Do elite sports systems mean more Olympic medals?

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Abstract

How do elite sports systems influence Olympic medal success? This paper uses the original data set of Bernard & Busse (2000) to analyse the effect of elite sport systems on Olympic medal success. Our results show that the existence of elite sports systems positively affects the total numbers of medals won, but not the total number of gold medals won. We explain this by suggesting that the extraordinary talent required in winning a gold medal cannot be surpassed by the employment of an elite sports system.

Keywords: Olympic Games success, elite sports systems, strategic approach.

JEL classification O10 and M31

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Introduction

The largest and most notable staged sporting event is the Olympic Games. The modern Olympic Games have developed and grown from their initial beginnings in 1896 to becoming the foremost sports event in the World (Balmer, Nevill, & Williams, 2003). The 2004 Athens Olympic Games hosted 11,099 athletes from 202 countries, the Olympic flame travelled for the first time to all continents, and four billion viewers world wide watched the games (Athens Olympic Committee, 2004).

International success for a country's athletes and performing well at the Olympic Games, are generally believed to be important for the prestige of that nation (Hoffmann, Ging, & Ramasamy, 2002; Johnson & Ali, 2002). As Olympic success drives many sports, it is viewed as a means of encouraging participation with an ensuing impact on the health of that nation as well as the financial viability of that sport (Hogan & Norton, 2000).

Within most sports the measure of success is determined by one nation's overall placing in relation to its competitors, in this sense coming first is what counts (Davis & Kay, 1990; dell'Osso & Szymanski, 1991). Most nations have an expectation of how their athletes will perform at each Games, and subsequently how many medals they are predicted to win. This is evidenced by the reports in the media after each Olympic Games have been held and the medal tables totalled (Bernard & Busse, 2000).

The philosophy behind the modern Olympic Games is one of participation rather than winning, and of competition between individual athletes and not between nations (IOC, 2005). However, the official International Olympic Committee's (IOC) table of medals documents the Olympic success for a nation, not an athlete. This method of reporting success at the Olympic Games is a move away from the Olympic ideal of individual athletes taking part.

In this paper we use the original data set of Bernard & Busse (2000) with the addition of a new dummy variable for countries with elite sports systems to determine the effect of these systems on Olympic success. For the purpose of this paper an elite sport system is a directed and calculated approach designed to produce athletes that win at the international level of sport. This approach encompasses the use of sports science, sports medicine, talent identification, and coaching targeted at the development of elite athletes. Elite athletes are those athletes that compete at international level for their countries. This paper is organised around five key areas. Firstly we discuss the literature on the methods for determining Olympic success. Secondly we examine the literature on statistical methods to calculate Olympic medal success. Thirdly, we outline the methodology. Fourthly, a discussion of the findings is presented. Finally the paper provides key conclusions.

Determining Olympic success

Two main methods are identified in the literature for determining the level of a nation's elite sporting success, the first is essentially a consequence of that nation's GDP and size of population. The second is a sport system characterised by a strategic approach which takes into account a nation's government and political systems as well as socio–cultural

influences which determine the nature of that country's elite sport system (Sport Industry Research Centre, 2003).

Elite sport systems range from a typically British middle and upper class approach based on taking part rather than winning. This concept is embodied in the Olympic ideal. At the other end of this continuum we see a 'win at all costs' approach. This 'win at all costs' approach is based on a highly rationalised and formalised system that links sports science and sports medicine approaches with specialised talent identification of athletes and development systems for them. This essentially comprises the elite sports system or strategic approach (Green & Oakley, 2001; Sport Industry Research Centre, 2003).

There was a noticeable shift toward the use of a systematic strategic approach post 1948 by communist countries, a move which proved very successful for those nations, in particular the German Democratic Republic and Union of Soviet Socialists Republics (Green & Oakley, 2001; Sport Industry Research Centre, 2003). The demise of these countries in the late 1980s and early 1990s left a sporting legacy for elite sport development that other countries have since drawn upon and developed to form their own strategic approach to elite sport development (Green & Oakley, 2001; Kuper & Sterken, 2005).

Within this elite sports system or strategic approach there are two systems for the development of athletes. The first is a systematic talent identification based system which selects and develops the individual, an example of this being the Australian model. The second system allows for the emergence of sporting elites through a competition structure, the UK system during the 1980s is an example of this.

