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Can a small nation be competitive in the global sporting arms race? The case of Denmark

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In 2014, the Danish elite sport organisation, Team Denmark (TD), celebrated its 30th anniversary. TD was founded by the government in response to the country's decline in international standings. This study examines how Denmark's international performance has developed in the global sporting arms race since then. It analyses how a small nation can improve its international competitiveness despite stagnating funding and growing international competition. The paper argues that the establishment of TD in 1984 is a key factor behind Denmark's success in elite sport. Measured in absolute terms, by a market share approach, and adjusted for differences in population, wealth, religion and relevant political factors, it is evident that Denmark is performing well and appears to be competitive. Denmark is now the leading nation in Scandinavia and is doing better than almost all other smaller countries in the Summer Olympic disciplines. By examining the development of Danish elite sport policies, the paper shows how the establishment of TD has created an elite sport structure that has helped Denmark to bounce back from its previous decline.

Keywords: Summer Olympic Games, global sporting arms race, Team Denmark, elite sport systems, medal standings, SPLISS study

1. INTRODUCTION

When the Danish elite sport organisation, Team Denmark (TD), was founded in 1984, Denmark's performance in international tournaments such as the Summer Olympic Games¹ was exceptionally poor. In the years leading up to 1984, Denmark enjoyed international success in very few sports. Its athletes' performance at the Olympic Games in 1972 (Munich) and 1976 (Montreal), for instance, resulted in only one and three medals, respectively. The nation had never before performed as badly. In 1980

(Moscow) and 1984 (Los Angeles), the Danish athletes' performances improved. However, with stronger nations not competing due to the US (1980) and Soviet Union (1984) boycotts, the Danish results did not demonstrate an increased international competitiveness in relative terms.

The reasons for Denmark's poor results over this period can be summarised in one word: "amateurism" (Nielsen & Storm, 2014). Compared to the athletes competing under the Soviet and Eastern European elite sport systems – such as the GDR's – the Danish athletes had only sporadic support

¹Denmark does not have a tradition for winter sports comparable to the other Nordic countries. This is due to climatic and topographical reasons. Thus, the following analysis focuses on summer sports only.

from sponsors, their parents and the few Danish sport federations that engaged seriously in elite sport (Danish Ministry of Culture, 1983a, 1983b). Taking a systematic approach to elite sport development, the Eastern Bloc fought to win this part of its Cold War with the West by investing huge amounts of resources into elite sport to demonstrate a broader (political) system of supremacy (D'Agati, 2013).

At the 1976 Olympics (Montreal), more than a third (35 per cent) of all medals available were won by the USSR and GDR, while the Eastern Bloc countries combined won more than half (51 per cent). Their dominance continued until 1988 (Seoul), the last Olympics before the collapse of the communist regimes, when the Eastern Bloc came close to winning half of the total medals (48 per cent). In Western countries, the Eastern Bloc athletes were said to be "state amateurs" (Nielsen & Storm, 2014). It was increasingly seen as imperative to implement appropriate measures to counteract the unequal terms of competition to catch up with their elite sport success.

Australia led the way by establishing the Australian Institute of Sport in 1981 (Böhlke & Robinson, 2009; Stewart, Nicholson, Smith, & Westerbeek, 2004) and other Western countries such as Western Germany, France, Norway and Switzerland also started new initiatives to support their athletes in order to create more equal competitive conditions. In Denmark, the political climate gradually developed from opposition to support for the use of government funds on elite sport (Hansen, 2012). This led to the establishment of TD in 1984 – a government-funded and regulated organisation in charge of improving Denmark's sporting performance. Now more than 30 years have passed. How has TD coped with the problems that instigated its foundation? Is Danish elite sport better off

today than it was 30 years ago in terms of its international standings?

This contribution aims to answer these questions by examining the Danish elite sport system in terms of the international standing of Danish elite sports. The paper adds to existing research on international elite sport success by evaluating the performance of a small – yet wealthy – country in the global sporting arms race. By means of a case study, it aims to assess whether a small nation can be competitive in an increasingly competitive international sporting environment. From a broader perspective, the study can provide insights into what small nations can do to become more competitive in an international sporting context.

The paper proceeds as follows: Section 2 provides a literature review of contemporary approaches to research in international elite sport and the factors deemed crucial to achieving success. Section 3 applies measures of performance to evaluate the development of Danish elite sport's international standing. In Section 4, the characteristics of the Danish elite sport model are examined to determine the link between the country's sporting success and TD's developmental role. The concluding Section 5 reflects on the implications of the study's core findings and future (research) perspectives.

2. LITERATURE REVIEW

Research in international elite sport has grown significantly over the years (Böhlke & Robinson, 2009). Besides various economic papers on medal standings and prediction models – usually produced prior to the Olympics² – policy researchers have started to dig deeper into the factors that are critical to achieving international sporting success. With regard to the Nordic countries, Augestad

²According to Andreff and Andreff (2014), around 30 studies elaborated on medal prediction models for the Summer Olympics from the 1970s onward.

and Bergsgard (2007), Storm (2008), Bergsgard and Norberg (2010) and Andersen and Ronglan (2012) are some of the most recent attempts to understand Scandinavia's elite sport policies, funding streams and the desire for international sporting success. These studies tend to take a comparative approach to identify similarities and differences among the Nordic nations.

Looking beyond the Scandinavian context, similar research has been conducted by Stewart et al. (2004), Green and Houlihan (2005), Houlihan and Green (2008) and Green (2009) on nations such as China, Japan, France, Poland, New Zealand, US, Germany, Australia, United Kingdom and Canada. Their overall conclusions are that there is an increasing convergence of elite sport systems (Shibli, Bingham, & Henry, 2007). Due to internationalisation and globalisation, nations have adopted similar elite sports systems and policies aimed at improving performance, thereby institutionalising a broad elite sport system template that only varies slightly between nations. However, studies by Böhlke and Robinson (2009), Andersen and Ronglan (2012) and De Bosscher, Shibli, Westerbeek, and Van Bottenburg (2015) conclude that despite this convergence, there are still significant differences between nations.

Other studies look deeper into the primary determinants of success in international elite sports (De Bosscher et al., 2015; Digel, Burk, & Fahrner, 2006; Green & Oakley, 2001), identifying a range of factors that are critical to sporting success. Some nations believe that specialising in a narrower set of sports will help them stay competitive in overall standings and recently some studies have focused on the determinants of success in specific sports. Examples include Sotiriadou, Gowthorp, and De Bosscher (2014); Truyens,

De Bosscher, Heyndels, and Westerbeek (2014); and Böhlke (2007) who focus on canoe sprint, athletics and cross-country skiing, respectively.

