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Economic Analysis Research Group (EARG)

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by Carl Singleton, J. James Reade, Johan Rewilak and Dominik Schreyer

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Department of Economics
University of Reading
Whiteknights
Reading
RG6 6AA
United Kingdom

www.reading.ac.uk

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Carl Singleton, J. James Reade, Johan Rewilak, Dominik Schreyer*

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Abstract

We revisit the magnitude of home advantage at the Summer and Winter Olympic Games, looking back all the way to Athens in 1896. By comparing a host country's success with their performances in previous and subsequent games, we find that home advantage has declined over time as participation and the diversity of competition have increased. Hosts of the Summer Olympics between 1988 and 2016 enjoyed a two-percentage-point boost in their shares of medals and finalists, compared with their performances overseas, in both men's and women's events. In this same contemporary period, the home advantage effect at the Winter Olympics was around fifty percent larger in men's events but non-existent in women's events. We also find evidence of significant performance spill overs on the previous and next Olympiads for countries when they hosted the Summer Games.

Keywords: Attendance, Gender economics, Home bias, Major sport events, Olympic Games, Referee bias, Sports economics

JEL Codes: D91, L83, Z2

* c.a.singleton@reading.ac.uk (corresponding author) & j.j.reade@reading.ac.uk, Department of Economics, University of Reading, Whiteknights Campus, RG6 6EL, UK. j.rewilak@aston.ac.uk, Department of Economics, Finance and Entrepreneurship, Aston University, Aston Triangle, Birmingham, B4 7ET, UK. dominik.schreyer@whu.edu, Center for Sports and Management (CSM), WHU – Otto Beisheim School of Management, Erkrather Str. 224a, 40233 Düsseldorf, Germany.

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1. Introduction

On July 8th, 2021, just two weeks before the Opening Ceremony at National Stadium, Tokyo, the news broke that the 2020 Olympic and Paralympic Summer Games host city would not allow spectators to attend most of the events and venues (Reuters, 2021a). Earlier in 2021, amid the then-ongoing coronavirus (COVID-19) pandemic, the Government of Japan, the Tokyo Metropolitan Government, and the Organising Committee had already decided to ban international spectators (Reuters, 2021b), primarily to prevent the games from becoming a global super-spreader event.[1] However, fearing that Tokyo might become a new domestic flash point of the airborne virus, given that the highly contagious new Delta variant was already spreading in the country, the Japanese Prime Minister, Yoshihide Suga, declared a state of emergency in the host city (Reuters, 2021a), making the 2020 Olympic and Paralympic Summer Games the first Modern Olympic Games without spectators (Guardian, 2021).

For the International Olympic Committee (IOC) this was bad news, and perhaps even more so for their many external stakeholders. For the media rights owners, an Olympic Games held in empty venues without spectators – otherwise an integral part of the product offered to third parties (c.f., Morrow, 1999) – means less atmospheric competition and a decrease in the quality of their broadcasts.[2] Similarly, for international corporate sponsors, spectator-less Games mean that their carefully tailored messaging becomes less emotionally charged and impactful. Domestic sponsors, all of them heavily relying on some form of spectator interactions on-site, might not even reach their audiences (c.f., Kirby, 2021). For the host city, Tokyo, and the nearby prefectures, the decision to ban spectators from most Olympic venues may not only further decrease the few tangible economic benefits from hosting such mega sports events (e.g., Allmers and Maennig, 2009; Baade & Matheson, 2004; Baumann et al., 2012; Feddersen & Maennig, 2013; Li et al., 2013) but also potentially reduce sporting home advantage, as recent research suggests from studying the causal effects of absent crowds in professional football (e.g., Bryson et al., 2021; Fischer & Haucap, 2021; Reade et al., 2020).[3]

[1] As Toshiro Muto, the chief executive of the Tokyo 2020 organizing committee, noted, more than 600,000 tickets purchased by international spectators from overseas had to be refunded (Reuters, 2021b).

[2] For these media-right owners, there might also be additional unexpected costs associated with broadcasting Olympic Games without any spectators, as some might want to increase the otherwise lost atmosphere by artificially enhancing the original broadcasting signal during the production process (e.g., by adding canned spectator atmosphere or virtualized spectators in the stands).

[3] For a recent review of the emerging literature exploring such causal effects explored during the Covid-19 pandemic, see Leitner et al., 2021.

Several studies have shown that countries tend to perform better at the Olympic Games when hosting (e.g., Rewilak, 2021). This may contribute to why governments are ultimately willing to spend substantial amounts to host such an event,[4] in addition to the other potential intangible benefits that arise from hosting.[5] For instance, Ball (1974), which was among the first analyses of the correlates of national success at the Olympic Games, noted that "[t]ypically hosts are more successful, at least in part because of their ability to enter larger than usual teams at relatively low financial expenditure" (191). However, other explanations of home advantage in professional sports range from reduced travel fatigue (e.g., Courneya and Carron, 1991), venue familiarity (e.g., Pollard, 2002), and the influence of social pressure on the performances of both athletes (e.g., Ferraresi & Gucciardi, 2021) and judges or referees (e.g., Buraimo et al., 2010). Any of these explanations could apply to a mega sports event such as the Olympic Games (c.f., Balmer et al., 2003).

