Should Cities go for the Gold? The Long-term Impacts of Hosting the Olympics

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Abstract

The Summer Olympics bring hundreds of thousands of visitors and generate upwards of $10 billion in spending for the host city. This large influx of tourism dollars is only part of the overall impact of hosting the Olympic games. In order to host the visitors and sporting events, cities must make sizable investments in infrastructure such as airports, arenas and highways. Additionally, the publicity and international exposure of a host city may benefit international trade and capital flows. Proponents argue that this investment will pay off through increased economic growth, but research confirming these claims is lacking. This paper examines whether or not hosting an Olympiad improves a city's long-term growth. In order to control for the self-selection of cities that host Olympic games, this paper matches Olympic host cities with cities that were finalists for the Olympic games, but were not selected by the International Olympic Committee. A difference-in-difference estimator examines post Olympic impacts for host cities between 1950 and 2005. Regression results provide no long-term impacts of hosting an Olympics on two measures of population, real GDP per capita and trade openness.

JEL Classification: O18, R11
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1 Introduction

On October 2, 2009, Rio de Janeiro won the right to host the 2016 Olympics. Brazilians celebrated on the beaches of Cocacabana, while members of the Chicago2016 Committee (the group organizing the bid on behalf of the city) were stunned at their first round loss. Chicago Mayor Richard M. Daley called the Olympics a "catalyst" for federal mass transit, security and infrastructure funding and a "once in a lifetime opportunity" to market Chicago as destination for tourists and business investment. He said "Our goal is to position Chicago to reap the benefits and lasting legacy of investment." The hospitality industry strongly supported the bid not only for the immediate increase in tourism during the Olympics, but also "the international exposure that Chicago will get" from hosting the Olympics (Bradley (April 1, 2009)). Supporters of the Chicago bid argued that hosting the Olympics would lead to significant economic benefits for the city and the region.[1]

Correspondingly, the Associated Press reported that "Rio is seeking to become the next Barcelona, Spain, a city that used the 1992 Olympic Games to improve its infrastructure and transform itself into a more popular destination for tourism and international events." The Rio bid includes significant investment in infrastructure and housing in hopes of spurring future economic growth. Even the International Olympic Committee complemented Rio's effort to "transform the region and leave a lasting and affordable legacy" (Azzoni (September 23, 2009)).

Every four years, people from all over the world prepare for a truly international sporting and spectator's event, the Summer Olympics. For two weeks, the host city is overrun with millions of spectators, athletes and corporate sponsors. No event provides as much media exposure or notoriety to a single urban area. The temporary economic impacts of such an event have been estimated for a number of recent Olympics. For all Summer Olympics between the 1984 Los Angeles games and the 2004 Athens games, estimated economic impacts range from $2.3 billion to $15.9 billion (Veraros et al. (2004)).[2]

These impacts are sizeable, but likely represent only a portion of the total impact on Olympic host cities and countries. There may be additional impacts due to the improvement or construction of infrastructure[3] needed to host an Olympiad, in addition to the international exposure during and before the two week event. In order to account for these supplementary impacts, this research examines population, real Gross Domestic Product (GDP) per capita and trade openness from 1950 through 2005 and is based on the idea that a city and country with better infrastructure and

[1] Chicago2016 commissioned an economic impact study of hosting the Olympics, which estimated a $22.5 billion benefit for the region and $13.7 billion for the city itself against estimated costs of $4.8 billion (Tootelian and Varshney (2009)).

[2] These types of economic impact studies are sensitive to assumptions and often generate a wide range of estimated impacts.

[3] Hosting the Olympic games typically requires improvements or construction of highways, airports and sporting venues to facilitate the large number of spectators and events.

international reputation should attract more businesses, investment and correspondingly people.[4] Of course, long-term positive impacts are not guaranteed because the associated costs of hosting the games (and debt incurred due to the construction of Olympic facilities) may limit net benefits. This may be the case under a competitive bidding process where cities bid away expected net benefits by promising better venues, greater security and improved transportation.[5]

Unfortunately, the application of a city to host the Olympics introduces an issue of self-selection. For example, the most recent Olympic host city Beijing experienced above average economic growth throughout the 1990s and 2000s. The strong bid and selection of Beijing in 2002 is likely linked to this economic growth as well as the perceived benefits for Beijing and China in the investment and exposure of hosting the Olympics. Historically, Olympic games have been exclusively awarded to highly populated urban areas in developed economies with the strong institutional capacity to organize and host an Olympiad. Between 1950 and 2006, Olympic host cities averaged populations of 6.3 million in countries with an average real GDP per capita of $\$9,546$. Correspondingly, the population of all other cities with at least $750,000$ people (in 2007) averaged 1.4 million in countries with an average real GDP per capita of $\$3,207$.[6]

Cities bidding to host the Olympic games are likely different from other cities across a variety of characteristics that influence their ability to host and benefit from the Olympics, as well as opportunities for future growth. Therefore, a natural counterfactual for Olympic host cities are cities that just lost out in the Olympic voting process. The bidding and voting process narrows down applicants to those cities with the institutional capacity and resources to successfully host an Olympic games. In the end, Olympic host cities and runner-ups have minimal differences in the expected benefits from hosting an Olympiad. These differences are further trivialized by two elements of the selection process: 1) The final two-way vote for the right to host the Olympics is typically won with less than 60% of the total vote and 2) the criticism and claims of corruption surrounding the award process for host cities (Baade and Matheson (2002)).

Results find that when awarded the Olympic games, host cities have larger populations and are

[4] We limit analysis to only Summer Olympics due to data availability and the smaller scale of the Winter Olympics.

[5] Humphreys and Zimbalist (2008) offer this as one explanation for why the literature on Olympic economic impacts has found limited or mixed results.

[6] All city data is from United Nations (2007) and all country data from Heston et al. (2006).

in countries with higher real GDP per capita than finalist cities. These differences persist after the Olympic games. Examining how these differences change over time provides no statistically significant impact on measures of population, city's population as a portion of a country's urban population, real GDP per capita, or trade openness[7]. These results are robust to the use of a propensity score matching estimator to 1) create an alternate control group from the population of all international cities and 2) limit the control group of finalist cities to only those finalist cities with similar pre-Olympic variables as host cities.

2 Olympics and Economic Impacts

A few papers have estimated economic impacts for specific Olympic games or predicted future impacts as part of a city's bid to host the Olympics (see Ritchie (1984), Hall (1987), Walle (1996), French and Disher (1997)). These papers are rich in detail, but lack generality across cities and do not provide a counterfactual to benchmark the host city's growth. They primarily focus on case studies and numerical analyses to examine potential benefits such as newly-constructed facilities, enhanced international reputation, urban revival and increased tourism.

Andranovich et al. (2001) highlight the scale of overall and public expenditures for three different U.S. Olympic games. For the 1984 Los Angeles games, the budget was $546 million for the event and there was an associated $100 million investment in public telecommunications infrastructure and renovation of Los Angeles' international airport. The 1996 Atlanta games had a budget of $1.58 billion with $517 million in infrastructure investment and an additional $609 million in federal infrastructure investment. The 2002 winter Olympics in Salt Lake City had a budget of $1.3 billion and a corresponding $1.3 billion investment in federal transportation infrastructure.

The most common approach to estimating the impacts of Olympic games are economic impact studies, which incorporate regional input-output tables to estimate the total effects of Olympic-related spending as it multiplies through the local economy. Humphreys and Plummer (1995) find an economic impact of $5.1 billion for Atlanta, Economics Research Associates (1984) estimates an impact of $2.3 billion for Los Angeles and Papanikos (1999) finds an impact of $15.9 billion

[7]This is defined as $(Exports + Imports)/Total\ GDP$

for Athens.[8] Criticism of these models includes that they are sensitive to assumptions regarding the regional economy, provide no measure of opportunity costs for public funds and may contain investigator bias because these studies are commissioned to support the Olympic bid itself (Baade and Matheson (2002)). Additionally, most economic impacts are accrued to private industries with limited tax liability. This can leave a city with limited tax revenue from hosting the Olympic games to fund large expenditures of public agencies. These impact studies only account for the short term impacts leading up to and including the event, but not impacts in the years following the Olympic games.

Three econometric studies provide estimates of the impact of hosting an Olympics on employment and/or migration. Hotchkiss et al. (2003) find a 17% increase in employment in counties that contained an Olympic venue relative to similar counties that did not host an event in the four years following the 1996 Olympics. For the 1984 Los Angeles games and the 1996 Atlanta games, Baade and Matheson (2002) find insignificant impacts on post-Olympic metropolitan area employment while controlling for population, income, taxes as well as other macroeconomic trends. Lybbert and Thilmany (2000) estimate the impact of four U.S. hosted Olympics on county level employment and net migration and found positive impacts. These positive impacts were greater for Summer Olympic hosts relative to Winter Olympic hosts.

