Who wins the paralympic medals? An analysis of the socio-economic determinants

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Abstract

Purpose – While the Olympic Games are always under the spotlight, the Paralympic Games are somehow ignored. This paper aims to invite the general public to think about the para-athletes and the differential treatments they received.

Design/methodology/approach – Among the participating countries, many of them were unable to win a single Olympic or Paralympic medal. When the dependent variable is left-censored, ordinary least squares regression is asymptotically biased downwards. In the literature, researchers typically employ the maximum likelihood Tobit model to take care of the censoring problem. However, some researchers argue that the Hurdle model has an advantage over the Tobit model in identifying the determinants of winning Olympic medals. Following their wisdom, this paper employs both the Tobit and Hurdle models in analysis.

Findings – The empirical evidence gathered in this paper suggests that population size, host status and average years of schooling are the big three socio-economic determinants when it comes to winning medals at the Paralympic Games and Olympic Games. The findings support the hypothesis that sports talent is randomly distributed and a large country has a higher chance to have talented athletes or para-athletes winning the Olympic medals. The strong host advantage also showed up in the following Paralympics but was not so strong at the next Olympics.

Originality/value – This paper not only examines the relationship between various social, economic and political factors in determining the success of a nation in the Paralympic Games but also attempts to identify possible non-traditional determinants.

Keywords Disability, Life expectancy, Democracy index, Hurdle model, Paralympic games

Paper type Research paper

Introduction

In 2016, the para-athlete from Algeria, Abdellatif Baka, won a gold medal in the 1,500 m race in the T13 category [1] at the Rio Paralympic Games with a world record-breaking time of 3 min 48.29 s (Menezes, 2016). This record was faster than the time it took Matt Centrowitz of the United States to win a Summer Olympic gold medal in the 1,500 m race one month earlier. However, the media did not give much attention to the remarkable record set by Abdellatif Baka. If he won the Summer Olympic gold medal instead of the Paralympic Games in Rio, his story would be covered by the media worldwide.

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Summer Olympic Games have been contaminated by selected athletes who used performance-enhancing drugs, such as Russian athletes who had been participating in the state-sponsored doping programme to boost their results (International Olympic Committee, 2016a). It was reported that some doping athletes had their positive test results covered up as they had bribed the drug-testing authorities in Rio (CBS, 2016). Worse still, some countries used methods to compromise the fluid tests. Thanks to the advancement in technology, the International Olympic Committee had adopted the state-of-the-art anti-doping technology including new blood tests that can check whether athletes received performance-enhancing gene therapy (Everts, 2016). With these new testing methods, more athletes have tested positive for banned substances, including Chinese swimmer Chen Xinyi (The Guardian, 2016). No matter how hard the International Olympic Committee attempted to identify all those athletes who use performance-enhancing drugs, it remains a mystery how many of the Olympic medallists are clean athletes. Therefore, distortions of results caused by doping will adversely affect the accuracy of research on the Olympic Games.

Moreover, the problem of the country of origin will also distort the research on the Olympic Games. The main reason is that some athletes, especially those who are not qualified as national team members in their own countries, choose to migrate to other countries. In the sports world, selected countries have dominated certain sports events and their athletes occupied a very high proportion of the top 20 or even top 30. However, the Olympic Games impose a strict quota on the number of athletes from a single country to join an event. Hence, those top athletes who are not selected to represent their own countries to join the Olympic Games may have to think of an alternate method to participate. This problem is particularly serious for Chinese table tennis players. For example, it was reported that 44 table tennis players who participated in the Rio Summer Olympic Games were Chinese-born but only six of them were representing China (Keh and Quealy, 2016). The United States, a sports superpower, is not short of heroes to represent the country in the Olympics and top American runners like David Torrence, Alexi Pappas and Peter Callahan chose to represent Peru, Greece and Belgium in the Olympics, respectively (Vasilogambros, 2016). If they decided to stay in the United States, their chance of joining the Olympics was slim. In the 2022 Beijing Winter Olympics, China launched a global recruitment campaign to recruit sports talents, and in the end, 15 out of 24 players on its ice hockey team were from overseas (Olsvik, 2022).

On the contrary, the use of performance-enhancing drugs is less common in the Paralympic Games and the migration of top Paralympic athletes is never reported in the media. To prevent these two factors from affecting research validity, we decided to choose to work on the Paralympic Games. This paper aims to invite the general public to think about the para-athletes and the differential treatments they received. Moreover, this paper not only examines the relationship between various social, economic and political factors in determining the success of a nation in the Paralympic Games but also attempts to identify possible non-traditional determinants.

