CONSEQUENCES OF TERRORISM ON OIL AND TOURISM INDUSTRY THROUGH FREQUENCY AND TIME FREQUENCY DOMAIN

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Introduction

How does terrorism affect the economy?

The heightened awareness of the human costs associated with terrorist events, as well as the significant redirection of economic resources have refocused efforts towards gaining a better understanding of the economic consequences of terrorism. Terrorism affects commerce and investment decisions as agents prefer to dedicate their resources to operations in safer places with equivalent profitability ratios (Essadam and Karagianis, 2014). It can also increase transaction costs and bring about changes in the regulatory environment. Government resources are also spent on counter terrorism measures and a country or region's tax status could also change because of the need for the reallocation of budget resources to face terrorism (Gaibulloev and Sandler, 2011). Most certainly, government expenditure decisions and counter-terrorism policies are affected. Citizens may also change their purchasing preferences and their perceived image about the reputation of a particular country or region because of the effects of terrorism. It is important to mention that developed and diversified economies are able to manage terrorism better than others, fundamentally, because more monetary and fiscal tools are available to be used against terror.

The rapid growth of the jihadist movement together with the spread of terrorist attacks and military conflicts over the last 30 years have increased concerns about terrorist incidents and its consequences for strategic sectors in the economy.

In this research, we focus specifically on tourism and the oil industry as we consider both sectors can have a profound effect on national economies on a global scale.

The importance of the tourism sector for the World´s economy is enormous, representing more than ten percent of global GDP, one in eleven jobs and a volume of more than 1,235 million tourists in 2016 (UNWTO, 2016). Furthermore, it is one of the main sources of foreign exchange earnings and taxes, also alleviating poverty especially in developing countries. Tourism is precisely one of the sectors worst hit by terrorism incidents as visitors tend to change their travel preferences in favor of countries which have not recently been hit by terrorism. Investors also change their direct investment preferences in the tourism sector from countries which have suffered attacks to safer ones with similar or equivalent profitability opportunities.

Scholars' interest and the existing literature about the effect of terrorism on tourism increased particularly after the 9/11 terrorist attacks in the U.S., when this country experienced an immediate and relevant drop in international tourism arrivals, especially from overseas. Hence, it was demonstrated that a single terrorism event can severely damage the tourism industry, even in a powerful country such as the U.S., rendering it less attractive for tourism and damaging its image abroad. Due to its influence on the international scene, it is precisely on the study of the U.S. on which one of our chapters is focused. We have endeavored to observe through time frequency techniques what the evolution of the monthly number of arrivals to the U.S is over the last 20 years.

The existing literature about terrorism and tourism follows three lines: motives for which terrorists target the tourism sector, solutions to minimize the risk of falling tourist numbers and the consequences of terrorism on tourism demand (Pizam and Smith, 2000; Gaibulloev and Sandler, 2011; Mc Baker, 2014). Times series methods such as ARIMA or VAR models have been traditionally used in terrorism and tourism research (Enders and Sandler, 1991;

Enders and Sandler, 1992; Liu and Pratt, 2017). The use of panel and panel VAR methods is very common in recent literature to analyze the consequences of terrorism on tourism as they provide more information, more variability, less collinearity, more degrees of freedom and greater efficiency, enabling the combination of a temporal dimension with a transversal dimension (Neumayer, 2004; Saha and Yap, 2013; Santana-Gallego et al., 2016) .

The existence of oil resources may be channeled into political or economic circumstances that are favorable to terrorism. This is important, not only for its direct human and economic effects on a particular country, but also for harming the interests and international position of powerful countries overseas. It has been proven that richness in oil resources may affect political stability, being as it is cause of interstate wars and different civil conflicts, especially in countries where human rights, democracy and government and legal structure are not properly developed (Collier and Hoeffler, 1988; Ross, 20004b; Fearon, 2005; Humphreys, 2005 and Colgan, 2013). It is also true that much of the world´s crude oil resources are located in regions that have been historically affected by wars and conflicts (EIA, 2018).

Knowing the strategic importance of the oil industry, it seems to be reasonable to analyze if there exists a link between terrorism and oil behavior, particularly when this industry is known for being one of the main funding sources for terrorist groups.

We assume that the OPEC organization is a dominant player within the oil market supply, accounting for half of the total and almost 70% of the world´s oil reserves (Sen and Babali, 2007). It also demonstrates superior understanding of the dynamics of the market, being considered as the most influential group for oil market behavior on a global scale. Moreover, seven of the main members are located in the Middle East and North Africa, which are considered to be some of the regions which have been more damaged by terrorism over the last 30 years (EIA, 2018).

Existing literature about the link between terrorism and oil industry use different methodologies and obtain quite different conclusions about the real effects of these variables. Therefore, it is our goal to clarify how terrorist attacks affect oil production behavior in OPEC countries by studying its dynamics in the time-frequency domain using wavelet tools for this resolution. The contribution of the paper is noteworthy, not only for using time-frequency methods for its analysis, but also for it considering terror as the independent variable as previous studies are mainly focused on the effects of oil production or oil prices on terrorism, and not the opposite analysis.

It would be also reasonable to extend this research to other influence groups in the oil industry or high producing countries such as the U.S. or Russia, especially when the development of new production techniques such as fracking have been gaining relevance in the last years, increasing worldwide resources and shifting the balance of power and influence among countries

To carry out this research, we first examine the relationship between terrorist attacks and tourist number of arrivals worldwide through an unbalanced panel data set with annual observations and fixed effects. The sample we use covers 167 countries for the period 1995 to 2014. As previously mentioned, panel analysis focuses on the causal relationship providing more information, more variability, less collinearity, more degrees of freedom and greater efficiency than other existing times series methods.

In the second and third paper we have employed wavelet analysis to perform the estimation of the spectral characteristics of a time series as a function of time, revealing how the different periodic components of the time series change over time. We use the continuous wavelet transform that maps the original time series, which is a function of just one variable (time) within a function of time and frequency; mainly wavelet coherence, which measures the degree of local correlation between two-time series in the time-frequency domain and the wavelet coherence phase differences. Moreover, in the second paper, we also have employed the vector auto regression model (VAR) in order to analyze the response of tourism to terrorism incidents through the impulse response function and its consequences through the Granger causality test. Employing these three analyses enables us to understand more clearly the relationship between terrorist and tourism in the U.S.

The structure of the thesis is as follows. First, we analyse the global consequences of terrorism on the tourism sector with a sample of 167 countries. Second, we focus on the effect of terrorism on the number of arrivals in the U.S.; as currently, the U.S. occupied the second position for international tourist arrivals (2015) with almost 77.5 million of travelers a year (UNWTO, 2016). Third, we analyze the consequences of terrorism on oil production for OPEC countries as it is considered that this influence group leads the global oil market industry and the majority of its main members are located in regions which have been highly exposed to terrorist conflicts over the last 30 years.

In the paper from the first thesis, "International Effects of Terrorism on Tourism Demand: A Panel Data Approach", we provide an analysis of the effects of terrorist attacks on the number of international arrivals by using an unbalanced panel data set with annual observations for 167 countries for the period 1995 to 2014. We decided to choose the number of arrivals as our dependent variable, as it is seems to be more reasonable to count tourists numbers than to estimate tourism revenues in the destination country as has been done by other authors in the literature. The results suggest that terrorist events negatively affect tourist arrivals. Moreover, our results confirm that terrorism poses a clear risk and, as such, represents one of the drawbacks of a potential destination and reduces tourist demand for that location. We also observe a spillover effect from affected countries to non-attacked countries and regions. Hence, it seems to be that neighbors of terror-stricken countries benefit in terms of the number of visitors. Finally, through the interaction between military expenditure as a percentage of GDP and the number of terrorist attacks, we quantify and demonstrate the existence of a percentage of military expenditure over GDP, above which, countries where terrorists attacks are observed improve their tourism statistics. That is, the quantity of resources that states under threat should spend on military expenditure for this to be efficient enough to improve tourism statistics. We finally provide some information about the attractiveness of the country, sense of belonging to the region, population, GDP and voice and accountability index, when we try to model tourism demand. Time and year fixed effects that we apply enable us to control for the idiosyncratic characteristics of each country and the circumstantial events that may have affected the country; trying to avoid omitting time-invariant variables.

