Studying the Relationship Between Economic Factors and Terrorism: How do Changes in Economy impact Changes in Terrorist Attacks Over Time?

Abstract

This paper studies the relationship between number of terrorist incidents and economic conditions over a three-year period. For our analysis, we first adopted various selection techniques to determine the reduced model that captured the change in number of terrorist attacks. Then, we used an extra sum of squares test to determine if the percent change in economic conditions over a three-year period provided extra explanatory power. While we did not have clear evidence based on the results of our extra sum of squares test, our data suggest a potential relationship between the interaction between region and changes in economic conditions and changes in terrorist incidents.

Introduction:

There is a general consensus that terrorism inflicts an enormous cost on the society. For example, the US has spent $2.7 trillion on counter-terrorism measures since 2002, which amounts to a yearly average expenditure of nearly $200 billion (Stimson Center, 2017). However, the true cost of terrorism goes beyond this figure when we take into account the psychological cost, the opportunity cost of the terrorism events, and the cost of rebuilding as a result of terrorism. Given the huge societal costs of terrorism, our paper attempts to create a regression analysis to model terrorism. By developing this model, we hope to make a first step in finding patterns of terrorism.

After developing a model, we will conduct an extra sum of squares test (ESS) to determine if changes in economic conditions can improve our model. Previous literature on terrorism (Shinn, 2016) suggest that economic instability is a determinant factor for instances of terrorism, our model attempts to see if a large three-year change in GDP per capita will correlate to instances of terrorism. Additionally, Meierrieks and Gries (2013) suggest that the relationship between economic factors and terrorism varies from region to region. Therefore, our model also includes an interaction term between GDP and region.

Methodology and Analysis:

Dataset Description

Our paper uses the Global Terrorism Dataset, compiled by START at the University of Maryland. This dataset includes information on 181,691 terrorist incidents across 191 countries in 47 years (1970-2017). To combine the terrorist incident data with quantitative characteristics of a country such as economic condition, quality of life, population, and other measures, we used GapMinder and their plethora of compiled sources (a full list of variables can be found in Table 3 in the appendix).

Data Manipulation

Certain countries and territories were removed, either due to incomplete GapMinder data (Vatican City, Taiwan, Hong Kong, Soviet Union, Syria, smaller island nations), or due to suspicious reporting of the total number of incidents (North Korea, Somalia, Oman). Unlike previous papers that focused on the instantaneous relationship between economic conditions and terrorism, we were interested in studying the relationship between changes of economic conditions and terrorism. To properly gauge economic change, our explanatory variable of interest in this study, percent change in GDP per capita over a three-year period centered that year was calculated (see Table 1 below).

Table 1: Sample variable calculation. Similar calculations are made for every Country-Year in our dataset.

Country	Year	Period	Percent Change in GDP	Incidents Before	Incidents After	Change Incidents
USA	2000	1999 to 2001	(GDP(2001) - GDP(1998))/ GDP(1998)[1]	# of Incidents 1996 to 1998	# of Incidents 2002 to 2004	Incidents After - Incidents Before

[1] GDP in 1998 used because GDP is recorded in December of that year. So, using 1998's GDP as a baseline would allow us to see the changes from the start of 1999 to the end of 2001.

The response variable, Change Incidents, is a measure of how the number of terrorist events are changing before and after the time period of interest. Table 1 below describes the calculations. To deal with inconsistencies in some of the GapMinder tables and the fact that terrorist event data is missing for the year 1993, we filtered our dataset to between the years 1998 and 2010, giving us 1040 country-years.

Analysis

We first used variable selection methods to determine which of the 18 Gapminder variables should be included in a best-fitting reduced model for an extra sum of squares (ESS). Based upon a residual analysis, we transformed several of our explanatory variables and reran the best subset analysis, and detailed analysis was provided in the additional analysis section of the appendix. This best-fitting reduced model is displayed below as the Reduced Model. This model has an R^2 of 0.27 and adjusted R^2 of 0.249.

