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The impact of terrorism on inbound tourism: disentangling the cross-spatial correlation

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Abstract

There is growing evidence that the recent wave of terrorism is underpinned by a common factor. This is illustrated by the heightened cross-country correlation of terrorist attacks. This has been largely ignored in the literature assessing the effect of terrorism in destination countries on inbound tourism: the standard approaches typically abstract from the possible impact of terrorism elsewhere on tourist arrivals in a given destination. We cast a gravity model into the common factor setting in the context of 35 OECD countries during 1995-2015 and show that the common approaches underestimate the repercussion of terrorist incidents on tourist inflows. We use the common correlated effects estimator to correct for the bias. Our results highlight the need for acknowledging the cross-section correlation in terrorism and using appropriate estimation strategies whenever the economic incidence of terrorism is examined.

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1. Introduction

The impact of terrorism on inbound tourism has been largely investigated in empirical research, given the particular vulnerability of the tourism industry to shocks (Baker and Coulter, 2007; Sönmez *et al*., 1999). The mainstream literature has often found a negative impact of terrorist incidents in destination countries on tourist arrivals (Ito and Lee, 2005; Karl *et al*., 2017; Llorca-Vivero, 2008; Sönmez, 1998). A legion of reasons were brought forward to explain this effect. Terrorist incidents render the tourism trip riskier, which would deter would-be tourists from travelling as they highly value their safety (Lepp and Gibson, 2003). In addition to the actual risk induced by terrorism, the latter affects how would-be tourists perceive a given terrorism-hit destination: the altered perception of risk could magnify the actual risk (Buigut and Amendah, 2016; Fletcher and Morakabati, 2008). This would lead to further drops in tourist arrivals to a hit-destination, as tourists switch to alternative destinations (Baker, 2014). Moreover, through their adverse effects on macroeconomic conditions in destination countries, terrorist attacks would reduce inbound tourism (Mitra *et al*., 2017).

A related stream of research has focused on studying the nature and characteristics of worldwide terrorism. A sketch of the "genealogy" of recent terrorism trends reveals a number of successive waves. One such wave is the violent nationalist movements that left their mark on the end of the colonial era (Bassil *et al*., 2019). A different wave is the ethnic-based quests of cultural and political autonomy within a number of countries (Lutz and Lutz, 2017). Another flow of terrorism was fueled by left-wing activists to topple capitalist governments in several countries, notably in Europe (Lutz and Lutz, 2017). The latest surge in violence is embodied by the so-called Islamic terrorism that emerged toward the end of the 1990s and strengthened throughout the 2000s, with the recent attacks in New York (2001), Madrid (2004), London (2005), Nice and Berlin (2016), and Istanbul (2017) (Bassil *et al*., 2019; Lutz and Lutz, 2017). Recent Islamic terrorist attacks are stained with a number of peculiarities: they have often targeted developed countries and been particularly deadly; moreover, they have commonly occurred in public places, typically visited by tourists (Teoman, 2017). Another structural feature of the latest terrorist attacks is their spatial correlation. Using principal component analysis, Gaibulloev *et al*. (2013) showed that there is a significant association between terrorist incidents across the globe. That is, they demonstrated that recent terrorism is a "global" phenomenon. Gaibulloev *et al*. (2013) provided various reasons that explain this. First, current terrorism is underpinned with ideologies that often identify a cluster of "enemy" countries and call for targeting those countries in concert. Second, in some cases, major political events may ignite terrorist attacks in a number of countries almost concurrently. In this vein, Dreher and Gassebner (2008) revealed that countries whose voting in the United Nations General Assembly was aligned with that of the United States were more hit by terrorism. Third, terrorist groups (like Al-Qaeda and the Islamic State in Iraq and Syria, ISIS) have dormant cells in the target countries that can be activated simultaneously. In this regard, Gurer (2017), Lutz and Lutz (2017) and Teoman (2017) have shown that the most recent terrorist incidents that hit European countries were committed by individuals having the citizenship of their country of residence while being linked to ISIS. Fourth, as countries previously hit by terrorist attacks started implementing anti-terrorism measures, terrorist groups reacted by enlarging their target countries. Overall, there is mounting evidence that the latest wave of terrorism is correlated across space.

