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Abstract

Roughly seven years before an Olympic Games, the International Olympic Committee (IOC) accepts bids from countries to host an Olympics. Subsequently, the IOC determines and announces to the world who has won (and lost) the right to host. Contrary to prior evidence, we find the announcements do not affect the bidding countries' stock markets. We complement prior studies by including additional, more recent, years of announcements, by investigating whether there are effects prior to the announcement, and by testing for an effect both parametrically and non-parametrically.

JEL Classification Codes: G14, L83, O18, R53, Z20

Keywords: Event study, impact analysis, Olympics, stock market

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1. Introduction

The average costs of a Summer and Winter Olympic Games are $5.2 billion and $3.1 billion, respectively, with some events' price tags running well over $10 billion (Flyvbjerg, Stewart, and Budzier (2016)). Furthermore, they overrun their budgets by 156% on average. These costs have large and important implications for local governments hosting the games as most recently noted in the popular press regarding the 2016 Summer Olympics in Rio de Janeiro (Worstall (2016), Kennedy (2016)).

In defense of such expenditures, boosters and governments argue the Olympics bring economic benefits to the community as well as jobs to the area. The argument for such large government outlays is often an ex-ante one put forth during the bidding process using macroeconomic multipliers or input-output models (Centre for South Australian Economic Studies and KPMG Peat Marwick (1993), Papanikos (1999)). However, ex-post academic studies provide evidence of only a small economic gain (Baade and Matheson (2016), Baumann, Engelhardt, and Matheson (2012)).

To provide a better understanding of the effects of hosting the Olympics, and more specifically to weigh in on the debate on the benefits of hosting the Games, we test for whether the prospect of hosting the Olympics impacts a host country's stock market. We evaluate this impact in the context of the International Olympic Committee's (IOC) host city/country bidding process, where cities/countries submit bids and compete to host an Olympics, culminating in the IOC's announcement of who has won (and lost) the right to host an Olympics. In our analysis, we conduct an "event study," as described by MacKinlay (1997) among others, with the triggering "event" being the announcement by the International Olympic Committee. Our analysis examines market-level stock price data of the prospective host countries around the time of the IOC announcement to see if abnormally positive or negative returns occur around the time of the announcement. Using the returns results, we can empirically test whether a host country's stock market rises, and by extension, whether hosting the Olympics increases the profits of its companies and the wealth of its citizens, consistent with the typical economic arguments made in support of hosting an Olympics.

The results provided below extend the current literature on the topic of IOC announcements on stock prices. Our results are in line with Berman, Brooks, and Davidson (2000) who use an event study approach to find no general impact of the announcement of the Sydney games on Australia. In contrast to the earlier study, Veraros, Kasimati, and Dawson (2004) find a positive impact of winning the bid for the summer 2004 Olympics on the Athens Stock Exchange using an event study approach. However, both early studies focus on a single event. In the literature looking at multiple announcements, in particular Dick and Wang (2010) and Mirman and Sharma (2010), they find statistically significant effects. The former study finds it for winners and the latter for losers of the bids. All the studies use standard parametric event study techniques in finding their effects.

We extend the event study literature on the impact of IOC announcements by (i) adding additional data (through the Chinese win of the 2022 Winter Olympics bidding process), (ii) analyzing stock market effects *prior* to the announcements to check for leakage of the announcement, and (iii) running non-parametric tests in addition to the standard parametric tests. Although our study contains more data, larger windows of analysis, and more robust estimates, we find little to no impact of the IOC announcements on the stock exchanges of the host countries. In other words, our results are in line with Berman, Brooks, and Davidson (2000), but in general fail to replicate the remaining literature even when taking a larger, longer, and more varied look at the data.

That being said, we see several rather large abnormal returns in the stock markets of countries who either won or lost their bid to host the Olympics. However, only one was large enough to reject a hypothesis of no effect after controlling for the fact so many tests were run. To test for an aggregate effect, we run on the order of 150 tests across multiple event windows and using parametric and non-parametric approaches. We find only three could potentially reject the null at a 5% type 1 error threshold. Overall, given the event study approach, our results suggest a weak to non-existent effect that the IOC announcement affects a bidding country's stock market.

2. Model

To test for whether the Olympics has an economic impact for the country who hosts the games, we analyze whether the Olympics increases profits of publicly traded companies in the host countries. To measure whether there is an impact on profits, we exploit the theory that stock prices increase in value when firms' expected future profits increase. In other words, if firm ABC suddenly has an increase in expected future profits of $1 billion, then the value of the firm increases on the order of $1 billion, after adjusting for a variety of factors such as the discount rate of the future earnings. Given the theory, it is key to pinpoint when firms' expected profits would likely increase as a result of hosting the Olympic games. If those times can be pinpointed, then measuring changes in the value of the firms in a host country, or their market capitalization as measured through their stock prices, provides evidence of an economic impact from hosting. In the case of the Olympic games, prior research suggests the point in time when companies are affected is when the IOC announces a country will host an Olympic games. It is at that point that firms can expect to be getting future business and profits from providing goods and services to the Games. As a result, we analyze the change in stock prices around the time of the IOC announcement.

To put it differently, we are using the event study approach following Berman, Brooks, and Davidson (2000), Veraros, Kasimati, and Dawson (2004), Dick and Wang (2010) and Mirman and Sharma (2010).

2.1 Event and estimation window

We take our notation and discussion of the event study model we use from MacKinlay (1997). In the context of event studies, our "event date" is the day of the IOC's announcement of who won the bidding process and will host the Olympics. To ensure we do not miss the potential impact of the announcement, we analyze a battery of event windows around the event date, investigating whether the announcement could have affected the stock market prior to the announcement, around the announcement, and after the announcement. In particular, we investigate eight different event windows, $[\tau_1, \tau_2]$, including [0,1], [0,2], [0,5], [0,9], [-2,2], [-5,5], [-5,-1], and [-2,-1] where $t = 0$ is the day of the announcement, τ_1 is the start of the event window, and τ_2 is the end of the window being analyzed. The days are counted as the change relative to the previous day and all windows are inclusive.

We analyze a wide range of windows for a variety of reasons. First, we are attempting to replicate previous studies. As a result, we include their windows. In particular, Dick and Wang (2010) include [0,1], [0,2], [0,5], [0,9]. However, we fail to replicate their results. Therefore, we investigate windows that start prior to the announcement date, or [-2,2], [-5,5], which is fairly common in the literature where information may be leaked. For completeness, we also provide estimates for windows [-5,-1] and [-2,-1] to be able to consider pre and post announcement effects separately and to ensure the effect isn't lost to changes in expectations right before the announcement.

Whatever the window, the objective is to capture whether host countries had abnormal returns during these event windows. In other words, do we see a country's stock market index, or a country's firms' profits, increase unexpectedly around the time of the announcement? Central to our analysis is the assumption that the news contained in the IOC announcement is unexpected. Otherwise, the announcement would be priced into the market in advance of the announcement. However, as noted above, we utilize eight different event windows, to help in identifying and isolating market effects even when there is leakage of the otherwise unexpected announcement result. Furthermore, we note the announcements are often a surprise to the general public as documented in the news. Refer to Magnay (2011) and BBC (2013) for the Pyeongchang and Tokyo games, respectively. Note that in a scenario where a city is expected to win, such as Beijing's winning bid for the 2022 Winter Olympics (Rauhala and Birnbaum (2015)), this would bias against finding a country-level stock market effect.

To estimate what is normal, we estimate returns of a country's stock market over an estimation window of $-241 \leq t \leq -41$. For comparability, we use the same estimation window as Dick and Wang (2010). All measures of t are trading days.