Literature review

In the literature, there are a large number of studies focused on the Olympic Games but scholars seldom pay attention to the Paralympic Games (see, for example, Kirkup and Major, 2006; Baimbridge, 1998; Hoffmann *et al.*, 2002; Dick and Wang, 2010; Billings and Holladay, 2012). Nevertheless, there is a key body of literature dedicated to disability sports (see, for example, White *et al.*, 2006; MacDonald *et al.*, 2016). These studies usually focus on the athletes at the personal or family levels. Bantjes *et al.* (2019) analyze the participation experience of athletes in competitive disability sports in South Africa. Werner (2015) examines the experiences of athletes, their parents and siblings upon their return from the Special Olympics World Games held in Athens. Kavussanu *et al.*, (2015) argue that disabled

athletes were less likely to have lower moral disengagement and antisocial behaviour than able-bodied athletes. It should be noted that the importance and popularity of the Paralympic Games are at a different level when compared with competitive disability sports events in general.

Researchers have gathered empirical evidence to show that socio-economic factors are directly related to a country's performance in the Olympic Games. Using panel data from the 1960 to 1996 Summer Olympic Games, Bernard and Busse (2004) argue that the distribution of medals across different countries was highly proportional to national income and somehow proportional to population size. Moreover, Johnson and Ali (2004) looked into all post-war Summer and Winter Olympic Games and they found that countries with larger population size and higher economic power were not only more likely to participate in the Games but also more likely to win more medals in the Summer Olympics. Based on the empirical data from the 1952 to 2004 Olympic Games, Lui and Suen (2008) show that income level and population were positively correlated to the total number of medals won by different countries.

In a recent study, Scelles *et al.* (2020) provide an excellent survey of the literature on Olympic medal performance. They employ Tobit and Hurdle models to forecast national team medal totals at the 2016 and 2020 Summer Olympics. While Bredtmann *et al.* (2016) employed ordinary least squares regressions, most researchers implement a Tobit model to examine Olympic Games performance at the national level, for example, Forrest *et al.* (2017) disaggregate individual sports to see whether income levels and host status have a more profound impact on some sports than others. They point out that some sports such as equestrian, sailing, diving, track cycling and competitive fencing require heavy investment in equipment and/or facilities. Winning Olympic medals in these elitist sports are restricted to athletes from the richest countries.

In respect of political factors, Johnson and Ali (2004) demonstrate that those ex-communist countries and countries under the single-party system tend to outperform countries under other political regimes. Communist countries and those single-party countries usually have very different approaches regarding sports training, motivation and participation when compared to more democratic countries and those countries with market economies. In another direction, Waguespack and Salomon (2015) show that past performance is a better predictor of future performance in sports where outcome includes a substantial subjective component, such as those involving external judges and referees. They argue that these sports with inherent uncertainty and ambiguity which may lead to favourable ex-post treatment for reputed athletes. In the literature, Hoffmann *et al.* (2002) and Tcha and Pershin (2003) find another interesting issue that is athletes' performance is affected by the annual average Celsius temperature in the home country. Tcha and Pershin use deviation from 18 °C as an independent variable in the analysis and argue that climate affects the training conditions and popularity of sports.

The first research article focusing on Paralympics was published in the *Journal of Sports Economics*, written by Buts *et al.* (2013). Based on the 1996 to 2008 Paralympic Game data, they use a Tobit panel to explain the medal points by 197 nations and conclude that the determinants of Paralympic Games and Olympic Games are similar. As expected, per capita income, host status, population size and the communist regime have statistically significant positive effects. In recent years, there a few more papers that discuss the Paralympic Games. For example, Kons *et al.* (2018) use Rio 2016 Olympic and Paralympic Games' judo matches data to analyze sportsmen's penalties, scores and efficiency. They conclude that Olympic judo athletes demonstrated greater scores and efficiency than those Paralympic athletes. Wilson and Ramchandani (2017) argue that there is a clear "home advantage" for hosting Winter Paralympic Games at the country level but it only matters for alpine skiing and cross-country skiing at the individual sport level. In their 2021 paper, Wilson and

Ramchandani show that a country hosting the Olympic and Paralympic Games experienced a large host nation effect.

Methodology

To allow meaningful comparison between the Olympic Games and the Paralympic Games, only countries that have participated in both Games will be included in the analysis in this paper. Even though more than 200 countries regularly competed in the Olympic Games, only those who sent national team members to participate in both Games from 2008 to 2016 are included. Based on these selection criteria, this research covers 164 participating countries (International Olympic Committee, 2016b). In the literature, many researchers use panel data which cover a long period to estimate the success of winning Olympic medals. Given the data are likely to be noisy, using a long data series has a higher chance to get statistically significant estimates. The drawback is that the world has changed drastically, especially in the new geopolitical landscape, in recent two decades and the statistically significant results may not represent the current situation. Since the breaking up of the former Union of Soviet Socialist Republics in 1991, the current cohort of elite athletes from those post-Soviet states is not selected or trained under the old training system. With this caveat in mind, this paper only makes use of data from the three recent Paralympic and Olympic Games for analysis to capture the latest development.