The literature that shed light on the impact of terrorist attacks on international tourism has typically ignored the global nature of recent terrorism[1]. By neglecting this aspect of terrorism, the estimation techniques commonly used in the extant literature have abstracted from the possible repercussions of terrorist attacks abroad on tourist inflows to a particular destination. In this respect, the purpose of this paper is threefold: (i) demonstrate that the common estimation techniques yield a biased estimate of the effect of terrorism on inbound tourism; (ii) provide an analytical framework that accounts for cross-section dependence among the variables and thus allows for spatially correlated terrorist attacks; and (iii) use an adequate estimation strategy. Our paper would thus bridge the gap between the literature inspecting the relation between terrorism and tourism, and the strand of research that revealed the correlated aspect of recent terrorism.

To do so, we use a gravity model and annual data covering 1995-2015 to assess the effect of terrorist incidents in destination countries on intra-OECD tourist arrivals[2]. The choice of the sample countries is relevant: (i) several OECD countries are important touristic destinations: in 2016, eight out of the first ten top touristic destinations were OECD countries (UNWTO, 2017); (ii) tourism is an important industry in a number of OECD countries where a large share of their export earnings originates from tourists (Culiuc, 2014); (iii) OECD countries have recently been the venue of terrorist attacks, many of which perpetrated by residents linked to ISIS; and (iv) the availability of consistent data on international bilateral tourism flows for OECD countries makes it suitable for panel data econometrics.

2. The gravity model, the common factor framework, and the Common Correlated Effects (CCE) estimator

Gravity models that have been recently used to study tourism flows between origin country i and destination country j (TF_{ij}) at a given point in time are based on the following multiplicative relationship:

$$TF_{ij} = O_i D_j \phi_{ij} \psi_{ij} \quad (1)$$

Where O_i captures the capacity of origin country as a "provider" of flows to all possible destination countries, D_j reflects the propensity of destination country to attract flows from all potential source countries, ϕ_{ij} embodies the ease of access of the flows from origin to destination, and ψ_{ij} represents the relative connectedness of each of the two countries with respect to the rest of the world (the so-called "third country" effect). Several metrics have been regularly used to proxy for the right-hand side variables of equation (1): the economic masses (GDPs) of origin and destination countries are meant to capture, respectively, O_i and D_j; a

[1] With the exception of papers studying the possible cross-country spillover effects of terrorism on tourism (Bassil *et al.*, 2019; Drakos and Kutan, 2003; Neumayer, 2004). The first two papers only cover a very small sample of countries, which makes their results highly sample-sensitive. Neumayer (2004) uses a large sample; however, he employs regional aggregates to check for spillover effects within countries of the same region. Moreover, his terrorism indicator does not reflect the magnitude of the terrorist attacks.

[2] Australia, Austria, Belgium, Canada, Chile, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Republic of Korea, Latvia, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

number of dyadic variables that would impede or foster the bilateral flows control for the ease of access between the two countries; while, in a panel setting, country-fixed effects as well as time effects are commonly used to account for the "third country" effect.

We employ the gravity setting to evaluate the impact of terrorist incidents in destination countries on inbound tourism while accounting for the cross-country correlation among the variables, notably terrorism. If such cross-sectional correlation is unaccounted for, the impacts of the regressors, including terrorism, would be biased. This is shown in the following illustrative model where, in a given year *t*, bilateral tourist flows $(TF_{ij,t})$ are supposed to depend on terrorism in destination country $\left(terror_{jt}\right)$ and "unobservables" (both variables are in logged):

$$TF_{ij,t} = \beta terror_{j,t} + \varepsilon_{ij,t} \qquad (2)$$

$$\varepsilon_{ij,t} = \alpha_{ij} + \gamma_{ij} f_t + \epsilon_{ij,t} \qquad (3)$$

$$terror_{j,t} = \delta_j + \lambda_j f_t + \omega_j g_t + \zeta_{jt} \qquad (4)$$