Olympic-related investment in infrastructure may benefit host cities. Hoffmann (2003) finds a positive impact of infrastructure investment on international capital flows. Fernandez and Montuenga-Gomez (2003) finds a positive impact of public capital on productivity growth in Spain. Chandra and Thompson (2000) use the exogenous placement of the U.S. interstate highway system to overcome the endogeneity of infrastructure investment. They find a positive impact of a county's proximity to highway infrastructure on economic activity.

The international exposure of the Olympics may increase information and lower uncertainty for potential investors in the host city. This should generate increased international trade and capital flows. The literature on the effects of international trade and Foreign Direct Investment (FDI) on economic growth is sizable. Most of this literature touts the benefits of the free international flow of

[8] All of these impact studies typically involve multiple scenarios and assumptions. The median estimated impact is adopted here.

goods and capital on economic growth (e.g. Frankel and Romer (1999) , Borensztein et al. (1998), Edwards (1993) and Levine and Renelt (1992)).

Two concerns are highlighted by the literature. First, there is limited analysis of impacts in the years after hosting the Olympic games and most of this analysis involves only a few U.S. cities. Second, a city that bids to host the Olympic games is fundamentally different from other cities. This type of self-selection biases estimated relationships between the Olympics and long term growth. It also limits generalizing the impacts (short and long term) of hosting an Olympics to other cities.

3 Olympic Bid and selection process

The process of selecting an Olympic host city typically begins almost a decade before the actual hosting of the games.[9] Informally, the process begins with the International Olympic Committee (IOC) sending out inquiries to determine which cities might be interested in hosting an upcoming Olympiad. Cities then communicate with their respective National Olympic Committees (NOC) to indicate their interest in representing their country as an applicant to the IOC.[10] Each NOC then promotes a single competitive city as an applicant to the IOC.

The formal process for becoming an Olympic host city has two distinct phases: 1) the application stage and 2) the candidate stage. The applicant stage consists of interested cities filling out a detailed questionnaire to the IOC Executive Board that addresses such questions as "What are your principal motivation and objectives for hosting the Olympic Games?" as well as detailed questions regarding proposed or existing infrastructure related to Olympic sporting venues and information on athlete lodging facilities and security (International Olympic Committee (2008a)). The cities that demonstrate sufficient potential to the IOC Executive Board are advanced to the candidate phase. The candidate phase involves the submission of a detailed plan for hosting the Olympics. The plan must address a number of event-related issues including overall vision, legal and political structure of the Olympic host committee, environmental conditions, financing, marketing, sport venues, security, accommodations, transportation, technology and media (International Olympic

[9]Most of the details regarding the formal process for becoming a host city were obtained from the International Olympic Committee and other details are from host city newspaper articles for recent Olympics.

[10]Before 1960, a NOC did not screen potential applicants and interested cities applied directly to the IOC.

Committee (2008b)). Each candidate city must guarantee and secure financing for all aspects of the Olympic games. Upon reviewing candidate files, the IOC Evaluation Commission conducts a series of site visits to evaluate the institutional capacity of candidate cities. These visits evaluate both planned and existing infrastructure and organizations that were mentioned as part of a candidate's bid. After evaluating all the candidate cities, the members of the IOC Evaluation Commission conduct a formal vote to determine the host city.

The host city is selected through a multi-round voting process in which the candidate with the least number of votes is removed in each round and then a re-vote is conducted for each subsequent round until a host city garners at least 50% of all votes. The Olympic host city is selected typically 6 to 7 years before the scheduled Olympic games in order to provide ample time to implement the extensive infrastructure, financing and organizational plans. The IOC monitors the preparation for the Olympic games in order to ensure preparedness of host cities and has threatened to remove the games from host cities that are behind schedule in implementing their bid. Table 1 provides voting outcomes for the last 17 Summer Olympic elections. The margin of victory tends to be small in the final round of the selection process: twelve of those votes were won with fewer than 60% of the vote total. In several cases the eventual winner did not receive the highest percentage of the vote in the first round.[11] We used the results of this voting process to code host cities and corresponding finalists used in our subsequent analysis.

[Insert Table 1 here]

A few factors impact the selection of a host city beyond the strength of candidate files. Hill (1992) outlines some of the political dynamics regarding Olympic bids. As with any voting process, cities with influential leaders or connections to voting members of the IOC will garner more votes relative to the strength of the their bid. Other factors such as geography and political ideology influence results. If a country recently hosted the Olympics, other cities of the same nationality will receive less support. Olympic bids by Beijing in the 1990s and Moscow in the 1970s had to overcome the large representation of western democracies on the IOC selection committee. Even individual members of the IOC may influence results. This concern was voiced when IOC president

[11]The limited number of candidates in the 1980, 1984 and 1988 Olympics is partly attributed to publicity regarding the large public debt incurred by Montreal in hosting the 1976 Olympics.

Juan Antonio Samaranch's home town of Barcelona received the 1992 Summer Olympics.

4 Methodology

In order to test if hosting the Olympics has long-term impacts, we adopt a difference-in-difference methodology with the assignment of treatment and control groups based on the Olympic selection process. The Olympic host cities represent the treatment group and finalist cities in the Olympic bidding process represent the control group.[12] Olympic vote results and announcement dates were compiled from IOC archives and host cities were matched with corresponding finalist cities for each Olympiad. Our process of coding host and finalist cities for estimation was complicated by the fact that some cities bid to host the Olympic games in more than one year even though no city hosted the games more than once over the study period. If the finalist for a given Olympiad ever hosted an Olympiad from 1956 to 2004 then it was excluded as a finalist city. In addition, each city was assigned to only one Olympiad as a host or control city. Any city that bid in multiple Olympics and never became a host city was assigned to the first Olympiad upon which the city became a finalist.

Starting in 1960, the International Olympic Committee limited each country to one candidate city. This led to large countries conducting their own selection process to identify the single city that would be nominated to host the games. In order to supplement the number of control cities used for this research, cities considered as finalist by a National Olympic Committee were considered as control cities. Identification of these additional finalists required detailed newspaper searches through electronic databases (e.g. NewsBank) and inquiries with National Olympic Committees. Additionally, Hill (1992) identifies several cities that fulfill this country finalist criterion. We identified five NOC finalists (Amsterdam, Boston, New Orleans, San Francisco and Toronto) in these supplemental searches and included them in subsequent analysis. These cities exhibited the civic infrastructure necessary to assemble a bid for a NOC and therefore meet the same self-selection criterion as other candidate cities. Table 2 details each Olympiad and corresponding host and

[12] Greenstone and Moretti (2004) adopts a similar methodology in examining the impacts of local economic development efforts to attract large manufacturing plants.

finalist cities.

[Insert Table 2 here]

The selection process for the Olympic games and the timing of the games themselves divides the analysis into three respective time periods: before the announcement of the host city for a given Olympiad; the time between the announcement of the host city and the actual playing of the Olympics; and after the playing of the Olympics. Since our interest is on the longer term impacts of the Olympics, we focus on comparisons from before to after the actual playing of the Olympics. There may be some impacts between announcement and hosting the games, which are related to the construction activity in preparation for the Olympics. Construction activity may provide a temporary influx of workers and income to a city, but this impact should be limited to before and during the Olympics.[13]

The difference-in-difference[14] (DD) estimation equation is given by Equation 1 where $y_{i,t}$ represents the outcome of interest (e.g. population, city percent of country population, real GDP per capita, trade openness)[15] for city i in year t; D_t is a dummy equal to one for observations after the playing of the Olympics for both treatment and control cities and zero otherwise; T_i is assigned a 1 for host cities and a zero for non-host finalist cities; and $\Sigma_{j=1}^{12}\delta_j Oly_{i,j}$ is a series of dummies that groups host and finalist cities for each Olympiad j.[16] Finally, β_3 gives the parameter of interest, the estimated post-Olympic impact of hosting the games on outcome $y_{i,t}$.

$$y_{i,t} = \alpha + \beta_1 D_t + \beta_2 T_i + \beta_3 D_t * T_i + \Sigma_{j=1}^{12}\delta_j Oly_{i,j} + \varepsilon_{i,t} \quad (1)$$

[13]Unreported regressions results are similar when using the announcement date versus the event date across all outcome variables.

[14]As discussed by Heckman et al. (1998) and Smith and Todd (2005), DD estimators are generally more effective than cross-sectional comparisons at removing biases from data.

[15]One can easily think of a number of possible outcomes for Olympic host cities such as employment, foreign direct investment or infrastructure expenditures. Unfortunately in order to incorporate more than just a few U.S. host cities requires international data over many years and thus only a few variables are available across our sample.

[16]We cannot include Moscow because it has no suitable finalist cities and is missing country level data from before 1980.