In the second paper, “Terrorism in the Behavior of International Monthly Arrivals in the United States”, we analyze the nexus between tourism in terms of the total number of arrivals and terrorism in the U.S. as the result of multiplying the number of terrorist attacks and the number of kills during each time series period with the objective of measuring the effect of an event and its intensity in terms of the number of victims. This enables us to capture both the quantity of terror events and their intensity in terms of the number of fatal victims.

Using continuous wavelet transformation methodology based on a time-frequency technique, we are able to analyze the evolution of the different frequency components of the time series over time. We use monthly observations for the period 1996 to 2016 and the wavelet coherency is estimated for frequencies corresponding to periods between 1.5 and 8 years. We also use the Granger causality test after VAR model estimation in order to examine the causality between both series. Finally, we use the impulse response function from a VAR model to analyze the reaction of tourism to terrorism. Our results suggest that an increase in terrorist attacks precedes a decrease in total arrivals in the U.S. Through VAR conclusions, we also show that terrorism explains the total arrivals, being the response to both variables negative.

In the third paper, “Terrorism and Oil Production Behavior in OPEC Countries”, we analyze how terrorist attacks affect monthly oil production in OPEC countries by studying its performance in the time-frequency domain and applying wavelet tools for its resolution. The results indicate that there exist three regions with higher coherency, which demonstrates the evidence of two structural changes during our period of analysis 1970-2016. Highlights of this research are very relevant as it has been observed that the existence of oil may be channeled into political or economic circumstances that encourage terrorism. This is even more important when OPEC countries represent more than 70% of the global oil reserves (EIA, 2018) and the majority of its members are located in regions that have been historically prone to political upheaval or conflicts; especially after the spread of ISIS (Islamic State of Iraq and Syria) during the last years through the Middle East and North Africa. These assertions reinforce the hypothesis that terrorist attacks may affect oil production in OPEC countries. Conclusions from this research are extremely relevant because of the strategic character of the oil industry. First, most of the developed countries in the world show oil dependence, which makes their economies dangerously vulnerable to external policies, especially from potential producers such as OPEC, U.S. or Russia. Moreover, producing countries are, in many cases, undiversified economies, unable to face macroeconomic turbulences and conflicts that may hit their oil industry capability. It is important to remember that oil is one of the main finance sources for terrorists groups all over the world. The strategic importance of the oil industry may also guide economic, political and military decisions of influence groups, leaders and governments.

Chapter 1

International Effects of Terrorism on Tourism Demand: A Panel Data Approach

1.1. INTRODUCTION

How do terrorist events affect tourism demand? The heightened awareness of the human costs associated with terrorist events, as well as the significant redirection of economic resources (presumably motivated by the perceived risks associated with possible future terrorist incidents) have refocused efforts towards a better understanding of the economic consequences of terrorism (Blomberg et al., 2004). Both analytical and descriptive analyses discuss the economic consequences of terrorism, the effectiveness of counter terrorism measures and trends in terrorist attacks, among other issues (Sandler, 2014). The recent terrorist attacks in Belgium, France, the U.K., the U.S. and some Middle East countries, such as Syria and Turkey in 2016 and 2017 respectively, have increased concerns about terrorist incidents. This has revived interest in the effects of terrorist attacks on the economy, and more particularly, on their consequences for the tourism industry.

The importance of the tourism sector in the world economy is enormous. Its main highlights are collected in the United Nations World Tourism Organization report 2016. According to this report, tourism represents 10% of the global GDP (accounting for direct, indirect and induced impacts). Moreover, it generates one in eleven jobs and US$1.5 trillion in exports (7% of the world's total exports).[1] Furthermore, the number of international tourists has increased from 25 million in 1950 to 1,235 million in 2016 and it is expected to continue increasing to 1.8 in 2030 (UNWTO, 2016). Furthermore, tourism is, in many cases, the main source of foreign exchange earnings and foreign direct investment (Drakos and Kutan, 2003) and it is also a relevant sector that provides important tax revenues and alleviates poverty, especially in developing countries (Yap and Saha, 2013). Globalization has increased fear of the consequences of terrorism on tourism. Nowadays, terrorism is one of the main concerns for multilateral organizations and governments around the world (Essaddam and Karagianis, 2014).[2]

According to existing quantitative literature, where drops in tourism have occurred these seem to be linked to terrorism. The main objective of this paper is to develop a tourism demand model that can capture the impact of terrorism on tourism. We also examine whether military expenditure as a percentage of GDP helps improve tourism statistics when terrorist attacks are observed. For instance, some authors affirm that when military coups occur, we observe severe negative effects on tourism development as government resources are spent on military and not on developing infrastructure (Teye, 1988). Our hypothesis suggests that military expenditure negatively affects tourism. However, in high risk countries (where terrorist events are observed) we expect a particular level of military expenditure above which an increase in this budget item could be profitable for tourism. Our findings confirm that the relationship is non-linear and it appears as a U-shaped effect. Finally, we present the spillover effects of terrorist attacks on countries located in the same

[1] Tourism constitutes also a significant share of exports, such as Israel (7%), Ukraine (7%), France (8%), the Philippines (8%), the U.S. (9%), Thailand (16%), Egypt (16%), Turkey (17%) and Kenya (18%) (Santana-Gallego, Rossello-Nadal, and Fourie 2016).

[2] According to Essaddam and Karagianis (2014), thirty six percent of multinational senior executives indicate terrorism as the largest threat they face.

geographical region and on those in different regions. Our intention is to show how neighboring regions benefit from or are harmed by a terrorist event. Hence, we expect that the distance from the attack is relevant in order to determine the transfer ratio (suggested in a study for Israel, Turkey and Greece by Drakos and Kutan, 2003). This is very relevant since "it has been observed that destinations that develop an unsafe reputation can be substituted by alternative destinations or cities that are perceived as safer for tourists" (Mc Baker, 2014).

To explore the effects of terrorism on tourism, we use yearly country-level data on terror incidents and international tourist arrivals for 167 countries for the period 1995 to 2014 and perform a panel data analysis including fixed effects.

This chapter makes three key contributions to the existing literature. First, we are analyzing an updated global sample, which includes most of the tourist traffic in the world. The majority of previous studies; except Liu and Pratt (2017), mostly focus on shorter samples or country level analysis. A bigger and more up to date sample makes it possible to draw global conclusions and to generate more information about the implications for other countries. This is precisely, the second contribution to the literature. We try to quantify on a global scale the tourist spillover effects from regions. In other words, how regions have benefited or have been affected in terms of tourists when a country suffers a terrorist event. To the best of our knowledge, no previous studies focus on this issue from a regional perspective and with a worldwide sample. Third, we apply an interaction effect between the number of terrorist events and level of military expenditure over GDP in order to test the effectiveness of the government military budget in improving tourism statistics. No previous studies approach this relationship using this method. To the best of our knowledge, Saha and Yap (2014) are the only ones to include the interaction between their variables which are terror and political stability. Our main objective is to determine if there is a particular level of military expenditure over GDP above which an improvement in tourism demand is observed.

1.1.1. Economic Consequences of Terrorism on Tourism

There are many channels through which terrorism can affect the economy. From a country perspective, terrorism affects commerce, increasing transaction costs and producing changes in the regulatory environment. Terrorism consumes government resources in an effort to prevent future attacks and it also affects international investment, as investors will prefer to transfer their investments to other countries with less risk and equivalent profitability ratios (Essaddam and Karagianis, 2014). For instance, the sum of the direct and indirect cost of the hijackings on 11 September 2001 was estimated between US$80 and US$90 billion (Kunreuther et al., 2003). Hence, it could be said that terrorism causes a small, but significant negative impact on per capita GDP growth (Sandler and Enders, 2008).

