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Reevaluation of the Employment Impact of the 1996 Summer Olympic Games

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Using empirical methods published more recently than our earlier analysis found in this journal, we continue to find a statistically significant and substantial employment impact of the 1996 Summer Olympic Games in Atlanta. Post-Olympics versus pre-Olympics employment gains in counties affected by the Olympics exceeded employment gains in the rest of the counties in Georgia by 11% by the end of 2000. In addition, Olympics-affected counties in the metro Atlanta area experienced employment gains relative to other major Southern metropolitan statistical areas of roughly 5%. These results stand up to robustness and falsification tests.

JEL Classification: J21, C21, L83

1. Introduction

In 2003, we published, with a coauthor, an analysis estimating the impact of the 1996 Summer Olympic Games on employment in Georgia (see Hotchkiss, Moore, and Zobay 2003; hereafter referred to as "HMZ 2003").[1] Since that time, more recently published research has warned of potential mis-specification of differences-in-differences analyses that do not account for serial correlation in the error terms when using data spanning several years (Bertrand, Duflo, and Mullainathan 2004), do not include both a level and trend effect in the same estimation when using time series data (Galster, Tatian, and Pettit 2004), and do not control for time-specific (unit invariant) and unit-specific (time invariant) effects (Dachis, Duranton, and Turner 2011). These empirical developments were pointed out by Feddersen and Maennig (FM; 2013a) in their efforts to challenge the findings of HMZ 2003.

The primary purpose of this article is to illustrate that the identification of a positive statistically and practically significant employment impact of the 1996 Summer Olympic Games persists in spite of the new specification and estimation techniques proposed by FM (2013a,b). The inability of FM to uncover a significant Olympic effect derives from a combination of their failure to weight log employment models to account for potential impact size (FM 2013a,b) and inclusion of counties surrounding those that hosted venues in the control sample (FM 2013b), in spite of the finding in FM (2013a) that these are empirically important

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[1] The analysis also found a statistically significant positive impact on wages, but the results for wages did not pass the robustness checks, so are not reconsidered here.

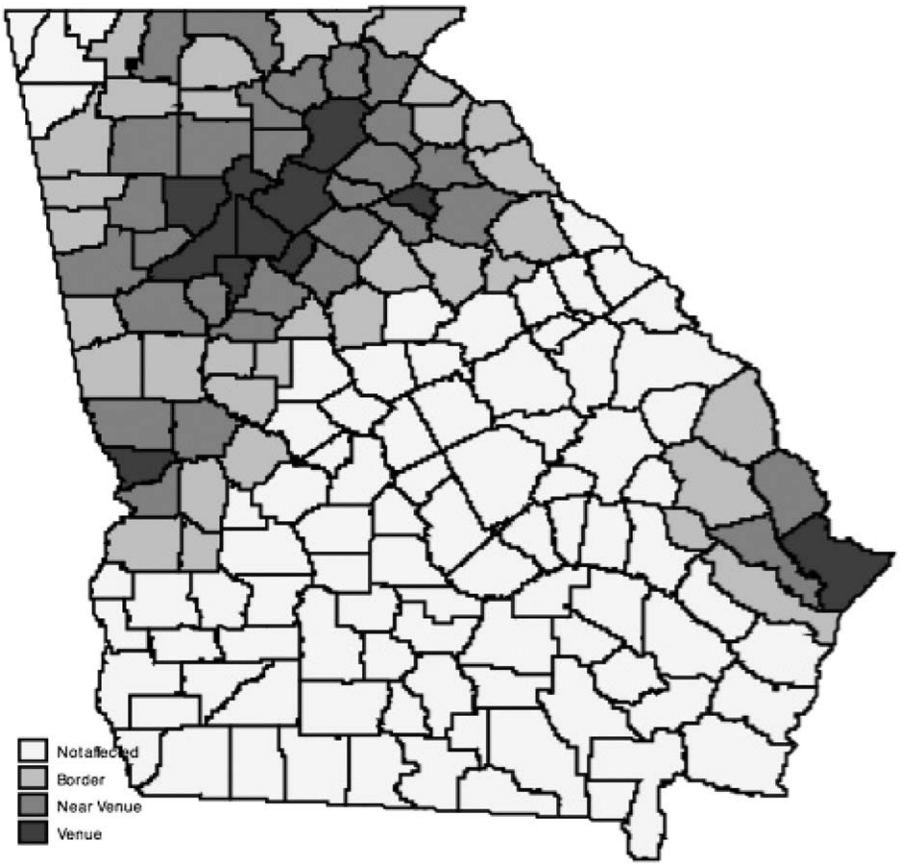

Figure 1. Map of Georgia counties indicating which counties hosted Olympic venues. Note: Darkest shaded counties indicate counties containing Olympic venues. One venue was located in Chattanooga, TN, hence bordering counties in north Georgia. Figure 1 in HMZ (2003) inadvertently left Near Venue Walton County unshaded, although that county was correctly identified as a Near Venue county in all analyses contained in that article and this one.