5 Data and Urban Area Population Trends

Since the Summer Olympics occurs only every four years, a panel data set with a larger number of years is required to estimate population and economic outcomes in Equation 1. We chose the time interval of 1950 through 2005 for a number of reasons. First, due to the disruption of Olympic games during World Wars I and II, analysis is limited before the 17th Olympiad in London in 1956. Second, 1950 represents the first year of annual observations for international city level population data. The last possible Olympiad to include given the most recently available data is the 28th Olympiad in Athens in 2004.

Since international data for urban areas is limited to population over our study period, we need to establish the relationship between hosting the Olympics and population change. Population modeling typically involves two major components of population change. The first component is the natural rate of population growth, which includes births minus deaths. This is assumed to be relatively stable for the time periods under examination in this research.[17] The second component is net migration, which includes in-migrants minus out-migrants. Two commonly cited factors that influence migration trends are employment opportunities and local amenities (e.g. climate, recreation, cultural facilities, etc.).[18]

The hypothesized impacts of hosting an Olympiad would be on jobs or amenities in the host city and country. There are a number of benefits to businesses and residents from improved infrastructure and international exposure. The improvement of roads and airports lowers transportation costs for businesses and improves urban transportation for residents. New stadiums and public spaces provide additional entertainment amenities. Benefits may be limited by the costs of hosting the Olympics and its associated debt burden negatively impacting long-term levels of infrastructure and event facilities. The international nature of the Olympics is symbolic of the openness of a country to foreign travelers and businesses as well as the cosmopolitan nature of the city. These impacts affect the overall attractiveness of the host country to international businesses as well as

[17]A region's natural rate of population growth can change over time, but in practice this typically occurs over many generations. There are some variation in this measure between urban and rural areas, but since this research just focuses on larger cities, identification of trends in wealthier countries is not a concern.

[18]See Muth (1971), Sutton (1996), and Lowry (1966) for the inclusion on employment variables in migration models. Greenwood (1985) and Graves and Knapp (1989) discuss the importance of amenities in migration trends.

domestic and international migrants.[19] Given the available data, we incorporate two measures of population: total population in an urban area and portion of a country's urban population in an urban area. The former provides a measure of both domestic and international migration, while the latter indicates impacts due to domestic migration between urban areas within the same country. We also test country level impacts with variables for real GDP per capita and trade openness.

Testing these hypotheses as well as additional outcome variables requires data from a number of sources. Data on the population of urban areas comes from the United Nation's *World Urbanization Prospects: The 2007 Revision report* (United Nations (2007)). The report includes a data appendix that estimates the population of urban agglomerations with more than 750,000 residents in 2007 for the years 1950-2025.[20] The estimates are generated from censuses, United Nations (UN) estimates and sample surveys. The data consists of observations every five years on the percent of a country's urban residents in an urban agglomeration and the population level of the urban agglomeration. Annual observations were imputed from that data.[21] The 750,000 inhabitant limit excludes two cities that bid for the Summer Olympics: Lausanne, Switerland and Florence, Italy. Data on country population, real GDP per capita and trade openness were collected from the *Penn World Tables version 6.2* (Heston et al. (2006)). Like UN population data, the Penn World Tables is available at a five-year interval and annual observations have been interpolated. Each city was matched with the corresponding country-year level observation from 1950-2005.[22] Variables that describe the ethnic, political and religious nature of countries are described in Table 3.[23]

[Insert Table 3 here or in an Appendix]

[19] It is possible for this to be a negative effect if a city/country is portrayed negatively as part of media coverage for a given Olympiad.

[20] We use the terms urban area and city interchangeable because the Olympics are awarded to a specific host city, but typically involve a larger integrated urban area for hosting events, housing visitors and transportation.

[21] We incorporated two different interpolation schemes. The results reported here rely on a simple linear interpolation between data points. The results are robust to the approach described in Fernandez (1981), which suggests a method for interpolation of low frequency data using other high frequency data in the same data set. In this case we use the annual country population estimates and the implied country populations from the UN City Population data (which includes both city population and the fraction of a country's population living in that city). The two sets of interpolated data are almost identical.

[22] Country level observations for pre-1970 Germany, pre-1990 Russia, Bulgaria, Ghana and a few annual observations for other countries were missing values or contained implausible data points and had to be excluded from analysis. For example Ghana's openness measured 986.5 in 1965. The average was 26.6 and the next largest was Panama at 173.

[23] Some of these variables also require interpolation to match the intervals of data not corresponding with the timing of the Olympic selection process.

The final data set consists of an unbalanced panel with 529 cities observed annually for 56 years. These cities represent 88 counties with a maximum of 140 unique cities in China and 44 countries containing only a single city. A balanced panel would consist of 29,624 city-year level observations for each of the population and macroeconomic variables. After eliminating city-year groups with missing data we have 25,848 city-year observations.

Figure 1 provides population trends over the study period for host cities, finalist cities and all cities with at least 750,000 people in 2007. Results highlight a large difference between host cities and the other cities in the data set. The different population levels and population growth for host cities demonstrates the concern of selection bias. Finalist cities are slightly smaller than host cities in 1950, but population differences grow over time. Figure 2 gives population trends for quartiles of real GDP per capita ($) for all cities relative to host and finalist cities. The large difference between host and other cities is prominent in this graph. One interesting trend is the convergence of populations along the income quartiles relative to the high population growth of host and finalist cities. Income stratification does not appear to be correlated with population differences among these international cities over time.

[Insert Figures 1 and 2 here]

In addition, Figures 3 and 4 provide Olympiad by Olympiad relative population trends from the playing of a Olympiad until 2005. Relative population is given by population in year t divided by Olympic year population for each city. Therefore population difference between host and finalist cities are normalized to one at the year of a given Olympiad. The solid line indicates relative population for the host city and the dotted lines represent the finalist cities. These figures show interesting variations in the population growth across Olympics. Overall results appear to vary by Olympics with a number of cities experiencing relatively higher population growth and others lower population growth than finalist cities. Specifically, host cities for the 1956, 1960, 1964, 1968 and 1996 had higher relative population growth after the Olympics than finalist cities. This was not the case for the 1972 host city of Munich, which experienced relative population growth below finalist Madrid. Host cities in 1976, 1984, 1988, 1992, 2000, and 2004 all experienced similar growth as finalist cities. The general trend is higher population growth for host cities, relative to finalist cities, that held Olympics in the 1950s and 1960s and similar population growth for host and finalist cities in the 1970s and 1980s. These trends may highlight decreasing net benefits for recent Olympics, which could be a result of escalating costs (e.g. security) for host cities. There may also exist diminishing international benefits for Olympic hosts given the widespread deepening of global trade and capital markets durring the 1970s and 1980s.

[Insert Figures 3 and 4 here]

The variables adopted for regression analysis are given in Table 4 and highlight all outcome variables of interest as well as any variable used in estimation. The differences between these three groups is apparent for a number of variables. As discussed, population levels are higher and grow faster for host cities relative to finalist cities. Host cities average over 1.5 million more people and a 5 percentage point higher five year population growth rate than finalist cities. Real GDP per capita is slightly higher for finalist cities than host cities. Cities in the data set that never bid for the Olympics tend to be poorer and smaller than finalist cities, though they grow at a faster rate. Host cities are larger in population, represent a larger share of a country's urban population and have higher real GDP per capita than all other cities in the data set. Additionally, host and finalist countries contain greater measures of economic freedom, lower language fractionalization, lower perceived corruption[24] and higher scores in the Human Development Index (HDI). Host and finalist countries are also less Muslim, more Catholic, had greater recent population growth and lower recent growth in real GDP per capita.

[Insert Table 4 here]

6 Propensity Score Matching

Any differences in population, income, political or culture attributes between host and control cities may be problematic for estimation if this results in fundamentally different growth paths for these cities and countries. In order to control for initial differences between host and finalist cities as well as provide for alternative control groups, two sets of Propensity Score Matching (PSM) estimators are included in the regression analysis. The first set of PSM estimators generates a control group

[24] A higher value for the Corruption Perception Index indicates less corruption.

from the set of all international cities with a population of at least 750, 000 in 2007. The second set of PSM estimators uses only the set of finalist cities identified in Table 2. Formally, we implement a block PSM estimator, where PSM is conducted separately for individual blocks of propensity scores (see Imbens (2004)). We modify this technique and do PSM for each Olympiad. This modification is useful in addressing the fact that our data provides a single host city for each Olympiad.

