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Keywords: Olympic Games, Mega Events, Public Infrastructure, Regional Development, Causal Effects, Sports Economics;

JEL Classification: H54, O18, R11, R53, R58, Z28, Z38;

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"If one wishes to know the true economic impact of an event, take whatever numbers the promoters are touting and move the decimal point one place to the left."

— Baade and Matheson (2016, p. 207)

1 Introduction

Preparing and hosting Olympic Games is a costly endeavor. Billions of dollars are invested in Olympic sports venues, general infrastructure and the organization of the event. To justify the use of substantial amounts of public funds, advocating policy makers put forward the argument of a high indirect profitability and positive long-term effects on the economy and population. Academic ex-post studies on the effects of hosting Olympics in turn tend to find impacts near zero or a fraction of ex-ante predictions (see a survey by Baade and Matheson, 2016). Papers estimating the effects across events based on counterfactual methods are inconclusive overall, but those using more careful identification strategies have not found significant effects on national economic outcomes of host countries or population size of host cities.

However, little is known about the nature and extent of the local economic effects for the Olympic host regions. Existing case studies on individual Olympic Games (Jasmand and Maennig, 2008; Hotchkiss et al., 2015, among others) have focused on different outcome variables and periods of effect, and draw different conclusions on the sign and size of the effects (Baade and Matheson, 2016). While the related literature on mega-events casts doubt on both event-induced long-run tourism effects (e.g. Fourie and Santana-Gallego, 2011) and an economic legacy of the sports facilities constructed (e.g. Coates and Humphreys, 2008), a growing body of literature has highlighted the positive regional economic effects of investments in transportation infrastructure (see Duranton and Turner, 2012; Ghani et al., 2016; Donaldson, 2018, among others, and Bröcker et al., 2019 for a recent survey). Although this literature is not directly related to mega-events, the findings are crucial as the renewal of general and transportation infrastructure typically accounts for a large portion of investments in the course of Olympic Games (Baade and Matheson, 2016; Short, 2018).

Against this background, this paper is the first to systematically analyze the economic effects of Olympic Games at the regional level. The results and conclusions drawn inform policy makers and the public on the expected total effects on regional development that arise from the different channels of action in the course of preparing and hosting Olympic Games. Specifically, we focus on effects on regional GDP per capita as a measure of regional economic prosperity. This allows an assessment of the expected benefits for the public, which usually bears substantial parts of the expenditures. We argue that national economic outcomes – on which related econometric papers have focused – are not feasible to study economic effects of mega events such as Olympic Games for several reasons:

First, regions compete for public resources. Benefits from public investments in the infrastructure of an Olympic host region may come at the expense of other regions of the country when Olympic Games have impeded public investment otherwise made in the latter regions. Similarly, also other expenditures made in the host region related to Olympic Games (firm investments; local, national and international visitors) could have otherwise been spent in other regions of the country. In addition, positive signaling effects through international media attention related to an Olympic event are mainly focused on the host region rather than the whole country. Thus, even if being a zero-sum game at the country level, the local economy may still benefit from Olympic Games.

Second, Olympic host countries are typically large economies. Even if the effects on the host region exceed any potential adverse effects on other regions in the country, the total effects are likely to be too small relative to the national economy to show up in broad aggregated national indicators (Scheu and Preuss, 2017). The 2002 Winter Olympics in Saltlake City (Utah) and the 1996 Summer Olympics in

Atlanta (Georgia) provide illustrative examples: Utah's share in US GDP amounted to 0.6% in 1995, the year of the election of the 2002 Olympics; Georgia's share in national GDP was at 2.5% by the time of the election of the 1996 Olympics. Similar proportions apply to the Russian and Korean regions Krasnodar and Gangwon hosting the Sochi 2014 and the Pyoengchang 2018 Winter Olympics.[1] This illustrates that only rather high average regional effects will eventually exhibit statistically measurable effects on national economic outcomes. In addition, Olympic host countries have differed substantially in size. To increase national GDP by 0.1%, Olympic Games are required to generate additional economic activities of around 20 billion USD in the United States but only of roughly 0.2 billion USD in Greece. Using international geocode standards for referencing the regional subdivisions of countries provides economic units that are much more homogeneous in size than the country level.[2]

These arguments, the absence of comprehensive time series on economic variables at the city level, and the fact that sports venues[3], general infrastructure investments and input-output-linkages spread far beyond the limits of host cities, make the regional level as a 'meso' level between the spatial macro (country) and micro (city) level the most plausible level of analysis of the economic effects of Olympic Games.

The results of the present paper show significant positive effects for hosting Summer Olympics on regional GDP per capita. While the more conservative estimates only confirm such effects for the year of the event and the year before, there is also evidence for positive longer-run effects in the post-event period in other specifications. Winter Olympics, in turn, do not show any positive effects on per capita GDP

[1]The median (mean) share of host regions (as defined in Section 3.1) of the Olympic Games included in the present analysis in national GDP is at 12% (22%).

[2]The regional level analyzed in this paper mainly corresponds to the EU NUTS 1 level (major socio-economic regions) in European countries and to the OECD TL 2 level (large regions) in Non-European countries (see Section 3.1 for details).

[3]See Jasmand and Maennig (2008) and Hotchkiss et al. (2015) for illustrative examples for the geographical dispersion of Olympic sports venues.

of host regions. If anything, the results on the latter rather point towards temporal declines in the years around the event. These differences can be explained by the smaller scale and commercial value of Winter Games and by arguments provided by the New Economic Geography literature. Pre-treatment trends evaluations and a number of robustness checks suggest that the results obtained can be interpreted as causal.

2 Related Literature and Conceptual Background

In recent decades, direct and indirect expenditures for hosting an Olympic event have amounted to sums of one- to two-digit billions of dollars. However, for a number of recent Olympics, official numbers on direct, indirect and/or total costs as well as public contributions do not even exist (Baade and Matheson, 2016; Short, 2018). In most instances, costs directly related to the event (sports venues and other Olympic infrastructure, management, etc.) are only a fraction of indirect costs (investments in transportation and other general infrastructure and amenities). The academic literature finds little evidence for economic benefits from Olympic sports infrastructure (Coates and Humphreys, 2008; Baade and Matheson, 2016). Moreover, there are typically no substantial long-run effects on tourism (Fourie and Santana-Gallego, 2011; Baade and Matheson, 2016) or on intangible assets such as athletic success (Contreras and Corvalan, 2014) or increased well-being (Dolan et al., 2019). However, economic theory as well as a growing body of empirical literature have highlighted the potential positive regional effects of infrastructure investments, especially with respect to transportation infrastructure (Banerjee et al., 2012; Duranton and Turner, 2012; Faber, 2014; Ahlfeldt and Feddersen, 2018; Donaldson, 2018; Gibbons et al., 2019, among others).

Numerous studies have evaluated the costs and benefits of individual Olympic Games on an ex-ante or ex-post basis. In their survey Baade and Matheson (2016) conclude that the economic impacts found ex-post are either near-zero or a fraction of those predicted by ex-ante studies. Related to the methodological framework of the present paper, several recent papers have used Difference-in-differences (DD) approaches to systematically study the effects across Olympics.

Analyzing 16 Summer Olympic Games, Rose and Spiegel (2011) find that being awarded with Summer Olympics leads to a permanent increase in national exports by as much as 20%. Finding similar impacts for unsuccessful bidding countries, the authors conclude that the effects are caused by the signaling effect from bidding rather than by the actual event. However, as illustrated by Maennig and Richter (2012), the results are driven by a selection bias resulting from a comparison of structurally different and nonmatching groups of countries. Based on the Rose and Spiegel (2011) data, Maennig and Richter (2012) illustrate that using propensity score matching, the significant effect on trade vanishes.[4]

Billings and Holladay (2012) analyze the long-run effects of 12 Summer Olympic Games on host city population size. To control for the self-selection of cities into the Olympic bidding process, the authors match host cities with unsuccessful finalist bidding cities. They neither find significant effects on the population of host cities nor on the proportion of host cities in countries' total urban population. In addition, they find only insignificant effects for economic indicators at the country level (GDP per capita, trade openness). In a similar approach, Nitsch and Wendland (2017) use a panel of one and a half centuries to study the effects on population size of host cities based on all Summer Olympics since Athens 1896. The authors conclude that the long-run effects on host city population are insignificant or even negative.

Following the news shock literature, Brückner and Pappa (2015) study the effect of news about Olympic host city application and election on countries' macroeconomic developments. For 30 Summer and Winter Olympics they find that invest-

[4]In addition, Bista (2017) shows that the OLS results in Rose and Spiegel (2011) do not hold if proper methodology commonly used by the trade literature (Poisson pseudo-maximum likelihood estimator) is applied.

ment, consumption and output significantly increase 9 to 7 years before the event in bidding countries and again 5 to 2 years before the Games in hosting countries. They interpret these findings as evidence for news about Olympic bids serving as signals for increases in government investments. However, in a reply Langer et al. (2018) illustrate that controlling for a number of key growth determinants not included by Brückner and Pappa (2015) and restricting the control group to a set of structurally similar countries eliminates all significant effects.

The related literature typically does not find significant local or regional effects of events and sports facilities for other large one-shot events such as FIFA World Cups (Baade and Matheson, 2004; Pfeifer et al., 2018), annually recurring events such as Formula 1 (Storm et al., 2019), or professional league sports (Siegfried and Zimbalist, 2000; Coates and Humphreys, 2003). Pfeifer et al. (2018) evaluate the infrastructure investment for the 2010 FIFA World Cup in South Africa at a highly disaggregated spatial scale using satellite images. They find large and persistent positive effects on employment and positive economic net benefits originating from investment in transportation infrastructure, especially in small, less populous and less developed locations. Investments in sports facilities in turn only exhibit short-run effects during the construction period that is related to the creation of temporary jobs.

Overall, previous papers on Olympic Games have illustrated that the results are sensitive to the construction of the counterfactual for Olympic hosts. Thus, to correctly identify the regional economic effects of an Olympic event, the control group has to be restricted to regions with similar revealed expectations and capacities about hosting the event, i.e. regions that have shown efforts to host the same event. Despite the fact that several previous papers based their identification strategies on a careful selection of the control group, several caveats of the approaches chosen are worth to be noted that the present paper seeks to address.

A crucial issue is the definition of the treatment period, as illustrated in Figure 1 in a stylized fashion. In comparison to other applicant regions, treatment of Olympic host regions starts after the the election ($T1$ in year τ_0) as a host city. In comparison to any other region, this treatment would already start with the application announcement because the application may already have a signaling effect (Rose and Spiegel, 2011; Brückner and Pappa, 2015). As investment in Olympic and general infrastructure takes place during the (typically) seven year period between host city election and the actual Olympic event, investment-induced demand effects may occur already in the course of this period. Similarly, the signal of being selected as a host city may induce increases in consumption, trade, FDI or tourism already before the event. As the event approaches, international media attention increases. This attention culminates in the year of the event, implying that the period after the event (taking place in $\tau_{\geq 7}$) can be characterized as the period in which potential event-induced effects take place ($T2$). In addition, prior infrastructure investments may exhibit (long-run) supply effects in T2.