As of today, however, it remains unknown how general this frequently observed home advantage is (e.g., Bernard & Busse, 2004; Blais-Morisset et al., 2017; Kuper & Sterken, 2001; Scelles et al., 2020; Schlembach et al., 2021). The size of the effect might be prone to selection bias, at least to some degree, as some studies have noted the significant differences in home advantage between the different sports at the Games (e.g., Forrest et al., 2017) and between male and female competition (e.g., Leeds & Leeds, 2012). Further, whether the home advantage is consistent over time remains to be seen, as most studies have not explored a full sample of all the modern Summer and Winter Games since 1896.[6]

In this chapter, we aim to quantify the home advantage effects at the Olympic Games held between 1896 and 2016. Unlike most previous research, we not only explore the effects for both the Summer and Winter Games but also address performance at the discipline level, rather than only at the Games level. Further, we add to the literature by examining the differences in home advantage over time and by gender. Finally, we ask whether home advantage depends

[4] However, with the cost of hosting the Olympic Games increasing, it remains questionable whether this is a cost-efficient approach to maximize Olympic success. For instance, in 2016, Rio/Brazil saw sports-related costs, i.e., not including new airports, roads, hotels, rails, and other infrastructure, of about USD 13.692bn (c.f., Flyvbjerg et al., 2021), which resulted in two additional medals (19 medals, 7 Gold medals (+3)), 6 Silver medals (+1)], and 6 Bronze medals (-3)) as compared to the countries Olympic performance in 2012. We thank Victor A. Matheson for pointing us towards this point.

[5] Alternatively, a government might also hope to generate intangible effects related to hosting a mega sporting event (e.g., Kavestos & Szymanski, 2010).

[6] To the best of our knowledge, Clarke (2000) and Kuper and Sterken (2001) have been the only authors to explore a potential Olympics home advantage with a data set reaching back to 1896, but both excluded the Winter Games from their analysis. In contrast, Balmer et al. (2001) focus on analysing Winter Olympic games between 1908 and 1998.

on the chosen measure of Olympic success, be that gold medals or some composite measure that includes silver and bronze medals, or whether athletes make it to finals.

In general, we find a large and statistically significant home advantage for the Olympic host, relative to when they did not host the Games, but this varies systematically in a number of ways. At the Games level, hosting has a larger impact on male than female success at the Summer Games. When analysing the Winter Games, hosting only appears to (largely) impact male success. These results are robust to estimating the host effect instead within Olympic disciplines. We also find that hosting a Summer Games is not only associated with greater success in that event but also in both the previous and next Games, particularly for men. However, there appears to be no similar spill over of success from hosting the Winter Games.

Mirroring recent findings for association football (e.g., Peeters & van Ours, 2021) and cricket (e.g., Reade, 2019), among other sports, we find that the home advantage effect appears to have diminished over time for both genders at the Summer Olympics, being as much as ten times larger in 1896-1936 than in 1988-2016.[7] We attribute this trend to two factors. First, there have been increases over time in the numbers of athletes, countries, and disciplines, such that hosting conveys less advantage from entering more athletes. Second, there have been reductions in the importance of most factors found to determine home advantage (c.f., Balmer et al., 2003) in an increasingly globalized world (e.g., Forrest et al., 2017).

The rest of the chapter proceeds as follows: Section 2 briefly reviews the literature on home advantage at the Olympic Games; Section 3 describes the data; Section 4 discusses the estimation approach and results; and Section 5 concludes.

2. A brief literature review

There is a vast literature on the home advantage in different domestic and international sporting tournaments, and mega sports events such as the Olympic Games are certainly no exception to this. For instance, although more broadly interested in modeling the determinants of Olympic success, several authors have explored the home advantage across multiple Olympic Games (e.g., Bernard & Busse, 2004; Kuper & Sterken, 2001; Maennig & Wellbrock, 2008). There are also numerous studies on individual games (e.g., Hoffmann et al., 2002), as well as on Olympic Sports performed outside the Olympic tournaments, including in boxing (Balmer et

[7] Somewhat similarly, Kuper and Sterken (2001) observe a decrease in the home advantage for Olympic Summer Games for pre- and post-World War II periods, i.e., between 1896 to 1936, and 1948 to 2000, respectively.

al., 2005), tennis (e.g., Nevill et al., 1997), and in track and field athletics (e.g., Ramchandani & Wilson, 2020). More recently, because the Covid-19 pandemic has induced worldwide natural experiments on the effects of crowds, there has been a remarkable renaissance in this literature, especially focused on association football (e.g., Bryson et al., 2021; Fischer & Haucap, 2021; McCarrick et al., 2021). Other professional sports are attracting similar interest (e.g., Fioravanti et al., 2021).

In general, there is consistent evidence for the existence of home advantage during the Olympic Games. To the best of our knowledge, Clark (2000), analysing the Summer Olympic Games held between 1896 and 1996, was among the first to discuss the home advantage in detail. Comparing the Summer Olympic performances of 17 previous hosts both home and away, proxied by the percentage of available medals won, Clark (2000) observed a significant home advantage, indicating that the host "wins over three times their usual percentage of medals" (84). Since, many authors have largely confirmed this finding (e.g., Rewilak, 2021), using different estimation techniques on increasingly more extensive and nuanced samples (c.f., Schlembach et al., 2021), despite potential confounding factors or omitted variables (e.g., attendances).[8]