2.2 Estimating abnormal returns

In determining what is abnormal, we use the estimation window to calculate normal returns using a market model. Specifically, we use ordinary least squares (OLS) to estimate the linear relationship

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \tag{1}$$

for each announcement date, or observation, "i", where R_{it} is the one-day return on country "i's" stock market. As noted above, "t" represents the date relative to the announcement. R_{mt} is the "market return" as measured by the MSCI World Index. All returns are calculated using closing prices. The estimated parameters from OLS are $\hat{\alpha}_i$, $\hat{\beta}_i$, and $\hat{\sigma}^2_{\varepsilon_i}$ by announcement "i." Note in our context the country level index is the individual announcement return while the global market is used as the overall market return. Normally, a country's stock market index is used as the overall market return relative to a specific firm's stock price return.

Given the OLS estimates of the linear relationship and error by country and announcement, we estimate whether a stock market has experienced something abnormal by calculating the error in the linear prediction, or

$$\widehat{AR}_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt} \tag{2}$$

where $\widehat{AR}_{it}$ is the sample of abnormal returns for firm "i" on day "t."

Note the sample abnormal return for country "i's" stock market, or $\widehat{AR}_{it}$, is calculated relative to the global market in period "t." The market term controls for systemic risk. The abnormal returns are normally distributed given standard assumptions with a mean zero and variance σ^2. The normality assumption will be used and then relaxed when testing for an effect of host announcements on stock market indices.

2.3 Estimation of the cumulative abnormal return

Our objective is to test the effect of the IOC host announcement on a bidder's stock market. To increase the power of the test, we aggregate abnormal returns over several days and announcements. The cumulative abnormal returns by event is calculated as

$$\widehat{CAR}\,(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau_2} \widehat{AR}_{i\tau} \tag{3}$$

and across events as

$$\overline{CAR}(\tau_1, \tau_2) = \frac{1}{N} \sum_{i=1}^{N} \sum_{\tau=\tau_1}^{\tau_2} \widehat{AR}_{i\tau} \tag{4}$$

where N is the total number of announcements/events and $[\tau_1, \tau_2]$ is the event window. Under the standard assumptions as discussed in MacKinlay (1997) and elsewhere, the variance of the statistics in equations 3 and 4 are estimated as

$$\text{var}\left(\widehat{CAR}(\tau_1,\tau_2)\right) = (\tau_1 - \tau_2 + 1)\hat{\sigma}_i^2 \tag{5}$$

$$\text{var}(\overline{CAR}(\tau_1,\tau_2)) = \frac{1}{N^2}\sum_{i=1}^{N}(\tau_1 - \tau_2 + 1)\hat{\sigma}_i^2 \tag{6}$$

respectively.

Again, as discussed in MacKinlay (1997) and elsewhere, the estimates can be normalized and assumed to be normal, or

$$\hat{\theta}(\tau_1,\tau_2) = \frac{\widehat{CAR}(\tau_1,\tau_2)}{\text{var}(\widehat{CAR}(\tau_1,\tau_2))^{\frac{1}{2}}} \sim N[0,1] \tag{7}$$

$$\hat{\theta}_0(\tau_1,\tau_2) = \frac{\overline{CAR}(\tau_1,\tau_2)}{\text{var}(\overline{CAR}(\tau_1,\tau_2))^{\frac{1}{2}}} \sim N[0,1] \tag{8}$$

under the hypothesis of a mean of zero. The hypothesis can be rejected with a specified level of confidence. These tests are referred to as parametric test statistics where normality and a constant variance in returns across time are assumed. These tests represent the standard event study approach to testing whether the announcements had an effect. If an effect had not occurred, then we would expect to fail to reject the null. However, if the null is rejected, then the alternative is the event had a positive or negative impact on stock prices. As a result, we are able to speculate that the abnormal return was due to the event, i.e., the IOC announcement increased or decreased the countries' companies' future profitability.

To summarize, we are testing whether there are abnormal returns over the event window. We calculate abnormal returns using parameters from an estimation window. If the abnormal returns are large, then we hypothesize it is due to the announcements. In calculating each abnormal return, we aggregate over several days around the event to ensure the impact of the information is not lost due to timing. Furthermore, we aggregate across events to improve the power of the test.

The above test for abnormal returns is a standard parametric approach, and is the approach followed in earlier work including Berman, Brooks, and Davidson (2000), Veraros, Kasimati, and Dawson (2004), Dick and Wang (2010) and Mirman and Sharma (2010).

The potential issue with the standard approach described above is that it relies on several potentially incorrect assumptions. In particular, the data may not be normally distributed and the variance in the data may have changed between the estimation window and event window. As a result, we extend the prior literature by further analyzing our tests using two non-parametric tests. Specifically, we use a sign and sign rank test.

The sign test tests whether more than half of the announcements result in a positive or negative abnormal return. In using the sign test, we are able to ignore the normality assumptions and variance estimate from the estimation window. We simply test whether the abnormal return is a "fair coin flip." To run the test, we count the number of countries with a positive cumulative abnormal return, calling it N^{+}, and the total number of announcements N. Again, following MacKinlay (1997), the test statistic for the sign test is calculated as

$$\hat{\theta}_1(\tau_1, \tau_2) = \left[\frac{\hat{N}^+}{N} - 0.5\right]\frac{\sqrt{N}}{0.5} \sim N[0,1] \quad (9)$$

An issue with the sign test relates to the fact it does not account for the size of each effect. As a result, we further analyze the data using the Wilcoxon sign rank test. Specifically, we take the absolute values of all the cumulative abnormal returns, or $\left|\overline{CAR_\iota(\tau_1, \tau_2)}\right|$, and rank them. Let $\hat{R}_{i,\tau_1,\tau_2}$ be the ranking and $\hat{R}^{+}_{i,\tau_1,\tau_2}$ be the rank if the cumulative abnormal return is greater than zero and zero otherwise. Given the ranking, the test statistic is calculated as

$$\widehat{W}(\tau_1, \tau_2) = \sum_{i=1}^{N} \hat{R}^{+}_{i,\tau_1,\tau_2} \quad (10)$$

As before, the test statistic does not require an assumption about the normality of the abnormal returns or an estimate of the variance using the estimation window. Note, W ranges between $[0, \frac{N(N+1)}{2}]$. Furthermore, if W is significantly large or small, then the test statistic rejects the null hypothesis that the average cumulative abnormal return, or $CAR(\tau_1, \tau_2)$, is zero. For sufficiently large N, the test statistic becomes

$$\hat{\theta}_2(\tau_1, \tau_2) = \frac{\widehat{W}(\tau_1, \tau_2) - \frac{N(N+1)}{4}}{\sqrt{\frac{N(N+1)(2N+1)}{24}}} \sim N[0,1] \quad (11)$$

We only use the asymptotic results for the full sample of losers. Otherwise, the critical values must be determined through a counting process. We take the critical values of W for small N from Wilcoxon and Wilcox (1964). In other words, for a given type 1 error and N, which determine the low and high critical values C_L and C_H, if $W < C_L$ or $C_H < W$, we then evaluate the null that the average cumulative abnormal return is zero.

3. Data

To run the event study, we require two types of data. Specifically, the analysis requires the IOC announcement dates as well as stock index data for each winning and losing country in the bidding process.

To acquire the dates of the announcements as well as the winners and losers, Grasso, Mallon, and Heijmans (2015) provides information on an Olympics by Olympics basis. More recent winning bids can be found on the official Olympics.org website under each Olympics' documentation. To ensure transparency, the complete lists of winners and losers, as well as the announcement dates, are provided in Tables 1 and 2.

The stock data of the winners and losers comes from country stock market data for the days

-241 to +9 where the announcement date is $t = 0$. Data between -241 and -41 is used as the estimation window and the data between -5 and 9 is used for the event windows. To reiterate, the days are trading days. When available, the data was acquired from Yahoo Finance API. When unavailable on Yahoo Finance, the data was acquired through Thomson Reuters' Datastream. Note several decisions had to be made regarding what index should be used to represent a country as multiple indices exist. For transparency, the list of indices used in the analysis is provided in Tables 1 and 2. The MSCI World Index, the index used the calculate market returns, was collected from Yahoo Finance.

