Causal Linkages Between Domestic Terrorism and Economic Growth

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Abstract

We use the Hsiao-Granger method to test for growth-terrorism causality for seven Western European countries. In bivariate settings, the impact of economic performance on domestic terrorism is very strong. In trivariate settings, the impact of performance on terrorism diminishes. Here, we find that economic performance leads terrorist violence in robust ways only for three out of seven countries. Terrorism is almost never found to causally influence growth in bivariate and trivariate specifications. Our findings indicate that (i) the role of economic performance in determining terrorist violence appears to have been important for some countries and (ii) all attacked economies have been successful in adjusting to the threat of terrorism.

Keywords: Domestic Terrorism, Growth, Hsiao-Granger Causality, Western Europe

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INTRODUCTION

The question of causality between terrorism and economic performance has not been settled. Does terrorism produce noticeable damages to aggregate performance, does poor economic performance contribute to the generation of terror, or do both effects exist side by side? On the one hand, the allocation and accumulation of resources may be negatively influenced by terrorism, for instance, as investment or savings are discouraged, consequently also affecting economic growth. On the other hand, economic factors may play an important role in explaining terrorism, for example, as low opportunity costs of violence – manifested in poor economic growth – may foster conflict.

This contribution aims to identify the links between the intensity of domestic terrorism and the rate of real GDP per capita growth.[1] We investigate this relationship for seven Western European countries.[2] All investigated countries experienced substantial economic success in the past. Most countries grew between 2 and 4% p.a. between 1950 and 2004. Nevertheless, these countries also suffered episodes of major political violence, especially in comparison to other countries in this part of the world. In fact, the seven selected countries accounted for 97% of all reported terrorist attacks and 96% of all reported terror-related fatalities from 1950 to 2004, according to the *Terrorism in Western Europe: Events Data* (TWEED) dataset of Engene (2007).[3] Most domestic terrorist organizations in the investigated countries were driven by leftist, ethnic-nationalist or separatist ideologies (cf. Engene, 2007). Thus, they were potentially motivated by political factors. However, terrorism cannot be sensibly explained by one 'root cause' only. With our analysis, we want to find out whether economic performance – economic growth – also swayed the terrorists' calculus. At the same time, we want to analyze whether terrorism negatively affected growth.

We test for growth-terrorism Granger causality in a time-series framework. We try to detect causality only in a statistical but not purely philosophical – 'cause and effect' – sense. That is, through our analysis we are able to assess whether changes in terrorism (growth) are helpful for forecasting future changes in growth (terrorism). Our analysis is helpful in approximating 'real' causality without implying it, so corresponding interpretations should be made carefully. In order to investigate for Granger causality in our empirical framework, we first examine the stationarity properties of the underlying time series through a unit root test. At this point we are also able to identify structural breaks, that is, major changes in the country's economic or political history during the period of observation. We then process our data in accordance with the unit root test results. When we test for Granger causality, we rely on the Hsiao-Granger procedure to circumvent common problems associated with detecting Granger causality in time-series frameworks. In comparison to standard Granger causality tests, our procedure allows for high variations in lag length selection. In order to avoid omitted variable biases and to check for robustness, we test for causality in a bivariate and trivariate system. By testing for Granger causality in a time-series setting, we add to existing evidence which has mainly blanked out the question of causality between economic performance and terrorist violence.

As our main results, we find that (i) all the investigated growth and terror series

exhibit structural breaks that match with important turning points in the countries' economic and political history. (ii) In bivariate systems, economic growth leads terrorist violence in all cases, whereas terrorism causally influences growth only in the case of Portugal. It appears as if economic performance influences the terrorists' calculus, yet the resiliency of attacked economies is generally high, so terror-induced shocks do not feed through to growth. (iii) Knowing that bivariate causality tests are prone to inconsistencies, we also perform causality tests in trivariate systems. The findings confirm that economies under attack are successful in adjusting to the threats of terror, so growth is not impaired. With respect to Granger causality running from growth to terrorism, the results weaken previous ones from the bivariate analysis. Economic performance robustly sways the terrorists' calculus only for Germany, Portugal and Spain, but not for the rest of the sample. That is, in some countries solid growth may raise the opportunity costs of terror, thus discouraging violent behavior, for instance as individuals find more economic opportunities; the opposite relationship should hold in periods of economic downturn. Policymakers should not underestimate the role of economic factors – and of the opportunity costs of violence – in impacting domestic terrorism. For some countries in Western Europe, economic success apparently contributed to a crowding out of domestic terrorism. However, factors other than economic performance – for instance political instability, demographic pressures or international politics – should also be considered when explaining terrorism dynamics, in particular when growth-terrorism links are not found to be strong.

The remainder of this contribution is organized as follows. In Section 2, we discuss the academic literature on possible interactions between terrorism and growth. In Section 3, we introduce the data and our methodology, and also present our empirical results. In Section 4, we discuss our findings. We sum up our results in Section 5.