counties. In addition, FM (2013a) applied an inappropriate test to determine at what point in time employment growth for the affected counties diverged. The robustness checks included in the original HMZ (2003) article are repeated here for the new specification. We update the estimated employment impact of the 1996 Summer Olympic Games and add some context in which to evaluate the cost of those job gains.[2]

2. Background

Atlanta, and various other locations in the state of Georgia, hosted the 1996 Summer Olympic Games. HMZ (2003) implemented a differences-in-differences analysis to estimate the impact

[2] Note that the impact measured here is more appropriately attributed to the combined effects of the Olympics and Paralympics, which immediately followed the Olympics and made use of the same Venues. This, of course, applies to any analysis of the impact of the 1996 Summer Olympic Games.

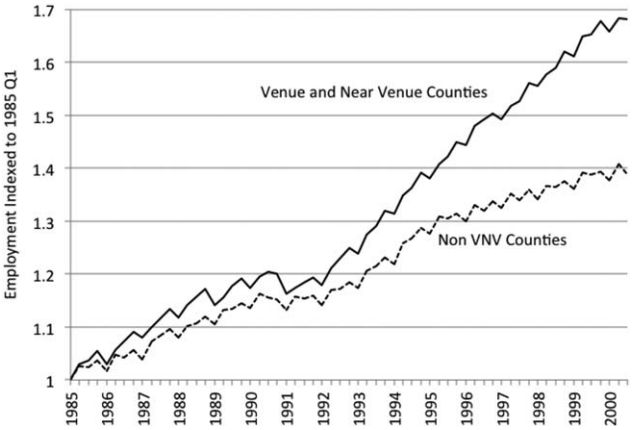

Figure 2. Indices for total employment in VNV and non-VNV counties, 1985 as base. Notes: VNV counties are those counties that either hosted or are contiguous to counties that hosted an Olympic event. Employment plotted from 1985Q1 through 2000Q3.

on employment in Venue and Near Venue (VNV) counties—these are counties that either hosted or were contiguous with counties that physically hosted an Olympic event. Figure 1 shows a map of Georgia with the counties hosting venues shaded the darkest. Counties surrounding those counties are referred to as Near Venue counties, and counties surrounding those will be referred to as border counties.[3]

HMZ (2003) included separate level and growth differences-in-differences analyses, a random-growth model falsification test, and a metropolitan-effect validity test. However, the differences-in-differences analysis did not include the level and growth effect simultaneously, nor were the standard errors corrected for potential serial correlation, nor were county- or time-specific effects included in the analysis. This reevaluation of that original analysis does all of these things. In addition, in implementing the new specification, we uncovered how important it is to weight employment growth by county size, allowing, for example, a 1% increase in employment from a large county to contribute more to the estimate of total employment impact than a 1% increase in employment from a small county. By not weighting, a 1% change in employment in small counties is inappropriately given the same importance for job creation as a 1% change in employment in large counties. Alternatively, we estimate the employment equation in levels, rather than logs, getting similar results as it also accurately accounts for county size.

Figure 2 plots indices of employment for VNV and non-VNV counties. Visually, it appears that something happened in the early/mid-1990s to make employment (especially the growth) in VNV counties deviate from that of non-VNV counties. Note that the announcement of Atlanta as the host city for the 1996 Summer Olympics was made in September 1990, so we might expect to see some impact any time between the announcement and leading up to the Games themselves. The data are quarterly employment data obtained from administrative employment records (see HMZ 2003, pp. 692–4, for details).

[3] Note that there was an error in Figure 1 in HMZ (2003)—Walton county was erroneously left unshaded as a Near Venue county. However, this was merely an error in the figure, rather than an analytical error; Walton county was (and is here) correctly coded as a Near Venue county in all analyses.