The United Kingdom (UK) system has since moved away from this competition structure and now employs a strategic system. This change in approach has led to a noticeable improvement in their performance in the 2000 Sydney Olympic Games (Green & Oakley, 2001; Sport Industry Research Centre, 2003). The competition system works on a pyramid type structure with a large number of participants at the bottom from which the elite will emerge or be identified. The fittest and strongest will be pushed to the top to reach the highest levels within that sport. Funding for this approach is aimed at developing a broad participation base through competition structures, and increased facility provision. The systematic talent identification model works on the basis of developing role models and sporting heroes who then encourage others to take up that sport, a 'trickle down effect'. Funding in the talent identification model is aimed at targeting those that have already been noted as talented (Hogan & Norton, 2000).

The most notable or well documented use of the strategic approach which focuses on systematic talent identification and development is the Australian model (Green & Oakley, 2001; Sport Industry Research Centre, 2003). This was launched on 26th January 1981 with the development of the Australian Institute of Sport (AIS) following a national outcry over Australia's poorest sports performance in 40 years at the 1976 Olympic Games in Montreal. Australia failed to bring back one gold medal, winning only one silver and four bronze medals (Daly, 1991; Denholm, 2000; Green & Oakley, 2001;

Hogan & Norton, 2000; Shilbury & Deane, 2001). The development of AIS was the major strategy utilised by the Australian Government to enable their athletes to compete effectively with other countries that had adopted the use of sophisticated sports science techniques to enhance athletic improvement and development (Shilbury & Deane, 2001).

The strategic approach to developing elite athletes is a means of adding value to a nation's elite sporting system. This contribution is based on the total value of all individual inputs being exceeded by the value of the resulting output, the purpose being the generation of greater returns (medal success) on investment of resources above those had the resources been invested elsewhere. This added value is a measure of a nation's competitive advantage (Davis & Kay, 1990; dell'Osso & Szymanski, 1991). It comes from a unique capability to achieve at a lower overall cost (dell'Osso & Szymanski, 1991).

A number of other nations are employing a strategic approach to develop a competitive advantage in order to generate greater medal success, these nations include Canada, China, Columbia, Ecuador, Finland, France, Ireland, Korea, New Zealand, Northern Ireland, Norway, Scotland, South Africa, Spain, Taiwan, United States of America, and Wales (International Forum on Elite Sport, 2005).

The use of statistical methods in calculating Olympic success

Olympic medal success can essentially be explained by using a statistical calculation taking into account a country's GDP per capita and size of population (Bernard & Busse, 2000; Johnson & Ali, 2002; Kuper & Sterken, 2005; Sport Industry Research Centre, 2003). Our empirical model is based on the pioneer study of Bernard & Busse (2000) and includes the following variables:

- GDP per capita (Bernard & Busse, 2000; Johnson & Ali, 2002).
- Population size (Bernard & Busse, 2000; Johnson & Ali, 2002).
- Home advantage.
  Cost of attending is reduced and facilities can be tailored to best suit home athletes. There is also a home crowd advantage which influences subjective judging by officials to score home athletes and teams disproportionately higher (Balmer et al., 2003). There is home country influence in adding new sports (Bernard & Busse, 2000) and more athletes from the host nation are able to attend (Kuper & Sterken, 2005).
- Whether resources are planned and allocated for sport (Bernard & Busse, 2000).
- Whether the nation is socialist or communist.
  Resources will be more efficiently directed to elite sport as a result of central planning policies (Bernard & Busse, 2000).

Top athletes in countries that have a large population but low GDP may be hindered by 'poverty' in their achievement of sporting potential and consequently medal success (Johnson & Ali, 2002; Kuper & Sterken, 2005; Sport Industry Research Centre, 2003). Given this, nations with a higher GDP per capita and larger population are likely to

outperform smaller nations at the Olympic Games (Bernard & Busse, 2000; Johnson & Ali, 2002), although population size as an important variable is less clear (Kuper & Sterken, 2005). Medal success can be viewed as dependant upon a country's economic development and size of gene pool from which to train athletes. This is not surprising as to become an Olympic athlete requires much training and allocation of resources (Bernard & Busse, 2000). Given this approach, massive economic growth would be required for a nation with a small economy to achieve improved international success leading to improved sports rankings. However, the growth required for this success is not possible given the restricting effects of the global economy that would directly impact on that nation (Sport Industry Research Centre, 2003).