[Figure 1 about here.]

While being subject to methodological shortcomings, results in Rose and Spiegel (2011) and Brückner and Pappa (2015) point towards a pattern of growing effects after the election that increase towards the year of the event. In contrast, Billings and Holladay (2012), Maennig and Richter (2012) and Nitsch and Wendland (2017) exclusively focus on event-induced effects and include the investment period between τ_0 and τ_7 in the pre-treatment period. Effects already occurring between the election and the event will thus bias the parameters estimated for the post-event period in these papers. Further, these papers only estimate a single parameter for the post-event period. This means that any temporary effects in the post-event period remain invisible. As the post-event period lasts several decades for the earlier Olympics included in these papers, their econometric framework can only detect stable long-run effects. Thus, to account for non-linear effects with unknown lags and duration, dynamic effects for different phases after the election of host cities are modeled in the present paper. This allows conclusions to be drawn on the timing and longevity of any potential investment- and event-induced effects.

Since the 1980s, Olympic Games are typically associated with substantial regional transformation including the provision of new or the refurbishment of existing venues as well as large infrastructure investment (Short, 2018). In addition, also the commercial value of Olympic Games has increased dramatically since the 1980s with increasing global mass and social media coverage and the commercialization of the Olympic event. Previous papers mainly assumed similar effects for Olympic Games in the 2000s and 1950s (or even 1990s).[5] The present paper restricts the analysis to Olympic Games from the 1990s onwards. This ensures that policy conclusions are drawn from a set of Olympic events of comparable scale and commercial value as future events.[6]

The majority of previous papers studied Summer Olympic Games only, while Brückner and Pappa (2015) and Langer et al. (2018) pool Summer and Winter Games. Also focusing Summer Games, Rose and Spiegel (2011) note that they estimated both separate and combined Winter and Summer Olympic effects as a sensitivity analysis, with Winter Games not showing any significant effects. Different effects for Summer and Winter Olympics seem plausible as they differ in scale (Flyvbjerg et al., 2016), type of sports infrastructure, commercial value and international media outreach. Thus, while pooling Summer and Winter Olympics in some specifications, their heterogeneity is explicitly taken into account and effects are estimated separately for Summer and Winter Games in other specifications.

[5] Only Rose and Spiegel (2011) and Brückner and Pappa (2015) mention the analysis of subperiods as robustness checks.

[6] Truthfully, however, this choice is not only motivated by the lack of comparability with earlier events, but also related to limited availability of historic data on GDP at the regional level.

3 Data

3.1 Definition of Regions and Regional GDP per capita

The regional level of analysis is NUTS 1 for European countries.[7] In four countries included (Czech Republic, Finland, Norway, Slovakia) the NUTS 1 level is identical to the country (NUTS 0) level. In these instances aggregated NUTS 2 regions (consisting of the NUTS 2 region of the host city and the adjacent NUTS 2 regions) instead of NUTS 1 are used to enhance the comparability of regions with respect to population size. For Non-European countries the OECD territorial level of large regions (TL 2) is used.[8] On the one hand the choice of this spatial level is driven by much better data availability among Non-EU countries. On the other hand it is also likely to better reflect the regional economic interlinkages relevant for Olympic Games (investment, local value chains, improvements in inter-regional infrastructure, tourist travel patterns) and the geographic dispersion of Olympic sports venues (see Jasmand and Maennig, 2008; Hotchkiss et al., 2015) than the small scaled NUTS 2 or OECD TL 3 level.

Table 1 illustrates the size of the regions in the sample in terms of population. Despite the standardization of the spatial scale to comparable international levels, regions still vary substantially in size: The mean population of Olympic Summer (Winter) Games host regions is at 12.5 (6.0) million inhabitants, with a standard deviation of 10.9 (4.6) million. The control group of unsuccessful applicant regions

[7] Nomenclature of Territorial Units for Statistics (NUTS) is a geocode standard for referencing the administrative divisions of countries for statistical purposes in the EU. NUTS 1 is the largest level below the country level (major socio-economic regions). This corresponds, for instance, to the level of German *Bundesländer*, or to the *Statistical Regions* of England. NUTS 2 corresponds, for instance, to the level of German *Regierungsbezirke*, French *Régions* or Italian *Regioni*.

[8] For the case of the United States, for instance, this corresponds to the *Federal States*, for Japan to groups of typically 4-5 *Todōfuken (Prefectures)*. The smaller scale TL 3 level corresponds, for instance, to the level of *Economic Areas* defined by the United States Bureau of Economic Analysis, and to that of *Todōfuken*. Note that the OECD TL 2 level corresponds either to the NUTS 1 or the NUTS 2 level in European OECD countries. However, in Non-EU countries TL 2 regions are quite populous and correspond to NUTS 1 rather than NUTS 2 in population size. In addition, in the largest European countries Germany and the UK, TL 2 equals NUTS 1. See OECD (2018) for further details.

shows similar size and variation. They are slightly smaller on average but differences between hosts and applicants are statistically insignificant within both types of Olympic Games.

[Table 1 about here.]

GDP (per capita) is the only economic variable available at the regional level for an acceptable range of countries and years. Data is obtained mainly from two data sources. For EU-28 regions plus Norway mainly the Cambridge Econometrics (CE) European Regional Database is used.[9] This source provides annual data on real GDP for the 1980-2015 period for regions in the old EU member states and Norway, and the 1990-2015 period for regions in the new member states.[10] For Non-EU countries OECD regional data are used, available from around 1990 or 2000 to 2016 for most countries. OECD data are also used for European countries for 2016 as the CE data terminate in 2015. The OECD data also include regions of several additional (non-OECD) countries that have been bidding for Olympic Games covered by the sample (Brazil, China, Russia, South Africa, Turkey). OECD data are replaced by longer time series available from the national statistical offices for the United States and Japan.[11] Both countries hosted Olympic Games (Atlanta 1996, Nagano 1998, Saltlake City 2002) for which the OECD data do not cover the pre-treatment period.[12] Given the otherwise occurring loss of three of only 15 Olympic Games to be analyzed, the use of alternative data sources in these instances seems justified. The combined data sources lead to an unbalanced panel of data for real GDP per capita from 1980 to 2016.

In constructing the dependent variable, we follow the approach by Billings and Holladay (2012) who use host city population as a share of the host country's urban population to study the population effects of Olympic Games on host cities.

[9] See `https://www.camecon.com/european-regional-data` for details.

[10] For East German regions data are available since 1991.

[11] See `https://apps.bea.gov/regional/downloadzip.cfm` and `https://www.esri.cao.go.jp/jp/sna/data/data_list/kenmin/files/files_kenmin.html`;

[12] The OECD regional data only cover the period 2001-2014 for Japan and 1997-2016 for the US.

Accordingly, to estimate the Olympic effects on regional economic development, we use the ratio of GDP per capita in region i relative to national GDP per capita of country c that region i belongs to:

$$pcGDP_{it} = \frac{pcGDPreg_{it}}{pcGDPnat_{ct}} \times 100. \quad (1)$$

This transformation helps to eliminate severe measurement errors resulting from substantial differences in national long-term growth as well as in national business cycles that determine regional developments to a large extent. Even within highly integrated economic areas such as the EU, national factors still explain the vast majority of regional growth (Webber et al., 2019). In addition, measurement errors resulting from the use of different data sources and numbers based on different systems of national accounts over time in some instances (see Section 4) are substantially reduced through equation (1) as statistical breaks in national time series data would only affect $pcGDP$ if changing the ratio of GDP per capita of i relative to c but not if shifting national levels. Using $pcGDP$ also eliminates challenges imposed by changes in exchange rates over time and data published in Euros (CE data) versus national currencies (OECD data). Given the results of the previous papers focusing on the country level, it seems fair to assume that effects of Olympic Games on $pcGDPnat_{ct}$ are either zero (in the absence of regional effects or in case of adverse effects on other regions of the same country) or too small to be detected (in case the sum of regional effects get lost in national aggregates). To check the robustness of the results with respect to the calculation of $pcGDP$, also the effects of Olympics on regional GDP per capita relative to other regions in the country (excluding focal region i when calculating $pcGDPnat_{ct}$) are estimated. In addition, we estimate the effects of Olympic Games on the regional share in national GDP rather than on GDP per capita to account for potential effects on $pcGDP$ induced by volatile regional population dynamics.

3.2 Olympic hosts and applicants

Bidding for the Olympics and host city election are public processes. Therefore, detailed data on bidding are publicly available through a number of different sources.[13] In the analysis, Olympic hosts are the group of treated regions. The group of control regions consists of unsuccessful candidate regions (i.e. bidding regions entering the final host city elections) and applicant regions not shortlisted by the IOC (i.e. applications not accepted by the IOC for the final elections).[14]

Table A1 in the appendix summarizes host and control regions (and their status) for all 15 Olympic Games (7 Summer Games and 8 Winter Games) included in the econometric analysis. The earliest events covered are the 1992 Olympics in Albertville and Barcelona. These events were elected in 1986. The latest event included are the 2020 Tokyo Summer Olympics elected in 2013. Later events are excluded because of a lack of sufficient data for the treatment period. In addition, the 2008 Summer Olympics in Bejing are excluded because of insufficient data on the host region for the pre-treatment period.[15] Further, a region is only included in the analysis as a control region if data on the pre-treatment period covers at least two years before the host city election. While the number of events covered is rather small, some of the previous papers on Olympic Games using DD estimates were based on similar numbers (Rose and Spiegel, 2011; Billings and Holladay, 2012; Maennig and Richter, 2012).

Table 2 illustrates *pcGDP* for the 15 host regions in the year of the election (τ_0) and the year of the Olympic event (τ_7). Regions nesting Summer (Winter) Olympics

[13]For details see, for instance, `https://gamesbids.com/eng/past-bid-results`.

[14]The latter regions need to be included to ensure consistency across Olympic Games because of a change in the IOC's bidding process. Prior to 1999 all applicant cities were considered candidate cities entering the host city election. Since 1999 cities are selected by the National Olympic Committees (NOC) and make a formal bid. At this stage they are official applicant cities. The IOC Executive Board then creates a shortlist of applicants to proceed to the final stage, i.e. candidate cities. See Short (2018) for details.

[15]OECD regional GDP data on China are available only for 2004-2013. The National Bureau of Statistics of China (NBS) provides regional GDP data only from 2000 onwards. In addition, a recent study (Chen et al., 2019) points out serious bias in local GDP data throughout China that has not been adequately corrected by NBS.

host cities typically have per capita GDP levels above (below) the national average as they are usually located in metropolitan areas (major cities of rural mountainous regions).[16] As Table 2 reveals, in 7 (5) Olympic regions *pcGDP* was higher (lower) in the year of the event, τ_7, than in the election year, τ_0, with an average increase of 3.8 percentage points. While decreases are moderate (between -0.2 and -3.4 %-points), increases amount to more than 15 %-points for the Athens 2004 and Sochi 2014 Olympics. In general, with Sydney 2000 as an exception, all regions with declining *pcGDP* hosted Winter Olympics.

[Table 2 about here.]