Among the participating countries, many of them were unable to win a single Olympic or Paralympic medal. When the dependent variable is left-censored, ordinary least squares regression is asymptotically biased downwards. In the literature, researchers typically employ the maximum likelihood Tobit model to take care of the censoring problem (see, for example, Bernard and Busse, 2004; Lui and Suen, 2008). However, Scelles *et al.* (2020) argue that the Hurdle model has an advantage over the Tobit model in identifying the determinants of winning Olympic medals. Following their wisdom, this paper employs both the Tobit and Hurdle models in analysis. As for the dependent variable, researchers commonly use either (weighted) medal points or medal share and this paper uses both for comparison purposes.

In respect of independent variables, researchers, such as Bernard and Busse (2004), Johnson and Ali (2004) and Lui and Suen (2008), identified that income, population size and "home advantage" matter whereas other covariates are also suggested by different researchers (see Scelles *et al.*, 2020 for a review on Olympic medal performance). This paper runs left-censored regressions as follows:

$$\begin{aligned} \textit{Medal Share/Weighted Medal Points} = {} & \beta_0 + \beta_1 RGDP_{t-3} + \beta_2 RPOP + \beta_3 Democracy \\ & + \beta_4 Life + \beta_5 Schooling + \beta_6 Host \\ & + \beta_7 Former\_Host + \beta_8 Host\_Continent \\ & + \beta_9 Year + \varepsilon \end{aligned}$$

Medals won by different countries from 2008 to 2016 were extracted from the official website of the International Paralympic Committee and the International Olympic Committee. The weighted medal point is based on the number of medals received and gold, silver and bronze medals are given a weighting of 3, 2 and 1, respectively. For medal share, it is the number of medals won by a country expressed as a share of all medals awarded in a given year. The number of medals awarded in a given year fluctuates whereas using market share as the dependent variable captures the interdependence or zero-sum game nature across countries.

For national income, we use real GDP per capita (PPP) from the World Bank, which offers a more accurate picture and a better indication of a country's national income level when compared to nominal GDP and real GDP. To enable comparison across different years, this paper does not use real GDP per capita directly but adopts $RGDP_{t-3}$ as an independent variable. RGDP, or relative real GDP per capita, is computed as the real GDP per capita

divided by the real GDP per capita of the United States. Some researchers prefer to use the natural logarithm of real GDP per capita as an independent variable. However, this approach is fine when dealing with a cross-sectional dataset. When we handle a panel dataset, which covers a long period of time, adopting the RGDP method can completely take care of the price level issue. For comparison purposes, this paper also runs all models using the natural logarithm of GDP per capita and the results are essentially the same.

Similarly, RPOP stands for relative population size to the population size of the United States, and the population data are extracted from the World Bank database. For health status and education level, we used life expectancy (*Life*) at birth from the World Bank and mean years of schooling (*Schooling*) from the United Nations database.

It should be noted that all governments or national sports associations formulate disability policies or allocate funding based on past results, and sports-related policies are likely to change after each major event, such as the Paralympic Games. Hence, it may not be appropriate to use current year data as the independent variables to predict the medal points. With this caveat in mind, we used RGDP data with a three-year lag, hereafter denoted as $RGDP_{t-3}$. For example, the censored regression on the 2016 Paralympic Games, the income data based on 2013 data.

As for political structure, existing studies mostly used two methods to categorize countries. The first method is to categorize countries into authoritarian, democratic, totalitarian and others, while the second method is to categorize countries into communist, socialist and capitalist. However, the political status of countries has changed drastically after the political upheaval of Europe and the Third Wave of Democratization. At present, there is only a small number of countries remain pure communist or non-democratic. In other words, the methodology used by Johnson and Ali (2004) may not be suitable for today's world (see also Zaoui and Bayle, 2017). Therefore, instead of using the political regime, we employ the democracy index (*Democracy*) compiled by the Economist Intelligence Unit of the United Kingdom to categorize the type of political regime for each country. The index is based on sub-scores in five categories including pluralism, civil liberty, political culture, the functioning of government and political participation. The higher the numeric score, the more democratic the country is, with ten representing full democracy whilst zero representing an authoritarian regime. For example, China as an authoritarian regime has been given a numeric score of 3 in a recent report.