CAUSAL LINKS BETWEEN TERRORISM AND GROWTH

Potential Impact of Terrorism on Economic Growth

A central short-run goal of terrorists is economic destabilization. Terrorist actions – assassinations, bombings, and so forth – are means to achieve this short-run goal. Long-run political objectives – such as a redistribution of wealth and power – are to be enforced through such actions. Collier (1999) identifies several channels through which civil war affects the economy; Collier's ideas may be transferred to terrorism as another form of violent conflict. The channels of transaction from conflict to the economy are: destruction, disruption, diversion, dissaving and portfolio substitution.[4] Destruction refers to the direct costs of terrorism, as human and physical capital are destroyed through terrorist strikes. The disruption effect may for instance become manifest in higher transaction costs, as the effectiveness of public institutions is challenged and manipulated by terror, as insecurity in general increases, and so forth. Diversion occurs when public resources are shifted from output-enhancing to non-productive – defence

and security – expenditures. Dissaving refers to a decline in savings that affects the economy's capital stock. Portfolio substitution means the flight of human, physical and financial capital from a country in the face of conflict. Through all these effects economic performance may suffer, in particular as they may reinforce each other. Inter alia, Eckstein and Tsiddon (2004), Naor (2006) and Mirza and Verdier (2008) provide related theoretical considerations that also discuss how terror may act negatively on economic activity. In general, terrorism may distort the allocation of resources, basically through the disruption, diversion and portfolio substitution channel. It may also negatively influence resource accumulation, mainly via the destruction and dissaving channel.

Empirical evidence indicates that terrorism adversely influences international trade (cf. Nitsch and Schumacher, 2004; Blomberg and Hess 2006; Mirza and Verdier, 2008).[5] Its unfavorable impact on tourism is well-documented, in particular for several Mediterranean countries (cf. Enders and Sandler, 1991; Enders *et al.*, 1992; Drakos and Kutan, 2003). Transnational terrorism also appears to distort domestic and foreign direct investment (cf. Enders and Sandler, 1996; Fielding, 2003; Abadie and Gardeazabal, 2008). Blomberg, Hess and Orphinades (2004) furthermore find that resources are relocated from investment to government spending in times of terrorist violence. A number of studies consequently detect a substantial negative influence of terrorism on overall economic growth (cf. Abadie and Gardeazabal, 2003; Eckstein and Tsiddon, 2004; Crain and Crain, 2006; Gaibulloev and Sandler, 2008). In general, existing evidence confirms that terrorists are able to destabilize targeted economies. Here, economic activity is affected through various channels, for instance through the destruction of national capital stocks, the disruption of trade or tourism flows, or the diversion of resources away from private investment, ultimately resulting in negative growth effects.

Possible Effects of Economic Performance on Terrorism

Economic theory argues that terrorists are rational individuals which choose their levels of violent activity according to the costs and benefits arising from their actions (cf., e.g., Sandler and Enders, 2004). Because of terrorists' presumed rationality, the opportunity costs of terror also matter. Intuitively, low opportunity costs of violence – that is, few prospects of economic activity – lead to elevated terrorist activity, whereas high opportunity costs result in the opposite (cf., e.g., Freytag *et al.*, 2008). Times of economic success mean, inter alia, more individual economic opportunities and economic participation. Higher levels of overall growth should coincide with higher opportunity costs of terror and thus less violence. Conversely, in periods of economic downturn should be accompanied by fewer economic opportunities and participation and thus by more economic dissatisfaction. In times of economic crisis, dissidents are more likely to resort to violence as the opportunity costs of terror are low, while the potential long-run payoffs from violence – a redistribution of scarce economic resources which is to be enforced by means of terrorism – are comparatively high (cf. Blomberg, Hess and Weerapana, 2004).

To some extent, empirical evidence suggests that economic performance and

terrorism are linked along the lines discussed before. The findings of Collier and Hoeffler (1998) indicate that higher levels of economic development coincide with lower likelihoods of civil war, providing initial evidence that economic success and conflict are diametrically opposed. Considering economic development and terrorism, several studies find that higher levels of development are obstacles to the production of transnational terrorism (cf., e.g., Santos Bravo and Mendes Dias, 2006; Lai, 2007; Freytag *et al.*, 2008). Blomberg and Hess (2008) also find that higher incomes are a strong deterrence to the genesis of domestic terrorism. Furthermore, there is evidence connecting solid short-run economic conditions with less political violence (cf. Muller and Weede, 1990; Freytag *et al.*, 2008).[6] In general, the evidence indicates that terrorism and economic conditions are linked. Here, economic success seems to impede the genesis of terrorism, presumably due to higher opportunity costs of conflict. In other words, in times of stronger economic performance individuals simply have more to lose.

Research Contribution and Focus

Feasible theoretical reasoning and empirical evidence have been brought forward considering the effects of terrorism on growth and of growth on terrorism. Still, to the best of our knowledge no study has analyzed the causal nature of the growth-terrorism nexus. Also, due to data constraints past evidence has focused almost exclusively on transnational terrorism, although domestic terrorism is a far more common phenomenon (cf. Enders and Sandler, 2008). With this contribution we want to add to existing empirical evidence by providing a time-series analysis of Granger causality between domestic terrorism and economic growth. Here, multiple directions of causality are plausible. (i) Economic performance may granger-cause terrorism, or (ii) terrorism may granger-cause performance. On the one hand, terrorism affects the allocation and accumulation of resources. On the other hand, economic performance may also impact the opportunity costs of terror. (iii) If the two processes exist simultaneously, then feedback between them is detected. Such a relationship may hint at the existence of a vicious circle of conflict and economic decline, as previously discussed by Blomberg, Hess and Thacker (2006). Lastly, (iv) a causal relationship between performance and terror in the statistical sense may also be non-existent when there is no evidence of substantial links.