The following table reviews key literature for calculating medal success at the Olympic Games.

Table 1: Review of key literature for calculating medal success				
Study	**Main issue**	**Data collection**	**Key findings**	**Limitations**
Bernard & Busse (2000)	Considers role of population and economic resources. Whether large population and high GDP per capita needed to generate high medal totals.	Model based on GDP, population, host country effect, communist or socialist government. Number of athletes country allowed to send. Effects of 1980 and 1984 boycotts are considered by not including these data in the equation. Assumes Olympic talent is randomly distributed. Uses 150 countries over 30 years (1960 – 1996). Figures obtained from IOC and World Bank.	Statistical significance of GDP per capita indicates resources are important in producing medals. Host country and whether country is socialist or communist has significant effect.	Does not take into consideration nation specific talent in particular events. Generalised approach to predicting medal outcomes. Model does not take into account those countries that participate in the games but do not invest in sport so have a low medal outcome.
Johnson & Ali (2002)	Investigates economic and political factors that encourage a nation to send their athletes. Analyses determinants of success. They develop a cost for Olympic medal success.	Data included for Summer and Winter Games from 1952 to 2002. Variables include GDP per capita, population size, host country effect, climatic conditions, and political environment.	Nations with higher GDP per capita send more athletes to both Summer and Winter Games, linear effect found. For Summer Games nations send 4 to 5 more participants per $US 1,000 GDP per capita. High income nations send more female athletes, an extra $US 1,000 GDP per capita equates to two more female athletes. Nations with larger populations send more athletes (3 to 4 million equates to one extra male athlete and 25 million for one female athlete). Find overwhelming home nation bias with host sending 210 more athletes, 63 of whom are female. Neighbouring	Does not take into consideration nation specific talent in particular events. Generalised approach to predicting medal outcomes. Model does not take into account those countries that participate in the games but do not invest in sport so have a low medal outcome.

			nations to the host send an average of 45 more athletes, one third are female. Find no evidence of communist nations sending more athletes. Cold climate has positive effect on participation.	
Matros & Namoro (2004)	Uses game theory to predict medal success. Investigates countries' strategic behaviour in terms of budget allocation to sports and economic differences in countries.	Uses 2001 GDP per capita and population of eight countries with their Olympic performances 1960 – 2000. Does pair wise comparison between Singapore and New Zealand, Greece and Portugal, Switzerland and Luxembourg, China and India. Builds model which uses host, political regime, and demographics variables.	Concludes countries allocate funds differently to sport and some use strategic allocation of resources to target medals. This affects willingness of athletes to invest themselves into sports leading to optimal participation rates. Data show smaller countries invest in few sports and most countries win medals in same events.	More precise data are required to test the findings.
Kuper & Sterken (2005)	Analyses development of Summer Olympic Games to construct a model for future distributions of medals.	Include 118 countries that won a medal since 1896. Differences through time analysed using split samples. GDP, sports cultural variable based on classification of legal system, population, and participation by athletes included as variables. Methodology follows Johnson & Ali (2002), two models are estimated – participation, and performance in terms of medals.	Finds economic variable important for participation and success. Impact of population size less clear. Home effect important, especially for participation but less clear for success. Socialist countries send more athletes and win more medals. Media attention is important in explaining participation and success.	Does not take into consideration nation specific talent in particular events. Generalised approach to predicting medal outcomes. Model does not take into account those countries that participate in the games but do not invest in sport so have a low medal outcome.
Balmer et al (2003)	Examines home advantage for Olympic Games.	Examined male data from track and field athletics which	In both pre-war and post-war overall home advantage	Does not take into consideration nation specific