Reduced Model: ChangeIncidents = log(ArmedForcesPercentLabor) + log(EnergyUsePerCapita) + log(MurderPer100000) + log(Population) + log(UnemploymentRate) + Region + Year

We then conducted an extra sum of squares test to determine if adding the variables *PercentChangeGDP* or *Region*PercentChangeGDP* would improve our model. We based this test upon the literature cited in our introduction. Details for the full and reduced models are provided in the Appendix. While the ESS did not result in a small p-value ($F(8, 492) = 1.728$, $p = 0.0895$), Figure 1, and Figure 2 indicates the interaction term could potential be useful. When comparing the trend lines in Figure 2 we see trend-lines with different slopes for different regions.

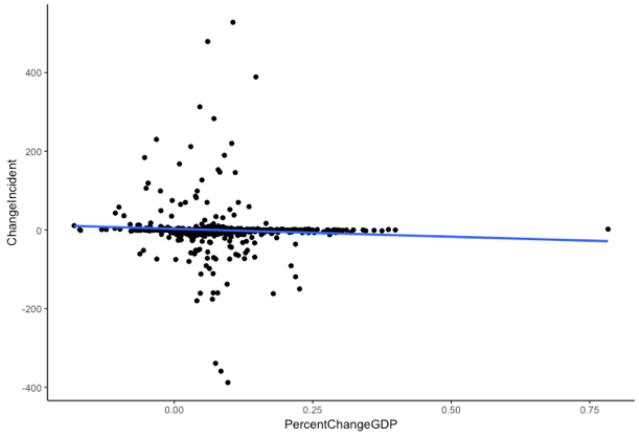

Figure 1: Scatterplot of PercentChangeGDP and ChangeIncidents

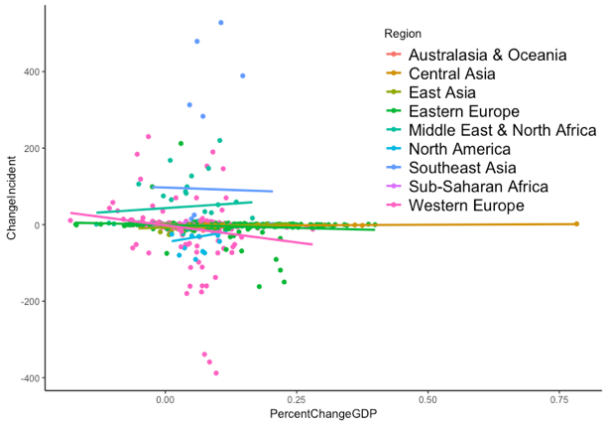

Figure 2: PercentChangeGDP vs ChangeIncidents colored by Region

Discussion

In summary, our findings provide at best weak evidence that change in GDP per capita over a three-year period and the interaction between region and change in GDP per capita are related to our response variable ($F(8, 492) = 1.728$, $p = 0.0895$). In other words, we might see different patterns in how terrorism relates to economy activity of countries in different regions. This finding partly aligns with some of the previous literatures which suggest that the relationship between economic growth and terrorism is heterogeneous across space (Yildirim & Ocal, 2010; Meierrieks & Gries, 2013). However, there are several limitations in our model.

Firstly, though our "region" variable partially captured some differences between countries such as political system and cultural factors, we did not have indicators suggesting whether the country was experiencing a civil war or not due to the accessibility of reliable data related to civil war records. Studies have shown that the civil war indicator, the political system, and the level of development (whether the country was a developing country or a developed country in a given year) could have great impacts on terrorism (Blomberg, Hess, & Weerapana, 2004; Li, 2005). Hence, accounting for civil wars and these other qualitative variables might yield a different result. Secondly, the use of our explanatory variable, percentage change in GDP, might not fully capture the economic conditions of a country. Later studies could incorporate several other economic indices such as Human Development Index, unemployment rate, inflation to get a more comprehensive picture. Thirdly, our variable of interest, the change in GDP over three year period provided insights into the stability of but dismissed the scale of GDP. To illustrate, an increase in GDP per capita from 50 to 60 dollars as well as from 10000 to 12000 dollars return 20% increase. However, the former case is very different from the latter one, since the larger the base, the harder it is to have big changes or fluctuations. Lastly, our response variable, change in the number of terrorisms does not account for the severity of the terrorist attacks. For example, the use of explosive bombs has higher severity and could indicate a severe presence of terrorism activities than a single person opening a gun fire. Therefore, we suggest later research to use a measure that captures both the severity of attacks and the number of incidents in the model.