In the next section, we test for Granger causality between domestic terrorism and economic performance. As we are well aware that economic growth and domestic terrorism may also be determined by other factors, we test for causality in trivariate time-series settings which include a related control variable.[7] As a control, we choose trade openness, as this variable may interact with growth as well as with terrorism. On the one hand, trade may impact growth, for instance by inducing specialization and technology diffusion; increases in trade openness may translate into higher economic growth (cf. Harrison, 1996). On the other hand, trade may for instance be regarded as a threat by 'globalization losers' when jobs are lost, or as an opportunity by 'globalization winners' when trade increases wealth. Depending on which mechanism dominates, terrorism may increase or decrease with rising trade openness as the opportunity costs of violence are affected.[8]

EMPIRICAL ANALYSIS

Data

We extract data on growth and terrorism for seven Western European countries. *Economic growth* is measured by the rate of real GDP per capita growth in 2000 constant prices. Data for growth comes from the PENN World Table of Heston, Summers and Aten (2006). *Domestic terrorism* is indicated by the total number of individuals killed and wounded by acts of domestic terrorism in a given year and country. That is, we use raw data on terrorist victims – on the intensity of terror – rather than on terrorist attacks.[9] We transform the series by taking the natural logarithm and adding unity to allow for zero observations.[10] Data on domestic terrorism comes from the TWEED dataset as described by Engene (2007).

We also test for growth-terrorism causality in a trivariate setting, using trade openness as a control variable to reduce potential problems due to omitted variables. *Trade openness* is measured as the logarithm of the sum of exports and imports divided by real GDP in 2000 constant prices. Data for openness also comes from the PENN World Table.

Econometric Procedure

Below, we want to investigate the causal linkages between domestic terrorism and economic growth. Methodologically, we proceed as follows. (i) We conduct unit root tests to identify the order of integration of the investigated time series, and to check for potential breaks in the series. (ii) As we need de-trended $I(0)$ time series to carry out the Granger causality analyses properly we then process the data accordingly, building on unit root test results. (iii) We employ this processed data when we execute a number of causality tests using the Hsiao-Granger method. First, we test for causality in bivariate settings, where we only consider the growth and terrorism series. Then, we also test for Granger causality in a trivariate scenario to broaden the evidence and to evaluate the robustness of our bivariate causality test results.

Unit Root Test

We first have to identify the order of integration of the investigated series. To ensure a correct application of the causality test, all series need to be $I(0)$, that is, stationary and not exhibiting a unit root. The series cover long time spans. Therefore, they may exhibit unexpected shifts – structural breaks – that are a consequence of e.g. major structural changes in the economic or political realm. Conventional unit root tests do not account for structural breaks and therefore may produce biased results.

In order to account for possible breaks in the data, we use the unit root test (ZA test) of Zivot and Andrews (1992) which allows for a structural break. Through this test the investigated series are identified as $I(1)$ – difference-stationary – or $I(0)$ with a break in the deterministic trend, that is, trend-stationary. We use model C of the ZA test which allows for a break to occur in both intercept and

trend. The test also gives the dates of the endogenously determined structural breaks, thus further unveiling underlying dynamics.[11]

Table 1 gives the results of the ZA test for all investigated series. For growth and terrorism, the unit root test always indicates that the series are $I(0)$ with a trend. For trade openness, the series are identified to be $I(1)$ in six out of seven cases. The calculated break dates fit in very well with economic and political history. For instance, for Portugal, Spain and Greece most break dates coincide with their transition to democracy. For the United Kingdom, the structural break for the terror series matches the beginning of the Troubles in Northern Ireland. For France, the break date for the economic growth series coincides with the end of the Thirty Glorious Years of steady economic development. For the other countries, similar observations can be made.[12]

– Table 1 here –

Processing of Time-Series Data

Based on the results of the ZA test, we now process the time-series data in order to obtain $I(0)$ series. For six out of seven series on trade openness, the ZA test indicates the existence of a unit root. Here, we achieve stationarity by simply taking first differences.

When the ZA test does not indicate a unit root, the series is $I(0)$ with a trend. This is the case for one openness series and all growth and terror series. If so, utilizing a difference filter to obtain stationarity is neither necessary nor useful. Instead, we de-trend the data following the method proposed by, inter alia, Fernandez (1997). We run an OLS regression of the following form:

$$y_t = \alpha + \beta t + \gamma DU_t + \delta D_t + \lambda DT_t + \hat{y}_t. \tag{1}$$

y_t is the dependent variable representing the respective series for growth, terror or openness. α is a constant, t is a time trend, and DU_t, D_t and DT_t take values depending on the calculated break date T_B: $DU_t = 1$ for $t < T_B$, 0 otherwise; $D_t = 1$ for $t = T_B$, 0 otherwise; $DT_t = (t - T_B)$ for $t > T_B$, 0 otherwise. $\hat{y}_t$ is the residual from the OLS estimation. By using this approach, we are able to eliminate trends and to take into account underlying structural changes which may otherwise lead to biased results. We obtain the residuals of the respective estimations, $\hat{y}_t$, and use these de-trended residual data in the subsequent causality analyses.