A core theoretical approach has evolved from the research outlined above. Drawing on and synthesising existing research, De Bosscher, De Knop, Van Bottenburg, and Shibli (2006); De Bosscher (2007); De Bosscher, Bingham, Shibli, Von Bottenburg, and De Knop (2008); De Bosscher, De Knop, and Bottenburg (2009); and De Bosscher et al. (2015) have developed one of the most comprehensive frameworks for analysing the competitiveness of nations in international elite sport: the SPLISS³ model. The framework is based on the notion that the formula for international elite sport success can be divided into various determinants located on the micro, meso and macro levels.

Determinants at the macro level, such as population, wealth, landmass and political or religious system characteristics, are shown to explain around 50 per cent of the differences in nations' international sporting successes (De Bosscher, 2007; De Bosscher et al., 2015). The determinants at the meso and micro levels such as national sport policies and the individual athletes' personal characteristics and immediate environment(s) contribute to explaining the differences that cannot be explained by macro level factors (De Bosscher, 2007).

The macro level determinants are difficult to control, especially in the short term. Changes in GDP or population size are long-term determinants, whereas elite sport policies and the athletes' micro level environments can change more quickly (De Bosscher, 2007). The SPLISS 1.0 (De Bosscher et al., 2008) and 2.0 studies (De Bosscher et al., 2015), of which Denmark participated in 2.0,⁴ identify nine critical factors at the

³SPLISS: "Sport Policy Factors Leading to International Sporting Success".

⁴The Danish results from the SPLISS 2.0 study can be found in Storm and Jørgensen (2014).

meso level. The 1.0 study evaluates these meso level factors for four nations. The 2.0 study increases the number of nations to 15 and uses the study's data to identify the most important factors for an efficient elite sport system. These include financial support (i.e. direct financial support for the national elite sport system), organisational structure and scientific research. Other important factors are talent identification, talent development, training facilities, provision and development of coaches and (access to) (inter)national competition. Factors such as (a high level of) sport participation, and athletic and post-career support are less important (De Bosscher et al., 2015). Overall, SPLISS 1.0 and 2.0 provide a useful mechanism to evaluate national elite sport policies.

In the following sections of this paper, we will evaluate the Danish elite sport model following this theoretical approach. We use the following model – illustrated in Figure 1 – inspired by the SPLISS study as our line of progression.

Starting from the output side (i.e. the results gained – by competing nations – in international sporting competition), our aim is to illustrate how international success in sport can be measured and how it is possible to approach the question of what constitutes a successful elite sport system. From there we move on to evaluate the Danish elite sport system in more detail by looking at its input and throughput. We use new data as well as results from previous research (see below) such as the SPLISS 2.0 study (De Bosscher et al., 2015; Storm & Tofft-Jørgensen, 2014) to fulfil this task.

3. THE DEVELOPMENT OF DENMARK'S INTERNATIONAL STANDINGS: OUTPUT⁵

The international literature on elite sport performance offers a range of methods to

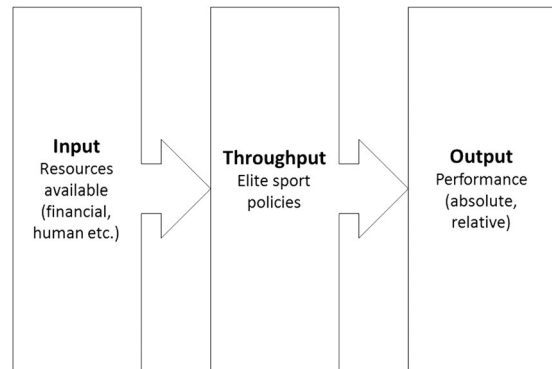


Fig. 1. Model for examining the development of Danish elite sport (Source: De Bosscher et al., 2016)

measure international sporting success on the output side. Here we apply, discuss and develop those that are most suitable for measuring a small nation's standings in order to analyse Denmark's performance development.

The most frequently used way of measuring international elite sport success is to look at the medal table from the Olympic Games. Another is the total number of medals in international tournaments. Figure 2 shows the total number of Danish medals won from 1975 to 2015.

The figure displays a significant and steady improvement in Danish elite sport results since the establishment of TD in 1984. From a total of 40–50 medals in the 1980s, the number of medals has increased markedly in the years leading up to 2015 and in recent years the total number has been 115–125 medals.

However, these numbers are not a valid measure of Denmark's competitiveness in elite sport. First, there has been an increase in the number of international elite sport tournaments. Consequently, an increased medal tally does not necessarily reflect real improvement in the Danish standings, but

⁵Parts of the following two sections build upon Nielsen and Storm (2014), and Storm and Nielsen (2013).

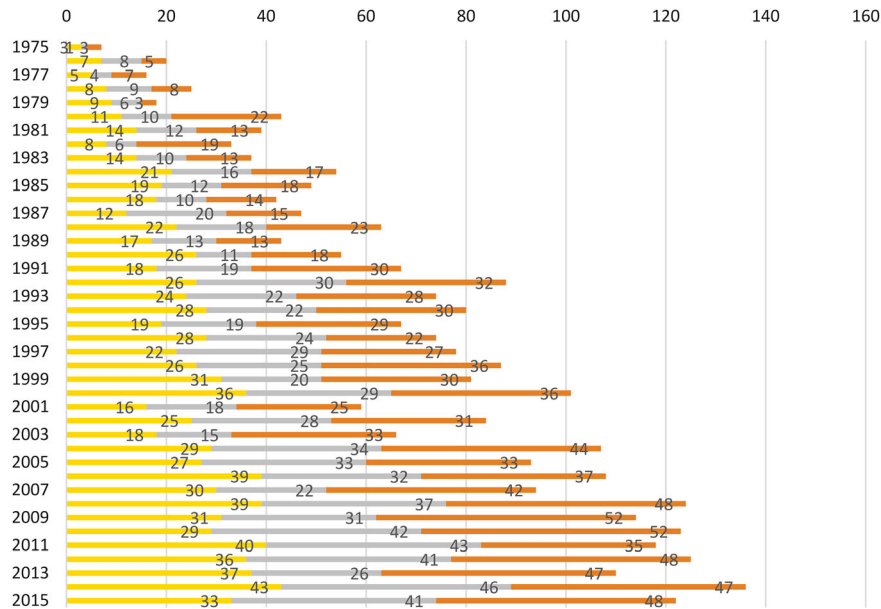


Fig. 2. Total Danish medals in international senior tournaments from 1975 to 2015. Note: http://www.dif.dk/da/ol_elite/medaljer_og_mesterskaber

is rather an effect of the larger number of medals on offer. Second, some disciplines can be considered “soft” in the sense that the standard of international competition is low. If the increase in the number of medals is mainly in such “soft” disciplines, it does not indicate improved performance (Storm, 2008).

