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The Olympic impact on hosting candidate countries

Rio de Janeiro
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Dissertação submetida a Escola de Pós-Graduação em Economia como requesito parcial para a obtenção do grau de Mestre em Economia.

Área de Concentração: Econometria Aplicada

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Resumo

Neste artigo é analisado o impacto de sediar as Olimpíadas de Verão em agregados macroeconômicos como PIB, consumo, gastos do governo e investimentos per capitas. Os dados utilizados estão em painel e contêm o período entre dez anos antes e dez anos depois do evento contendo os Jogos Olímpicos de Verão entre 1960 e 1996. Os países da amostra são apenas os candidatos a sediar os jogos, essa estratégia amostral permite estimar os efeitos médios de tratamento de forma consistente, pois assume-se que esses países são comparáveis entre si. Para avaliar o impacto dos jogos é lançado mão de técnicas em painel como o Efeito Fixo e a Primeira Diferença e, além disso, faz-se um teste de quebra estrutural desenvolvido por Andrews (1993) entre os países sede. Os resultados indicam um efeito positivo e robusto dos Jogos Olímpicos de Verão em todas as variáveis de interesse. No entanto, a distribuição no tempo e antecipação desses efeitos é ambígua nos testes mudando de forma significativa dependendo do modelo e nível de significância utilizados.
PALAVRAS CHAVE: *Olimpíadas, Efeito de Tratamento.*

Abstract

In this paper, we analyze the impact of hosting the Summer Olympics on macroeconomic aggregates such as GDP, consumption, government consumption and investments per capita. The data is in panel structure and includes the period of ten years before and ten years after the event containing the Olympic Summer Games between 1960 and 1996. The sample countries comprise only candidates to host the games. This sampling strategy allows us to estimate the average treatment effect consistently, because it is assumed that these countries are comparable to each other, including those that ultimately hosted the games. The impact of hosting the Olympic games is measured by Fixed Effect and First Difference regressions. Moreover, we do a structural break test developed by Andrews (1993) to identify if hosting the Olympic Games creates anticipation effects for demand changes that stimulate current GDP, consumption, government consumption and investments. The results indicate a positive effect of the Summer Olympics in all variables of interest. However, the distribution in time and anticipation of these effects is unclear in the tests, changing significantly depending on the model and the significance level used.

Contents

1 Introduction

The objective of this paper is to investigate whether there is an effect of hosting the Summer Olympic games on macroeconomic aggregate variables such as GDP, consumption, government consumption, and investment per capita. Besides that, we also investigate if hosting the Summer Olympic games creates an anticipation effect for demand that stimulates such macroeconomic aggregate variables. With this purpose, we use Fixed Effect and First Difference estimation in a panel data framework and also apply a structural break test.

It is easy to find studies that support the subsidy to local sporting events, most of them argue that they provide great economic benefits to the countries and cities. Those works are usually of no interest to the academic audience but still have great influence, for example, Bicalho (2009).

Common sense, acclaimed by the masses and politicians, states that major sporting events have a positive impact on the economic activity, however, there is disbelief among economists about that conclusion. This incredulity is confirmed by some studies such as Sterken (2006), which estimates a significant drop in GDP of the countries hosting the FIFA World Cup. There are also articles reporting negative economic effects because of the large costs of hosting the Olympics, see Owen (2005). Many Olympics projects are typically associated with great white elephants, such as sports conglomerates that are seldom used or hotel infrastructure and transport built to accommodate only a three weeks peak demand. Given this negative experience, it should be tested, using past experience, whether there is indeed a positive impact in the host cities of the Olympic Games.

Only recently, Rose and Spiegel (2011), using a variety of international market models, statistically robust results were obtained showing that hosting the Olympics has a significant positive long-term impact on exports. Furthermore, they show that candidates who lost the election to host the Olympics also have a similar positive effect on exports. The explanation of Rose and Spiegel (2011) for this result is that what is important is not the purpose of hosting the games itself because of its direct benefits, but the signal sent by the candidates to the international market when they reach the final stage of the Olympics selection process. However, as the authors acknowledge, the model does not fit some important aspects of the data. Namely, they do not explain why the economically open countries are still applying for the event and why countries applying again and again. Unlike their paper, the argument used here is based on financial decisions and anticipation of demand created in the host city by the results of the elections[1].

Another point to be reported is how some studies deal with the selection bias caused by the host city selection. First, it is worth noting the use of the Winter Olympics to improve the database, as in Bruckner and Pappa (2011). This strategy may cause bias

[1]From the 1996 Olympics host city is announced seven years before the start of the game. However, the announcement earlier in the Olympics took place between four and eight years before.

in the results, because the Winter Olympics and Summer Olympics are two completely different events, despite being made by the same organization - the International Olympic Committee (IOC). Firstly, the number of participants and countries represented, which gradually grows in both events, is much higher in the summer games than in the winter ones. For instance, at the Beijing Olympics in 2008 there were 10,942 athletes from 204 countries. Meanwhile, in the Winter Games in Vancouver in 2010 there were nearly 2,600 athletes representing 82 nations. In addition, revenues derived from broadcasting the games is much higher in the Summer Olympics, still looking at China and Canada the difference is 500 million dollars[2]. Therefore, it is assumed that the Winter Olympics is not the event of interest in this study, the treatment used is the Summer Olympics.

Secondly, it is crucial to account for the impact attributed to unobservable differences between the countries that host the Olympic Games (selection bias) and the effect of hosting the games itself (treatment). Addressing this possibility, all the countries selected for the sample participated in the final choice made by the IOC, named candidates. This alternative strategy for the control group derives from Greenstone et al. (2008). The essential assumption for identification of the problem is that candidates to the Olympics, winners and losers, are similar in terms of economic productivity. Thus, the only difference between those countries is having hosted the Olympics or not.

Since the Olympic Games are announced several years before the event itself and economic agents can anticipate future effects immediately, it is important to test for structural changes on the interest variables. Besides that, in this experiment, it is also interesting to know when the structural changing happened, if it happened indeed. The objective is to identify if hosting the Olympic Games creates anticipation effects for demand changes that stimulate current GDP, consumption, government consumption and investments. With this purpose, Dynamic Panel Data Models are estimated to take into account the past values of the dependent variables. Dynamic Panel Models have their own characteristics as set by Anderson and Hsiao (1982) and Arellano and Bond (1991). The former uses past realization as instrumental variables in a Two Step Least Square (TSLS) setting, and the latter estimates a Generalized Method of Moments (GMM) model. Using these estimates, the Andrews (1993) technique can test the existence of a structural break in the growth rates of the variables of interest when the period of change is chosen endogenously. This technique allows the time of the structural change to be unknown, which presents an advantage over other ways of structural breaks tests in this context.

In this article, it is found that the average treatment effect in the candidate countries is positive for GDP, consumption, government consumption, and investment, all in per capita level. Meanwhile, the beginning period of the impacts is uncertain. However, all tests indicate an anticipation in all variables using a significance level of 1%. Additionally, the analysis of structural breaking in the treaties has strong evidence of anticipation, all

[2]See Table 5 annexed to consult the revenue record.

of the estimates for all variables are significant at 1%.

The subsequent sections are organized as follows: Section 2 discusses the methodological analysis of panel and structural break models used in the article; Section 3 discusses the data and the estimation results; and, finally, Section 4 concludes the analysis.

2 Methodology

2.1 Fixed Effect and First Difference

Firstly, it is important to discuss a linear regression using panel data, which, in this setting, has two dimensions. The first dimension is time, indexed by t, $t = 1, 2...T$ [3]. The second dimension is the cities/countries that were candidates for the Olympic Games, and is indexed by i, $i = 1, 2, ..., N$. Therefore, the panel will have T observations in time and N cities/countries, totalizing $T \times N$ observations.

A linear panel model can be defined by the following equation:

$$y_{it} = \mathbf{x_{it}}\boldsymbol{\beta} + c_i + u_{it} \qquad \begin{array}{c} t = 1, 2, ..., T \\ i = 1, 2, ..., N \end{array} \tag{2.1}$$

where y_{it} is the dependent variable - GDP, consumption, government spending and investments per capital - $\mathbf{x_{it}}$ is a row vector of dimension K, $\boldsymbol{\beta}$ is the vector of parameters, c_i is the unobservable heterogeneity and u_{it} is the idiosyncratic error. In this paper, c_i is treated as an unobservable component following Wooldridge (2010), thus, the heterogeneity between countries is not a parameter to be estimated. In the list of covariates, it is included year dummies to capture the seasonality of each particular period. As well as the interaction between the dummy for countries that host the Olympics and the dummy that indicates how many periods before/after t is from the Olympics. The parameters of the latter covariates are the most important, capturing the average treatment effect of the Olympics in every period of the sample.