HMZ (2003) estimated two employment equations separately, one that tested for a level shift in employment and one that tested for a shift in the growth, respectively:

$$\ln\text{Emp}_{it} = \beta' X_i + \alpha_1 \text{VNV}_i + \alpha_2 \text{POST}_t + \alpha_3 \text{VNV}_i \times \text{POST}_t + \epsilon_{it} \quad (1)$$

$$\ln\text{Emp}_{it} = \beta' X_i + \gamma_1 t + \gamma_2 t \times \text{VNV}_i + \gamma_3 t \times \text{POST}_t + \gamma_4 t \times \text{VNV}_i \times \text{POST}_t + \epsilon_{it}, \quad (2)$$

where $\ln\text{Emp}_{it}$ is log employment in county i in quarter t, X_i are county-specific characteristics (including shares of employment in each broad industry and log population in 1990), $\text{VNV}_i = 1$ if county i is a Venue or Near Venue county, and $\text{POST}_t = 1$ if the observation appears after the designated intervention date associated with the Olympic effect. The coefficients, $\hat{\alpha}_3$ and $\hat{\gamma}_4$, were estimated to be highly statistically different from zero, indicating a significant increase in employment levels and employment growth among VNV counties after the Olympics, relative to before the Olympics, and relative to employment level and growth change among non-VNV counties.

That original article also included estimation of a random-growth model to test whether there were any systematic differences between VNV and non-VNV counties prior to the Olympics that could provide an alternative explanation for a significant "Olympic effect." Although the model passed that test, one can see from Figure 2 that VNV counties may have benefited from steeper employment growth even prior to the Olympics and if that original steeper growth is not controlled for in the level estimation, $\hat{\alpha}_3$ could be biased upward.

3. Reevaluation

There are several goals for the new estimation presented here: (i) control for differences in underlying trend employment growth between VNV and non-VNV counties, (ii) include county-specific and time-specific fixed effects, (iii) estimate standard errors that correct for possible heterskedasticity and serial correlation, and (iv) weight employment growth by county size to allow each percentage change in employment to accurately reflect the magnitude of the impact on total employment according to the size of the county. Controlling for county specific (time-invariant) fixed effects and time-specific (county-invariant) effects means that we are not able to separately identify the effects of county-specific characteristics included in the original estimations (the X_i s), VNV_i, or POST_t separately. The estimating equation now takes the following form:

$$\ln\text{Emp}_{it} = \delta_1 t \times \text{VNV}_i + \delta_2 \text{POST}_t \times \text{VNV}_i + \delta_3 (t - I) \times \text{POST}_t \times \text{VNV}_i + \tau_t + \varphi_i + e_{it}, \quad (3)$$

where everything is described as above, I is the endogenously determined quarter of intervention, τ_t is the time-specific effect, and φ_i is the county-specific effect. The estimate of δ_1 reflects the amount by which the underlying employment growth in VNV counties differs from that in non-VNV counties. The $(t - I)$ modifier produces a spline knot at the intervention point I, allowing the coefficient δ_3 to capture the deviation of employment growth in the VNV counties post-intervention from their underlying growth, captured by δ_1 (for example, see Poirier 1976 and Cukierman, Rama, and van Ours 2001).

The appeal of this specification is that it permits one to calculate a combined level and growth effect to determine how many more jobs (overall) were generated as a result of the Olympics. The total employment impact can be calculated as follows:

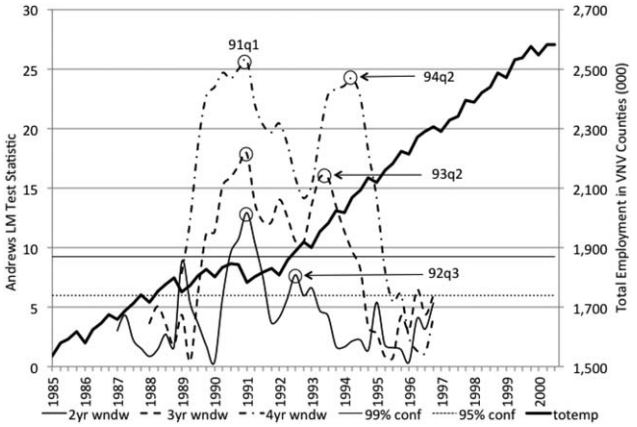

Figure 3. Andrews test statistics calculated for structural change using varying window, VNV county employment. Notes: Calculations based on the Andrews (1993) Lagrange multiplier test statistic, with confidence thresholds from Andrews (2003).

$$\frac{\partial \text{Emp}}{\partial(\text{POST}\times\text{VNV})} = [\hat{\delta}_2 + \hat{\delta}_3(t-I)]\times\text{Emp}.^{4} \tag{4}$$

Since there were years of preparation prior to the Olympics (which were held in 1996), we might expect the year in which VNV county employment deviates from non-VNV county employment (I) would be some time prior to the Olympics. In fact, the finance, monetary policy, and tax literatures abound with the importance of "announcement effects" (for example, see Mertens and Ravn 2011; Hussain 2011; Kalay, 2014). In addition, construction on Olympic venues began in 1993 (ACOG 1997).