4. Results

We analyze the results along several dimensions - parametrically and non-parametrically, winning and losing bids, and varying event size windows. To allow for replication, and because the number of events is relatively small, we provide the cumulative abnormal returns and associated error estimates, or $\widehat{CAR}_i(\tau_1, \tau_2)$ and $\hat{\sigma}^2_{\varepsilon_i}$, for winners and losers in Tables 3 and 4.

By dividing the cumulative abnormal returns by $\sqrt{(\tau_2 - \tau_1 + 1}\,\hat{\sigma}_{\varepsilon_i}$, one can see the number of standard deviations away from the mean a particular stock market had during a particular event window. The Canadian stock market during its 9/30/1981 winning bid saw a 4.3 standard deviation abnormal return during the event window $\tau_1 = -2$ and $\tau_2 = -1$. The next highest was the USA's *losing* 10/17/1986 bid with a 3.76 standard deviation abnormal return during the event window $\tau_1 = -5$ and $\tau_2 = 5$. However, this later event as well as several others with a z-statistic above 2.5 cannot be used to reject a null of no effect because of the large number of tests. In particular, one is not able to use these later individual cases to reject a null of no effect once a Bonferroni correction is made. However, the large shocks do suggest further analysis is necessary.

Rather than looking at abnormal returns by announcement, we analyze the aggregate effect.

The results for the winners, first losers (those ranked in second place in the last round of the competition), and losers of the bidding process are in Tables 5-7. For the winning bids, the cumulative abnormal returns are generally positive post announcement. However, this is also true for the first losers and all losers with the exception of the summer games. In other words, if the analysis is aggregated and one ignores the distinction between summer and winter games, then it seems countries are positively impacted no matter the outcome. Furthermore, the impacts are relatively large at around 0.5% for post announcement windows. Note however that once the summer games are analyzed separately, the losers are generally negative and winners are generally positive. Although informative, this type of analysis ignores the statistical properties of the statistics.

Relying on the statistical properties of the estimated average effects, we fail to reject that the cumulative abnormal return is different from zero for nearly every cumulative return, as determined by the test statistic described in Equation 8. The top two average cumulative return test statistics are 1.76 and 2.06 for the winners of the summer games when using the interval $\tau_1 = 0$ and $\tau_2 = 1$ and the losers of the winter games when using the interval $\tau_1 = 0$ and $\tau_2 = 1$, respectively. However, the latter would be expected to be negative. Furthermore, they aren't particularly large. As in the individual test cases, any observed statistical significance across any of the tests must be weighted with the fact that so many tests are being run.

Relative to the closest study, Dick and Wang (2010) (DW), the estimates of the variation of the cumulative abnormal returns are very similar. For instance, we find the standard deviation of the cumulative abnormal return for the winning countries to be the same (up to three decimal places) for both the summer and winter games. Our estimates for the losers are slightly smaller, or .003 versus .004 in DW. What differentiates our results, i.e., we fail to reject a null of no effect, is our estimated impacts are significantly smaller. For instance, our estimated cumulative abnormal return for winning bids in the [0,1] event window is 0.0007 versus 0.011 in the case of DW. Therefore, our results are consistent in terms of the variation in the data. However, the estimated cumulative abnormal return statistics do not coincide. Although our results are markedly different, we note the key difference is we have additional data and have potentially used different country stock market indexes.

As our results run relatively contrary to prior evidence, in particular DW, we perform two additional non-parametric tests not in the previous literature. The results of our first non-parametric test, the sign test, are provided in Tables 8-10. For the winning bids, as in the *CAR* case, we find abnormal returns on average happened more than 50% of the time after the announcement date. However, only one provides sufficient evidence to support rejection at the 5% significance level following the statistic defined in equation 9. The only other test statistic above 2, and only slightly above, should arguably be the opposite sign, i.e., negative. In particular, the winter Olympic losers for the [0, 1] event window are similar to the parametric results. On aggregate, the results show little to arguably no evidence regarding the idea that the IOC announcement has a statistically significant impact on stock markets. This is especially true after the consideration of implementing a Bonferroni correction for the number of tests being run.

As our final non-parametric test, we run the Wilcoxon sign rank test described in equations 10 and 11. The results are provided in Tables 11-13. The only test statistic in the entire group to be outside of the critical values, based on a 5% type 1 error threshold, is the “all games” under the [0, 2] event window. The remaining results fail to reject the null of no cumulative effect.

5. Small country analysis

As a potential critique of the analysis, winning the Olympics bid can have a large monetary benefit to the country, but the effect could be small relative to the size of the country’s economy or stock market. As a result, our analysis might simply be trying to find a “needle in a haystack.”

Given this issue, we analyze the effect of the announcements conditional on the host country's size. In other words, we control for how important the bid can be relative to the country's stock market.

We take two approaches to answer the critique. In the first, we follow the approach of Dick and Wang (2010) by analyzing the correlation between a country's $\overline{CAR}(0,5)$ (and $\theta_0(0,5)$) and its size using a simple linear regression, or

$$y_i = \beta_0 + \beta_1 \, share \ of \ GDP + \beta_2 \, Summer \ Games + \varepsilon_i, \tag{12}$$

As in Dick and Wang (2010), we focus on the winners and where the size variable is "taken as the percentage of the individual country GDP relative to the world GDP in the announcement year." The GDP data was taken from the United States Department of Agriculture's ERS International Macroeconomic Data Set. The results are in Table 14. As before, we fail to find any meaningful impact of the bid on a country's stock market even when controlling for size.

The second approach bifurcates the dataset into a group of the large cities and a set of the small cities as defined by the size of the cities hosting the games, where a "win" by a large city within a country might be viewed as a "win" for the country as a whole resulting in more extensive national stock market effects. Given this split, we re-run the parametric results. The results are provided in Table 15. As seen here and throughout the paper, the results fail to reject a null hypothesis of no announcement effect under any reasonable significance level with the exception of the [0,2] event window for the winners (as seen before).

6. Difference in winners and losers

As an additional robustness check of the results, we calculate the difference in the stock market returns between winners and losers using both the parametric and non-parametric approaches. In other words, we work to improve the power of the test under the assumption that winning the bid to host the Olympics would positively affect a country's companies' future profits while it would hurt countries who lose the bidding process.

Under standard assumptions, the difference in the cumulative abnormal returns, or the parametric approach, is estimated as

$$\overline{DCAR}(\tau_1,\tau_2) = \frac{1}{N}\sum_{i-1}^{N}\sum_{\tau=\tau_1}^{\tau_2}(-1)^L\widehat{AR}_{i\tau} \tag{13}$$

where $L = 1$ if observation i was a losing bid, and zero otherwise. Its estimated variance is

$$\text{var}(\overline{DCAR}(\tau_1,\tau_2)) = \frac{1}{N^2}\sum_{i-1}^{N}(\tau_1+\tau_2+1)\hat{\sigma}_i^2 \tag{14}$$

and the test statistic can be estimated as

$$\hat{\theta}_3(\tau_1,\tau_2) = \frac{\overline{DCAR}(\tau_1,\tau_2)}{\text{var}(\overline{DCAR}(\tau_1,\tau_2))^{1/2}} \sim \text{N}[0,1] \tag{15}$$

under the hypothesis of a mean of zero. In terms of the non-parametric test, we calculate the test statistic as

$$\hat{\theta}_4(\tau_1,\tau_2) = \left[\frac{\widehat{N}_W^+ + \widehat{N}_L^-}{N} - 0.5\right]\frac{\sqrt{N}}{0.5} \sim \text{N}[0,1] \tag{16}$$

where N is the number of winners and losers, N_W^+ is the number of winners with a positive abnormal return in the event window, and N_L^- is the number of losers with a negative abnormal return in the event window.