The unobservable effects in each country are important control variables accounting for the time invariant characteristics specific to each candidate. For example, any time-invariant characteristics, such as climate or geography, is controlled by c_i. The year dummy is also important in a very similar sense, because it controls factors specific to each year, for example, overall economic activity.

In the most general model, the equation (2.1) admits different assumptions about the variable c_i. If it is correlated with the variables $\mathbf{x}_{it}$, then c_i is called a fixed effect. Alternatively, it is possible to assume that c_i is uncorrelated with $\mathbf{x}_{it}$. In this case, c_i is called a random effect. It is clear that the way to estimate the vector of parameters $\boldsymbol{\beta}$ changes in both cases. When c_i is a fixed effect, it is eliminated by subtracting the mean over time for each individual or by tacking the first difference. Meanwhile, in the random effect model, c_i is incorporated into the error term, i.e., $c_i + u_{it}$.

In this article, the term c_i is treated as a fixed effect and is estimated in two ways. In the first approach, called Fixed Effect (FE), the structural equation (2.1) is transformed

[3] Actually, the time will be counted from -10 to 10 indicating ten years before the Olympic Games until ten years later. Although, for didactic reasons and no loss of generality the time is treated from 1 to T in section 2.

so that the average over time is subtracted from individual i. Mathematically, the term $\bar{y}_i = \sum_{t=1}^{T} y_{it}$ is subtracted from structural equation, thus the term c_i is eliminated from the equation. In the second approach, called the First Difference (FD), as the name suggests, it is taken the first difference of the structural equation to eliminate c_i[4]. Both techniques have similar estimates and inferences when $T = 2$. In this case, FD is easier to implement and all procedures that can be applied to a single *cross-section*- such as robust to heteroskedasticity-robust inference - can be applied directly.

When $T > 2$ and the strict exogeneity assumption holds,

$$E(u_{it}|\mathbf{x}_i, c_i) = 0 \ \forall t$$

, the choice between FE and FD hinges to the assumption about the idiosyncratic errors, u_{it}. In particular, the FE estimator is more efficient if u_{it} is serially uncorrelated, while FD is most effective when u_{it} follows a random walk. In many cases it is likely that the truth is somewhere in between.

2.2 Dynamic Panel Data

When there are autoregressive terms on the right hand side of the structural equation, the above approaches must not be applied because the strict exogeneity assumption is necessarily violated, therefore the estimates are inconsistent. Thus, it is thoroughly necessary to apply a different technique.

Simplifying the equation (2.1), which will have only one autoregressive term of the outcome, we have:

$$y_{it} = \gamma y_{it-1} + c_i + u_{it} \qquad \begin{array}{c} t = 1, 2, ..., T \\ i = 1, 2, ..., N \end{array} \tag{2.2}$$

The equation (2.2) is usually estimated by instrumental variables, because, certainly, the lagged regressors y_{it-1} is correlated with c_i. Anderson and Hsiao (1982) noted that $(y_{it} - y_{it-1}) - \gamma(y_{it-1} - y_{it-2})$, which is the first time difference of $y_{it} - \gamma y_{it-1}$, is uncorrelated with y_{it-2}, turning it out to be a valid instrument to estimate γ. Furthermore, as the estimator of the Generalized Method of Moments (GMM) can be seen as an instrumental variables estimator, Arellano and Bond (1991) propose to use (GMM) to estimate (2.2) efficiently, noting that all the lags of y_{it} after the second also consist of valid instruments. Thus, all these restrictions can be explored in the context of a GMM to estimate γ.

[4] More precisely, the estimators of the FE model $\hat{\boldsymbol{\beta}}_{\boldsymbol{EF}}$ and FD $\hat{\boldsymbol{\beta}}_{\boldsymbol{FD}}$ are

$$\hat{\boldsymbol{\beta}}_{\boldsymbol{FE}} = \left(\sum_{i=1}^{N}\sum_{t=1}^{T} \ddot{\mathbf{x}}_{\mathbf{it}}'\ddot{\mathbf{x}}_{\mathbf{it}}\right)^{-1}\left(\sum_{i=1}^{N}\sum_{t=1}^{T} \ddot{\mathbf{x}}_{\mathbf{it}}'\ddot{y}_{it}\right)$$
$$\hat{\boldsymbol{\beta}}_{\boldsymbol{FD}} = \left(\sum_{i=1}^{N}\sum_{t=1}^{T} \Delta\mathbf{x}_{it}'\Delta\mathbf{x}_{it}\right)^{-1}\left(\sum_{i=1}^{N}\sum_{t=1}^{T} \Delta\mathbf{x}_{it}'\Delta y_{it}\right)$$

where $\ddot{\mathbf{x}}_{\mathbf{it}} = \mathbf{x}_{it} - \bar{\mathbf{x}}_i$ and $\ddot{y}_{it} = y_{it} - \bar{y}_i$.

In principle, both estimators are consistent, therefore they converge in probability for the same value. If we have large sample sizes, N and T large enough, we expect that those estimates to be similar. However, for small samples it does not necessarily occur. Expressed by the formulas bellow, the conditions required respectively for the model of Anderson and Hsiao (1982), and Arellano and Bond (1991) are

$$
\begin{aligned}
&E\left[(\Delta y_{it} - \gamma \Delta y_{it-1}) y_{it-2}\right] = 0 \qquad\qquad t = 3, ..., T \\
&E\left[(\Delta y_{it} - \gamma \Delta y_{it-1}) y_{it-j}\right] = 0 \quad t = 3, ..., T \text{ e } j = 2, \ldots, (t-1)
\end{aligned}
$$

In principle, one should prefer the Arellano and Bond (1991) estimates, because they are more efficient. However, there are some cases where the the method of Anderson and Hsiao (1982) is preferd, one such case is when there is a specification error in the model of Arellano and Bond (1991). When several moment restrictions are imposed, as in the case of Arellano and Bond, one must be careful to check if the covariance matrix of these restrictions is not singular. This can occur when the covariance of $\Delta y_{it} - \gamma \Delta y_{it-1}$ and y_{it-2} is similar to the covariance of $\Delta y_{it} - \gamma \Delta y_{it-1}$ and y_{it-3}. As the estimates used in GMM, directly depend on the inverse of the covariance matrix of the constraints currently being imposed, the non-singularity is crucial to have a correctly specified model. This problem does not occur necessarily in Anderson and Hsiao, because in this case, the model imposes only the restriction that the covariance of $\Delta y_{it} - \gamma \Delta y_{it-1}$ and y_{it-2} is zero.

2.3 Structural Break

Finally, we analyze a structural break test as in Andrews (1993). The main point is to investigate if the parameters of the equation change when the structural break date is unknown. In that sense, we specify a restricted time interval that includes the Olympic games which is the potential cause of structural change, but change may occur only after a lag of unknown length or before the event due to anticipation of the event. This is analogous to test a model of aggregate or disaggregate productivity for structural change that occurs some time around the 1973 oil price shock.

This setting is important in this context due to the announcement of the Olympic Games. The announcement happens from five to seven years before the games. Since the economic agents can anticipate their financial decisions whenever they are more convenient, we must test the moment the anticipation occurs. Of course, this analysis is done only in the countries that hosted the Olympic Games.

This technique is applicable in a context of instrumental variables estimation, as in (2.3), when the date of structural break is unknown, i.e., it is unknown when the Olympic effect starts, but it is possible to detect if it occurred within a certain period of time. The test to be used is known as the supreme test of Wald, or sup Wald test.

The idea is to check for changes in the structural equation coefficients. The null

hypothesis is that there was no structural break, namely the Olympics caused no change in the value of regression coefficients. If the sup Wald test leads us to reject the null hypothesis, one can conclude that such coefficients had their values changed from the date associated with the highest Wald test.

To estimate the coefficients, we used the instrumental variables method. The existence of structural break is tested in each period included in the time window around the reference date - Olympic Games, $t = 0$. The window adopted is at five years around $t = 0$. After calculating the coefficients and deciding the window, the Wald statistics for each of these dates within the window is calculated.

