−83.296	−89.483	−74.756	−84.37	−89.655
SBM-C	Data - P	1875757	10352042	47432805	10603810	37654247	19038098	11631136
	Projection - P	1875757	381085.67	3836669.2	996361.9	3099216	1194029	1828410
	Diff.(%) - P	0	−96.319	−91.911	−90.604	−91.769	−93.728	−84.28
	Data - I	691.5	5992.9	44271	6093	18936.5	5032.5	16857.4
	Projection - I	691.5	148.47639	2298.7096	573.7299	1856.87	715.3928	954.7128
	Diff.(%) - I	0	−97.522	−94.808	−90.584	−90.194	−85.785	−94.337

(*Continued*)

Table 4. (*Continued*)

DEA Model	Indicators	Latvia	Portugal	Spain	Greece	Poland	Romania	Belgium
SBM-V	Data - P	1875757	10352042	47432805	10603810	37654247	19038098	11631136
	Projection - P	1875757	594790.03	5448658.4	1208748	5311314	1419403	1722246
	Diff.(%) - P	0	−94.254	−88.513	−88.601	−85.895	−92.544	−85.193
	Data - I	691.5	5992.9	44271	6093	18936.5	5032.5	16857.4
	Projection - I	691.5	215.98014	9221.2158	640.8174	4780.238	786.5826	1454.897
	Diff.(%) - I	0	−96.396	−79.171	−89.483	−74.756	−84.37	−91.369
SUPER SBM-C	Data - P	1875757	10352042	47432805	10603810	37654247	19038098	11631136
	Projection - P	1875757	381085.67	3836669.2	996361.9	3099216	1194029	1828410
	Diff.(%) - P	0	−96.319	−91.911	−90.604	−91.769	−93.728	−84.28
	Data - I	691.5	5992.9	44271	6093	18936.5	5032.5	16857.4
	Projection - I	725.903	148.47639	2298.7096	573.7299	1856.87	715.3928	954.7128
	Diff.(%) - I	4.975123	−97.522	−94.808	−90.584	−90.194	−85.785	−94.337
SUPER SBM-V	Data - P	1875757	10352042	47432805	10603810	37654247	19038098	11631136
	Projection - P	1875757	594790.03	5448658.4	1208748	5311314	1419403	1722246
	Diff.(%) - P	0	−94.254	−88.513	−88.601	−85.895	−92.544	−85.193
	Data - I	691.5	5992.9	44271	6093	18936.5	5032.5	16857.4
	Projection - I	1498.931	215.98014	9221.2158	640.8174	4780.238	786.5826	1454.897
	Diff.(%) - I	116.7651	−96.396	−79.171	−89.483	−74.756	−84.37	−91.369

Source: own elaboration (2023)

5. Discussion and conclusions

This study investigates sports funding policies using public funds in European Union countries and explores their efficiency in fulfilling two public policy objectives: supporting the population's sporting activities and promoting sports representation. Moreover, this study aimed to benchmark the efficient sports funding policies using public funds in EU countries to identify potential outliers. To answer these research questions, several data envelopment models were used to examine public funds utilization for funding sports in EU countries, operating under conditions of constant and variable returns to scale, including radial and non-radial DEA models.

The most technically efficient financial systems operating under constant returns to scale are those of Latvia, Luxembourg, Malta, and Slovenia. The most technically efficient financial systems operating under variable returns to scale are technically efficient units under constant returns to scale plus Denmark, Germany, Estonia, Hungary, Netherlands, Slovenia, Slovakia, and Finland. Portugal has the least efficient public funding for sports, followed by Spain (under constant returns to scale) and Greece (under variable returns to scale). The super-efficient SBM operating under constant and variable returns to scale was used to identify whether there are statistical outliers among sports funding systems using public funds in European Union countries. The super-efficiency scores revealed that none of the systems are statistical outliers.