The results of the difference between winners and losers are provided in Table 16 for the parametric test and Table 17 for the non-parametric test. Unlike before, none of the test results show a test statistic above 2. In other words, we fail to reject the hypothesis that the difference in the returns, which would be expected to be positive if a winning announcement was good and a losing announcement was bad, is zero.

7. Conclusion

Cities who host the Olympics spend substantial sums of public funds to prepare and host the event. Boosters and governments who bid to host the Olympics argue the economic benefits of hosting outweigh the costs. However, the argument for such large government outlays is often an ex-ante one put forth during the bidding process using macroeconomic multipliers or input-output models.

To analyze the actual benefits rather than predictions, researchers have used a variety of methods based on measured outcomes in the host city and country after the Olympics have taken place. We take one of these approaches by testing for the impact that hosting the games has on the profits of the firms in the host country. To test for an impact on firm profits, we follow the literature by using an "event study" approach. The event study approach measures stock prices right around the time of the IOC announcement of the winning bid, and if stock prices (expected profits) rise during that period, then researchers can conclude there are substantial economic profits for the country hosting the games.

The literature we refer to and follow includes Veraros, Kasimati, and Dawson (2004), Dick and Wang (2010), and Mirman and Sharma (2010). In these studies, the researchers have found some statistically significant evidence that announcements impact stock markets, and by extension, hosting the Olympic games has an economic benefit.

In following the earlier work, we have failed to find any statistically significant impact of the announcements on stock prices. In other words, we find that an argument for a positive economic impact from the Games cannot be justified using an event study approach.

Given our findings run contrary to previous results, we have extended the event study approach along several dimensions. In particular, we have (i) used additional data, (ii) investigated a larger range of event windows (time around the announcement), (iii) tested for an effect using two additional non-parametric tests in addition to the standard parametric tests, and (iv) considered the difference in impacts between winners and losers using both the parametric and non-parametric approaches. Furthermore, we have worked to make our findings transparent. In particular, we have provided the announcement dates, stock indexes used, and individual cumulative abnormal returns used in determining our findings. As a result, researchers can analyze and replicate our work.

The debate regarding the economic benefits of the Olympics is important. As part of the debate, we hope our results provide a transparent and empirically driven analysis that informs the public on the benefits of hosting, and by extension, whether they should or should not host an Olympic Games.

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Table 1: Data Description: Winning Bids

Olympics	Announcement	Country Name	Stock Index	Source of Index
Winter 1988	09/30/1981	Canada	S&P/TSX Composite	Yahoo Finance
Summer 1988	09/30/1981	South Korea	KOSPI Composite	Thomson Reuters' Datastream
Winter 1992	10/17/1986	France	CAC General Index	Thomson Reuters' Datastream
Summer 1992	10/17/1986	Spain	Madrid SE General (IGBM)	Thomson Reuters' Datastream
Winter 1994	09/15/1988	Norway	OSEBX.OL	Yahoo Finance
Summer 1996	09/18/1990	USA	S&P 500	Yahoo Finance
Winter 1998	06/15/1991	Japan	Nikkei 225	Yahoo Finance
Summer 2000	09/23/1993	Australia	All Ordinaries	Yahoo Finance
Winter 2002	06/16/1995	USA	S&P 500	Yahoo Finance
Summer 2004	09/05/1997	Greece	Athens Index Composite	Yahoo Finance
Winter 2006	06/19/1999	Italy	FTSE MIB Index	Yahoo Finance
Summer 2008	07/13/2001	China	SSE Composite	Yahoo Finance
Winter 2010	07/02/2003	Canada	S&P/TSX Composite	Yahoo Finance
Summer 2012	07/06/2005	UK	FTSE 100	Yahoo Finance
Winter 2014	07/04/2007	Russia	RSF EE MT (RUR) INDEX	Thomson Reuters' Datastream
Summer 2016	10/02/2009	Brazil	IBOVESPA	Yahoo Finance
Winter 2018	07/06/2011	South Korea	KOSPI Composite	Yahoo Finance
Summer 2020	09/07/2013	Japan	Nikkei 225	Yahoo Finance
Winter 2022	07/31/2015	China	SSE Composite	Yahoo Finance

Table 2: Data Description: Losing Bids

Olympics	Announcement	Country Name	Stock Index	Source of Index
Winter 1988	09/30/1981	Sweden	AFFARSVARLDEN GENERAL INDEX	Thomson Reuters' Datastream
Winter 1988	09/30/1981	Italy	ITALY-DS Market	Thomson Reuters' Datastream
Summer 1988	09/30/1981	Japan	NIKKEI 225 STOCK AVERAGE	Thomson Reuters' Datastream
Winter 1992	10/17/1986	Sweden	AFFARSVARLDEN GENERAL INDEX	Thomson Reuters' Datastream
Winter 1992	10/17/1986	Norway	OSEBX.OL	Yahoo Finance
Winter 1992	10/17/1986	Italy	ITALY-DS Market	Thomson Reuters' Datastream
Winter 1992	10/17/1986	USA	S&P 500	Yahoo Finance
Winter 1992	10/17/1986	Germany	DAX 30 PERFORMANCE	Thomson Reuters' Datastream
Summer 1992	10/17/1986	France	CAC General	Thomson Reuters' Datastream
Summer 1992	10/17/1986	Australia	All Ordinaries	Yahoo Finance
Summer 1992	10/17/1986	UK	FTSE 100	Yahoo Finance
Summer 1992	10/17/1986	Netherlands	AEX INDEX (AEX) DS-CALC	Thomson Reuters' Datastream
Winter 1994	09/15/1988	Sweden	AFFARSVARLDEN GENERAL INDEX	Thomson Reuters' Datastream
Winter 1994	09/15/1988	USA	S&P 500	Yahoo Finance
Summer 1996	09/18/1990	Greece	Athens Composite Index	Yahoo Finance
Summer 1996	09/18/1990	Canada	S&P/TSX Composite	Yahoo Finance
Summer 1996	09/18/1990	Australia	All Ordinaries	Yahoo Finance
Summer 1996	09/18/1990	UK	FTSE 100	Yahoo Finance
Winter 1998	06/15/1991	USA	S&P 500	Yahoo Finance
Winter 1998	06/15/1991	Sweden	AFFARSVARLDEN GENERAL INDEX	Thomson Reuters' Datastream
Winter 1998	06/15/1991	Spain	IBEX 35	Yahoo Finance
Winter 1998	06/15/1991	Italy	ITALY-DS Market	Thomson Reuters' Datastream
Summer 2000	09/23/1993	China	SSE Composite	Yahoo Finance
Summer 2000	09/23/1993	UK	FTSE 100	Yahoo Finance
Summer 2000	09/23/1993	Germany	Dax	Yahoo Finance
Summer 2000	09/23/1993	Turkey	BIST NATIONAL 100	Thomson Reuters' Datastream
Winter 2002	06/16/1995	Switzerland	Swiss Market Index	Thomson Reuters' Datastream
Winter 2002	06/16/1995	Sweden	AFFARSVARLDEN GENERAL INDEX	Thomson Reuters' Datastream
Winter 2002	06/16/1995	Canada	S&P/TSX Composite	Yahoo Finance
Summer 2004	09/05/1997	Italy	ITALY-DS Market	Thomson Reuters' Datastream
Summer 2004	09/05/1997	South Africa	FTSE/JSE ALL SHARE	Thomson Reuters' Datastream
Summer 2004	09/05/1997	Sweden	AFFARSVARLDEN GENERAL INDEX	Thomson Reuters' Datastream
Summer 2004	09/05/1997	Argentina	ARGENTINA MERVAL	Thomson Reuters' Datastream
Winter 2006	06/19/1999	Switzerland	Swiss Market Index	Yahoo Finance
Winter 2006	06/19/1999	Finland	OMX HELSINKI (OMXH)	Thomson Reuters' Datastream
Winter 2006	06/19/1999	Austria	ATX	Yahoo Finance
Winter 2006	06/19/1999	Slovakia	SLOVAKIA SAX 16	Thomson Reuters' Datastream
Winter 2006	06/19/1999	Poland	WARSAW GENERAL INDEX 20	Thomson Reuters' Datastream
Summer 2008	07/13/2001	Canada	S&P/TSX Composite	Yahoo Finance
Summer 2008	07/13/2001	France	CAC 40	Yahoo Finance
Summer 2008	07/13/2001	Turkey	Borsa Istanbul 100	Yahoo Finance
Summer 2008	07/13/2001	Japan	NIKKEI 225	Yahoo Finance
Winter 2010	07/02/2003	South Korea	KOSPI	Yahoo Finance
Winter 2010	07/02/2003	Austria	ATX	Yahoo Finance
Summer 2012	07/06/2005	France	CAC 40	Yahoo Finance
Summer 2012	07/06/2005	Spain	IBEX 35	Yahoo Finance
Summer 2012	07/06/2005	USA	S&P 500	Yahoo Finance
Summer 2012	07/06/2005	Russia	RSF EE MT (RUR) INDEX	Thomson Reuters' Datastream
Winter 2014	07/04/2007	South Korea	KOSPI	Yahoo Finance
Winter 2014	07/04/2007	Austria	ATX	Yahoo Finance
Summer 2016	10/02/2009	Spain	IBEX 35	Yahoo Finance
Summer 2016	10/02/2009	Japan	NIKKEI 225	Yahoo Finance
Summer 2016	10/02/2009	USA	S&P 500	Yahoo Finance
Winter 2018	07/06/2011	Germany	Dax	Yahoo Finance
Winter 2018	07/06/2011	France	CAC 40	Yahoo Finance
Summer 2020	09/07/2013	Turkey	Borsa Istanbul 100	Yahoo Finance
Summer 2020	09/07/2013	Spain	IBEX 35	Yahoo Finance