With $ij = 1, 2, \dots, N$ (country-pairs); $j = 1, 2, \dots, M$ (destination countries) and $t = 1, 2, \dots, T$(time). In this setting, the errors have a country-pair time-invariant specific component $\left(\alpha_{ij}\right)$, are driven by an unobserved "common factor" (f_t) with country-pair-specific "factor loadings" $\left(\gamma_{ij}\right)$, and a white noise $\left(\epsilon_{ij}\right)$. The common factor may represent (strong) shocks that would potentially affect all sample countries or (weak) shocks impacting a subset of countries. Those shocks are allowed to have a different impact across countries. Further, the set-up entails cross-sectional dependence since the errors would be correlated across country-pairs at any point in time via the common factor. Terrorism in destination country is assumed to be affected by a country-specific effect $\left(\delta_j\right)$, the same unobserved factor driving the errors (f_t), an additional factor (g_t) as well as a white noise $\left(\zeta_j\right)$. The common factor (f_t) allows for the possible correlation of terrorist incidents across countries: it embodies the part of terrorism that is "global", potentially affecting all countries albeit differently. Note that the setting entails an endogeneity problem since the regressor and the errors are both impacted by f_t.

The conventional estimation approach in the literature (using fixed effects estimators) fails to yield unbiased estimates in the presence of a common unobserved factor: using equation (4) and solving for f_t we get the following expression:

$$f_t = \frac{1}{\lambda_j}\left(terror_{j,t} - \delta_j - \omega_j g_t - \zeta_{j,t}\right)$$

Replacing f_t by the above expression in equation (3); equation (2) becomes:

$$TF_{ij,t} = \beta terror_{j,t} + \alpha_{ij} + \frac{\gamma_{ij}}{\lambda_j}\left(terror_{j,t} - \delta_j - \omega_j g_t - \zeta_{j,t}\right) + \epsilon_{ij,t}$$

$$TF_{ij,t} = \left(\beta + \frac{\gamma_{ij}}{\lambda_j}\right) terror_{j,t} + \alpha_{ij} - \left(\frac{\gamma_{ij}}{\lambda_j}\right)\delta_j + \frac{\gamma_{ij}}{\lambda_j}\left(-\omega_j g_t - \zeta_{j,t}\right) + \epsilon_{ij,t}$$

$$TF_{ij,t} = \beta' terror_{j,t} + \alpha_{ij} - \left(\frac{\gamma_{ij}}{\lambda_j}\right)\delta_j + \frac{\gamma_{ij}}{\lambda_j}\left(-\omega_j g_t - \zeta_{j,t}\right) + \epsilon_{ij,t} \qquad (5)$$

With $\beta' = \beta + \frac{\gamma_{ij}}{\lambda_j}$

As can be seen from equation (5), estimating equation (2) using the standard practice in the literature yields a biased and inconsistent estimate of β, where the estimated parameter will pick up the impact of the common factor. That is, the estimated effect of terrorism in destination country on inbound tourism would be also capturing the impact of terrorism elsewhere. This issue is easily generalized to the case of a standard gravity equation with multiple regressors, where each is assumed to be driven by a number of factors.

To obtain unbiased estimates, we follow Pesaran (2006) and augment the model with cross-sectional averages of the variables. To illustrate, consider the following cross-sectional averages in year *t*: $\overline{TF}_t = \frac{1}{N}\sum_{ij=1}^{N} TF_{ij,t}$; $\overline{terror}_t = \frac{1}{M}\sum_{j=1}^{M} terror_{j,t}$; $\bar{\alpha} = \frac{1}{N}\sum_{ij=1}^{N} \alpha_{ij}$; $\bar{\beta} = \frac{1}{N}\sum_{ij=1}^{N} \beta = \beta$; and $\bar{\gamma} = \frac{1}{N}\sum_{ij=1}^{N} \gamma_{ij}$.