This study has important theoretical and especially practical implications. It adds to the current knowledge related to the efficiency of public funding of sports by using DEA method to evaluate the situation in the EU, the method which supports studying policies from diverse settings. The practical aspects of this study are connected with the fact that during current turbulent times, affected by recent crises, most governments have to cope with significant budget deficits and their levels of public debt increase over acceptable levels. Countries should learn from examples of best practice, identify successful strategies that can be adapted or replicated in their own conditions, and which could possibly improve the ratio between the inputs and outputs, based on benchmarking and learning from leaders. The national solutions represent different institutional varieties, within which the concrete determinants of higher efficiency of the inputs used would need individual analysis, which cannot be delivered by single academic research. Taking this into the account, our results can serve as one of the inputs for national accountability and fiscal discipline "watchdogs" and interested "think-tanks".

Our study possesses limitations in two areas: limited range and complexity of datasets and a deterministic approach to the methodology. For a more comprehensive analysis, the optimization process can include not only variables that are proxies for public investments in sports and human resources of the countries but also those that would capture new technologies (f.e. processing of big data by artificial intelligence) that influence sports activity outcomes. Based on our findings, we can confirm that the deterministic approach was used correctly, as no statistical outliers were identified in sports funding systems using public funds in European Union countries. Another option is a stochastic optimization approach based on a stochastic frontier analysis.

Our results are partly unique, as an analysis covering all European Union member countries has not been conducted previously; however, many similarities with previous studies can be found. Škoric and Hodak (2011) state that the sports development indicator, expressed as the number of registered athletes, does not depend on the volume of public funds invested. Kučera and Nemec (2021) demonstrated using a regression analysis that the sports activity of the population does not depend on the volume of public funds invested in sports, expressed as a percentage of GDP. Therefore, an increase in public expenditure may not achieve the desired effect for more sports-active individuals in the population.

Mitchell et al. (2012) highlighted and demonstrated with historical examples that the motivation for financing professional sports and representation from public funds is often to link the success of sports to political objectives. This assumes that increased public spending leads to more sporting achievements, resulting in increased political support. Rosenthal and Wolfson (2013) also highlighted a more general link between welfare expenditure and political support. However, to maximize the benefits of additional spending, it is important to increase the efficiency of expenditures and compare the efficiency of domestic sports expenditure with that of other countries. De Bosscher et al. (2019) identified a need for prioritisation (especially in the case of limited financial sources) as a deliberate strategic choice for an efficient way to invest funding.

The conclusions of other authors who applied DEA to different areas of sports also stressed that there was poor or no evidence of the efficient use of inputs, including public funds (Guzmán-Raja & Guzmán-Raja, 2021; Meza et al., 2015; Niu & Zhang, 2021). Our results reinforce these previous results and suggest that governments should adopt a more evidence-based approach to sports expenditure.

Funding
This study was supported by the Slovak Scientific Grant Agency, VEGA [grant number: VEGA 1/0442/22].

Author details
Jozef Kučera[1]
E-mail: jkucera2@student.umb.sk
ORCID ID: http://orcid.org/0000-0002-6165-6965
Emília Zimková[1]
ORCID ID: http://orcid.org/0000-0003-1648-8103
Juraj Nemec[2]
ORCID ID: http://orcid.org/0000-0002-5881-7422
Miroslav Nemec[3]
ORCID ID: http://orcid.org/0000-0001-6432-132X
[1] Faculty of Economics, Matej Bel University, Banská Bystrica, Slovak Republic.
[2] Faculty of Economics and Administration, Masaryk University, Brno, Czech Republic.
[3] Faculty of Arts, Matej Bel University, Banská Bystrica, Slovak Republic.

Disclosure statement
No potential conflict of interest was reported by the authors.

Citation information
Cite this article as: A comparative analysis of the efficiency of public funding policies for sports in the European Union, Jozef Kučera, Emília Zimková, Juraj Nemec & Miroslav Nemec, *Cogent Social Sciences* (2023), 9: 2280335.

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