Buts *et al.* (2013) argue that hosting the Paralympics as well as being a former host country are positively related to success as measured by the weighted medal point. For example, Great Britain, being the host of the Olympic and Paralympic Games, performed exceptionally well in 2012. They find that the host advantage was much larger in the Paralympic Games than in the Olympics. Hence, this paper includes the current host country (*Host*) and former host country (*Former_Host*) dummies in the censored regression. Lastly, a year dummy (*Year*) is included to estimate the year fixed effects of each Olympic Games, if any.

Without any doubt, climate and environment affect the performance of the athletes. If a sportsman from Australia has to fly to Great Britain to participate in the Paralympic Games, he/she has to experience a strikingly different climate condition. Putting aside the ideal temperature (18 °C) issue, athletes take time to adapt to the host country's climate and environment, especially those who have to fly across different continents. The other side of the coin is that athletes who participate in the Paralympic Games in their neighbouring country may not have to adjust to any climate change. Would they perform better than joining the Paralympics on a different continent? To answer this question, this paper includes a host country's continent (*Host_Continent*) as an independent variable.

Public investment in sports is another potential independent variable but no database that captures data of all nations. Some countries provide comprehensive sports training in the education system and it is difficult, if not impossible, to single out public investment in sports. Others may argue that we should include sports participation in a country as an explanatory variable. However, the definition of "sports participation" is debatable. For example, all

formal elementary and secondary school curricula include a physical education component. Should we include participation in physical education at school as sports participation? With these limitations in mind, these two potential variables are not included in the analysis.

Findings

Tobit model

Table 1 presents the random effects Tobit model results of the three editions of the Paralympic Games separately as well as in a panel. From the table, we can see that most of the predictor variables have the predicted sign and are statistically significant. Although the $RGDP_{t-3}$ variable has the predicted sign which is consistent with the prior studies (see Bernard and Busse, 2004; Lui and Suen, 2008; Buts *et al.,* 2013), it is not statistically significant. Although developing countries have low GDP per capita, countries like Kenya won many Olympic medals and produced some of the best distance runners in the world. However, their performance at the Paralympic Games is not as impressive as at the Olympic Games. Suppose elite athletes who were capable of winning Paralympic medals were randomly distributed in the world, countries with larger population sizes would have a large share of Paralympic medallists (Bernard and Busse, 2004). This conjecture is supported by the large and highly significant coefficient estimates of *RPOP* in separate regression of each Paralympic Games and the Tobit panel of the full sample. According to the United Nations, the development level of countries is correlated to the prevalence of disability. Indeed, in some developing countries, as much as 20% of the population are disabled, and most disabled persons are extremely poor (United Nations, 2006). Their situation can hardly be improved due to the incomprehensive and undeveloped medical and healthcare services. Hence underdeveloped or developing countries with a large population should have a larger pool of para-athletes, *ceteris paribus*.

Similarly, spending a huge investment in hosting the Paralympics paid off in respect of winning more medals. The home advantage is substantial and statistically significant at any practical level. This finding is consistent with the existing studies on the Olympic Games (e.g. Johnson and Ali, 2004). This host effect extends beyond one Paralympic Games and the positive and significant effect is clearly captured by the coefficient estimate of the *Former_Host* dummy. The host effect, however, does not go beyond the national boundary to benefit the neighbouring countries. The estimates of the *Host_Continent* dummy are mostly negative and statistically insignificant. Athletes joining the Paralympics within the same continent did not enjoy an advantage when compared with athletes from other parts of the world.

The political regime (*Democracy*) and life expectancy at birth (*Life*) of the participating countries seem to be unimportant in determining success in winning medals. The democracy index has an insignificant and negative coefficient estimate in all four models presented in Table 1. On the other hand, the life expectancy variable has small positive and insignificant estimates. One surprising result from Table 1 is the strongly positive and statistically significant estimates of the mean years of schooling variable (*Schooling*). People may relate high average years of schooling to the developed countries which have high real GDP per capita. However, there are developing countries that invested heavily in human capital. For example, Ukraine, with a nominal GDP per capita of USD3,726.9 in December 2020 (CEIC Data, 2021), spent 6% of its GDP on education which was one of the highest percentage shares in the world (Kahkonen, 2018). On average, Ukrainians had received slightly over 11 years of education, which was much higher than the average of 7.95 years in the dataset.

