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## **Historical and contemporary trends in competitive balance in the Commonwealth Games**

### **Las tendencias históricas y contemporáneas en el equilibrio competitivo en los Juegos de la Commonwealth**

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#### **Abstract**

Studies of competitive balance in sport have considered primarily professional leagues and team sports. This paper investigates trends in competitive balance in a multi-sport event context – the Commonwealth Games – using three distinct indicators. The investigation demonstrated that the Games have become significantly less competitive overall between 1930 and 2010 ( $p < 0.01$ ) according to two indicators – the percentage of nations to win a medal point and the coefficient of variation in nations' market share (medal points won divided by medals points available). Conversely, one indicator – Herfindahl-Hirschman Index (the sum of the squares of nations' market shares in a given edition) – revealed that there has been a strong, albeit insignificant, improvement in the overall standard of the competition over the last twenty years ( $p > 0.10$ ). Events contested by 'men only' were found to be the most balanced relative to both 'women only' and 'mixed / open' events across all indicators. Boxing and athletics emerged as the most balanced sports compared with diving, cycling, swimming and, to a lesser extent, weightlifting. The findings are of value to competition authorities to determine whether to implement corrective measures in order to maintain or improve competitive balance.

**Key words:** competition; elite performance; multi-sport events; uncertainty of outcome

#### **Resumen**

Los estudios sobre equilibrio competitivo en deporte han considerado principalmente ligas profesionales y deportes de equipo. Esta investigación analiza las tendencias en el equilibrio competitivo en un contexto de un evento multideportivo: Los Juegos de la Commonwealth, empleando para ello tres indicadores diferentes. Así, los resultados muestran que el nivel competitivo de los Juegos ha decrecido globalmente entre 1930 y 2010 ( $p < 0.01$ ) de acuerdo a dos indicadores: el porcentaje de naciones que han ganado una medalla y el coeficiente de variación en la cuota de mercado de los países (medallas ganadas entre las medallas disponibles). Por otra parte, el indicador de Herfindahl-Hirschman, que refleja la suma de los cuadrados de las cuotas de mercado de los países en una edición determinada, sugiere que ha habido una mejora, aunque insignificante, en el nivel competitivo global en los últimos 20 años ( $p > 0.10$ ). Los eventos en los que competían hombres únicamente han estado más equilibrados con respecto a los de mujeres o los mixtos, y este resultado se refleja en los tres indicadores. El boxeo y el atletismo han sido los deportes más equilibrados, comparados con los saltos de trampolín, el ciclismo, la natación y, en menor medida, la halterofilia. Estos resultados proporcionan una valiosa fuente de información para la gestión de los Juegos, en aras de implementar medidas correctivas para mantener o mejorar el equilibrio de la competición.

**Palabras clave:** equilibrio competitivo; alto rendimiento; eventos multideportivos; incertidumbre en el resultado.

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## Introduction

This paper examines the concept of competitive balance in the Commonwealth Games. In simple descriptive terms, it is measured by changes in the relative share of success between nations over time. A statistical interpretation is made using a normalised measure of dispersion and a commonly accepted industry concentration ratio is also applied. The analysis includes a consideration of competitive balance in nations' overall performance in each edition of the competition since 1930; by type of event ('men only', 'women only' and 'mixed / open' events contested by both men and women); and, at individual sport level for six sports that have been contested on a consistent basis in the post-World War II era. The paper is structured in the following order. The contribution of the research to academia and management practice is first acknowledged. This is followed by a brief contextual overview of the Commonwealth Games. The alternative competitiveness indicators used in this study and their interpretations are explained subsequently in the methodology section. The research findings are then presented, discussed and summarised.

### *Theoretical considerations and practical relevance*

In business terminology, competitive balance is normally used to describe a market situation where no business is too big or has an unfair advantage (see FT Lexicon, 2013). Academic literature on sports economics is inundated with studies of competitive balance to establish the degree of equality of the playing strengths of teams in professional sports leagues. The main focus of these studies have been North American team sports (e.g. Butler, 1995; Maxcy and Mondello, 2006; Soebbing, 2008) and, to a lesser extent, leagues in Europe (e.g. Ramchandani, 2012; Williams, 2012) and the rest of the world (e.g. Booth, 2005). There has also been some limited consideration on the state of competitiveness within individual sports (e.g. Du Bois and Heyndels, 2007; Laband, 1990). Other lines of relevant literature debate the suitability of methods employed to measure competitiveness (e.g. Owen, 2010; Owen, Ryan and Weatherston, 2007) and consider potential factors that affect, or are influenced by, competitive balance (e.g. Borland and MacDonald, 2003; Brandes and Franck, 2007; Szymanski, 2003). However, to the best of our knowledge, there has been no formal assessment to date of this concept in major multi-sport events that are held less frequently.

