Estimating the Determinants of

Summer Olympic Game Performance

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Abstract

Numerous prior studies have attempted to ascertain the determinants of Olympic medals awarded. Most studies found that population and GDP were positively related to the number of Olympic medals awarded. The present study generally confirms these earlier results. In addition, lagged values of medals awarded were also significant, suggesting that prior performance is an excellent proxy of unobservable country-specific attributes that may contribute to overall Summer Olympic performance. Finally, using the models estimated in the present study, predictions were made for the 2012 Summer Olympics. These predictions were very similar to the actual values and thus serve as a test of the statistical robustness of the models estimated in this study.

Introduction

There has been much prior research on national Olympic performance (Emrich, Klein, Pitsch, and Pierdzioch, 2012; Vagenas and Vlachokyriakou, 2012; Forrest, Sanz, and Tena, 2010; Wu, Liang, and Yang, 2009; Li, Liang, Chen, and Morita, 2008; Lui and Suen, 2008; Rathke and Woitek, 2008; Bernard and Busse, 2004; Churilov and Flitman, 2004; Hoffman, Ging, and Ramasamy, 2004; Johnson, 2004; Lins, Gomes, de Mello, and de Mello, 2003; Tcha and Pershin, 2003; Lozano, Villa, Guerrero, and Cortes, 2002; Condon, Golden, and Wasil, 1999).

Several of the above studies utilized a frontier analysis (data envelopement analysis). In this type of study, the determinants of Olympic medal success were not directly addressed. Instead, a ranking of Olympic performance was estimated (Wu, Liang, and Chen, 2009; Wu, Liang, and Yang, 2009; Li, Liang, Chen, and Morita, 2008; Churilov and Flitman, 2006; Lins, Gomes, de Mello, and de Mello, 2003; Lozano, Villa, Guerrero, and Cortes, 2002).

Other studies used a wide variety of analyses including neural networks (Condon, Golden, and Wasil, 1999); revealed comparative advantage (Tcha and Pershin, 2003); efficiency and production analyses (Rathke and Woitek, 2008); Tobit analysis (Forrest, Sanz, and Tena, 2010); and Poisson analysis (Lui and Suen, 2008).

Finally, many other prior studies used least squares regression (Emrich, Klein, Pitsch, and Pierdzioch, 2012; Vagenas and Vlachokyriakou, 2012; Bernard and Busse, 2004; Hoffman, Ging, and Ramasamy, 2004; Johnson and Ali, 2004). Data used by these studies differed greatly. Emrich, Klein, Pitsch, and Pierdzioch (2012) used annual data from four Olympics (1996, 2000, 2004, and 2008); they did not, however, pool the data but instead ran four separate regressions. Vagenas and Vlachokyriakou (2012) used data from 2004 Olympics; Hoffman, Ging, and Ramasamy (2004) used data for the ASEAN counties for the year 2000. Bernard and Busse (2004) and Johnson and Ali (2004) both used much larger data sets; Bernard and Busse (2004) looked at the Olympics from 1960 – 1996, and Johnson and Ali (2004) looked at the 1952 – 2000 Olympics. Both studies pooled their data. Bernard and Busse (2004) used the ratio of medals won to total number of medals awarded during the Olympics as their dependent variable; Johnson and Ali (2004) used the total number of medals won as their dependent variable. Bernard and Busse (2004) had the simplest model; they used only three explanatory variables: population, GDP per capita, and year dummy variables. Johnson and Ali (2004) used, in addition to GDP and population, a host country dummy variable, a political regime dummy variable, and a weather variable.

As noted above, most prior research looked at a variety of explanatory variables. However, there are two variables that appear in almost all studies on this topic: population and GDP. The reasons for the inclusion of these two variables are that a more populous country would have a greater pool of talent to draw on and hence would be more likely to win at the Olympics, richer countries would be expected to have the resources to invest in sports programs and would thus be more likely to win medals at the Olympics. One other frequently used explanatory variable is the host dummy variable, which equals one if the country in question is the host of that year's Olympics. The reason for including this variable is because the host country may benefit from the additional capital spending on sports infrastructures that are necessary due to the hosting of the Olympics. In addition, there is a potential home field advantage in that fans do not have to travel as far in order to attend and cheer on the home team. Finally, the hosting country's athletes are probably more familiar with the sporting facilities than are athletes from other countries. Given the above, all three of these variables (population, GDP per capita, and the dummy host variable) are used as explanatory variables in the present study.