Olympic disciplines are the most prestigious and difficult to win (Balmer, Nevill, & Williams, 2003). Focusing on these disciplines is a way of overcoming the problem of measuring international competitiveness (Storm & Nielsen, 2013). The Olympic medal count is a significant and relatively unambiguous measure of Denmark’s performance in international elite sport. However, it is very sensitive to marginal or random variances in performance. For a

small nation like Denmark, a few fourth places instead of bronze medals can have a strong impact on its medal tally. Therefore, rather than looking only at the top three results in these events, it is appropriate to consider positions outside of the medals as well (Shibli et al., 2007; Storm, Nielsen, & Thomsen, 2016).

Table 1 shows the development of the top 25 nations measured by allocating points to the countries that finished in the top eight in Olympic disciplines from 1988 to 2015. The results are weighted by awarding gold medals eight points, silver medals seven points and so on ending with one point for an eighth place. Whereas the ranking of no. 1–8 is unambiguous in most Olympic disciplines, it is not so in others.⁶

⁶For instance, in some sports (e.g. badminton, boxing and tennis) it is impossible to rank quarterfinalists and all are ranked no. 5 in this study. Furthermore, in other sports (judo, taekwondo and wrestling) the ranking of nos. 5–8 is

Table 1. Development in top eight points 1988–2015 (top 25 nations plus selected others)^a

		Seoul	Barcelona	Atlanta	Sydney	Athens	Beijing					London		
Position (2015)	Country	1988	1992	1996	2000	2004	2008	2009	2010	2011	2012	2013	2014	2015
1	US	959	1071	1018	1001	1032	1068	968	1037	964	1096	1062	1068	952
2	China	330	529	551	580	672	967	723	866	924	843	721	777	847
3	Russia	1313	1113	734	866	867	806	738	885	885	846	847	802	778
4	Great Britain	337	283	204	337	385	499	534	567	596	708	546	581	602
5	Germany	–	883	759	721	624	499	671	602	596	558	694	639	564
6	France	271	420	444	502	420	476	465	507	499	421	416	520	468
7	Australia	241	296	435	623	553	515	417	444	456	434	351	472	417
8	Japan	178	256	209	236	387	330	312	438	402	385	387	439	389
9	Netherlands	137	169	208	275	230	211	220	191	216	239	253	256	364
10	Canada	197	219	235	222	225	254	223	235	234	228	223	248	269
11	Italy	234	263	386	401	352	359	381	340	333	357	395	283	257
12	Ukraine	–	–	294	318	318	276	209	237	271	249	255	244	245
13	Poland	218	238	229	223	184	215	217	201	224	152	227	188	242
14	South Korea	296	281	285	300	326	289	250	295	273	304	232	237	235
15	New Zealand	115	129	73	63	96	124	121	146	190	171	195	191	223
16	Hungary	356	333	222	212	228	161	225	217	199	194	234	188	191
17	Spain	71	288	211	208	284	246	325	251	200	217	301	244	190
18	Brazil	67	58	135	122	135	178	163	162	180	173	280	254	186
19	Kenya	85	73	86	90	67	143	121	178	168	112	143	180	164
20	Belarus	–	–	199	234	192	206	152	184	221	162	147	149	162
21	Cuba	–	328	256	310	245	261	198	200	148	156	164	139	157
22	Azerbaijan	–	–	15	39	75	76	123	106	136	102	125	90	156
23	Kazakhstan	–	–	103	116	119	152	66	97	149	123	139	147	137
24	Jamaica	44	44	69	68	79	124	135	118	101	112	96	99	136
25	Denmark	70	79	107	92	98	87	146	84	112	148	133	129	132
27	Sweden	151	182	135	145	127	106	109	121	118	123	123	147	116
59	Norway	59	85	75	80	68	94	66	67	67	46	42	36	30

Note: ^aSummer Olympics only.

In addition to the Olympic years, the table includes top eight points in the years between the Beijing and London Games (2009, 2010 and 2011) and the years between the London and the Rio Games (2013, 2014 and 2015). In these years, results in world championships and similar competitions or world rankings in disciplines that are part of the upcoming Summer Olympics are included. This is not a straightforward exercise. The approach takes into account the conditions of participation at the Olympics. In disciplines with only one participant per nation, only the highest ranked athlete per nation in the respective discipline is included in the calculation of the “simulated” Olympic results in that specific year. This result, for example, in a fourth place counted as a third place, such as happened with Jonas Høgh Christensen’s fourth place at the World Championships in Finsbury in 2011, when two British competitors placed in front of him.

The approach also takes into account that, in some cases, athletes compete for bronze medals at the Olympics, whereas this is not necessarily the case at World Championships. In such cases, only the bronze medalist at the World Championship, which was the highest ranked in the discipline’s official world rankings at the time the World Cup was held, is included in the calculation. In some instances, there are no unambiguous way of finding no. 1–8 in Olympic disciplines in years in-between the Olympic Games and some discretionary judgment has to be applied.⁷

The inclusion of the years in between the Olympic years gives a more balanced view of the development of Denmark’s – and other small nations’ – standings and adds to existing performance measurement methodologies by offering a year-by-year approach to Olympic success by means of allocating top eight points.

The results of this approach reveal a significant improvement for Denmark over the long term, although with some fluctuations. The total sum of top eight points for Denmark in the Olympic Games decreased significantly from Atlanta to Beijing (1996: 108; 2000: 92; 2004: 98; 2008: 85). However, from 2009 onward, the Danish results started to soar. The 2012 London Games represents a breakthrough and Denmark has achieved even better results since then.