Much of the previous research concerning elite performance in multi-sport events has focused on the determinants of sporting success including, for example, macro-economic variables (e.g. Bernard and Busse, 2004; Bian, 2005), sports policy factors (e.g. De Bosscher et al., 2006; Oakley and Green, 2001) and home advantage (e.g. Balmer, Neville and Williams, 2001, 2003; Ramchandani and Wilson, 2010, 2011, 2012). It is this evident gap in the extant literature which this paper seeks to address using the Commonwealth Games as a case study. Moreover, the comparative analysis of competitiveness within and between events contested by men, women and both men and women is a novel concept that adds more academic weight to the research. The same argument also exists for the individual sports examined in this research – athletics, boxing, cycling, diving, swimming and weightlifting – which have not been evaluated previously in competitive balance literature.

From a practical standpoint, the investigation provides a worthwhile test of the prevailing perception that the overall standard of the competition is getting stronger (see Degun, 2012). It is in the best interests of event organisers and promoters that competitive balance be improved, or at least maintained, in order that the unpredictability of sporting contests is not compromised. Indeed, some studies supporting the conventional uncertainty of outcome hypothesis have shown that competitive balance in sport is correlated with attendance demand (e.g. Meehan, Nelson and Richardson, 2007; Rascher and Solmes, 2007). If this is correct, then any decline in competition may result in reduced income from gate receipts. Furthermore, although not proven conclusively, if the demand for watching sport on television is also affected by competitive balance, then there is a danger that commercial and broadcasting revenues may also be affected adversely. Not only is it therefore important for competition authorities such as the Commonwealth Games Federation (CGF) – the organisation responsible for the direction and control of the Commonwealth Games – to be conscious of the state of competitiveness but also to continue to monitor it going forward and implement corrective measures in order to avoid any negative financial consequences.

#### *The Commonwealth Games in context*

In 1930 Hamilton, Canada, hosted the inaugural edition of the Commonwealth Games, with 11 countries and 400 athletes contesting six sports and 59 events. Since then, there have been 18 further editions, conducted every four years (except for 1942 and 1946 due to World War II). Attendance at each edition of the Commonwealth Games has steadily increased to the point that since 2002 all Commonwealth nations have been represented. As the number of nations taking part has increased, so too have the number of athletes, sports and events, as shown in Table 1.

Table 1: Growth of the Commonwealth Games 1930-2010

<b>Year</b>	<b>Host City (Nation)</b>	<b>Nations</b>	<b>Athletes</b>	<b>Sports</b>	<b>Events</b>
1930	Hamilton (Canada)	11	400	6	59
1934	London (England)	16	500	6	68
1938	Sydney (Australia)	15	464	7	71
1950	Auckland (New Zealand)	12	590	9	88
1954	Vancouver (Canada)	24	662	9	91
1958	Cardiff (Wales)	35	1,122	9	94
1962	Perth (Australia)	35	863	9	104
1966	Kingston (Jamaica)	34	1,050	9	110
1970	Edinburgh (Scotland)	42	1,383	9	121
1974	Christchurch (New Zealand)	38	1,276	9	121
1978	Edmonton (Canada)	46	1,474	10	128
1982	Brisbane (Australia)	46	1,583	10	142
1986	Edinburgh (Scotland)	26	1,662	10	163
1990	Auckland (New Zealand)	55	2,073	10	204
1994	Victoria (Canada)	63	2,557	10	217
1998	Kuala Lumpur (Malaysia)	70	3,633	15	213
2002	Manchester (England)	72	3,679	17	281
2006	Melbourne (Australia)	71	4,049	16	245
2010	Delhi (India)	71	4,352	17	272

Source: The CGF (2013)

The Commonwealth Games comprises events for 'men only', 'women only' and 'mixed / open' events contested by both genders. Whilst 'men only' and 'women only' events have been contested in all editions between 1930 and 2010, 'mixed / open' events were first introduced in 1966. According to Ramchandani and Wilson's (2011) analysis, historically, 'men only' events have dominated the proportion of events contested in each edition, albeit since 2002 events for women account for around 45% of the programme. By contrast, fewer than 3% of the events contested are 'mixed / open'. The modern day competition programme must include a minimum of ten core sports – athletics, badminton, boxing, hockey, lawn bowls, netball, rugby sevens, squash, swimming and weightlifting. Host nations can also select up to seven sports from an optional list. Amongst others, the list of optional sports includes cycling and diving. Only four sports have been held in every edition of the competition – athletics, boxing, diving and swimming. Mandatory team sports such as hockey, rugby sevens and netball were not held prior to 1998. In order to broaden the scope of the analysis at individual sport level, we have included six sports that have been contested regularly in the last 16 editions since 1950. This includes four core sports of athletics, boxing, swimming and weightlifting plus two optional sports of cycling (encompassing road, mountain bike and track disciplines) and diving.