GDP (per capita) is extremely volatile in economies dominated by natural resources such as the petroleum and gas industry. Among the relevant bidding regions this is the case for the US region Alaska (candidate region for the 1992 and 1994 Winter Olympics) and for the Russian regions Krasnodar (2014 Winter Olympics host region) and St. Petersburg (candidate region for the 2012 Summer Olympics). While the former region is a large player this industry itself, the latter two are indirectly affected through the heavy influence of this industry on Russian national GDP through equation (1).[17] Therefore Alaska and St. Petersburg are excluded as control regions. In addition, also specifications are estimated without the Sochi 2014 Olympics to avoid bias resulting from strong influences on *pcGDP* in the Krasnodar region that may be induced by volatile petroleum and gas prices rather than the Olympics.

[16]Note that differences in *pcGDP* between hosts and applicants are statistically insignificant according to t-tests for both Winter and Summer Olympics.

[17]For instance, *pcGDP* drops from from 2.65 in τ_{-5} to 1.93 in τ_1 in Alaska, and from 2.57 in τ_{-1} to 2.82 in τ_0 in St. Petersburg. *pcGDP* is equal to 0.65 in the Krasnodar region in τ_{-5} before dropping to 0.53 in τ_{-2} and increasing back to 0.69 in τ_2.

4 Identification strategy and econometric model

As illustrated by Billings and Holladay (2012), Maennig and Richter (2012) and Langer et al. (2018), failure to account for the self-selection into the Olmypic bidding process leads to substantial selection bias in the empirical analysis. Therefore, the identification strategy in this paper is based on comparing Olympic hosts only with regions that also made significant efforts to host the same Olympic Games. Thus, the control group consists only of regions with comparable capacities and similar revealed expectations on the cost/benefit-ratio of staging such an event. This approach has been used in the context of Olympic Games before (Billings and Holladay, 2012; Contreras and Corvalan, 2014; Nitsch and Wendland, 2017).

While candidate and applicant regions are most closely related to the idea of using runners-up to construct counterfactuals (Greenstone and Moretti, 2003; Greenstone et al., 2010), losers of national bids prior to applicant nominations by the national Olympic committees, and regions withdrawing their application may be non-optimal control regions.[18] The former may be considered as inferior applicants, the latter may have revised their expectations about the costs and benefits of hosting Olympic Games during the application process. Therefore both groups are not considered as control regions in the main analysis but are included in some specifications of the sensitivity analysis.

Figure 2 illustrates the average developments in $pcGDP$ of Olympic hosts and applicants for all 15 Olympics (left panel) and separately for Summer and Winter Games (right panel) between between year τ_{-5} and τ_{12}. The vertical lines at τ_0 and τ_7 indicate the usual election year and the year of the event. For illustrative purposes $pcGDP$ is normalized to 100 in τ_0. As Figure 2 suggests, effects may already occur in the investment period between host city election and the event. It also suggests the existence of nonlinearities. The right panel further suggests substantial differences

[18] In the Olympics sample included only one application was withdrawn (Rome for the 2020 Olympics). Regions losing national bids are not official candidate regions. Prior national bids took place in several countries and Olympic Games (see Short, 2018).

in the effects for Summer and Winter Games in terms of size and longevity. This calls for separate analyses for the two groups of events.

[Figure 2 about here.]

Any effects in the course of the treatment are a priori unknown in timing, size and duration. For instance, investment effects may ease soon after newly built infrastructure is completed while long-run supply- or event-induced effects may only kick-in a few years after the event. Accounting for dynamic effects with unknown lags requires the econometric model to include separate treatment effects for each phase of the treatment process. Therefore, a generalized DD framework is used allowing the detection of dynamic, non-linear effects.

Year τ_0 is denoted as seven years prior to the year of the Olympic Games (τ_7). In the analysis τ_1 rather than τ_0 is regarded as the beginning of the treatment period for two reasons: First, Olympic hosts are typically – but not always – selected seven years before the event. Host cities for the 1992 Summer and Winter Olympics and the 1996 Summer Olympics were selected only six years before the event. Second, for the sample of Olympic Games included, IOC election sessions took place between June and October (and immediate effects on $pcGDP$ within only a few weeks after the election appear implausible). This means that τ_1 is the earliest year to be entirely after host city election while for τ_0 the pre-election phase covers large parts of or even the whole calender year.

Equation (2) describes the general econometric model used in the estimations.

$$pcGDP_{iot} = \alpha_i + \sum_{\substack{\tau=-5 \\ \tau\neq 0}}^{12} \beta_\tau Host_{io} \times Phase_{o\tau} + \sum_{\substack{\tau=-5 \\ \tau\neq 0}}^{12} \gamma_\tau Phase_{o\tau} + \delta_{ot} + X_{iot}^{'}\theta + \epsilon_{iot}, \tag{2}$$

where index i denotes region, o specific Olympic Games, and t year. $Host_{io}$ is a dummy variable equal to 1 if region i is host of one of the Olympic Games (o)

covered by the analysis and is zero otherwise. $Phase_{o\tau}$ is a dummy variable equal to 1 if region i is a host or applicant of Olympics o and the period equals τ. Thus, $\beta_{1\leq\tau<7}$ describe the lagged treatment effects in year τ after the election but before the event, and $\beta_{\tau\geq 7}$ those from the year of the event onwards. τ_0 is left out to identify $\beta_{\tau\neq 0}$. $\beta_{\tau<0}$ describes potential anticipatory (leading) effects prior to the election. They can be used to test the parallel trends assumption in the pre-treatment period and thus the causality of any post-treatment effects (Angrist and Pischke, 2009). Anticipatory effects can be plausible if Olympic host regions are compared to non-applicant regions because of a potential signaling effect associated with news about the application (Rose and Spiegel, 2011; Brückner and Pappa, 2015). However, such effects should not take place if only applicant regions are used as a control group.

In equation (2) α_i is a region fixed effect, γ_τ is a phase fixed effect and δ_{ot} is an individual fixed effect for each Olympic Games by year. X_{iot} contains additional controls (see two paragraphs below) and θ is the corresponding vector of parameters to be estimated. ϵ_{iot} is an error term that may be heteroskedastic and serially correlated within regions.

The inclusion of Olympic-year fixed effects has a few implications that are worth to be highlighted (for similar argumentation see Greenstone and Moretti, 2003). It guarantees that the β's are identified from comparisons within a set of winning-losing regions of specific Olympics o and not between different Olympic Games. This accounts for the fact that different types of regions have applied for different Olympic Games throughout the observation period. While earlier applicants mainly consisted of regions in OECD countries, in more recent Games more regions (hosting mega cities) from non-OECD countries have entered and won the Olympic bidding process. In addition, this ensures that we do not compare hosts and applicants of Olympics of different scales such as Summer and Winter Games or early and recent Olympics. Also, the β's and Olympics-year fixed effects can be separately identified because the Olympics (and their elections) take place in different years. Further, regions that were applicants several times can be included as control regions for each Olympics they applied for.

Despite the transformation of the dependent variable to a measure of relative regional to national GDP per capita as described in equation (1), the compilation of data still invokes a few potential challenges that need to be addressed to avoid potential bias from structural breaks: First, both US and Japanese time series available for the 1980-2016 period from national statistical offices include statistical breaks resulting from calculations based on different versions of the System of National Accounts (SNA). Second, the switch from CE to OECD data for European regions in the year 2016 also invokes a potential structural break. Third, the transformation of absolute to relative GDP p.c. generates a structural break for West German regions after the German reunification. To account for each of these (potential) breaks, matrix X consists of the following individual dummy variables, each equal to one (and zero otherwise) for: i) US regions prior to 1997; ii) Japanese regions prior to 1996; iii) Japanese regions after 2005; iv) European regions and the year 2016 (if OECD data are available for 2016); v) all West German regions after 1990;

The sample is restricted to observations between $\tau = -5$ (five years before the election) and $\tau = 12$ (five years after the event). As illustrated in Table 3, this ensures that the sample contains a reasonable minimum number of host and control regions for each phase τ as well as a symmetric number of (six) years pre-election (including the election year), post-election/before-event, and post-event (including the year of the event). This results in a 18-year time span for each Olympic tournament.

[Table 3 about here.]

The general model in equation (2) is used to assess the dynamics of potential economic effects of Olympics on $pcGDP$ as well as to test the pre-trends. However, this model cannot test the post-treatment effects efficiently. Imposing the common trend assumption, the causal treatment effects are thus estimated using a semi-dynamic model without lead effects in a second step. In this model all β's are restricted to zero for $\tau_{\leq 0}$. To account for potential heterogeneity in the effects of Summer and Winter Olympics, the sample is split into Summer and Winter Games in some of the specifications.

Special attention should be paid to the fact that the number of (treated) regions, i.e. clusters, is moderate – though clusters are very homogeneous in size. This is particularly relevant when estimating separate effects for Summer and Winter Games. In such instances t-statistics based on cluster-robust standard errors can lead to severe over-rejection of the null hypothesis (Bertrand et al., 2004; Cameron et al., 2008). Therefore, rather than using a cluster-robust variance estimator, inference is based on the wild cluster bootstrap (Cameron et al., 2008) using the Stata package 'boottest' by Roodman et al. (2019). As illustrated by Cameron et al. (2008), this procedure does well even if the number of clusters is very small. As a robustness check, we also follow an alternative approach suggested by Bertrand et al. (2004) to avoid over-rejection of the null hypothesis in the presence of serially correlated outcomes and a small number of groups (clusters) in DD analysis, and collapse time series information to a pre-election, pre-event and post-event period.[19]

5 Results

5.1 Pre-trend testing and preliminary results

The key identifying assumption of common trends is tested for pre-trends using an econometric model of equation (2). Any statistical significances in the coefficients for $\tau_{\leq 0}$ point towards lead effects that would violate the common-trend assumption and a causal interpretation of the results. This fully dynamic model is only identified

[19] An alternative to using a DD framework would be the use of the synthetic control method (Abadie and Gardeazabal, 2003; Abadie et al., 2010). However, this method requires rather long time-series in the pre-treatment period for each event, which do not exist for a substantial share of the events included. In addition, it does not account for potential statistical breaks resulting from data from different systems of National Statistical Accounts during the treatment period. Therefore, we refrain from using the synthetic control method as an alternative approach.

if one lead term is dropped (τ_0).

[Figure 3 about here.]

Figure 3 illustrates the effects of Olympic Games on host regions' *pcGDP* estimated for each year $\tau_{\neq 0}$ before and after host city election. The estimates in panel (a) and (b) include Summer and Winter Olympics. Those in panel (c) and (d) limit the sample to Summer, those in (e) and (f) to Winter Olympics. Panels (b), (d) and (f) exclude Games (Athens 2004, Sochi 2014) with host regions regarded as outliers in post-treatment trends (see Table 2). Solid lines denote mean effects, dashed lines the 95% confidence intervals based on the wild cluster bootstrap (Cameron et al., 2008; Roodman et al., 2019) with the null hypothesis imposed and 9,999 replications. The two vertical lines at τ_0 and τ_7 mark the year of host city election (or the year before host city election in instances with 6 years between election and event) and the actual Olympic event. Table A2 in the appendix illustrates the corresponding estimates for the coefficients.