Additionally, we calculated the percentage change of GDP using the difference between the first year and the third year's GDP. This approach allowed us to see a general trend in a three-year time frame, but we also missed important information such as the fluctuations in the economy happening within the three-year time frame, and the aggregated change of GDP does not specify if the change was continuous contraction/expansion or not. For example, there might be a 3% drop between the 2nd year and the 1st year, but a 6% increase between the 2nd year and 3rd year. Future research could try to analyze the data using a one-year time frame or create indicators to suggest whether there is continuous recession/expansion or fluctuations.

Conclusions

Overall, we did not find strong evidence to show the stability of economy over three years or its interaction between regions related to the change in number of terrorist attacks. However, the relationship between economic stability and terrorism attacks is still worth exploring. Terrorism is a challenging topic, and this work is only an initial attempt to study the pattern of change in economic activity and terrorism. Future research may build on our results and use different parameters to capture terrorism across different countries or regions.

References

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Appendix

Table 2 GapMinder datasets:

Variable	Description
ArmedForces	Number of active duty military personnel
ArmedForcesPercentLabor	military personnel as a percent of total labor force
ChildMortality	Deaths of children under 5 years old per 1000 births
DemocracyScore	Scale from Autocracy (-10) to Democracy (10).
EmploymentRate	Percent of working age population that was employed in the previous year
EnergyProductionPerCapita	Energy refers to petroleum, gas, coal, solar, hydro, etc.
EnergyUsePerCapita	Indigenous production + imports - exports
GDP	Gross Domestic Product
GDPPerCapita	Gross Domestic Product per person
GiniCoefficient	Measure of wealth inequality
HumanDevelopmentIndex	Ranks countries by human development (health level, education level, and living standards)
Inflation	Rate of change in product prices
LaborForceParticipation	Participation rate in the labor force. includes those not working but actively searching for work
LifeExpectancy	Average length of life
MilitaryExpenditure	Includes expenditure on armed forces, peacekeeping operations, and defense ministries among others.
MurderPer100000	Number of murders per 100000 people
Population	Number of people living in the country
UnemploymentRate	Percent of working age population that had been unemployed in the given year.

