EXTENDED ABSTRACT

Title: Econometric estimation of economic effects of cultural and tourism events with network interference: a fuzzy DiD approach to panel spatiotemporal treatment estimation

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Abstract: *(minimum1500 words)*

In recent years, festivals and special events have become one of the fastest growing category of tourism attractions (Crompton and McKayn, 1997; Getz, 1993, 1997; Thrane, 2002; Getz and Page, 2016; Wilson et al. 2017). One of the advantages of such kind of events is that they can create a demand in a time that might be regarded as off-season. This use of events to fill the gap left in the off-peak season by a seasonal drop in tourism demand has been confirmed by several scholars (Connell, Page and Mayer, 2015; Getz and Page, 2016). Moreover, they can be considered as marking tools as well as generator of income (Saayman and Saayman, 2006). Impact analysis of festivals and cultural events has been an important issue in event studies for decades, in particular with a reference to the empirical assessment of the impact on local economies of the expenditure incurred by visitors and to the production of the events (among others, Gazel and Schwer, 1997; Brown et al., 2002; Schunk and Teel, 2002; Stynes et al., 2003; Tohmo, 2005; Herrero et al. 2006; Bracalente et al., 2011; Andersson and Lundberg, 2013).

Since the seminal work of Baade and Dye (1988; 1990) almost thirty years ago, the analysis of the economic impact of sports teams, stadiums, and major athletic events on host economies has elicited significant attention from sports economists (e.g. Coates and Humphreys, 1999; 2002; Baade and Matheson, 2002; 2004; Baade, Baumann, and Matheson, 2008; Hagn and Maennig, 2008; Jasmand and Maennig, 2008; Feddersen and Maennig, 2010). While the academic literature agrees that ex post studies produce better estimates than ex ante approaches, there is no consensus on the right empirical techniques. In an overview paper, Baumann and Matheson (2011) list numerous problems of ex-post econometric studies: both city and time effects must be considered; unit roots are a major

problem; usage of fixed effects can create additional econometric problems; the solution for autocorrelation is complicated, and in some cases the researcher may be better off ignoring this problem than correcting it; the effect of an event or championship need not be in only one period; most often an event is measured as a simple dummy variable in the period it occurred, but clearly

In this study, we present an important development and to our opinion solve this problem. We model the problem of estimating economic impact of an event as a spatio-temporal autocorrelation problem, by defining two types of connections: temporal – two events are connected in a certain time moment if they take place at the same time; and spatial – the events are connected through spatial weight distance matrices. To estimate the economic effects of the Venice carnival, we utilize a three part empirical strategy. Firstly, we estimate ARIMA and intervention analysis univariate time series models for all included competing events individually to derive estimated number of visitors by time period and event. Secondly, we derive spatial and temporal weight matrices (if the event took place on different places in the city we use Fréchet means and/or medians). Finally, we derive a new, spatiotemporal autoregressive (AR) difference-and-differences estimator, to estimate the causal, event-specific effects of Venice Carnival, taking into account spatial and temporal dependence between the events. To this end we extend the spatial AR difference-and-differences estimator of Delgado and Florax (2015) with controling for non-satisfying the SUTVA assumption using fuzzy difference-in-differences time-corrected Wald ratio and changes-in-changes (Athey and Imbens, 2006) estimation (de Chaisemartin and D'Haultfoeuille, 2017).

The basic form of a spatial autoregressive difference-in-differences estimator is (Delgado and Florax, 2015):

$$D_L \circ T = (I + \rho L^s) D \circ T = (I + \rho W_s) D \circ T \qquad (1)$$

where W_s is a $(2n \times 2n)$ block-diagonal row-standardized spatial weights matrix containing non-zero elements for spatial units belonging to contiguity class s, L^s is the

spatial lag operator, ρ is the spatial autoregressive parameter and $\circ$ signals element-by-element matrix multiplication (i.e. Hadamard product)