As Figure 3 reveals, the coefficients for $\tau_{\leq 0}$ are insignificant at the 5% level for all six specifications. Table A2 illustrates that this is also the case at the 10% level. In addition, F-tests (see also Table A2) reject any joint significance of lead effects in τ_{-5} to τ_{-1}, irrespective of whether Summer and Winter Games are estimated together or separated and of whether outliers are included or excluded. Figure 3 (a) to (d) points towards positive dynamics from around τ_3 onwards. However, as illustrated in (e) and (f) these dynamics seem to be mainly driven by Summer Olympics. The differences between Summer and Winter Games emphasize the importance of analyzing these two types of events separately. Figure 3 also illustrates that pre-trends – unlike treatment effects – are unaffected by the exclusion of the Athens 2004 and Sochi 2014 Olympics.

Tables A3 and A4 perform the same analysis using the regional share in national GDP (Table A3) and in national population (Table A4) rather than *pcGDP*. Pre-trends (coefficients for $\tau_{\leq 0}$) are again insignificant throughout all specifications for both of these variables determining $pcGDP$. For periods $\tau_{\geq 0}$ population dynamics are rather positive for regions hosting Summer as well as Winter Games (but only weakly significant in the short-run after the Olympic event). The dynamics for the share of host regions in national GDP is mainly positive for Summer Games host regions but not for hosts of Winter Games.

5.2 Main results

Thus, in order to evaluate the (lagged) regional effects of hosting Olympic Games efficiently, the coefficients for τ_{-5} to τ_0 can be restricted to zero. This restriction is supported by the results in Section 5.1and leads to a semi-dynamic model allowing for lagged effects only.

The main results for this model are illustrated in Table 4. Specifications (1) and (2) again include Summer and Winter, (3) and (4) only Summer, and (5) and (6) only Winter Olympics. Specifications with even numbers again exclude the two Olympic events (Athens 2004 and Sochi 2014) for which the host regions show the strongest positive change in $pcGDP$ between τ_0 and τ_7 (see Table 2). Excluding these outliers ensures that the results are not driven by factors not related to Olympics. Separating Summer and Winter Olympics makes sure that estimates are based on samples of comparable events. All specifications again contain regional, phase and year-Olympics fixed effects, as well as the additional controls discussed in Section 4.

[Table 4 about here.]

Specifications (1) illustrates significant positive effects of hosting Olympics on $pcGDP$ only for the year prior to the event (τ_6) of about 3.7 %-points. The remaining coefficients for all $\tau_{\geq 3}$ are positive but insignificant. The significance in τ_6 vanishes an positive coefficients shrink in size once the outliers Athens 2004 and Sochi 2014 are excluded in specification (2).

For the sample of Summer Games the effects are more pronounced, as illustrated in specifications (3) and (4). Hosting Summer Games significantly raises *pcGDP* in the year of the event (τ_7) and the year before (τ_6). The effects are significant at the 5% level in both specifications. In addition, specification (3) suggests sustained positive effects also in the years after the event, that are significant at the 10% level in years (τ_9) to (τ_{11}) and show coefficients of similar or even bigger size – although being insignificant – for the remaining years after the event. Excluding Athens 2004 reduces the size of the coefficients. However, also in this more conservative specification (4), hosting Summer Olympic Games significantly raises *pcGDP* by 3.3 and 3.6 %-points in τ_6 and τ_7. Effects for the years after the event are now insignificant but the coefficients are of similar size as those for τ_6 and τ_7. This indicates that the positive effects could be permanent at least in some instances.

Winter Olympics in turn do not cause any positive effect on *pcGDP* of host regions. Specifications (5) and (6) illustrate only insignificant coefficients. In addition, dynamics are rather negative than positive for τ_8 to τ_{10} in specification (5) and throughout τ_2 to τ_{11} in specification (6). Thus, if anything, hosting Winter Olympic Games seems to have a temporary negative effect on *pcGDP* in the years around the event. Given the smaller scale and commercial value of Winter Games, and the fact that they mainly take place in peripheral rather than core regions, the less favorable results for Winter Olympics are not particularly surprising (see Section 6 for a detailed discussion).

5.3 Robustness checks

In addition to testing different specifications and samples, and to calculating significance levels using the wild cluster bootstrap rather than cluster robust standard errors, comprehensive sensitivity analysis is performed to test the robustness of the results obtained in the previous section: First, the set of control regions is extended to increase the number of degrees of freedom. Second, regional GDP per capita relative to the remaining regions of the country (without the focal region) is used instead of regional GDP per capita relative to the national level (including the focal region). Third, placebo treatments are implemented. Fourth, estimations are presented that collapse time series information.

Extended set of control regions

A first set of robustness specifications replicates the analysis of Section 5.2 but extends the sample of control regions to applicant regions with withdrawn applications (one instance only) and to regions losing national bids prior to candidate nomination by the National Olympic Committee[20]. Details on the extended sample are provided in Table A1 in the appendix.

[Table 5 about here.]

As Table 5 reveals, the results obtained remain qualitatively unchanged to those in Section 5.2. In specification (1) again only the effect in τ_6 is significant and in specification (2) all coefficients are insignificant. In specifications (3) and (4) the effects increase in size but the estimates are more imprecise compared to the main results in Table 5.2: The effects estimated for τ_7 increase to 7.0 and 5.5 %-points in (3) and (4) and remain significant at the 5% level. Those for τ_6 also increase but are only significant at the 10% level in (3) and insignificant in (4). Similar to Section 5.2, the remaining coefficients are significant at the 10% level in (3) and become insignificant in (4). The coefficients for Winter Games remain unchanged in sign, size and insignificance in (5). The same applies to the majority of coefficients in (6). However, now the negative effects for τ_7 and τ_8 are significant at the 10% level: Hosting Winter Olympic Games reduces *pcGDP* by 2.3 (2.7) %-points in the year of (after) the event. Despite their partial insignificance, the coefficients for $\tau_{\geq 7}$ again indicate a longer lifetime for potential effects induced by Summer than by Winter Games.

[20] Regions losing national bids against regions elected as Olympic hosts are excluded from the extended group of control regions. Their inclusion would violate the stable unit treatment value assumption (SUTVA).

Different measure of relative GDP per capita

Through influencing national GDP per capita, regional GDP per capita of a focal region appears in the enumerator and in the denominator of $pcGDP$. Thus, the higher a region's share in national GDP, the stronger the influence of regional on national GDP per capita. In regions with high shares in national GDP, the effect of a change in regional GDP per capita on $pcGDP$ will thus be smaller than the same change in a region with a low share in national GDP. To check the robustness of the results with respect to the calculation of $pcGDP$, also the effects of Olympic Games are estimated on

$$\overline{pcGDP}_{it} = \frac{pcGDPreg_{it}}{(GDP_{ct} - GDP_{it})/(Population_{ct} - Population_{it})} \times 100. \qquad (3)$$

Subtracting GDP (the population) of region i from national GDP (population), $\overline{pcGDP}_{it}$ is a measure of GDP per capita relative to other regions in the country (exlcluding i) rather than relative to the national level (including i). Unlike $pcGDP_{it}$, $\overline{pcGDP}_{it}$ is not affected by changes in $pcGDPnat_{ct}$ due to changes in $pcGDPreg_{it}$.

Table 6 reports the effects of Olympic Games on $\overline{pcGDP}_{it}$ for the six main specifications. The results remain qualitatively unchanged in all specifications. Compared to the main results of Table 5.2, coefficients increase in size. Also standard errors increase, leading to a slight decline in significance levels in specifications (1), (3) and (4). However, the effects found for Summer Olympic Games and the periods τ_6 and τ_7 are still significant at the 5% and 10% level, respectively. In the prefered specification (4) for Summer Games, the increase in regional GDP per capita relative to the remaining regions of the host country amounts to 4.2 and 4.4 %-points in τ_6 and τ_7.

[Table 6 about here.]

Placebo treatments

As another test for the credibility of the results, placebo tests are run for specifications (1) to (6) of Section 5.2. Excluding the actual Olympics hosts from the analysis, for each of the Olympic Games the best runner-up region with data on *pcGDP* available is treated as the host region. In a few instances this order was changed for regions with multiple applications to ensure that a placebo host can be assigned to each Olympic event. As Table 7 reveals, all coefficients obtained using this placebo treatment are insignificant apart from τ_5 in specification (6). This supports the interpretation of the results obtained in Section 5.2 as causally related to being an Olympic host and not to signals sent by promising candidates. .

[Table 7 about here.]

Collapsed time series information

As an alternative solution to overrejection of the null hypothesis when using a cluster robust variance estimator in the presence of serially correlated outcomes and a small number of groups in DD analysis, Bertrand et al. (2004) suggest to collapse time series information into a "pre"- and a "post"-treatment period. Thus, to follow this approach and to match the characteristics of the treatment at hand, the panel is collapsed to three periods of six years: The "pre-election" period (τ_{-5} to τ_0), the "post-election" period (τ_1 to τ_6) and the "post-event" period (τ_7 to τ_{12}); For each of these collapsed periods, *pcGDP* is averaged over the years within this period. To identify the model, the pre-election period is left out, implying that leading effects are again assumed to be zero. Instead of individual phase fixed effects and year-Olympics fixed effects, aggregated phase and aggregated year-Olympic fixed effects are used for each period (where aggregated year is the median calender year for each aggregated period and Olympics).

The results are summarized in Table 8. They are in line with the main results presented in Section 5.2. The coefficients for the combined Summer and Winter

Olympics effects in specification (1) and (2) are insignificant for both post-periods. For Summer Games the post-event period is significant at the 10% level in (3) and at the 5% level in (4). According to (3) *pcGDP* of host regions is increased by 11.4 %-points relative to national *pcGDP* during the 5 years after the event (including the year of the event). In the more conservative specification (4) that excludes the Athens 2004 Olympics, this post-event effect amounts to an increase by 4.4 %-points. The effect for the post-election period is insignificant. Also in line with the main results, the effects for Winter Games are negative but statistically insignificant. This holds for specifications (5) and (6). Thus, the results for this modification support the hypothesis of sustained positive effects of Summer Olympic Games after the event as well as rather negative effects for Winter Games that are – if at all – temporary only.

[Table 8 about here.]

6 Discussion and Conclusions

This paper contributes to the literature by providing the first analysis of the causal economic effects of Olympic Games at the regional level. Recent papers have not found significant positive short- or long-run effects on national economic outcomes or long-run local population size. However, neither the national level (limited economic magnitude of the Olympic event compared to national economies and substantial heterogeneity in country size; possible adverse effects on other regions of the country) nor the city level (only population but no data on economic indicators available; spatial scale too narrow to grasp the area subject to economic activities directly or indirectly related to the Olympics) seem to be suited to study the average economic effects of hosting Olympics. The results for the regional level in this paper illustrate a number of interesting findings:

First, Olympic Summer and Winter Games have different effects on GDP per capita in host regions. Therefore, pooling Summer and Winter Games in analyzing the economic effects hides the true effects of each type of Olympic Games.