Table 3: Cumulative Abnormal Returns by Country: Winning Bids

Country	Announcement	$\hat{\sigma}_{\varepsilon_i}$	$\widehat{CAR}_i(\tau_1,\tau_2)$ $\tau_1=0$, $\tau_2=1$	$\tau_1=0$, $\tau_2=2$	$\tau_1=0$, $\tau_2=5$	$\tau_1=0$, $\tau_2=9$	$\tau_1=-2$, $\tau_2=2$	$\tau_1=-5$, $\tau_2=5$	$\tau_1=-5$, $\tau_2=-1$	$\tau_1=-2$, $\tau_2=-1$
Canada	09/30/1981	0.0064	0.0035	0.0108	-0.0066	-0.0142	0.0498	-1.0135	-0.0069	0.0390
South Korea	09/30/1981	0.0135	-0.0238	0.0073	0.0522	-0.0137	-0.0141	-0.0072	-0.0594	-0.0214
France	10/17/1986	0.0134	-0.0326	-0.0332	0.0064	-0.0083	-0.0648	-0.03	-0.0364	-0.0317
Spain	10/17/1986	0.0135	-0.0178	-0.026	-0.0518	-0.12	-0.0327	-0.0676	-0.0158	-0.0068
Norway	09/15/1988	0.0203	0.0264	0.0321	0.0405	0.0371	0.0431	0.0542	0.0137	0.0111
USA	09/18/1990	0.0081	0.0088	0.0025	0.0041	0.0354	0.0048	-0.001	-0.0052	0.0023
Japan	06/15/1991	0.0138	0.0026	-0.0104	-0.0114	-0.0154	0.0029	0.0001	0.0114	0.0133
Australia	09/23/1993	0.0074	0.0118	0.0079	0.0158	0.0365	0.0058	0.0237	0.0078	-0.0021
USA	06/16/1995	0.0048	0.0102	0.0093	0.01	0.008	0.0085	0.0182	0.0081	-0.0009
Greece	09/05/1997	0.0176	0.0742	0.0861	0.0614	0.0663	0.0756	0.0428	-0.0186	-0.0105
Italy	06/19/1999	0.0154	-0.0023	0.0072	-0.0022	-0.0319	0.0056	-0.014	-0.0118	-0.0016
China	07/13/2001	0.0089	-0.0096	-0.0123	0.0049	-0.0369	-0.0232	-0.0044	-0.0093	-0.0109
Canada	07/02/2003	0.0064	-0.0054	-0.0038	0.0049	0.0057	-0.0036	0.0057	0.0008	0.0002
UK	07/06/2005	0.0046	-0.0033	0.0051	-0.0002	-0.0106	0.0082	0.019	0.0191	0.0031
Russia	07/04/2007	0.0135	0.0118	0.0122	0.0198	0.0322	0.0167	0.0162	-0.0036	0.0045
Brazil	10/02/2009	0.018	0.0317	0.0126	0.0132	0.0315	0.0219	0.0362	0.0231	0.0093
South Korea	07/06/2011	0.0081	0.0054	0.0076	-0.0106	-0.0117	0.0224	0.0172	0.0278	0.0149
Japan	09/07/2013	0.0161	0.0236	0.0187	0.0049	0.0213	-0.0022	0.0153	0.0104	-0.0209
China	07/31/2015	0.0168	-0.0306	0.0019	-0.0123	0.027	0.0046	-0.1387	-0.1264	0.0028

