

An Investigation into the Correlation between a Country's Total Olympic Medal Count, GDP, and Freedom Index through History

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ABSTRACT

In 2021, Tokyo held the delayed 2020 Olympics in the ongoing COVID-19 pandemic. As with any Olympics, the final medal count was of particular interest. Since 2004, South Korea has consistently ranked in the top ten most successful countries for four straight Summer Olympics. However, in 2021, it fell short of a top ten finish for the first time since 2004. There may be many factors that affect the final medal count in any Olympics, and this study compares and looks for correlations between some of these factors including final medal count, GDP, population, size of Olympic contingent, and Freedom Index. The study pays particular attention to South Korea and other countries which have seen a dramatic change in Freedom Index score since 1972, when the index was first published.

Keywords

Olympics, medal count, Freedom Index, GDP, South Korea

I . Introduction

After a year-long delay due to the COVID-19 pandemic, the 2020 Summer Olympics were held in Tokyo, Japan in 2021 where 11,315 athletes from 206 teams competed in 339 events[1]. In contrast, the 2018 Winter Olympics were hosted in Pyeongchang, South Korea where 2,833 athletes from 92 teams competed in 102 events[2]. This makes the Summer Olympics nearly 3.5 times larger in scale than the Winter Olympics.

The Summer Olympics are more popular worldwide due to its scale, number of participating nations, and broadcast audience, and the medal race is also more heated. Some nations, particularly wealthier or more populous nations, always top the medal table, but other nations are fiercely competitive to finish within the top ten.

South Korea is one such nation that has finished in the top ten for the past four Summer Olympic since 2004 (excluding the 2020 Tokyo Olympics). In 2020, South Korean athletes won a total of 6 golds, 4 silvers, and 10 bronze medals for a total of 20 medals and a 16th place finish.

II . Related Research

Although the IOC has never published an “official” medal table, most unofficial medal tables rank countries based on *lexicographic order*[3], placing the highest priority on gold medals, followed by silver, and then bronze medals.

In performing analysis on medal winning countries, a variety of approaches have been proposed. These include both lexicographic order scoring, where gold medal wins are awarded more points than silver medals, and silver more than bronze medals[4][5], as well as more “fair” scoring methods such as de-emphasizing medal type and instead calculating the amount of *total* medals won, or medals won *per capita* based on population[3].

III . Factors Influencing Total Medal Count

This paper focuses on the total medal count for the Summer Olympic Games. But what factors may contribute to total medal count? Certainly population size matters, as countries with more people have a wider pool of talent to choose from. Additionally, GDP certainly plays a role, as wealthier countries can afford better training facilities and programs, and can also send more athletes to the Olympics

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(and more athletes means more chances to win). But additionally, this paper explores whether or not a country’s civil liberties and political rights, which constitute a measurement of its freedom, make any difference in final medal counts.

IV. Analysis and Results

For this study, two Olympics data sets were merged together to perform the data analysis. The first is a complete listing of all athletes, events, and medals in both Summer and Winter Olympics from 1896 to the 2016 Summer Games[6]. The second contains a listing of all athletes, events, and medals won in the 2020 Tokyo Olympics[7].

Additionally, global GDP and population data from The World Bank[8][9], dating back to 1960, were merged with Freedom House’s global Freedom Index[10], dating back to 1972. The Freedom Index contains scores between 1 to 7 for a nation’s civil liberties and political rights, with lower numbers indicating more freedom, and also classifies each nation as either “free”, “partly free”, or “not free.”

Finally, all the data sets were merged together and a subset was created which contained data only for the Summer Olympics from 1972 to 2020. Rows with null values were discarded, and only medal winning countries were considered in the analysis (71 of the 206 countries participating in the 2020 Olympics have never won a medal).

South Korea was paid particular attention to in the analysis because between 1972 to 2020, its GDP increased nearly 150-fold, and its Freedom Index rose from “not free” in 1972, to “partly free” from 1972 to 1988, to “free” from 1988.

In the analysis, first, team events were corrected to count as only one medal win for a country. Then, the top ten medal winning nations between 1972 to 2020 were calculated (Fig 1).

