

Methods for Measuring the Costs of Conflict

Alberto Abadie - Harvard University

Javier Gardeazabal - University of the Basque Country

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Abstract

This paper reviews the methods for measuring the economic cost of conflict. Estimating the economic costs of conflict require a counterfactual calculation, which makes this task very difficult. Social researchers have resorted to different estimation methods depending on the particular effect being estimated. The method used in each case depends on the units being analyzed (firms, sectors, regions or countries), the outcome variable under study (aggregate output, market valuation of firms, market shares, etc.) and data availability (a single cross section, time series or panel data). This paper reviews all existing methods used in the literature to assess the economic impact of conflict: cost accounting, cross section methods, time series methods, panel data methods, event studies, and comparative case studies. The paper ends with a comparison and discussion of costs estimates.

1 Introduction

Conflict manifests in several forms, from strikes, demonstrations and riots to guerrilla warfare, terrorism and civil war. In turn, these forms of conflict have economic, social, psychological and other type of costs. Notwithstanding the importance of other type of costs, this paper focuses on the measurement of the economic costs of conflict.

Estimating the economic cost of conflict is a difficult task. In order to grasp the magnitude of the problem, it amounts to calculating what a given economic magnitude, say GDP, would have been in the absence of conflict. A counterfactual calculation difficult to carry out. Conflict itself is an unobservable magnitude, what makes statistical inference problematic as researchers have to resort to proxy indicators of the level of conflict such as the number of casualties in a war or the number of political assassinations. Therefore, it is not surprising that, despite its relevance, the issue has received little attention relatively to other topics. Recent events, the September 11-th and the war in Iraq, have triggered a new surge in this area of research. While the estimation of the magnitude of the economic costs of conflict remains an unsettled question, the empirical evidence surveyed in this article suggests that the effect is negative and significant.

In studying the economic cost of conflict we will distinguish among various types of costs. Economic costs can be classified into direct and indirect costs. For example, a civil war has a direct economic cost equal to all property destroyed plus an indirect cost that includes the production loss during and after the conflict due to casualties and capital destruction during the conflict. Analyzing the temporal dimension, we can classify the economic costs of conflict into contemporaneous and accumulated costs. The contemporaneous costs, also referred to as impact costs, are those incurred in the same period as the conflict. The accumulated or long-run cost is the sum of the period by period costs.

In this paper we focus on the methods for estimating the economic costs of conflict and the quantitative values obtained. The methods used are diverse and range from time series methods to cross-section and panel data methods. The methods used in the literature are determined by the objective of the study and data availability. When the objective is to assess the economic cost of conflict in a particular country, region or sector, time series methods are typically used, while if the purpose is to assess the economic impact of conflict for the average of a set of countries, researchers have used panel data methods.

In this survey we review the different methods used in the literature to estimate the economic effect of conflict. Section 2 reviews the method of cost accounting. Section 3 comments on regression methods using cross section data. Section 4 examines the contribution of time series methods, in particular the transfer function and vector autorregresion methods. Regression methods using panel data are reviewed in section 5. Section 6 covers event studies. Section 7 reviews the comparative case study method. Finally, section 8 discusses the state of the art in measuring the cost of conflict and offers a view of the road ahead.

2 The cost accounting method

The cost accounting method is probably the simplest and more straightforward method of estimating the economic cost of conflict. It simply adds up the monetary value of direct and indirect costs. Direct costs estimates are based on actual data from public accounts and statistical records. The estimates of the indirect costs of conflict include costs such as the production loss due to capital destruction and the compounded value of subsequent production loss during the post-conflict period. Production loss estimates are subject to criticism as they require some counterfactual estimate, typically from a regression model, plus some hypothesis about the interest rate to be applied in calculating the compounded value.

A good example of this approach is Arunatilake, Jayasuriya and Kelegama (2001) estimates of the cost of civil war in Sri Lanka over the 1984-1996 period. They estimate that the direct cost of war in Sri Lanka was 61.9 per cent of Sri Lanka's 1996 GDP or over six billion US dollars at the then prevailing exchange rate. This estimate includes the extra government military spending due to the war (41.3 per cent of Sri Lanka's 1996 GDP), the LTTE military spending (4.1 %), the cost of providing for the refugees (3%) and damages to capital assets and land (13.5%). In addition they provide indirect costs estimates from lost income due to foregone investment (8.61%), reduced tourist arrivals (17%), foregone foreign investment (71.2%), human capital of dead or injured persons (2.5%) and other costs. Total direct and indirect costs added up to 168 per cent of Sri Lanka's 1996 GDP. The methods used in estimating indirect costs range from simple regressions (In order to estimate the indirect cost accruing from the lost income due to foregone investment, they estimate a regression model of the GDP growth rate as a function of the investment to GDP ratio using time series of these aggregates) to plausible tourist arrivals scenarios and back of the envelope calculations.