Table 4: Cumulative Abnormal Returns by Country: Losing Bids

Country Name	Announcement	$\hat{\sigma}_{\varepsilon_i}$	$\widehat{CAR}_i(\tau_1,\tau_2)$ $\tau_1=0$, $\tau_2=1$	$\tau_1=0$, $\tau_2=2$	$\tau_1=0$, $\tau_2=5$	$\tau_1=0$, $\tau_2=9$	$\tau_1=-2$, $\tau_2=2$	$\tau_1=-5$, $\tau_2=5$	$\tau_1=-5$, $\tau_2=-1$	$\tau_1=-2$, $\tau_2=-1$
Sweden	09/30/1981	0.0086	0.0131	0.0086	0.0274	0.0466	-0.0218	-0.0066	-0.034	-0.0304
Italy	09/30/1981	0.0282	0.0149	0.0013	-0.0407	-0.0996	-0.0208	0.0055	0.0462	-0.0221
Japan	09/30/1981	0.0056	-0.0001	-0.0025	0.0128	0.0147	-0.006	-0.0003	-0.013	-0.0035
Sweden	10/17/1986	0.0116	-0.0033	-0.0153	-0.0063	0.0059	-0.028	-0.0404	-0.0341	-0.0127
Norway	10/17/1986	0.0097	0.0112	0.0103	0.0083	0.0061	-0.0003	0.0142	0.006	-0.0106
Italy	10/17/1986	0.0199	0.0107	0.0105	-0.0057	-0.0381	0.0204	0.012	0.0176	0.01
USA	10/17/1986	0.0055	0.0032	0.012	0.0401	0.0383	0.0345	0.0684	0.0283	0.0225
Germany	10/17/1986	0.0141	-0.014	-0.0034	0.0165	-0.0048	-0.0112	0.0049	-0.0116	-0.0078
France	10/17/1986	0.0134	-0.0326	-0.0332	0.0064	-0.0083	-0.0648	-0.03	-0.0364	-0.0317
Australia	10/17/1986	0.0085	0.0047	0.0124	0.0031	0.0027	0.0134	0.0116	0.0084	0.001
UK	10/17/1986	0.0079	-0.0006	0.0045	0.0042	0.0161	0.0146	0.0078	0.0036	0.0101
Netherlands	10/17/1986	0.0091	0.0009	0.005	0.014	0.0045	0.0105	-0.003	-0.0171	0.0055
Sweden	09/15/1988	0.0148	-0.0049	0.0053	0.0345	0.0205	0.0057	0.0458	0.0113	0.0004
USA	09/15/1988	0.0172	0.0009	-0.0057	0.0056	-0.0021	0.0009	0.0123	0.0068	0.0066
Greece	09/18/1990	0.0244	-0.0576	-0.0605	-0.1483	-0.2289	-0.0049	-0.1545	-0.0063	0.0556
Canada	09/18/1990	0.0056	0.0138	0.0151	0.0095	0.0094	0.0192	0.0098	0.0003	0.004
Australia	09/18/1990	0.0095	-0.0072	-0.0026	-0.0295	-0.026	-0.0096	-0.0368	-0.0073	-0.007
UK	09/18/1990	0.008	-0.0041	-0.0202	-0.0199	0.0031	-0.032	-0.04	-0.0201	-0.0118
USA	06/15/1991	0.0087	-0.0027	-0.0058	-0.0156	-0.0111	0.002	-0.0083	0.0072	0.0078
Sweden	06/15/1991	0.0122	0.0236	0.0347	0.0373	0.0476	0.0239	0.0373	0.0000	-0.0109
Spain	06/15/1991	0.0132	-0.0051	-0.0132	-0.0056	-0.0049	-0.0486	-0.0333	-0.0276	-0.0354
Italy	06/15/1991	0.0115	0.0239	0.0189	-0.0198	0.0018	0.0108	-0.0123	0.0075	-0.0081
China	09/23/1993	0.0502	-0.0092	-0.0097	-0.0004	-0.0252	0.0091	0.0221	0.0225	0.0188
UK	09/23/1993	0.0061	-0.002	0.0029	0.0059	0.0201	0.0073	0.0182	0.0123	0.0044
Germany	09/23/1993	0.0079	-0.0066	0.0048	0.0032	0.0314	-0.0052	0.0198	0.0166	-0.0101
Turkey	09/23/1993	0.0246	0.0286	0.0507	0.0153	0.0493	0.0566	0.0183	0.003	0.0059
Switzerland	06/16/1995	0.0077	-0.0015	-0.0005	0.0066	0.0161	-0.0021	0.0052	-0.0014	-0.0015
Sweden	06/16/1995	0.0079	0.0109	0.0138	0.0188	0.0291	0.0019	0.01	-0.0088	-0.0119
Canada	06/16/1995	0.0047	0.0058	0.0025	-0.0046	-0.0002	0.0063	0.005	0.0096	0.0038
Italy	09/05/1997	0.0101	0.004	-0.0032	-0.0181	0.0153	-0.0105	0.0071	0.0252	-0.0073
South Africa	09/05/1997	0.0056	0.0056	-0.0015	-0.025	-0.0274	0.0063	-0.0323	-0.0073	0.0077
Sweden	09/05/1997	0.0079	-0.0005	0.0045	-0.0152	-0.0004	-0.0157	-0.0196	-0.0044	-0.0202
Argentina	09/05/1997	0.0106	-0.0057	-0.011	-0.0179	-0.0359	-0.0147	-0.0758	-0.0579	-0.0037
Switzerland	06/19/1999	0.0137	0.0008	-0.003	-0.017	-0.0132	0.0001	-0.0148	0.0022	0.0031
Finland	06/19/1999	0.0187	0.0374	0.0278	0.0111	0.0252	0.0267	0.0098	-0.0014	-0.0011
Austria	06/19/1999	0.0148	0.0223	0.0205	0.0065	0.0328	0.0209	0.0047	-0.0018	0.0004
Slovakia	06/19/1999	0.0161	0.0072	0.0134	-0.0143	-0.026	0.0175	-0.0452	-0.0309	0.0041
Poland	06/19/1999	0.0264	0.0109	0.0082	0.036	0.0008	0.024	0.0402	0.0041	0.0158
Canada	07/13/2001	0.0117	-0.0016	-0.0065	0.0091	0.0082	-0.0077	0.002	-0.007	-0.0012
France	07/13/2001	0.0101	0.0143	0.0051	-0.0172	-0.0162	-0.0084	-0.0416	-0.0244	-0.0135
Turkey	07/13/2001	0.0444	-0.0038	-0.0485	0.057	0.0803	-0.0953	-0.1416	-0.1986	-0.0468
Japan	07/13/2001	0.0158	-0.0029	-0.0199	-0.0585	-0.0435	-0.0152	-0.0673	-0.0088	0.0047
South Korea	07/02/2003	0.0203	0.0169	0.0281	0.0462	0.0634	0.027	0.0699	0.0237	-0.0012
Austria	07/02/2003	0.0089	0.0061	0.0103	0.008	0.0189	0.0087	0.0124	0.0044	-0.0016
France	07/06/2005	0.0061	-0.0033	0.0078	0.0082	0.025	0.001	0.0228	0.0146	-0.0068
Spain	07/06/2005	0.0058	-0.0136	-0.0054	-0.0003	0.0077	-0.0108	0.0116	0.0119	-0.0054
USA	07/06/2005	0.0037	0.0011	0.0015	-0.0029	0.0007	0.0098	0.0047	0.0075	0.0082
Russia	07/06/2005	0.0141	0.0269	0.0358	0.0366	0.0201	0.0415	0.0663	0.0297	0.0057
South Korea	07/04/2007	0.0079	0.0229	0.0265	0.0443	0.0553	0.0508	0.0579	0.0135	0.0243
Austria	07/04/2007	0.0079	0.0056	0.008	-0.0091	-0.0276	-0.0008	-0.0156	-0.0066	-0.0088
Spain	10/02/2009	0.0133	0.0051	0.0103	-0.01	-0.0212	-0.0008	-0.0101	-0.0001	-0.0111
Japan	10/02/2009	0.0278	-0.0309	-0.0434	-0.0237	-0.009	-0.0428	-0.07	-0.0464	0.0006
USA	10/02/2009	0.0115	0.0137	0.0058	0.0052	0.0045	0.0004	0.0078	0.0026	-0.0054
Germany	07/06/2011	0.0054	-0.0005	-0.0031	-0.0048	-0.0126	-0.002	-0.005	-0.0002	0.001
France	07/06/2011	0.0054	-0.0041	-0.0123	-0.0218	-0.0423	-0.0201	-0.0299	-0.008	-0.0078
Turkey	09/07/2013	0.0159	0.0528	0.0494	0.0783	0.1178	0.0504	0.0763	-0.002	0.001
Spain	09/07/2013	0.0094	-0.0039	-0.0002	0.0073	0.0159	0.0155	0.0292	0.0219	0.0157

Table 5: Average Cumulative Abnormal Returns: Winning Bids

Event Window ([τ_1, τ_2])	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
All Games								
$\overline{CAR}$	0.0045	0.0071	0.0075	0.0020	0.0068	-0.0015	-0.0090	-0.0003
St. dev. ($\overline{CAR}$)	0.0042	0.0051	0.0072	0.0093	0.0066	0.0098	0.0066	0.0042
Test statistic	1.0698	1.3988	1.044	0.2178	1.0337	-0.1507	-1.3671	-0.0788
Summer Games								
$\overline{CAR}$	0.0106	0.0113	0.0116	0.0011	0.0049	0.0063	-0.0053	-0.0064
St. dev. ($\overline{CAR}$)	0.0060	0.0074	0.0105	0.0135	0.0096	0.0142	0.0096	0.0060
Test statistic	1.7576	1.5309	1.1101	0.0813	0.5135	0.4444	-0.5569	-1.0630
Winter Games								
$\overline{CAR}$	-0.0011	0.0034	0.0039	0.0029	0.0085	-0.0085	-0.0123	0.0052
St. dev. ($\overline{CAR}$)	0.0058	0.0070	0.0100	0.0129	0.0091	0.0135	0.0091	0.0058
Test statistic	-0.1889	0.4779	0.3874	0.2228	0.9369	-0.6272	-1.3546	0.8960