Second, Summer Olympic Games have at least temporary positive effects on host regions. In the most conservative estimation, regional per capita GDP significantly increases by 3.6 %-points relative to national per capita GDP in the year of the event and by 3.3 %-points in the year before, compared to the counterfactual of not hosting Olympic Games. The results for these two years are quite robust against a number of modifications made in the sensitivity analysis. While there is no robust statistical evidence for medium- or long-run effects after the event, results still point towards positive post-game effects. Despite their insignificance the coefficients estimated remain positive and rather large for each of the 5 years after the event. Further, collapsing individual years – as suggested by Bertrand et al. (2004) – to a post-election and a post-event period, yields a significant effect for the latter: On average, GDP per capita increases by 4.5 %-points in the year of the event and the following five years in this model.

Third, hosting Winter Olympic Games does not have any positive effects on regional GDP per capita. Conversely, the more conservative specifications even illustrate temporary negative effects for the years around the event: Per capita GDP decreases by around 2.3 and 2.7 %-points relative to the national level in the year of the event and the year after in the most pessimistic specification. All negative effects become insignificant in year 2 after the event at the latest. In contrast to the positive effects found for Summer Games, the negative results for Winter Games are less robust against the various modifications made in the sensitivity analysis.

The less favorable results for Winter than for Summer Games are not particularly surprising. Winter Games are of smaller scale in budget, number of participants, international media outreach, and thus in commercial value. Therefore, growth stimulating effects caused by investment as well as effects induced by the event itself can be expected to be of smaller scale. Further, as Winter Olympics take place during the typically rather short winter tourism peak season, host regions are more likely to suffer from capacity constraints and crowding-out than metropolitan Summer Olympics regions. As shown by Fourie and Santana-Gallego (2011), mega-events taking place during peak-season have no effect on tourist arrivals because of crowding-out.[21]

An additional interpretation for the absence of or even negative effects for Winter Games is provided by the New Economic Geography literature: They mostly take place not in core but peripheral regions (such as the Albertville, Lillehammer, Nagano, Pyeongchang, and Saltlake City Winter Olympics). Declining transportation costs due to investments in inter-regional transportation infrastructure for Olympic Games can cause further polarization between core and periphery (Krugman, 1991). The recent empirical literature on the effects of modern high-speed transportation infrastructure seems to support this hypothesis for countries such as China (Faber, 2014; Qin, 2017; Baum-Snow et al., 2018; Yu et al., 2019, among others), France (Charnoz et al., 2018) and Japan (Li and Xu, 2018).

In evaluating the positive effects found for Summer Games, not a zero-effects-scenario should serve as a benchmark. Ideally, the economic benefits estimated can be related to costs (per capita). However, data on (direct plus indirect) total costs of Olympics as well as on public spending are rare and where available, their reliability does not meet the standards of academic research (Baade and Matheson, 2016; Flyvbjerg et al., 2016; Short, 2018). Therefore, we refrain from calculating average net benefits. Still, existing empirical evidence on the economic effects of infrastructure investments can be used to evaluate the scale of the effects estimated in this paper: Several recent papers have revealed substantial impacts on regional GDP and employment with respect to upgrades in modern transportation infrastructure. Ahlfeldt and Feddersen (2018) estimate a causal increase of about 8.5%

[21] However, with a few positive exceptions (such as Barcelona and Saltlake City), long-run effects of Olympic Games on tourism have been rather limited in general (Fourie and Santana-Gallego, 2011; Baade and Matheson, 2016).

in regional GDP for counties with intermediate stops of a newly built German high-speed rail. Duranton and Turner (2012) conclude that a 10% increase in a U.S. city's stock of highways causes a 1%-5% increase in city employment over a 20 year period. Similarly, for Britain Gibbons et al. (2019) find that a 10% increase in accessibility causally increases local employment by 3%-5%. Therefore, as highlighted by Pfeifer et al. (2018), directly upgrading the general infrastructure and amenities of a city or region rather than taking the costly detour of additionally building large sports facilities with little subsequent economic benefits (Siegfried and Zimbalist, 2000; Coates and Humphreys, 2008), is likely to be a more efficient use of public resources.[22]

Of course, the present analysis and results have further limitations that need to be discussed. All effects estimated are based on a measure of *relative* regional to national GDP per capita levels. Thus, the increases (decreases) for Summer (Winter) Games are relative to national GDP per capita. As previous papers have illustrated, the effects of Olympic Games on national economic outcomes are statistically not different from zero. Therefore, we argue that the effects estimated can be interpreted as "*absolute*" because the effects on national GDP per capita can be plausibly assumed to be negligible.

The different results for Summer and Winter Olympics suggest substantial heterogeneity among the two types of events. According to the raw existing calculations (Baade and Matheson, 2016; Short, 2018), Olympic Games since the 1990s have varied substantially in direct and indirect costs also within the groups of Summer and Winter Olympics. The estimation of models based on the sums invested could also take into account this within-heterogeneity. However, as argued above, reliable and comparable data on total or public costs for hosting Olympic Games, as well as on direct costs and general infrastructure investments, do not exist.

[22] With respect to the benefits of large sports facilities, Ahlfeldt and Maennig (2010) and Ahlfeldt and Kavetsos (2014) suggest that unconventional and iconic architecture creates the highest positive externalities on surrounding neighborhoods.

The analysis cannot provide evidence for differences between regions in developed and developing countries due to a limited number of Olympic events in the latter. Further, even for EU and OECD countries, GDP (per capita) is the only economic indicator available at the regional level for an acceptable number of countries and years. Once sufficient time series become available at the regional level, it would be useful to expand the analysis to other economic, social and environmental outcomes.

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A Appendix

[Table A1 about here.]

[Table A2 about here.]

[Table A3 about here.]

[Table A4 about here.]

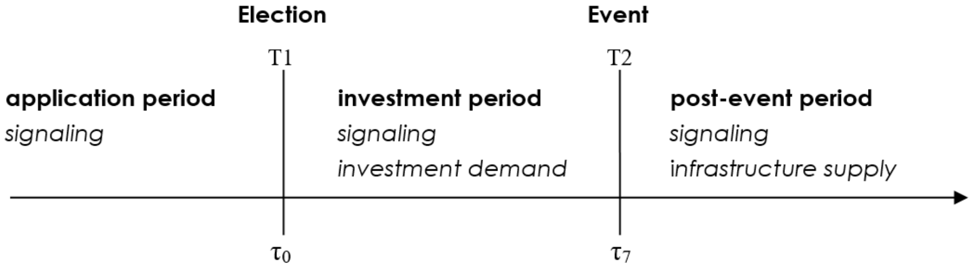
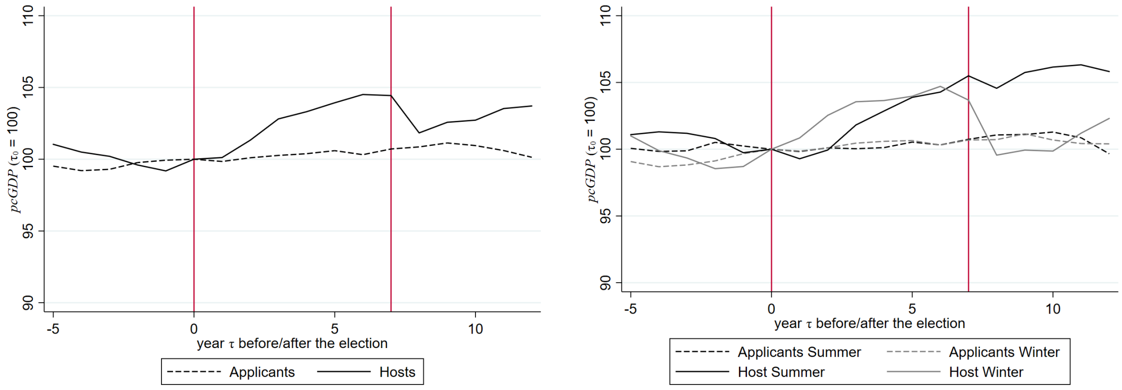


Figure 1: From host city application to event-induced effects

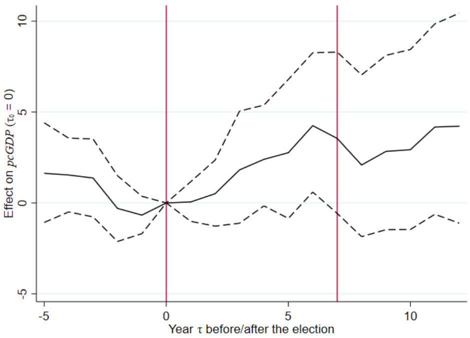


(a) All Olympics

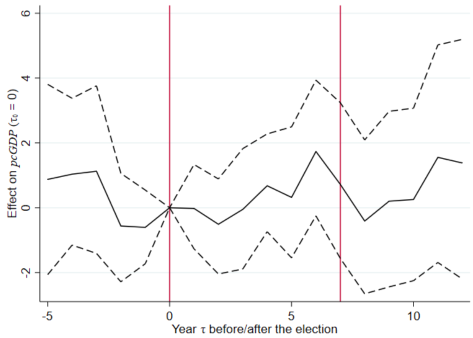
(b) Summer and Winter Olympics separated

Figure 2: Trends in $pcGDP$ ($\tau_0 = 100$)

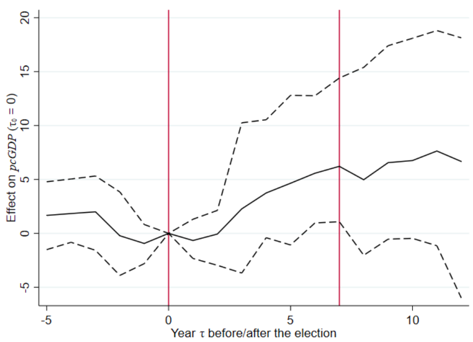
Note: Vertical lines in τ_0 and τ_7 indicate years of election and tournament.



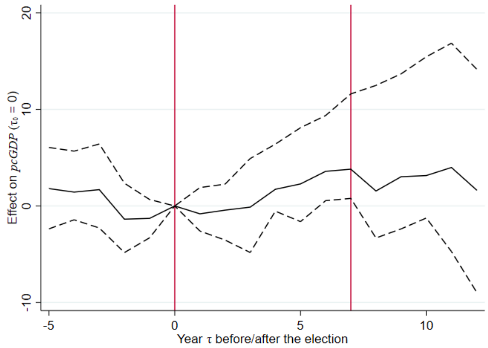
(a) All



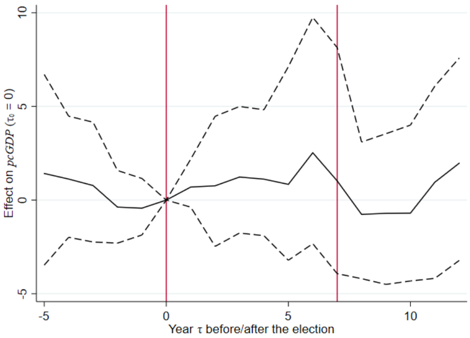
(b) All excl. Athens & Sochi



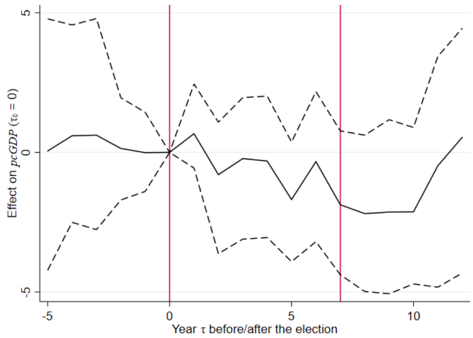
(c) Summer



(d) Summer excl. Athens



(e) Winter



(f) Winter excl. Sochi

Figure 3: Dynamic treatment effects on *pcGDP*

Note: Solid lines denote means, dashed lines denote 95% confidence intervals based on the wild cluster bootstrap with null imposed and 9,999 replications (Cameron et al., 2008; Roodman et al., 2019). Vertical lines in τ_0 and τ_7 indicate years of election and tournament.