Hsiao-Granger Causality Test

Bivariate Causality Test

Tests for Granger causality are important tools in time-series analyses, for instance as employed in Kollias, Naxakis and Zarangas (2004). A potential shortcoming of standard Granger causality analyses is that they may suffer from arbitrary lag length selection because the considered time-series variables are constrained to all enter at the same lag length. This may yield inconsistent results due to model misspecifications (cf. Braun and Mittnik, 1993). We hence

rely on the sequential approach of Hsiao (1979, 1982) to test for Granger causality, which in particular circumvents problems associated with lag length selection. This procedure has been applied in e.g. Hsiao (1979, 1982) or Gries, Kraft and Meierrieks (2008).

Granger's (1969) definition of non-causality states that if it is easier to predict a series x_t when including information from a series y_t instead of only employing lagged values of x_t, then y_t Granger-causes x_t, denoted $y_t \Rightarrow x_t$. Bidirectional causality – or feedback – is present when x_t also Granger-causes y_t. By combining this definition of Granger causality with Akaike's (1969) *Final Prediction Error* (*FPE*), we can apply Hsiao's approach toward testing for causality between the time series.

In its basic form, the causality testing procedure requires us to first consider an autoregressive process:

$$y_t^* = \alpha + \sum_{i=1}^{m}(L)\beta y_t^* + u_t. \tag{2}$$

In Equation (2), the sigma sign in front of the lag operator (L) indicates the lag order of the series running from 1 to m. u_t is a white noise term with the usual statistical properties and α is a constant term. y_t^* is operationalized depending on the previous ZA tests. If the series is $I(0)$ with a trend, we employ the residuals obtained from Equation (1), $\hat{y}_t$. If the series is $I(1)$, we use the usual difference filter where y_t^* is equal to $y_{t-1} - y_t$ in order to obtain stationarity. We choose the lag order that yields the smallest FPE, denoted $FPE_{y^*}(m^*, 0)$. The individual FPE are calculated from the following equation with lags varying from 1 to m:

$$FPE_{y^*}(m, 0) = \frac{(T + m + 1)}{(T - m - 1)} \times \frac{SSE}{T}. \tag{3}$$

Here, T is the number of observations and SSE is the residual sum of squares. Then, we allow another variable x_t^* to enter our model, so we receive the subsequent vector autoregression model (VAR):

$$y_t^* = \alpha + \sum_{i=1}^{m}(L)\beta y_t^* + \sum_{j=1}^{n}(L)\gamma x_t^* + u_t, \tag{4}$$

$$x_t^* = \alpha + \sum_{j=1}^{n}(L)\gamma x_t^* + \sum_{i=1}^{m}(L)\beta y_t^* + v_t. \tag{5}$$

u_t and v_t are white noise terms with the usual statistical properties, and α is a constant. The sigma sign in front of the lag operator (L) indicates the lag order of the series, where y_t^* and x_t^* again take values based on the previous ZA tests. Either they represent the residuals obtained from Equation (1), or they are difference-stationary series where the usual difference-filter has been employed. Note that in both cases the series are now $I(0)$, so the causality testing procedure can be conducted properly. While y_t^* steadily enters Equation (4) with the lag order from Equation (3) that yields the smallest FPE, m^*, x_t^*

enters with a sequence of lags varying from 1 to n. The FPE of Equation (4) are computed, with the specific lag order being chosen that generates the smallest FPE, denoted as $FPE_{y^*}(m^*, n^*)$, from:

$$FPE_{y^*}(m^*, n) = \frac{(T + m + n + 1)}{(T - m - n - 1)} \times \frac{SSE}{T}. \tag{6}$$

By comparing the two minimal FPE, we can draw conclusions regarding causality. If $FPE_{y^*}(m^*, 0) > FPE_{y^*}(m^*, n^*)$, then $x_t^* \Rightarrow y_t^*$, thus Granger causality is established. If $FPE_{y^*}(m^*, 0) < FPE_{y^*}(m^*, n^*)$, then $x_t^* \not\Rightarrow y_t^*$ and no Granger causality is detected. Testing for Granger causality running from y_t^* to x_t^* requires us to repeat the previously described steps this time with x_t^* being the dependent variable, so we ultimately arrive at Equation (5).

Trivariate Causality Test

It is a well-known fact that causality tests in bivariate settings may produce inconsistent results. Lütkepohl (1982) shows that whether or not Granger causality is detected in a bivariate specification may be due to omitted variables. In order to reduce the possibility of omitted variables, we transform our bivariate model into a trivariate one by including a control variable.