Actually, the effect of education level on medals obtained by participating countries is debatable. On one hand, educational institutions are likely to have compulsory physical education lessons to ensure all-rounded student development. On the other hand, less-

Table 1. Tobit model: weighted medal points at the paralympics

Variable	2008	2012	2016	2008–2016
RGDP $_{t-3}$	25.6454* (14.256)	11.0844 (15.581)	14.1203 (17.062)	15.1070 (9.744)
RPOP	35.7545*** (11.957)	43.6815*** (11.675)	95.7100*** (10.125)	69.8510*** (5.862)
Democracy Index	−1.0911 (3.008)	−1.1709 (2.768)	−4.6139 (3.097)	−2.7661 (1.754)
Life Expectancy	0.6539 (0.813)	0.2671 (0.877)	0.6043 (1.133)	0.5981 (0.586)
Mean Years of Schooling	9.0536*** (2.438)	11.7292*** (2.703)	11.8919*** (2.972)	12.5989*** (1.658)
Host	342.1724*** (69.148)	181.3724*** (46.982)	114.9215** (55.883)	165.7646*** (32.851)
Former Host	19.1594 (46.990)	325.5660*** (68.312)	260.3029*** (54.245)	165.1446*** (32.311)
Host Continent	−28.4187** (13.266)	4.6209 (11.992)	−14.4356 (16.530)	−11.0078 (7.507)
Year_2012				−3.3880 (7.595)
Year_2016				−5.3870 (7.688)
Constant	−123.9444*** (45.460)	−128.1520** (52.188)	−141.0440** (64.391)	−149.0265*** (33.770)
Observations	142	143	133	418
Log likelihood	−410.4	−407.2	−434.1	−1,272

Note(s): Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

developed or underdeveloped countries may not emphasize schooling but may encourage sports activities. For example, Brazil has relatively low mean years of schooling but it has a strong sports culture (Choi, 2010). Brazilians believe that excelling in sports, especially football, can earn handsome returns and can change their fate. The situation is similar to people in Kenya and Jamaica.

However, some sports do require much more than common sense or physical strength or instinct. Take golf as an example, golfers have to calculate the forces and aerodynamics that occur when swinging the club, during the ball's flight in the air or so, and knowing the physics behind will give a competitive edge to golfers (Real World Physics Problems, undated). This explains why professional golfers are using the latest technology to teach them how to play better (Parker, 2021) and high-tech gadgets are allowed to help the players in the US Open (Wall, 2021). Other sports may only require skills, experience and of utmost importance, physical strength. Africa has advantages in sports that require physical strength due to their body structure (Entine, 2013). People may argue that countries with higher education levels may excel in some sports and countries with relatively low education levels may excel in other sports activities. Therefore, the overall effect of schooling on medal-winning should be uncertain and inconclusive. However, the results presented in Table 1 firmly suggest that countries with higher average years of schooling can win more medals at the Paralympic Games.

After examining the factors that affect para-athletes' performance in the last three Paralympic Games, it is natural to extend the analysis to the Olympics. In order to examine the differences between the Paralympic Games and Olympic Games, we rerun the censored regression using the Summer Olympic Games data and present the results in Table 2. The socio-economic determinants of the medal outcomes at the Olympic Games are essentially the same as those at the Paralympics Games.

As expected, population size matters in determining the weighted medal points of a country for both Games. The democracy index is negatively but not significantly related to a country's performance in the Summer Olympics. This outcome shows weak support with the findings of Johnson and Ali (2004), which show that single-party and communist regimes win more Olympic medals. There is a general belief that some less democratic countries adopt

Table 2.
Tobit model: weighted medal points at the olympics

Variable	2008	2012	2016	2008–2016
RGDP $_{t-3}$	3.8569 (10.462)	8.3026 (9.728)	11.6267 (11.525)	6.2743 (6.120)
RPOP	33.7030*** (7.575)	29.3255*** (7.384)	33.9882*** (5.705)	33.1377*** (3.403)
Democracy Index	−1.7714 (2.015)	−0.6237 (1.814)	−1.1735 (1.772)	−0.8333 (1.025)
Life Expectancy	0.2518 (0.517)	0.2179 (0.539)	−0.0905 (0.544)	0.1115 (0.314)
Mean Years of Schooling	8.6186*** (1.579)	7.9951*** (1.662)	8.3556*** (1.617)	8.7152*** (0.934)
Host	99.9149** (44.614)	104.9585*** (31.271)	36.6888 (33.531)	83.0988*** (19.687)
Former Host	−6.9839 (31.134)	81.1207* (44.146)	109.5428*** (32.710)	55.3361*** (19.368)
Host Continent	−19.2039** (8.804)	−1.5251 (8.018)	4.6650 (9.431)	−5.6564 (4.473)
Year_2012				1.1721 (4.511)
Year_2016				1.2742 (4.488)
Constant	−80.5204*** (29.007)	−85.0729*** (31.479)	−64.7680** (30.229)	−82.0475*** (17.991)
Observations	143	143	143	429
Log likelihood	−399.2	−399.7	−409.2	−1,215

Note(s): Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

special approaches to train their athletes, intending to showcase the superiority of their political system. For example, the former communist state Soviet Union had a plethora of state-sponsored sporting programmes to cultivate outstanding athletes and enhance their soft power (O'Mahony, 2006).