While many authors have explored a potential home advantage during the Summer Olympic Games (e.g., Celik & Gius, 2014; Forrest et al., 2010; Scelles et al., 2020), only a few have challenged the general nature of the observed effect. For instance, Balmer et al. (2001) were the first to explore home advantage at the Winter Olympic Games. They observed potential differences between individual sports, noting that home advantage was significantly greater when performances were assessed by judges (e.g., figure skating). Later, Forrest et al. (2017) observed a similar pattern during the Summer Olympic Games, concluding that home advantage varies in magnitude, depending on whether the outcome is strongly dependent on judges. Somewhat similarly, Lui and Suen (2008), presenting separate host effects for every Summer Olympic between 1952 and 2004, noted that not all hosts benefitted equally in terms of subsequent Olympic success. Finally, Leeds and Leeds (2012), estimating separate models of Olympic success for men and women, during the Summer Games, not only observed gender-specific differences in home advantage effects but also differences in the outcomes. They found

[8] There seems to exist no study modeling stadium attendances at the Olympic Games (c.f., Schreyer and Ansari), despite a keen interest in analysing such attendances for Olympic sports if held outside the tournament. For instance, there exist various empirical studies modeling the potential determinants of association football stadium attendances (e.g., Bond & Addesa, 2020; Cox, 2018; Nielsen et al., 2019; Reade et al., 2020b; Wallrafen et al., 2019), but not a single one exploring stadium attendances at the Olympic Football Tournament.

that being a host had a greater impact on the number of gold medals won than on silver and bronze medals.

In the broader economic, psychology and sport science literature, most authors have typically discussed three factors that might stimulate a significant home advantage in sports (c.f., Balmer et al., 2003): first, visitor fatigue due to travel; second, a lack of familiarity with the venue for athletes from abroad, including an unknown climate; and third, the social support of the home audience, which might induce referee bias (e.g., Sutter & Kocher, 2004). Earlier studies on the effect of playing behind closed doors in one-off football matches seem to observe a reduced home advantage (e.g., Pettersson-Lidbom and Priks, 2010), suggesting that home crowds affect referee decision-making to some degree. However, during the Olympic Games, athletes compete in many different sports, and, as indicated above, not all these sports involve important subjective judgements.

While some of these frequently cited explanations might be less pronounced in an increasingly globalized world (e.g., Forrest et al., 2017), there are two other factors that might benefit the hosts in this specific context. First, in the run up the Olympic Games, governments normally mobilize resources to construct the many state-of-the-art sports facilities that the IOC requires. As Olympic host cities are typically selected seven years in advance of the Games, this provides time to raise performances, take advantage of new training facilities, and for home athletes to become familiar with the venues and courses, for example, the frozen track and slopes at the Winter Games. Forrest et al. (2010) show that this factor can also create an ex-ante host effect at the Olympic Games.[9] Second, under rather new IOC policies, host countries traditionally play a key role in selecting any new sports and events to be included in the Games (Lui and Suen, 2008). As such, hosts might not only have chosen attractive or locally popular new sports in the past but also those in which Olympic success is more likely. For instance, in Tokyo, the sport of Karate will finally make its Olympic debut, which is a sport invented and traditionally dominated by Japanese athletes. Baseball (and softball), comfortably the most popular sport in Japan, will also make its return in Tokyo.[10]

[9] An anecdotal example would be the United Kingdom and their success in Beijing 2008 being attributed to the ex-ante host effect in London 2012. Though, this may have also been cofounded with their ex-post success after hosting the 2002 Commonwealth Games. The construction of the Manchester Velodrome for cycling and new facilities for athletics, tennis, and squash may affected success by UK athletes in Beijing (Nevill et al., 2009).

[10] See the following report by Japan's National Public Opinion Research Institute: https://www.crs.or.jp/data/pdf/sports16.pdf

3. Data

We collected data on all the medallists and finalists at the modern Summer and Winter Olympic Games between 1896 and 2016, by submitting a data request to the IOC. These data give us the results for each individual event at the Games.[12] The data are up to date as of January 2018, accounting for all medals stripped and reassigned for doping offences up to this time. We distinguish between countries rather than territory or geography. In other words, we distinguish between West Germany and Germany, and Russia and the Soviet Union.[13] We look to distinguish between men's and women's events throughout the analysis, so mixed gender events are dropped from the analysis, e.g., equestrian sports.