The cost accounting method has also been applied to the evaluation of the economic cost of participating in a war. Davis, Murphy and Topel (2006) estimated that the pre-invasion present value cost of the war in Iraq for the United States. These costs included military resources, the value of lost lives and injuries sustained by U.S. soldiers, the lifetime medical costs of treating injured soldiers and humanitarian assistance and postwar reconstruction. They estimated the annual cost of war under different scenarios and then computed the present value using various discount schemes. Their estimated cost of the war in Iraq for the U.S. ranged from 100 to 870 billions of 2003 U.S. dollars (0.9 to 7.8 per cent of U.S. GDP). In another paper, Bilmes and Stiglitz (2006) using the same methodology but including WHAT? estimated that the total economic costs of the war in Iraq for the U.S. would range from one to three trillions U.S. dollars.

The cost accounting methodology provides costs estimates that are numerically easy to perform and the calculations can be carried out for a multiplicity of scenarios. However, the cost accounting methodology requires expertise in listing all types of costs and designing the different scenarios. From an statistical point of view, the cost accounting method does not

allow the researcher to perform statistical inference as the estimates do not come with standard errors.

3 Inference based on cross-section data

A simple way to assess the economic effect of conflict is by means of a simple regression model. Often, a regression equation is postulated where some economic variable, the outcome, is regressed on a measure of conflict and other control variables. When a cross section data set on these variables is available, one can exploit the cross section variation in the conflict measurement to assess its effect on the outcome variable. The quantitative value of these estimates can be interpreted as a steady-state calculation of the effect of conflict on the average unit of analysis. Some examples of this approach follow.

Venieris and Gupta (1986) provides a neat example of this methodology. They claim that socio political instability, an index composed by the number of deaths, protest demonstrations and regime type, negatively affects savings. Using a sample of 49 non communist countries, they report the following estimates¹

$$\frac{S}{Y} = -0.052 - 0.022SPI + other\ covariates$$

(0.78) (-3.27)

where the left hand side variable is the savings to GDP ratio and SPI stands for socio political instability. This evidence supports the hypothesis that higher socio political instability results in lower savings. Unfortunately, the authors do not report descriptive statistics on the SPI index and therefore we cannot state the quantitative effect of sociopolitical instability on the savings to GDP ratio.

A quantitative estimate of the effect of sociopolitical instability on investment is feasible, however, in a second example of this approach by Alesina and Perotti (1996). They argue that the level of sociopolitical instability, an index reflecting political assassinations, coups and other variables, should affect investment negatively. Using a sample of 71 countries and sample averages of the period 1960-1985, they report the following estimated equation

$$\frac{I}{Y} = 27.36 - 0.50 SPI + other\ covariates$$

(9.34) (-2.39)

where the left hand side variable is the investment to GDP ratio and SPI stands for socio political instability. To avoid the possibility of reverse causation (from investment to socio political stability) bias, Alesina and Perotti used instrumental variable estimators. The regression coefficient estimates are meaningless unless the scale of the explanatory variable is specified. This poses a problem when the explanatory variable is an index, as in the present case. One way of conducting a simple quantitative assessment of the impact of the SPI index on the investment

¹Hereinafter figures within parentheses are t statistics.

ratio is as follows. Alesina and Perotti report a standard deviation of the SPI index of 11.95. To give an idea of what this magnitude means, 11.95 would be the increase in the index of socio political instability when we move from the USA to Chile. A one standard deviation increase in the index of sociopolitical instability would generate a fall in investment of $0.5 \times 11.95 = 5.975$ percentage points in the investment to GDP ratio. This quantitative value requires two remarks. First, a one standard deviation change in the SPI index is a change in this index from a low value of SPI to a high value of SPI that could be difficult to observe in any particular country in a short period of time. Second, this cross-section estimate of the cost of conflict represents an average of the effect over countries. Therefore, particular conflict episodes can have smaller or larger impacts on the investment ratio.