Type	Regions	Mean	Std. Dev.	Min	Max
Summer Host	7	12.5	10.9	3.9	35.7
Summer Applicant	19	7.9	4.3	2.5	19.3
Winter Host	8	6.0	4.6	1.5	15.2
Winter Applicant	22	4.8	3.5	1.7	12.5

Table 1: Regional population (in million inhabitants)

Region hosting	*pcGDP* in year of Election ($\tau = 0$)	Event ($\tau = 7$)	Δ
	(national $pcGDP = 100$)		(in %-points)
Summer Games			
Barcelona 1992 (ES5)	108.7	111.7	3.0
Atlanta 1996 (US13)	95.4	101.9	6.5
Sydney 2000 (AU1)	106.5	106.2	-0.4
Athens 2004 (EL3)	114.9	130.3	15.4
London 2012 (UKI)	163.7	171.8	8.0
Rio 2016 (BR19)	145.5	n.a.	n.a.
Tokyo 2020 (JPD)	119.0	n.a.	n.a.
Winter Games			
Albertville 1992 (FR7)	99.1	97.7	-1.4
Lillehammer 1994 (NO02)	79.4	76.1	-3.4
Nagano 1998 (JPC)	94.5	94.3	-0.2
Saltlake City 2002 (US48)	84.5	86.2	1.7
Turin 2006 (ITC)	123.0	121.1	-1.9
Vancouver 2010 (CA59)	91.9	94.0	2.1
Sochi 2014 (RU32)	60.1	76.3	16.2
Pyeongchang 2018 (KR06)	81.3	n.a.	n.a.

For region codes and names see Table A1

Table 2: GDP per capita in Olympic host regions

Phase	Host	Candidate	Total
$\tau = -8$	10	46	56
$\tau = -7$	12	48	60
$\tau = -6$	12	48	60
$\tau = -5$	14	57	71
$\tau = -4$	14	57	71
$\tau = -3$	15	58	73
$\tau = -2$	15	59	74
$\tau = -1$	15	59	74
$\tau = 0$ (year of election)	15	59	74
$\tau = 1$	15	59	74
$\tau = 2$	15	58	73
$\tau = 3$	14	58	72
$\tau = 4$	14	56	70
$\tau = 5$	14	55	69
$\tau = 6$	13	54	67
$\tau = 7$ (year of event)	12	53	65
$\tau = 8$	11	47	58
$\tau = 9$	11	47	58
$\tau = 10$	11	43	54
$\tau = 11$	11	41	52
$\tau = 12$	10	32	42
$\tau = 13$	10	32	42
$\tau = 14$	9	28	37
$\tau = 15$	9	28	37

Table 3: Number of observations per period

	(1) All	(2) All	(3) Summer	(4) Summer	(5) Winter	(6) Winter
τ_1	−0.513	−0.310	−1.321	−1.100	0.275	0.438
	(0.803)	(0.905)	(0.933)	(1.054)	(1.208)	(1.373)
τ_2	−0.057	−0.796	−0.721	−0.717	0.344	−1.031
	(0.904)	(0.839)	(1.280)	(1.539)	(1.369)	(0.955)
τ_3	1.255	−0.336	1.621	−0.391	0.811	−0.455
	(1.320)	(1.008)	(2.423)	(2.029)	(1.383)	(1.000)
τ_4	1.836	0.393	3.094	1.455	0.699	−0.542
	(1.180)	(0.866)	(1.881)	(1.396)	(1.416)	(1.092)
τ_5	2.202	0.036	3.996	2.012	0.420	−1.921
	(1.554)	(1.012)	(2.301)	(1.713)	(2.106)	(1.106)
τ_6	3.690**	1.453	4.924**	3.317**	2.109	−0.563
	(1.559)	(1.036)	(2.022)	(1.641)	(2.301)	(1.007)
τ_7 (year of event)	2.992	0.440	5.572**	3.553**	0.608	−2.108
	(1.775)	(1.223)	(2.230)	(1.617)	(2.401)	(1.239)
τ_8	1.532	−0.689	4.337	1.309	−1.182	−2.426
	(1.900)	(1.316)	(3.051)	(2.399)	(1.585)	(1.359)
τ_9	2.281	−0.076	5.920*	2.790	−1.125	−2.369
	(2.073)	(1.468)	(3.147)	(2.444)	(1.718)	(1.517)
τ_{10}	2.373	−0.025	6.115*	2.909	−1.118	−2.362
	(2.166)	(1.529)	(3.288)	(2.534)	(1.852)	(1.565)
τ_{11}	3.621	1.275	7.001*	3.747	0.535	−0.709
	(2.290)	(1.824)	(3.498)	(3.209)	(2.240)	(1.996)
τ_{12}	3.669	1.104	6.043	1.432	1.552	0.308
	(2.474)	(1.938)	(4.330)	(3.791)	(2.370)	(2.108)
Regional f.e.	yes	yes	yes	yes	yes	yes
Phase f.e.	yes	yes	yes	yes	yes	yes
Year × Olympics f.e.	yes	yes	yes	yes	yes	yes
Additional controls	yes	yes	yes	yes	yes	yes
Games excluded		Athens, Sochi		Athens		Sochi
Observations	918	770	406	316	512	454
R^2	0.497	0.518	0.512	0.552	0.548	0.524
Adj. R^2	0.312	0.330	0.312	0.341	0.374	0.336

Table 4: Dynamic treatment effects on *pcGDP*

Note: Cluster robust standard errors in parentheses; p-values obtained using the wild cluster bootstrap with null imposed (Cameron et al., 2008; Roodman et al., 2019) based on 9,999 replications; * ($p < .1$), ** ($p < .05$), *** ($p < .01$);

	(1) All	(2) All	(3) Summer	(4) Summer	(5) Winter	(6) Winter
τ_1	−0.586	−0.404	−1.357	−1.142	0.205	0.351
	(0.800)	(0.898)	(1.035)	(1.166)	(1.150)	(1.306)
τ_2	0.024	−0.636	−0.611	−0.569	0.353	−0.959
	(0.992)	(1.007)	(1.543)	(1.808)	(1.276)	(0.879)
τ_3	1.309	−0.171	1.592	−0.277	0.858	−0.344
	(1.424)	(1.275)	(2.676)	(2.557)	(1.290)	(0.938)
τ_4	2.067	0.759	3.412	1.967	0.774	−0.400
	(1.226)	(1.095)	(2.023)	(1.894)	(1.323)	(1.034)
τ_5	2.420	0.410	4.577*	2.866	0.313	−2.011
	(1.512)	(1.210)	(2.037)	(1.642)	(2.024)	(0.977)
τ_6	4.004*	1.946	5.562*	4.216	1.911	−0.757
	(1.682)	(1.531)	(2.299)	(2.376)	(2.228)	(0.825)
τ_7 (year of event)	3.597	1.282	6.984**	5.474**	0.394	−2.320*
	(1.881)	(1.799)	(2.062)	(2.131)	(2.315)	(1.046)
τ_8	2.226	0.205	5.961	3.653	−1.428	−2.651*
	(2.010)	(1.849)	(2.642)	(2.796)	(1.434)	(1.175)
τ_9	3.066	0.922	7.689*	5.325	−1.345	−2.567
	(2.300)	(2.189)	(2.953)	(3.294)	(1.564)	(1.340)
τ_{10}	3.163	0.979	7.918*	5.491	−1.360	−2.583
	(2.342)	(2.177)	(2.937)	(3.140)	(1.726)	(1.415)
τ_{11}	4.507	2.387	9.004	6.642	0.267	−0.955
	(2.606)	(2.607)	(3.573)	(4.336)	(2.118)	(1.862)
τ_{12}	3.910	1.483	6.858	2.746	1.244	0.022
	(2.455)	(2.071)	(3.940)	(3.569)	(2.268)	(1.995)
Regional f.e.	yes	yes	yes	yes	yes	yes
Phase f.e.	yes	yes	yes	yes	yes	yes
Year × Olympics f.e.	yes	yes	yes	yes	yes	yes
Additional controls	yes	yes	yes	yes	yes	yes
Games excluded		Athens, Sochi		Athens		Sochi
Observations	1122	974	582	492	540	482
R^2	0.326	0.280	0.282	0.238	0.525	0.492
Adj. R^2	0.136	0.074	0.097	0.038	0.355	0.308

Table 5: Dynamic treatment effects using an extended set of control regions

Note: Cluster robust standard errors in parentheses; p-values obtained using the wild cluster bootstrap with null imposed (Cameron et al., 2008; Roodman et al., 2019) based on 9,999 replications; * ($p < .1$), ** ($p < .05$), *** ($p < .01$);

	(1) All	(2) All	(3) Summer	(4) Summer	(5) Winter	(6) Winter
τ_1	−1.641	−0.964	−2.139	−1.570	−1.024	−0.324
	(1.166)	(1.150)	(1.307)	(1.305)	(1.870)	(1.809)
τ_2	−1.115	−1.580	−1.080	−0.935	−1.747	−2.469
	(1.242)	(1.279)	(1.738)	(2.044)	(1.938)	(1.815)
τ_3	0.945	−1.201	3.443	−0.610	−1.592	−1.983
	(2.323)	(1.460)	(4.078)	(2.462)	(2.202)	(1.988)
τ_4	1.654	−0.279	5.317	1.784	−1.789	−2.137
	(2.235)	(1.449)	(3.438)	(1.717)	(2.344)	(2.241)
τ_5	2.293	−0.888	6.760	2.276	−2.609	−4.285
	(2.812)	(1.702)	(4.397)	(2.231)	(2.719)	(2.621)
τ_6	4.084	0.785	8.114**	4.165*	−0.795	−2.885
	(2.749)	(1.793)	(3.945)	(2.164)	(2.729)	(2.487)
τ_7 (year of event)	3.391	−0.644	9.550**	4.379**	−2.560	−4.905
	(3.255)	(2.071)	(4.682)	(1.862)	(2.961)	(2.782)
τ_8	1.921	−2.212	8.579	1.507	−4.588	−5.404
	(3.856)	(2.193)	(6.074)	(2.763)	(2.856)	(2.993)
τ_9	3.297	−1.204	11.188	3.536	−4.234	−5.050
	(4.221)	(2.395)	(6.585)	(3.074)	(2.907)	(3.048)
τ_{10}	3.416	−1.206	11.596*	3.720	−4.355	−5.171
	(4.323)	(2.328)	(6.786)	(2.925)	(2.744)	(2.811)
τ_{11}	5.307	0.733	13.197	5.196	−2.051	−2.867
	(4.396)	(2.654)	(7.022)	(4.184)	(3.009)	(3.100)
τ_{12}	5.141	−0.042	12.199	1.144	−0.923	−1.739
	(4.787)	(2.540)	(8.907)	(4.369)	(3.054)	(3.121)
Regional f.e.	yes	yes	yes	yes	yes	yes
Phase f.e.	yes	yes	yes	yes	yes	yes
Year × Olympics f.e.	yes	yes	yes	yes	yes	yes
Additional controls	yes	yes	yes	yes	yes	yes
Games excluded		Athens, Sochi		Athens		Sochi
Observations	918	770	406	316	512	454
R^2	0.432	0.498	0.473	0.559	0.518	0.496
Adj. R^2	0.223	0.303	0.256	0.351	0.332	0.297