Determining the Quarter of Intervention

Determining the quarter of intervention (I) becomes more complicated in the presence of heteroskedastic error terms, as there is no likelihood function with which to perform the usual model specification tests (see Wooldridge 2010, ch. 13). In spite of this, FM (2013a) continued to rely on the model F-statistic to determine the point of intervention.[5]

We employ a statistical test developed by Andrews (1993), which is designed to identify a structural change in a data series with an unknown change point. In this context, a structural change means a change in the trend before and after a particular point in time. So, rather than tell us at what point VNV and non-VNV employment growth were most likely to have diverged from

[4] This is derived by rearranging the terms and solving for *Emp* from the following derivative of log employment:

$$\frac{\partial \ln Emp}{\partial(POST * VNV)} = \frac{\partial Emp/\partial(POST * VNV)}{Emp}.$$

[5] The model *F*-statistic (even corrected for the presence of heteroskedasticity) is only valid for model choice under conditions in which it has a monotonic relationship with the maximum likelihood function; this was the case in the original HMZ 2003 specification, but is not the case in the presence of heteroskedasticy. FM have not provided us with requested programs and details of their analysis.

one another, the Andrews test tells us the point at which employment growth in VNV counties is most likely to have changed trajectories.[6] Figure 3 illustrates the Andrews statistics estimated for various "windows." For example, a two-year window asks at a particular point in time whether the trend one year prior to that point differs statistically from the trend in the series one year after that point.

Whenever the Andrews test statistic exceeds the 95% confidence threshold, we are 95% confident that the employment series has changed trajectory on either side of the window indicated (99% confidence thresholds are also reported on the chart).[7] We can be most confident of a structural change in trend of the series where the Andrews test statistic reaches its highest points. Figure 3 indicates several candidates for testing for an Olympic intervention. The Andrews test results indicate a high probability that the trend in employment growth in VNV counties underwent a structural change in 1991Q1 (recall that the 1996 Summer Olympic Games were announced in 1990Q3). Other highly likely trend changes occurred in 1992Q3, 1993Q2, and 1994Q2. Taking a conservative approach, we test for an Olympic intervention for each of these split point candidates. The question is whether at any of these potential split points post-split employment growth in VNV counties exceeded pre-split employment growth by more than post-split employment growth in non-VNV counties exceeded pre-split employment growth. Ultimately, the exact point of intervention is not as important as whether there is a statistical VNV versus non-VNV difference in pre- and post-Olympic intervention employment growth.

Again, recall that it is not surprising that employment in VNV counties might have deviated from employment growth in non-VNV counties prior to the actual occurrence of the Games themselves, in summer 1996. For example, construction began on the largest Olympic facility (the Olympic Stadium) in 1993, and all of the rest of the facilities were completely constructed by March 1996 (ACOG 1997). In addition, there were several test events held in completed venues prior to the Olympic Games.

Importance of County Size

Taking logs of employment (as in Eqn. 3) converts absolute changes in employment to relative (percentage) changes. County population (and employment) in Georgia varies greatly, from 1,915 in Taliaferro County to 648,779 in Fulton County (in 1990). Not using county size weights, when counties are the observation unit, one emphasizes the impact of counties with smaller than average population and de-emphasizes the impact of counties with larger than average population, even though a 1% increase in employment in a large county contributes a greater number of jobs to the total than a 1% increase in a small county. As the task is to estimate the total employment impact of the Olympics, one must use weighted data when estimating an employment equation in logs.[8]

When county employment growth is weighted by county size, there are multiple points of significant Olympic impact, including the point of intervention identified by FM (2013a). Not

[6] See Hotchkiss, Pitts, and Rios-Avila (2014) for another application of the Andrews (1993) test.

[7] Since we are using the test as one of model specification and to be conservative in our hypothesis testing, we rely on the LM test statistic (see Cameron and Trivedi 2005). The confidence thresholds are found in Andrews (2003).

[8] Size of contribution of each county can also be captured by estimating Equation 3 in levels (rather than logs). These results are presented below as one of the robustness checks, which also contain results using a variety of different weighting schemes.