Methodologically, we build on the previously discussed procedure. We are now interested in the causal relationship between the series y_t and z_t. Therefore, we first consider an autoregressive process as in Equation (2) and determine the accordant minimal FPE as in Equation (3). Then, we consider a bivariate VAR as in Equation (4), where the added variable x_t now is the control variable, namely trade openness. We calculate the minimal FPE as in Equation (5). Next, we consider a trivariate VAR, where a new variable z_t enters with lags varying from 1 to p, while y_t^* and x_t^* enter the model with the lag order that yields the smallest FPE, $m^*$and n^*.[13] The corresponding FPE is computed, with the specific lag order being chosen that generates the smallest FPE, denoted as $FPE_{y^*}(m^*, n^*, p^*)$, from the following equation with the known notation:

$$FPE_{y^*}(m^*, n^*, p) = \frac{(T + m + n + p + 1)}{(T - m - n - p - 1)} \times \frac{SSE}{T}. \tag{7}$$

By comparing the two minimal FPE from the bivariate and trivariate VAR, we can draw conclusions on causality. If $FPE_{y^*}(m^*, n^*, 0) > FPE_{y^*}(m^*, n^*, p^*)$, then $z_t^* \Rightarrow y_t^*$; Granger causality is established, conditional upon the presence of x_t. If $FPE_{y^*}(m^*, n^*, 0) < FPE_{y^*}(m^*, n^*, p^*)$, then $z_t^* \not\Rightarrow y_t^*$ and no Granger causality is detected. In order to test for causality from z_t^* to x_t^*, we would have to repeat the procedure the other way around.

Bivariate Causality Test Results

Table 2 gives the results of the bivariate tests for causality running from terrorism to real GDP per capita growth. Our results indicate that terrorism causally sways economic growth only in the case of Portugal. For all other countries, we do not detect a causal link. We may therefore assume that strong and developed economies are able to endure terrorist violence without suffering major negative

growth effects. Rather, they seem to be able to absorb risk associated with domestic terrorism. This is in line with Enders and Sandler (2008) who also argue that economies that are, inter alia, diversified and exhibit well-developed institutions are generally able to withstand the adverse macroeconomic effects of terrorism.

In Table 2, we report our findings on causality running from growth to terrorism. Here, economic growth *always* exerts a causal influence on terrorist violence. That is, we can assume that economic growth affects the terrorists' calculus by having an impact on the opportunity costs of violence. Economic success allows for more economic participation and opportunities, thus making violence more costly. The contrary should hold for times of economic decline.

In general, for our sample we do not find strong support that economic growth is affected by violence. Rather, targeted economies appear to be stable enough to withstand the threat of domestic terrorism without suffering major economic setbacks.[14] We find that growth unidirectionally causes domestic terrorist violence for six out of seven countries. For Portugal we find bidirectional Granger causality. In the bivariate model specification, a strong link runs from economic growth to terrorist violence, presumably as the opportunity costs of political violence are impacted. This matches with previous empirical findings which attribute a strong role to economic factors in shaping the patterns of conflict and terrorist violence (cf., e.g., Collier and Hoeffler, 1998; Blomberg, Hess and Weerapana 2004; Blomberg and Hess, 2008; Freytag *et al.*, 2008).

– Table 2 here –

Trivariate Causality Test Results

We have already argued that care should be taken interpreting bivariate causality test results due to the possibility of misleading results. Table 2 has given an initial hint that such caution could be appropriate for our analysis. The reported joint F-statistics are not always significant, indicating that our causality inferences may be spurious. To reduce potential bias due to omitted variables and to raise the explanatory power of our analysis, we also test for Granger causality between domestic terrorism and economic growth, conditional upon the presence of trade openness. Earlier, we already outlined the underlying mechanisms. On the one hand, trade may influence growth via increased specialization and so forth. On the other hand, trade may also influence terrorist activity, mainly by affecting the opportunity costs of violence. That is, from a theoretical point of view there is the possibility that trade openness may drive growth as well as terrorism. By accounting for trade openness in a trivariate system, we are able to reduce inconsistent causality inferences which may have resulted from the omission of trade openness in a bivariate model.[15]

Table 3 gives the results of the trivariate Granger causality tests running from terrorism to real GDP per capita growth. The link from terrorism to growth found in the bivariate system for Portugal is not detected in the trivariate case. Concerning Germany and Spain, we interpret our results as in Triacca (1998), also concluding that there is no causal relationship from terrorism to growth for

these countries. In the bivariate system, we have already detected that there is no Granger causality running from terrorist violence to economic growth; in the trivariate system, the comparison between the two FPE now only *seems* to suggest a causal effect from terror to growth. Following Triacca (1998), we argue that it is actually trade openness – the omitted variable in the bivariate system – that causes growth, and *not* terrorism.[16] We therefore cannot state that for Germany and Spain Granger causality runs from terrorist violence to growth. To sum up, when including information on trade openness in a higher dimensional process, we are hence unable to discover any statistical causality effect of terrorism on economic growth. This confirms our earlier interpretation that attacked economies have been successful in coping with the threats of domestic terrorism. We attribute this resilience to the strength of the markets and institutions of attacked economies (cf. Enders and Sandler, 2008).