## **Methodology**

### *Data collation and performance measurement*

The results of previous editions of the Commonwealth Games were collated from the official website of the CGF ([www.cgf.com](http://www.cgf.com)). The approach used to quantify nations' performance involved converting the total number of medals won by any given nation into points – 3 per gold, 2 per silver and 1 per bronze – expressed subsequently as a percentage of the total number of points awarded in that edition. This performance indicator is known as 'market share'. It is an accepted measure of nations' performance in academia (see Ramchandani and Wilson, 2010, 2011, 2012) and it has also been endorsed by national agencies responsible for elite sport in their performance evaluations (see Sport NI, 2012; sportscotland, 2011). For example, in the XIX Commonwealth Games held in Delhi, India, in 2010, Scotland won 9 gold medals (27 points), 10 silver medals (20 points) and 7 bronze medals (7 points), which equates to 54 medal points collectively. Based on the number of gold (272), silver (270) and bronze (278) medals awarded in 2010 overall, the total number of points available was 1,634. Therefore, Scotland's overall market share was 3.30% (i.e.  $54 / 1634$ ). The consideration of medal points and market shares for all nations provided the basis for undertaking the investigation of competitive balance across all editions.

### *Competitive balance indicators*

This research uses three indicators to measure competitive balance – proportion of medal point winning nations (PWN); coefficient of variation (CV) in nations' market share; and, the Herfindahl-Hirschman Index (HHI). PWN is a descriptive measurement of competitiveness. It is calculated as the number of nations to win at least one medal point in a given edition divided by the total number of nations taking part in that edition. The PWN indicator can range between  $1/N$  to 1, where N is the number of nations competing in a given edition. A high value of PWN is indicative of greater competition for medals amongst nations. CV measures statistical

dispersion and is the ratio of the standard deviation of a data set (e.g. medal points or market share) to the mean of that data set. It is a more robust statistic than standard deviation when comparing the degree of variation between data sets. CV is also a unit-less indicator. A low CV indicates that the data is closely clustered around the mean (i.e. equality amongst nations) whereas a high CV indicates more dispersion (i.e. inequality amongst nations). HHI is a market concentration indicator. It is the sum of the squares of the market share for each nation in a given edition. For the purpose of this research, a normalised version of HHI was used to account for differences in the number of nations in each edition over time, using the formula  $(HHI - 1/N) / (1 - 1/N)$ , where N is the number of nations competing in a given edition. The value of this normalised HHI can range between 0 and 1. Higher values mean greater concentration, less competition, and more control held by individual nations. The advantage of using these standardised indicators is that they can be used to compare competitiveness over time, even when the number of nations in different editions is unequal, as well as between different events and sports, on a like-for-like basis.

#### *Analytical procedure*

The competitive balance of each Commonwealth Games edition (i.e. 1930, 1934, 1938 and so on) was ranked according to its score for each indicator, with 1 representing the most balanced edition. This process was repeated for the sub-analysis of event type and individual sports. The direction and strength of the change in competitiveness with the passage of time was examined using correlation analysis. For each indicator, a positive correlation coefficient (r) would in this case imply a declining trend, whereas a negative value of r represents an improvement. Apart from the 'within event' and 'within sport' time series analysis, the competitive balance between different events and between different sports was also inspected. This was done by ranking the indicator scores for each type of event and sport relative to the other events and sports respectively for every edition and then comparing their average (median) ranks.

## **Results and Discussion**

The results are presented and discussed: first, longitudinally (1930-2010); and second, for more recent editions of the Commonwealth Games (1990 onwards).

### ***Historical outlook***

#### *Overall performance*

The competitiveness indicators' scores and ranks for the 19 editions of the Commonwealth Games to date are shown in Table 2. For two of the three indicators examined, 1950 was the most competitive edition (PWN and CV); whereas, according to one indicator the most competitive season was 1982 (HHI). The most imbalanced editions were 1930 (HHI), 1978 (PWN) and 1998 (CV), depending on which indicator is considered. The final row of Table 2 presents the correlations between the rank for each indicator and time. Overall, between 1930 and 2010, there has been a strong and statistically significant reduction in competitive balance measured in terms of PWN ( $r = 0.84$ ,  $p < 0.01$ ) and CV ( $r = 0.88$ ,  $p < 0.01$ ). However, the HHI indicator reveals an improving but insignificant trend in competitive balance of nations' overall performance during the same time period ( $r = -0.32$ ,  $p = 0.18$ ). This discrepancy between indicators is also evident when we consider that the overall competitiveness of most recent

edition, 2010, is ranked 16<sup>th</sup> (out of 19) according to PWN and 13<sup>th</sup> according to CV, but as high as second for HHI.