The regression for the coefficients is written bellow:

$$y_{it} = c_i + \gamma_1(1 - d_t)y_{it-1} + \gamma_0 d_t y_{it-1} + u_{it} \tag{2.3}$$

Here, d_t represents the dummy variable to assess the possibility of structural break around the Olympics. d_t assume the value zero if $t < t^*$ and the value one otherwise. The variable t^* represents each year inside window. Therefore, 11 Wald statistics were estimated for each variable of interest, with the null hypothesis that $\gamma_0 - \gamma_1 = 0$.

At the end of this phase, 11 Wald statistics are obtained and it is found which is the highest one - the supreme value of the statistic Wald. The latter is compared with its corresponding critical value, tabulated by Andrews (2003). If the statistic is greater than the critical value, the null hypothesis is rejected, as a result, we could conclude that there was a change in the dynamics of (2.3). At the period with the highest value for the Wald statistic, there would be a structural break. Intuitively, this period would most likely be the time when economic agents anticipate their actions due to the announcement of the Olympic Games.

3 Data and Results

3.1 Data

In order to carry out the proposed regressions, data from two sources were used. Firstly, it was necessary to find countries that reached the final voting in the Summer Olympic Games between 1960 and 1996, information obtained from the official site of the Olympics - www.olympics.com. Here you can find the finalist cities[5], the winning cities, and other information such as the process of selecting the hosting city of the games. Data relating to GDP, consumption, government consumption, and investment per capita were collected from Penn World Tables 7.0 Heston et al. (2011). In the appendix, Table 6 shows all the candidate cities for the period in concern.

It is important to highlight some aspects of the data. The first aspect is that although the games are hosted by cities and not countries, the lack of data forced the use of variables at national level. However, this does not invalidate the analysis, it only changes the range of the effects from cities to countries. Additionally, there are six countries in the sample of candidates who were excluded from the regressions due to the absence of data: Hungary in 1960 Olympics, Germany in 1972, Russia in 1976 and 1980 and Serbia in 1992 and 1996 games. Among these, there are two host countries, Germany in 1972 and Russia in 1980.

The panel is structured as follows: each individual panel refers to a candidate in a particular Olympics, and every individual in the sample has 21 observations in time, such that $t = -10, -9, \dots, 01, 2, \dots, 9, 10$ where $t^* = 0$ refers to the Olympic year. In total, there are 32 candidates with 21 observations in time summing up 672 observations.

3.2 Regression Results

As noted above, the major problem in assessing the impacts of the Olympics Games is the lack of randomness in the host cities. To minimize this effect in the estimates, only the final candidates are chosen in the sample and it is assumed that these are comparable to each other. The first attempt to evaluate the average treatment effect of the Summer Olympics is uses a panel linear regression according to the FE approach. This model can be described by the following equation:

$$y_{it} = \beta_0 + \theta_{year} + \sum_{j=-9}^{10} \rho_j * D_t(j) * host_i + c_i + u_{it} \tag{3.1}$$

where y_{it} is the dependent variable, $D_t(j)$ is a dummy variable assuming value 1 if t corresponds to j year after/before the Olympics and 0 otherwise, $host_i$ is a dummy variable indicating whether the country i is hosting the Olympic Games, β_0 is the intercept, θ_{year} is

[5] More specifically the elected cities record is on Olympics Summer Games Fonds List.

an indicator that changes the intercept for each year and, finally and most importantly, ρ_j is the most important parameter in this study and measures the impact of the Olympics in year j before/after the Olympics. Additionally, the variables c_i and u_{it} correspond to the unobservable effect and idiosyncratic error, respectively.

Fixed Effect model was chosen instead of the Random Effect because it is evident that the independent variable $host_i$ is correlated with the unobserved effect c_i. This happens because a country about to host an Olympic event is chosen, among other factors particular to each country, by its economic performance. This makes the Random Effect regression parameters inconsistent. Furthermore, we detected the presence of a serial correlation in the errors of the regressions, so we used robust standard errors in the inferences.

The results in Table 1 and the Figure 1 show the Fixed Effect regression parameters measuring the Olympics effect on the following per capita macroeconomic variables: GDP, consumption, government consumption, and investment. In the table, the parameters presented correspond to the interactions of host countries, $host_i$, with the 'lags' and 'leads' of the Olympic year, $D_t(j)$. The figure shows the same estimated parameters from the table and also the confidence intervals of 90% and 95%. In all variables, the regressions indicate a positive impact of the Olympics. Starting with the GDP, note that the parameters ρ_{-6} up to ρ_{10} are all greater than zero and significant at a significance level of 1%, i.e., six years before the Olympics there is evidence of a positive effect that persisted up to 10 years later. This result indicates that as soon as the country is elected to be the host for the Olympic Games the per capita GDP reacts positively.

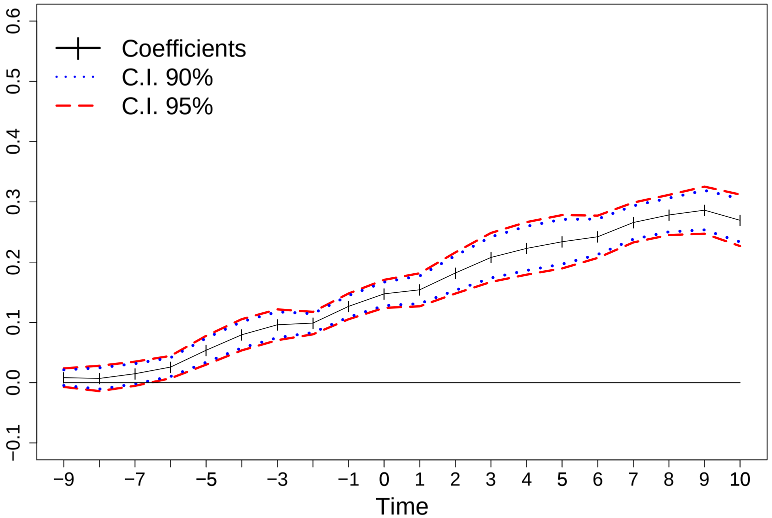
In per capita consumption, the regression indicates a positive increase at 5% significance level starting seven years before the event has occurred. Similarly to the GDP, there is an evidence of immediate reaction of consumption after the election announcement. Since government is the leading provider of infrastructure for the event in all countries, government consumption, as it was expected, increases only seven years before the games.

At last, concerning the investment, the parameters ρ_{-9} and ρ_{-8} are negative and statistically significant, but the olympic effect turns out to be positive and significant from five years before the Olympic year, ρ_{-5}, until ten years latter, ρ_{10}. This means that, before the announcement, the hosting country invests relatively less than the non hosting countries.

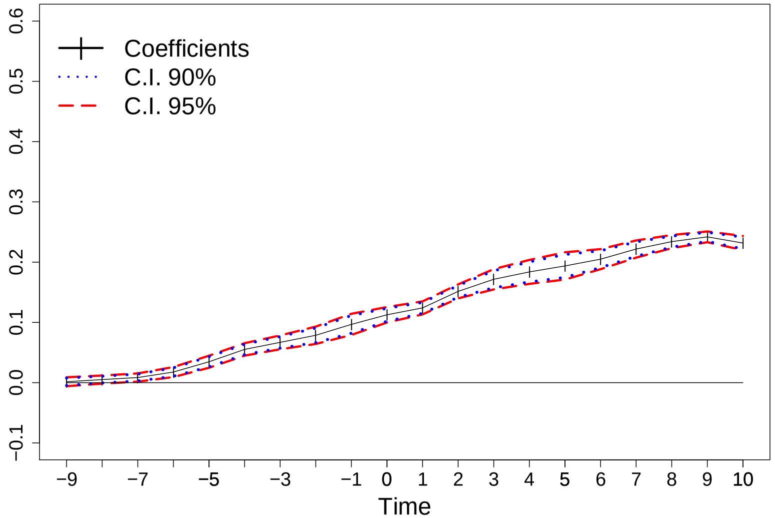
Complementing the above results, a First Difference estimation was made. This approach helps to explain better the average treatment effect, because the unit root tests on the errors of the Fixed Effect regressions indicate autocorrelation. When the number of periods in the panel is greater than or equal to two and the hypothesis of strict exogeneity is guaranteed a choice between Fixed Effect and First Difference depends on the structure of the idiosyncratic errors, u_{it}. If errors are serially uncorrelated, Fixed Effect has more