In the same vein, diversified economies are able to manage the attacks better than others in macroeconomic terms (Sandler and Enders, 2004). Advanced economies can also apply monetary and fiscal policy in order to improve the economy after the attack, for example as the U.S. did following 9/11. Taxes could be increased to cover the costs associated with counter terrorism measures. Hence, small economies and under-developed economies tend to suffer the effects of a terrorist attack more, as the availability of economic policy tools to restore the balance is restricted (Enders and Sandler, 2006; Gaibulloev and Sandler, 2011).

With regard to the effects of the terrorist attacks on tourism, Seddighi et al. (2001) and Stafford et al. (2002) affirm that terrorist attacks may cause political instability, which culminate in the decline of tourist arrivals to those destinations. For instance, Enders and Sandler (1991) conclude that "a typical terrorist incident in Spain resulted in a drop of 140,000 tourists".

The economic effects of terrorism have been thoroughly investigated in the academic literature. However, only a few empirical studies have focused on the consequences of terrorism on tourism demand on a global scale. The existing literature about terrorism and tourism demand follows, in general, three lines: motives for which terrorists target the tourism sector, solutions to minimize the risk of decreasing tourists and the consequences of terrorism on tourism demand (Pizam and Smith, 2000; Gaibulloev and Sandler, 2011; Mc Baker, 2014).

Enders and Sandler (1991) built an autoregressive integrated moving average (ARIMA) technique with a transfer function to construct a forecasting model for the share of tourism. Their results suggest that terrorist incidents have had an adverse effect on tourism revenues in Europe and that tourists have moved from some countries to others to minimize the risk of experiencing terrorist incidents. Enders and Sandler (1992) provide empirical evidence on the link between terrorism and the tourism sector for a sample of European countries and through a vector autoregressive analysis (VAR). Using an ARIMA model with a transfer function based on the time series of terrorist attacks in Austria, Greece and Italy, they find that a terrorist attack in Greece costs 23.4% of its annual tourism income for 1998 (Enders and Sandler, 1992). Drakos and Kutan (2003) also developed an empirical research regarding the effects of terrorism on tourism arrivals to Greece, Israel and Turkey. Their results show that terrorism causes a significant negative effect on tourism and that the intensity, in terms of causalities and geographical situation, are also relevant for tourism rates. In addition, there is also a substitution effect between Greece and Turkey when one of them suffers a terrorist attack. Neumayer (2004) conducts an empirical investigation regarding political instability impacts on tourism using fixed effects and a dynamic generalized method of moments panel data models. He was the first to present a comprehensive general quantitative estimation of the impact of political violence on tourism for the period 1977 to 2000. His results suggest that human rights violations, conflict, and other politically motivated violent events negatively affect tourist arrivals. Llorca-Vivero

(2008), using bilateral tourism data to estimate a cross-sectional gravity model, studies the effect of terror attacks on tourist arrivals by analyzing tourism from the G-7 countries to 134 destinations. The research evaluates the differentiation between routine tourist flows and international arrivals following terrorism, pointing to a larger deviation in developing countries. He finds that terrorism seriously damages the tourism industry, having a particularly severe effect in developing countries. More recently, Robbins (2012) uses a cross-sectional gravity equation to measure the impact of terrorism on international tourist flows for eight European destination countries for the period 1991 to 2009. He shows that both the amount of terrorist attacks and the number of fatalities due to terrorism negatively affect tourism flows to European destination countries.

Yap and Saha (2013) employ panel data methodology from 139 countries for the period 1999-2009 to evaluate the effects of political stability, terrorism and corruption on tourism development, particularly UNESCO-listed heritage destinations. Their results suggest that in the presence of heritage, terrorism has a negative effect on tourism demand even though its effect is lower than that of political instability. In a similar study, Saha and Yap (2014) aim to analyze the effects of the interaction between political instability and terrorism on tourism developments using panel data from 139 countries for the period 1999-2009. Their findings suggest that the effect of political instability on tourism is higher than the effect of one-off terrorist attacks. They even claim that terrorist attacks can increase tourism in low-to moderate political risk countries. Santana-Gallego et al. (2016) examine the effect of terrorism, crime and corruption on tourism arrivals for 171 countries (1995-2013) through a panel data analysis employing three-dimensional analysis to total tourist arrivals but disaggregated by destination and country of origin (through a gravity model for bilateral tourism flows). Their findings illustrate that terrorism and crime have a negative effect on tourism demand, being this effect, in general, greater for leisure tourism than for business tourism.[3] They also affirm that the level of development of the country (HDI) and its attractiveness (UNESCO) are determinant factors for terrorism effects on international arrivals. By using a panel/zero-inflated negative binomial regression model, Goldman and Neubauer-Shani (2016) study the incidence of tourism on transnational terrorism. They conclude that there is an inverse U-relationship between the number of arrivals and number of attacks perpetrated by foreigners, and also a robust significant relationship between number of arrivals to a country and terror attacks in which both the attacker and the victim are foreigners. Liu and Pratt (2017) examine tourism's vulnerability and resilience to terrorism for 95 countries from 1995 to 2012 through an autoregressive distributed lag model (ARDL). Their conclusions suggest that in general, international tourism is resilient to terrorism. Moreover, there is no long-run effect of terrorism on international tourism and the short-run effect of terrorism on international tourism is quite small.

This study follows the recent trend in the literature to use panel data methodology instead of time series methods. The richness and semi-global character of the data is also remarkable as, apart from Santana-Gallego et al. (2016) or Liu and Pratt (2017), no previous mentioned studies have employed such a wide database. To the best of our knowledge, there are no previous similar studies that quantify the tourist spillover effects from countries and regions on a global scale as most of them address the issue for a specific country or region. Finally, while Saha and Yap (2014) use the interaction effect to analyze the relationship between political stability and terrorism, we are interested in observing, with the same method, what the effectiveness of increasing military expenditure over GDP is in countries where terrorist events have been observed. The objective is to determine if, in high risk countries, there exists a particular level of military expenditure over GDP above which tourism figures start

[3] They affirm that leisure tourism represents about 70% of the total number of arrivals. In our case, we only focus on this kind of tourism, which is the most representative and the more sensitive to terrorist events.

to improve. In other words, how much of the total country income would be necessary to spend on the military if countries wished to improve their tourism rates.

The chapter proceeds as follows. Section 2 describes the main dataset used and its characteristics. Section 3 presents the methodology as well as the main proposed statistical model based on the standard panel method using terrorist events as the main regressor. Section 4 discusses our empirical results, showing the main evidence of the chapter. Section 5 provides our interpretation, findings and final conclusions.

1.2. DATA

The annual data examined in this chapter correspond to 167 countries for the period 1995 to 2014. It is important to mention that, there is not complete information on each variable though the years. As a result, we consider a sample up to 2,076 observations.[4] The rapid growth of the jihadist attacks and the spread of the Middle East war conflicts during the last 15 years, justifies the election of the selected period. Similar temporal space has been recently chosen by authors such as Santana-Gallego et al. (2016).

International arrival data was obtained from the World Bank Database 2015 (World Bank, 2015) . The total number of terrorist events by year was obtained from Global Terrorism Database (National Consortium for the Study of Terrorism and Responses to Terrorism (START) 2015), which records both domestic and transactional terrorism.[5] This terrorism database collects broad information about terrorist attacks from 1970 to 2014.[6] It has been

[4] The UN Organization recognizes 193 sovereign states. We do not have enough information of Nauru Republic, Montenegro, Libya, Liberia, Iceland, Guinea, Gabon, Eritrea, Equatorial Guinea, Cote de´Ivoire, Myanmar, Qatar, Serbia, Sta. Lucia, Sudan, Timor–Leste, Togo, Trinidad and Tobago, Turkmenistan, Uzbekistan, Vietnam, Malawi, San Marino, Somalia, South Sudan or Syria. As a result, we obtain a sample of 167 countries.

[5] Type of recorded events: assassination, hijacking, kidnapping, barricade incident, bombing/explosion, armed assault, unarmed assault, facility/infrastructure attack).

[6] Other similar and popular datasets are the RAND (2012) terrorist event database and the International Terrorism: Attributes of Terrorist Events (ITERATE).

used in recent similar papers such as Santana-Gallego et al. (2016) or Pizam and Smith (2000).