Table 2: Overall competitive balance in the Commonwealth Games

Year	PWN		CV		HHI	
	Score	Rank	Score	Rank	Score	Rank
1930	0.818	2	149.77	3	0.204	19
1934	0.750	3	159.27	4	0.189	17
1938	0.667	5	142.48	2	0.149	12
1950	1.000	1	125.75	1	0.132	8
1954	0.708	4	164.29	5	0.112	3
1958	0.657	6	223.02	8	0.142	11
1962	0.629	9	250.92	11	0.180	16
1966	0.647	7	208.61	6	0.124	5
1970	0.643	8	230.50	10	0.127	6
1974	0.553	11	219.74	7	0.127	7
1978	0.457	19	278.24	14	0.168	15
1982	0.500	17	269.35	12	0.089	1
1986	0.577	10	223.30	9	0.192	18
1990	0.545	13	278.93	15	0.141	10
1994	0.524	15	314.93	18	0.157	13
1998	0.486	18	336.18	19	0.161	14
2002	0.542	14	290.18	16	0.117	4
2006	0.549	12	309.68	17	0.135	9
2010	0.507	16	272.08	13	0.104	2
Correlation with Time (1930 = 1, 2010 = 19)		0.84 p = 0.00		0.88 p = 0.00		-0.32 p = 0.18

### *Analysis by event type*

Table 3 presents the findings for the different event types. For the PWN and CV indicators, the overall decline in competitive balance over time (as shown above) appears to be the result of a strong decline in competitiveness within events contested by 'men only' ( $0.88 \leq r \leq 0.91$ ,  $p < 0.01$ ). By contrast, HHI does not reveal any significant change for 'men only' events in the long term ( $r = -0.36$ ,  $p = 0.13$ ). For 'women only' events, CV demonstrates a moderate decline ( $r = 0.61$ ,  $p = 0.01$ ) whereas there is no significant pattern using PWN ( $r = 0.25$ ,  $p = 0.30$ ) and a moderate improvement according to HHI ( $r = -0.56$ ,  $p = 0.01$ ). Competitive balance in 'mixed / open' events has remained relatively unchanged using PWN and CV ( $-0.14 \leq r \leq -0.12$ ,  $p > 0.56$ ) but improved to some extent on the basis of HHI ( $r = -0.66$ ,  $p < 0.01$ ).

Despite mixed trends over time within the different events, closer scrutiny of the data in Table 3 (Rank II) reveals that there is consenting evidence across all three indicators about the level of competitive balance between the event types. The competitiveness of 'men only' events is consistently better than both 'women only' and 'mixed / open' events using PWN, CV and HHI. Moreover, 'women only' events tend to be typically more competitive than 'mixed / open' events, regardless of which indicator is considered.