Taking the cross-section averages of both sides of equation (2), we get:

$\overline{TF}_t = \beta\overline{terror}_t + \bar{\alpha} + \bar{\gamma} f_t$; thus: $f_t = \frac{1}{\bar{\gamma}}(\overline{TF}_t - \beta\overline{terror}_t - \bar{\alpha})$

Replacing f_t by the above expression in equation (3), equation (2) becomes:

$$TF_{ij,t} = \beta terror_{j,t} + \alpha_{ij} + \frac{\gamma_{ij}}{\bar{\gamma}}(\overline{TF}_t - \beta\overline{terror}_t - \bar{\alpha}) + \epsilon_{ij,t}$$

Which implies: $TF_{ij,t} = \beta terror_{j,t} + \left(\alpha_{ij} - \bar{\alpha}\frac{\gamma_{ij}}{\bar{\gamma}}\right) + \frac{\gamma_{ij}}{\bar{\gamma}}\overline{TF}_t - \frac{\gamma_{ij}}{\bar{\gamma}}\beta\overline{terror}_t + \epsilon_{ij,t}$

This can be re-arranged as follows:

$$TF_{ij,t} = \beta terror_{j,t} + \pi_{1ij} + \pi_{2ij}\overline{TF}_t + \pi_{3ij}\overline{terror}_t + \epsilon_{ij,t} \qquad (6)$$

With $\pi_{1ij} = \left(\alpha_{ij} - \bar{\alpha}\frac{\gamma_{ij}}{\bar{\gamma}}\right)$; $\pi_{2ij} = \frac{\gamma_{ij}}{\bar{\gamma}}$; and $\pi_{3ij} = -\frac{\gamma_{ij}}{\bar{\gamma}}\beta$

Thus, adding cross-sectional averages of the independent and dependent variables enables us to "strip out" the bias when estimating the impact of terrorism in the destination country on bilateral tourism flows while controlling for cross-section correlation. In practice, estimating equation (6) entails adding country-pair specific effects (α_{ij}) and linear combinations of interaction terms between country-pair dummies (φ_{ij}) and the cross-section averages of the dependent and independent variables. Estimating the resulting equation via ordinary least squares yields the CCE estimate of the relevant parameter (β).[3]

[3] The CCE estimator has several properties, including yielding consistent estimates in relatively small samples, in the presence of nonstationary variables and structural breaks (Chudik *et al*., 2011; Kapetanios *et al*., 2011; Pesaran, 2006; Pesaran and Tosetti, 2011).

3. Empirical strategy and data[4]

The following equation embodies the estimated specifications:

$$TF_{ij,t} = \beta_0 + \beta_1 GDP_{i,t} + \beta_2 GDP_{j,t} + \beta_3 terror_{j,t} + \boldsymbol{\delta}'(\boldsymbol{control_{ij}}) + \boldsymbol{\eta}'(\boldsymbol{control_{ij,t}}) + \lambda_t + \varepsilon_{ij,t} \quad (7)$$

It assumes that the dependent variable (the natural logarithm of the number of tourist arrivals from OECD-origin country i to OECD-destination country *j* in year *t*) depends on: the economic masses of each of the origin and destination countries (measured by the natural logarithm of their real GDPs), the terrorism indicator reflecting the magnitude of terrorist incidents in destination country ($terror_{j,t}$), a vector of time-invariant control variables ($\boldsymbol{control_{ij}}$), a set of time varying control variables ($\boldsymbol{control_{ij,t}}$), time-varying shocks ($\lambda_t$) and the error term ($\varepsilon_{ij,t}$). The two vectors contain factors that affect the ease of access of tourists from country i to country *j*. The time-invariant vector includes the following regressors: the *distance* separating the capital cities of the country-pair, and the following dummy variables: *contiguity*, *common language*, *common colonizer*, *colony*, and *common country*. This set of factors takes into account geographical as well as cultural and historical factors that could hinder or boost bilateral tourist flows. The time-varying vector encompasses the following: the total bilateral trade between the two countries (*trade*), the real bilateral exchange rate (*rber*) of the currencies of the two countries, and the following dummy variables: *eu* and *common currency*. This cluster factors in economic relations and intra-regional agreements that would influence bilateral tourist flows. The time effects capture international tourism trends affecting all countries equally.