	Objectives are assess significance of home advantage, and examine differences in home advantage between events with differing judging styles.	has objective measurable outcome, gymnastics with subjective measure used to determine placing of athlete, team games, boxing with subjective measure used, and weightlifting with objective measure used. Inclusion criteria is minimum of one medal won. Includes host nation variable. Uses post war and pre war data (after 1936 restrictions placed on numbers of competitors from home nation to stop vast numbers entering).	found to be significant. Home advantage significantly greater for events that are subjectively judged. Objectively judged events showed no home advantage. Team games have significant home advantage pre and post war. Authors hypothesise home crowd influences officials' subjective judging. Home advantage is not present for events that are objectively judged. Authors also hypothesise that boycotts enhanced the performance of host nations.	talent in particular events. Generalised approach to predicting medal outcomes. Model does not take into account those countries that participate in the games but do not invest in sport so have a low medal outcome.
Hoffman et al (2002)	Regression testing of a number of hypotheses of determinants for Summer Olympic Games success.	Sample of 76 countries from 2002 Sydney Olympics with selection criteria of having won minimum of one medal. Regressions estimated using ordinary least squares technique. Variables include GNP per capita, population, number of times hosted Summer Olympics, whether existing or previous socialist/communist nation, and climate temperature of nation.	Findings differ from Johnson & Ali (2002) and Bernard & Busse (2000). Hoffman et al (2002) quantifies impact of climatic factors and finds countries in a warmer (US, Australia, and China) or colder climate (Canada and Sweden) are expected to win an extra 14 to 20 medals. Finds diminishing return with population and GNP per capita. In medium term centralised approach to sporting policy and sporting infrastructure improvements promise to have some effect.	Does not take into consideration nation specific talent in particular events. Generalised approach to predicting medal outcomes. Model does not take into account those countries that participate in the games but do not invest in sport so have a low medal outcome.

From examining the literature we find that improved chances of success are more likely to result from an ability to resource elite sport, combined with the necessary strategic management of those resources (Bernard & Busse, 2000; Matros & Namoro, 2004). Bernard & Busse (2000) use an economic statistical model based on the variables listed above to predict the expected number of medals that a nation should win at the Olympic Games. Included in their model is the addition of a measure of resources that enable athletes to train, combined with the number of athletes a country may send to the Olympic Games. The authors used their model to predict medal outcomes prior to the 2000 Sydney Olympic Games. They found that GDP alone could not be used as a predictor of medal success, host country and use of government resources play a critical role in totals of medals won. Kuper & Sterken (2005) find the economic power of a nation is crucial for participation and success. They also note the effect of population size on participation is not as important, but instead cite home effect as especially relevant in terms of numbers participating, but not on success. Balmer et al., (2003) find that for those sports that are subjectively officiated there is a home advantage, whereas sports which are objectively officiated receive no home advantage.

Hoffman et al (2002) confirm the effect of public policy in improving medal success as significant. They list population size and national culture as variables that are likely to be effective in the long term, and that these will have a diminishing return. Conversely the effects of a centralised approach to sporting policy and improvements in sporting infrastructure are more likely to impact in the medium term. Johnson & Ali (2002) argue that single party or communist regimes send similar numbers of athletes to the Games as non communist regimes, but relatively these countries' athletes win more medals.

Kuper & Sterken (2005) build on the economic model to show that climatic conditions are an important variable for outdoor sports and that this will affect medal success. Countries with temperate warmer climates (Australia, China, Russia, and US) or colder humid countries (Canada and Sweden) are expected to win more medals. Johnson & Ali (2002) indicate that the colder climate nations perform better than warmer ones.

Comparisons of medal success between poorer and richer nations can in some ways be explained by statistical models which are based on GDP. However, these models cannot explain the differences in medal success within particular sports. The use of these statistical models is limited, an issue that is further demonstrated by the medal results which indicate that no single nation is able to dominate the Olympic Games in all sports (Matros & Namoro, 2004; Sport Industry Research Centre, 2003). If they were, then success would be based solely on population and GDP for each country. The fact that no nation is able to dominate the Games could be used to imply either one of two things; that countries are using resources strategically and focussing on sports that they stand a reasonably good chance of winning, and achieving this win, or there are certain sports which are traditionally more important for a nation and as such these receive more support and interest within that nation.