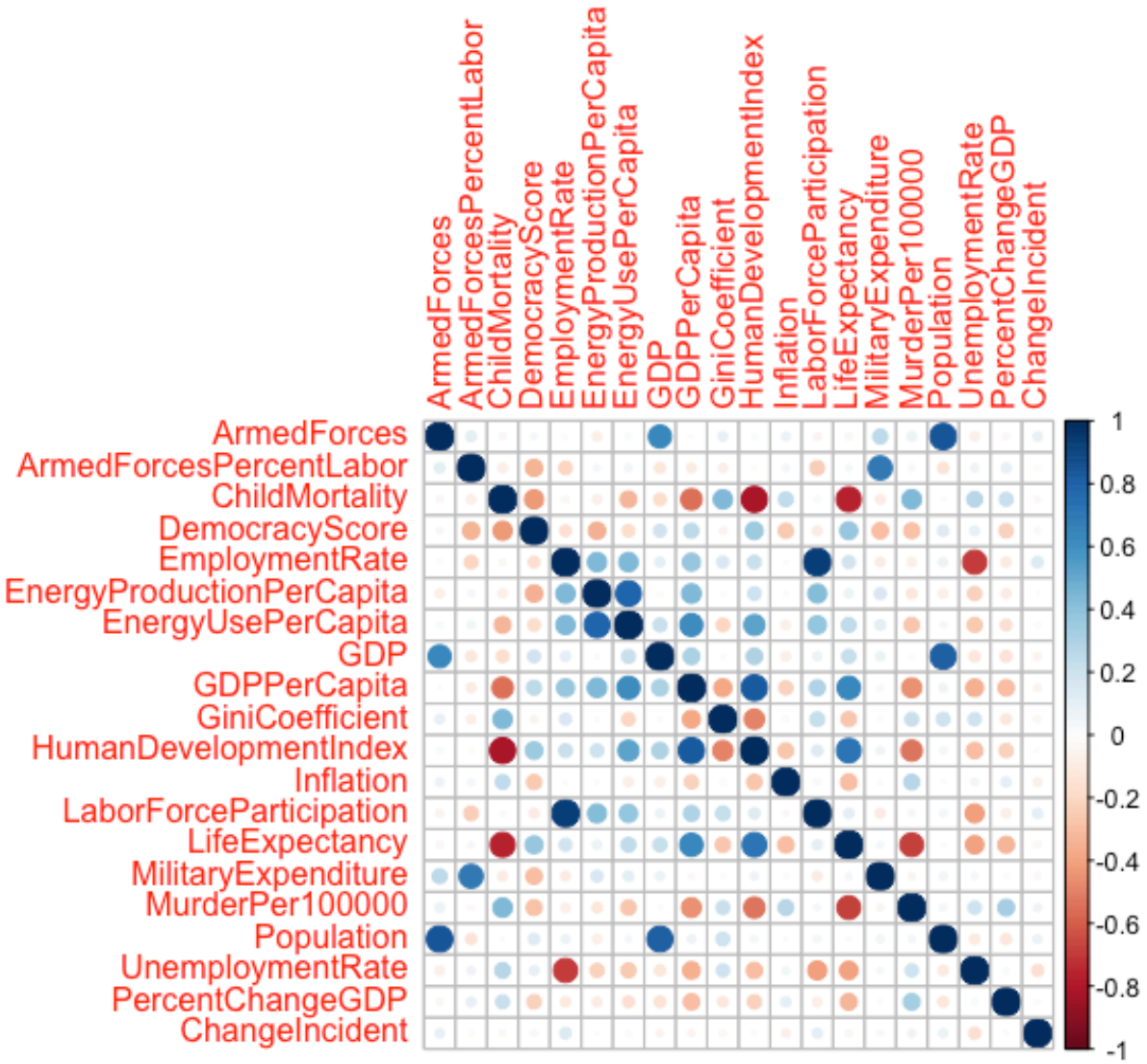

Figure 3: Correlation matrix plot with GapMinder data, PercentChangeGDP, and ChangeIncident.

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Coefficients:
                                Estimate Std. Error t value Pr(>|t|)
(Intercept)                   -5539.3986  1427.1864  -3.881 0.000118 ***
log(ArmedForcesPercentLabor)    -11.1486     4.5470  -2.452 0.014553 *
log(EnergyUsePerCapita)         -19.1645     6.3379  -3.024 0.002625 **
RegionCentral Asia              -45.5989    21.3724  -2.134 0.033367 *
RegionEast Asia                  -0.5536    16.9049  -0.033 0.973889
RegionEastern Europe             -3.7381    13.3402  -0.280 0.779428
RegionMiddle East & North Africa  65.0129    18.3003   3.553 0.000418 ***
RegionNorth America             -35.3580    19.0109  -1.860 0.063490 .
RegionSoutheast Asia             98.1151    19.3825   5.062 5.84e-07 ***
RegionSub-Saharan Africa        -34.3110    57.1928  -0.600 0.548833
RegionWestern Europe              5.0572    12.2877   0.412 0.680834
log(MurderPer100000)             19.4456     3.4911   5.570 4.16e-08 ***
log(Population)                   3.4971     2.5021   1.398 0.162839
log(UnemploymentRate)           -22.7644     5.4592  -4.170 3.59e-05 ***
Year                              2.8287     0.7059   4.007 7.08e-05 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 54.73 on 500 degrees of freedom
  (525 observations deleted due to missingness)
Multiple R-squared:  0.2698,    Adjusted R-squared:  0.2494
F-statistic:  13.2 on 14 and 500 DF,  p-value: < 2.2e-16
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Figure 4: Summary and coefficients of Model from the Reduced Model