The rest of the variables, such as military expenditure over GDP, GDP at purchaser prices (constant 2010 US$), population, voice and accountability index, were obtained from the World Development or Governance Indicators (World Bank, 2015) and from the UNESCO World Heritage Centre. Table 1 shows the main descriptive statistics of each variable.

1.3. METHODOLOGY

In this article, we examine the impact of terrorist events on the number of international arrivals using an unbalanced fixed effects panel data analysis for 167 countries for the period 1995 to 2014.[7] The reason why we include panel data analysis is that it provides more information, more variability, less collinearity, more degrees of freedom and greater efficiency (Baltagi, 2008). Furthermore, it enables the combination of a temporal dimension with a transversal dimension. Panel methodology can be found in similar recent studies such as Santana-Gallego et al. (2016) or Saha and Yap (2014).

We structure a new tourism demand as follows:

$$ln\ NA_{i,t} = \beta_1\, TA_{i,t} + \sum_{h=1}^{4} \gamma\, R_i + £_1\, ln\ TAIN_{i,t} + £_2\, ln\ TAOUT_{i,t} + \beta_2\, ME_{i,t} + \beta_3\, TA_{i,t}\, x\, ME_{i,t} +$$

$$\beta_4\, GDP_{i,t} + \beta_5\, WHS_i + \beta_6\, ln\ N_{i,t} + \beta_7\, VA_{i,t} + \mu_i + \Omega_t$$

where $NA_{i,t}$ is the number of international tourism arrivals in country “i” and year “t”, ln is equal to neperian logarithm, $TA_{i,t}$ is the number of terrorist attacks per year and country, R_i is a dummy for each of the four regions we define (Africa and Middle East, Asia and Pacific,

[7] We apply annual data similar to other authors such as Blomberg et al. (2004).

Americas, Europe), $TAIN_{i,t}$ is a dummy that captures if a terrorist attacks occurs in a given region, $TAOUT_{i,t}$ is a dummy that captures if a terrorist attacks occurs outside of a given region, $ME_{i,t}$ is equal to the percentage of military expenditure over GPD per year and country, $GDP_{i,t}$ is the GDP at purchaser prices (constant 2010 US$), WHS_i is a dummy which captures whether the region has a site currently belonging to the UNESCO World Heritage Sites, $N_{i,t}$ is the total population per year and country, $VA_{i,t}$ is the voice and accountability index, μ_i is a fixed effect country, $\boldsymbol{\Omega}_t$ is a fixed effect year.

The dependent variable used is the natural logarithm of the number of international arrivals per year and country ($ln\ NA_{i,t}$), similar to the methodology used by authors, such as Neumayer (2004), Yap and Saha (2013) or Santana-Gallego et al. (2016).[8] Since the dependent variable is expressed as a logarithm, the coefficient can be interpreted as elasticity. This variable has the advantage of being measured with great precision for the simple reason that it is easier to count tourism numbers than to estimate tourism revenues of tourists in the destination country, as is done by some authors in the literature.[9]

Our independent variable is the total number of terrorist events per year and country ($TA_{i,t}$) divided by one hundred. Empirical researchers such as Feridun (2011) and Neumayer (2004) used the number of terrorist incidents as a proxy to measure the effects of terrorism on tourism demand. Some authors affirm that the more severe and the more frequent the TA is the greater the impact on tourism demand is due to the higher perceived risk (Pizam, 1999). In some cases, they use the number of victims as a proxy of the intensity of the attack (Drakos and Kutan, 2003; Robbins, 2012). After consideration, we have not included the number of victims registered per year as a measure of intensity of the attack because of the

[8] "International inbound tourists (overnight visitors) are the number of tourists who travel to a country other than that in which they have their usual residence, but outside their usual environment, for a period not exceeding 12 months and whose main purpose in visiting is other than an activity remunerated from within the country visited" (World Bank Database, 2015).

[9] Santana-Gallego et al. (2016) also uses tourist arrivals from UNWTO (2015), but they differentiate between leisure and business trips. They also control for population through expressing this variable per 10,000 inhabitants. Saha and Yap (2013) extract the data from Euromonitor International.

potential collinearity between events and causalities so that analyzing them together could be problematic. Nevertheless, the tested analysis considering this variable does not change our main signs and coefficients, with this variable remaining negative and significant.

With the aim of controlling by region of origin, we define dummy variables for each of our four defined regions (R_i). This is done in a similar way by Sandler and Enders (2008). Pizam and Smith (2000) and Drakos and Kutan (2003) also advocate considering differences between regions or countries when talking about terrorism effects on tourism.[10]

Terrorism, one form of political violence, poses a clear risk and as such represents one of the drawbacks of a potential destination and reduces tourist demand for that location (Sönmez and Graefe, 1998; Martin and Gu, 1992). The effects of terrorism incidents on tourism demand vary across countries (Llorca-Vivero 2008). Neighbors of terror-stricken countries could also suffer from terrorism(Eric Neumayer and Plümper, 2009). Nevertheless, "it has been observed that destinations that develop an unsafe reputation can be substituted by alternative destinations or cities that are perceived as being safer for tourists" (Mc Baker 2014). Tourists aim to minimize the risk of terrorist attack by substituting more risky destinations for safe ones (Araña and León, 2008). For all these reasons, and with the aim of observing the spillover effects between regions, we define two variables. First, the total number of terrorist events (divided by one hundred) that take place in the region each country belongs to, per year and country ($TAIN_{i,t}$). Second, the total sum of terrorist events (divided by one hundred) that take place out of the region each country belongs to, per year and country ($TAOUT_{i,t}$). The objective is to observe the behavior of the substitution flow effects between regions and countries. That is to say, how regions benefit or are harmed when a terrorist attack takes place outside or within a particular region.

[10] Asia and Pacific region is randomly taken as the dummy reference region.

We want to study whether the interaction of international arrivals is influenced by the military expenditure in countries where we observe terrorist attacks. To do so, we interact the number of terrorist attacks ($TA_{i,t}$) and the military expenditure ($ME_{i,t}$) as a percentage of GDP. The objective is to study what occurs with the number of international tourist arrivals when the military expenditure varies in countries where we observe terrorist attacks. To the best of our knowledge, no authors have employed this methodology to analyze the joint effect of these variables. In a similar way, Saha and Yap (2014) employ the interaction methodology in order to analyze the synergies between political instability and terrorism. The importance of the conclusions we obtain from this interaction term is relevant as we are quantifying the effectiveness of military expenditure on tourism demand in dangerous countries. Results could guide important geopolitical and budget decisions. The inflexion point from which the percentage of military expenditure over GDP improves tourism is shown in equation 2.

$$\frac{\partial Ln\ NA}{\partial\ TA} = \beta_1 + \beta_3\ ME = 0 \qquad (2)$$

In recent years, some papers have employed the panel dimension of the data by introducing a set of instruments for geography, policy or institutions (Blomberg et al., 2004). Taking into account the existing literature, we also include some relevant control variables in our model.

Pizam and Smith (2000) claim that the effects of terrorism on the economy are lower in countries with high levels of wealth, technological progress and freedom (ie: Israel). The majority of the authors include GDP measures in their models as a proxy for income or country development (Peng et al., 2014; Saha and Yap, 2014). Similarly, we include GDP at purchaser's prices ($GDP_{i,t}$).[11]

[11] PPP (constant 2010 US$).

It is also common in the literature to include a dummy for the UNESCO World Heritage Sites ($N_{i,t}$) in order to control for the attractiveness of the country for tourists (Saha and Yap, 2014; Santana-Gallego et al., 2016).

Countries which are politically stable but face a small number of terrorist events (USA or Spain) could suffer less from the impacts of terrorism on their tourism industry than those countries that are politically unstable and prone to terrorist activities (Pakistan and Afganistan) (Saha and Yap, 2014). Political events such as coups and internal political problems have far more severe impacts on tourism activity than one-off terrorist attacks (Fletcher and Morakabati, 2008). Hence, it is crucial that tourism demand models should include political risk variables in order to obtain more accurate forecasts of tourist business in the presence of political instability and terrorism (E. Neumayer 2004). Voice and accountability ($VA_{i,t}$) is used as a proxy for the quality of the institutions on each country, capturing to what extent citizens are able to participate in the election of their government as well as representing freedom of expression, association and media. In this way we endeavor to interpret the effect of human freedoms, right and democracy on international tourism decisions.