This is further emphasised by the Sport Industry Research Centre (2003) who comment that the method of calculation is unable to statistically explain the differences in medal

success for a small number of nations at the same level of economic development. They conclude that further research in this area would not produce a viable contribution. However, given the sums of money invested in sporting success and the likely benefits to each sport and that nation to be accrued from it, some form of cost based analysis approach needs to be undertaken in order to assess overall benefits and risk associated with sporting investment for a nation (Kuper & Sterken, 2005). The more accurate the model, the better the decision making process in terms of assessing medal success as a result of this investment.

Apart from the work of Matros & Namoro (2004) no account of the effect of elite sports performance systems is included in these statistical models. The authors use game theory to develop a model which explains why nations of equal population and GDP perform better. They explain this as a nation being more interested in sport and as such this reflects a strategic use of resources by those nations. This variable may well be used to explain some of this difference in a nation's ability to excell in international sport. There is a gap in the literature in this area. This represents a potentially important finding as the inclusion of elite sport system data could be used to effectively measure and benchmark the expected outcome of implementing such a system representing the strategic use of resources.

Methodology

Our empirical model uses secondary data. It is from the original data set from the pioneer study of Bernard & Busse (2000), and includes the independent variables listed in Table 2. The expected signs of the independent variables are also presented in this table along with an explanation, source and reference to the literature. The data set was emailed to us by Andrew B. Bernard in response to our request. The data used in Bernard & Busse's study was obtained by them from two main sources, the first from Wallechinsky (1992) *The complete book of the Olympics*, which contains all medal data of the Olympic Games. The second source for the population and GDP measures came from the World Bank and the United Nations. They include data for 187 countries over a 30 year period (Bernard & Busse, 2000).

Variable	Source	Expected Effect	Explanation	Previous Literature
GDP	Bernard & Busse (2000)	Positive	Funds available affect resources availability for athletes to reach their potential and thus medal success.	Bernard & Busse (2000), Hoffmann et al. (2002), Johnson & Ali (2002), Kuper & Sterken (2005), Matros & Namoro (2004), SIRC (2003).
Population	Bernard & Busse (2000)	Positive	Larger population means a larger gene pool from which elite athletes will emerge.	Bernard & Busse (2000), Hoffmann et al. (2002), Johnson & Ali (2002), Kuper & Sterken (2005), Matros & Namoro (2004).
Host	Bernard-Busse (2000)	Positive	Home advantage has an impact on number of athletes able to attend and influences home crowd effects.	Balmer et al., (2003), Bernard & Busse (2000), Johnson & Ali (2002), Hoffmann et al. (2002), Kuper & Sterken (2005), Matros & Namoro (2004).
Soviet	Bernard & Busse (2000)	Positive	Political system is able to direct resources more effectively.	Bernard & Busse (2000), Johnson & Ali (2002), Hoffmann et al. (2002), Kuper & Sterken (2005), Matros & Namoro (2004).
Elite Sport Systems	International Forum on Elite Sport (2005)	Positive	Strategic approach to targeted events and effective use of limited resources.	Matros & Namoro (2004).

Table 2: List of independent variables

In order to gauge the effect of elite sports systems on Olympic success, four different dependent variables are used, these are the number of total medals won, the number of gold medals won, the number of silver medals won and finally the number of bronze medals won.

The elite sport system dummy is used only for those Olympic Games in which a country actually employed an elite sport system. In all regressions the standard errors are White (1980) corrected.

Findings and discussion

Our results (Table 3) show that GDP and population remain the most important variables in explaining Olympic success as both variables have positive and significant signs in all specifications (Regressions 1 through 4). Being the host nation also has a significant and positive effect on the number of total medals won (regression 1). This is also the case for the number of gold medals won (regression 2), and the number of silver medals won (regression 3), but not on bronze medals won (regression 4). Home advantage is explained in the literature by Balmer et al., (2003) and Bernard & Busse (2000). This is in contrast to the findings presented by Kuper & Sterken (2005).

Consistent with Bernard & Busse (2000) we find that planned economies and ex-Soviet nations perform better than non communist regimes (regressions 1 through 4).