Propensity Score Matching was introduced by Rosenbaum and Rubin (1983) and has been applied in economics by a number of scholars (e.g. Dehejia and Wahba (2002), Smith and Todd (2005), Mocan and Tekin (2006), List et al. (2003), Jalan and Ravallion (2003), O'Keefe (2004)). The premise behind a propensity score matching estimator is similar in spirit to using the Olympic selection process to match host with finalist cities. In a traditional propensity score matching procedure, each treatment unit (host city) is matched with one of more control units (non-host or finalist cities) based on the assumption of unconfoundedness which is given as

$$(y_i = 0, y_i = 1) \perp T_i | X_i, \qquad Pr(T_i = 1|X_i) \in (0, 1) \tag{2}$$

where one only observes outcome $y_{i,t}$ and T_i is set equal to one for host cities, 0 otherwise. This assumption implies that assignment to the treatment group is conditional on some set of observed characteristics (X_i). Another assumption implicit in PSM is the existence of a common support, which provides that each treatment unit can be matched with a corresponding control unit. Given that both of these assumptions hold, the treatment and control units do not systematically differ from each other. In practice, implementing matching methods based on values of X_i is impractical when the number of variables becomes sufficiently large. In order to address this dimensionality issue, Rosenbaum and Rubin (1983) propose the use of a propensity score estimator ($p(X_i)$). Rosenbaum and Rubin (1983) prove that conditioning on $p(X_i)$ is equivalent to conditioning on X_i and therefore both the unconfoundedness and common support assumptions are maintained.

Implementing a propensity score matching estimator involves two steps. First, one estimates a binary regression model to obtain $p(X_i)$. The functional form and variables included in X_i is based on hypothesized factors that influence the probability of treatment. In order to test that the estimated propensity score satisfies the unconfoundedness assumption conditional on the propensity score ($p(X_i)$), we follow the procedure outlines in the appendix of Dehejia and Wahba (2002).[25] In summary, this procedure involves stratifying all observations into five equally spaced intervals of propensity scores (e.g. 0-0.2,...,0.8-1). We created additional intervals until there is no statistical difference in propensity scores for treatment and control groups within the same strata. Next, we tested whether each of the individual covariates used in estimating the propensity score was statisticaly different for control and treatment observations. We then further stratified the data into smaller strata until all covariates were insignificantly different from one another at the 5% level.[26]

Second, an algorithm based on estimated propensity scores must be defined in order to match a relevant control observation for each treated unit. The premise behind any matching algorithm is to discard all unmatched control observations. Therefore, propensity score matching models incorporate only a subset of the observations of standard regression models. A number of algorithms have been implemented in order to enhance the quality of matches. Some commonly used methods include nearest neighbor matching, caliper matching, kernel matching and variants with and without the replacement of matched control units (see Dehejia and Wahba (2002), Smith and Todd (2005) or Mocan and Tekin (2006)). These different algorithms vary in the pool of control units they select from and the overall tolerance for non-identical propensity scores between matched and control units. As discussed by Dehejia and Wahba (2002), the inherent trade-off in all matching algorithms is between bias reduction and efficiency. Reducing the number of control observations ensures closers matches and reduced bias, but does so at the expenses of more precise estimates.

6.1 Estimating a Propensity Score

For our application of PSM, we want to match a host city with a control city based on pre-Olympic variables $X_{i,j}$ for a given Olympiad j, which influence the probability of becoming a host city $Pr(T_{i,j} = 1|X_{i,j})$. This probability is determined by a probit regression model where we estimate $T_{i,j}$ on city- and country-level variables ($X_{i,j}$) for the year before each Olympiad. We

[25]This is often referred to as testing if the estimated propensity score satisfies the Balancing Property Hypothesis.

[26]If further stratification does not properly balance the covariates, the propensity score equation needs to be re-estimated with interaction or higher order terms and the procedure repeated until the covariates are balanced.

include six variables for ethnic, religious, language and political characteristics[27] as well as two variables to measure recent trends in population and GDP growth. These two growth variables control if Olympic selection is influenced by recent trends that may influence post-Olympic growth. We estimate separate propensity score equations for each set of potential control cities: 1) all international cities and 2) cities that were finalists in the Olympic host city selection process.

The results of propensity score estimation are given in Table 5 and generate the estimated propensity score, $\widehat{T}_{i,j}$, for each set of possible control groups. We formally test the unconfoundness assumption for each Olympiad and find that propensity scores and covariates were insignificantly different (at the 5% level) between treatment and control groups within a given propensity score strata.[28] A common support for propensity scores exists between host and potential control cities.

[Insert Table 4 here]

Propensity score estimation highlights some attributes that predict if a city is selected to become a host city. Cities that are more Muslim are less likely to become host cities, while cities that have higher recent population growth and score higher on the Human Development Index are all more likely to host the Olympics. Larger cities relative to total country population have a higher probability of hosting the Olympics for either control group.

6.2 Matching Algorithm

We implement an Olympiad-by-Olympiad matching procedure separately for the set of all cities and the set of finalist cities. We use a nearest neighbor propensity score matching algorithm without replacement to find cities that contain similar propensity scores as the host city for a given Olympiad. In order to do this, we took the estimated propensity score $\widehat{T}_{i,j}$ and partitioned the data by host and other cities. Then each host city is sequentially matched with the city that contains the nearest value of the estimated propensity score. The nearest neighbor matching algorithm chooses for each host city i in Olympic j, the corresponding control city $k \neq i$ that minimizes

[27] The choice of these variables is dictated by data that is consistently available across the entire panel of cities and years as well as maintaining the unconfoundness assumption. A number of other specifications with variations in a few variables produced similar propensity scores.

[28] These statistical tests were implemented using the program pscore in Stata 10.0 and we limit reporting the details of the unconfoundness here. Results of this test are available upon request.

$\| \widehat{T}_{i,j} - \widehat{T}_{k,j} \|$.[29] This process is repeated for each of the 12 Olympics in our data set and matched control cities are only used once.[30] In order to enhance the quality of PSM based on the control group of finalist cities, a given host city may be matched with a finalist city for any Olympics. Any temporal differences between treatment and control cities with this type of matching is addressed through year fixed effects in later regression analysis.

Figure 5 illustrates the matching of estimated propensity scores for host cities with all cities large enough to be included in the UN population data set. The bars show the fitted value for the Olympic host and for the city with the closest estimated propensity score to that host. The average difference in propensity scores is 0.004 and the standard deviation is 0.007. The best match is Montreal and Stockholm for the 1976 Olympics with identical propensity scores. The worst match is Sydney and Oslo for the 2000 Olympics with a propensity score difference of 0.019.

Figure 6 provides the estimated propensity scores for host cities matched to the set of cities that were finalists for the Olympics. The average difference in propensity scores is 0.072 and the standard deviation is 0.08. The best match is Montreal and Birmingham, U.K., for the 1976 Olympics with a difference of less than 0.001. The worst match is Atlanta and Cape Town for the 1996 Olympics with a difference of 0.26. The quality of matches is lower for this group than for the set of all cities. This is not surprising, given that there are 28 cities in the finalist category and over 500 in the full data set.

[Insert Figures 5 and 6]

7 Regression Results

Tables 6 and 7 provide regression results for four regression models for each outcome variable (population, city's population as percent of country's urban population, trade openness and real GDP per capita).[31] The variable of interest is *Olympic Host City*Post Olympic Time Period*, which

[29]Since the order upon which Olympics are matched may influence results, we chose the match order that minimizes $\Sigma_{j=1}^{12}(\widehat{T}_{i,j} - \widehat{T}_{k,j})^2$.

[30]PS regressions include a dummy variable for each of the twelve matched host and control cities.

[31]Since observations are limited before the 1956 Olympics and after the 2004 Olympics, we conducted separate regressions without each of these Olympics and found results to be similar. This was also the case with the exclusion of the five national finalist cities of Amsterdam, Boston, New Orleans, San Francisco and Toronto.

captures trends for host cities after the Olympics while controlling for pre-Olympic host city trends. Identification is obtained from comparisons with three different control groups: a propensity score determined sample from the population of all cities, the population of finalist cities and a PSM determined subset of finalist cities. The results in Column 1 provide a baseline estimate in which *Olympic Host City Indicator* is set to 1 for each host city and *Olympic Host City*Post Olympic Time Period* is set to 1 for each year after the Olympiad for each host city. This specification includes year fixed effects to control for global population and economic conditions and since non-host cities are not matched with host cities, fixed effects for each Olympiad and the Post Olympic Time Period Indicator are excluded. Column 2 provides results for the alternate control group drawn from the population of all cities greater than 750,000 in 2007 given in Figure 6. In this specification, Matching Group fixed effects isolate identification to differences between the host and matched control city for a given Olympiad. Column 3 provides results for the subsample of host cities and finalist cities given in Table 2. Column 4 contains a subset of model 3 based on PSM with only finalist cities.

Column 1 includes all cities in the UN data set and consists of 25,848 city-year level observations. Columns 2 includes matching groups and pairs an Olympic host with one other city from the UN data set and generates a total of 1,258 city year observations. Column 3 includes host cities and finalist cities which leads to an average sample of slightly over 3 cities per Olympiad (including hosts) and 2,019 city-year observations. The final column returns to nearest neighbor matching and 1,258 city-year observations.