The regression includes interaction effects with controls for time and country fixed effects ("µi" fixed effect country, "Ωt" fixed effect year). The main objective of the country fixed effects is to control for the idiosyncratic characteristics of each country. Time effects try to capture the circumstantial events that may have affected the country in a given year in order to avoid omitting time-invariant variables. More particularly, our fixed effects mainly try to control for the positive relationship between terrorism and tourism even when our assumption in relation to the terrorist attacks is fulfilled. The positive trend of tourism, in spite of increasing number of global terrorist attacks, is due to a number of factors, among which are strong economic growth, the increase in disposable income and leisure time, easing of travel restrictions, successful tourist promotion, and the recognition of the importance of tourism by governments (Mc Baker 2014). That is precisely what our fixed effects try to capture. Similar panel fixed effects are employed by Saha and Yap (2014) or Santana-Gallego et al. (2016). Hausman (1978) demonstrated that the difference between the fixed effect (FE) and random effect (RE) coefficients can be used to test the null hypothesis of non-correlation between the variables and μi, Ωt. Hence, the Hausman H_0 means that the estimators of the FE and RE do not differ noticeably. If H_0 is rejected, estimators differ, so fixed effects should be preferred over random effects. If H0 cannot be rejected, there is no bias to be worried about and we prefer random effects, as the model is more efficient.12 In our regression model, H0 is rejected. This means that the difference between the random and fixed effect coefficients is significant. Hence, we should use fixed effects (see results in Table 2).

1.4. EMPIRICAL RESULTS

We construct an unbalanced panel data model to examine the impact of terrorism on tourism demand. The results from this section lend support to the majority of findings and assumptions we reported earlier. Table 3 presents the results of estimating equation (1) for the dependent variable $ln\ NA_{i,t}$. As can be observed, we start from a very simplified model, successively including all the control variables considered with the objective of demonstrating the stability of the coefficients and signs that lead to a robust demand model.

As can be seen in Table 3 model seven, the coefficient of the variable $TA_{i,t}$ shows that when the number of terrorist events grow by 100 units, this entails a decrease in the number of arrivals of around 10.7%. Hence, the results suggest there is a negative effect of terrorism on

[12] This test is based on “Specification Tests in Econometrics” (Hausman , 1978).

the destination country. It is important to mention the robustness of our results, as the coefficients and signs remain negative and significant regardless of the model used and are in line with the related literature.

The results about regions R_i do not provide relevant insights. The present results only show that tourists tend to go more to Europe than to America or Africa and Middle East, when compared with Asia.

After demonstrating this, we move on to testing the spillover effects between regions. Positive coefficient of $TAIN_{i,t}$ shows that that if a terrorist attack takes place in a given region, the other group of countries located in the region increase their number of arrivals. This hypothesis suggests that even if there is a terrorist attack in a country from a particular region, we observe a positive substitution effect and the neighboring countries located in the same region will increase their number of arrivals by around 0.5% per one hundred unit increase in the number of attacks. It can also be observed that this substitution effect is lower if the attack takes place in countries located outside the region $TAOUT_{i,t}$. In this case, non-affected regions increase their number of arrivals by around 0.1% per one hundred increases in the number of tourists. This statement is in the line with the results of Santana-Gallego et al. (2016) or Mc Baker (2014). They show that destinations that are considered as unsafe can be substituted by other, safer areas. Drakos and Kutan (2003) also corroborated the spillover effect between Greece and Turkey when one of them suffered a terrorist event.

Regarding the expected negative effect of military expenditure on tourism rates $ME_{i,t}$, our results show that there is a negative relationship between military expenditure over GDP and tourism statistics. This can be explained as government resources are being spent on the military and not on developing infrastructure that might enhance tourism (Teye, 1988). Through our study of the interaction between military expenditure and the number of terrorist attacks, we observe that there is a U-shape effect with a particular inflexion point where an increase in the military budget increases the number of arrivals per capita. Accordingly, we observe that in high risk countries (where terrorist attacks are observed) there appears to be a level of military expenditure as a percentage of GDP above which an increase positively affects tourism demand in terms of the number of arrivals. Specifically, this happens when the military budget expenditure over GPD is higher than 4.46%. This relationship is clearly observed in some Arabian countries such as Saudi Arabia (9.8% over GDP, World Bank, 2016) or Israel (5.7% over GDP, World Bank, 2016), among others.

We obtain this percentage by introducing coefficients β_1 and β_3 in equation (3)

$$\frac{\partial Ln\, NA}{\partial\, TA} = \beta_1 + \beta_3\, ME = 0 \qquad ME = \frac{\beta_1}{\beta_3} = -\frac{0.107}{0.024} = 4.46\% \qquad (3)$$

As can be seen, there is a negative relationship between $GDP_{i,t}$ and the number of arrivals. This could probably be explained because the higher the disposable income in the country is, the more national tourists there are who are able to go abroad. The variables voice and accountability $VA_{i,t}$ and World Heritage Destination WHS_i are positively related with the number of arrivals. Hence, the more democratic and politically stable the country is, and the more attractive it is in terms of heritage and the greater the number of arrivals received by the country is. Finally, population is positively related to the number of arrivals, suggesting that more populated countries attract a larger number of international tourists.

To sum up, our results suggest that terrorism has a negative impact on tourism demand. Moreover, present results corroborate the spillover effect from countries which are affected by attacks to the ones which are not affected both within and outside of the region; with this effect being larger for countries located in the same region. Finally, by considering the coefficients of $TA_{i,t}$ and the interaction $ME_{i,t}\ x\ TA_{i,t}$, we determine the percentage of military expenditure above which tourism rates begin to improve in countries where terrorist attacks are present.

1.5. CONCLUSIONS

Using a unique dataset that provides information on the annual incidence of international terrorism for 167 countries from 1995 to 2014, this article analyzes the consequences of terrorism on tourism demand through a panel analysis with fixed effects. The findings of the panel analysis suggest that the incidence of terrorism plays an important role when trying to determine the number of tourist international arrivals. The number of terrorist events is revealed to have a significant negative effect on tourist arrivals. Hence, our results suggest that the more risky the country is, the lower the number of tourists is that is received by this country.

The results also show that there is a spillover effect from the countries affected by a terrorist attack to other non-affected countries located within and outside the damaged region. This gain in tourists is larger for countries belonging to the affected region. In other words, our results suggest that tourists change their travel decision when terrorist events occur, moving from risky to safe areas both within and outside of the region.

Related to the consequences of military expenditure on tourism arrivals, the results illustrate that the main relationship is negative. However, for countries where terrorist incidents are present, a particular level of military expenditure over GDP is observed from which an increase in the number arrivals can be seen. Hence, our results suggest that international tourist arrivals can significantly increase if military expenditure over GDP is high enough.

Definitively, our results show that the consequences of terrorist attacks on tourism are significant even when annual changes are being analyzed. Our findings show, not only the economic impact of terrorism on tourism, but also an important set of significant political, social and geographical assertions that have potential implications for policy makers who undertake counterterrorism measures.

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Table 1.- Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
NA (total)	2.620	5609164	1.13e+07	3000	8.38e+07
TA (total)	3007	27.58131	149.489	0	3925
ME (% over GDP)	3007	2.331156	1.780913	0	17.33469
GDP (US$)	2906	3.98e+11	1.36e+12	1.18e+08	1.62e+13
WHS (index)	3007	.9215165	.2689757	0	1
N (total)	3006	5.91e+07	1.49e+08	201678	1.36e+09
VA (index)	2282	.0043362	.9427864	-2.238878	1.826381

Note: NA are the international tourism arrivals per capita by country, TA is the number of terrorist attacks, ME is the percentage of military expenditure over GDP, GDP is the GDP at purchaser prices (constant 2010 US$), WHS is the current membership to the UNESCO World Heritage Sites list, N is the total population.