3.1. Market Share: Adjusting for the Increase in Medal Events

As mentioned above, the number of international elite events has increased over the years and the same is true for Olympic events. In 1984, the Olympics consisted of 221 events, whereas the 2012 London Olympics had 302 medal events. Calculating market share adjusts for the fact that an increase in the number of events in itself could lead to an increase in medals or top eight points (De Bosscher, 2007; Shibli et al., 2007; Shibli & Bingham, 2008; UK Sport, 2003).

ambiguous because of the repechage system. In this study, losers of bronze medal matches are ranked no. 5 and losers of the preceding repechage round ranked no. 7.

⁷For instance, in football there is no competition with eligibility criteria similar to the Olympic competition in between the Olympic Games. In this study, the results from the FIFA U-20 World Cup are included in uneven years and the results from the World Cup in even years. Another example is tennis, where ATP/WTa double rankings cannot be used directly because they include double pairs with the players of different nationality, which is not permitted in the Olympics. In this study, the ranking of nos. 1–8 is based on a simple addition of double points for the two best players per nation. In athletics, rankings based on season’s best results are used. This has the effect that in years with no IAAF World Championships the standing of Kenya is boosted because its distance runners consistently do much better in terms of best times than in actual competitions in championships. In this study, no attempt has been made to correct for this effect.

Table 2. Development in market share of top eight points 1988–2015 (Denmark and selected nations)^a

	Seoul	Barcelona	Atlanta	Sydney	Athens	Beijing	London						
	1988	1992	1996	2000	2004	2008	2009	2010	2011	2012	2013	2014	2015
US	8.44%	9.42%	9.88%	9.19%	9.42%	9.67%	9.12%	9.30%	8.64%	9.88%	9.45%	9.39%	8.38%
China	2.90%	4.65%	5.75%	5.33%	6.14%	8.76%	6.81%	7.76%	8.28%	7.60%	6.41%	6.83%	7.46%
Great Britain	2.96%	2.49%	2.01%	3.10%	3.52%	4.52%	5.03%	5.08%	5.34%	6.38%	4.86%	5.11%	4.97%
Germany	–	7.77%	7.67%	6.62%	5.70%	4.52%	6.32%	5.40%	5.34%	5.03%	6.17%	5.62%	5.30%
Australia	2.12%	2.60%	4.41%	5.72%	5.05%	4.66%	3.93%	3.98%	4.09%	3.91%	3.12%	4.15%	3.67%
France	2.38%	3.69%	4.44%	4.61%	3.83%	4.31%	4.38%	4.55%	4.47%	3.80%	3.70%	4.57%	4.12%
New Zealand	1.01%	1.13%	0.76%	0.58%	0.88%	1.12%	1.14%	1.31%	1.70%	1.54%	1.73%	1.68%	1.96%
Denmark	0.62%	0.69%	1.08%	0.84%	0.89%	0.79%	1.38%	0.75%	1.00%	1.33%	1.18%	1.13%	1.16%
Sweden	1.33%	1.60%	1.38%	1.33%	1.16%	0.96%	1.03%	1.08%	1.06%	1.11%	1.09%	1.29%	1.02%
Norway	0.52%	0.75%	0.91%	0.73%	0.62%	0.85%	0.62%	0.60%	0.60%	0.41%	0.37%	0.32%	0.26%

Note: ^aSummer Olympics only.

However, this is not the case for Denmark. Table 2 displays the development in its market share of top eight points from 1988 to 2015. In accordance with Figure 1 and Table 1, the market share table (Table 2) shows an increase in Denmark's international standings. After the Atlanta Olympics (1996), the Danish results declined towards Beijing (2008), but soared to a higher level than any previous year between 2009 and 2015.

3.2. Regression Analysis: A Relative Measure of Performance

The analysis based on absolute and market share developments in medals and top eight points shows a clear improvement in Denmark's standings since the foundation of TD. However, is Denmark's elite sport performance as good as one could expect taking into account its wealth, population, political system and other relevant macro factors? Below, we will aim to measure Denmark's results by correcting for macro variables that undoubtedly have an influence on international elite sport competitiveness (De Bosscher, 2007; De Bosscher et al., 2015).

We do this by using a standard OLS regression model, which serves two interconnected purposes. First, it helps us to identify the macro level determinants of international sporting success. Second, based on an analysis of the regression results, we can divide the observed nations in two groups – nations that punch above their weight and nations that underperform – taking their respective resources into account (De Bosscher, 2007; De Bosscher et al., 2015). This allows us to determine how efficient Denmark is in relation to its macro level platform, and, in turn, better assess how the Danish elite sport system functions.

Following such an approach, De Bosscher et al. (2015) argue that nations which perform better than expected can be

considered as having well-functioning elite sport systems. On the other hand, nations performing below their expected score indicate weak elite sport policies or – perhaps – no policies or elite sport system at all.

3.2.1. Model and variables

As a dependent variable for our model of relative performance, we use top eight points and deploy a number of independent variables in order to see which ones influence success. The independent variables, *POP* (β_1) and *GDP pr. cap* (β_2) are usually used in performance analyses like this. Previous studies have found that population size and wealth (measured by GDP) have significant influence on international sporting success (e.g. Andreff & Andreff, 2010; Bernard & Busse, 2004; Johnson & Ali, 2004; Kuper & Sterken, 2012). The model tests whether our data are able to confirm such correlations. *Density* (β_3) is deployed to test whether variances in population density (pop/area) influence performance. The decision to include this variable is inspired by De Bosscher (2007), who argues that high levels of population density can have a positive impact on the efficiency of elite sport systems because training facilities usually are closer to each other in densely populated nations. This (hypothetically) reduces travelling distances to training facilities for athletes and thus output performance because it gives athletes more time to train.

In addition, we include three dummy variables to adjust the figures according to religious and political factors affecting performance. As pointed out in the introduction, countries in the Eastern Bloc invested intensively in elite sport. We test whether this still influences their performance and also if the “one party state tradition” affects the performance of contemporary communist nations by entering a dummy variable for former *Eastern Bloc nations*

Table 3. Model variables

Variables	Description
Top eight points	Top eight points in year N, (Gold = 8 points, Silver = 7 points ... 7th place = 2 points, 8th place = 1 point)
β_1 : POP	Population base measured in millions. ^a
β_2 : GDP/CAP	GDP per capita (PPP) measured in the international dollar. ^b
β_3 : Density	Population density: POP/Area
β_4 : Muslim	Dummy measuring whether a majority of the population is Muslim.
β_5 : Eastern European Country	Dummy measuring whether the country was a member of the pre-1989 Eastern Block.
β_6 : Communist	Dummy measuring whether the country is communist.