Table 6: Dynamic treatment effects using $\overline{pcGDP}$ instead of $pcGDP$

Note: Cluster robust standard errors in parentheses; p-values obtained using the wild cluster bootstrap with null imposed (Cameron et al., 2008; Roodman et al., 2019) based on 9,999 replications; * ($p < .1$), ** ($p < .05$), *** ($p < .01$);

	(1) All	(2) All	(3) Summer	(4) Summer	(5) Winter	(6) Winter
τ_1	−0.742	−0.840	−1.826	−1.298	0.228	−0.533
	(0.862)	(0.849)	(1.101)	(1.311)	(1.296)	(1.300)
τ_2	−0.082	−0.277	−1.364	−0.751	0.938	−0.018
	(1.037)	(1.017)	(1.439)	(1.873)	(1.390)	(1.267)
τ_3	−0.313	−0.939	−1.553	−1.641	0.672	−0.498
	(1.182)	(1.188)	(2.043)	(2.665)	(1.220)	(0.736)
τ_4	−0.829	−1.560	−1.938	−2.290	0.044	−1.097
	(1.138)	(1.151)	(2.056)	(2.622)	(1.179)	(0.766)
τ_5	−1.271	−1.937	−2.135	−2.705	−0.607	−1.444**
	(1.348)	(1.512)	(2.783)	(3.563)	(0.953)	(0.647)
τ_6	−0.501	−0.720	−1.276	−1.390	0.143	−0.223
	(1.204)	(1.418)	(2.485)	(3.221)	(0.883)	(0.975)
τ_7 (year of event)	−1.141	−1.364	−2.592	−3.246	0.083	0.093
	(1.146)	(1.398)	(2.214)	(2.686)	(0.765)	(0.954)
τ_8	−1.232	−1.596	−3.759	−4.731	0.574	0.308
	(1.458)	(1.805)	(2.797)	(3.697)	(1.123)	(1.342)
τ_9	−2.159	−2.730	−4.288	−5.570	−0.624	−1.001
	(1.429)	(1.705)	(3.113)	(4.019)	(0.939)	(1.037)
τ_{10}	−2.703	−3.231	−5.173	−6.768	−0.705	−1.091
	(1.731)	(1.977)	(3.264)	(4.167)	(1.777)	(1.789)
τ_{11}	−3.093	−3.498	−5.980	−7.441	−0.808	−1.194
	(1.949)	(2.255)	(3.700)	(4.996)	(1.974)	(1.983)
τ_{12}	−2.816	−3.229	−6.373	−8.874	−0.508	−0.894
	(2.086)	(2.485)	(4.134)	(6.099)	(2.214)	(2.218)
Regional f.e.	yes	yes	yes	yes	yes	yes
Phase f.e.	yes	yes	yes	yes	yes	yes
Year × Olympics f.e.	yes	yes	yes	yes	yes	yes
Additional controls	yes	yes	yes	yes	yes	yes
Games excluded		Athens, Sochi		Athens		Sochi
Observations	679	562	299	227	380	335
R^2	0.564	0.590	0.527	0.606	0.653	0.631
Adj. R^2	0.319	0.339	0.221	0.293	0.452	0.410

Table 7: Placebo test with runner-up region as treated

Note: Cluster robust standard errors in parentheses; p-values obtained using the wild cluster bootstrap with null imposed (Cameron et al., 2008; Roodman et al., 2019) based on 9,999 replications; * ($p < .1$), ** ($p < .05$), *** ($p < .01$);

	(1) All	(2) All	(3) Summer	(4) Summer	(5) Winter	(6) Winter
τ_1 to τ_6	0.717	−0.457	3.405	0.639	−0.419	−0.723
	(1.606)	(1.252)	(2.684)	(1.532)	(2.038)	(2.055)
τ_7 to τ_{12}	4.386	−0.231	11.40*	4.449**	−3.895	−4.047
	(3.845)	(2.109)	(5.728)	(1.986)	(2.649)	(2.742)
Regional f.e.	yes	yes	yes	yes	yes	yes
Aggr. phase f.e.	yes	yes	yes	yes	yes	yes
Aggr. year × Oly. f.e.	yes	yes	yes	yes	yes	yes
Additional controls	yes	yes	yes	yes	yes	yes
Games excluded		Athens, Sochi		Athens		Sochi
Observations	162	135	74	59	88	76
R^2	0.585	0.691	0.667	0.800	0.666	0.600
Adjusted R^2	0.456	0.586	0.542	0.710	0.553	0.464

Table 8: Treatment effects on *pcGDP* in aggregated 6-year periods

Note: Cluster robust standard errors in parentheses; * ($p < .1$), ** ($p < .05$), *** ($p < .01$); Aggr. year denotes median calender year of each aggregated phase; Phases here denote the aggregated periods τ_1 to τ_6 and τ_7 to τ_{12} (with τ_{-5} to τ_0 as a reference);

Winter Games	Code	Region Name	Status	Summer Games	Code	Region Name	Status
Albertville 1992	FR7	Centre-Est	Host	*Barcelona 1992*	ES5	Este	Host
	SE3	Norra Sverige	Candidate		FR1	Region parisienne	Candidate
	ITH	Nord-est	Candidate		UKG	West Midlands	Candidate
	US02	Alaska	Candidate		NL3	West Nederland	Candidate
	DE2	Bayern	Candidate	*Atlanta 1996*	US13	Georgia	Host
Lillehammer 1994	NO02[a)]	Hedmark og Oppland[a)]	Host		UKD	North West	Candidate
	SE3	Norra Sverige	Candidate	*Sydney 2000*	AU1	New South Wales	Host
	US02	Alaska	Candidate		UKD	North West	Candidate
Nagano 1998	JPC	Kita-Kanto, Koshin	Host		DE3	Berlin	Candidate
	SE3	Norra Sverige	Candidate	*Athens 2004*	EL3	Attiki	Host
	ES2	Noreste	Candidate		ITI	Centro	Candidate
Saltlake 2002	US49	Utah	Host		SE1	Ostra Sverige	Candidate
	SE3	Norra Sverige	Candidate		ES6	Sur	Applicant
	CA24	Quebec	Candidate		FR3	Nord	Applicant
	AT2	Suedoesterreich	Applicant	*London 2012*	UKI	London	Host
	ES2	Noreste	Applicant		FR1	Region parisienne	Candidate
	ITH	Nord-est	Applicant		ES3	Comunidad de Madrid	Candidate
	SK04	Vychodne Slovensko	Applicant		US36	New York	Candidate
Torino 2006	ITC	Nord-ovest	Host		RU18	Moskwa	Candidate
	AT2	Suedoesterreich	Applicant		DED	Sachsen	Applicant
	FI1B[b)]	Helsinki-Uusimaa[b)]	Applicant		DE1	Baden-Wuerttemberg	National bid
	PL2	Region Poludniowy	Applicant		DE6	Hamburg	National bid
	SK04[c)]	Vychodne Slovensko[c)]	Applicant		DE7	Hessen	National bid
	AT3	Westoesterreich	National bid		DEA	Nordrhein-Westfalen	National bid
Vancouver 2010	CA59	British Columbia	Host		ES6	Sur	National bid
	AT3	Westoesterreich	Candidate		BR20	Sao Paulo	National bid
	ES2	Noreste	Applicant		US06	California	National bid
	CA24	Quebec	National bid	*Rio 2016*	BR19	Rio De Janeiro	Host
	CA48	Alberta	National bid		ES3	Comunidad de Madrid	Candidate
Sochi 2014	RU32	Krasnodar Krai	Host		US17	Illinois	Candidate
	AT3	Westoesterreich	Candidate		CZ01[d)]	Praha[d)]	Applicant
	BG4	Yugozapaden & Yuzhen tsentralen	Applicant		US06	California	National bid
	ES2	Noreste	Applicant		US42	Pennsylvania	National bid
Pyeongchang 2018	KR06	Gangwon-do	Host		US48	Texas	National bid
	DE2	Bayern	Candidate		JPJ	Kyushu, Okinawa	National bid
	FR8	Mediterranee	National bid	*Tokio 2020*	JPD	Minami-Kanto	Host
					TR1	Istanbul Bolgesi	Candidate
					ES3	Comunidad de Madrid	Candidate
					ITI	Centro	Withdrawn

Table A1: Host and control regions by Olympic Games

Note: Candidate... applications shortlisted by IOC; Applicant... applications not shortlisted by IOC; Withdrawn... Application withdrawn by applicant; National bid... regions losing national bid prior to official application by National Olympic Committee; Excluded regions: i) Later Olympic hosts, ii) regions with missing or insufficient data on regional *pcGDP*, iii) losers of national bids in host country; Candidate regions sorted by their final ranking in the host city election; [a)]Including regions NO01 (Oslo og Akershus), NO03 (Sør-Østlandet), NO05 (Vestlandet), NO06 (Trøndelag); [b)]Including region FI1C (Etelae-Suomi) [c)]Including region SK03 (Stredne Slovensko) [d)]Including region CZ02 (Stredni Cechy).