In addition, two other explanatory variables are used in this study. They are the number of medals awarded in the past two Olympics. The reason for including these variables is to capture any potential country-specific factors that may increase a nation's probability of winning medals at an Olympics. There are many non-quantifiable factors that may affect the number of medals awarded; these factors include a nation's athletic tradition, the health of the populace, and geographic or weather conditions that allow for greater participation in certain athletic events. The effects of many of these factors may be captured by the first and second lagged values of the total number of medals awarded. Therefore, the purpose of the present study is to use much more recent data to isolate the factors that may affect the number of medals awarded during the Summer Olympic Games.

Data and Results

Four Olympics (1996, 2000, 2004, and 2008) and 204 countries were examined. Olympics prior to 1996 were not examined. There are two reasons for excluding Olympics prior to 1996. First, due to the break-up of the Soviet Union, and the fall of the Communist governments in Eastern Europe in the late 1980s and early 1990s, it is somewhat problematic to assign medal totals to the newly created countries of the 1990s, especially countries that are some of the biggest medal winners of the Olympics. Second, economic data from the former Soviet Union and the former Soviet bloc countries is questionable at best. Given that many of their currencies were not convertible and given that economic indicators were usually considered state secrets, much of the economic data available for these nations prior to the early 1990s were estimates at best and may not have truly reflected the economic wealth of these nations in question. Hence, given the above, Olympics prior to 1996 were excluded from the current study even though other studies have used them in their analyses.

Olympic medal counts and team size data were obtained from the Sports Reference website at www.sports-reference.com. Population data was collected from the World Bank database and GDP data was from the United Nations database. All data was pooled for the present study. All dollars values are in constant year dollars (1982-1984).

Olympic medal data used in this study was adjusted to take account of medals stripped and re-awarded by the IOC due to violations of Olympic rules, such as failing drug tests and disrupting awards ceremonies. IOC stripped medals from 11 athletes in 14 events in the 2000 Olympic Games, from 14 athletes in 14 events in the 2004 Olympic Games, and from 5 athletes in 6 events in the 2008 Olympic Games.

Even though Olympics prior to 1996 were not examined, it was necessary to use data from the 1988 and 1992 Olympics in order to construct the lagged explanatory variables. As noted earlier, some countries that existed in 1996 did not exist in 1988. For example, the Czech Republic and Slovakia participated in the 1988 and 1992 games as Czechoslovakia. Six countries, Bosnia and Herzegovina, Croatia, Macedonia, Slovenia, Montenegro, and Serbia, competed as Yugoslavia in 1988 and individually in 1992. In 1988, the Soviet Union was in existence, but in 1992, it competed as the Unified Team, which consisted of the former Soviet Union countries, except for the Baltic States. Medal break downs had to be calculated for all of the new countries in order to obtain the first and second lagged variables. In order to calculate the lagged total number of medals won by these new countries, the percentage of overall medals won by these new countries in the 1996-2008 Olympics were calculated. These percentages were then applied to total medals awarded in 1988 and 1992 by their "parent" countries in order to obtain the total number of medals that would have been won by these new countries in 1988 and 1992 if they had existed then.

Two dependent variables were used. The first is total medals awarded. The second is medals awarded per athlete. Given the pooled nature of the data set, fixed and random effects were initially estimated. The Lagrange Multiplier Test indicated, however, that these panel data estimation techniques were not statistically more robust than ordinary least squares (OLS). Hence, OLS was used to estimate the models presented in this study.

Results for the total medals regression are presented on Table 1; results for the medals awarded per athlete regression are presented on Table 2. As can be ascertained from the results, for the first regression, the host country variable and population are significant and positive as expected. GDP per capita and the second lag are insignificant, while the first lag is significant and positive. Hence, host countries with large populations will win more medals, and the number of medals awarded in the previous Olympics is a good indicator of the number of medals that will be awarded in the current Olympics. For the medals awarded per athlete regression, host country is insignificant, but all other explanatory variables are significant with positive signs. These results are generally consistent with the results of prior studies.

In order to test the validity of the above results, the medals awarded per country were predicted for the 2012 Summer Olympics. Predictions were only made for those countries that won medals in 2012. The total medals awarded predictions are presented on Table 3. The largest error in terms of total medals awarded was 18 (Russia). Most errors were less than 5, which suggest that the model used in this study is statistically robust.