Table 6: Average Cumulative Abnormal Returns: First Losing Bids

Event Window ([τ_1, τ_2])	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
All Games								
$\overline{CAR}$	0.0007	0.0012	0.0044	0.0051	0.0015	0.005	0.0006	0.0003
St. dev. ($\overline{CAR}$)	0.0057	0.0069	0.0098	0.0127	0.009	0.0133	0.009	0.0057
Test statistic	0.1204	0.1758	0.4438	0.4008	0.1693	0.3732	0.0673	0.0523
Summer Games								
$\overline{CAR}$	-0.0047	-0.0053	-0.0069	-0.0114	-0.0038	-0.0072	-0.0003	0.0015
St. dev. ($\overline{CAR}$)	0.01	0.0122	0.0173	0.0223	0.0158	0.0234	0.0158	0.0100
Test statistic	-0.4746	-0.4362	-0.3983	-0.5106	-0.2412	-0.3061	-0.0178	0.1529
Winter Games								
$\overline{CAR}$	0.0061	0.0078	0.0156	0.0216	0.0068	0.0171	0.0015	-0.0009
St. dev. ($\overline{CAR}$)	0.0054	0.0066	0.0094	0.0121	0.0085	0.0127	0.0085	0.0054
Test statistic	1.1299	1.1753	1.6684	1.7856	0.8012	1.3497	0.1743	-0.1726

Table 7: Average Cumulative Abnormal Returns: Losing Bids

Event Window ($[\tau_1, \tau_2]$)	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
<u>All Games</u>								
$\overline{CAR}$	0.0035	0.0026	0.0013	0.0023	0.0007	-0.0032	-0.0045	-0.0019
St. dev. ($\overline{CAR}$)	0.0030	0.0036	0.0051	0.0066	0.0047	0.0069	0.0047	0.0030
Test statistic	1.1690	0.7085	0.2449	0.3472	0.1407	-0.4647	-0.9576	-0.6453
<u>Summer Games</u>								
$\overline{CAR}$	-0.0005	-0.0017	-0.0037	0.0002	-0.003	-0.0129	-0.0092	-0.0012
St. dev. ($\overline{CAR}$)	0.0044	0.0054	0.0077	0.0099	0.007	0.0104	0.007	0.0044
Test statistic	-0.1125	-0.3196	-0.478	0.0168	-0.4212	-1.2379	-1.3126	-0.2747
<u>Winter Games</u>								
$\overline{CAR}$	0.0079	0.0074	0.0067	0.0047	0.0047	0.0075	0.0008	-0.0027
St. dev. ($\overline{CAR}$)	0.0038	0.0047	0.0066	0.0085	0.006	0.0089	0.006	0.0038
Test statistic	2.0600	1.5743	1.0206	0.5466	0.7765	0.844	0.1339	-0.7004

Table 8: Non-Parametric Sign Test: Winning Bids

Event Window ($[\tau_1, \tau_2]$)	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
<u>All Games</u>								
Positive Abnormal Return (N^+/N)	0.58	0.74	0.63	0.53	0.68	0.58	0.47	0.53
Test statistic (θ_1)	0.69	2.06	1.15	0.23	1.61	0.69	-0.23	0.23
<u>Summer Games</u>								
Positive Abnormal Return (N^+/N)	0.56	0.78	0.78	0.56	0.56	0.56	0.44	0.33
Test statistic (θ_1)	0.33	1.67	1.67	0.33	0.33	0.33	-0.33	-1.00
<u>Winter Games</u>								
Positive Abnormal Return (N^+/N)	0.6	0.7	0.5	0.5	0.8	0.6	0.5	0.7
Test statistic (θ_1)	0.63	1.26	0.00	0.00	1.90	0.63	0.00	1.26

Table 9: Non-Parametric Sign Test: First Losing Bids

Event Window ($[\tau_1, \tau_2]$)	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
<u>All Games</u>								
Positive Abnormal Return (N^+/N)	0.44	0.44	0.61	0.61	0.50	0.56	0.44	0.44
Test statistic (θ_1)	-0.47	-0.47	0.94	0.94	0.00	0.47	-0.47	-0.47
<u>Summer Games</u>								
Positive Abnormal Return (N^+/N)	0.33	0.33	0.56	0.56	0.33	0.56	0.33	0.33
Test statistic (θ_1)	-1.00	-1.00	0.33	0.33	-1.00	0.33	-1.00	-1.00
<u>Winter Games</u>								
Positive Abnormal Return (N^+/N)	0.56	0.56	0.67	0.67	0.67	0.56	0.56	0.56
Test statistic (θ_1)	0.33	0.33	1.00	1.00	1.00	0.33	0.33	0.33

Table 10: Non-Parametric Sign Test: Losing Bids

Event Window ($[\tau_1, \tau_2]$)	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
<u>All Games</u>								
Positive Abnormal Return (N^+/N)	0.54	0.58	0.54	0.6	0.54	0.58	0.49	0.47
Test statistic (θ_1)	0.66	1.19	0.66	1.46	0.66	1.19	-0.13	-0.4
<u>Summer Games</u>								
Positive Abnormal Return (N^+/N)	0.4	0.5	0.53	0.63	0.47	0.53	0.47	0.5
Test statistic (θ_1)	-1.1	0	0.37	1.46	-0.37	0.37	-0.37	0
<u>Winter Games</u>								
Positive Abnormal Return (N^+/N)	0.7	0.67	0.56	0.56	0.63	0.63	0.52	0.44
Test statistic (θ_1)	2.12	1.73	0.58	0.58	1.35	1.35	0.19	-0.58

Table 11: Wilcoxian Sign Rank Test: Winning Bids

Event Window ($[\tau_1, \tau_2]$)	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
<u>All Games</u>								
W-statistic (θ_2)	107	150	111	90	131	104	95	102
Critical Values (C_L, C_H)					(46,144)			
<u>Summer Games</u>								
W-statistic (θ_2)	21	38	33	24	26	20	19	20
Critical Values (C_L, C_H)					(6,39)			
<u>Winter Games</u>								
W-statistic (θ_2)	35	40	26	26	45	36	30	36
Critical Values (C_L, C_H)					(8,47)			

Critical values are determined by a two-sided test with a type 1 error threshold of 5%. The critical values are from Wilcoxon and Wilcox (1964) with N equal to 19, 9, and 10 for the All, Summer, and Winter games, respectively.

Table 12: Wilcoxian Sign Rank Test: First Losing Bids

Event Window ($[\tau_1, \tau_2]$)	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
All Games								
W-statistic (θ_2)	60	56	96	92	89	85	59	81
Critical Values (C_L, C_H)					(40,131)			
Summer Games								
W-statistic (θ_2)	13	12	27	28	14	26	9	13
Critical Values (C_L, C_H)					(6,39)			
Winter Games								
W-statistic (θ_2)	18	16	23	21	31	19	22	28
Critical Values (C_L, C_H)					(6,39)			

Critical values are determined by a two-sided test with a type 1 error threshold of 5%. The critical values are from Wilcoxon and Wilcox (1964) with N equal to 18, 9, and 9 for the All, Summer, and Winter games, respectively.

Table 13: Wilcoxian Sign Rank Test: Losing Bids

Event Window ($[\tau_1, \tau_2]$)	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
All Games								
W-statistic (θ_2)	738	898	897	995	892	1064	813	885
Critical Values (C_L, C_H)					(579.81,1073.19)			
Summer Games								
W-statistic (θ_2)	157	235	280	326	218	300	228	258
Critical Values (C_L, C_H)					(137,328)			
Winter Games								
W-statistic (θ_2)	218	215	176	190	232	244	183	190
Critical Values (C_L, C_H)					(107,271)			

Critical values are determined by a two-sided test with a type 1 error threshold of 5%. The critical values for the Summer and Winter games are from Wilcoxon and Wilcox (1964) with N equal to 30 and 27, respectively. The critical values for the All games case is determined by equation 11 with N = 57.