[Insert Tables 5 and 6 here]

An important issue highlighted by Betrand et al. (2008) is the problem of serial correlation and a downward bias in standard errors in estimating a difference-in-difference model. This type of bias leads to the false positive rejection of the null hypothesis of coefficients equal to zero. In order to correct for this problem, Betrand et al. (2008) advocate the use of clustered bootstrapped t -statistics. This technique extends traditional bootstrapping methods to obtain an empirical distribution of parameter values that accounts for correlation in errors across time within a given group.[32] Results for all regressions include clustered bootstrapped t-statistics, which are reported in parentheses.[33]

Coefficients for *Olympic Host City*Post Olympic Time Period* model 1 indicate that host cities contain larger populations initially and post Olympic host cities become significantly larger than other cities by an average of over 4 million people.[34] Models 2 through 4 incorporate control groups and provide insignificant coefficients for population regressions. None of the models for percent urban contain significant coefficients, but coefficients range from -4.4 to -30.2. These coefficients for models 2 through 4 can be interpreted as the average effect of hosting the Olympics on post-Olympic percent urban. For model 4, a coefficient of -8.9 indicates a decrease in magnitude of 8.9 percentage points for the portion of a host city's population in a country's urban population.

Coefficients for real GDP per capita regressions are only significant for model 1 and indicate that post-Olympic host cities average $4,865 more real GDP per capita than all other cities in the data set. Models 3 and 4 find small coefficients and low t-statistics indicating no affect on real GDP per capita. Trade openness contains some interesting results. When using PSM based on all cities, we find a significant and positive impact of 34.1 from hosting the Olympics. This represents a doubling of trade openness for the average host or finalist city in our data set. This effects appears too large to be caused by hosting the Olympics alone and highlights our concern that cities that bid for the Olympics are likely different than other cities. Models 3 and 4 address this concern and find small coefficients with t-statistics less than one. With an improved control group, there is no relationship between hosting the Olympics and trade openness.

8 Conclusion

The Olympic games have generated substantial attention on the immediate impacts of hosting such a large scale sporting event, but little research has focused on longer term impacts. Olympic host cities tend be larger and locate in wealthier countries than other cities in the UN data set. These

[32] Chernick (2008) provides a good treatment of bootstrapping techniques and clustered bootstrapping.
[33] All bootstrapped t-statistics generated using 5,000 replications.
[34] Figure 1 highlights this effect, with the population difference between host and all other cities increasing over time.

differences persist after the hosting of the Olympics. Results are robust when comparing host cities with three different sets of control groups. Additionally, results for city population as a percent of the country's urban population and real GDP per capita highlight the importance of incorporating matching estimators in order to address the self-selection of Olympic host cities. Insignificant impacts for measures of population, real GDP per capita and openness is consistent with the theory that host cities bid away potential benefits in an effort to win the right to host the Games. These bids come in the form of facilities, transportation infrastructure and security. The large expenditures and competitive selection process in hosting recent Olympics may lower potential long-term net benefits for recent host cities. These result have important policy implications because of the large public investment required for the Olympics and the growing costs of hosting an Olympiad. Conclusions merit additional research into specific impacts of Olympic related investment such as large arenas or improved roads and airports. It may be the case that overall impacts are limited, but specific elements of Olympic investment are beneficial for the long term growth of a city.

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Summer Olympic Host (Year)	No. of Candidates	Rounds	% of votes received by winner in first round	Ranking of the winner in first round	% of votes received by the winner in the final round
Helsinki (1952)	10	2	50	1	54
Melbourne (1956)	10	4	34	1	53
Rome (1960)	7	3	25	1	59
Tokyo (1964)	4	1	59	1	59
Mexico City (1968)	4	1	58	1	58
Munich (1972)	4	2	51	1	52
Montreal (1976)	3	2	36	2	59
Moscow (1980)	2	1	66	1	66
Los Angeles (1984) a	2	1	100	1	100
Seoul (1988)	2	1	66	1	66
Barcelona (1992)	6	3	34	1	55
Atlanta (1996)	6	5	22	2	59
Sydney (2000)	5	4	34	2	51
Athens (2004)	11	4	30	1	65
Beijing (2008)	10	2	43	1	53
London (2012)	9	1	23	1	52
Rio de Janeiro (2016)	7	2	28	2	67

Source: http://www.gamesbids.com

a. For the 1984 games, the candidate city of Tehran withdrew its bid before the first round vote.

Table 1: Voting Outcomes for Past 17 Summer Olympic Bids

Olympiad	**XVI**	**XVII**	**XVIII**	**XIX**	**XX**	**XXI**	**XXII**
Year	1956	1960	1964	1968	1972	1976	1980
Host	Melbourne	Rome	Tokyo	Mexico City	Munich	Montreal	Moscow
Finalist	*Buenos Aires*	*Brussels*	*Vienna*	*Lyon*	*Madrid*	*Amsterdam*	
	Chicago	*Budapest*				*Toronto*	
	Detroit	*New York*					
	Minneapolis	*Rio de Janeiro*					
	Philadelphia						
	San Francisco						

Olympiad	**XXIII**	**XXIV**	**XXV**	**XXVI**	**XXVII**	**XXVIII**
Year	1984	1988	1992	1996	2000	2004
Host	Los Angeles	Seoul	Barcelona	Atlanta	Sydney	Athens
Finalist	*Tehran*	*Nagoya*	*Paris*	*Manchester*	*Berlin*	*Cape Town*
	Boston		*Brisbane*	*Belgrade*	*Istanbul*	*Stockholm*
	New Orleans		*Birmingham*			

Note: All cities that submitted a bid and never hosted an Olympiad (and have not previously been used) are used as finalists. The finalist cities of Florence and Lausanne are excluded because of missing population data.

Table 2: Host and Olympic Finalist Cities 1956-2004

Name	Definition	Source
Dependent Variables		
Population	Urban area population in 000s	United Nations (2007)
Per capita GDP	Per capita real GDP in 2000 dollars based on international prices	Heston et al. (2006)
Openness	Index of trade openness equal to (exports + imports)/GDP	Heston et al. (2006)
Percent Urban	Portion of a country's urban population in the urban area	United Nations (2007)
Independent Variables		
Percent Total	Portion of country population in urban area	United Nations (2007)
Language Fractionalization	Probability that two randomly selected people from a given country will not belong to the same linguistic group. The higher the number, the more fractionalized society.	Alesina et al. (2003)
Corruption Perception Index	This index measures perceptions of the degree of corruption as seen by business people, risk analysts and ranges between 10 (highly clean) and 0 (highly corrupt).	Transparency International (http://www.transparency.org/)
Economic Freedom Index	A composite index between 0 and 100 that measures perceptions regarding the freedom to engage in economic activities.	Heritage Foundation (http://www.heritage.org/index/)
Human Development Index (HDI)	This is a composite index that measures the average achievements in a country in three basic dimensions: life expectancy at birth; adult literacy rate and gross enrollment for schools; real GDP per capita.	United Nations Development Program (http://hdr.undp.org/)
Population Growth Rate	Urban area five year growth rate (1.0 = 100%)	Author's calculation and United Nations (2007) data
Economic Growth Rate	Country five year growth rate in real GDP per capita (1.0 = 100%)	Author's calculation and Heston et al. (2006) data
Percentage Muslim	Percent of Population that is Muslim in 1980	La Porta et al. (1999)
Percentage Catholic	Percent of Population that is Catholic in 1980	La Porta et al. (1999)

Table 3: Variable Definitions

	All Cities		Finalist Cities		Host Cities	
	Mean	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**
Dependent Variables						
Population (000s)	1,349	*2,168*	4,539	*5,117*	6,286	*7,246*
Real GDP per capita	4,350	*7,018*	10,122	*9,482*	9,652	*8,961*
Openness	32.91	*26.40*	30.55	*25.73*	27.07	*17.53*
Percent Urban	6.57	*12.53*	14.47	*13.29*	20.59	*15.10*
Independent Variables						
Percent Total	3.32	*7.71*	9.76	*8.67*	13.15	*8.73*
Language Fractionalization	0.32	*0.29*	0.25	*0.19*	0.23	*0.17*
Corruption Perception Index	1.18	*13.55*	6.60	*15.41*	2.50	*18.47*
Economic Freedom Index	59.0	*55.3*	78.3	*46.4*	79.0	*41.7*
Human Development Index	0.62	*0.19*	0.83	*0.09*	0.83	*0.09*
Population Growth Rate	0.15	*0.39*	0.19	*0.97*	0.24	*1.17*
Economic Growth Rate	0.39	*0.38*	0.30	*0.33*	0.32	*0.34*
Percentage Muslim	12.75	*26.40*	3.43	*16.07*	0.55	*1.50*
Percentage Catholic	25.05	*35.05*	41.46	*31.50*	40.35	*33.45*
N =	25,848		2,019		637	