Table 1. OLS Estimation of Log Employment, VNV Versus Non-VNV Counties

	County Weights Are Average Employment Over Entire Time Period				Replication of FM (2013a) Unweighted	FM (2013a) Weighted
Intervention (I) =	1991Q1	1992Q3	1993Q2	1994Q2	1992Q1	1992Q1
Intercept	10.6139***	10.7796***	10.7443***	10.6849***	7.9503***	10.7607***
	(0.5358)	(0.5442)	(0.5469)	(0.5425)	(0.1128)	(0.5348)
$t \times VNV$ (δ_1)	0.0068	0.0038	0.0045	0.0055	0.0229***	0.0042
	(0.0089)	(0.0091)	(0.0091)	(0.0090)	(0.0053)	(0.0089)
POST × VNV (δ_2)	−0.0317*	−0.0001	0.0043	0.0074	−0.0357*	−0.0088
	(0.0187)	(0.0107)	(0.0101)	(0.0102)	(0.0146)[a]	(0.0128)
$(t - I) \times$ POST × VNV (δ_3)	0.0112**	0.0144**	0.0144**	0.0145**	0.0050	0.0141**
	(0.0056)	(0.0065)	(0.0066)	(0.0065)	(0.0057)	(0.0062)
$\frac{\partial \ln Emp}{\partial(POST \times VNV)} = \hat{\delta}_2 + Nyrs\hat{\delta}_3 =$	0.0750	0.1155**	0.1088**	0.0978**	0.0668	0.1110**
	(0.0498)	(0.0500)	(0.0492)	(0.0460)	(0.0470)	(0.0485)
Total Employment Impact: $\left[\frac{\partial \ln Emp}{\partial(POST \times VNV)}\right] \times Emp =$	n/a	261,265	250,035	229,331	n/a	248,365

Notes: Data are quarterly, but are transformed to annual equivalence to match estimation of FM (2013a). Estimation includes county and time fixed effects. Robust standard errors are reported. *, **, *** indicate statistical significance at the 90%, 95%, and 99% confidence levels, respectively. There are a total of 10,017 observations and 159 unique counties. Nyrs = number of years between intervention and 2000Q3; Emp = average employment in VNV counties between intervention and 2000Q3.

[a]Standard error reported for this estimate in FM is "0.0186," which appears to be a typo.

Table 2. OLS Estimation of Different County Comparisons, Specification of Employment, and Weighting Schemes; Calculated for Split at 1993Q2

County Group Comparison	Weight	Marginal Effect $\frac{\partial(\text{DepVar})}{\partial(\text{POST}\times\text{VNV})}=\hat{\delta}_2+\text{Nyrs}\hat{\delta}_3$	Employment Impact of the Olympics[a]
VNV versus non-VNV			
Log employment as dep. var. (results reported in Table 1)	Average county employment	0.1088** (0.0492)	250,035
Log employment as dep. var.	Average county population	0.0835** (0.0421)	191,893
Log employment as dep. var.	County population in 1990	0.0824** (0.0418)	189,365
Level employment as dep. var.	No weight	9,977** (4342.75)	389,103
Venue versus non-VNV	Average county employment	0.1137** (0.0538)	220,879 (Venue counties only)
Near venue versus non-VNV	Average county employment	0.0807** (0.0466)	28,686 (Near Venue counties only)
Venue versus non-VNV plus near venue	Average county employment	0.0958* (0.0522)	220,160 (Venue counties only)
Border versus rest of GA	Average county employment	0.0297 (0.0469)	n/a

Notes: See notes to Table 1. Nyrs is equal to 7.25 (the number of years between 1993Q2 and 2000Q3).
[a]For regressions with log employment as dependent variable, employment impact of the Olympics equals $\left[\frac{\partial \ln\text{Emp}}{\partial(\text{POST}\times\text{VNV})}\right]\times$Emp, where Emp is the average employment in the group of counties of interest between 1993Q2 and 2000Q3. For regressions with level employment as dependent variable, employment impact of the Olympics equals $\left[\frac{\partial \ln\text{Emp}}{\partial(\text{POST}\times\text{VNV})}\right]\times$(# of VNV counties). There are 39 VNV counties.

weighting each county's employment growth by its contribution to total employment partially explains why FM (2013a, 2013b) did not find a statistically significant impact.

4. Estimation Results

Table 1 contains the results from estimating Equation 3 at various split points of the data. The results indicate a significant deviation in employment between VNV and non-VNV counties at each split point suggested by the Andrews (1993) test statistic, except 1991Q1. Table 1 also contains a replication of the results reported by FM (2013a), using their erroneously determined intervention point, and the weighted version of those results, which also produces a statistically significant Olympic effect.[9]

The first column of Table 1 indicates that the first split point suggested by the Andrews (1993) test, in 1991Q1, is not a point at which VNV employment growth deviated significantly from non-VNV employment growth. This suggests that at this point in time there was an event

[9] We are able to replicate the estimation results reported by FM (2013a), with the exception of what appears to be a minor reporting error in their results (noted in the table), and the model *F*-statistic; in spite of our requests for programs and details in attempts to resolve these differences, the authors did not provide them.

that affected both VNV and non-VNV employment similarly. The ending of the 1990/91 recession in 1991Q1 is the most likely explanation. In addition, as it turns out, determining the exact point of intervention is a bit of a nonissue—a positive and significant deviation of employment growth in VNV counties from employment growth in non-VNV counties can be found at any split point during the relevant period, from 1991Q3 through the Olympics. For concreteness, we will discuss results just for those split points identified by the Andrews test statistic as having the greatest likelihood of being points of trend shift for VNV county employment.