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Coefficients: (1 not defined because of singularities)
                                                  Estimate Std. Error t value Pr(>|t|)
(Intercept)                                     -4767.3146  1653.8575  -2.883  0.00412 **
log(ArmedForcesPercentLabor)                      -12.6817     4.8883  -2.594  0.00976 **
log(EnergyUsePerCapita)                           -20.5061     6.5934  -3.110  0.00198 **
RegionCentral Asia                                -67.2181    35.3150  -1.903  0.05757 .
RegionEast Asia                                    12.7312    29.1529   0.437  0.66252
RegionEastern Europe                               19.0364    25.2619   0.754  0.45147
RegionMiddle East & North Africa                   72.6663    28.2988   2.568  0.01053 *
RegionNorth America                               -60.5564    41.2982  -1.466  0.14320
RegionSoutheast Asia                              100.8928    33.5411   3.008  0.00276 **
RegionSub-Saharan Africa                          -32.8678    57.3500  -0.573  0.56683
RegionWestern Europe                               25.5109    24.3801   1.046  0.29590
log(MurderPer100000)                               22.9334     3.6962   6.205 1.16e-09 ***
log(Population)                                     3.0429     2.5278   1.204  0.22926
log(UnemploymentRate)                             -24.8000     5.5885  -4.438 1.12e-05 ***
Year                                                2.4463     0.8161   2.998  0.00286 **
PercentChangeGDP                                  244.2000   368.5240   0.663  0.50787
RegionCentral Asia:PercentChangeGDP               -95.3136   376.6301  -0.253  0.80032
RegionEast Asia:PercentChangeGDP                 -187.0684   406.7583  -0.460  0.64579
RegionEastern Europe:PercentChangeGDP            -316.5456   369.4945  -0.857  0.39203
RegionMiddle East & North Africa:PercentChangeGDP   9.3460   398.4823   0.023  0.98130
RegionNorth America:PercentChangeGDP              325.9721   572.3575   0.570  0.56926
RegionSoutheast Asia:PercentChangeGDP             -83.2585   418.7577  -0.199  0.84248
RegionSub-Saharan Africa:PercentChangeGDP              NA         NA      NA       NA
RegionWestern Europe:PercentChangeGDP             -324.4006   368.1598  -0.881  0.37867
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 54.41 on 492 degrees of freedom
  (525 observations deleted due to missingness)
Multiple R-squared:  0.2898,    Adjusted R-squared:  0.258
F-statistic: 9.125 on 22 and 492 DF,  p-value: < 2.2e-16
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Figure 5: Summary and Coefficients of Model from the Full Model

Additional Analysis:

Using an Indicator Variable to Detect the Effect of Large Changes in GDP:

After conducting our initial ESS test, we attempted to create indicator variables that would signify changes in GDP of specific sizes. The idea behind this was that there might not be a linear relationship between changes in GDP and changes in Terrorism (going from 5% to 6% change might not be the same as going from 19% to 20% change), and rather there might be some limit point above which this relationship takes a different shape. We tested breakpoints ranging from -.2 to 0.5, incrementing by 0.01 to see how these indicators were related to changes in terrorism. To test this relationship, we added the indicator variable to the Reduced Model above and saw the significance of the indicator variable coefficient (this gives the same p-value as an ESS test when there is only one variable difference between the two models). We did find that a breakpoint of .17 (17% growth in GDP) had a coefficient p-value of .0228, however we didn't feel this was a low enough p-value to overcome multiple comparison issues (There would be a 97.5% chance of at least one type 1 error with 71 significance tests with an alpha-level of 0.05).