In his highly cited paper, Barro (1991) studied the sources of economic growth empirically for a sample of 98 countries. He reports the following estimates

$$\Delta y_i = -0.0075 y_{0i} - 0.0195 REV_i - 0.0333 ASSASS_i + \text{other covariates}$$

(-6.25)
(-3.10)
(-2.15)

$$\left(\frac{I}{Y}\right)_i = -0.0098 y_{0i} - 0.055 REV_i - 0.068 ASSASS_i + \text{other covariates}$$

(-2.04)
(-2.62)
(-2.52)

where Δy_i is the average per capita rate of growth of country i over the 1960-1985 period, $\left(\frac{I}{Y}\right)_i$ is the average over the same period of the private investment to GDP ratio, y_{0i} is the initial per capita GDP, REV measures the number of revolutions and coups per year and $ASSASS$ records the number of political assassinations per million population per year. To avoid the possible reverse causation from growth to political stability Barro uses the instrumental variables estimation technique. According to the previous estimates, REV and $ASSASS$ are measures of political instability negatively associated with growth. Again, using the standard deviations of these variables we can compute the quantitative effect. A one standard deviation increase in the number of revolutions and coups per year reduces per capita growth rate in almost half a percentage point ($-0.0195 \times 0.23 = -0.0045$) and private investment to GDP ratio in 1.26 percentage points ($-0.055 \times 0.23 = -0.0126$). Similarly, a one standard deviation increase in the number of political assassinations per million population per year reduces per capita growth rate in 0.29 per cent ($-0.0333 \times 0.086 = -0.0029$) and the investment ratio in 0.58 percentage points ($-0.068 \times 0.086 = -0.0058$).

Abadie and Gardeazabal (2008) hypothesize that terrorism risk can scare capital away from those countries exposed to higher risks. They analyze the effect of terrorism on the net foreign direct investment position (domestic assets owned by foreign investors minus foreign assets held by domestic investors) in a sample of 98 countries in 2003. They report the following estimates

$$\frac{NFDI \text{ position}}{Y} = 1.5354 - 0.0025 GTI + \text{other covariates}$$

(3.5723)
(-2.0833)

where the left hand side variable is the net foreign direct investment position (assets minus

liabilities) over GDP and GTI is a Global Terrorism Index. The standard deviation of the terrorism index is 19.82. A one standard deviation change in this index would be the change in terrorist risk if we move from Italy to the United States. According to their findings, a one standard deviation increase in terrorist risk induces a fall in the net foreign direct investment position over GDP ratio of $0.0025 \times 19.82 = 0.0495$, almost 5 percentage points.

Interestingly, Koubi (2005) studied the effect of war on growth both during the war and postwar periods. She reports the following cross-country growth regressions for a sample of 78 countries

$$\Delta y_{60-89} = \underset{(-1.87)}{-0.266} \times BD_{60-89} + \text{other covariates}$$

$$\Delta y_{75-89} = \underset{(1.94)}{3.25} \times BD_{60-74} + \text{other covariates}$$

where Δy_{60-89} and Δy_{75-89} stand for the average annual rate of growth during the period 1960-1989 and 1975-1989 respectively and BD_{60-74} and BD_{60-89} are the number of battle deaths in the 1960-1974 and 1960-1989 periods.² Her findings indicate that contemporaneous effect of war on growth is negative, but the effect of war on the subsequent growth rate during the post-war period is positive, the so called “peace dividend” effect. Unfortunately, Koubi did not report descriptive statistics of the variables used in her analysis and therefore we cannot compute a quantitative value of the cost of conflict.

Inference based on cross section data suffers from some drawbacks. First, it is typically the case that several covariates can be jointly determined with the dependent variable or causality might run backwards (reverse causation), therefore parameter estimates might suffer from the endogeneity bias. In order to circumvent this problem instrumental variables estimators can be used. This is the approach followed by Alesina and Perotti (1996) and Barro (1991). Second, cross section inference is to be interpreted as averages over units of analysis. Therefore, particular conflict episodes can have smaller or larger impacts. Third, cross section inference forces researchers to adopt a static specification and cannot study the dynamic effect of conflict on the outcome.