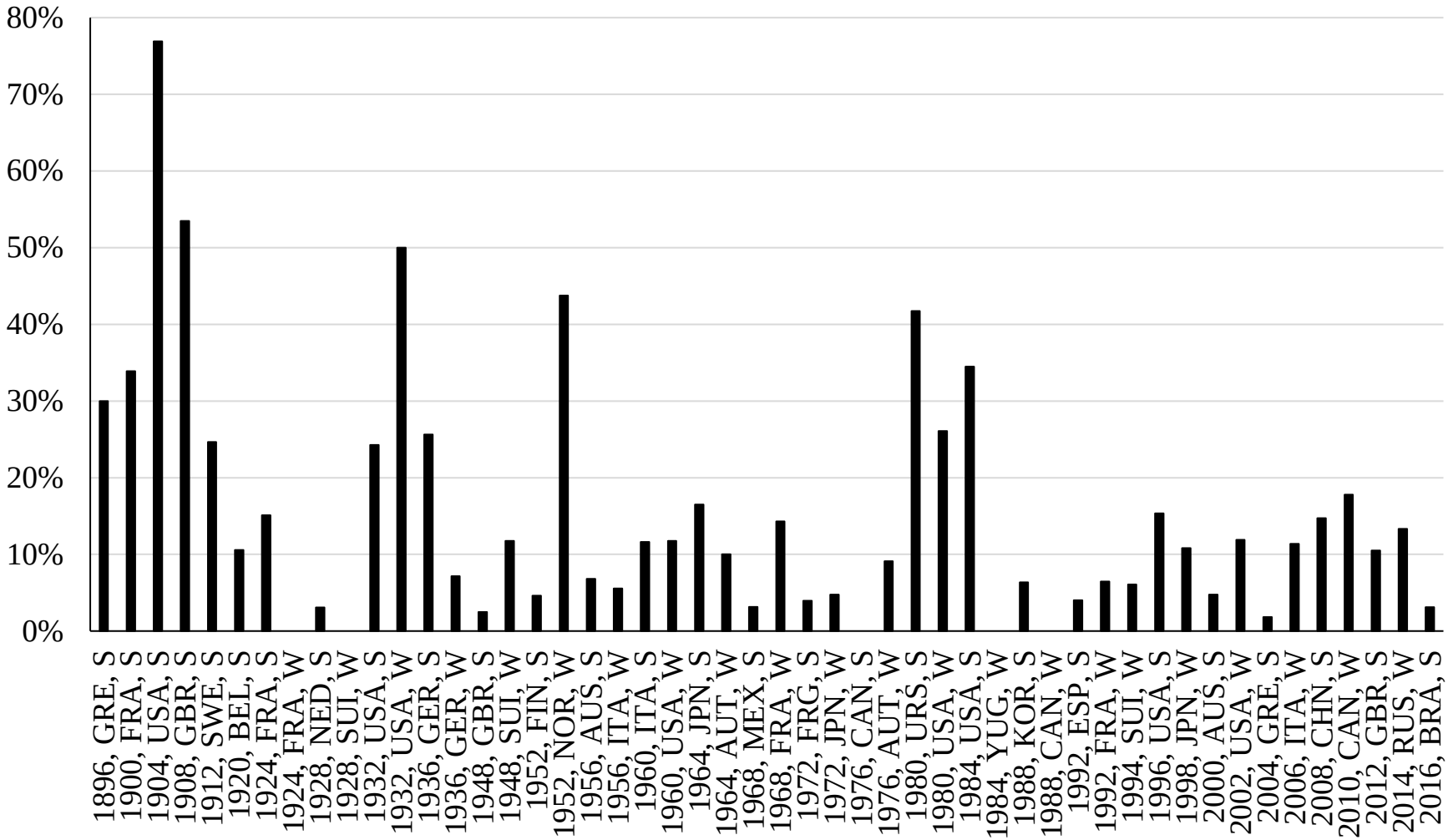
Figures 1 and 2 show the percentages of all gold medals won by the host country in men's and women's events, respectively, for every modern Games up to 2016 – this is equivalent to the proportions of events won by the hosts, as we count the medals awarded to athletes in team events only once. In the early Summer and Winter Olympiads, the host nations won a substantial proportion of the events. For example, USA won 77% of the gold medals in men's events when hosting the Summer Games for the first time in 1904, compared with 24% when hosting in 1932, and 15% at Atlanta 1996. However, the 1984 Summer Games in Los Angeles were an anomaly to this pattern, being affected by the Cold War boycotts and competitiveness that increased the home athletes' medal chances. Notably at the 1904 and 1908 Summer Olympics, the host nations won every gold medal in the women's events, compared with the best home performance in recent history by China, with 19% of the gold medals won at Beijing 2008 in women's events.

To study home advantage, we compare the performance of host countries when they held the Games with when they did not. Comparing the Olympic success of USA, who have hosted both the Summer and Winter Olympic games more than once, with other countries that have never hosted a Games would make no good sense. Because the numbers of events, medals and event finalists change over time, generally increasing, we measure Olympic success according to the share (or percentage) achieved by a country within a Games. We consider three different

[12] We drop winter sports that appeared at early Summer Olympics, such as Ice Hockey and Skating at Antwerp, 1920, and skating at London 1908.