We use annual data on 35 OECD countries over the 1995-2015 period and apply three estimation strategies. The first two echo the standard approaches used when employing a gravity setting to examine international bilateral tourism flows, whereas the third applies the CCE estimator. In the first estimation strategy, the error is assumed to have the following structure: $\varepsilon_{ij,t} = \alpha_i + \mu_j + \xi_{ij,t}$ where α_i and μ_j are country effects and $\xi_{ij,t}$ is a white noise. Since the country-effects are likely to be correlated with the regressors, equation (7) is augmented with origin-country and destination-country dummies. Moreover, in this setting the time shocks are captured by year dummies. We call this estimation strategy the country-fixed effects (CFE). The second strategy assumes that $\varepsilon_{ij,t} = \phi_{ij} + \xi_{ij,t}$ where ϕ_{ij} are country-pair effects and $\xi_{ij,t}$ is a white noise. When estimating equation (7) via this strategy, country-pair dummy variables are added as well as year dummies reflecting time shocks. Since country-pair dummies absorb all variables included in vector $\boldsymbol{control_{ij}}$, the latter drops out when applying this strategy. We label the latter strategy the country-pair-fixed effects (CPFE). Implementing the CCE estimator assumes that $\varepsilon_{ij,t} = \alpha_{ij} + \boldsymbol{\delta}'_{ij}\boldsymbol{f}_t + \xi_{ij,t}$ where α_{ij} represents country-pair effects, $\boldsymbol{f}_t$ is a vector of unobserved common factors, and $\xi_{ij,t}$ is a white noise. Estimating equation (7) via the CCE estimator entails augmenting it with country-pair dummies and cross-sectional averages of the dependent and time-varying independent variables. Since country-pair dummies are included in the equation, vector $\boldsymbol{control_{ij}}$ drops out when using the CCE estimation.

[4] Data description and sources as well as the expected signs of the control variables are found in, respectively, tables AI and AII of the appendix.

4. Findings

4.1. Pre-estimations analysis

Prior to the estimations, we scrutinize two features of our data set: the cross-sectional dependence as well as the time series properties of our continuous variables. Table I lays out average cross-section correlation coefficients as well as the corresponding Pesaran (2004) cross-section dependence (CD) test statistics. Cross-sectional correlation is a prominent feature of our data. Moreover, with the exception of the exchange rate variable, we reject the null of cross-spatial independence across all variables. Interestingly, table I reveals that terrorist assaults across OECD countries are positively correlated and detects the presence of cross-section dependence in the terrorism variable. Taken together, those results testify to the main attribute of recent terrorist incidents across our sample countries: their global nature. This corroborates the findings of Gaibulloev *et al*. (2013) who showed that there is a common driver for a large proportion of recent terrorist incidents, notably in European countries.

Table I: Cross-section correlation and unit root tests

Correlation coefficients/tests	$\mathbf{TF_{ij}}$	$\mathbf{GDP_i}$	$\mathbf{GDP_j}$	$\mathbf{Trade_{ij}}$	$\mathbf{Rber_{ij}}$	$\mathbf{Terror_j}$
Average ρ	0.29	0.92	0.92	0.76	0.00	0.14
Average |ρ|	0.39	0.92	0.92	0.78	0.48	0.23
CD (p.value)	1211.6 (0.00)	3553.1 (0.00)	3553.1 (0.00)	2870.6 (0.00)	0.43 (0.66)	532.6 (0.00)
CIPS	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
CIPS*	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)

Note: i) all variables are in logs; ii) ρ and |ρ| represent, respectively, the average and average absolute correlation coefficients across N(N-1) sets of correlations; iii) CD reports the Pesaran cross-section dependence statistic, distributed standard normal under the null of cross-section independence; iv) the CIPS test is based on augmented Dickey Fuller (ADF) regressions with an intercept as well as cross sectional averages of the dependent and independent variables, the null hypothesis is the nonstationarity of the variable for all country-pairs the alternative being stationarity for some country-pairs, the ideal lag augmentation of the ADF regressions was based on the Akaike Information Criterion (AIC); v) the starred version of the CIPS test is similar to the original one except for the presence of an intercept and a trend in the ADF regressions; vi) the table shows the order of integration of the variables: I(0): stationary, I(1): nonstationary.