4 Inference using time series

Time series methods have been used in the past to assess the economic impact of terrorism and other types of conflict. The identification strategy exploits the time variation of the conflict measurement for a single unit (region or country). These methods have been applied to aggregate figures such as per capita gross domestic product as well as to sectoral figures such as tourism revenue. Two approaches have been used in the past: the transfer function and vector autorregresion.

²The actual values reported by Koubi (2005) are those reported above times 10^{-7} .

4.1 The transfer function approach

The transfer model provides a framework for the quantitative assessment of the contemporaneous economic impact of conflict as well as the dynamic period by period effect and the long run (accumulated) effect. As an example consider the simplest of all possible transfer functions

$$y_t = ay_{t-1} + bx_t + \varepsilon_t, \quad (1)$$

where the outcome variable, y_t , is now indexed by time and depends on its immediate lag, the contemporaneous value of the conflict measurement, x_t , and a zero mean shock, ε_t . Suppose that the conflict measurement experiments a unit increase in period t and returns to its original level from time $t + 1$ onwards. The contemporaneous response of the outcome variable equals b , at time $t + 1$ the outcome increases by ab , at time $t + 2$ by a^2b , at time $t + 3$ by a^3b , and so on. The accumulated response or long-run response, to a unit increase in conflict measurement is $b(1 + a + a^2 + a^3 + \dots) = b/(1 - a)$. Therefore, the response of the outcome variable is higher the larger the value of b and this response is more persistent the closer the value of a to unity. Theoretically, the value of b should be negative, that is, an increase in the conflict measurement should reduce the outcome variable.

A general transfer model is

$$y_t = \frac{B(L)}{A(L)}x_t + \frac{C(L)}{D(L)}\varepsilon_t \quad (2)$$

where y_t is the outcome variable such as per capita GDP, x_t is a measure of terrorism intensity such as the number of terrorist incidents, $A(L)$, $C(L)$ and $D(L)$ are polynomials of the form $A(L) = 1 - a_1L - a_2L^2 - \dots - a_pL^p$, L is the lag operator, $B(L) = b_0 - b_1L - b_2L^2 - \dots - b_qL^q$ and ε_t is a zero-mean white noise. It is easy to see that equation 1 can be obtained from equation 2 assuming $A(L) = D(L) = 1 - aL$, $B(L) = b$ and $C(L) = 1$.

The transfer function methodology is a powerful tool for measurement and provides a simple interpretation of the dynamics of the cost of conflict. Some selective applications of this methodology follow. In an influential paper Enders, Sandler and Parise (1992) used transfer function analysis to estimate the effect of terrorism on tourism receipts in Greece, Italy and Austria during the 1968-1988 period. Their outcome variable y_t was the (log) share of tourism revenues relative to that of all other countries in the sample (the market share). Their measure of terrorism, x_t , was the number of transnational terrorism incidents. For the case of Greece, Enders et al. (1992) estimated a transfer function of the form

$$y_t = \underset{(7.39)}{0.7085}y_{t-1} - \underset{(-2.23)}{0.0064}x_{t-3} + \varepsilon_t - \underset{(3.19)}{0.4076}\varepsilon_{t-1}.$$

According to their findings, a unit increase in the number of terrorism incidents, x_t , has no contemporaneous effect on tourism receipts, and it generates a change in tourism receipts in the amount of 0.0064 three quarters later. The reason for this delay in the response, the authors

argue, is that “it takes time for tourist to revise their plans; many reservations on airlines and cruise ships cannot be altered without paying a sizable premium.” Therefore, an additional terrorist incident in Greece resulted in a fall in the (log of) Greece’s tourism market share of 0.0064 (a 1.0064 percentage loss of market share), three quarters later, $0.0064 \times 0.7085 = 0.0045$ (1.0045 percentage points) four quarters later, and so on.

Another application of the transfer function approach is Enders and Sandler (1996) where they analyze the effect of terrorism on Foreign Direct Investment (FDI). By inducing a sense of fear and heightened financial risks, terrorism can dissuade foreign capital inflows and scare domestic capital away. Using data on net (inflows minus outflows) foreign direct investment in Spain and transnational terrorist incidents during the period 1975-1991 they estimated the following transfer function

$$y_t = 23.663 - 0.593 y_{t-1} - 23.817 x_{t-11} + \varepsilon_t - 0.459 \varepsilon_{t-6},$$

(1.713)
(-5.989)
(-2.900)
(-3.763)

where y_t is the change in net foreign direct investment measured in millions of (real 1990) US dollars and x_t is the number of transnational terrorist incidents. According to their estimates, an additional transnational terrorist incident in Spain leads to a fall of 23.8 millions of US dollars in net FDI into Spain eleven quarters later. Since the estimated coefficient of the first lag of net FDI is negative, the net FDI response to the incident oscillates from negative to positive, and so on. Twelve quarters after the incident, net FDI rises by $23.8 \times 0.593 = 14.113$ millions of US dollars.