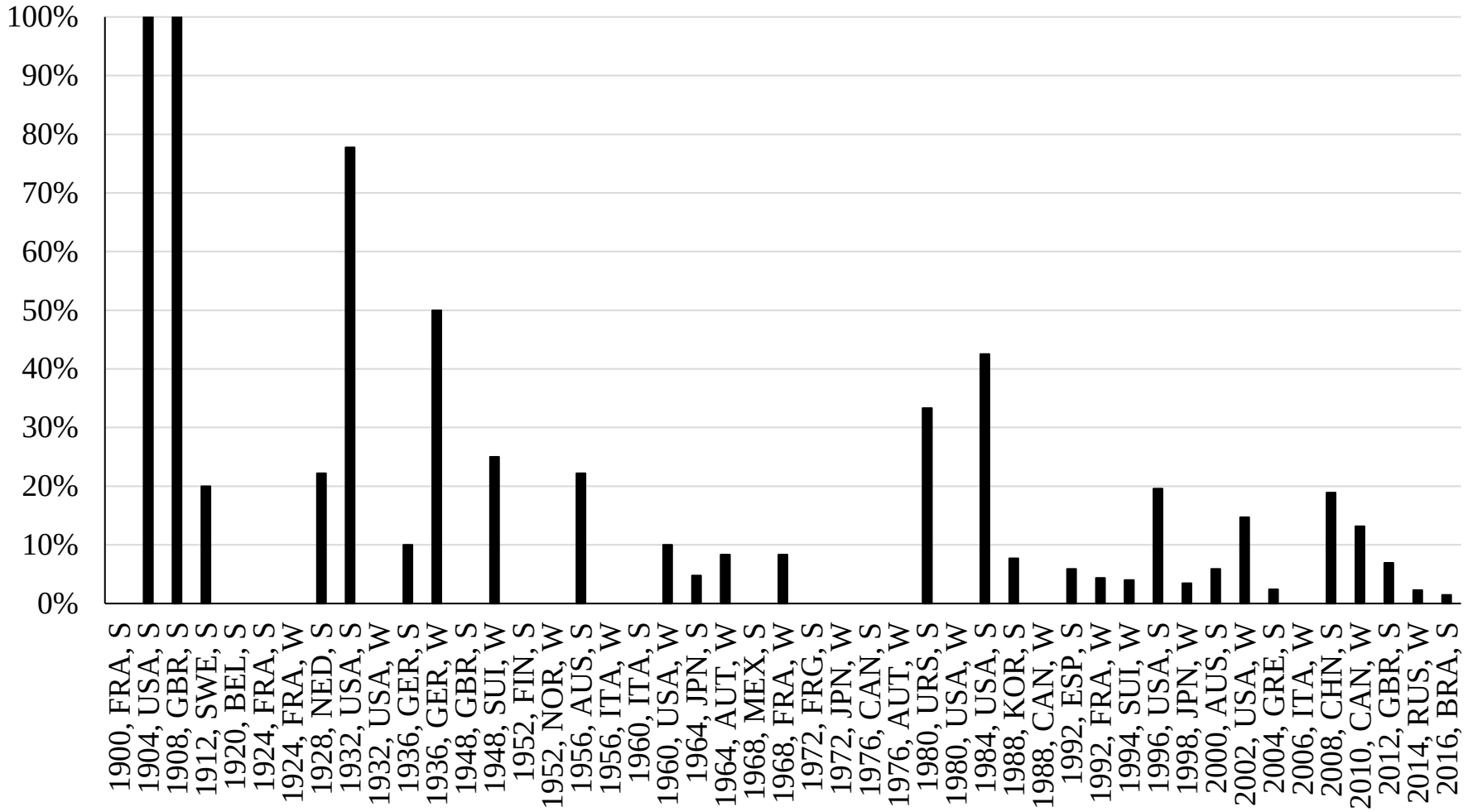
[13] As we later focus the analysis on only countries that have ever hosted the games, addressing the historical changes to the world map are not too challenging. Yugoslavia, Soviet Union, Germany and Korea are the principal areas of change that are reflected in the dataset and estimation samples.

FIGURE 1: Percentage of all gold medals in MEN's events won by the host country at the Summer and Winter Olympic Games, 1896-2016



Notes: author calculations using data from the International Olympic Committee and Olympics.com. "S" denotes a Summer Olympic Games. "W" denotes a Winter Olympic Games.

FIGURE 2: Percentage of all gold medals in WOMEN's events won by the host country at the Summer and Winter Olympic Games, 1900-2016



Notes: author calculations using data from the International Olympic Committee and Olympics.com. "S" denotes a Summer Olympic Games. "W" denotes a Winter Olympic Games.

measures of Olympic success for each country and Games: first, the percentage of all gold medals received; second, the percentage of all medals received (gold, silver and bronze); and third, by assuming that reaching an event's final is a successful outcome and awarding points for the subsequent results, aggregated for each country as the percentage of total points available. We assign the points using a Fibonacci sequence, where a final position (4-8) is awarded 1 point, a bronze medal gets 2 points, a silver medal gets 3 points, and a gold medal gets 5 points (see for other applications of this scoring: Condon et al., 1999; Mitchell & Stewart, 2007; Rewilak, 2021). This places a greater value (or weight) on winning than an athlete finishing in a final. It reduces the mass of zero values within country-games-discipline cells. Further, the points score measure reflects the fact that some Olympic federations set broader targets, ambitions, and metrics of success than only medals, such as top-16 or top-8 finishes.

Table 1 shows the average measures of Olympic success for countries that have ever hosted the Games. The top panel looks at all Games and their hosts in 1896-2016. The bottom panel focuses on the more recent Games and their hosts in 1988-2016. We chose the latter period as it begins just after the Cold War boycott-affected 1980 and 1984 Olympiads. Since 1896, host nations have tended to achieve a lower proportion of overall Olympic success at the Winter Games compared with the Summer. For both men's and women's events at the Summer Games, and men's events at the Winter Games, over the entire history of the modern Olympics, the differences in the proportion of success achieved by nations that ever hosted compared with years when they did not is significantly positive, at least at the 5% level. The raw average improvement in performance when hosting is greater for the share of gold medals achieved than for all medals or Olympic points, except for women's events at the Winter Games, for which there is generally a smaller and not significant difference in average performances when hosting instead of not hosting. In the later 1988-2016 period, the average share of Olympic success achieved is greater for nations when they hosted, but not significantly so. Like in the whole 1896-2016 period, the differences in the average success of nations that ever hosted the games in 1988-2016, compared with when they did not host, are greatest when measured in terms of only gold medals, and are smallest for women's events at the Winter Games.