The coefficient estimates of the relative real GDP per capita ($RGDP_{t-3}$) variable are positive but statistically insignificant. These results show weak support for the findings reported in Bernard and Busse (2004) and Buts *et al.* (2013). Given that socio-economically backward countries usually have a much lower education level and a higher proportion of disabled bodies, life expectancy at birth, an indicator of health status and well-being of national citizens, should have a significant impact on determining the medals won. Yet, life expectancy at birth is proven to be statistically insignificant, showing that population effects still dominate despite the presence of health factors.

The host effect remains strong and significant except for the Rio de Janeiro 2016 Olympic Games. While Brazil failed to capture the home advantage to win more Olympics medals, their para-athletes were very successful in materializing the advantage of hosting the Paralympic Games (c.f. Table 1). In the last three Olympic Games, only Great Britain was able to enjoy the premium being the former host as reflected in the large and significant coefficient estimate of the *Former_Host* dummy. The coefficient estimate for the 2012 censored regression is large but only significant at the 0.1 level. It shows that China only weakly benefited from hosting the previous Olympic Games.

Comparing the results presented in Tables 1 and 2, the signs of the coefficient estimates are almost identical but the magnitudes vary. For RPOP, the magnitudes in Table 1 are higher than those in Table 2 which suggests that the relative population size has a stronger positive impact on winning Paralympics medals than Olympics medals. Similarly, countries with higher average years of schooling were able to win more medals at the Paralympic Games than at the Olympic Games. The coefficient estimates of the *Host* dummy are much larger in Table 1 than in Table 2 and these results are consistent with Bernard and Busse's (2004) finding that the host effect was much larger in the Paralympics than in the Olympics. The former host effect also exhibits a stronger influence in the Paralympics.

For $RGDP_{t-3}$, the results presented are inconsistent with prior studies that find significant positive effects on real GDP per capita (e.g. Bernard and Busse, 2004; Buts *et al.*, 2013). One possible explanation to understand why GDP per capita does not matter is that medal-winning demonstrates a country's soft power. Winning more gold medals in the Olympics is an indirect reflection of power and prestige, thereby enhancing the international reputation of a nation (Hunter, 2009). Media around the world frequently report the Summer Olympic Medal Table and compare the performance of the big countries. Hence, countries, whether developed or developing or underdeveloped, are all willing to invest in their elite athletes. This phenomenon will dampen the impact of GDP per capita. On the other hand, the Paralympic Games lack media coverage. Politicians and media do not associate winning Paralympic medals with a nation's soft power. People may argue that the paralympic athletes can take advantage of the facilities that are developed in richer countries. However, the types of equipment used by paralympic athletes are very different from able-bodied athletes and can be expensive. Thus, even big countries are not willing to spend too much money on para-athletes. This explains why the remarkable record set by the para-athlete Abdellatif Baka in the 2016 Rio Paralympic Games was not widely reported by the media.

In general, most countries do not care about the Paralympic Games as much as the Olympic Games and they allocate much less budget to para-athletes. Take cash rewards as an example, monetary rewards are given to athletes to motivate them to achieve better results but the amounts given to athletes and para-athletes are different for most countries. For example, Russia gave USD135,000 to each gold medallist in the Rio Olympics, which was 2.7 times more than the amount (USD50,000) they gave to para-athletes (Hale, 2016). The

difference in cash incentives received by Hong Kong's athletes and para-athletes was even bigger. Hong Kong Government paid USD386,762.43 to gold medallists of the Rio Olympics, which was 7.5 times higher than the amount received by para-athletes, which was USD51,575.84 (Hong Kong Sports Institute Limited, 2016).

Another reason behind the disparity in funding allocation is because Paralympians are extremely resource-hungry when compared to able-bodied athletes. To support a para-athlete, the government has to pay for their adaptive equipment, maintenance of the special equipment, medical staff, psychologist and many more (Shpigel, 2016). The required expenditure is so much more than the amount required by the Olympic athletes. For example, Alana Nichols, a sprint kayaking US *para*-athlete, said that three types of special equipment are needed for training, including a monoski, wheelchair and kayak, which cost USD7,000 (Garcia, 2016), while a kayak for able-bodied athletes costs around USD1,200 to USD2,500 only.