^aIMF Data and Statistics, <http://www.imf.org/external/data.htm>. Missing data in the IMF files have been supplemented with data from the World Bank, <http://databank.worldbank.org/>

^bIMF Data and Statistics, <http://www.imf.org/external/data.htm>. Missing data in the IMF files have been supplemented with data from the World Bank, <http://databank.worldbank.org/>

(β_5)⁸ and a dummy variable for current *communist* nations (β_6).

Furthermore, a *Muslim* dummy (β_4) is deployed into the model, also inspired by De Bosscher (2007), to adjust for the fact that female elite athletes are more or less absent in Muslim countries and are therefore not usually in contention for medals or top eight results. Based on this, our initial model used for measuring relative performance is expressed as:

$$\begin{aligned} \ln \text{Top} - 8 = & \beta_0 + \beta_1 \ln \text{POP} \\ & + \beta_2 \ln \text{GDP per capita} \\ & + \beta_3 \ln \text{Density} + \beta_4 \text{Muslim} \\ & + \beta_5 \text{Eastern European Country} \\ & + \beta_6 \text{Communist} + \epsilon, \end{aligned}$$

where β_0 and ϵ represents the equation's constant and error term, respectively (Table 3).

The regression results based on data for 2012 (London, $N = 110$)⁹ reveals that all variables are significant except *Density* (β_3) and *Communist* (β_6). These variables are withdrawn from the model. The final model has an R^2 value of 0.581, that is, 58.1 per cent of the variation in output (the dependent variable) can be explained by the variations in the significant explanatory (independent) variables. This is quite a good model compared to the ones used in previous studies (see e.g. De Bosscher et al., 2015), which has had R^2 values of around 0.50.¹⁰ Regression results for our final 2012 model are displayed in Table 4.¹¹

To assess the efficiency of the included nations' elite sport systems, residual values

⁸New former Yugoslavian nations are part of the variable. Albania is included as well.

⁹ $N=110$ refers to the fact that of the 204 nations taking part in London 2012, 110 achieved a top eight place.

¹⁰De Bosscher et al. (2015) present three models with different dependent variables. It should be noted that only one of the models were based on (the total number of) top eighth placings. This is the model we refer to here in terms of R^2 -value comparisons.

¹¹No outliers ± 3 standard deviations away from the mean were found regarding the final model. A Kolmogorov-Smirnov test showed that the error term for the final regression model is normally distributed (sign = 0.200). This is further confirmed by a Shapiro-Wilk test for normality (sign = 0.626). Furthermore, visual inspections of scatterplots did not reveal any problems with the aptness of the data. Unacceptable correlations between the independent variables were not found either (i.e. no problems of multicollinearity (VIF < 10)).

Table 4. Regression results, 2012 London data

$R^2 = 0.581$. $N = (110)$	Coefficient	Std. error	t-Value	Sig.
Constant	-5.011	0.957	(-0.5234)	0.000***
β_1 : Pop	0.584	0.060	9.821	0.000***
β_2 : GDP/ cap	0.726	0.253	-3.697	0.000***
β_4 : Muslim	-0.963	0.253	-3.697	0.000***
β_5 : Eastern European Country	1.096	0.248	4.416	0.000***

Note: *** $P \leq .01$.

Table 5. Nation ranking based on residual values 2012 and 2015 (selected nations)

Ranking 2012/2015	Nation	Residual 2012/2015	Top-8 – Rank 2012/2015	Top-8 – Points 2012/2015
1/1	Jamaica	2.577/2.551	25/24	112/137
2/9	Grenada	1.864/1.292	84/89	10/7
3/4	Kenya	1.774/1.773	25/19	112/164
4/3	New Zealand	1.740/1.846	17/15	171/223
5/-	Samoa	1.739/-	90/-	7/-
6/12	Ethiopia	1.692/1.067	29/35	90/83
7/2	Mongolia	1.563/1.866	52/33	41/88
8/9	Great Britain	1.546/1.215	4/4	708/602
9/7	Australia	1.490/1.334	6/7	434/468
10/8	Cuba	1.464/1.328	19/21	156/157
11/11	Bahamas	1.284/1.088		
12/13	Denmark	1.284/1.052	21/25	148/132
16/6	Netherlands	1.044/1.378	12/9	239/364
19/17	Germany	1.031/0.927	5/5	558/564
20/16	France	0.951/0.965	7/6	421/564
29/28	Sweden	0.770/0.672	23/27	123/116
61/74	Norway	-0.135/-0.638	48/59	46/3

(which represent over-/underperformance) are calculated by subtracting the observed performance from the calculated expected performance modelled from the regression (De Bosscher, 2007; De Bosscher et al., 2015).

In Table 5, a ranking based on residuals is made for 2012 and 2015 using the same regression model variables for both years, but using data for 2012 and 2015

respectively.¹² Positive residual values indicate a better performance than expected taking the independent variables in to account and vice versa. The table shows that a different picture of nations' performance than the rankings based on absolute top eight points and market share emerges when socio-economic, political and religious factors are taken into account.

¹²Tests for aptness of data (please see the Appendix) in the 2015 regression model also reveal that the model lays within acceptable tests scores.

This relative ranking indicates that the top-ranked nations have found an efficient way of using their resources to achieve international success in elite sport. However, there may be other factors behind their success (De Bosscher et al., 2015), such as specialisation. Some of the top-ranked nations in Table 5 are sporting monocultures in the sense that they are competitive only in a few sports in which they have a strong tradition and/or competitive advantage. All three of the top-ranked nations in 2012 (Jamaica, Kenya and Ethiopia) are extremely specialised, being competitive in a few running disciplines only. This also applies to Mongolia, which is only competitive in judo and wrestling. The high ranking of other nations with very small populations, such as Grenada and Samoa, does not show anything about their elite sport systems as their ranking reflects only one medal or top eight placing. Ignoring sporting monocultures and micro nations, the table indicates that based on the results in 2012 and 2015 the following countries appear to have the most efficient elite sport systems: New Zealand, Great Britain, Australia, the Netherlands and Denmark.

Denmark's residual values are positive and the country's ranking is better than measured in absolute terms or by market share. To analyse the Danish elite sport model's development and efficiency over time, we ran regressions and calculated residuals for all data available from 1988 to 2015 based on the approach above.¹³ Table 6 shows that Denmark's relative performance improves over time. From 2009 onward, its residual values increased compared to the earlier periods.