Table 4: Urban Area and Country Summary Statistics 1950-2005

	All Cities	Finalist Cities Only
Percent Total	0.0395***	0.0497**
	(3.80)	(2.26)
Language Fractionalization	0.924	-0.397
	(1.41)	(-0.40)
Corruption Perception Index	-0.0079	-0.0116
	(-0.84)	(-0.89)
Economic Freedom Index	0.0034	0.0006
	(1.14)	(0.14)
Human Development Index	3.206**	4.947
	(2.20)	(1.70)
Population Growth Rate	0.910	7.706***
	(1.06)	(3.01)
Economic Growth Rate	0.545	1.101
	(1.83)	(1.22)
Percentage Muslim	-0.435**	-0.236
	(-2.12)	(-0.69)
Percentage Catholic	-0.0054	-0.0066
	(-1.34)	(-1.01)
Intercept	-5.851***	-7.032**
	(-4.09)	(-2.49)
R^2	0.27	0.25
N	6,204	324

Note: Dependent variable is an indicator for host city. Both regressions include only cities for years that correspond to the year before an Olympiad and column headers indicate the set of possible control group cities. *** significant at 0.01, ** significant at 0.05

Table 5: Propensity Score Regression

Table 6: Regressions with Population Variables

	(1)	(2)	(3)	(4)
Dep Var	Population	Population	Population	Population
Model	*OLS - all cities*	*PSM - all cities*	*Host/Finalists*	*PSM - Finalists*
Olympic Host City Indicator	2971.7***	3625.5	996.8	1194.1
	(6.19)	(1.54)	(0.66)	(0.33)
Post-Olympic Time Period Indicator		14218.0***	-1038.5	4279.4
		(2.62)	(-0.94)	(1.37)
Olympic Host City * Post-Olympic Time Period	4494.4***	-9456.8	3002.2	1511.3
	(7.79)	(-1.78)	(1.08)	(0.72)
Intercept	620.4***	-2665.7	2807.7**	-1342.1
	(10.82)	(-0.69)	(2.15)	(-0.33)
R^2	0.201	0.624	0.365	0.524
N	25,848	1,258	2,019	1,258
Fixed Effects	Year	Year	Year	Year
		Matching Group	Olympiad	Matching Group

	(1)	(2)	(3)	(4)
Dep Var	Percent Urban	Percent Urban	Percent Urban	Percent Urban
Model	*OLS - all cities*	*PSM - all cities*	*Host/Finalists*	*PSM - Finalists*
Olympic Host City Indicator	16.43***	0.234	11.65**	7.472
	(2.64)	(0.04)	(1.97)	(1.13)
Post-Olympic Time Period Indicator		33.43**	2.217	7.048
		(2.01)	(1.23)	(1.25)
Olympic Host City * Post-Olympic Time Period	-4.384	-30.23	-7.542	-8.937
	(-0.69)	(-1.82)	(-1.42)	(-1.47)
Intercept	6.331***	26.67***	7.604	14.32
	(8.66)	(2.71)	(1.24)	(1.84)
R^2	0.0344	0.759	0.518	0.613
N	25,848	1,258	2,019	1,258
Fixed Effects	Year	Year	Year	Year
		Matching Group	Olympiad	Matching Group

Note: Matching Group fixed effects indicate a matched host and control city using the propensity score matching procedure outlined earlier. *bootstrapped t-statistics clustered at the city level in parentheses.*
*** significant at .01, ** significant at 0.05

Table 7: Regressions with Non-Population Variables

	(1)	(2)	(3)	(4)
Dep Var	Real GDP per capita ($)	Real GDP per capita ($)	Real GDP per capita ($)	Real GDP per capita ($)
Model	*OLS - all cities*	*PSM - all cities*	*Host/Finalists*	*PSM - Finalists*
Olympic Host City Indicator	3039.7***	345.3	258.1	869.6
	(3.28)	(0.18)	(0.19)	(0.42)
Post Olympic Time Period Indicator		-4747.6	2776.6**	1499.0
		(-1.39)	(2.37)	(0.81)
Olympic Host City * Post Olympic Time Period	4865.4***	6221.0	-1734.7	-157.1
	(3.30)	(1.91)	(-1.01)	(-0.07)
Intercept	631.9***	1065.0	2077.0	367.8
	(10.93)	(0.37)	(1.68)	(0.17)
R^2	0.299	0.812	0.839	0.835
N	25,848	1,258	2,019	1,258
Fixed Effects	Year	Year	Year	Year
		Matching Group	Olympiad	Matching Group

	(1)	(2)	(3)	(4)
Dep Var	Openness	Openness	Openness	Openness
Model	*OLS - all cities*	*PSM - all cities*	*Host/Finalists*	*PSM - Finalists*
Olympic Host City Indicator	-8.156***	-10.49	-5.938	-11.96
	(-2.80)	(-1.65)	(-1.04)	(-0.98)
Post Olympic Time Period Indicator		-31.07**	10.94	9.103
		(-2.12)	(1.42)	(0.79)
Olympic Host City * Post Olympic Time Period	3.964	34.09**	-3.113	-6.801
	(1.21)	(2.28)	(-0.35)	(-0.67)
Intercept	23.30***	26.72***	-2.546	15.36
	(20.14)	(3.79)	(-0.45)	(1.12)
R^2	0.169	0.783	0.559	0.566
N	25,848	1,258	2,019	1,258
Fixed Effects	Year	Year	Year	Year
		Matching Group	Olympiad	Matching Group

Note: Matching Group fixed effects indicate a matched host and control city using the propensity score matching procedure outlined earlier.
bootstrapped t-statistics clustered at the city level in parentheses.
*** significant at .01, ** significant at 0.05