Table 2.- Haussman Test

rho | .97784796 (fraction of variance due to u_i)

F test that all u_i=0: F(142, 1925) = 285.03	Prob > F = 0.0000
Random-effects GLS regression	Number of obs = 2076
Group variable: idcountry	Number of groups = 143
R-sq: within = 0.3482	Obs per group: min = 1
between = 0.3655	avg = 14.5
overall = 0.3282	max = 16
	Wald chi2(12) = 1090.37
Corr (u_i, X) = 0 (assumed)	Prob > chi2 = 0.0000
Test: Ho: difference in coefficients not systematic	
chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B) =	49.81
Prob>chi2 =	0.0000
(V_b-V_B is not positive definite)	

Note: as observed in Table 2, Ho is rejected. This means that the difference between the random and fixed effects coefficients is significant. Hence, we should use fixed effects.

Table 3.- Regression Results

VARIABLES	(1) *ln NA*	(2) *ln NA*	(3) *ln NA*	(4) *ln NA*	(5) *ln NA*	(6) *ln NA*	(7) *ln NA*
TA	-0.195*	-0.356***	-1.024***	-0.986***	-0.986***	-1.001***	-1.074***
	(-1.775)	(-3.294)	(-3.582)	(-3.449)	(-3.449)	(-3.505)	(-3.634)
Europe		2.530***	0.698***	0.810***	0.810***	0.600***	0.575***
		(13.481)	(6.133)	(6.944)	(6.944)	(4.369)	(4.002)
Africa & Middle East		-1.266***	-1.822***	-1.854***	-1.854***	-1.477***	-1.540***
		(-4.475)	(-15.479)	(-15.726)	(-15.726)	(-8.420)	(-8.051)
Americas		2.107***	-2.938***	-2.927***	-2.927***	-2.722***	-2.852***
		(11.222)	(-25.986)	(-25.899)	(-25.899)	(-20.443)	(-20.663)
TAIN		0.142***	0.143***	0.144***	0.144***	0.137***	0.051***
		(22.577)	(22.592)	(22.732)	(22.732)	(19.937)	(5.341)
TAOUT		0.059***	0.057***	0.060***	0.060***	0.058***	-0.011
		(15.369)	(15.026)	(15.476)	(15.476)	(14.700)	(-1.360)
ME			-0.044***	-0.042***	-0.042***	-0.041***	-0.027**
			(-4.460)	(-4.222)	(-4.222)	(-4.114)	(-2.375)
TA x ME			0.211**	0.205**	0.205**	0.206**	0.241***
			(2.492)	(2.415)	(2.415)	(2.428)	(2.693)
GDP				-0.119***	-0.119***	-0.114***	-0.096***
				(-4.376)	(-4.376)	(-4.170)	(-3.266)
WHS					1.404***	0.813***	0.729***
					(12.109)	(3.458)	(2.915)
ln N						0.239***	0.207**
						(2.894)	(2.311)
VA							0.118***
							(3.172)
Constant	9.946***	10.966***	15.635***	15.638***	14.233***	10.569***	12.485***
	(39.246)	(74.367)	(169.648)	(169.380)	(97.804)	(8.294)	(8.868)
Observations	2,587	2,587	2,587	2,562	2,562	2,562	2,076
R-squared	0.969	0.971	0.971	0.971	0.971	0.971	0.977
FE (year and country)	YES	YES	YES	YES	YES	YES	YES
Adj. R-squared	0.967	0.969	0.969	0.969	0.969	0.969	0.975

*Note: Table 3 shows the panel regression model for our sample. We start from a very simple model to finish with the most complex model. NA is number international tourism arrivals, ln is equal to logarithm, TA is the number of terrorist attacks per year and country, belonging to a region is specified by a dummy, TAIN is the number of terrorist attacks that occur in a given region, TAOUT is the number of terrorist attacks that occur outside that region, ME is equal to the percentage of military expenditure over GPD is the GDP at purchaser´s prices (constant 2010m US$), WHS captures the belonging to UNESCO World Heritage List, N is the total population, VA is the voice and accountability index. The significance levels are as follows: *** p<0.01, ** p<0.05, * p<0.1. Our database comes mainly from GTD database and World Bank Database. It covers a sample of 167 countries with annual observations for the period 1995 to 2014.*

Figure 1: Mean of the Total Number of Terrorist Attacks from 1995 to 2014

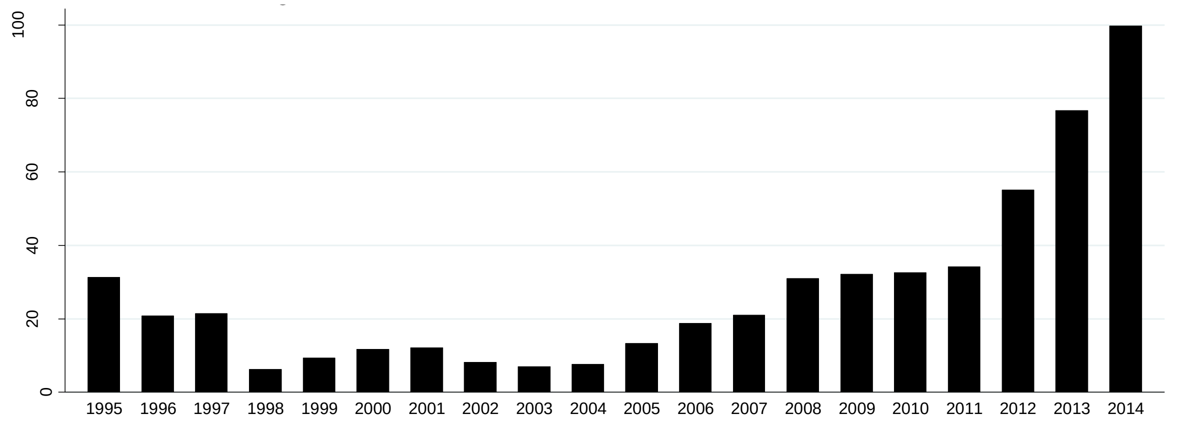


Figure 2: Mean of the Total Number of Arrivals from 1995 to 2014

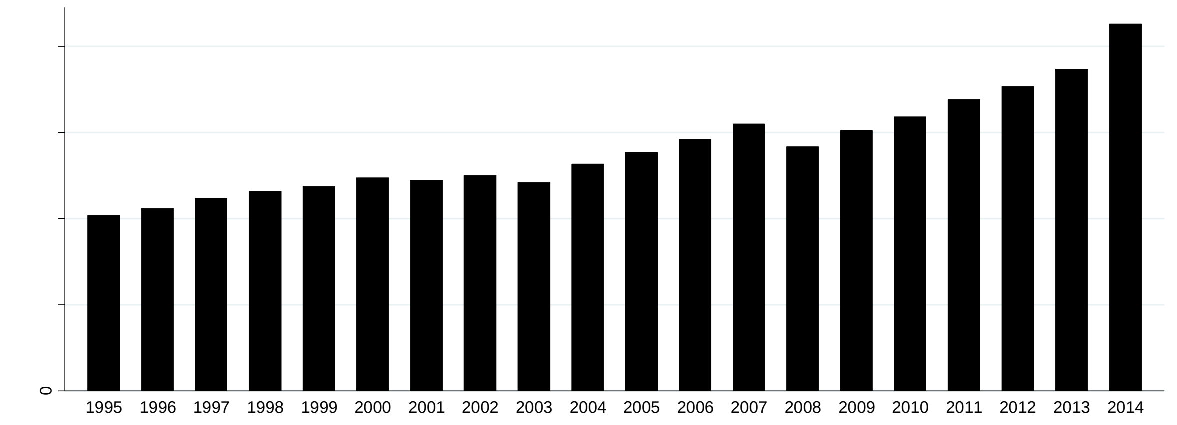
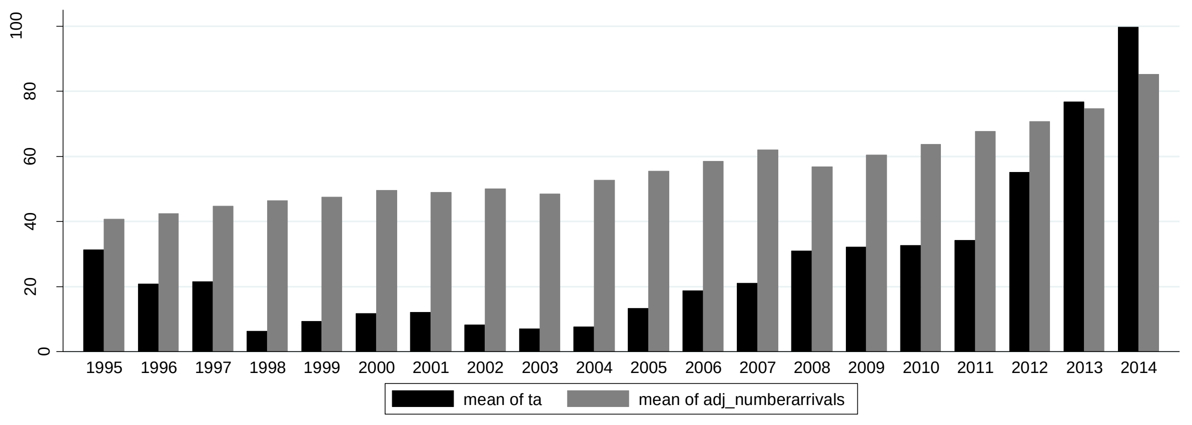