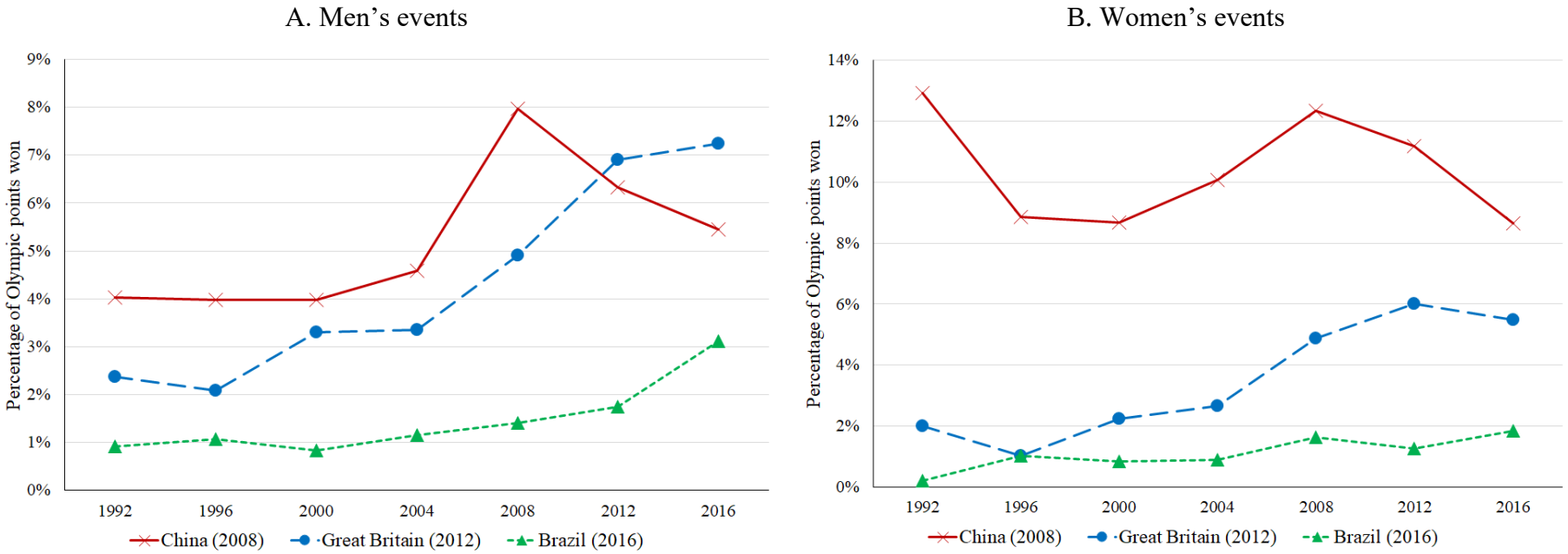
TABLE 1: Mean differences in the share of success at the Olympic Games when hosting vs not hosting – only countries who hosted in the given period

	Summer		Winter	
	Male	Female	Male	Female
1896-2016:				
Golds	0.142***	0.154***	0.070***	0.005
Medals	0.131***	0.139***	0.036**	0.039
Olympic points	0.130***	0.145***	0.041**	0.030
N country-games	510	493	228	228
1988-2016:				
Golds	0.037	0.037	0.050*	0.006
Medals	0.022	0.016	0.025	0.006
Olympic points	0.021*	0.019	0.029*	0.007
N country-games	64	64	63	63

Notes: ***, **, * indicate significance from zero, i.e., no difference (success when hosting minus when not hosting), at 1%, 5% and 10% levels, respectively, two-sided unpaired *t*-tests.

Figure 3 focuses on the last three hosts of the Summer Olympic Games, China in 2008, United Kingdom (Great Britain and Northern Ireland) in 2012, and Brazil in 2016, showing the percentage of points they won in each Games since 1992. In this period and according to this measure of success, Brazil's Olympic performance was greatest in Rio de Janeiro for both men's and women's events. For China and the UK, there is a clear increasing performance trend in the two Games leading up to their home events. Both countries also performed relatively well in the Games after hosting, and the UK even achieved a higher proportion of Olympic points success in 2016 than in 2012 for the men's events. These patterns for the three most recent hosts of the Summer Games suggest spill overs in Olympic performance from hosting to the previous and following Olympiads.

FIGURE 3: Percentage of all Olympic points won by host countries of the last three Summer Olympic Games, 1992-2016



Notes: author calculations using data from the International Olympic Committee and Olympics.com. Olympic Points are summed over all men's or women's events in a Games according to the following: Gold=5, Silver=3, Bronze=2, and Finalist=1.

4. Estimation and Results

The descriptive statistics of Olympic success in Table 1 may not provide robust estimates of the home advantage effect at the Olympic Games. Therefore, we use regression analysis to address some of the heterogeneity over the different countries and the Olympiads. To begin with, we carry out a country-games level analysis, as is common in the literature (e.g., Bernard & Busse, 2004; Forrest et al., 2010; Lowen et al., 2016). This will allow us to address the fact that some countries have hosted the Games more than once. We then extend this approach and address the general heterogeneity over countries in the strengths within individual Olympic disciplines. This could matter when estimating the home advantage effect, because the disciplines appearing at a Games and their competitiveness may be correlated with whatever country is hosting and their likelihood of being successful. This should also account for sport and discipline heterogeneity across Olympic Games, accounting for the fact that the number of medals available within each sport or discipline changes over time. The discipline-level approach will also address the selection of new or returning disciplines into a Games that match a host's strengths. For example, the UK's performance in women's boxing, introduced at the 2012 Olympics, would only be compared with women's boxing at the 2016 Olympics. Finally, a regression analysis allows us to address Games level heterogeneity. For example, all countries would have expected to achieve a higher share of Olympic success at the Moscow 1980 Games given the boycott by many countries and athletes.