Delgado and Florax list four possibilities for estimation, listed below (D is the basic treatment variable, D_L is its spatial autoregressive form and $\widetilde{D}$ its spatially lagged form):

$$y = \alpha_0 + \alpha_1 D + \alpha_2 T + \alpha_3 D \circ T + \varepsilon \qquad (2)$$

$$y = \alpha_0 + \alpha_1 \widetilde{D} + \alpha_2 T + \alpha_3 \widetilde{D} \circ T + \varepsilon \qquad (3)$$

$$y = \alpha_0 + \alpha_1 D + \alpha_2 T + \alpha_3 D_L \circ T + \varepsilon \qquad (4)$$

$$y = \alpha_0 + \alpha_1 \widetilde{D} + \alpha_2 T + \alpha_3 \widetilde{D}_L \circ T + \varepsilon \qquad (5)$$

Finally, they define their difference-in-differences estimator in two equations below which define also appropriate form of average treatment effect decomposed of direct and indirect (neighbor-related) parts.

$$+y = \alpha_0 + \alpha_1 D + \alpha_2 T + \alpha_3 D_L \circ T + \varepsilon = \alpha_0 + \alpha_1 D + \alpha_2 T + \alpha_3 (I + \rho W) D \circ T + \varepsilon$$
$$= \alpha_0 + \alpha_1 D + \alpha_2 T + \alpha_3 D \circ T + \alpha_4 WD \circ T + \varepsilon \qquad (6)$$

$$ATE = \alpha_3 (1 + \rho \overline{WD}) = \alpha_3 + \alpha_4 \overline{WD} \qquad (7)$$

where $\overline{WD}$ is the average proportion of treated neighbors, which can also be interpreted as the probability of the neighbors being treated.

Our proposed novel estimators take the following forms (W_{STDID} stands for basic Wald ratio estimator, W_{STTC} for its time-corrected form and W_{STCIC} for its changes-and-changes form; we refer to standard notation used in de Chaisemartin and D'Haultfoeuille, 2017):

$$W_{STDID} = \frac{\alpha_3}{E(D_{11}) - E(D_{10})} + \frac{\alpha_4 \overline{SD}}{E(D_{1swd}) - E(D_{10})} + \frac{\alpha_5 \overline{TD}}{E(D_{1twd}) - E(D_{10})} + \frac{\alpha_6 \overline{STD}}{E(D_{1stwd}) - E(D_{10})} + \frac{\alpha_7 \overline{TSD}}{E(D_{1tswd}) - E(D_{10})} \quad (8)$$

$$W_{STTC} = \frac{\alpha_{3TC}}{E(D_{11}) - E(D_{10})} + \frac{\alpha_{4TC} \overline{SD}}{E(D_{1swd}) - E(D_{10})} + \frac{\alpha_{5TC} \overline{TD}}{E(D_{1twd}) - E(D_{10})} + \frac{\alpha_{6TC} \overline{STD}}{E(D_{1stwd}) - E(D_{10})} + \frac{\alpha_{7TC} \overline{TSD}}{E(D_{1tswd}) - E(D_{10})} \quad (9)$$

$$W_{STCIC} = \frac{\alpha_{3CIC}}{E(D_{11}) - E(D_{10})} + \frac{\alpha_{4CIC} \overline{SD}}{E(D_{1swd}) - E(D_{10})} + \frac{\alpha_{5CIC} \overline{TD}}{E(D_{1twd}) - E(D_{10})} + \frac{\alpha_{6CIC} \overline{STD}}{E(D_{1stwd}) - E(D_{10})} + \frac{\alpha_{7CIC} \overline{TSD}}{E(D_{1tswd}) - E(D_{10})} \quad (10)$$

Following the explicit forms of three novel econometric estimators in (8)-(10) we study their asymptotic properties using functional delta and Stein approaches and present results of Monte Carlo simulations.

We use the newly developed method on the example of Venice Carnival which is one of the most internationally known festival celebrated in Italy. This culture and congregation of masked people began in the 15th century, but its tradition dates back to the 11th century. Although there is not much left today of the historical and cultural tradition of the Venice Carnival, in the late 1970's a new popular spirit of Venice Carnival bloomed wild. Soon the city authorities began what is presently the current cultural celebration of the Carnival, mainly for tourists. Unlike many Venetian celebrations that remain almost unknown to the public, the culture of the Venice Carnival seems to be thriving as much as it ever did with a strong positive balance of costs-benefits (Santoro and Massiani, 2014).