Figure 3: Mean of the Total Number of Terrorist Attack and Arrivals from 1995 to 2014



Chapter 2

Terrorism in the Behavior of International Monthly Arrivals in the United States

2.1. INTRODUCTION

International travel and tourism is a significant contributor to economic growth and development, with worldwide growth in international tourist arrivals outpacing national income growth one out of every two years over the past 30 years (Baker, 2014).

In 2016, there were 1.235 billion international tourist arrivals worldwide, with a growth of 4% as compared to 1.186 billion in 2015. The ranking of United Nations World Tourism Organization showed that U.S. is in the second position by international tourist arrivals in 2015 with almost 77.5 millions arrivals.

Terrorism is the premeditated use or threat to use violence by individuals or subnational groups to obtain a political or social objective through the intimidation of a large audience beyond that of the immediate victims (Enders and Sandler, 2011). This definition is consistent with other authors in the literature such as Hoffman (2006) or RAND (2012). Seddighi et al. (2001) and Stafford et al. (2002) state that the effects of terrorist attacks might cause political instability, which leads to the decline or disappearance of tourist arrivals in some tourist destinations.

Recent terrorist attacks and conflicts during the last 30 years, and the considerable current spread of ISIS (Islamic State of Iraq and Syria), have rekindled the interest in the effects of terrorist attacks on the economy, and more particularly, on their consequences for tourism industry. Moreover, political and military relevance of the U.S. in the international scene, place this country as one of the main targets for terrorists at a global scale.

The literature confirm that terrorist attacks alter tourism demand, showing an increasing demand to cancel travel or holiday plans particularly after the 9/11 terrorist attack (Chen et al., 2004; Floyd et al., 2012; Kingsbury and Brunn, 2004).

In the past few years, since 1996, we have observed several terrorist events in the U.S. that have been able to cause negative impact on tourism demand and alter the flow of international travellers.

Terrorist attacks in the U.S. in September 2001, have had a negative and significant impact on tourism demand and international travel. It was precisely after September 11, 2001 that scholars in the tourism field showed increased interest in the topic.

The attacks induced substitution away from air travel generally and caused a shift in the preferences of tourists. The U.S. experienced an immediate and relevant drop in international arrivals after 9/11, especially from overseas. Some related factors, such the perception that U.S. visa policy became more restrictive in the wake of 9/11, may also have negative indirect effects on tourism arrivals. Hence, one terrorism event can become one country less attractive travel destination, damaging its image abroad (Alden, 2008).

The literature on modelling and forecasting arrivals time series is extensive. Both analytical and descriptive analysis discuss the economic consequences of terrorism, the effectiveness of the counter terrorism measures and the trends in terrorist attacks, among other issues (Sandler 2014). The existing literature about terrorism and tourism demand follows in general three lines: motives for which terrorist’s target tourism sector, solutions to minimize the risk of tourists and the consequences of terrorism on tourism demand (Pizam and Smith, 2000; Gaibulloev and Sandler, 2011; Baker, 2014).

Enders et al. (1992) provide empirical evidence on the link between terrorism and the tourism sector for a sample of European countries and through a vector autoregressive analysis (VAR). Using an ARIMA model with a transfer function based on the time series of terrorist attacks in Austria, Greece and Italy, they find that a terrorist attack in Greece costs 23.4% of its annual tourism income for 1998 (Enders and Sandler 1992).

Llorca-Vivero (2008), using bilateral tourism data to estimate a cross-sectional gravity model, studies the effect of terror attacks on tourist arrivals by analyzing tourism from the G-7 countries to 134 destinations. The research evaluated the differentiation between routine tourist flows and international arrivals following terrorism, pointing to a larger deviation in the developing countries. He finds that terrorism seriously damages the tourism industry, with particularly severe effects in developing countries. More recently, Robbins (2012) uses a cross-sectional gravity equation to mea- sure the impact of terrorism on international tourist flows for eight European destination countries for the period 1991 to 2009. He shows that both the amount of terrorist attacks and the number of fatalities due to terrorism influence negatively tourism flows to European destination countries. Altindag (2014) analyses the effect of crime on tourism by using panel data that includes tourism flows to European countries. He finds that violent crime is negatively associated with tourist ar- rivals and tourism revenue.

If we look at the U.S. the impact of 9/11 on travel and tourism flows to the United States has been evaluated in several studies. Lee et al. (2005), evaluate the impact of the 9/11 attacks on the demand for air travel to the USA using a time series intervention model and found a significant overall drop in tourism demand. Similarly, Blunk et al. (2006) evaluate whether post 9/11 U.S. airline travel volume returned to its pre 9/11 trend and found that it had not by 2004. Bonham et al. (2006) quantify the initial impact of 9/11 on tourist arrivals to Hawaii and their recovery using a Vector Error Correction model (VECM). The results indicate that substitution away from foreign arrivals and towards U.S. citizen arrivals took place in Hawaii and that the positive shock to U.S. citizen arrivals offset the negative shock to foreign arrivals. The Hawaiian tourism industry had fully recovered from the 9/11 shock by 2003. Blalock et al. (2009), for example, quantify the increase in the number of auto driving fatalities due to substitution away from airline travel after 9/11. Despite the well-documented decline in foreign arrivals to the United States after 9/11, the negative post 9/11 trend in arrivals starts to improve from 2002 to 2007.

In line with our data that corresponds to the terrorism events and number of kills occasioned by assassination, hijacking, kidnapping, barricade incident, bombing/explosion, armed assault, un-armed assault, facility/infrastructure attack, this article is focusing on a time period with several terrorist events, a situation that allows to analyze the magnitude and temporal scale of the relation between terrorism and tourism in a more differentiated way. Also, our results try to corroborate previous studies, taking into consideration the tested impact of 9/11 on U.S. tourism behavior. We also want to analyze if recent stability and terror problems in the U.S. shows a similar negative effect on tourism demand.

The contributions of this chapter are threefold. First, to our knowledge this is the first paper that use a methodology based on a time-frequency technique that is able to analyze the evolution of the different frequency components of the time series overtime. Second, we use Granger causality test after VAR model estimation to examine the causality direction between both time series. Finally, we analyze the reaction of tourism over terrorism using the impulse response function from VAR model.

The chapter proceeds as follows. Section 2 describes the methodology. Section 3 discusses our empirical results, showing the main evidences of the chapter. Section 4 presents the conclusions of the study.