Figure 1: Fixed Effect Estimation

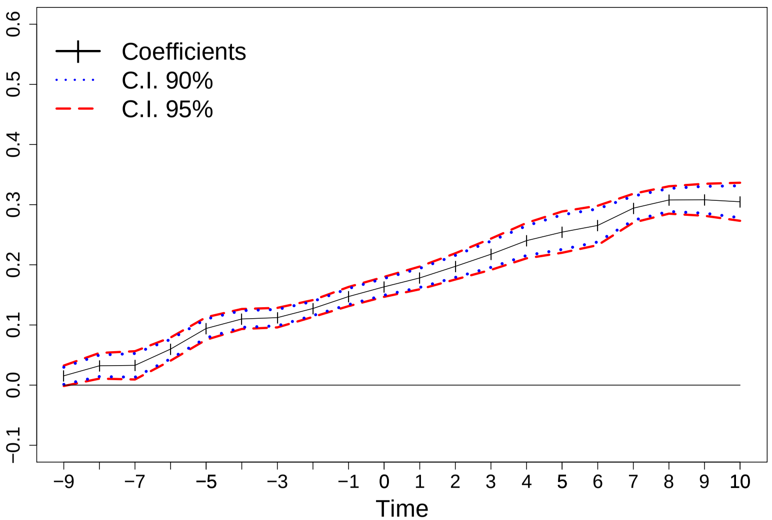
(a) GDP



(b) Consumption



(c) Government Consumption



(d) Investment

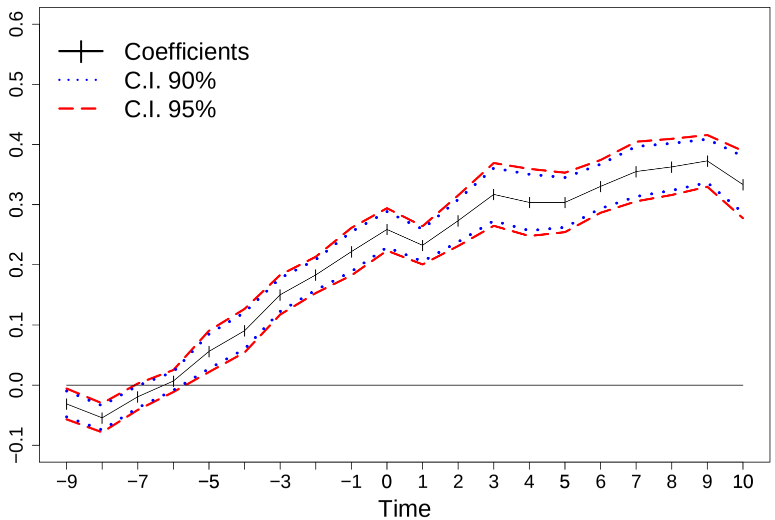


Table 1: Fixed Effect Estimation

	GDP		Consumption		Government Consumption		Investment	
Parameter	Estimative	Standard Error	Estimative	Standard Error	Estimative	Standard Error	Estimative	Standard Error
ρ_{-9}	0.008	0.008	0.002	0.004	0.015·	0.009	−0.031*	0.013
ρ_{-8}	0.007	0.011	0.005	0.003	0.032**	0.011	−0.054***	0.012
ρ_{-7}	0.015	0.010	0.009*	0.003	0.033**	0.012	−0.019·	0.011
ρ_{-6}	0.026**	0.009	0.018***	0.004	0.06***	0.010	0.007	0.009
ρ_{-5}	0.054***	0.012	0.035***	0.005	0.094***	0.010	0.056**	0.017
ρ_{-4}	0.079***	0.013	0.055***	0.005	0.110***	0.008	0.090***	0.018
ρ_{-3}	0.096***	0.013	0.067***	0.006	0.112***	0.008	0.150***	0.017
ρ_{-2}	0.099***	0.009	0.079***	0.007	0.127***	0.007	0.183***	0.015
ρ_{-1}	0.127***	0.011	0.097***	0.009	0.147***	0.008	0.222***	0.020
ρ_0 (Olympic Year)	0.147***	0.012	0.113***	0.007	0.163***	0.008	0.259***	0.018
ρ_1	0.154***	0.014	0.124***	0.005	0.178***	0.010	0.232***	0.016
ρ_2	0.182***	0.017	0.151***	0.006	0.197***	0.011	0.273***	0.021
ρ_3	0.208***	0.021	0.172***	0.009	0.218***	0.013	0.317***	0.027
ρ_4	0.223***	0.022	0.184***	0.010	0.240***	0.015	0.304***	0.028
ρ_5	0.234***	0.023	0.194***	0.012	0.254***	0.017	0.304***	0.025
ρ_6	0.242***	0.018	0.205***	0.008	0.265***	0.017	0.330***	0.022
ρ_7	0.266***	0.017	0.222***	0.007	0.294***	0.012	0.355***	0.025
ρ_8	0.278***	0.017	0.234***	0.006	0.308***	0.012	0.363***	0.024
ρ_9	0.286***	0.020	0.242***	0.005	0.308***	0.014	0.373***	0.022
ρ_{10}	0.269***	0.022	0.232***	0.006	0.305***	0.016	0.333***	0.028

Data Source: Penn World Table 7.0. 2005 constant prices, PPP (Laspeyres). All dependent variables are per capita level.
The regressions were done using the R software and the plm package Croissant et al. (2008).
Formula: $y_{it} = \beta_0 + \theta_{year} + \sum_{j=-9}^{10} \rho_j * D_t(j) * host_i + c_i + u_{it}$. The time dummy variables are omitted.
The Standard Errors displayed in parenthesis are robust to heteroscedasticity following Driscoll and Kraay (1998).
Significance: '***' 0.001 '**' 0.01 '*' 0.05

efficient estimators. However, if the errors follow a random walk, First Difference is more efficient than the former approach. Nevertheless, in many cases it is likely that the truth is between the two models.

The First Difference regression is also performed following the model from equation (3.1) and their estimates are in Table 2 and Figure 2. These table and figure are organized exactly like the previous one, showing the parameters that measure the average impact of treatment during the years before and after the Olympics. Similarly to the results obtained in Table 1, all variables are positively affected by the event. In particular for the GDP, at 5% significance level, the only parameter that is not significant is ρ_{-8}. The effect on GDP grows until nine years after the Olympic year and it has a short decay in the last year. The impact on consumption due to the treatment is also positive and is positive at the significance level of 1% during all years in the sample. Government consumption is also positively affected at 1% significance level. Six years before the event the parameter almost doubles indicating that the government spends relatively more money after the announcement. And finally, the result on investment, the only parameter which is statistically lower than zero is ρ_{-8}, nine years before the games. The impact turns out to be positive five years before the games and continues positive until the end of the sample.

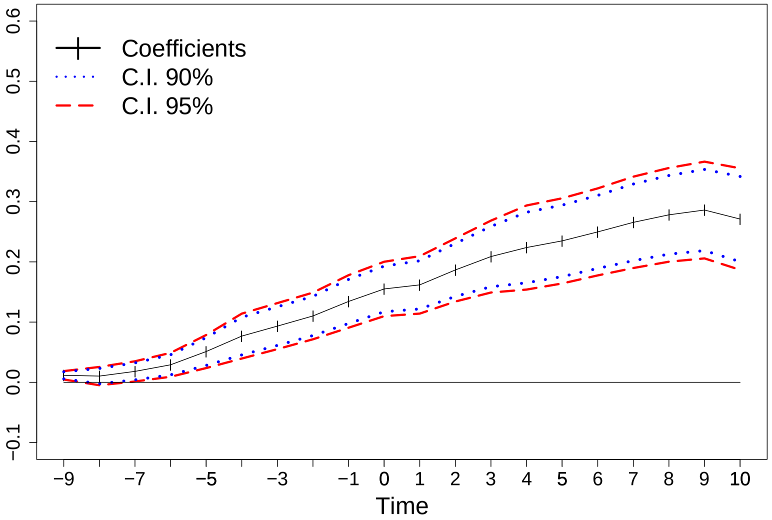
As seen above, both approaches have similar values to the economic performance of the countries. Both estimates based on Fixed Effect and on First Difference reveal that the impact of the Olympics on the candidate countries is positive. All the macroeconomic aggregates studied here are affected before the start of the Olympics. This result was expected, since the decision of the hosting city occurs between four and seven years before the official opening of the games. Furthermore, the similarity between the estimation indicates that the strictly exogeneity assumption is maintained turning the results more robust.