Following previous but scarce ex-post econometric analyzes in cultural economics we estimate economic effects of Venice Carnival on tourism and employment of approximately 50,000 additional tourists and 170,000 overnight stays yearly due to the event and a significant drop in short-term unemployment. We approximate the total economic impact taking into account direct, indirect and induced effects.

To use our novel approach we include 8 “competing events”, the Venice Carnival and seven others, all shortly listed below:

- Carnival (Carnevale): This is the big one, Venice's greatest tourist event. St. Mark's Square fills with glamorous, sinister figures in mask and costumes. The Carnival takes place in February, during the ten days leading up to Shrove Tuesday.
- La Sensa: The Festa della Sensa celebrates the relationship between Venice and the sea. It involves a procession of boats traditionally led by the doge who throws a ring into the waves to symbolise a marriage between Venice and the sea. The event follows Ascension Day, and in 2012 took place on 20th May.
- The Vogalonga: This is a huge and cheerful rowing event which takes place on a Sunday in May or June. In 2012 the date was 27th May.
- The Biennale: The Biennale started as an art show every two years, and has grown to become an umbrella organisation covering a large range of events, including the Venice Film Festival. The event takes place biannualy, in each odd year.
- Festa del Redentore: Every year Venice gives thanks for its relief from a severe outbreak of plague in the late sixteenth century. The religious celebrations are held on the third Sunday of July. The night before (Saturday) is a great party with feasting followed by night-time fireworks and the weekend finishes with a gondola regatta.
- Venice Film Festival: The annual International Film Festival in Venice is part of the Biennale (see above). In 2011 the dates were 31st August to the 10th September.

- Regata Storica: Venice is fond of boating, and this 'historic regatta' is the largest event in the year. In 2011 the Regata Storica took place on 4th September.
- Biennale Theater (Theater alle Tese): The Tese Cinquecentesche host the Teatro alle Tese, opened in 2000: a flexible space conceived for theatre and music productions as well as meetings.

In our initial estimation stage, the following simple four-part econometric procedure is followed:

1) We clean the data from seasonal and cyclical effects

$$TA = \alpha Q1 + \beta Q2 + \gamma Q3 + \delta Q4 + \theta TAV + \varepsilon_t \qquad (11)$$

2) We use Box-Jenkins procedure in order to

a) Provide identification for the process

b) Estimate the parameters of the process

c) Use diagnostic checks to determine if the residuals are in fact white noise

3) We use the following interrupted time-series specification of intervention analysis

$$TA_t = b_0 + b_1 T + b_2 X_t + b_3 XT_t + \varepsilon_t \qquad (12)$$

4) We calculate the final consumption effects.

The symbols above in (11) and (12) stand for variables, estimated coefficients and error terms of the two econometric equations and are defined in more detail in the article. Based on the information on the location and time of the events we define the spatial and temporal weight matrices and finally use novel spatiotemporal autoregressive difference-in-differences estimators to estimate the event-specific treatment causal effects of the Venice Carnival. Results are subject to sensivity analysis with several robustness checks performed.

This article contributes towards the empirical assessment of the economic impact of cultural events with a case study, relevant because of its cultural and long tradition relevance. We also present a novel method in general ex-post econometric verification literature, able to solve the main pressing problem in the literature, as well as three novel spatiotemporal difference-in-differences estimators contributing to the growing econometric literature in this field. The estimators can easily be generalized to spatial difference-in-differences SUTVA-corrected estimation as well as additional econometric (e.g. following Clarke, 2017) and Bayesian perspectives. The study has wide consequences and large potential of becoming a standard method in future estimations of economic impact of cultural, sport, congress and other events, taking into account the spatial and spatiotemporal perspectives.

Keywords: *causal inference, average treatment effect, difference-in-differences, spatial econometrics, spatiotemporal autoregressive models, Venice carnival*

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