	(1) All	(2) All	(3) Summer	(4) Summer	(5) Winter	(6) Winter
τ_{-5}	1.628	0.874	1.667	1.798	1.420	0.051
	(1.247)	(1.275)	(1.376)	(1.744)	(2.006)	(1.761)
τ_{-4}	1.536	1.035	1.840	1.435	1.122	0.595
	(0.926)	(1.009)	(1.245)	(1.467)	(1.309)	(1.362)
τ_{-3}	1.370	1.126	2.000	1.690	0.777	0.616
	(0.958)	(1.106)	(1.387)	(1.701)	(1.317)	(1.493)
τ_{-2}	−0.301	−0.563	−0.220	−1.371	−0.375	0.141
	(0.846)	(0.784)	(1.536)	(1.382)	(0.908)	(0.855)
τ_{-1}	−0.670	−0.606	−0.934	−1.288	−0.433	−0.010
	(0.526)	(0.568)	(0.770)	(0.824)	(0.749)	(0.751)
τ_1	0.053	−0.021	−0.660	−0.815	0.694	0.671
	(0.496)	(0.584)	(0.745)	(0.886)	(0.554)	(0.644)
τ_2	0.506	−0.510	−0.063	−0.435	0.762	−0.798
	(0.830)	(0.695)	(1.011)	(1.175)	(1.464)	(1.037)
τ_3	1.817	−0.051	2.274	−0.120	1.230	−0.222
	(1.398)	(0.902)	(2.667)	(1.886)	(1.391)	(0.957)
τ_4	2.398*	0.678	3.747*	1.726	1.117	−0.310
	(1.272)	(0.780)	(2.211)	(1.397)	(1.390)	(0.988)
τ_5	2.763	0.319	4.649	2.283	0.839	−1.689*
	(1.722)	(1.033)	(2.748)	(1.987)	(2.180)	(0.926)
τ_6	4.250**	1.735*	5.577**	3.588**	2.527	−0.331
	(1.737)	(1.077)	(2.356)	(1.699)	(2.503)	(1.137)
τ_7 (year of event)	3.550	0.720	6.217**	3.809**	1.026	−1.876
	(1.944)	(1.197)	(2.685)	(1.825)	(2.526)	(1.112)
τ_8	2.086	−0.411	4.975	1.549	−0.764	−2.193
	(2.048)	(1.260)	(3.482)	(2.434)	(1.574)	(1.290)
τ_9	2.835	0.202	6.557*	3.030	−0.707	−2.137
	(2.204)	(1.374)	(3.571)	(2.448)	(1.646)	(1.368)
τ_{10}	2.928	0.254	6.753*	3.149	−0.699	−2.129
	(2.279)	(1.406)	(3.735)	(2.613)	(1.660)	(1.225)
τ_{11}	4.175*	1.554	7.638*	3.985	0.953	−0.477
	(2.345)	(1.635)	(3.855)	(3.157)	(1.975)	(1.583)
τ_{12}	4.221	1.381	6.669	1.647	1.970	0.540
	(2.521)	(1.732)	(4.685)	(3.681)	(2.127)	(1.734)
Regional f.e.	yes	yes	yes	yes	yes	yes
Phase f.e.	yes	yes	yes	yes	yes	yes
Year × Olympics f.e.	yes	yes	yes	yes	yes	yes
Additional controls	yes	yes	yes	yes	yes	yes
Games excluded		Athens, Sochi		Athens		Sochi
F-test pre trends	1.183	0.630	1.514	1.379	0.398	0.413
p-value	0.475	0.786	0.550	0.587	0.952	0.948
Observations	918	770	406	316	512	454
R^2	0.503	0.522	0.520	0.564	0.553	0.525
Adj. R^2	0.316	0.331	0.310	0.343	0.373	0.327

Table A2: Treatment effects on $pcGDP$ including pre-trends

Note: Cluster robust standard errors in parentheses; p-values obtained using the wild cluster bootstrap with null imposed (Cameron et al., 2008; Roodman et al., 2019) based on 9,999 replications; * ($p < .1$), ** ($p < .05$), *** ($p < .01$);

	(1) All	(2) All	(3) Summer	(4) Summer	(5) Winter	(6) Winter
τ_{-5}	0.403	0.187	0.186	0.156	0.511	0.201
	(0.301)	(0.237)	(0.247)	(0.269)	(0.514)	(0.370)
τ_{-4}	0.390	0.140	0.249	0.035	0.440	0.208
	(0.266)	(0.192)	(0.327)	(0.264)	(0.402)	(0.282)
τ_{-3}	0.360	0.164	0.327	0.131	0.373	0.190
	(0.223)	(0.182)	(0.298)	(0.275)	(0.337)	(0.259)
τ_{-2}	0.301	0.064	0.336	−0.016	0.269	0.134
	(0.213)	(0.127)	(0.367)	(0.201)	(0.254)	(0.163)
τ_{-1}	0.055	−0.019	−0.028	−0.127	0.130	0.075
	(0.098)	(0.090)	(0.131)	(0.101)	(0.147)	(0.136)
τ_{1}	−0.057	−0.073	−0.141	−0.191	0.019	0.030
	(0.063)	(0.071)	(0.105)	(0.109)	(0.063)	(0.070)
τ_{2}	0.017	−0.095	0.088	−0.040	−0.168	−0.174
	(0.135)	(0.119)	(0.189)	(0.183)	(0.193)	(0.186)
τ_{3}	0.327	−0.083	0.851	−0.033	−0.200	−0.146
	(0.424)	(0.139)	(0.817)	(0.263)	(0.228)	(0.187)
τ_{4}	0.385	0.009	0.968	0.132	−0.186	−0.108
	(0.411)	(0.129)	(0.765)	(0.209)	(0.244)	(0.198)
τ_{5}	0.493	−0.005	1.155	0.201	−0.300	−0.271
	(0.493)	(0.151)	(0.876)	(0.246)	(0.239)	(0.218)
τ_{6}	0.748	0.261	1.330	0.417	0.012	0.065
	(0.502)	(0.209)	(0.855)	(0.327)	(0.288)	(0.290)
τ_{7} (year of event)	0.788	0.206	1.728**	0.621**	−0.135	−0.130
	(0.573)	(0.228)	(0.980)	(0.289)	(0.278)	(0.306)
τ_{8}	0.787	0.051	1.662	0.241	−0.115	−0.144
	(0.669)	(0.271)	(1.216)	(0.487)	(0.330)	(0.343)
τ_{9}	0.979	0.174	1.999	0.446	−0.043	−0.072
	(0.738)	(0.307)	(1.345)	(0.615)	(0.315)	(0.326)
τ_{10}	1.045	0.232	2.079	0.508	0.011	−0.017
	(0.755)	(0.332)	(1.358)	(0.621)	(0.356)	(0.370)
τ_{11}	1.259	0.449	2.188	0.566	0.325	0.296
	(0.773)	(0.398)	(1.434)	(0.810)	(0.426)	(0.438)
τ_{12}	1.166	0.275	1.860	−0.291	0.471	0.442
	(0.847)	(0.432)	(1.792)	(0.904)	(0.456)	(0.467)
Regional f.e.	yes	yes	yes	yes	yes	yes
Phase f.e.	yes	yes	yes	yes	yes	yes
Year × Olympics f.e.	yes	yes	yes	yes	yes	yes
Additional controls	yes	yes	yes	yes	yes	yes
Games excluded		Athens, Sochi		Athens		Sochi
F-test pre trends	0.933	0.462	1.897	3.053	0.303	0.323
p-value	0.533	0.842	0.338	0.160	0.933	0.935
Observations	918	770	406	316	512	454
R^2	0.372	0.419	0.448	0.542	0.392	0.383
Adj. R^2	0.136	0.186	0.208	0.309	0.146	0.126

Table A3: Treatment effects on share in national GDP including pre-trends

Note: Cluster robust standard errors in parentheses; p-values obtained using the wild cluster bootstrap with null imposed (Cameron et al., 2008; Roodman et al., 2019) based on 9,999 replications; * ($p < .1$), ** ($p < .05$), *** ($p < .01$);

	(1) All	(2) All	(3) Summer	(4) Summer	(5) Winter	(6) Winter
τ_{-5}	−0.034	−0.041	−0.039	−0.010	−0.023	−0.056
	(0.099)	(0.109)	(0.142)	(0.174)	(0.140)	(0.141)
τ_{-4}	−0.058	−0.071	−0.057	−0.042	−0.052	−0.084
	(0.079)	(0.087)	(0.099)	(0.121)	(0.118)	(0.119)
τ_{-3}	−0.024	−0.030	0.002	0.018	−0.044	−0.068
	(0.057)	(0.061)	(0.064)	(0.074)	(0.090)	(0.092)
τ_{-2}	−0.010	−0.013	0.018	0.029	−0.036	−0.050
	(0.039)	(0.042)	(0.044)	(0.051)	(0.062)	(0.064)
τ_{-1}	−0.003	−0.006	0.011	0.013	−0.015	−0.022
	(0.021)	(0.024)	(0.028)	(0.033)	(0.032)	(0.034)
τ_1	0.014	0.018	0.000	−0.001	0.027	0.035
	(0.025)	(0.029)	(0.044)	(0.054)	(0.028)	(0.029)
τ_1	0.026	0.039	0.058	0.067	0.010	0.032
	(0.047)	(0.052)	(0.055)	(0.065)	(0.080)	(0.083)
τ_3	0.019	0.038	0.016	0.019	0.033	0.066
	(0.062)	(0.067)	(0.078)	(0.092)	(0.099)	(0.101)
τ_4	0.022	0.050	−0.019	−0.016	0.066	0.111
	(0.085)	(0.093)	(0.124)	(0.152)	(0.121)	(0.120)
τ_5	0.036	0.093	−0.033	0.018	0.098	0.161
	(0.100)	(0.104)	(0.150)	(0.173)	(0.154)	(0.152)
τ_6	0.089	0.147	0.010	0.042	0.182	0.261
	(0.120)	(0.131)	(0.174)	(0.209)	(0.175)	(0.172)
τ_7 (year of event)	0.194	0.269*	0.182	0.243	0.229	0.315
	(0.122)	(0.126)	(0.154)	(0.171)	(0.194)	(0.192)
τ_8	0.243	0.290*	0.171	0.221	0.315	0.346
	(0.134)	(0.147)	(0.181)	(0.214)	(0.210)	(0.221)
τ_9	0.285*	0.333*	0.201	0.254	0.366	0.397
	(0.152)	(0.168)	(0.198)	(0.237)	(0.242)	(0.254)
τ_{10}	0.319	0.375	0.216	0.280	0.417	0.448
	(0.173)	(0.191)	(0.226)	(0.270)	(0.275)	(0.287)
τ_{11}	0.334	0.396	0.167	0.233	0.477	0.507
	(0.190)	(0.209)	(0.227)	(0.268)	(0.305)	(0.318)
τ_{12}	0.320	0.396	0.013	0.063	0.535	0.565
	(0.222)	(0.244)	(0.220)	(0.253)	(0.335)	(0.348)
Regional f.e.	yes	yes	yes	yes	yes	yes
Phase f.e.	yes	yes	yes	yes	yes	yes
Year × Olympics f.e.	yes	yes	yes	yes	yes	yes
Additional controls	yes	yes	yes	yes	yes	yes
Games excluded		Athens, Sochi		Athens		Sochi
F-test pre trends	1.171	0.997	1.960	1.684	1.062	0.971
p-value	0.432	0.582	0.320	0.493	0.631	0.728
Observations	918	770	406	316	512	454
R^2	0.604	0.666	0.366	0.397	0.657	0.707
Adj. R^2	0.455	0.532	0.089	0.091	0.518	0.585

Table A4: Treatment effects on share in national population including pre-trends

Note: Cluster robust standard errors in parentheses; p-values obtained using the wild cluster bootstrap with null imposed (Cameron et al., 2008; Roodman et al., 2019) based on 9,999 replications; * ($p < .1$), ** ($p < .05$), *** ($p < .01$);