The estimates of δ_1 in Table 1 indicate that the underlying VNV county employment growth rate was not statistically different than employment growth in non-VNV counties, preintervention. In addition, the estimates of δ_3 indicate that employment in VNV counties grew about 1.44% faster annually post intervention, relative to before, compared to the change in employment growth in non-VNV counties. The bottom row of Table 1 indicates that the overall employment gains post-Olympics versus pre-Olympics were about 11% greater in VNV counties than in non-VNV counties by the end of 2000—amounting to roughly 250,000 jobs.

5. Robustness

Type of County and Weighting Scheme

Table 2 contains the first set of robustness checks. Here, we report the results from using different weighting variables for the log employment regression, the results using level employment instead of log employment, and the impact on VNV counties separately, as well as a falsification test for border counties. To simplify the comparisons, we chose 1993Q2 (the midpoint intervention candidate) as the point of intervention for all estimations.

The employment impact estimated using average county population and county population in 1990 as weights is smaller than when average county employment is used as a weight—roughly 189,000 versus 250,000 jobs—but significantly larger (389,000) when it is estimated in levels (no weights). The bottom line of these robustness checks is that regardless of the weight chosen, or whether the analysis is performed in levels rather than logs, the estimation identifies a statistically significant and meaningfully large employment impact of the Olympics.

The last four rows of Table 2 compare the employment impacts for different groups of counties by themselves. These results are comparable to the 10.9% employment impact in VNV counties, relative to non-VNV counties, using average county employment as the observation weight. The employment impact in Venue counties alone (vs. non-VNV counties) was 11.4% and the employment impact in Near Venue counties alone (vs. non-VNV counties) was 8.1%—when the analysis is appropriately weighted, a larger impact of the Olympics on Venue counties than on Near Venue counties is uncovered.[10] In addition, the statistically significant impact on Venue county employment even when Near Venue counties are included in the control group, as was done by FM (2013b), confirms that the employment impact of the 1996 Summer Olympic Games was greater in Venue counties than in Near Venue counties; although the statistical significance of the impact is weaker, as would be expected when Near Venue counties are included in the control.

[10] FM (2013a) found that the employment impact was statistically significant in Near Venue counties and insignificant in Venue counties, again, not weighting the regressions.

Table 3. Random-Growth Model Falsification Results

	Post time period						
Pre time period	1986	1987	1988	1989	1998	1999	2000
Results for post- versus pre-Olympic impact							
1985					−	−	−*
1986					−	−	−**
1987					+*	+**	+
1988					+	+	−
1989					+	+	−
Pre-event test results							
1985	−	−**	−*	−*			
1986		−**	−*	−**			
1987			+	+			
1988				−			
Post-event test results							
1998						+	−
1999							−*

Notes: Potential event time period is defined as 1990–1997. The sign and significance level correspond to the estimated partial derivative: $\frac{\partial \ln Emp}{\partial (POST \times VNV)}$. *, **, *** indicate statistical significance at the 90%, 95%, and 99% confidence levels, respectively.

Although it is intuitive for the employment impact to be greatest in those counties that hosted venues, we would not have been surprised if the larger impact had been found in the Near Venue counties. Previous research finds that there can be significant positive impacts of mega-events on neighboring geographic areas (Leeds 2008 and Zhang and Zhao 2007, for example), and can even displace usual economic activity in the short-term in the area closest to the event (for example, see Hultkrantz 1998). As noted by Newman (1999), there is also the possibility of long-term economic displacement when host areas use events, such as the Olympics, as an opportunity to redefine land use, often displacing residents and pushing existing economic activity away from the venue. It should also be noted that metropolitan areas in Georgia (where Olympic venues were located) are not densely populated (most residents locate in the suburbs), so any in-migration that resulted from hosting the Olympics would be expected to be concentrated in Near Venue counties (the suburbs). In the end, it is an empirical question—where did the presence of the Olympic Games have their biggest impact? FM (2013b) simply choose to ignore any possible impact of the Olympics on neighboring geographic areas, and include the Near Venue counties in their control group, which will clearly constrain (bias) the potential measured impact of the Olympics toward zero.[11]

To illustrate that there is something special about these VNV counties, we treat counties that border VNV counties (see Figure 1) as the treated group. Results in the last row of Table 2 show that not just any county will do. There is no significant employment difference comparing counties that border VNV counties to the rest of Georgia, indicating that there was something different about VNV counties—the presence or nearness of Olympic venues.