4.2 The interrupted time series approach

Interrupted Time Series (ITS) is a research technique

4.3 Vector autoregressions

Another way to model the dynamic interaction between the outcome variable and conflict measurement is the vector autorregression (VAR) approach. Within this context, both the outcome variable, the conflict measurement and possibly other variables depend on lagged values of all variables considered. The simplest of all VAR models is a two-variable (the outcome y_t and the conflict measurement x_t) one-lag model of the form

$$y_t = a_{11}y_{t-1} + a_{12}x_{t-1} + \varepsilon_{yt} \tag{3}$$

$$x_t = a_{21}y_{t-1} + a_{22}x_{t-1} + \varepsilon_{xt}$$

where the a_{ij} ’s are parameters and ε_{yt} and ε_{xt} are zero mean random disturbances. As long as there are no restrictions on the parameters of the VAR, estimation boils down to a simple ordinary least squares regression for each equation. The VAR technique allows us to estimate

the response of the outcome to a shock in the conflict measurement. Suppose $y_0 = x_0 = \varepsilon_{y0} = \varepsilon_{y1} = \dots = \varepsilon_{yt} = 0$ and we shock the conflict measurement in one unit, $\varepsilon_{x1} = 1$. As a result of this shock, $x_1 = 1$ and the time pattern of the outcome would be $y_1 = 0$, $y_2 = a_{12}x_1 = a_{12}$, $x_2 = a_{22}x_1 = a_{22}$, $y_3 = a_{11}y_2 + a_{12}x_2 = a_{11}a_{12} + a_{12}a_{22}$ and so on. This sequence of responses is called Impulse Response Function (IRF) and can be computed as a function of the coefficients of the VAR. Adding up these responses, would give us the accumulated response. Notice that, for the shock to have any effect on the outcome a_{12} must be non-zero. Otherwise, the time pattern of the outcome would be unchanged by the shock. In the latter case, when $a_{12} = 0$, it is said that x_t does not Granger-cause y_t .

Enders and Sandler (1991) postulated a VAR for the number of tourists visiting Spain n_t and the number of transnational terrorist incidents in Spain i_t . Their specification was slightly different from the simplest model 3

$$n_t = \alpha_1 + A_{11}(L)n_{t-1} + A_{12}(L)i_{t-1} + \varepsilon_{nt}$$

$$i_t = \alpha_2 + A_{21}(L)n_{t-1} + A_{22}(L)i_{t-1} + \varepsilon_{it}$$

where the alphas include a constant term and seasonal dummies and the $A_{ij}(L)$ are polynomials in the lag operator. Using monthly data for the period 1970-1988 they fitted a 12-lag VAR and found that the number of terrorist incidents Granger-caused the number of tourists (that is, they rejected the hypothesis $A_{12}(L) = 0$), but the number of tourists did not Granger-cause the number of terrorist incidents. The VAR model allowed them to compute the impulse response function to a shock in ε_{it} . As a result of a unit shock in the disturbance of the incidents equation, the accumulated response of the number of tourists was that 140,847 tourists did not visit Spain.

Another example of the use of VARs to assess the economic effects of terrorism is Eckstein and Tsiddon (2004). They postulate a VAR for the Israeli economy during the 1980-2003 period including (the logs of) four macroeconomic magnitudes, per capita GDP (GDP), investment (I), exports (X) and non-durable consumption (C). They also include as exogenous variables the real interest rate (R) and a terrorism index (TER). According to their findings, terrorism has a negative and significant coefficient in all but the consumption equation.³ Using the estimated VAR up to the third quarter of 2003, Eckstein and Tsiddon simulate the paths of all four variables for the period 2003:4 to 2005:3 under three scenarios: (i) terror stops as of 2003:4, (ii) terror continues until 2004:3 and (iii) terror continues until 2005:3. Under those scenarios, per capita GDP growth would be 2.5%, 0% and -2% respectively.