Table I also reports the results of the Pesaran (2007) panel unit root test (CIPS) across our variables. The test is based on country-specific augmented Dickey-Fuller (ADF) regressions and accounts for cross-section dependence among the variables. Results suggest that one cannot ignore possible nonstationary series in terms of the dependent variable, the GDP of destination countries and the exchange rate variable.

4.2. Estimations results

Table II presents the results of the three estimation strategies. Before discussing the main variable of interest (terrorism), we first comment on the found results of the CFE and CPFE estimations. As commonly established in the literature, the economic masses of the exchanging countries positively and significantly affect bilateral tourism flows. The adverse and significant effect of distance (in the CFE estimation) on inbound tourism testifies to the importance of transportation costs (Culiuc, 2014; Marrocu and Paci, 2013).

Table II: Results

Regressor	Estimation strategy		
	CFE	CPFE	CCE
GDP_i	0.923*** (0.12)	0.958*** (0.13)	0.856*** (0.14)
GDP_j	0.610*** (0.10)	0.643*** (0.11)	0.554*** (0.13)
Terror	-0.015*** (0.005)	-0.015*** (0.006)	-0.019*** (0.004)
Trade	0.205*** (0.02)	0.182*** (0.03)	0.035 (0.02)
Rber	-0.198*** (0.05)	-0.197*** (0.05)	-0.332*** (0.05)
EU	0.145*** (0.05)	0.154*** (0.05)	-0.214 (0.25)
C. Currency	0.052 (0.04)	0.046 (0.04)	-0.021 (0.05)
Distance	-0.861*** (0.05)	-	-
Contiguity	0.504*** (0.14)	-	-
C. Language	0.483*** (0.08)	-	-
Colony	1.522*** (0.24)	-	-
C. Colonizer	0.767 (0.49)	-	-
C. Country	-0.102 (0.23)	-	-
Constant	-26.613*** (4.70)	-37.175*** (4.80)	-7.571*** (3.08)
Observations	18156	18156	18156
Country-pairs	981	981	981
RMSE	0.358	0.357	0.173
CIPS	I(1)	I(1)	I(0)
CIPS*	I(1)	I(1)	I(0)

Note: i) regressors in *italic* are in logs; ii) the "C" letter appearing in front of a number of dummy variables stands for "common"; iii) between parentheses standard errors are robust to cross-sectional heteroskedasticity and within country-pair serial correlation; iv) asterisk *** denotes a p-value equal or less than 1 percent; v) the CIPS and CIPS* tests are similar to the ones implemented in Table I.

Vivid bilateral trade relations seem to significantly enhance bilateral tourism flows, as typically found in the literature (Chasapopoulos *et al*., 2014; Leitão, 2010; Zhang, 2015). Moreover, monetary costs negatively and significantly impact tourist arrivals: an appreciation of the currency of destination country relatively to that of the origin country reduces tourism between the country-pair (Khoshnevis Yazdi and Khanalizadeh, 2017). Findings also suggest that the European integration process has favored bilateral tourism flows, as ascertained previously (Gil-Pareja *et al*., 2007). The CFE estimation shows that sharing a common language and having had colonial ties tend to bolster tourism between OECD countries[5]. This is in line

[5] The insignificant impact of sharing a common colonizer after 1945 and having been part of the same country suggest that direct colonial relationships matter most for intra-OECD tourism flows.

with the recent findings of Fourie and Santana-Gallego (2013). Finally, the standard approaches' results suggest that sharing a common currency does not have a significant effect on intra-OECD tourism. This is in accordance with the latest findings of Saayman *et al*. (2016) and Santana-Gallego *et al*. (2016) who demonstrated that the common currency's positive impact on tourism was short-lived and became insignificant after 2007.

As was pointed out in section 2, the standard approaches fail to correctly control for cross-section correlation among the variables. Further, table I has shed light on the prevalence of cross-sectional dependence among our variables. Thus, the estimates of the standard approaches are presumably biased with the underlying endogeneity issue. Moreover, the CIPS test hints at the presence of *I(1)* residuals across the CFE and CPFE estimations.