Based on the above results, we will now evaluate the development of the Danish

elite sports model in more detail to see whether its improved performance (output) can be linked to its resources (input) and elite sport policies (throughputs).

4. DANISH ELITE SPORT POLICIES: IN- AND THROUGHPUTS

4.1. Danish Inputs

Danish elite sport's total financial input is difficult to estimate because reliable data representing *indirect* input to TD from sources other than private sponsorships and public funding is absent. As pointed out by Ibsen, Hansen, and Storm (2010), reliable data on the cost of elite sport in municipalities, local voluntary sports clubs and cost associated with professional elite sport does not exist.

Concerning *direct* (state level) input, the development of TD's total revenues and expenditure on elite sport from 1985 to 2015 is displayed in Figure 3. The data are taken from TD's annual reports and are displayed in 2015 prices.

Regardless of whether it is measured as total revenue or total expenditure (spending by TD on elite sport), there is a marked increase in input between 1985 and 1993. This is mainly due to a general increase in profits from national lotteries over the same period. However, from 1994 onward, total inputs from TD show a small decline. This has happened in spite of new private sources of funding in recent years. A private fund has granted 55m DKK in support in the last Olympic cycle. This has compensated for a reduction in governmental support. In addition to the (funding) input to the elite sport system from TD,

¹³We used the same model – dependent and independent variables – for each year, but used data for the specific year in question for each regression. Detailed regression results are displayed in the appendix (Tables A1 and A2). For robustness, each year's models have been checked for aptness of data – as was the case in the 2012 model described in the text.

Table 6. Denmark and selected nation's residuals 1988–2015^a

	Australia	China	Denmark	France	Germany	Great Britain	New Zealand	Norway	Sweden	Switzerland	US
1988	1.332	0.970	0.881	0.498	N/A	0.889	1.972	0.635	1.377	0.282	0.440
1992	1.181	1.787	0.403	0.821	1.338	0.643	1.454	0.330	1.110	−0.371	0.772
1996	1.399	1.954	0.394	0.903	1.325	0.306	0.458	−0.170	0.587	−0.145	2.884
2000	1.836	1.090	0.639	0.907	1.057	0.626	0.811	0.301	0.903	0.551	0.381
2004	1.692	0.912	0.710	0.796	1.022	0.771	1.096	0.152	0.732	0.936	0.552
2008	1.683	0.778	0.746	0.977	0.826	1.067	1.473	0.668	0.656	0.406	0.604
2009	1.324	0.838	1.033	0.945	1.153	1.148	1.194	0.005	0.506	0.091	0.624
2010	1.525	0.341	0.840	1.000	0.959	1.174	1.754	0.437	0.849	0.076	0.426
2011	1.636	1.007	0.998	1.230	1.231	1.469	1.826	0.312	0.766	0.230	0.873
2012	1.490	0.786	1.271	0.951	1.031	1.546	1.740	−0.135	0.770	−0.239	0.776
2013	1.353	0.239	1.324	0.951	1.260	1.274	1.992	−0.001	0.893	0.278	0.696
2014	1.673	0.458	1.262	1.252	1.240	1.368	1.914	−0.197	1.042	−0.021	0.839
2015	1.334	0.460	1.052	0.965	0.927	1.215	1.846	−0.638	0.572	0.361	0.541

^aResidual values for 1988 and 1992 are less robust compared to the rest of the years included, as the numbers of nations included in the 1988 and 1992 regressions were small due to lack of data on top eight points for a number of nations.

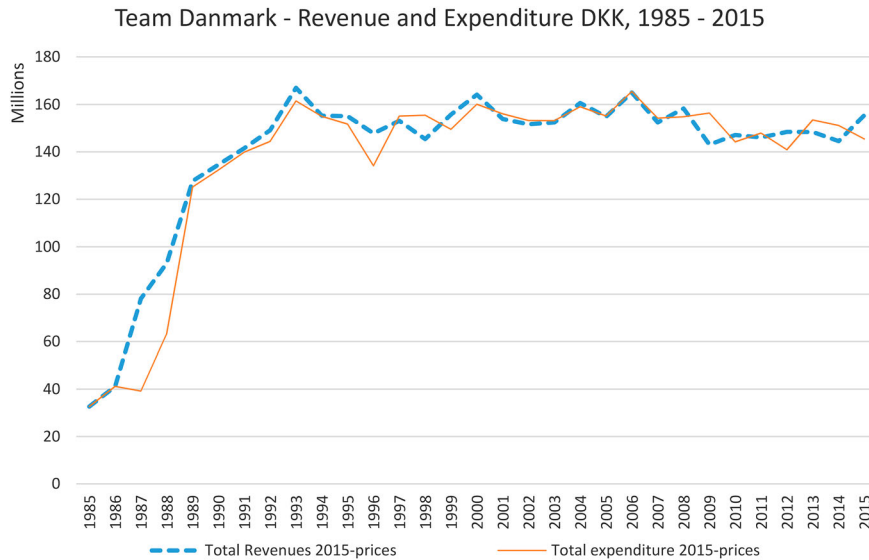


Fig. 3. Team Danmark's total revenue and expenditure, 1985–2014

input from the sport federations needs to be added to give a complete picture of the total direct costs associated with Danish elite sport. A report from the Danish consultancy firm KPMG in 2002 (KPMG Consulting, 2002) estimated that, on average, the supported federations added 100 per cent to the input provided by TD. However, it is not clear how the federations' inputs associated with elite sport have developed over time.

Without objective measures, we assume that Danish elite sport's total (financial) input varies – more or less – in accordance with the overall financial input provided by TD (but with a higher total than displayed). If this assumption is correct, the development over the whole period examined indicates that the Danish system has become more efficient.

The first years of TD's existence involved an increase in funding and improved output in the late 1980s and early 1990s. From 1996, which represents a temporary peak measured by top eight points and market share, Denmark's standing was threatened by increased international competition

(Storm et al., 2016) and a decline in performance at the 2000 (Sydney), 2004 (Athens) and 2008 (Beijing) Olympics. These declines happened in spite of the fact that in this period (2000–2008), TD provided the highest level of funding seen in relation to the rest of the examined period.

However, from 2009 onward, Denmark's output (performance) increased despite a small decrease in TD's input, thus indicating an improved system effect. A calculation of the annual cost (TD expenditure) per top eight points – displayed in Figure 4 – shows a significant improvement from 1.7m DKK in 2000–2004 to 1.1m DKK in recent years.