All significant coefficients have higher values than the commonly found in similar articles. However, this result was expected, since the other articles considered all countries of the world and gathered data from the Summer Olympics and the Winter Olympics, the latter being much smaller than the former. For instance, in Bruckner and Pappa (2011), the peak of the olympic effect on the macroeconomic aggregates are: investment is 3%, in consumption 2.2%, government consumption is 1.9% and, at last, in investment is 6%.

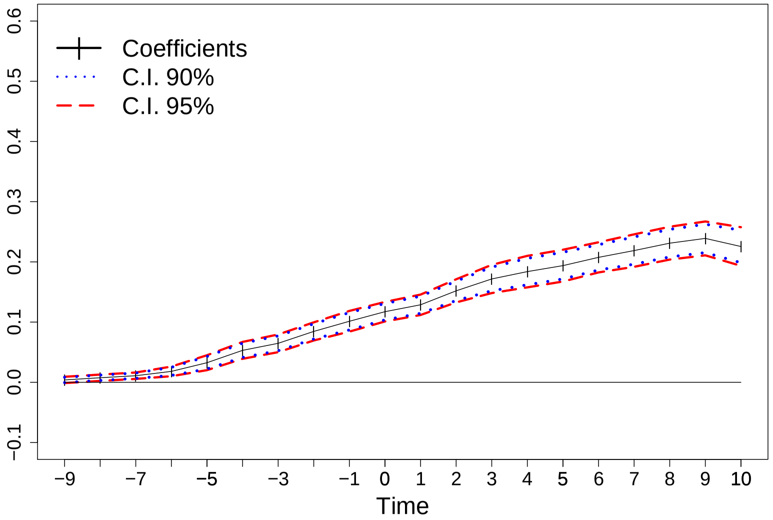
In addition, accounting for the presence of panel unit root on the variables of interest, we also run a fixed effect regression on first difference. First we test the series of interest of each country for the presence of panel unit root. On the following tests Levin et al. (2002), Breitung (2001) and Im et al. (2003), it is not possible to reject the unit root at the usual significant levels of 5% and 10%. This gives these series a long term growth trend characteristic, inconsistent with mean reversion. Additionally, these tests also indicate the presence of unit root on the first difference, however, it is unlikely that these variables

Figure 2: First Difference Estimation

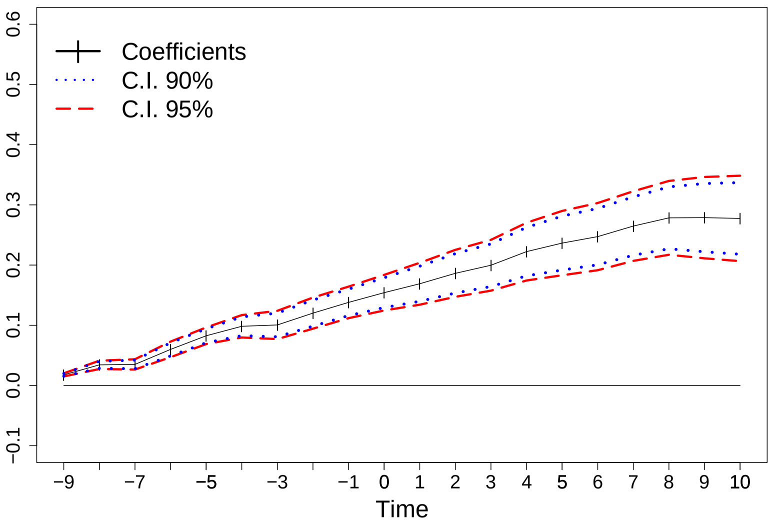
(a) GDP



(b) Consumption



(c) Government Consumption



(d) Investment

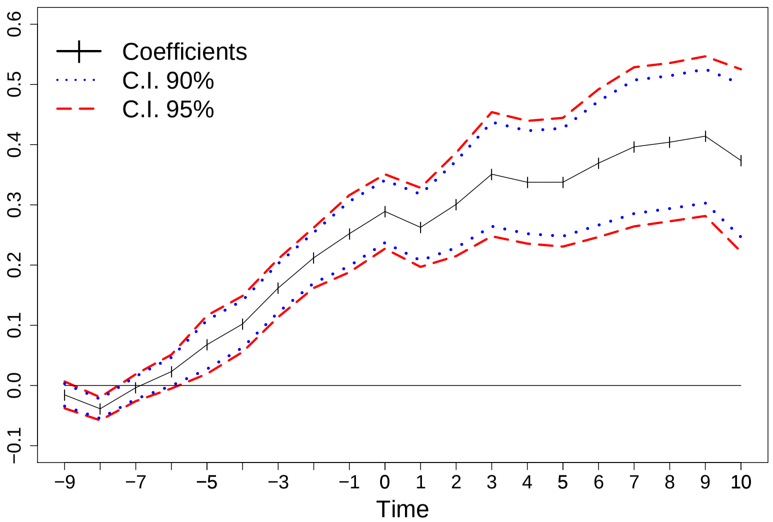


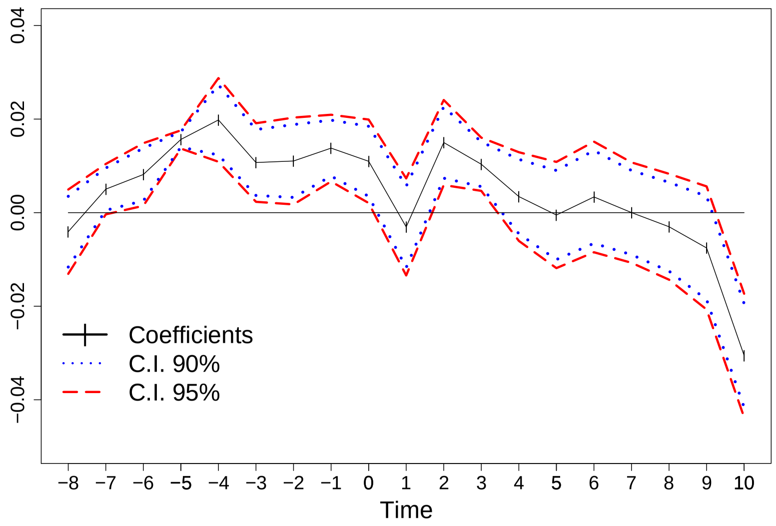
Table 2: First Difference Estimation

	GDP		Consumption		Government Consumption		Investment	
Parameter	Estimative	Standard Error	Estimative	Standard Error	Estimative	Standard Error	Estimative	Standard Error
ρ_{-9}	0.012**	0.004	0.004***	0.003	0.018***	0.001	−0.016	0.011
ρ_{-8}	0.010	0.008	0.008***	0.003	0.034***	0.004	−0.039***	0.01
ρ_{-7}	0.018*	0.009	0.011***	0.003	0.035***	0.004	−0.004	0.011
ρ_{-6}	0.029**	0.010	0.018***	0.004	0.06***	0.007	0.023	0.014
ρ_{-5}	0.051***	0.014	0.033***	0.006	0.083***	0.007	0.068**	0.025
ρ_{-4}	0.077***	0.019	0.053***	0.007	0.098***	0.009	0.102***	0.024
ρ_{-3}	0.093***	0.019	0.065***	0.007	0.101***	0.012	0.162***	0.025
ρ_{-2}	0.110***	0.02	0.085***	0.008	0.120***	0.013	0.212***	0.026
ρ_{-1}	0.134***	0.022	0.101***	0.009	0.138***	0.013	0.252***	0.033
ρ_0 (Olympic Year)	0.155***	0.023	0.117***	0.008	0.154***	0.015	0.289***	0.031
ρ_1	0.162***	0.024	0.129***	0.009	0.169***	0.018	0.263***	0.033
ρ_2	0.187***	0.027	0.152***	0.010	0.186***	0.020	0.301***	0.044
ρ_3	0.209***	0.030	0.172***	0.012	0.200***	0.021	0.351***	0.052
ρ_4	0.224***	0.036	0.184***	0.013	0.222***	0.024	0.338***	0.052
ρ_5	0.235***	0.036	0.194***	0.013	0.237***	0.027	0.338***	0.054
ρ_6	0.250***	0.037	0.208***	0.013	0.247***	0.028	0.369***	0.062
ρ_7	0.266***	0.039	0.219***	0.014	0.265***	0.029	0.396***	0.067
ρ_8	0.278***	0.040	0.231***	0.014	0.278***	0.031	0.404***	0.067
ρ_9	0.286***	0.041	0.239***	0.014	0.279***	0.034	0.414***	0.068
ρ_{10}	0.271***	0.043	0.226***	0.016	0.277***	0.036	0.374***	0.077