Table 14: Regression of Impact vs. Size

	$\overline{CAR}(0,5)$	$\overline{CAR}(0,5)$	$\theta_0(0,5)$	$\theta_0(0,5)$
Share of GDP	-0.065	-0.06	-0.223	-0.062
	(0.066)	(0.064)	(2.147)	(2.186)
Summer Games	-	-0.007	-	-0.237
	-	(0.012)	-	(0.344)
R^2	0.035	0.055	0.000	0.028

Note: The regression run $y_i = \beta_0 + \beta_1$ share of GDP + β_2 Summer Games + ε_1 where $y_i = \{\overline{CAR}(0,5)_i, \theta_0(0,5)_i\}$ for a bid of a particular host country in a particular year is represented by the subscript "i," β_0, β_1, and β_2 are estimated using OLS, and the Summer Games is included in a subset of years following Dick and Wang (2010).

Table 15: Small versus Large CAR Results

Event Window ($[\tau_1, \tau_2]$)	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
Winners: Small Cities								
$\overline{CAR}$	0.0025	-0.0032	-0.0025	-0.0060	-0.0025	-0.0014	0.0012	0.0006
St. dev. ($\overline{CAR}$)	0.0062	0.0075	0.0107	0.0138	0.0097	0.0145	0.0097	0.0062
Test statistic	0.4087	-0.4185	-0.2372	-0.4371	-0.2599	-0.0937	0.1209	0.1015
Winners: Large Cities								
$\overline{CAR}$	0.0059	0.0146	0.0149	0.0079	0.0136	-0.0016	-0.0164	-0.0010
St. dev. ($\overline{CAR}$)	0.0060	0.0074	0.0105	0.0135	0.0096	0.0142	0.0096	0.0060
Test statistic	1.7576	1.5309	1.1101	0.0813	0.5135	0.4444	-0.5569	-1.0630
Losers: Small Cities								
$\overline{CAR}$	0.0041	0.0021	-0.0011	-0.0038	0.0023	0.0027	0.0037	0.0002
St. dev. ($\overline{CAR}$)	0.0043	0.0053	0.0074	0.0096	0.0068	0.0101	0.0068	0.0043
Test statistic	0.9477	0.4005	-0.1412	-0.3910	0.3435	0.2650	0.5477	0.0526
Losers: Large Cities								
$\overline{CAR}$	0.0031	0.0028	0.0026	0.0058	-0.0003	-0.0067	-0.0093	-0.0032
St. dev. ($\overline{CAR}$)	0.0040	0.0048	0.0069	0.0088	0.0063	0.0093	0.0063	0.0040
Test statistic	0.7836	0.5850	0.3792	0.6586	-0.0510	-0.7179	-1.4803	-0.7971

Note: In performing the Large vs. Small City analysis, the host cities associated with each country's Olympic bid were identified and were sorted into either the large or small group based on the size of the city's metropolitan area or national capital status. Notably, rather than pooling summer and winter Olympics bids together and using a single large/small cut-off, we utilized one cut-off for Summer Olympics bids and one cut-off for Winter Olympics bids. Because Summer Olympics tend to be held in large cities and Winter Olympics tend to be held in remote (small) hamlets, not utilizing different cut-offs for summer and winter Olympics would have resulted in the summer bids clustering in the large city group and winter bids clustering in the small city group. For the Summer Olympics, bidding cities that were the largest metropolitan area in the respective country or were the national capital were treated as "Large" - all other cities were treated as "Small," resulting in 27 large cities and 12 small cities. For the Winter Olympics, bidding cities that were among the largest 25 metropolitan areas in the respective country were treated as "Large" - all other cities were treated as "Small," resulting in 20 large cities and 17 small cities. For transparency, the large bids are defined as Buenos Aires (Argentina), Sydney (Australia), Klagenfurt (Austria), Salzburg (Austria), Calgary (Canada), Quebec City (Canada), Toronto (Canada), Vancouver (Canada), Beijing (China), Beijing (China), Helsinki (Finland), Paris (France), Berlin (Germany), Munich (Germany), Athens (Greece), Rome (Italy), Torino (Italy), Tokyo (Japan), Amsterdam (Netherlands), Lillehammer (Norway), Moscow (Russia), Poprad-Tatry (Slovakia), Seoul (South Korea), Madrid (Spain), Falun (Sweden), Ostersund (Sweden), Stockholm (Sweden), Sion (Switzerland), Istanbul (Turkey), London (UK), and New York (USA) while the small bids are defined as Brisbane (Australia), Melbourne (Australia), Rio (Brazil), Albertville (France), Annecy (France), Berchtesgaden (Germany), Aosta (Italy), Cortina d'Ampezzo (Italy), Nagano (Japan), Nagoya (Japan), Osaka (Japan), Zakopane (Poland), Sochi (Russia), Cape Town (South Africa), Pyeongchang (South Korea), Barcelona (Spain), Jaca (Spain), Birmingham (UK), Manchester (UK), Atlanta (USA), Anchorage (USA), Chicago (USA), Salt Lake City (USA).

Table 16: Difference in Cumulative Abnormal Returns

Event Window ([τ_1, τ_2])	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
All Games								
$\overline{DCAR}$	-0.0015	-0.0001	0.0009	-0.0012	0.0012	0.0020	0.0011	0.0013
St. dev. ($\overline{DCAR}$)	0.0025	0.0030	0.0042	0.0055	0.0039	0.0057	0.0039	0.0025
Test statistic	-0.6033	-0.0466	0.2222	-0.2216	0.3121	0.3566	0.2855	0.5506
Summer Games								
$\overline{DCAR}$	0.0028	0.0040	0.0055	0.0001	0.0034	0.0114	0.0059	-0.0005
St. dev. ($\overline{DCAR}$)	0.0037	0.0045	0.0064	0.0083	0.0058	0.0087	0.0058	0.0037
Test statistic	0.7673	0.8735	0.8615	0.0151	0.5839	1.3141	1.0055	-0.1467
Winter Games								
$\overline{DCAR}$	-0.0060	-0.0045	-0.0039	-0.0026	-0.0011	-0.0078	-0.0039	0.0033
St. dev. ($\overline{DCAR}$)	0.0032	0.0039	0.0055	0.0071	0.0050	0.0075	0.0050	0.0032
Test statistic	-1.8903	-1.1410	-0.7018	-0.3684	-0.2206	-1.0427	-0.7778	1.0486

Table 17: Difference in Returns with Non-Parametric Sign Test

Event Window ([τ_1, τ_2])	[0,1]	[0,2]	[0,5]	[0,9]	[-2,2]	[-5,5]	[-5,-1]	[-2,-1]
All Games								
Expected Abnormal Return $\frac{(N_W^+ + N_L^-)}{N}$	0.49	0.50	0.50	0.43	0.51	0.46	0.50	0.53
Test statistic (θ_4)	-0.23	0.00	0.00	-1.15	0.23	-0.69	0.00	0.46
Summer Games								
Expected Abnormal Return $\frac{(N_W^+ + N_L^-)}{N}$	0.59	0.56	0.54	0.41	0.54	0.49	0.51	0.46
Test statistic (θ_4)	1.12	0.8	0.48	-1.12	0.48	-0.16	0.16	-0.48
Winter Games								
Expected Abnormal Return $\frac{(N_W^+ + N_L^-)}{N}$	0.38	0.43	0.46	0.46	0.49	0.43	0.49	0.59
Test statistic (θ_4)	-1.48	-0.82	-0.49	-0.49	-0.16	-0.82	-0.16	1.15