³Notice that since all equations include lags of all variables, it is sufficient that the terrorism index is significant in only one equation for it to have effects on all four variables.

5 Panel data methods

Oftentimes, the cost of conflict assessment is attempted using time series data on several countries, a panel data set. The identification strategy exploits the time and cross-section variation in the level of conflict. This type of data allows the researcher to control for unobserved heterogeneity, something that cannot be accounted for with neither time series nor cross sections. However, this advantage is obtained at the cost of a more involved interpretation.

Knight, Loayza and Villanueva (1996) quantified the effect of wars on the investment to GDP ratio of panel of 79 countries over the 1971-1985 period. They report the following regression

$$\left(\frac{I}{Y}\right)_{it} = -1.3232W_{it} + \text{other covariates}$$

(-6.78)

where W_{it} is the number of war years as a fraction of the total number of years in the sample. They find a significant and negative effect of war on the investment to output ratio. According to their estimates, an additional year of war reduces the investment to GDP ratio in 1.32 percentage points.

Collier (1999) presents evidence on the effect of civil wars on the rate of growth using a sample of 92 countries over the three decades 1960-1989 (three time units, one for each decade). He found a negative and significant effect of civil war and the postwar era on economic growth. He presents an estimated equation

$$\Delta y_{it} = -0.00018W_{it} - 0.00022PW_{it} + \text{other covariates}$$

(-4.43) (-2.11)

where Δy_{it} is country i 's average annual per capita GDP growth rate in decade t , W_{it} is the number of months with civil war in country i during decade t and PW_{it} is the number of months in the five years postwar period in decade t . Multiplying the coefficient on W_{it} by the number of months in a decade, Collier argues, we obtain an estimate of the effect of war on the rate of growth, i.e. $0.00018 \times 120 = 0.0216$, a 2.16 per cent fall in the average growth rate. In an unpublished manuscript, Hoeffler and Reynal-Querol (2003) obtain a similar estimate of 2.4 per cent fall in the annual rate of growth. The coefficient estimate on PW_{it} indicates that the postwar period also inflicts a fall in the growth rate of about the same magnitude as in the war period.

Easterly and Levine (1997) use an unbalanced panel of 95 countries over the three decade period 1960-1989 to shed light on the effect of ethnic diversity on growth. Although it was not their goal to measure the effect of conflict on economic growth, their regressions included political instability as a controlling factor. They use the number of political assassinations as a proxy for the level of political instability. Their findings indicate that higher levels of political instability lead to lower growth.

Blomberg, Hess and Orphanides (2004) provide evidence on the effect of various forms of

conflict on economic growth. They consider, terrorism, internal conflict and external conflict. Using an unbalanced sample of 177 countries from 1968 to 2000 they fit the following panel-growth regression

$$\Delta y_{it} = \underset{(-12.002)}{-5.545} y_{it-1} \underset{(-1.773)}{-0.438} T_{it} \underset{(-5.226)}{-1.270} I_{it} \underset{(-4.458)}{-3.745} E_{it} + \text{other covariates}$$

where Δy_{it} is the rate of growth of per capita GDP for country i in period t , and T_{it} , I_{it} and E_{it} are dummy variables indicating whether in country i in period t there was, respectively, a terrorist incident, internal conflict and external conflict. According to their findings, prevalence of terrorism, internal conflict and external conflict reduce per capita growth in 0.438%, 1.270% and 3.745% respectively. Terrorism seems to have a lower economic impact than internal conflict which in turn has a lower effect than external conflict.

Tavares (2004) also provides evidence on the effect of terrorism on per capita GDP growth. He uses a sample of unspecified countries for the period 1987-2001 and reports the following estimated regression

$$\Delta y_{it} = \underset{(4.80)}{0.261} \Delta y_{it-1} \underset{(1.20)}{0.017} y_{it} \underset{(-2.89)}{-0.029} T_{it} + \underset{(3.15)}{0.121} (T_{it} \times PR_{it}) + \text{other covariates}$$

where T_{it} is the number of terrorist attacks per 10 million inhabitants, PR_{it} stands for the level of political rights, an index ranging from 0 to 1. According to his results, a one standard deviation increase in the level of terrorism leads to a fall in per capita GDP growth of about 0.17% ($0.029 \times 5.99 = 0.17$) in a country scoring at lower end of political rights index and to an increase in per capita GDP growth of 0.55% ($(-0.029 + 0.121) \times 5.99 = 0.55$) for a country scoring at the upper end of the political rights index.