[11] FM (2013a) present what they claim is further evidence of no Olympic effect by estimating a nonparametric model that does not actually estimate trend change differences of affected areas versus nonaffected areas; their estimates consider only level differences (albeit, at each time period). They acknowledge that the slope of the trends of employment differences between treated and control groups changes from negative to positive around the time of the Olympics, but provide no estimate of the statistical difference in that slope change. Not allowing for trend effects at the same time as level effects was the source of their original criticism of HMZ; it is unclear, therefore, why they chose to impose this constraint in their second analysis.

Random-growth Model Falsification Test

In our original article (HMZ 2003), we presented a falsification check in the form of a Heckman and Hotz (1989) random-growth model. The idea behind this check is to make sure that the difference in employment growth, pre- and post-Olympics, in VNV and non-VNV counties is not a difference in employment growth that exists both pre- and post-Olympics. In other words, we want to rule out that VNV counties perpetually grow at a different rate than non-VNV counties when comparing two arbitrary time periods. The implementation of the random-growth model here differs somewhat from that in our original article. There were no county fixed effects in that original analysis and the random-growth model estimation was designed to essentially difference away any fixed effects specific to VNV and non-VNV counties. Here, as we already include county and time fixed effects, we simply re-estimate the model described in Equation 3 using all possible years safely before any possible Olympic effect (say, before 1990, when the Olympics were announced), then using all possible years safely after any possible Olympic effect (say, after 1997, the year following the Olympic events), then comparing years after and before that Olympic window. Table 3 contains a summary of the results from this analysis, and, for ease of exposition, contains only the sign and significance level of the partial derivative $\frac{\partial \ln Emp}{\partial(POST \times VNV)}$.

By comparing only two years of county data at a time (as prescribed by the test), we are asking a lot from the fixed-effects regression. Consequently, we are looking for patterns of falsification. In other words, do the results in the separate pre- and post-Olympic periods look more like what we are claiming to be an Olympic effect, or, does the VNV/non-VNV employment deviation appear most convincingly when comparing employment pre- and post-Olympics? The only comparisons yielding positive and statistically significant partial derivatives are found in the comparison of post- versus pre-Olympic time periods, supporting the estimate of a positive employment impact of the Olympic Games seen in Table 1. The majority of the partial derivatives in either the pre-event or post-event comparisons are negative, with some significance in the pre-event period suggesting that before the Olympics, VNV counties were more likely to have been experiencing slower employment growth than non-VNV counties. These separate pre- and post-Olympic analyses suggest that there is not an intrinsic difference between VNV and non-VNV counties that would lead us to conclude that VNV counties perpetually grow faster, regardless of the time period considered.

Metropolitan Statistical Area Comparison Validity Test

As a further validity test, we compare employment growth in VNV counties in the Atlanta Metropolitan Statistical Area (MSA) to employment growth in other major Southern MSAs between 1990 and 2000. Just over 70%of the 1996 Summer Olympic activity took place in Fulton County (calculations using data from ACOG 1997), which is the heart of the Atlanta MSA. To determine whether the impact of the Olympic Games was really just an MSA effect, we re-estimate Equation 3 using just the Atlanta metro VNV counties as the treatment, and other Southern MSAs that were similar to Atlanta in 1990 as controls.[12] We find that the change in Atlanta

[12] The criteria for inclusion in the control group of MSAs included a 1990 population level between one million and three million people and positive population growth between 1990 and 1997. The control MSAs included Charlotte, NC; Dallas, TX; Fort Lauderdale, FL; Fort Worth, TX; Greensboro, NC; Memphis, TN; Miami, FL; New Orleans, LA; Norfolk, Virginia; Orlando, FL; San Antonio, TX; and Tampa, FL. Full estimation results are available on request.

metro VNV employment growth from pre- to post-Olympics is statistically significantly greater than the change in employment growth among other Southern MSAs. The marginal effect tells us that employment in the Atlanta metro VNV counties grew about 5% more after 1993 than before 1993, relative to the change in growth experienced in other Southern MSAs.