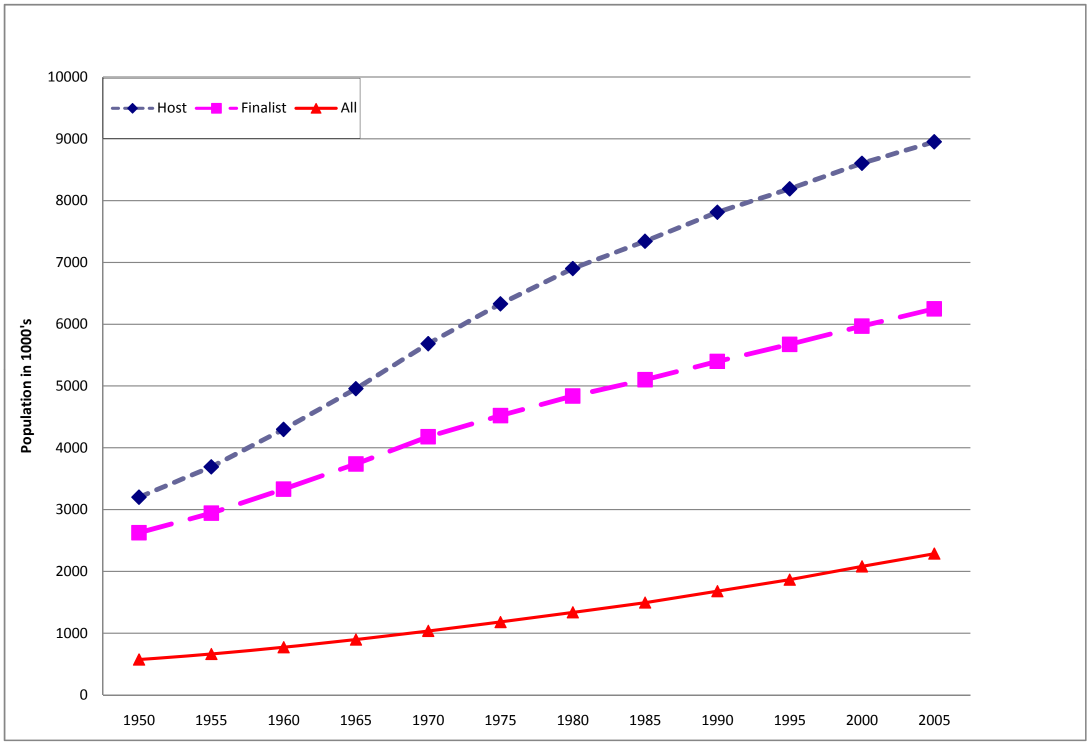

Figure 1: Total Population 1950-2005

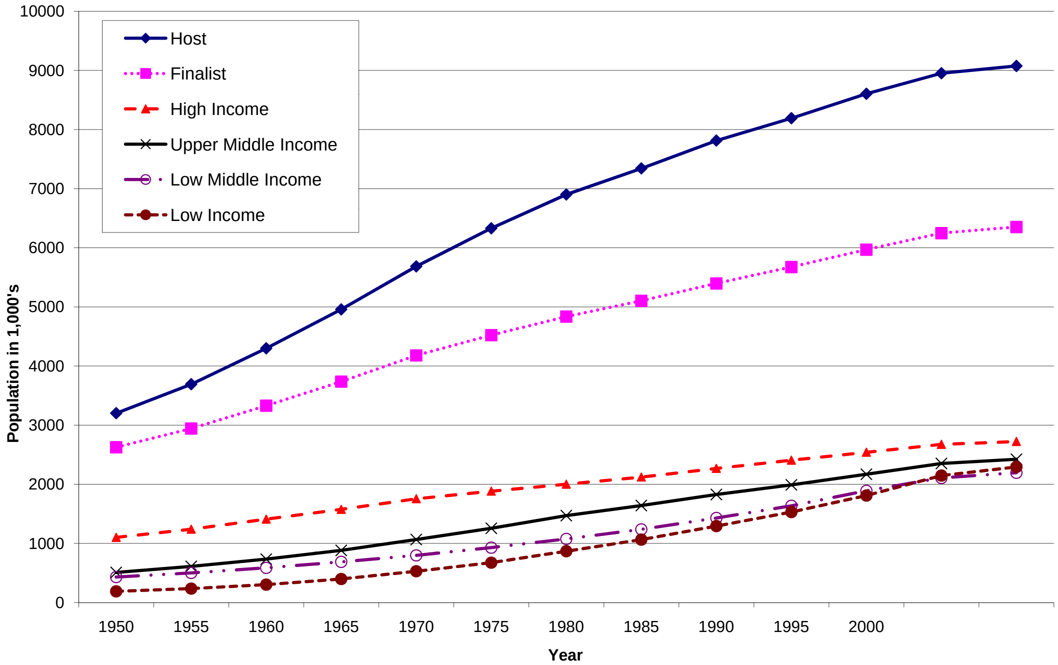

Figure 2: Total Population by Income Groups 1950-2005

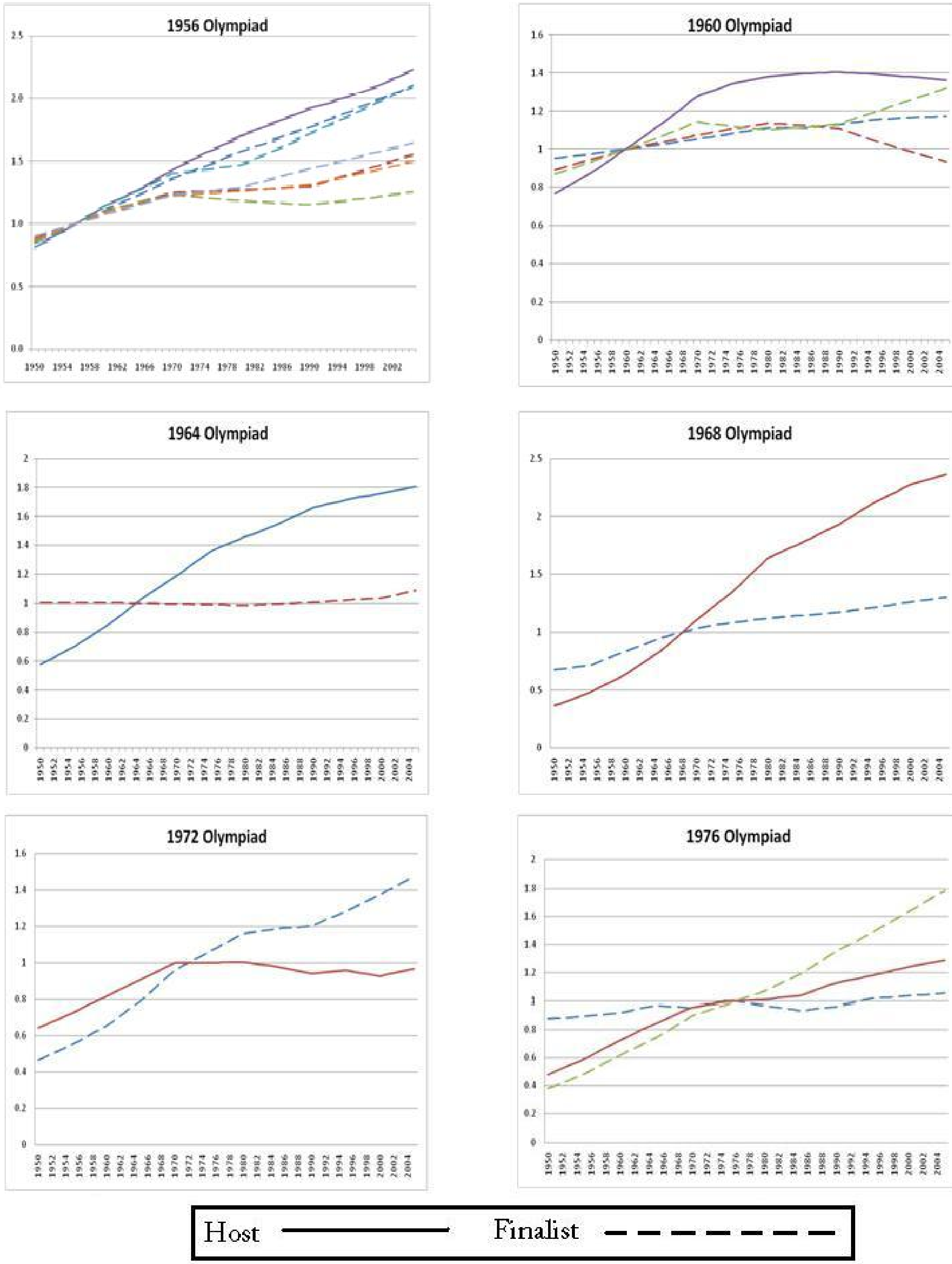

Figure 3: Relative Population Trends for each Olympiad 1950-2005

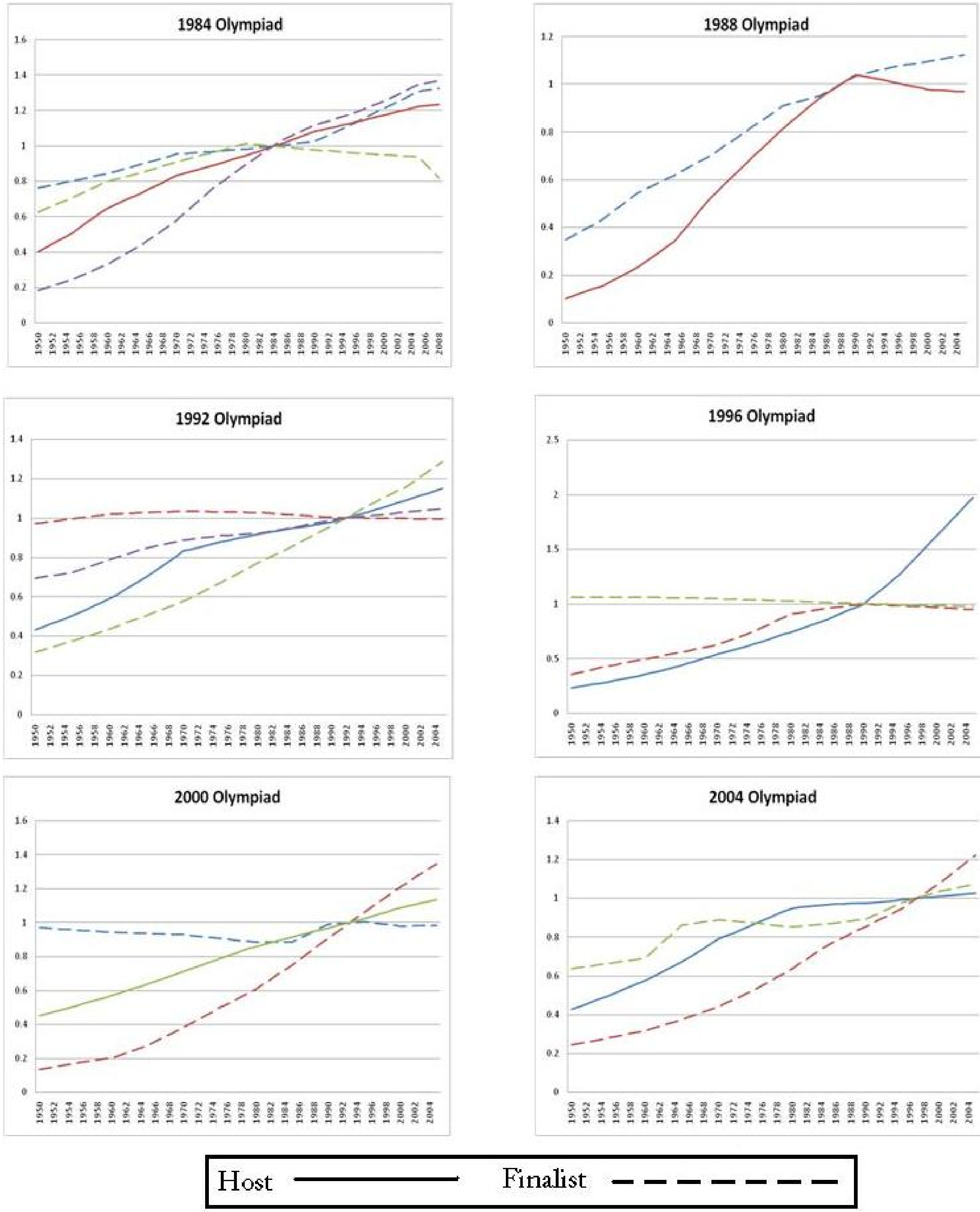

Figure 4: Relative Population Trends for each Olympiad 1950-2005 cont.