Table 3: Competitive balance by event type

Year	PWN						CV						HHI					
	Men		Women		Mixed		Men		Women		Mixed		Men		Women		Mixed	
	Score	Rank I (II)	Score	Rank I (II)	Score	Rank I (II)	Score	Rank I (II)	Score	Rank I (II)	Score	Rank I (II)	Score	Rank I (II)	Score	Rank I (II)	Score	Rank I (II)
1930	0.727	3 (1)	0.455	3 (2)	n/a	n/a	151.11	4 (1)	154.16	1 (2)	n/a	n/a	0.208	19 (1)	0.216	9 (2)	n/a	n/a
1934	0.750	2 (1)	0.438	4 (2)	n/a	n/a	150.76	3 (1)	191.85	5 (2)	n/a	n/a	0.170	17 (1)	0.270	17 (2)	n/a	n/a
1938	0.667	5 (1)	0.467	2 (2)	n/a	n/a	135.73	2 (1)	176.93	4 (2)	n/a	n/a	0.136	13 (1)	0.228	12 (2)	n/a	n/a
1950	1.000	1 (1)	0.500	1 (2)	n/a	n/a	116.42	1 (1)	171.26	2 (2)	n/a	n/a	0.113	9 (1)	0.244	13 (2)	n/a	n/a
1954	0.708	4 (1)	0.375	6 (2)	n/a	n/a	163.81	5 (1)	171.88	3 (2)	n/a	n/a	0.112	8 (1)	0.123	3 (2)	n/a	n/a
1958	0.657	6 (1)	0.143	18 (2)	n/a	n/a	200.38	8 (1)	339.39	14 (2)	n/a	n/a	0.115	10 (1)	0.329	18 (2)	n/a	n/a
1962	0.629	7 (1)	0.114	19 (2)	n/a	n/a	226.49	11 (1)	346.82	15 (2)	n/a	n/a	0.147	16 (1)	0.344	19 (2)	n/a	n/a
1966	0.600	9 (1)	0.229	16 (2)	0.143	3 (3)	181.65	6 (1)	300.16	9 (3)	299.65	2 (2)	0.094	2 (1)	0.257	14 (3)	0.257	6 (2)
1970	0.619	8 (1)	0.262	13 (2)	0.024	12 (3)	199.19	7 (1)	332.48	12 (2)	648.07	12 (3)	0.094	3 (1)	0.263	16 (2)	1.000	12 (3)
1974	0.553	10 (1)	0.289	10 (2)	0.079	11 (3)	205.23	9 (1)	292.58	8 (2)	397.19	8 (3)	0.111	6 (1)	0.227	11 (2)	0.415	11 (3)
1978	0.457	17 (1)	0.174	17 (2)	0.087	9 (3)	253.67	12 (1)	347.44	16 (2)	408.46	10 (3)	0.140	15 (1)	0.262	15 (2)	0.363	10 (3)
1982	0.478	15 (1)	0.239	15 (2)	0.174	2 (3)	255.58	13 (1)	318.70	11 (3)	317.49	5 (2)	0.088	1 (1)	0.091	1 (2)	0.191	3 (3)
1986	0.538	11 (1)	0.346	7 (2)	0.192	1 (3)	218.70	10 (1)	232.53	6 (2)	261.66	1 (3)	0.184	18 (1)	0.208	6 (2)	0.263	7 (3)
1990	0.455	18 (1)	0.273	12 (2)	0.091	8 (3)	255.68	14 (1)	339.19	13 (2)	388.92	7 (3)	0.119	11 (1)	0.209	7 (2)	0.275	8 (3)
1994	0.492	13 (1)	0.286	11 (2)	0.095	7 (3)	293.14	18 (1)	364.72	18 (2)	416.60	11 (3)	0.136	14 (1)	0.211	8 (2)	0.275	9 (3)
1998	0.457	16 (1)	0.257	14 (2)	0.114	4 (3)	305.90	19 (1)	392.09	19 (3)	379.23	6 (2)	0.134	12 (1)	0.220	10 (3)	0.205	4 (2)
2002	0.486	14 (1)	0.319	9 (2)	0.097	6 (3)	282.86	17 (1)	310.13	10 (2)	317.00	4 (3)	0.111	7 (1)	0.134	4 (2)	0.140	1 (3)
2006	0.507	12 (1)	0.324	8 (2)	0.085	10 (3)	277.00	16 (1)	356.67	17 (2)	405.38	9 (3)	0.108	5 (1)	0.179	5 (2)	0.231	5 (3)
2010	0.437	19 (1)	0.380	5 (2)	0.113	5 (3)	267.26	15 (1)	288.55	7 (2)	316.36	3 (3)	0.101	4 (1)	0.117	2 (2)	0.141	2 (3)
<b>Correlation of Rank I with Time (1930 = 1, 2010 = 19)</b>	0.88 p = 0.00		0.25 p = 0.30		-0.12 p = 0.62			0.91 p = 0.00		0.61 p = 0.01		-0.14 p = 0.57		-0.36 p = 0.13		-0.56 p = 0.01		-0.66 p = 0.00
<b>Median Rank II</b>	1		2		3		1		2		3		1		2		3	

Note: For each indicator, Rank I is based on comparisons over time within each event type, whereas Rank II is based on comparisons between event types in each edition.



### *Sport-specific results*

To re-iterate, the sport-specific analysis is based on six sports that have been contested regularly since 1950. The competitiveness scores for each sport over time are illustrated in Table 4 and the corresponding ranks within and between sports appear in Table 5. For all six sports examined, competitive balance using PWN and CV has weakened either moderately or strongly between 1950 and 2010 ( $0.50 \leq r \leq 0.88$ ,  $p < 0.05$ ). However, measured using the HHI indicator, there are no significant changes in competitive balance within these sports during the same period ( $-0.40 \leq r \leq 0.20$ ,  $p > 0.12$ ).

As with the different event types the level of competitiveness also fluctuates between sports (see Table 4). Averaged across the last 16 editions, athletics is the most balanced sport using PWN, with a median rank of 1, followed by boxing (median rank of 2), whereas the least competitive sport is diving (median rank of 6). For the other two indicators, boxing tops the competitiveness rankings, followed by athletics. The order of the median ranks for the other four sports is essentially the same across all indicators, with diving being the least competitive as shown in Table 5.

### *Contemporary trends (1990 - 2010)*

As referenced previously, the scale of the Commonwealth Games has increased considerably in more recent editions, both in terms of the number of nations taking part and the programme of sports and events contested. In order to examine more contemporary trends in competitive balance, the analysis was restricted to the last six editions spanning 20 years. The time period chosen also has the advantage of excluding the 1986 edition, which can be regarded as atypical as a result of being affected by a boycott by several nations. Focusing on a shorter span of time does however have the residual outcome of compromising the statistical reliability of the trends.

Using the 1990 - 2010 time frame, we observed little or no change in competitive balance overall and in 'men only' events on the basis of the PWN and CV indicators ( $-0.31 \leq r \leq 0.09$ ,  $p > 0.54$ ), but a strong improvement in competitiveness measured using HHI ( $-0.83 \leq r \leq -0.71$ ,  $0.04 < p < 0.11$ ). On the other hand, there is an improvement of differing strengths and significance within 'women only' events ( $-0.83 \leq r \leq -0.49$ ,  $0.04 < p < 0.32$ ) and 'mixed / open' events ( $-0.66 \leq r \leq -0.20$ ,  $p > 0.15$ ) across all indicators during this period – see Table 6. Between the different event types, consistent with the historical view, 'men only' events (median rank of 1) emerge as being more balanced than 'women only' events (median rank of 2), which in turn are more balanced than 'mixed / open' events (median rank of 3).