Neumayer (2004) estimates the effect of political violence on tourist arrivals using a panel of 194 countries during the period 1977-2000. The estimated equation is

$$n_{it} = \underset{(3.56)}{0.63} n_{it-1} \underset{(3.51)}{-0.12} c_{it} + \text{other covariates}$$

where n_{it} is the (log of) the number of annual tourist arrivals (overnight visitors) and c_{it} is Uppsala Conflict Data Project armed conflict intensity index. A one standard deviation increase in the conflict index results in a ($0.12 \times 0.82 = 0.0984$) 9.8 per cent fall in the number of tourists the same year, ($0.0984 \times 0.63 = 0.062$) a 6.2 per cent fall a year after, and so on.

Given the diversity of sample periods, countries, covariates, functional specification and estimation methods, it is very difficult to compare the different pieces of evidence available. However, the effect is negative and statistically significant.

6 Event studies

A further methodology used in assessing the economic impact of terrorism is the event study methodology. Event studies are used to measure the effect on stock prices of certain types of events such as the release of information on profits, dividend payment, corporate debt issuance, investment decisions, etc. This methodology has been applied to assess the effect of terrorist attacks on stock prices. This methodology relies on the assumption of efficient markets according to which share prices should reflect all available information, including any economic or social event. Therefore, if terrorism affects the economy negatively, then terrorist attacks should be accompanied by falls in stock prices.

The event study methodology identifies abnormal returns on stock prices as the difference between the actual return and the normal return on a stock. Let P_t be the stock price at time t and $R_t = (P_t - P_{t-1})/P_{t-1}$ its rate of return. Normal returns are computed as the mean daily return on a window of T trading days before each event: if $t = 0$ is the day of the event, normal return as the arithmetic mean of daily returns from $-t_1$ to $-t_2$. The abnormal return is computed as

$$AR_t = R_t - \sum_{t=-t_1}^{-t_2} R_t.$$

In addition to abnormal returns, the event study methodology also relies on cumulated abnormal returns defined as

$$CAR_t = \prod_{i=0}^I (1 + AR_{t+i}) - 1$$

where I is the number of periods during which the returns are accumulated.

Chen and Siems (2004) investigated the Dow Jones Industrial index reaction to 14 terrorist and military events. Out of the 14 events analyzed, 12 had a statistically significant abnormal return and the September 11th was the event with the largest abnormal return (-7.14%). Chen and Siems also applied the same methodology to assess the effect of the 9/11 event on 33 stock market indexes from 28 countries, 31 of which exhibited negative and statistically significant abnormal returns.

A more sophisticated way of computing the normal return is the market model of financial economics

$$R_{it} = \beta_i R_{Mt} + u_{it}$$

where R_{it} is the return on stock i on day t in excess over the risk-free rate of return, R_{Mt} is the return on the market portfolio (also measured in excess over the risk free rate of return) and u_{it} is a zero mean disturbance. Identifying the normal return as the systematic part of the previous equation implies that the residuals from this equation are the abnormal returns. Sometimes the market model is extended to a three-factor model à la Fama and French (1993, 1996). Using this framework, a few other papers provide evidence in favor of the hypothesis that terrorism

and violent conflict affects asset prices negatively, see Chesney and Reshetar (2007), Guidolin and La Ferrara (2005) and Drakos (2008). In an interesting paper Karolyi and Martell (2005) find that a terrorist attack perpetrated against a firm has on average a direct impact on the firm's stock rate of return of -0.83 per cent, what amounts to 401 million US dollars in market capitalization.

Abadie and Gardeazabal (2003) used the September 18, 1998 - November 28, 1999 cease fire declared by terrorist organization ETA to assess the effect of terrorism on the stock market valuation of Spanish companies. If the terrorist conflict was perceived to have a negative impact on the Basque economy, Basque stocks (stocks of firms with a significant part of their business in the Basque Country) should have shown a positive performance relative to non-Basque stocks (stocks of firms without a significant part of their business in the Basque Country) as the truce became credible. Similarly, Basque stocks should have performed poorly, relative to non-Basque stocks, at the end of the truce. Abadie and Gardeazabal reported the following estimated regressions

$$R_{Basque} = -0.0004 + 0.6739R_{Market} + 0.0049D_{Good} - 0.0017D_{Bad} + other\ covariates$$