On top of cash awards, government and other organizations may give non-monetary rewards and other fringe benefits to athletes. For example, Russian athletes received free cars and housing subsidies in addition to their cash bonuses (Stuff, 2016). Also, medallists from wealthy countries are more likely to receive a large amount of monetary and in-kind sponsorship, when compared with athletes from less-developed or underdeveloped countries. For example, para-athletes in the United Kingdom receive funding support from the National Lottery (Cockroft, 2016).

As a note of caution, the dependent variable used in the above Tobit analysis is the weighted medal points and the number of medals awarded in each edition of the Paralympics and Olympics was not the same. In many Paralympic events, they are likely to be divided into subcategories and para-athletes compete in each category for medals. As a result, there are much more medals awarded in the Paralympics than in the Olympics. In the dataset, the Paralympic Games and Olympic Games held in Rio awarded 1,578 and 963 medals, respectively. The stronger host effect in the Paralympics than in the Olympics may be partly due to more medals awarded in the Paralympics. This issue will be addressed using medal share as the independent variable in the last part of this section.

Hurdle model

In estimating the national performance in winning medals at the Olympics, researchers typically resort to a Tobit to account for a large number of countries that are unable to win a single medal. Some researchers also implement a Hurdle model to conduct the analysis. Scelles *et al.* (2020) argue that a Hurdle model has its advantage over a Tobit model. A Hurdle model not only has one equation to account for the probability of winning no medals but also a second equation to estimate the number of medals won for countries winning at least one. This paper rerun the censored regression on the full Paralympics and Olympics samples using a Hurdle model with weighted medal points as the dependent variable and the results are presented in Table 3. Following Schelles *et al.* (2020), only the results of the second equation are reported in this paper.

From Table 3, the big four socio-economic determinants at the Paralympic Games are relative population size (*RPOP*), average years of schooling, host and former host whereas only the first three are important determinants at the Olympic Games. Undeniably, countries hosting the Paralympics and Olympics performed exceptionally well in winning medals and the host effect can extend to the following Paralympic Games but not the next Olympic Games. The positive effects of hosting the Games and *RPOP* are stronger in the Paralympics than in the Olympics. On the contrary, the average years of schooling factor have a stronger impact at the Olympic Games than at the Paralympic Games.

So far the censored regression results reported in Tables 1–3 use weighted medal points as the dependent variable. As mentioned earlier, each Paralympic Games awards much more medals than the corresponding Olympic Games. Other things being equal, a larger coefficient

Variable	Paralympics	Olympics
$RGDP_{t-3}$	0.0477 (0.295)	−0.3250 (0.282)
RPOP	0.6539*** (0.157)	0.5881*** (0.123)
Democracy Index	−0.0054 (0.050)	0.0417 (0.043)
Life Expectancy	0.0063 (0.018)	−0.0022 (0.015)
Mean Years of Schooling	0.2204*** (0.050)	0.2427*** (0.039)
Host	1.9869** (0.798)	1.8040** (0.703)
Former Host	1.5722** (0.774)	0.9291 (0.689)
Host Continent	−0.0706 (0.218)	−0.1126 (0.191)
Year_2012	−0.0421 (0.220)	0.0284 (0.193)
Year_2016	−0.1264 (0.214)	0.0406 (0.184)
Constant	0.0206 (1.046)	−0.1357 (0.894)
Observations	418	429
Log likelihood	−965.4	−860.4

Note(s): Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 3. Hurdle model: weighted medal points in 2008–2016

estimate for the Paralympic sample than the Olympic sample does not necessarily mean a stronger effect at the Paralympic Games. To address the potential issue of weighted medal points, this paper also uses medal share as the dependent variable and this approach can take care of the difference in the total number of medals awarded in the Paralympics and Olympics.

Columns 1 and 2 of Table 4 are the results of the Tobit and Hurdle models with medal share at Paralympic Games as the dependent variable while columns 3 and 4 report the results of the corresponding analysis of the Olympic Games. For the Paralympic Games, the big four socio-economic determinants that best explain the success of a country in winning more medals are relative population size, average years of schooling, host status and former host status. For the Olympic Games, the three most important socio-economic determinants are relative population size, average years of schooling and host status while former host status is also statistically significant in the Tobit analysis (column 3). Relative GDP per capita remains statistically insignificant in all four models and this finding is inconsistent with the prior literature.