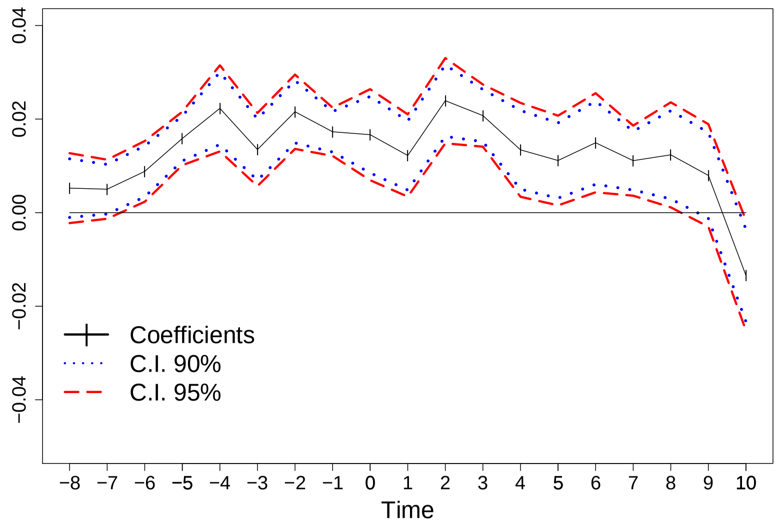
Data Source: Penn World Table 7.0. 2005 constant prices, PPP (Laspeyres). All dependent variables are per capita level.
The regressions were done using the R software and the plm package Croissant et al. (2008).
Formula: $y_{it} = \beta_0 + \theta_{year} + \sum_{j=-9}^{10} \rho_j * D_t(j) * host_i + c_i + u_{it}$. The time dummy variables are omitted.
The Standard Errors displayed in parenthesis are robust to heteroscedasticity following Driscoll and Kraay (1998).
Significance: '***' 0.001 '**' 0.01 '*' 0.05

Figure 3: Fixed Effect (First Difference)

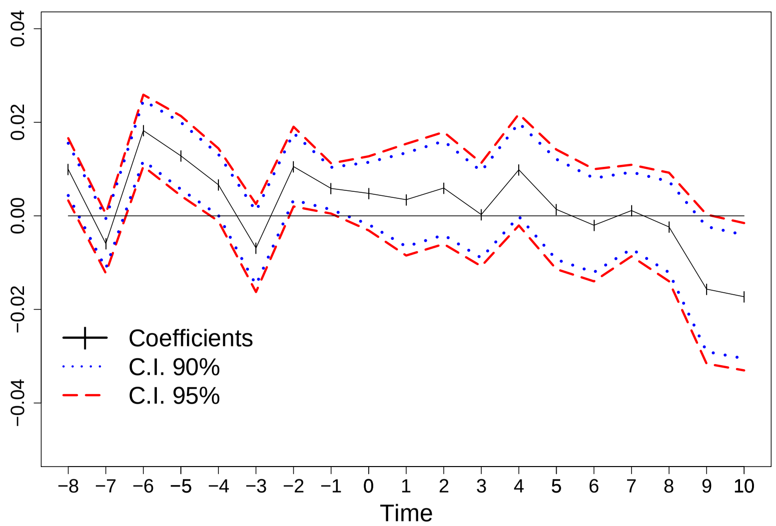
(a) GDP



(b) Consumption



(c) Government Consumption



(d) Investment

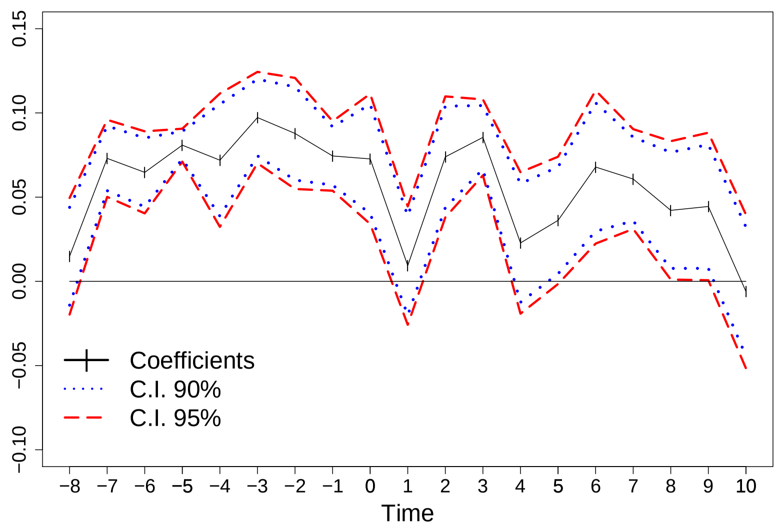


Table 3: Fixed Effect (First Difference)

	GDP		Consumption		Government Consumption		Investment	
Parameter	Estimative	Standard Error	Estimative	Standard Error	Estimative	Standard Error	Estimative	Standard Error
ρ_{-8}	−0.004	0.004	0.005	0.004	0.010**	0.003	0.015	0.018
ρ_{-7}	0.005	0.008	0.005	0.003	−0.006	0.003	0.073***	0.012
ρ_{-6}	0.008*	0.009	0.009**	0.003	0.018***	0.004	0.065***	0.012
ρ_{-5}	0.016***	0.010	0.016***	0.003	0.013**	0.004	0.081***	0.005
ρ_{-4}	0.020***	0.014	0.022***	0.005	0.007	0.004	0.072***	0.020
ρ_{-3}	0.011*	0.019	0.013***	0.004	−0.007	0.005	0.097***	0.014
ρ_{-2}	0.011*	0.019	0.022***	0.004	0.011*	0.004	0.088***	0.017
ρ_{-1}	0.014***	0.020	0.017***	0.003	0.006*	0.003	0.074***	0.011
ρ_0 (Olympic Year)	0.011*	0.022	0.017***	0.005	0.005	0.004	0.073***	0.020
ρ_1	−0.003	0.023	0.012**	0.004	0.003	0.006	0.009	0.018
ρ_2	0.015**	0.024	0.024***	0.005	0.006	0.006	0.074***	0.018
ρ_3	0.010***	0.027	0.021***	0.003	0.000	0.006	0.085***	0.011
ρ_4	0.003	0.030	0.013**	0.005	0.010	0.006	0.023	0.021
ρ_5	−0.001	0.036	0.011*	0.005	0.001	0.007	0.036	0.019
ρ_6	0.003	0.036	0.015**	0.005	−0.002	0.006	0.068**	0.023
ρ_7	0.000	0.037	0.011**	0.004	0.001	0.005	0.061***	0.015
ρ_8	−0.003	0.039	0.012*	0.006	−0.002	0.006	0.042*	0.021
ρ_9	−0.008	0.04	0.008	0.006	−0.016	0.008	0.044*	0.022
ρ_{10}	−0.031***	0.041	−0.013*	0.006	−0.017*	0.008	−0.006	0.023

Data Source: Penn World Table 7.0. 2005 constant prices, PPP (Laspeyres). All dependent variables are per capita level.
The regressions were done using the R software and the plm package Croissant et al. (2008).
Formula: $\Delta y_{it} = \beta_0 + \theta_{year} + \sum_{j=-8}^{10} \rho_j * D_t(j) * host_i + c_i + u_{it}$. The time dummy variables are omitted.
The Standard Errors displayed in parenthesis are robust to heteroscedasticity following Driscoll and Kraay (1998).
Significance: '***' 0.001 '**' 0.01 '*' 0.05

are second order integrated, $I(2)$.