The CCE estimation points to the significant and positive role played by the GDPs of the origin and destination countries, corroborating the standard approaches' holdings. It also reveals the negative and significant impact of the exchange rate. Interestingly, the effects of the EU dummy variable and bilateral trade become insignificant. Arguably, trade and policy variables are significant channels of cross-country correlation. Trade ties are an important vector transporting shocks across OECD countries where the share of intra-regional trade in total OECD trade averaged 69 percent during 2010-2015[6]. On the other hand, given that policy variables typically reflect coordinated measures at a regional level, they tend to heighten the connections among members of the same agreement. Hence, once the cross-sectional dependence noise was taken into account in the CCE estimation, the effects of those variables became insignificant. The CIPS test suggests that the CCE residuals are stationary. Also, the root mean square error (RMSE) shows that the CCE model better fits the data than the CFE and CPFE models.

The impact of the terrorism indicator is found to be negative and significant across the three specifications, lending support to the extant findings showing that terrorist incidents in destination countries have typically reduced tourism inflows. As mentioned earlier, the CFE and CPFE estimates are likely biased. It is interesting to understand the bias of the standard approaches' estimate of the terrorism indicator. As argued in the introduction and found when inspecting the cross-sectional dependence of our variables, the recent waves of terrorism experienced by several OECD countries are positively correlated. When such correlation is not accounted for (in the CE and CPE models), the estimated effect of a terrorist attack in a given destination country would be also picking up the impact of terrorist incidents elsewhere. This would cause an upward bias in the estimated negative effect of terrorism in destination countries on tourist arrivals: in other words, the standard techniques underestimate the impact of terrorism in a given country on tourist inflows. To illustrate, consider a terrorist incident in France. This would deter would-be tourists from selecting this country as their destination. Hence the typically found negative impact of terrorism in destination countries on tourist inflows ("typical" effect). However, a terrorist attack in a country perceived as an alternative destination to France by would-be tourists (say Italy) would also affect tourist arrivals to France: some of those tourists would substitute away from Italy to France. Thus, terrorist attacks elsewhere would positively affect tourist arrivals to a given destination. This "substitution" effect was highlighted in studies examining possible cross-country spillover effects of terrorism (Drakos and Kutan, 2003; Bassil *et al*., 2019; Neumayer, 2004). The bias in the estimate of the impact of terrorism on tourist arrivals when using standard approaches is due to the fact that the latter would be confounding the (negative) "typical" effect with the (positive) "substitution" effect. As the CCE

[6] United Nations Comtrade database.

estimation shows, when the cross-country correlation in terms of terrorism is accounted for, the bias is corrected.

5. Conclusion

Building on the literature investigating the terrorism/tourism nexus, we cast a gravity model into the common factor framework to estimate the effect of terrorism in destination countries on tourist arrivals using the CCE estimator. The common factor setting is used to capture the correlation among recent terrorist attacks that affected numerous OECD countries. Our results show that the standard estimation techniques underestimate the effect of terrorism on inbound tourism. This reflects the inability of those techniques to factor in spatial correlations. In contrast, the CCE estimator properly controls for cross-country correlations, notably in terms of terrorism, and eliminates the resulting bias. Thus, our research contributes to the tourism/terrorism literature by proposing a possible estimation strategy that would correct for spatial correlation-induced bias.

At a more general level, our research sheds light on the necessity of acknowledging the global nature of the latest terrorism wave and accommodating estimation strategies accordingly. We recommend this to be done whenever the research entails testing the economic incidence of terrorism, otherwise the results would be biased, possibly leading to erroneous conclusions. This is especially important in tourism policy-oriented research where designing practical recommendations to policy makers is the norm.

The present research can be expanded in at least two dimensions. The terrorism indicator used in this paper encompasses all terrorist incidents occurring in destination countries. That is, it includes domestic terrorist attacks, where perpetrators/victims are of the same nationality (that of the destination country), as well as transnational terrorist incidents involving perpetrators/victims of different nationalities. A first possible extension to our research would narrow down the analysis by considering the impact of exclusively transnational terrorist incidents in destination countries on tourist arrivals. Indeed, transnational terrorism is likely to exhibit a more pronounced spatial correlation than overall terrorism, which would lead to a more severe bias if such correlation is unaccounted for properly. Thus, applying the CCE estimation would be especially appropriate in this case. A second venue for future research consists of enlarging the sample countries to include a number of developing countries and examining whether our findings can be generalized when employing a sample of more heterogeneous countries.