	Paralympics		Olympics	
Variable	Tobit	Hurdle	Tobit	Hurdle
$RGDP_{t-3}$	0.0049 (0.003)	−0.0442 (0.279)	0.0031 (0.003)	−0.2051 (0.256)
RPOP	0.0213*** (0.002)	0.6193*** (0.149)	0.0171*** (0.002)	0.5853*** (0.112)
Democracy Index	−0.0007 (0.001)	0.0084 (0.048)	−0.0004 (0.001)	0.0311 (0.039)
Life Expectancy	0.0002 (0.000)	0.0114 (0.017)	0.0001 (0.000)	−0.0022 (0.014)
Mean Years of Schooling	0.0040*** (0.001)	0.2030*** (0.047)	0.0046*** (0.000)	0.2343*** (0.035)
Host	0.0574*** (0.010)	1.9602*** (0.755)	0.0386*** (0.010)	1.5986** (0.639)
Former Host	0.0504*** (0.010)	1.5373** (0.732)	0.0246** (0.010)	0.8447 (0.626)
Host Continent	−0.0036 (0.002)	−0.0590 (0.206)	−0.0030 (0.002)	−0.1020 (0.173)
Year_2012	−0.0016 (0.002)	−0.1562 (0.209)	0.0006 (0.002)	0.0644 (0.175)
Year_2016	−0.0027 (0.002)	−0.2216 (0.203)	0.0004 (0.002)	0.0500 (0.167)
Constant	−0.0484*** (0.011)	−8.1126*** (0.990)	−0.0432*** (0.009)	−7.4706*** (0.811)
Observations	418	418	429	429
Log likelihood	498.4	795.5	537.4	883.0

Note(s): Standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 4. Censored regression: medal share in 2008–2016

With medal share as the dependent variable, this paper is more comfortable comparing the magnitudes of the coefficient estimates. As expected, population size and host status matter and these two variables have a larger effect at the Paralympic Games than at the Olympic Games. The strong host effect was also demonstrated in the following Paralympics but not so strong at the next Olympics. The average education level of a country proves to be an important socio-economic determinant and its effect is stronger at the Olympics than at the Paralympics. Countries with higher average years of schooling are more successful in winning Paralympic and Olympic medals.

Concluding remarks and policy implications

While the Olympic Games are always under the spotlight, the Paralympic Games are somehow ignored, despite the fact that para-athletes are very inspiring in the sense that they have to overcome their physical or mental disability to compete in sports events. Some athletes with disability hope to change how society views disability, but still, the governments, the general public and even the journalists are lagging. This discourages para-athletes. To let people know more about the disabled athletes and the Paralympic Games is the motivation behind this paper. Publishing a research article in a refereed journal may induce readers to think about these para-athletes and the differential treatments they received.

The empirical evidence gathered in this paper suggests that population size, host status and average years of schooling are the big three socio-economic determinants when it comes to winning medals at the Paralympic Games and Olympic Games. The findings support the hypothesis that sports talent is randomly distributed and a large country has a higher chance to have talented athletes or para-athletes winning the Olympic medals. However, disabled persons are not randomly distributed in the world and economically backward countries are unlikely to be able to support a comprehensive health care system. These countries should have a higher proportion of disabled people and hence more para-athletes but the empirical evidence suggests that the population effect still dominates at the Paralympic Games. The strong host advantage also showed up in the following Paralympics but was not so strong at the next Olympics. It should be noted that the linkage between the average years of schooling and winning Olympics may mediate through other factors. Further research is required to establish their relationship.

In contrast, relative GDP per capita is not a critical factor in determining a country's success. The political regime (as measured by the democracy index) and life expectancy at birth are not correlated to the number of medals a country won at the Paralympics or Olympics. Although not analyzed in the literature, the results presented in this paper show that the mean years of schooling play an important role in explaining a country's success in winning medals at the Games. The finding is particularly inspiring as many governments mainly relate the provision of educational opportunities to economic development and societal needs. The empirical evidence suggests that upgrading the educational level of the general public has many non-economic benefits and can improve a country's ability to win more medals at the Paralympic Games and Olympic Games.

Lastly, politicians and the media do not place as much emphasis on the Paralympic Games as compared to the Olympic Games. Most countries, if not all, do not treat the Paralympic Games as a platform to display their strength and the superiority of their political system and they allocate much less funding to disabled athletes. It is encouraging to observe that there is an increasing number of countries taking the initiative to treat their athletes and para-athletes equally by providing them with equal funding and cash rewards, such as South Korea, Malaysia and Kenya (Ching, 2016). This is the first step towards an egalitarian society between able-bodied and disabled persons and we hope to see further progress in this regard in the near future.

Note

1. In Paralympic Games, the T13 category is for athletes with a moderate visual impairment. Athletes in this category usually do not require a guide and are able to recognize contours from a distance of 2–6 m (Wikipedia, 2019).

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