Table 3 and Figure 3 are arranged just like the previous ones and show the results of the Fixed Effect regression on first difference data. The olympic effect on GDP growth is statistically positive from six years before the olympic year until three years later, with exception of ρ_1, and it is statistically negative ten years later. At 5% of significance, the treatment effect on consumption is positive from six years before the games until eight years later, but ten years later the effect is negative. The regression on government consumption, also at 5% level, indicates that the olympic effect is positive only before the games - ρ_{-1}, ρ_{-2}, ρ_{-5}, ρ_{-6}, ρ_{-8} - and that the effect is negative ten years after the games. At last, the investment is positively affected by the treatment before and after the games. As expected, the effect before the games on investment is greater and more significant before the games than after it.

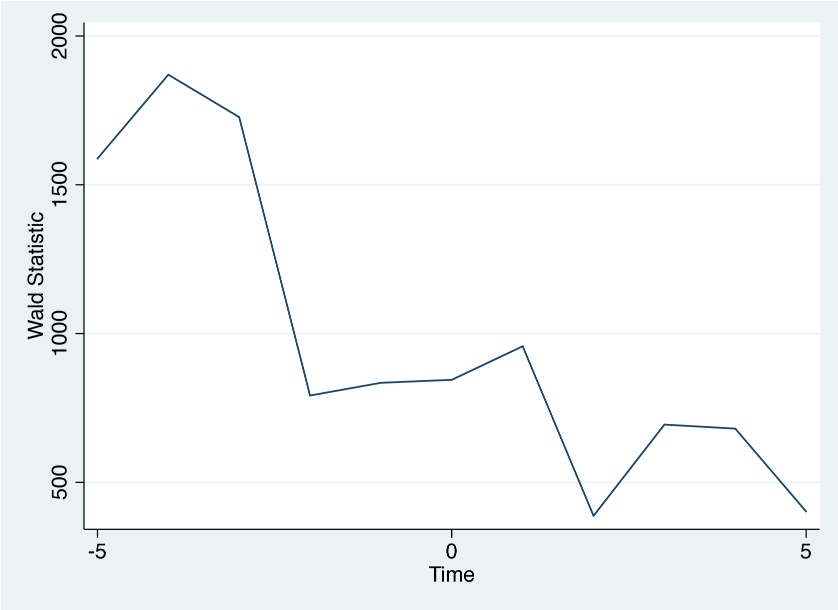
The estimates of equation (2.2) by GMM (Arellano and Bond) have proved unsuitable, since the estimation of the covariance moment matrix used was numerically singular in all cases. The only way to calculate the GMM estimates in this case is making use of the Penrose and Moore generalized inverse matrix, something that compromises the estimation. For this reason, we dismiss the Arellano and Bond technique for the dynamic panel estimates, using only Anderson and Hsiao estimation to test for structural break.

The next step is to test the structural break based on Andrews (1993) work. In this environment, the structure breaking point is not arbitrary. The procedure calculates what is the most likely point where the break has occurred, if it has been ever occurred. This technique does not support series with unit roots, so the data used in the equation (2.3) are first differenced, because the above tests did not reject the unit root hypothesis. Applying the Andrews test, we conclude with great confidence that there was a structural break in the model for all interest variables. The evolution of the values from the Wald test are in Figure 4. The highest value of each series, the Wald's test and the regression‘s parameters during the breaks for the samples before and afterwards the break are in Table 4.

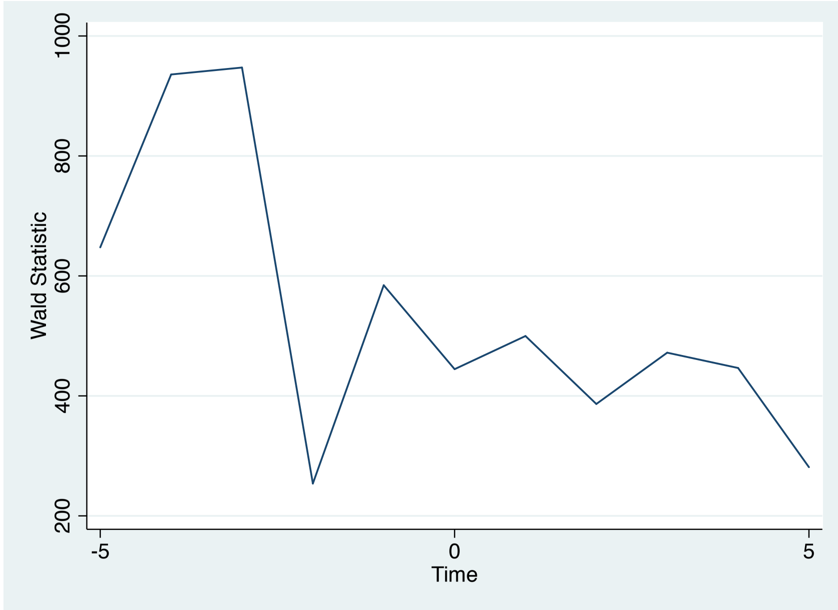
Starting with the graphics that show the Wald statistic values for each period, notice that for almost all variables the statistics values are quite distinct on only one year compared to the other years. It indicates a structural break in value of $E(\Delta y_t|\mathcal{I}_{t-1})$, conditional expectation of GDP, consumption, government consumption and investment. The question that follows is the period in which the structural break occurred. All variables exhibit a break before the Olympics: in case of GDP, the break took place four years before the games; in case of consumption, the break occurred three years before the games; in the of government consumption, the break took place only one year before; and, finally, the investment break took place four years before the Olympics. The magnitude of the break is difficult to interpret, because all coefficients are statistically equal to zero at 5% significance level.

Figure 4: Wald‘s Statistics Evolution

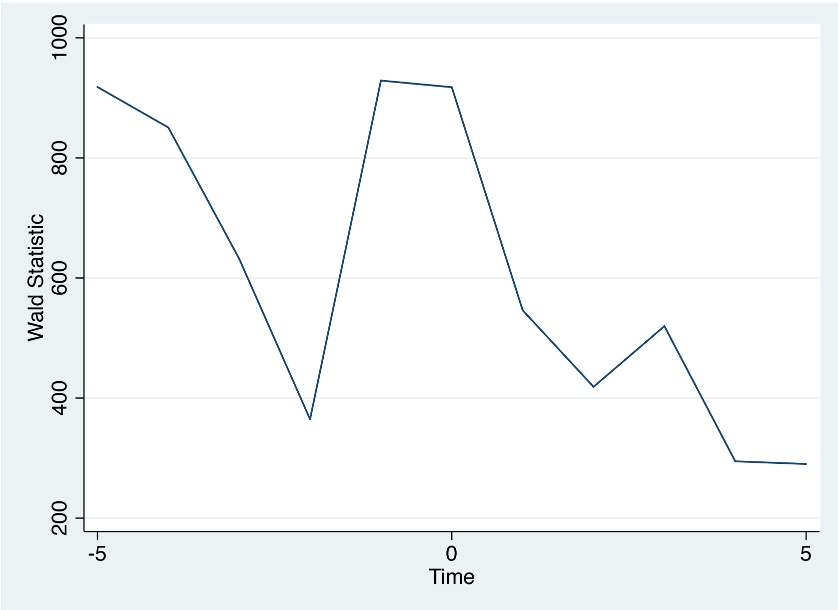
(a) GDP



(b) Consumption



(c) Government Consumption



(d) Investment

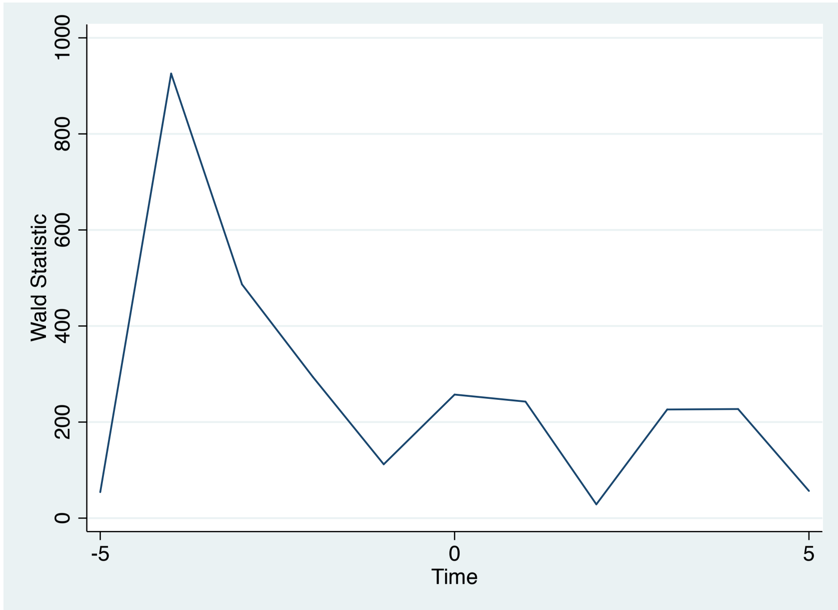


Table 4: Structural Break Test

Variable	Parameters Before the break γ_0	 After the Break γ_1	Andrews Test
GDP	-0.365	1.144	sup Wald = 1870.03
	(0.216)	(0.707)	$t^* = -4$
Consumption	-0.368	1.338	sup Wald = 947.39
	(0.507)	(0.973)	$t^* = -3$
Government Consumption	-0.264	0.622	sup Wald = 928.81
	(0.180)	(0.540)	$t^* = -1$
Investment	-0.178	0.345	sup Wald = 925.62
	(-0.178)	(0.209)	$t^* = -4$