Variable	**(1) Dependent Variable:Number of Total Medals**	**(2) Dependent Variable: Number of Gold Medals**	**(3) Dependent Variable: Number of Silver Medals**	**(4) Dependent Variable: Number of Bronze Medals**
GDP	1.59e- 11*** (7.17)	6.03e- 2*** (6.34)	4.97e- 2*** (7.06)	4.69e- 2*** (7.55)
Population	1.98e- 08*** (3.35)	7.49e- 09*** (3.09)	7.26e- 09*** (3.29)	5.03e- 09*** (3.12)
Host Country	29.05108** (2.11)	14.65624** (2.34)	9.919266* (1.92)	4.479266 (1.41)
Planned Economy	3.955231** (2.35)	1.19248* (1.77)	1.382013** (2.25)	1.49747** (2.42)
Soviet	33.35094*** (7.72)	11.73565*** (6.41)	10.61028*** (7.66)	11.00544*** (8.71)
Elite Sport System Dummy	5.865181** (2.50)	1.455331 (1.55)	1.957126** (2.36)	2.438567*** (2.70)
Constant	0.3202759* (1.68)	-0.1041508 (-1.24)	0.098299 (1.40)	0.327681*** (5.32)
R-Square	0.6492	0.6037	0.6266	0.6235
Number of Observations	1254	1254	1254	1253

Table 3: Results table

*** significant at 1 percent level
** significant at 5 percent level
* significant at 10 percent level
t-statistics are given in parentheses

Our main interest variable, the *elite sports system* dummy has a positive and significant sign in regression 1, implying a positive effect of elite sport systems on Olympic success, measured by the total number of medals won. This is consistent with the findings presented by Bernard & Busse (2000) and Matros & Namoro (2004). However, when we look at the effects of elite sport systems on the number of gold, silver and bronze medals won separately, we find another interesting result. There is no statistically significant effect of elite sport systems on the number of gold medals won. We suggest this might be the result of extraordinary talent within the individual athlete that cannot be provided by external sources such as the implementation of an elite sports system. What we can

observe from our results is the elite sport systems have a significant effect on silver and bronze medals won in Olympics (regressions 3 and 4). Elite sports systems encourage medal winning but not the winning of gold medals.

Sporting success at the highest level, the Olympic Games is determined by the official medals table of the IOC based on the number of gold medals won. Our findings put into question a nation's investment in creating an elite sports system to improve their placing in the medal rankings given that this is based on gold medals alone. Given the criteria for a nation's placing on this table, GDP and population with the willingness of a nation to promote and support sport appear to be the key determinants for elite sporting success (Hoffmann et al., 2002; Kuper & Sterken, 2005). From this we suggest wealthier nations with a large population interested in supporting sport will beat smaller less well off nations despite their use of elite sporting systems designed to leverage a competitive advantage. This is of importance given the levels of investment in creating elite sports systems with the aim of international success for a nation. However, the implementation of elite sports systems does reward a nation with more silver and bronze medals, but this in itself is not enough to improve a nations overall placing in the official IOC medal table.

Conclusions

The inclusion of the elite sports systems differentiates our work from previous studies. We find the strategic use of resources in the development and employment of elite sports systems has a significant effect on a country's ability to win Olympic medals. This is also significant for the number of silver and bronze medals won. However, elite sports systems do not have a significant effect for the number of gold medals won by a nation. We suggest this is a result of athletic ability that cannot be surpassed by the implementation of an elite sports system. Countries with large populations, high GDPs and the willingness to resource sport will disadvantage smaller nations in achieving international sporting success despite smaller nation's use of elite sporting systems to leverage competitive advantage. The use of elite sports systems increases the total numbers of medals won but this will not affect a nation's ranking in the IOC medal table which is based primarily on the number of gold medals won.

The data set used was obtained from Bernard & Busse. Figures contained in this data set and the numbers of nations taking part in the Olympic Games need to be updated. We leave this for others to do and suggest that as part of this exercise a prediction for the 2008 Beijing Games be undertaken which includes the variable for elite sports systems. We also do not take into consideration nation specific talent in particular events. The numbers of countries employing a strategic approach to the development of elite sports systems also provides a rich avenue for future research as there may be some that have not registered with the International Forum on Elite Sport from where we obtained our data. The approach taken is a generalised one to predicting medal outcomes and Olympic Games have been investigated from a summer Olympic Games perspective only. This area of the literature is not well researched, only a limited number of previous studies exist. The contribution of this study lies in developing this area of the literature further.

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