(1.33) (18.41) (2.33) (-2.13)

$$R_{Non-Basque} = 0.0001 + 0.8096R_{Market} + 0.0005D_{Good} + 0.0001D_{Bad} + other\ covariates$$

(0.50) (43.53) (0.56) (0.25)

where R_{Basque} and $R_{Non-Basque}$ stand for the return on the Basque and non-Basque portfolios, R_{Market} is the return on the market portfolio and D_{Good} and D_{Bad} are dummy variables that take the value of one during a "Good News" period when the cease fire became credible and a "Bad News" period when the peace process collapsed. In accordance with the theoretical prediction, the dummy variables were significant for the Basque portfolio and not significant for the non-Basque portfolio. Compounding the 0.0044 coefficient on the Good News dummy over the 22 trading sessions of the Good News period, we obtain a compounded abnormal return of 10.14 percent for the Basque portfolio relative to the non-Basque portfolio. Analogous calculations yield a -11.21-percent compounded abnormal return for the Basque portfolio relative to the non-Basque portfolio during the 66 trading sessions of the Bad News period.

7 Case studies

A case study is a tool in social science research. It is a meticulous study of a single unit. This methodology has also been used to assess the economic cost of conflict in a country or region under conflict. Within the case study methodology, we will distinguish two types: the general case and comparative case studies.

7.1 The general case

In the general case, a particular conflict in a country or region is examined in depth. In fact, some of the previously mentioned papers can be considered case studies. There are case studies of the effect of armed conflict in Nicaragua (DiAddario, 1997), Nepal (Kumar, 2003) and Sri Lanka (Arunatilake, Jayasuriya and Kelegama, 2001). Case studies have also been used in order to study the economic effects of terrorism in Israel (Eckstein and Tsiddon, 2004) and Spain (Enders and Sandler, 1991 and 1996). There are also examples of case studies of the economic effect of conflicts in specific sectors such as the effect of the 9/11 terrorist events on airline stocks (Drakos 2004) and Chicago real estate (Abadie and Dermisi 2008 and Dermisi 2007).

7.2 Comparative case studies

Comparative case studies are often used by researchers to study the effect of events or policy measures on aggregate units such as regions or countries. The goal in these studies is to estimate the evolution of outcomes (such as average income, crime rates, etc.) for a unit affected by an event and compare it with the evolution of a control group. It is often the case that there is not a single control unit with the same characteristics of the unit exposed and therefore a combination of control units is a better comparison group than any single unit. A particular way of carrying out this comparison is the synthetic control method suggested by Abadie and Gardeazabal (2003) to estimate the economic impact of terrorism in the Basque Country economy. Using a synthetic control method, Abadie and Gardeazabal formed a comparison group as a combination of other Spanish regions that were “similar” in various economic dimensions to the Basque Country economy in the period prior to the uprising of terrorism. The synthetic control method can be easily describe as follows.⁴ Let J be the number of available control regions and $W = (w_1, \dots, w_J)$ a vector of non negative weights which sum to one. Let X_1 be a $(K \times 1)$ vector of pre-conflict values of K growth predictors. Let X_1 be a $(K \times J)$ matrix which contains the values of the same variables for the J possible control regions. Let V be a diagonal matrix with nonnegative components. The values of the diagonal elements of V reflect the relative importance of the different growth predictors. The vector of weights W^* is chosen to minimize $(X_0 - X_1 W)' V (X_0 - X_1 W)$ subject to $w_j \geq 0$ ($j = 1, 2, \dots, J$) and $w_1 + \dots + w_J = 1$. Let Y_1 be a $(T \times 1)$ vector whose elements are the per capita GDP of the Basque Country during the post-treatment period values of the outcome for the conflict unit. Let Y_0 be a $(T \times J)$ matrix which contains the values of the same variables for the control regions. The per capita GDP of the synthetic Basque Country was computed as $Y_1^* = Y_0 W^*$. Therefore the per capita GDP loss due to terrorism is $Y_1 - Y_1^*$. Using this procedure Abadie and Gardeazabal estimated that the comparison yielded a 10% annual per capita GDP loss over a 20-year period.

⁴See Abadie, Diamond and Hainmueller 2008 for a more detailed explanation of the method.

8 Discussion

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