The contemporary trends within the individual sports examined are somewhat varied. The statistical strength of these trends also varies. Accepting the statistical limitations of the results, for three sports – athletics, swimming and weightlifting – competitive balance has improved strongly or moderately across all indicators ( $-0.94 \leq r \leq -0.66$ ). Conversely, competitiveness in boxing has declined for all indicators ( $0.77 \leq r \leq 0.94$ ). Cycling demonstrates an improvement for two indicators (PWN and HHI) but a decline for one (CV), whereas in the case of diving there is an improving trend for one indicator (HHI) but the other two suggest a decline (PWN and CV). The competitive balance between sports since 1990 (based on their median ranks) however follows an almost identical pattern to the longitudinal trend. The only difference is that the median ranks for cycling and swimming are identical for all indicators.

Table 4: Competitive balance by sport (indicator scores)

Year	PWN						CV						HHI					
	Ath.	Box.	Cyc.	Div.	Swi.	Wei.	Ath.	Box.	Cyc.	Div.	Swi.	Wei.	Ath.	Box.	Cyc.	Div.	Swi.	Wei.
1950	0.750	0.667	0.250	0.417	0.583	0.500	139.62	95.82	234.17	139.81	126.78	116.46	0.162	0.077	0.457	0.163	0.134	0.113
1954	0.583	0.333	0.208	0.208	0.292	0.375	169.04	171.34	276.08	230.31	199.20	192.31	0.119	0.122	0.318	0.221	0.165	0.154
1958	0.371	0.286	0.143	0.086	0.171	0.286	231.33	206.51	339.72	431.41	350.42	177.12	0.153	0.122	0.330	0.532	0.351	0.090
1962	0.400	0.400	0.086	0.086	0.143	0.286	269.80	173.85	375.54	365.48	370.76	206.91	0.208	0.086	0.403	0.382	0.393	0.122
1966	0.500	0.324	0.147	0.088	0.147	0.265	194.35	186.30	276.00	368.88	310.64	225.79	0.107	0.098	0.217	0.388	0.275	0.145
1970	0.357	0.381	0.167	0.071	0.167	0.262	236.50	180.72	289.89	405.64	383.64	240.67	0.133	0.078	0.200	0.392	0.350	0.138
1974	0.395	0.395	0.132	0.079	0.158	0.237	223.80	177.93	378.51	385.07	316.87	242.47	0.132	0.083	0.377	0.390	0.264	0.155
1978	0.283	0.326	0.109	0.065	0.087	0.152	281.24	199.41	353.07	458.47	370.03	299.28	0.172	0.086	0.271	0.457	0.298	0.195
1982	0.304	0.326	0.087	0.087	0.087	0.152	256.56	226.72	376.46	384.90	375.32	299.28	0.143	0.112	0.308	0.322	0.306	0.195
1986	0.269	0.385	0.231	0.115	0.192	0.269	250.27	194.32	271.30	338.34	255.91	226.92	0.241	0.145	0.283	0.440	0.252	0.198
1990	0.236	0.291	0.109	0.091	0.073	0.145	301.04	205.84	414.62	440.26	459.86	313.51	0.165	0.077	0.313	0.352	0.385	0.179
1994	0.222	0.333	0.095	0.063	0.095	0.143	299.87	230.18	453.13	503.60	460.03	344.19	0.143	0.084	0.326	0.403	0.376	0.188
1998	0.329	0.300	0.100	0.057	0.086	0.129	310.59	243.93	452.36	516.84	514.32	323.39	0.138	0.085	0.292	0.382	0.378	0.149
2002	0.319	0.250	0.083	0.042	0.139	0.181	272.39	240.72	463.22	486.44	441.96	287.97	0.103	0.080	0.298	0.329	0.271	0.115
2006	0.324	0.268	0.113	0.056	0.113	0.239	293.13	266.67	466.56	516.99	420.86	300.58	0.121	0.100	0.307	0.376	0.249	0.127
2010	0.338	0.225	0.127	0.056	0.141	0.197	262.16	274.58	443.08	479.63	426.33	299.91	0.097	0.106	0.277	0.324	0.256	0.127

Table 5: Competitive balance by sport (indicator ranks)