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Team
USA          1298.0
Russia       1182.0
Germany      978.0
China        636.0
UK           450.0
Australia    399.0
France       367.0
Japan        351.0
Italy        335.0
South Korea  272.0
Name: All, dtype: float64
    
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Figure 1. Total medals won by country from 1972 to 2020 (top ten winners).

Notice that from 1972, South Korea is the tenth place *total* medal winner.

Next, a heat map analysis was conducted to chart changing freedoms over time for each of the 135 medal-winning nations. The analysis focused on nations with the greatest change in freedoms. Fig.2 shows a sample. (South Korea is in the red box.)

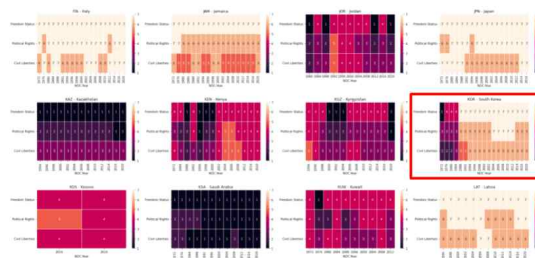


Figure 2. Freedom Status, Political Rights, Civil Liberties changes from 1972 to 2020

After this, the nations with the largest change in freedoms were ranked according to total medals won within the time frame (Fig. 3).

Medal Rank	Medal Count	Country Name	Political Rights	Civil Liberties
1	579	South Korea	26	15
2	566	Romania	11	8
3	510	Spain	27	13
4	480	Brazil	42	23
5	284	Bulgaria	1	1
6	240	Argentina	14	21
7	217	Ukraine	47	28
8	149	Croatia	31	26
9	103	Kenya	25	18
10	100	Nigeria	18	25
11	93	Mexico	33	40
12	68	India	49	41
13	67	Turkey	36	19
14	64	Pakistan	19	38
15	59	South Africa	23	39
16	53	Ethiopia	40	33
17	51	Azerbaijan	48	42
18	47	Indonesia	8	24
19	39	Fiji	24	29
20	39	Dominican Republic	43	46
21	26	Mongolia	4	3
...
25	22	Ghana	5	4

Figure 3. Top medal winning countries with the greatest change in freedom, 1972 to 2020.

Of these, the top ten were more closely analyzed in terms of medal tally, freedoms, GDP growth, population, and contingent size. Fig.4 shows a sample of the comparison between medals and freedom change. (South Korea is in the red box.)

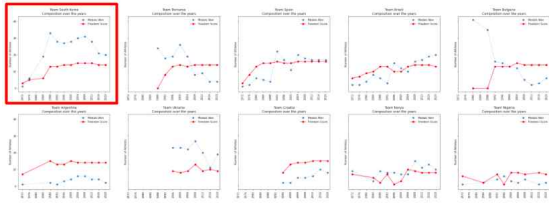


Figure 4. Freedom Index changes vs Medal tally, 1972 to 2020 for selected nations

Finally, eight possible correlations were calculated in Python and graphed, not only for the 10 selected nations, but also for all 135 medal-winning nations from 1972 to 2020. Fig.5 shows graphs of these correlations (contingent size vs. medals is shown in the red box). Fig.6 shows the correlations.

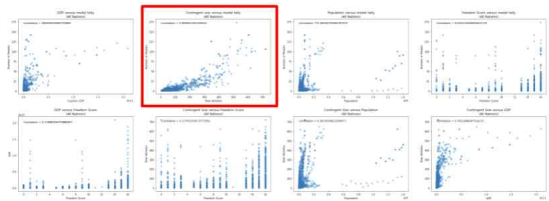


Figure 5. Correlations between medals, GDP, contingent size, population, and Freedom Index

Correlation	All Nations
GDP vs Medals	0.60499
Contingent size vs Medals	0.85966
Population vs Medals	0.38629
Freedom vs Medals	0.01011
GDP vs Freedom	0.11988
Contingent size vs Freedom	0.23705
Contingent size vs Population	0.36199
Contingent size vs GDP	0.59115

Figure 6. Table of correlations.