Concluding Remarks

Numerous prior studies have attempted to ascertain the determinants of Olympic medals awarded. Most studies found that population and GDP were positively related to the number of Olympic medals awarded. The present study generally confirms these earlier results. In addition, lagged values of medals awarded were also significant, suggesting that prior performance is an excellent proxy of unobservable country-specific attributes that may contribute to overall Summer Olympic performance. Finally, using the models estimated in the present study, predictions were made for the 2012 Summer Olympics. These predictions were very similar to the actual values and thus serve as a test of the statistical robustness of the model estimated in this study.

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Table 1

OLS Regression

Total Medals

Variable	Coefficient	Standard Deviation	Test Statistic
Intercept	-3.474	1.376	-2.525**
Host Country	14.30	1.65	8.668***
Log of Population	0.197	0.064	3.078***
Log of Per Capita GDP	0.0944	0.079	1.194
First Lag of Total Medals	0.898	0.0388	23.096***
Second Lag of Total Medals	0.0617	0.0392	1.577

$R^2 = 0.946$

**= significant at 5% level

*** = significant at 10% level

Table 2

OLS Regression

Total Medals per Athlete

Variable	Coefficient	Standard Deviation	Test Statistic
Intercept	-0.902	0.018	-4.998***
Host Country	-0.00367	0.0223	-0.164
Log of Population	0.0051	0.000875	5.824***
Log of Per Capita GDP	0.0034	0.00105	3.244***
First Lag of Total Medals	0.443	0.0398	11.123***
Second Lag of Total Medals	0.14	0.0358	3.906***

$R^2 = 0.436$

*** = significant at 10% level

Table 3
Total Medal Prediction for 2012 Summer Olympics

Country	Total Medals (Actual)	Total Medals (Predicted)	Error (Actual - Predicted)
Afghanistan	1	0	1
Algeria	1	0	1
Argentina	4	3	1
Armenia	3	3	0
Australia	35	39	-4
Azerbaijan	10	4	6
Bahamas	1	0	1
Bahrain	1	0	1
Belarus	12	15	-3
Belgium	3	0	3
Botswana	1	0	1
Brazil	17	12	5
Bulgaria	2	2	0
Canada	18	14	4
China	88	88	0
Chinese Taipei	2	2	0
Colombia	8	0	8
Croatia	6	2	4
Cyprus	1	0	1
Czech Republic	10	3	7
Denmark	9	4	5
Dominican Republic	2	0	2
Egypt	2	0	2
Estonia	2	0	2
Ethiopia	7	4	3
Finland	3	1	2
France	34	35	-1
Gabon	1	0	1
Georgia	7	3	4
Germany	44	35	9
Great Britain	65	54	-4
Greece	2	1	1
Grenada	1	0	1
Guatemala	1	0	1
Hong Kong	1	0	1
Hungary	18	7	11
India	6	1	5

Indonesia	2	3	-1
Iran	12	0	12
Ireland	5	1	4
Italy	28	22	6
Jamaica	12	8	4
Japan	38	21	17
Kazakhstan	13	10	3
Kenya	11	11	0
Kuwait	1	0	1
Latvia	2	0	2
Lithuania	5	2	3
Malaysia	2	0	2
Mexico	7	1	6
Moldova	2	0	2
Mongolia	5	1	4
Montenegro	1	0	1
Morocco	1	0	1
Netherlands	20	12	8
New Zealand	13	6	7
Norway	4	6	-2
Poland	10	7	3
Portugal	1	0	1
Qatar	2	0	2
Romania	9	5	4
Russia	82	64	18
Saudi Arabia	1	0	1
Serbia	4	1	3
Singapore	2	0	2
Slovakia	4	3	1
Slovenia	4	2	2
South Africa	6	0	6
South Korea	28	26	2
Spain	17	14	3
Sweden	8	2	6
Switzerland	4	4	0
Tajikistan	1	0	1
Thailand	3	2	1
Trinidad and Tobago	4	0	4
Tunisia	3	0	3
Turkey	5	5	0

Uganda	1	0	1
Ukraine	20	22	-2
United States	104	97	7
Uzbekistan	3	3	0
Venezuela	1	0	1
Note: If the predicted value was estimated to be negative, then that number was converted to a 0.			