6. Conclusion and Policy Implications for New Estimates of Olympic Impact

This article incorporates some methodological improvements over our earlier analysis of the employment impact of the 1996 Summer Olympic Games in Georgia, and corrects errors made by FM (2013a) in their critique of our earlier work. We estimate that employment grew more in counties that hosted and were near counties that hosted Olympic venues, post-Olympics versus pre-Olympics, by more than employment growth changed in the rest of Georgia. This additional employment growth added about 250,000 jobs for these VNV counties. This estimate is slightly smaller than the 293,000 estimate reported from our earlier analysis. 250,000 jobs is roughly one third of all jobs created in VNV counties from 1993Q2 (the midpoint intervention candidate) to 2000Q3. We perform multiple robustness checks to verify the validity of the results. Comparison to growth in other Southern MSAs that were similar to Atlanta in 1990 suggests a lower bound for the employment impact of the 1996 Summer Olympic Games of 5%—employment in the Atlanta metro area VNV counties grew 5% more post-Olympic versus pre-Olympics, relative to other MSAs of similar 1990 characteristics. However, this lower bound excludes the employment impact on non-Atlanta metro VNV counties.

Of course, finding a statistically and practically significant impact on employment begs the question of whether the job creation benefit was worth the cost. The Government Accounting Office estimates that the combined total cost of the Summer Olympic and Paralympic Games in Atlanta amounted to $2.4 billion (GAO 2001). If 100% of the cost of hosting the Olympics is assigned to job creation, then each additional job created cost roughly $9600. Considering only the $427 million spent by Federal and local governments (GAO 2001), the taxpayer cost per job created comes to roughly only $1,700. Clearly this should be considered an upper bound, as it does not assign any costs to other benefits that resulted from hosting the Olympics, such as facilities and infrastructure, which remained in place after the Games. To put this "cost-per-job" estimate into perspective, Bartik (1994) estimates that jobs created by the hundreds of millions of dollars spent each year by New York, Michigan, and Louisiana in the early 1990s, through tax incentives offered to companies to promote economic development, cost $26,000 per job created (over a 6.5-year period). In addition, Luger and Bae (2005) estimate that jobs created in North Carolina in 1999 from economic development tax incentives cost $147,000 per job created. On the low end of most estimates, Faulk (2002) estimates that Georgia spent $2500 per job created through tax incentives paid to firms between 1993 and 1995. Although job creation was not generally regarded as one of the major motivations for hosting the Olympic Games in Atlanta, it nevertheless appears to have been a substantial side benefit.

Two articles recently published by FM (2013a,b) call into question the significant employment effects that were reported in our earlier analysis (HMZ 2003). We have incorporated the methodological improvements suggested by FM (2013a), corrected for their errors, and continue to find statistically and practically significant employment impacts of the 1996 Summer Olympic Games. The inability of FM (2013a) to find a significant impact on the total number of jobs

created results from not recognizing the importance of weighting job growth (when measured as a relative change) by county size. The failure of FM (2013b) to find a significant impact likely results from misclassifying part of the treatment area as part of their control group. In spite of finding in their earlier article (FM 2013a) that the measured employment impact was driven by the impact on employment in Near Venue counties, their later analysis arbitrarily includes the Near Venue counties in the control group, biasing any measured effect toward zero. As demonstrated in this article, a finding of significant employment effects in Near Venue counties is probable.

We recognize that the results in the article are in contrast with many others on the impact of Olympic Games (see FM 2013b for a discussion of these studies). It is important to recognize that exact circumstances determining the impact of any major event can never be replicated. In other words, just because Georgia experienced a significant long-term employment boost from hosting the 1996 Summer Olympic Games does not mean the next host will experience the same impact. Why might the Atlanta Olympics have generated the significant impact identified in this article? First, the Atlanta Olympics were planned from the beginning in such a way as to avoid creating a huge public debt. This was accomplished partly by utilizing many existing facilities for Olympic venues (ACOG 1997, Ch. 27). Second, unlike many other Olympics, the venue sites that were constructed for the Atlanta Olympics were planned with post-Olympic usage in mind. So, for example, the Olympic stadium became Turner Field, home to the Atlanta Braves for 20 years; the Olympic Natatorium became the Georgia Tech Recreation Center; and the Olympic Village become student dormitories for Georgia State University and Georgia Tech. Centennial Olympic Park revitalized the surrounding area and has become a center for tourism in Atlanta featuring the Georgia Aquarium and the World of Coca-Cola, along with hotels, shopping, museums, and high-rise residential developments. Would some of this development have happened in Atlanta without the Olympics? Perhaps, but it is certainly the case that all of these developments would not have been initiated in such a concentrated period of time.

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