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Appendix

Table AI: Data description and sources used

Variable	Source	Description
TF	The United Nations World Tourism Organization.	Tourism flows between the origin country *i* and the destination country *j*. For some countries: arrivals of non-resident tourists at national borders (by country of origin, if not available, by nationality). For others: arrivals of non-resident tourists in all types of accommodation establishments (by country of origin, if not available, by nationality). For Australia, Japan, Korea, New Zealand and the UK: arrivals of non-resident visitors at national borders (by country of residence, if not available, by nationality) (in logs).
GDP_i	The World Bank, World Development Indicators (WDI).	Origin country's real GDP (in logs).
GDP_j	The World Bank (WDI).	Destination country's real GDP (in logs).
Terror	Global Terrorism Database.	Following Eckstein and Tsiddon (2004), we construct a terrorism index that captures both the count (number of attacks) and the magnitude (number of human casualties) effects for terrorism in the destination country *j*. This would take into consideration the uneven importance of different terrorist attacks in terms of casualties: $Terror_{jt} = \log\left(e + \frac{number_{jt} + deaths_{jt} + injuries_{jt}}{3}\right)$
Distance	CEPII, GeoDist database.	Distance between capital cities of the two countries (in logs).
Trade	The United Nations Comtrade database.	Sum of total bilateral exports and bilateral imports of destination country to/from origin country (in logs).
Rber	OECD, https://data.oecd.org/conversion/exchange-rates.htm;13/6/2017	Real bilateral exchange rate is the nominal bilateral exchange rate (price of the currency of destination with respect to that of the origin) times the ratio of the CPI of destination to the CPI of origin. Nominal bilateral exchange rates were computed as follows: price of the USD with respect to the currency of the origin divided by the price of the USD with respect to the currency of the destination (in logs).
EU	CEPII, gravity dataset, Head *et al*., 2010.	Dummy taking a value of 1 if the two countries are members of the European Union, 0 otherwise.
Contiguity	CEPII, GeoDist database.	Dummy taking a value of 1 if the two countries share a common border, 0 otherwise.

Variable	Source	Description
Common language	CEPII, GeoDist database.	Dummy taking a value of 1 if a language is spoken by at least 9 percent of the population of each country, 0 otherwise.
Colony	CEPII, GeoDist database.	Dummy taking a value of 1 if the two countries have ever had a colonial link, 0 otherwise.
Common colonizer	CEPII, GeoDist database.	Dummy taking a value of 1 if the two countries have had the same colonizer after 1945, 0 otherwise.
Common country	CEPII, GeoDist database.	Dummy taking a value of 1 if the two countries were/are the same country, 0 otherwise.
Common currency	CEPII, gravity dataset, Head *et al*., 2010.	Dummy taking a value of 1 if the two countries share the same currency, 0 otherwise.

Table AII: Expected signs of the control variables

Variable	**Expected sign**	**Rationale**
GDP_i	+	A high GDP level in origin country implies a high purchasing power of would-be tourists.
GDP_j	+	A high GDP level in destination country reflects developed tourism and transport infrastructures.
Distance	-	Larger distance implies greater transport costs.
Trade	+	More intense trade relations between two countries would reflect more intertwined bilateral economic relations, and a greater exposure of a given country *vis-à-vis* would-be tourists from the other country.
Rber	-	A depreciation of the domestic currency relatively to the currency of the destination country implies higher monetary costs.
EU	+	Being members of regional agreements would reduce the cost of traveling between two countries.
Contiguity	+	Proximity implies smaller transportation costs.
Common language	+	Sharing a common language would reduce the "cultural" distance.
Historical links (colony, common colonizer, common country)	+/-	Sharing historical links can encourage or discourage bilateral flow of tourists between the two countries depending on the type of relations they had.
Common currency	+	Sharing a common currency would reduce monetary costs.