We estimate the following using least squares, separately for men's and women's events, separately for Summer and Winter Games, and only over countries that hosted a Games in the estimation period:

$$y_{it} = \alpha + \beta H_{it} + c_i + g_t + \varepsilon_{it} \ , \qquad (1)$$

where y_{it} gives one of the three different relative measures of success described above. i denotes either a country or a country-discipline and *t* denotes a Games. H_{it} is a dummy variable taking the value one when a country was hosting that Games and zero otherwise. β is the coefficient of interest, giving our estimate of the home advantage effect. We include two-way fixed effects in the regression model. c_i addresses the tendency of some countries to do better than others at the Olympics, or within disciplines, regardless of who was hosting. g_t is a Games fixed effect, that can address differences or trends in competitiveness between Olympiads. α is a constant, and the remaining heterogeneity in Olympic success is contained within the error term, ε_{it}.

We estimate Equation (1) using weighted least squares, where the weights are constructed according to the total numbers of medals or points available within a Games or Games-discipline for each gender. The dependent variables used in Equation (1) are the mean values of success over the numbers of individual events within a Games or Games-discipline. Therefore, we would expect substantial heteroskedasticity in the model residuals. We confirm this with the standard Breusch-Pagan test and that the weighting does whiten the residuals somewhat, but not sufficiently. Therefore, we will also report Eicker–Huber–White heteroskedasticity-robust standard errors.[14]

Table 2 presents the regression results that encompass the entire sample period. In each panel, the rows correspond to the three different dependent variable, or measures of Olympic success, only reporting the coefficient estimate of β for the home advantage effect in Equation (1) along with its standard error in parenthesis. The top panel shows estimates at the country-games level, and the bottom panel shows results at the country-discipline-games level.

The estimated host effect is positive and statistically significant for male athletes at both the Summer and Winter Olympics. At the country-games level, hosting may increase the share of men's gold medals won by 0.104 at the Summer Games and by 0.067 at the Winter Games. When we broaden how success is measured by including all medals (points), the magnitude of the equivalent effect falls to 0.087 (0.081) for the Summer Games and 0.033 (0.037) for the Winter Games.

The estimated host effect for female athletes differs dramatically from the effect in men's events, being statistically significant but approximately half as large as the magnitude for male athletes at the country-games level. On average, hosting increased the share of female gold medals attained by 0.054 at the Summer Olympics. This effect is 0.037 and 0.038 units when the dependent variable is the medal share and points share, respectively. Hosting the Winter Olympics had no statistically significant impact on a country's success in women's events.

[14] We also estimated all regression models without the weighting and only robust standard errors. The patterns of home advantage over time, seasons and gender were qualitatively similar with or without the weighting, but the point estimates were marginally higher in the latter case. We also found that our results were robust to estimating Equation (1) in first-differences with country or country-discipline specific trends – these results are available on request.

TABLE 2: Estimated effects of hosting the Olympic Games on the share of success achieved in the same Games, modern history, 1896-2016

	Summer		Winter	
	Male	Female	Male	Female
Within country - Dep. variable:				
Golds	0.104***	0.054***	0.067***	-0.004
	(0.023)	(0.015)	(0.016)	(0.013)
Medals	0.087***	0.037***	0.033***	0.010
	(0.022)	(0.012)	(0.009)	(0.010)
Olympic points	0.081***	0.038***	0.037***	0.010
	(0.020)	(0.009)	(0.008)	(0.009)
N country-games	510	493	228	228
Within country-discipline - Dep. variable:				
Golds	0.099***	0.050***	0.068***	-0.004
	(0.010)	(0.010)	(0.016)	(0.012)
Medals	0.082***	0.035***	0.033***	0.008
	(0.007)	(0.006)	(0.009)	(0.009)
Olympic points	0.077***	0.036***	0.037***	0.009
	(0.007)	(0.005)	(0.008)	(0.007)
N country-games-disciplines	11,547	6,251	2,405	1,394

Notes: ***, ** indicate significance from one at 1%, 5% and 10% levels, respectively, two-sided tests. Robust standard errors are displayed in parentheses. Least squares estimates of β in Equation 1, with Games/Games-discipline fixed effects and each observation weighted according to the square root of the total number of golds/medals/points available at the Games/Games-discipline.

The lower panel of Table 2 shows the equivalent results as the higher panel but with estimates of Equation (1) at the country-discipline-games level. Overall, the findings mirror those obtained at the country-games level, in terms of the patterns across the genders, measures of success, and the Summer or Winter Games, although the coefficient magnitudes are generally smaller for the Summer Olympics in the lower panel. This suggests that the estimates of the home advantage effect at the country-games level are marginally biased upward by the selection of events into a Games that a host nation is expected to excel in.

In Table 3, we split the sample into three sub-periods, focusing on the points share as the preferred measure of success. The first period examines the Games from the first modern

Olympiad up to the 1936 Games. The second period focuses on the Cold War period, and the final period focuses on a more contemporary sample of Games and hosts from 1988 onward.[15] As for the descriptive statistics presented in Section 3, the regression results, at the country-games-discipline level, show clearly that the home advantage effects have diminished over time. In the early period, for example, hosting the Games was associated with an increase in the Summer Olympic points share by 0.207 for men's events and by 0.131 for women's events.[16] In comparison, the significant home advantage effects in 1988-2016 were 0.021 and 0.017 for men's and women's events, respectively. These latter effects are not statistically different from one another, suggesting that the advantage of hosting has converged over time for male and female athletes. At the Winter Games, since 1988, there was no advantage within disciplines for countries from hosting women's events, but the home advantage effect for men's events was approximately 50% greater than at the Summer Games.