This is not a perfect indicator because there is a time lag between expenditure and effect. However, the figures indicates increased efficiency and higher return on investment. The question of efficiency, and the general functioning of the Danish elite sport system, will be dealt with in more detail below where the focus is on throughputs.

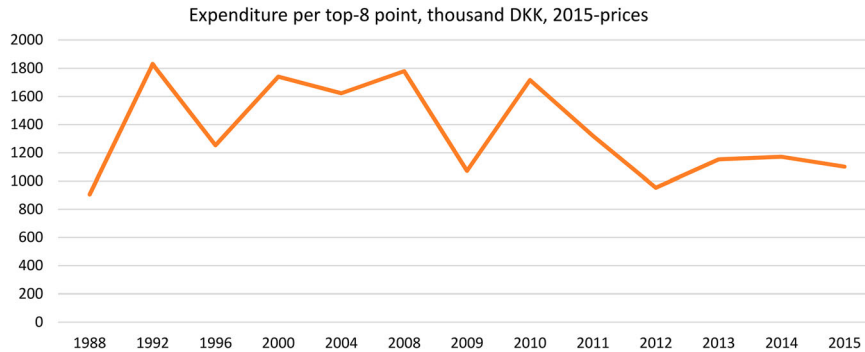


Fig. 4. Team Denmark's expenditure per top eight point, 1988–2015

4.2. Throughputs

There is a lack of detailed research on the Danish elite sport system during the first 15 years of TD operation. However, it can be argued that the establishment of Team Denmark (in itself) represented a crucial step of increased professionalisation which helped to build a platform from where further improvements of the Danish system could be achieved. In the late 1980s, TD started to develop its governance structures and relationships with federations and other relevant stakeholders. It developed a system of support, distributing funds to the federations and athletes (Kulturministeriet, 2001). Furthermore, it started to engage in talent development and provided a set of technical, physical, medical, psychological and dietary support facilities. It also provided specialised training facilities, supported the recruitment of top coaches and engaged in research and development activities (Kulturministeriet, 2001). It also introduced (post) athletic career support programmes (Nielsen, Nielsen, Christensen, & Storm, 2002).

In 2001, the Danish Ministry of Culture initiated an evaluation of TD in connection with a revision of the Danish parliamentary Act on Elite Sport (Kulturministeriet, 2001). The overall conclusion was that TD had helped to establish a well-functioning elite sport system. Nevertheless, there were still concerns about the system due to the

unrealised potential of municipal involvement and the lack of commercial sponsorship revenue in Danish elite sport.

The process prompted some minor revisions of the Danish Act on Elite Sport aimed at improving the areas identified as concerns, and a sharper (political) focus on output. The report concluded that the (public) financial resources allocated to TD would be more or less on the same level in the coming years. At the same time, however, it expressed a political ambition for improved output performance. As a result, TD assumed a greater organisational focus on medals by copying a New Public Management approach – cutting the number of supported disciplines and allocating its resources to fewer sports. The approach was inspired by nations such as Great Britain, Australia and New Zealand in the anticipation of a positive effect on international competitiveness (Storm, 2012).

TD's adoption of a more market-based "investment"-oriented support regime led to a heated debate in Denmark in the mid-2000s. It was criticised for compromising traditional Danish values of equality and fairness and for undermining the future potential in a range of non-supported sports. This was probably the most important change of elite sport policy in the last decade, and TD's more selective approach to support of federations may be one of the

main reasons why Denmark's international standing has improved significantly over the last six to seven years. However, the focus on a smaller set of supported disciplines does not seem to have narrowed down the range of sports in which Denmark is successful, as had been feared by the federations that were excluded from support in the process.¹⁴

In 2008, Storm conducted a research-based evaluation of the Danish elite sport system and TD. It concluded that the Danish elite sport system performed well in relation to several of the factors evaluated: organisation and structure, sports medicine and support services, corporation with federations and (post) athletic career support. Talent identification and development were among the areas in which the Danish system was in need of improving. Furthermore, TD needed less bureaucratic control procedures. Denmark's training facilities were also lagging behind international standards.

The SPLISS 2.0 study (De Bosscher *et al.*, 2015) makes similar conclusions. It paints a picture of an efficient Danish elite sport system overall, which, compared to the nations analysed, achieves above average scores for a majority of the policy factors evaluated, including "structure and organisation", "overall sport participation", "talent identification and talent development", "(post) athletic career support" and "international competition". Policy factors in which Denmark scored below the average were "financial support", "training facilities", "coach development and provision", and "research and innovation" (De Bosscher *et al.*, 2015).

In 2013, following up on the national SPLISS results, TD adjusted its guidelines

for financial support, along with its overall policy goals, in order to improve in relation to the national SPLISS report's findings (Storm & Tofft-Jørgensen, 2013), and the preliminary findings of the international comparisons. In 2013–2015, Danish researchers conducted annual surveys and qualitative interviews among performance directors, coaches, managers and athletes in the supported federations on behalf of TD (Storm, Rask, & Holskov, 2015). The results indicate a high level of satisfaction with the Danish elite sport system among all groups of respondents. Among the main concerns, however, was the level of the overall funding for Danish elite sport, and problems concerning the provision of access to international training facilities, which were also identified in the SPLISS study.

From an overall perspective, much evidence indicates that the system is largely efficient. TD seems to have gradually improved its procedures with regard to several of the critical throughputs. Although the evidence does not make proof of causality possible, we find it highly likely that it is the improvement of throughputs that have converted a relatively stable level of input into a higher output. In the next section, we briefly discuss the above findings and touch on the challenges that will face Danish elite sport in the years to come.

5. DISCUSSION, CONCLUDING REMARKS AND FUTURE PERSPECTIVES

The analysis reveals that whatever measure is used – in absolute terms, by a market share approach, or adjusted for socio-economic, political and religious factors – Denmark's performance (output) in elite sport

¹⁴It is important to stress that existing research is inconclusive as to whether allocating resources to a narrower set of disciplines is necessary to improve international standings. Even though a prioritised approach seems necessary to obtain a high level of international elite sport success, De Bosscher *et al.* (2015) conclude that it is the absolute amount of resources poured into the elite sport system that seems to matter the most in relation to output.

has improved over the years. The system appears to have become more efficient after the slump in the 1970s, when the country fell behind in the international sporting arms race. Denmark has even made a marked improvement in recent years, particularly between 2009 and 2015.