The table above illustrates that a country's Freedom Index plays less of a role in total medal count than initially expected. In fact, the correlation between Freedom Index and medal tally is barely 0.01, which is completely insignificant. And the largest correlation the Freedom Index had with any other variable was with contingent size at 0.237. But that is still less than the correlation between population and contingent size at 0.362.

In the end, the greatest correlation with medal count turns out to be the size of contingent sent to the Olympics. The correlation is 0.86, which is significant, indicating that sending more athletes leads to more chances to win. In the case of South Korea, excluding 1972, between 8% to 12% of its athletes won medals in the Olympics (Fig. 7).

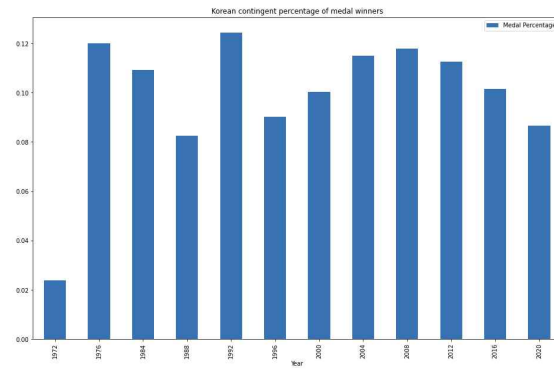


Figure 7. Percentage of South Korean athletes who won a medal, 1972 to 2020.

Additionally, GDP has a moderate correlation with both contingent size (0.591) and medals won (0.605), indicating that countries with a higher GDP have a greater ability to send a larger team.

V. Conclusion

This study focused on a variety of correlations that may influence a nation's total Summer Olympic medal count, including Freedom Index, GDP, population, and contingent size. But it did not account for additional influencing factors such as "home team advantage" for the hosting country, nor what effect a country's previous Olympic performance may have on future results. This study also does not consider medal wins at the Winter Olympics. Additionally, while a special focus was placed on South Korea, and it was found that between 8% to 12% of its athletes have won medals at each Summer Olympics since 1976, the same will not be true for every country, particularly those that have never won a single medal.

Therefore, further research with different methods, such as Data Envelopment Analysis (DEA) which has often been used for Olympics research may provide additional insights.

References

- [1] International Olympic Committee. Olympic Games: Tokyo 2020. [Internet]. Available: <https://olympics.com/en/olympic-games/tokyo-2020>
- [2] International Olympic Committee. Olympic Games: Pyeongchang 2018. [Internet]. Available: <https://olympics.com/en/olympic-games/pyeongchang-2018>
- [3] L. Churilov, A. Flitman. Towards fair ranking of Olympics achievements: the case of Sydney 2000. *Computers and Operations Research*, Vol. 33 pp. 2057-2082. Nov 6, 2004.
- [4] Xiyang Lei, Yongjun Li, Qiwei Xie, Liang Liang. Measuring Olympics achievements based on parallel DEA approach. *Annals of Operations Research*, Vol. 226 pp. 379-396. Sept 21, 2014.
- [5] S. Lozano, G. Villa, F. Guerrero, and P. Cortes. Measuring the performance of nations at the Summer Olympics using data envelopment analysis. *Journal of the Operational Research Society*, Vol. 53 pp. 501-511. 2002.
- [6] Randi H Griffin. 120 Years of Olympic History: Athletes and Results. Kaggle Dataset. June 15, 2018. [Internet]. Available: <https://www.kaggle.com/heesoo37/120-years-of-olympic-history-athletes-and-results/activity>
- [7] Petro Ivaniuk. Tokyo 2020 Olympics. Kaggle Dataset. Aug 31, 2021. [Internet]. Available: <https://www.kaggle.com/piterfm/tokyo-2020-olympics>
- [8] The World Bank. GDP (current \$US) | Data. The World Bank 2020. [Internet]. Available: <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD>
- [9] The World Bank. Population, total | Data. The World Bank 2020. [Internet]. Available: <https://data.worldbank.org/indicator/SP.POP.TOTL>
- [10] Freedom House. Freedom in the World. Freedom House 2020. [Internet]. Available: <https://freedomhouse.org/report/freedom-world>