TABLE 3: Estimated effects within country-discipline of hosting the Olympic Games on the share of Olympic points achieved in the same Games, 1896-1936 vs 1948-1984 vs 1988-2016

	Summer		Winter	
	Male	Female	Male	Female
1896-1936:				
Home	0.207***	0.131***		
	(0.020)	(0.041)		
N	1,328	216		
1948-1984:				
Home	0.048***	0.058***	0.045***	0.019
	(0.007)	(0.014)	(0.013)	(0.014)
N	2,090	710	736	336
1988-2016:				
Home	0.021***	0.017***	0.031***	0.001
	(0.003)	(0.003)	(0.009)	(0.009)
N	2,016	1,912	854	667

Notes: ***, ** indicate significance from one at 1%, 5% and 10% levels, respectively, two-sided tests. Robust standard errors are displayed in parentheses. Least squares estimates of Equation (1), with each observation weighted according to the square root of the total number of points available in the Games-discipline.

[15] The 1992 Winter Games contained a unified team of six of the former Soviet Republics. Similarly, 12 of the former Soviet Republics formed a team at the 1992 Summer Games. However, we split our sample from 1988 onwards primarily to exclude the boycotted Games of 1980 and 1984 from the modern period, which does not include Russia as a host nation.

[16] Too few Winter Olympiads occurred during this sample period to analyse them separately.

As shown by Forrest et al. (2010), there may be ex-ante Olympic success for a country related to hosting. Further, the impacts of hosting may have some persistence that at least carry into the following Olympiad. Therefore, we add two dummy variables into the regression model:

$$y_{it} = \alpha + \beta_1 N_{it} + \beta_2 H_{it} + \beta_3 L_{it} + c_i + g_t + \varepsilon_{it} \,, \qquad (2)$$

Where the ex-ante effect is given by N_{it} and the ex-by L_{it}.

Table 4 presents the results of estimating Equation (2) at the country-games-discipline level. The top panel shows the results over 1896-2016, and the bottom panel for only 1988-2016. The estimates of the host effect, β_2, are generally similar to those in Table 3. Both the ex-ante and ex-post effects of hosting over 1896-2016 are positive and significant in men's events and only at the Summer Games. This is also the case in the later 1988-2016 period. It is somewhat peculiar that the points share achieved by a country within disciplines is significantly lower in women's events ex-post hosting a Winter Games, relative to Games more than one Olympiad removed from hosting. In the 1988-2016 period for the Summer Games, the ex-ante effect for women's events is statistically significant and close in magnitude to the equivalent male estimate.

5. Conclusion

In this study we examine the magnitude of home advantage at the modern Olympic Games. We find a substantial positive effect on success from hosting. Although this effect has tended to favour male athletes from the host nation more than female athletes, the gender difference has converged over time at the Summer Games and was not statistically different within disciplines since 1988. This would be consistent with the diversity of participation, professionalism and competitiveness in the women's events catching up with the men's events. We only found home advantage at the Winter Games in men's events. These results are consistent with Rewilak (2021), who also found that the effects of hosting were similar for men and women at contemporary Summer Olympiads. The results here also complement the findings of Leeds and Leeds (2012), who observed some gender-specific patterns in home advantage at the Olympic Games. Our findings show that home advantage at the Olympics has diminished over time. The estimated host effects before the Second World War were ten times larger than the effects during 1988-2016. This is similar to the waning effects of communism found by Noland and Stahler (2017).

TABLE 4: Estimated effects within country-discipline of hosting the next, previous and current Olympic Games

	Summer		Winter	
	Male	Female	Male	Female
1896-2016:				
Home next (β_1)	0.011***	0.005	-0.001	0.001
	(0.004)	(0.005)	(0.006)	(0.009)
Home (β_2)	0.079***	0.037***	0.037***	0.007
	(0.007)	(0.005)	(0.008)	(0.008)
Home previous (β_3)	0.012***	0.001	0.000	-0.014**
	(0.004)	(0.005)	(0.005)	(0.006)
N	11,547	6,251	2,427	1,394
1988-2016:				
Home next (β_1)	0.008***	0.007**	-0.006	-0.003
	(0.003)	(0.003)	(0.006)	(0.010)
Home (β_2)	0.024***	0.019***	0.029***	-0.002
	(0.003)	(0.004)	(0.009)	(0.009)
Home previous (β_3)	0.012***	0.005	-0.003	-0.017**
	(0.003)	(0.004)	(0.007)	(0.008)
N	2,016	1,912	854	667

Notes: ***, ** indicate significance from one at 1%, 5% and 10% levels, respectively, two-sided tests. Robust standard errors are displayed in parentheses. Least squares estimates of Equation (2), with each observation weighted according to the square root of the total number of points available in the Games-discipline.

In terms of directions for future academic research, there is a large gap in our understanding of why differences in home advantage in professional sports might exist between men and women. One potentially valuable avenue could be to explore this issue from a behavioural economics or psychology perspective. In addition, a more robust study, examining the heterogeneity of the home advantage effects between the different disciplines and sports, by gender, could further inform which home advantage factors matter the most at the Olympic Games, as well as explaining any heterogeneity in the tendency of host nations to do particularly well on their own patch. Finally, we acknowledge that our two-way fixed effects models may lead to estimates of average host effects that are biased downwards if there is any plausible and substantial heterogeneity in the benefits of hosting. Therefore, we can interpret our results as lower bounds. Future research could look to alter the model or study this bias and accordingly change the assumptions and estimator.

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