It is arguable that the overall improvement would not have materialised without a well-organised elite sport system, and it seems that the establishment of TD has had a positive effect on Denmark's standing in international elite sport by developing and improving this system. The Danish system has demonstrated the capability to convert input into output through systematic improvement of the throughputs. Denmark has improved its competitiveness in the global sporting arms race by continuously improving the system and focusing its resources on selected sports. Interestingly, this has happened in spite of stagnating funding (input) for TD. This further indicates an improved throughput process, where a higher output has been achieved for a relatively fixed amount of input. Seen from a broader perspective, the Danish case shows how a small nation, despite limited resources, can be successful in international elite sport. By fine-tuning the throughput procedures and focusing more on output, the Danish system has helped constantly improve Danish competitiveness in international elite sport. This clearly shows that a well-functioning elite sport system can help small nations to become successful.

However, future success is far from guaranteed. The improvement of Denmark's international standing in recent years in spite of stagnating funds contradicts the general trend that the total amount of funding is the most important prerequisite for international sporting success (De

Bosscher et al., 2015). It will be very difficult to continue to do so. International competition and the investment and efforts required to stay competitive are increasing as reflected in the immense value accorded to medals in major sporting events (De Bosscher et al., 2015; Shibli et al., 2007). Furthermore, successful models are copied and results in decreasing returns,¹⁵ unless they adapt to the increasingly competitive international environment and constantly improve. To counter the ongoing pressure of international competition and uphold its current standing, TD can do two things.

First, it can work to improve its efficacy in the areas in which its performance is relatively poor. According to the SPLISS 2.0 study these are: research and innovation, training facilities, and coach provision and development (De Bosscher et al., 2015). TD has already put more focus on these factors by planning for a new national elite sports centre. The idea is to improve the overall standard of training facilities by providing more specialised facilities for the supported sports. Furthermore, TD aims at making better room for researchers in the new facilities. This could potentially make way for more cooperation between athletes and researchers and more innovation. In addition, improved conditions for coaches would potentially affect the Danish output positively. One central finding in the Danish part of the SPLISS 2.0 study were that, working as a coach – even at the highest level – is hard because employment is short term and uncertain. This makes many coaches leave sport in order to find better employment opportunities outside the sector. Future research can examine how and to what extent TD is able to improve the Danish elite sport system in these areas.

¹⁵ Australia has painfully experienced this effect by way of a consistent decline since its high point at the Sydney Olympics in 2000 as other countries have copied its successful structure.

Second, TD can work on increasing its revenue. The political priorities regarding sport in Denmark are mainly in favour of enhancing mass participation, and despite a generally positive attitude towards TD among Danish politicians, a significant increase in public elite sport spending is unlikely in the near future. If TD is committed to improving its performance, new sources of revenue must be found by way of private sponsorships.

The current ratio of TD's public and private revenue is around 80/20. This is a skewed distribution compared to similar organisations in other countries, and after 30 years of climbing up the ladder in international elite sport, primarily with public support, it seems clear that the next step for Danish elite sport could be to balance its sources of funding. This problem was identified in 2001 by the working group revising the Danish law on elite sport (Kulturministeriet, 2001). Although some progress has been made with respect to private sponsorships in recent years, this issue has not yet been dealt with in a systematic way.

The Danish elite sport system may be strengthened by improving the throughput factors that received low scores in the SPLISS 2.0 study. However, increasing private sponsorships might be the area with the greatest potential for upholding – or even increasing – the competitiveness of Danish elite sport in the future.

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APPENDIX

Table A1. Regression variable values

Year	Number of observations (N)	R ² -Value	Constant	POP	GDP/cap (PPP)	Muslim	EEC
1988 (OL)	55	0.620	−6.294 (−4.161)	0.767 (7.182)	0.852 (5.519)	−1.015 (−2.547)	2.154 (3.766)
1992 (OL)	67	0.562	−5.406 (−4.552)	0.551 (7.198)	0.843 (6.846)	−0.692 (−1.717)	1.288 (3.212)
1996 (OL)	89	0.520	−4.750 (−4.685)	0.407 (5.758)	0.818 (7.494)	−0.689 (−2.163)	1.118 (3.929)
2000 (OL)	99	0.519	−6.215 (−5.262)	0.640 (8.711)	0.869 (7.319)	−0.837 (−2.724)	1.376 (4.838)
2004 (OL)	110	0.605	−4.925 (−5.327)	0.601 (10.078)	0.742 (7.980)	−1.226 (−5.132)	1.193 (4.938)
2008 (OL)	105	0.556	−4.251 (−4.444)	0.638 (9.894)	0.646 (6.917)	−0.929 (−3.581)	0.959 (3.941)
2009	97	0.560	−4.831 (−4.421)	0.542 (8.224)	0.741 (6.948)	−0.854 (−3.218)	0.845 (3.431)
2010	102	0.623	−4.692 (−4.083)	0.699 (11.710)	0.667 (5.940)	−0.919 (−3.710)	1.094 (4.649)
2011	105	0.536	−3.620 (3.211)	0.540 (9.034)	0.603 (5.516)	−1.122 (−4.460)	1.024 (4.127)
2012 (OL)	110	0.581	−5.011 (−0.523)	0.584 (9.821)	0.726 (7.655)	−0.936 (−3.697)	1.096 (4.416)
2013	101	0.620	−3.701 (−3.372)	0.641 (10.793)	0.578 (5.433)	−1.267 (−5.433)	1.311 (−5.433)
2014	101	0.562	−3.575 (−2.865)	0.600 (9.857)	0.573 (4.763)	−0.973 (−3.859)	1.236 (4.943)
2015	103	0.590	−4.089 (−3.779)	0.583 (10.537)	0.644 (6.121)	−1.032 (4.334)	0.864 (3.834)

Note: All independent variables were significant in all models, $P < .05$, t -values in brackets. GDP and POP is log transformed. OL, Olympic year.

Table A2. Test for normality

	Kolmogorov–Smirnov	Shapiro–Wilk
1988 (OL)	0.200	0.396
1992 (OL)	0.065	0.037
1996 (OL)	0.200	0.189
2000 (OL)	0.200	0.116
2004 (OL)	0.200	0.687
2008 (OL)	0.200	0.796
2009	0.200	0.280
2010	0.200	0.961
2011	0.200	0.219
2012 (OL)	0.200	0.621
2013	0.200	0.855
2014	0.200	0.342
2015	0.136	0.706