With respect to the link from economic growth to terrorism, the results displayed in Table 3 show that economic growth granger-causes terrorism now only in the cases of Germany, Portugal and Spain. Note that for these cases the joint F-statistics now always indicate significance, adding to the reliability of the causality inferences. For France, Greece, Italy and the United Kingdom we cannot confirm our causality findings from the bivariate specification. That is, we still find some evidence for the idea that terrorism is impacted by growth through the latter's effect on the opportunity costs of violence. Conditional upon the presence of information on trade openness, the influence of economic performance on terrorism generally becomes less pronounced. Bivariate Granger causality tests have at times been known to deliver inconsistent results; these findings should therefore be considered with caution.

In general, the Granger causality test results of the trivariate case only partially confirm those of the bivariate analysis. On the one hand, the additional evidence supports our idea that attacked economies have been successful in adjusting to terrorist violence, thereby not incurring costs in the form of reduced growth. We do not detect any Granger causality running from terrorism to growth in trivariate systems. On the other hand, we should probably not overestimate the determining effect of economic performance on terrorism, as we see related causal relationships only for Germany, Portugal and Spain. This supports the evidence provided by, inter alia, Freytag et al. (2008) on the effect of income growth on terrorism. Still, the missing links for the other four countries of our sample also support views that are more skeptical of the impact of economic performance on terrorism (cf., e.g., Kurrild-Klitgaard, Justesen and Klemmensen 2006).

– Table 3 here –

DISCUSSION

Policy Implications

The results of our Hsiao-Granger causality analysis indicate that economic factors – at least in some countries – played an important role in shaping terrorist violence in Western Europe after the Second World War. In general, we provide support for policies that aim at increasing the opportunity costs of terror as,

for instance, advocated by Frey and Luechinger (2003). Apparently economic success – especially in Germany, Portugal and Spain – helped to reduce political violence by raising the opportunity costs of terrorism. Policies that focus on growth and economic development are thus also potentially helpful in scaling down terror risks. Related policies may yield additional dividends beyond raising economic status, as social stability and peace may also be affected. For Western Europe, developed welfare states may provide important institutional channels for disseminating economic success, likewise explaining a link from economic performance to domestic terrorism.[17] Our results also imply that domestic terrorist violence did not affect GDP per capita growth. Affected economies seem to have been generally successful in dealing with terror risks. Markets and institutions appear to have adjusted effectively to terror risks.

In general, we argue that (i) policies that aim at improving economic status should also be pursued because they may robustly reduce the propensity towards domestic terrorism at least in some countries. The opportunity costs of violence and the general influence of economic factors on terror should not be disregarded. (ii) Policies that aim to increase the efficiency of markets and institutions should also be undertaken because they help to protect economies from the negative effects of terrorism by increasing markets and institutions' resiliency to terrorist attacks.

Caveats

Several caveats can be brought forward with respect to our analysis. (i) Our evidence is region-specific, so the results may not hold for other world regions. These regions may exhibit less developed markets and institutions, so they are more prone to terror-induced shocks. Additionally, the relationship between economic factors and terrorism may be less pronounced. For instance, the studies of Feldmann and Perälä (2004) for Latin America or of Piazza (2007) for the Middle East suggest that other factors – for instance, political instability or state failure – matter more strongly to terrorism in these parts of the world. (ii) We only look at domestic terrorism. On the one hand, domestic terrorism is a more common phenomenon than transnational terrorism, so we should be able to thoroughly assess the interaction between terrorism and economic performance with our data. On the other hand, transnational terrorism may also contribute to this interaction, potentially amplifying the effects indicated by our analysis.[18] (iii) With respect to our policy advice, we acknowledge that terrorism is caused not only by economic factors. Economic success is not a panacea for terror. For instance, political participation may also be helpful as it influences the opportunity costs of violence as well (cf. Frey and Luechinger, 2003). In particular, this is true for conflict that is also obviously co-determined by political factors as e.g. in the case of ETA (cf. Barros, 2003).

SUMMARY

In this contribution, we tested for Granger causality between domestic terrorism and real GDP per capita growth. Using the Hsiao-Granger method to detect

causality in time series, we were able to circumvent common problems associated with causality analyses in time-series frameworks. We tested for causality in a bivariate and trivariate setting in order to provide robust results.

We found that (i) all investigated growth and terror series exhibit structural breaks matching major turning points in the countries' economic and political history. (ii) In bivariate systems, economic growth leads terrorist violence in all cases, whereas terrorism causally influences growth only for one country. We argued that economic performance appears to influence the terrorists' calculus, while attacked economies are generally resistant to domestic terrorism. (iii) We noted that bivariate causality tests may be prone to inconsistencies, so we also performed causality tests in trivariate systems. The findings confirmed that economies under attack are successful in adjusting to the threats of terror, so economic growth is not impaired. With respect to causality running from growth to terrorism, the results weaken those of the bivariate analysis. Economic performance robustly sways the terrorists' calculus only for Germany, Portugal and Spain, but not for France, Greece, Italy and the United Kingdom. Solid growth in some countries may raise the opportunity costs of terror, thus discouraging violent behavior, for instance as individuals find more economic opportunities. In the light of our results, policymakers therefore should not underestimate the role of economic factors – and the role of the opportunity costs of violence – in impacting domestic terrorism. For some countries in the investigated part of the world, economic success apparently has contributed to a crowding out of domestic terrorist violence. However, factors other than economic performance should also be considered when explaining terrorism dynamics, in particular when the links between economic growth and domestic terrorist violence are not found to be strong.