Regression Formula: $\Delta y_{it} = c_i + \gamma_1(1 - d_t)y_{it-1} + \gamma_0 d_t y_{it-1} + u_{it}$

The results presented in this section support the hypothesis that the Olympics have a significant positive impact on the economies of the host countries. Despite strong evidence of positive treatment effect, its starting period is imprecise and different among the models. Basically, the structural break test gives evidence of an earlier break for all variables of interest than other models, the First-Difference and the Fixed-Effect regressions. In case of he magnitude the average treatment effect in Fixed Effect and First Difference, the results are higher than those reported in the rest of the literature, however, this was expected, since the other models combine the Summer and the Winter Olympics.

4 Conclusion

The present study analyzes the average effect of hosting the Summer Olympics relying on the possibility of anticipation of this effect, its persistence and bias selection. Thus, we used only the candidate countries to the Olympic Games to remove the selection bias, allowing a consistent estimation of these effects on GDP, consumption, government consumption, and investment in per capital level. The analysis indicates a significant increase over all interest variables. Additionally, the structural break test between the countries that hosted the Summer Olympics confirms the anticipated impact on the researched variables.

According to the Fixed Effect Regression (First Difference Regression), at 5% significance level, the anticipation of the per capita GDP starts six years (seven years) before the games. The anticipation of the consumption starts nine years before the Olympics on both regressions. Government consumption anticipation starts eight years (nine years) before the Olympic Games; and the impact on investment is negative in years nine and eight (year eight) before the Olympic year, and turns out to be positive from five years before until the end of the series. In addition, the structural break tests also indicate an anticipation of the impact. Namely, the structural break occurs four years before the games on per capita GDP; three years before on consumption; one year on government consumption; and four years on investment.

A major problem of this study is the repetition of the countries in the sample. Although each country appears at different time intervals, the repetition is relatively large due to the simplification of representing each hosting country, which may have caused bias in the estimates. Moreover, the lack of randomization of the experiment still needs to be circumvented. Sampling only the candidate countries and assuming that these are comparable to each other helps reducing the bias, however, it may still be feasible to use techniques to minimize this problem. For instance, one can use covariates that help predict the likelihood of a city/country to become host of the Olympic Games to estimate the propensity score.

These results have important implications in the local subsidy policies for the Olympics. They confirm the common sense of the public and politicians about the economic benefits caused to countries willing to host the Summer Olympics. However, this study cannot ensure that hosting the Olympic Games is a good policy because we do not analyze the costs it implicates to society.

References

Anderson, T. and C. Hsiao (1982). Formulation and estimation of dynamic models using panel data. *Journal of Econometrics 18*(1), 47 – 82.

Andrews, D. W. K. (1993). Tests for parameter instability and structural change with unknown change point. *Econometrica 61*(4), pp. 821–856.

Andrews, D. W. K. (2003). Tests for parameter instability and structural change with unknown change point: A corrigendum. *Econometrica 71*(1), pp. 395–397.

Arellano, M. and S. Bond (1991). Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. *The Review of Economic Studies 58*(2), pp. 277–297.

Bicalho, A. (2009). Olimpíadas e copa do mundo podem elevar o crescimento do pib. *Relatório Semanal de Macroeconomia - Itaú Unibanco*.

Breitung, J. (2001). *The local power of some unit root tests for panel data*, Volume 15 of *Advances in Econometrics: Nonstationary Panels, Panel Cointegration, and Dynamic Panels*. Emerald Group Publishing Limited.

Bruckner, M. and E. Pappa (2011). For an olive wreath? olympic games and anticipation effects in macroeconomics. *School of Economics Working Papers*.

Croissant, Y., G. Millo, et al. (2008). Panel data econometrics in r: The plm package. *Journal of Statistical Software 27*(2), 1–43.

Driscoll, J. C. and A. C. Kraay (1998). Consistent covariance matrix estimation with spatially dependent panel data. *The Review of Economics and Statistics 80*(4), pp. 549–560.

Greenstone, M., R. Hornbeck, and E. Moretti (2008). Identifying agglomeration spillovers: evidence from million dollar plants. Technical report, National Bureau of Economic Research.

Heston, A., R. Summers, and B. Aten (2011, May). Penn world table version 7.0. *Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania*.

Im, K. S., M. Pesaran, and Y. Shin (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics 115*(1), 53 – 74.

Levin, A., C.-F. Lin, and C.-S. J. Chu (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics 108*(1), 1 – 24.

Owen, J. (2005). Estimating the cost and benefit of hosting olympic games: What can beijing expect from its 2008 games? *The Industrial Geographer 3*(1), 1–18.

Rose, A. K. and M. M. Spiegel (2011, JUN). The olympic effect. *ECONOMIC JOURNAL 121*(553), 652–677.

Sterken, E. (2006). Growth impact of major sporting events. *European Sport Management Quarterly 6*(4), 375–389.

Wooldridge, J. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). The MIT press.

A Apendix

Table 5: Olympic Games Transmition Revenue (Millions of Dollars)

Summer Olympic Games		Winter Olympic Games	
1960 Rome	US$1.2	1960 Squaw Valley	US$0.05
1964 Tokyo	US$1.6	1964 Innsbruck	US$0.937
1968 Mexico City	US$9.8	1968 Grenoble	US$2.6
1972 Munique	US$17.8	1972 Sapporo	US$8.5
1976 Montreal	US$34.9	1976 Innsbruck	US$11.6
1980 Moscow	US$88	1980 Lake Placid	US$20.7
1984 Los Angeles	US$286.9	1984 Sarajevo	US$102.7
1988 Seul	US$402.6	1988 Calgary	US$324.9
1992 Barcelona	US$636.1	1992 Albertville	US$291.9
1996 Atlanta	US$898.3	1994 Lillehammer	US$352.9
2000 Sydney	US$1,331.6	1998 Nagano	US$513.5
2004 Athenas	US$1,494	2002 Salt Lake	US$738
2008 Beijim	US$1,739	2006 Turin	US$831
		2010 Vancouver	US$1,279.5

Data Source: International Olympic Comitee, *Marketing fact file.*

Table 6: Summer Olympics Candidate Countries

	Winning City	Losing Cities
1960	Rome (Italy)	Lausanne (Suíça), Detroit (USA), Budapest (Hungria), Brussels (Belgium), Mexico City (Mexico), Tokyo (Japan)
1964	Tokyo (Japan)	Detroit (USA), Vienna (Austria), Brussels (Belgium), Mexico City (Mexico)
1968	Mexico City (Mexico)	Detroit (USA), Lyon (France), Buenos Aires (Argentina)
1972	Munique (Germany)	Montreal (Canada), Detroit (USA)
1976	Montreal (Canada)	Moscow (Russia), Los Angeles (USA),
1980	Moscow (Russia)	Los Angeles (USA)
1984	Los Angeles (USA)	Tehran (Iran)
1988	Seoul (South Corea)	Nagoya (Japan)
1992	Barcelona (Spain)	Paris (France), Brisbane (Australia), Belgrade (Yugoslavia/Serbia), Birmingham (United King), Amsterdam (Netherlands)
1996	Atlanta (USA),	Athenas (Greece), Toronto (Canada), Melbourne (Australia)

[1] Data Source: International Olympic Comitee.