Year	PWN						CV						HHI					
	Ath.	Box.	Cyc.	Div.	Swi.	Wei.	Ath.	Box.	Cyc.	Div.	Swi.	Wei.	Ath.	Box.	Cyc.	Div.	Swi.	Wei.
	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)	Rank I (II)
1950	1 (1)	1 (2)	1 (6)	1 (5)	1 (3)	1 (4)	1 (4)	1 (1)	1 (6)	1 (5)	1 (3)	1 (2)	12 (4)	1 (1)	16 (6)	1 (5)	1 (3)	2 (2)
1954	2 (1)	6 (3)	3 (5)	2 (5)	2 (4)	2 (2)	2 (1)	2 (2)	4 (6)	2 (5)	2 (4)	3 (3)	4 (1)	15 (2)	11 (6)	2 (5)	2 (4)	10 (3)
1958	6 (1)	13 (2)	6 (5)	7 (6)	4 (4)	3 (2)	5 (3)	10 (2)	6 (4)	9 (6)	6 (5)	2 (1)	11 (3)	14 (2)	13 (4)	16 (6)	12 (5)	1 (1)
1962	4 (1)	2 (1)	15 (5)	7 (5)	8 (4)	3 (3)	10 (3)	3 (1)	8 (6)	4 (4)	8 (5)	4 (2)	15 (3)	8 (1)	15 (6)	9 (4)	16 (5)	4 (2)
1966	3 (1)	10 (2)	5 (4)	5 (6)	7 (4)	6 (3)	3 (2)	6 (1)	3 (4)	5 (6)	4 (5)	5 (3)	3 (2)	10 (1)	2 (4)	10 (6)	8 (5)	8 (3)
1970	7 (2)	5 (1)	4 (4)	10 (6)	5 (4)	7 (3)	6 (2)	5 (1)	5 (4)	8 (6)	10 (5)	7 (3)	7 (2)	3 (1)	1 (4)	12 (6)	11 (5)	7 (3)
1974	5 (1)	3 (1)	7 (5)	9 (6)	6 (4)	9 (3)	4 (2)	4 (1)	10 (5)	7 (6)	5 (4)	8 (3)	6 (2)	5 (1)	14 (5)	11 (6)	6 (4)	11 (3)
1978	13 (2)	8 (1)	11 (4)	11 (6)	13 (5)	12 (3)	12 (2)	8 (1)	7 (4)	11 (6)	7 (5)	10 (3)	14 (2)	9 (1)	3 (4)	15 (6)	9 (5)	14 (3)
1982	12 (2)	8 (1)	14 (4)	6 (4)	13 (4)	12 (3)	8 (2)	11 (1)	9 (5)	6 (6)	9 (4)	10 (3)	10 (2)	13 (1)	9 (5)	3 (6)	10 (4)	14 (3)
1986	14 (2)	4 (1)	2 (4)	3 (6)	3 (5)	5 (2)	7 (3)	7 (1)	2 (5)	3 (6)	3 (4)	6 (2)	16 (3)	16 (1)	5 (5)	14 (6)	4 (4)	16 (2)
1990	15 (2)	12 (1)	10 (4)	4 (5)	16 (6)	14 (3)	15 (2)	9 (1)	11 (4)	10 (5)	14 (6)	14 (3)	13 (2)	2 (1)	10 (4)	6 (5)	15 (6)	12 (3)
1994	16 (2)	6 (1)	13 (4)	12 (6)	12 (4)	15 (3)	14 (2)	12 (1)	14 (4)	14 (6)	15 (5)	16 (3)	9 (2)	6 (1)	12 (4)	13 (6)	13 (5)	13 (3)
1998	9 (1)	11 (2)	12 (4)	13 (6)	15 (5)	16 (3)	16 (2)	14 (1)	13 (4)	15 (6)	16 (5)	15 (3)	8 (2)	7 (1)	6 (4)	8 (6)	14 (5)	9 (3)
2002	11 (1)	15 (2)	16 (5)	16 (6)	10 (4)	11 (3)	11 (2)	13 (1)	15 (5)	13 (6)	13 (4)	9 (3)	2 (2)	4 (1)	7 (5)	5 (6)	7 (4)	3 (3)
2006	10 (1)	14 (2)	9 (4)	14 (6)	11 (4)	8 (3)	13 (2)	15 (1)	16 (5)	16 (6)	11 (4)	13 (3)	5 (2)	11 (1)	8 (5)	7 (6)	3 (4)	6 (3)
2010	8 (1)	16 (2)	8 (5)	14 (6)	9 (4)	10 (3)	9 (1)	16 (2)	12 (5)	12 (6)	12 (4)	12 (3)	1 (1)	12 (2)	4 (5)	4 (6)	5 (4)	5 (3)
<b>Correlation of Rank I with Time (1950 = 1, 2010 = 16)</b>	0.69 p = 0.00	0.65 p = 0.00	0.50 p = 0.04	0.75 p = 0.00	0.67 p = 0.00	0.74 p = 0.00	0.75 p = 0.00	0.88 p = 0.00	0.81 p = 0.00	0.80 p = 0.00	0.77 p = 0.00	0.85 p = 0.00	-0.32 p = 0.23	0.00 p = 1.00	-0.40 p = 0.12	-0.05 p = 0.85	-0.07 p = 0.80	-0.20 p = 0.46
<b>Median Rank II</b>	1	1.5	4	6	4	3	2	1	5	6	4.5	3	2	1	5	6	4.5	3

Note: For each indicator, Rank I is based on comparisons over time within each sport, whereas Rank II is based on comparisons between individual sports in each edition.