Notes

[1] For our analysis we focus on domestic terrorism, that is, terrorism involving only citizens, groups or the territory of one country. In contrast, *transnational terrorism* means terrorism involving citizens, groups or the territory of more than one country. Here, either the sources or targets of transnational terrorism can be analyzed.

[2] The countries of the analysis with their time horizons are: France (1951-2004), Germany (1971-2004), Greece (1952-2004), Italy (1951-2004), Portugal (1951-2004), Spain (1951-2004) and the United Kingdom (1951-2004). No information on Germany is available before 1970; data prior to 1990 relates only to West Germany. The information on the United Kingdom also includes Northern Ireland.

[3] The TWEED dataset provides information on domestic terrorism for 18 Western European countries.

[4] Frey, Luechinger and Stutzer (2007) and Enders and Sandler (2008) bring forward similar theoretical channels of influence of terrorism on the economy. These studies also provide additional evidence on the macroeconomic consequences of terrorism that is not reported here.

[5] The empirical evidence reported in the following almost always refers to the phenomenon of transnational terrorism, given the lack of data on domestic terrorism in the past (cf. Enders and Sandler, 2008). Although we do not believe that transnational and domestic terrorism interact symmetrically with the economy, we report fitting evidence to show (i) that terrorism may damage the economy and (ii) economic factors may determine terrorist activity.

[6] Evidence on the *targets* of transnational terrorism either finds that short-run and long-run economic conditions do not matter strongly for terrorists' attack decisions (cf. Piazza, 2006; Drakos and Gofas, 2006; Kurrild-Klitgaard, Justesen and Klemmensen, 2006), or indicate that economically successful countries are more prone to terrorism (cf. Tavares, 2004; Blomberg, Hess and Weerapana 2004). Attackers from abroad may not be deterred by increased economic opportunities in the country they attack. Instead, economic success may increase the payoffs from terrorist strikes. That is, the cost-benefit considerations of transnational attackers may differ from those of domestic terrorists.

[7] Economic growth may also be driven by, inter alia, geography, trade or institutions. Terrorism may be determined by e.g. other material causes, political factors, demography or systemic reasons.

[8] Mirza and Verdier (2008) provide an overview of the terrorism-trade literature, focusing on transnational terrorism. It is reasonable to believe that at least some related findings can be transferred to the relationship between domestic terrorism and trade. Note that in the broader sense trade openness may also reflect the general quality of institutions (cf. Rodrik, 2000). Better institutional quality should coincide with less terrorist activity.

[9] When we use data on terrorist attack counts, we cannot possibly evaluate the ferocity of such attacks. For instance, both a minor, politically motivated damage to property and a severe bombing with multiple casualties count as one attack; here, it appears reasonable to assume that there is a much stronger interaction between the bombing and economic factors.

[10] We use the natural logarithm to better account for outliers. We add unity to the observations in order to compute the natural logarithm also in those years when there were no victims from terrorist attacks.

[11] Note that when two or more series used simultaneously in the following causality analysis are found to be $I(1)$, further tests for cointegration would be required in order to account for long-run equilibrium relationships between the series. As cointegration plays no role in our analysis, we do not discuss this point any further.

[12] We also use the unit root test of Clemente, Montañés and Reyes (1998) which allows for two structural breaks. These results generally confirm our results on stationarity and structural break dates.

[13] The trivariate VAR is not presented due to space constraints.

[14] We are well aware that terrorism may damage certain sectors of the economy, and we hinted at corresponding evidence in our literature review. Our analysis simply provides little evidence that such damages feed through to overall growth.

[15] One can argue that other factors potentially driving growth as well as terrorism should also be controlled for, such as the quality of economic institutions, political instability and transformation, or human capital endowment. We opt for trade openness because it matches

with our analysis on thereotical grounds and because data is available for all countries and time periods.

[16] Triacca (1998) provides proof for the following argument: If a variable Y_3 does not cause Y_1 in a bivariate system, but in a trivariate one where the variable Y_2 is also included, then Y_2 must cause Y_1 in the bivariate and trivariate system. We apply his proof to our causality evidence for Germany and Spain, where Y_1 is economic growth, Y_2 is trade openness and Y_3 is terrorist violence.

[17] See Burgoon (2006) for an in-depth discussion of the potential links between terrorism and welfare policies.

[18] However, clearly differentiating between domestic and transnational terrorism – as in our analysis – may be helpful to keep apart potentially different terrorists' calculi. As discussed before, transnational terrorists may be driven by other cost-benefit considerations than domestic terrorists. For instance, while transnational terrorists may find it attractive to attack rich countries because of the increased benefits of such attacks, domestic terrorists may reduce attacks at the same time due to the increased opportunity costs of violence.