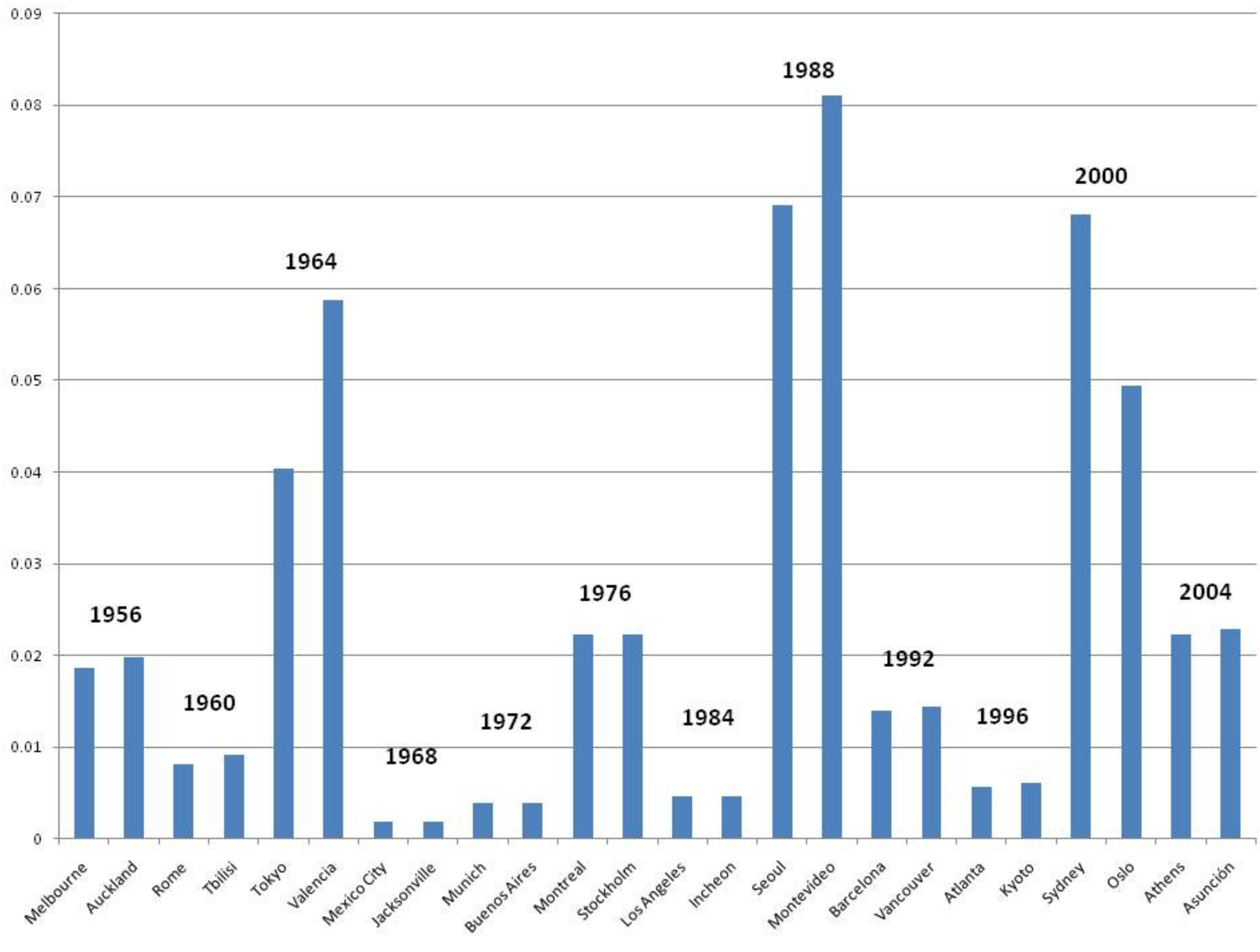

Figure 5: Matched Propensity Scores for All Cities Control Group

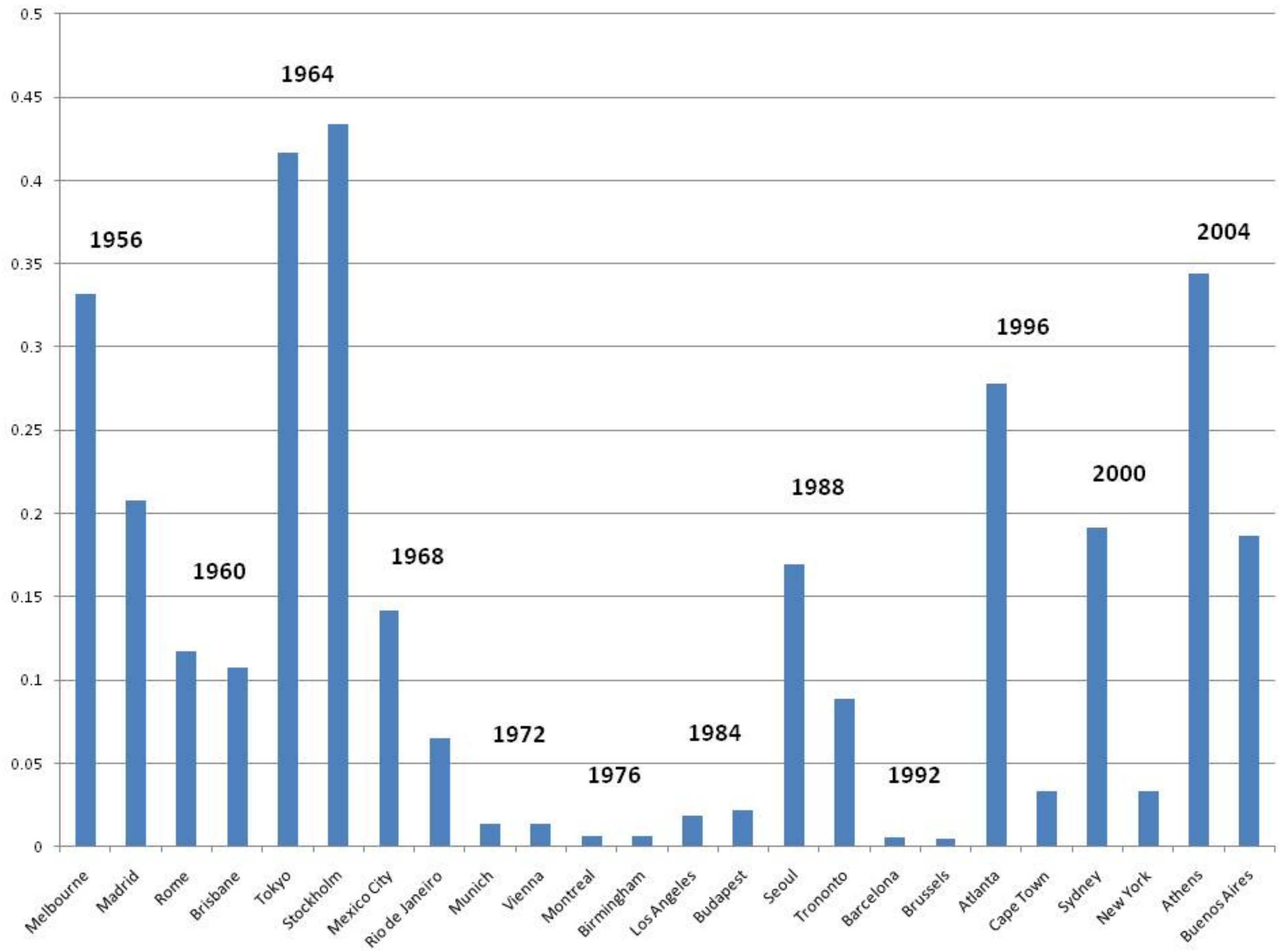

Figure 6: Matched Propensity Scores for Finalist Cities Control Group