Table 6: Trend and median ranks 1990 - 2010

	Trend (r and p values)			Event and sport comparisons (median ranks)		
	PWN	CV	HHI	PWN	CV	HHI
Overall	0.09 p = 0.87	- 0.31 p = 0.55	- 0.71 p = 0.11	n/a	n/a	n/a
Event: Men	0.03 p = 0.96	- 0.09 p = 0.87	- 0.83 p = 0.04	1	1	1
Event: Women	- 0.83 p = 0.04	- 0.49 p = 0.32	- 0.71 p = 0.11	2	2	2
Event: Mixed / Open	- 0.20 p = 0.70	- 0.54 p = 0.27	- 0.66 p = 0.15	3	3	3
Sport: Athletics	- 0.77 p = 0.07	- 0.77 p = 0.07	- 0.94 p = 0.01	1	2	2
Sport: Boxing	0.77 p = 0.07	0.94 p = 0.01	0.83 p = 0.04	2	1	1
Sport: Cycling	- 0.49 p = 0.32	0.37 p = 0.47	- 0.71 p = 0.11	4	4.5	4.5
Sport: Diving	0.73 p = 0.09	0.26 p = 0.62	- 0.54 p = 0.27	6	6	6
Sport: Swimming	- 0.89 p = 0.02	- 0.71 p = 0.11	- 0.89 p = 0.02	4	4.5	4.5
Sport: Weightlifting	- 0.71 p = 0.11	- 0.66 p = 0.15	- 0.77 p = 0.07	3	3	3

## Summary and Conclusions

This paper has attempted to make a genuine contribution to the existing literature on sports economics and elite sport performance by examining competitive balance in the context of a major multi-sport competition. In doing so, it stands to inform relevant authorities, in this case the CGF, with evidence to determine whether to implement corrective measures designed to maintain or improve competitive balance. The consideration of different event types and individual sports provides an extra layer of detail to the investigation. The interpretation of the trends discussed herein is dependent on a combination of two factors – the unit of measurement and the time frame examined.

Using alternative indicators has the advantage of broadening the criteria used to measure competitive balance. At the same time, when indicators provide mixed evidence about the direction, strength and significance of changes in competitive balance, as is the case with the competitiveness trends within events and within individual sports over time, it becomes more difficult to make authoritative judgements about these trends. Similarly, the research has shown that consideration of different time periods also affects how these trends are interpreted. Nonetheless, clear patterns do emerge about the competitive level between different types of events and between individual sports, both historically and in more recent editions. The key findings are summarised below.

- Two out of the three indicators examined revealed a strong and statistically significant decline in overall competitive balance between 1930 and 2010; by contrast, one indicator showed a strong, but insignificant, improvement over the last six editions spanning twenty years.
- The historical and contemporary trends within events contested by men are consistent with the overall pattern of competitiveness between nations. For both 'women only' and 'mixed / open' events, there are conflicting results depending on which indicator and time period is considered.
- At sport-specific level, there are either moderate or strong reductions in competitive balance using the 1950-2010 time frame for all six sports based on two indicators; there are however some variations in trends within sports since 1990.
- Comparisons between the different event types suggest that competition in 'men only' events is stronger than in 'women only' events across all indicators; the latter are in turn generally more balanced than 'mixed / open' events.
- The sport-specific comparisons demonstrate that boxing (two indicators) and athletics (one indicator) are the most balanced sports, with diving being the least competitive across all indicators.

One option to improve the overall competitive balance in the Commonwealth Games based on the research findings might be to re-configure the competition programme to include more events for 'men only' and restrict the number of 'mixed / open' events. The latter suggestion, however, is likely to be of limited value given that the events contested jointly by both men and women constitute a small fraction of the total events held in any edition (e.g. only seven such events were contested in Delhi 2010 out of 272 in total). Nevertheless, any planned increase in the scale of 'mixed / open' events by the CGF in forthcoming editions may serve to reduce balance in competition. Another option would be to address the imbalances identified at sport-specific level. However, while this paper reveals how competitive balance in the Commonwealth Games has evolved over time, it does not investigate the reasons behind certain sports contested in the competition being more balanced relative to others. Consequently, it is difficult to speculate about why athletics and boxing exhibit greater balance than weightlifting, cycling, swimming and diving. To this end, future research efforts should endeavour to explain the causal factors that influence competitive balance within specific sports. The identification of such reasons will help managers to make informed decisions in order to improve competition.

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