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Table 1: Zivot-Andrews Unit Root Test

Country	Series	ZA Statistics	Break Date	Inference
France	Growth (G)	-6.722[a]	1974	I(0) + Trend
	Terrorism (T)	-5.636[a]	1989	I(0) + Trend
	Openness	-3.787	1982	I(1)
Germany	Growth (G)	-5.113[b]	1988	I(0) + Trend
	Terrorism (T)	-6.614[a]	1995	I(0) + Trend
	Openness	-3.904	1993	I(1)
Greece	Growth (G)	-10.006[a]	1974	I(0) + Trend
	Terrorism (T)	-5.934[a]	1985	I(0) + Trend
	Openness	-5.025	1973	I(1)
Italy	Growth (G)	-7.233[a]	1963	I(0) + Trend
	Terrorism (T)	-5.400[b]	1971	I(0) + Trend
	Openness	-2.917	1973	I(1)
Portugal	Growth (G)	-6.792[a]	1974	I(0) + Trend
	Terrorism (T)	-6.513[a]	1975	I(0) + Trend
	Openness	-5.125[b]	1974	I(0) + Trend
Spain	Growth (G)	-7.754[a]	1975	I(0) + Trend
	Terrorism (T)	-6.385[a]	1971	I(0) + Trend
	Openness	-4.606	1959	I(1)
UK	Growth (G)	-6.147[a]	1983	I(0) + Trend
	Terrorism (T)	-5.130[b]	1969	I(0) + Trend
	Openness	-3.593	1981	I(1)

Notes: (b), (a) indicates significance of the Zivot-Andrews Unit Root Test at 5% and 1% levels, that is, rejection of the hypothesis of unit root presence. Critical values are taken from Zivot and Andrews (1992).

Table 2: Terrorism-Growth Bivariate Causality Test

Country	FPE (m,0)	FPE (m,n)	F-Stat	T ⇒ G	FPE (m,0)	FPE (m,n)	F-Stat	G ⇒ T
France	2.1184 (1,0)	2.3718 (1,1)	0.236	NO	1.8558 (1,0)	1.7156 (1,1)	1.453	YES
Germany	2.0725 (4,0)	2.4928 (4,2)	2.651^{b}	NO	0.8187 (1,0)	0.6665 (1,2)	3.268^{b}	YES
Greece	6.8433 (1,0)	7.0927 (1,5)	1.254	NO	0.5640 (1,0)	0.5287 (1,1)	0.349	YES
Italy	4.0109 (1,0)	4.0169 (1,1)	0.128	NO	1.4802 (1,0)	1.3581 (1,1)	0.630	YES
Portugal	9.2646 (1,0)	8.5833 (1,1)	0.917	YES	0.2965 (5,0)	0.2655 (5,3)	3.102^{a}	YES
Spain	6.5819 (1,0)	8.5833 (1,1)	0.917	NO	0.5009 (6,0)	0.2798 (6,3)	2.753^{b}	YES
UK	3.2292 (2,0)	3.4394 (2,1)	1.404	NO	1.1821 (1,0)	1.1774 (1,1)	1.112	YES

Notes: FPE (m,0) indicates the minimal FPE of autoregressive process with the optimal lag length m^*. FPE (m,n) indicates the minimal FPE of the two variable VAR process with the optimal lag lengths m^* and n^*. We allow for a maximum of six lags. (b) and (a) denote significance of the joint F-statistics at 5% and 1% levels, respectively.

Table 3: Terrorism-Growth Trivariate Causality Test

Country	FPE (m,n,0)	FPE (m,n,p)	F-Stat	T ⇒ G	FPE (m,n,0)	FPE (m,n,p)	F-Stat	G ⇒ T
France	2.3739	2.4408	0.661	NO	1.7136	1.7778	1.338	NO
	(1,1,0)	(1,1,1)			(1,1,0)	(1,1,1)		
Germany	2.5289	2.4753	2.61^{b}	NO^{+}	0.6335	0.5894	4.23^{a}	YES
	(4,1,0)	(4,1,2)			(1,1,0)	(1,1,2)		
Greece	7.1225	7.1755	1.262	NO	0.5345	0.5556	0.378	NO
	(1,1,0)	(1,1,5)			(1,1,0)	(1,1,1)		
Italy	4.0602	4.1992	0.106	NO	1.4085	1.4303	0.516	NO
	(1,1,0)	(1,1,1)			(1,1,0)	(1,1,1)		
Portugal	8.6179	8.7752	0.868	NO	0.2966	0.2692	2.892^{b}	YES
	(1,1,0)	(1,1,1)			(5,1,0)	(5,1,3)		
Spain	6.2268	5.9240	3.093^{b}	NO^{+}	0.5113	0.4809	2.193^{b}	YES
	(1,3,0)	(1,3,1)			(6,1,0)	(6,1,6)		
UK	3.1570	3.2664	2.095^{c}	NO	1.1727	1.2052	0.872	NO
	(2,2,0)	(2,2,1)			(1,1,0)	(1,1,1)		

Notes: FPE (m,n,0) indicates the minimal FPE of the bivariate VAR with the optimal lag lengths m^{*} and n^{*}. FPE (m,n,p) indicates the minimal FPE of the trivariate VAR with the optimal lag lengths m^{*}, n^{*} and p^{*}. We allow for a maximum of six lags. (c) (b) and (a) denote significance of the joint F-statistics at 10%, 5% and 1% levels, respectively. (+) indicates that causality is driven by the control variable. See the text for a further discussion.