2.2. METHODOLOGY

2.2.1. Wavelet Analysis

The wavelet transform offers localized frequency decomposition, providing information about frequency components. Wavelets have significant advantages over basic Fourier analysis when the series under study is stationary – see Gençay et al., (2002), Percival and Walden (2000) and Ramsey (2002). In our research, we use continuous wavelet analysis tools, mainly wavelet coherence, measuring the degree of local correlation between two-time series in the time-frequency domain, and the wavelet coherence phase differences.

2.2.1.1.The Continuous Wavelet Transform

The continuous wavelet transform of a time series $x(t)$, with respect to the wavelet ψ, is a function $WT_x(a, \tau)$ defined as:

$$WT_x(a,\tau) = \int_{-\infty}^{+\infty} x(t)\psi_{a,\tau}^*(t)dt, \quad (1)$$

where $WT_x(a,\tau)$ are the wavelet coefficients of $x(t)$ at a certain scale a and a shift τ, where,

$$\psi_{a,\tau}^* = \frac{1}{\sqrt{a}}\psi^*\left(\frac{t-\tau}{a}\right) \quad (2)$$

is the complex conjugate of the wavelet function ψ. The parameter a is a scaling factor that controls the stretching factor of the wavelet and τ is a location parameter in time. Then, $WT_x(a,\tau)$ will be a matrix of time series. The scaling factor a is a positive real number that simply means stretching it (if $a > 1$), or compressing it (if $a < 1$). If a is positive, we assume that we are using an analytic or progressive wavelet, i.e., its Fourier transform is defined by the positive frequency axis, $\Psi(\omega) = 0$ when $\omega < 0$.

The lower the value of the scaling factor, the more higher frequency components are reflected in the continuous wavelet transform, thus we are dealing with the short-run components of the signal. As the scaling factor increases, we are dealing with lower frequency components of the time series, focussing on the long-run components. Then, the continuous wavelet transform is a multidimensional transform; from one-time series we obtain a matrix of time series that show different frequency components (depending on the scaling factor) of the original one.

If the wavelet function ψ is complex, then the wavelet transform $WT_x(a,\tau)$ will also be complex, with amplitude, $|WT_x(a,\tau)|$, and phase, $\phi_x(a,\tau)$. The real part of the wavelet transform, $\Re\mathrm{e}\{WT_x\}$, and its imaginary part, $\Im\mathrm{m}\{WT_x\}$ define the phase or phase-angle of the wavelet transform:

$$\phi_x = \mathrm{Arctan}\left(\frac{\Im\mathrm{m}\{WT_x\}}{\Re\mathrm{e}\{WT_x\}}\right). \qquad (3)$$

The phase of a given time-series $x(t)$ is measured in radians, ranging from $-\pi/2$ to $+\pi/2$. Then, the phase is also a matrix containing the angle of each frequency component of the original time series. The phase will be used to extract conclusions of the synchronism between two time series, applying the wavelet coherency and the phase difference between time series (Aguiar-Conraria and Soares, 2011a,b and 2014).

The wavelet or mother wavelet used to analyze the time series must satisfy certain technical conditions to provide effective time-frequency location properties (Daubechies, 1992). First, it has to be a function of finite energy, $\int_{-\infty}^{+\infty} \psi(t)dt = 0$. There are many different wavelet families, but the election of a certain wavelet will depend on the application itself.

Related to time localization properties, we can normalize the wavelet function so that $\int_{-\infty}^{+\infty} |\psi(t)|^2 dt = 1$. $|\psi(t)|^2$ defines a probability density function, and therefore we can obtain the mean, μ_{ψ}, and the standard deviation, σ_{ψ}, of this distribution. They are called the center and the radius of the wavelet, respectively. If we consider the Fourier transform of the mother wavelet, $\Psi(\omega)$, in a similar way we can calculate its mean and standard deviation, μ_{Ψ} and σ_{Ψ}.

These quantities define the Heisenberg box in the time-frequency plane: $[\mu_{\psi} - \sigma_{\psi}, \mu_{\psi} + \sigma_{\psi}] \times [\mu_{\Psi} - \sigma_{\Psi}, \mu_{\Psi} - \sigma_{\Psi}]$. We say that ψ is localized around the point (μ_{ψ}, μ_{Ψ}) of the time–frequency plane with an uncertainty given by $\sigma_{\psi}\sigma_{\Psi}$. In our context, the Heisenberg's uncertainty principle establishes that $\sigma_{\psi}\sigma_{\Psi} \geq 1/2$.

The Morlet wavelet,

$$\psi(t) = \pi^{-\frac{1}{4}} e^{i\omega_0 t} e^{-t^2/2} \quad (4)$$

is a complex valued wavelet, so we will be able to measure the synchronism between two time series. This wavelet has optimal time–frequency concentration, in the sense that $\sigma_{\psi}\sigma_{\Psi} = 1/2$. Therefore, using this wavelet, we have the optimum trade off between time and frequency resolution. On the other hand, the Morlet can be considered as a wavelet (with finite energy, defined as before) when the frequency parameter $\omega_0 = 6$. For this value of the Morlet wavelet, the wavelet scale, a, satisfies the inverse relation $f \approx 1/a$, as the rest of the most used mother wavelets.

2.2.1.2. Wavelet and Cross Wavelet Power Spectrum, and Wavelet Coherency

The wavelet power spectrum (WPS) or the scalogram of a time series $x(t)$, as it is called, is the squared amplitude of the wavelet transform, that is: $WPS_x(a, \tau) = |WT_x(a, \tau)|^2$. The wavelet power spectrum lets us know the distribution of the energy (spectral density) of a time-series across the two-dimensional time–frequency representation.

While the wavelet power spectrum shows the variance of a time-series in the time-frequency plane, the cross wavelet power spectrum (CWPS) of two time-series $x(t)$ and $y(t)$ shows the covariance between these time series in the time-frequency plane:

$$CWPS_{xy}(a,\tau) = \left|WT_x(a,\tau)WT_y(a,\tau)^*\right| , \quad (5)$$

where * represents the complex conjugate, as before.

Therefore, the complex wavelet coherency between two time series $x(t)$ and $y(t)$ is defined as the ratio of the cross-spectrum and the product of the power spectrum of both series:

$$WCO_{xy} = \frac{SO\left(WT_x(a,\tau)WT_y(a,\tau)^*\right)}{\sqrt{SO(|WT_x(a,\tau)|^2)SO\left(\left|WT_y(a,\tau)\right|^2\right)}}, \quad (6)$$

where SO is a smoothing operator in both time and scale. Without the smoothing operator, the wavelet coherency would be always one for all times and scales (see Aguiar-Conraria et al. (2008) for details).

As the WCO_{xy} is a matrix of complex time series, we can split it again into amplitude and phase, $WCO_{xy} = \left|WCO_{xy}\right|e^{i\phi_{xy}}$. The amplitude matrix is the wavelet coherency, WC_{xy} and the angle ϕ_{xy} is called the phase difference between both time series:

$$\phi_{xy} = \text{Arctan}\left(\frac{\Im\text{m}\{WCO_{xy}\}}{\Re\text{e}\{WCO_{xy}\}}\right), \quad (7)$$

ϕ_{xy} is the phase difference between time series $x(t)$ and $y(t)$, and tells us about the synchronism between those time series. ϕ_{xy} ranging from $-\pi$ to π.

On the one hand, if $\phi_{xy} = 0$ then both time series move in phase. This will mean that both time series increase or decrease their values at the same time. If $\phi_{xy} \epsilon \left(-\frac{\pi}{2}, 0\right)$, they move in phase but the time series $x(t)$ is leading; if $\phi_{xy}\epsilon\left(0,\frac{\pi}{2}\right)$, the time series $y(t)$ is leading. Therefore, in these cases we can find that one time series anticipates the increase or decrease of the other one. On the other hand, a phase difference of π or − π indicates an anti-phase relation, when one time series increases, the other one is decreasing in time. Finally, if $\phi_{xy}\epsilon\left(-\frac{\pi}{2},-\pi\right)$, both time series are out of phase but $x(t)$ is leading; if $\phi_{xy}\epsilon\left(\frac{\pi}{2},\pi\right)$, $y(t)$ is leading. In this case this means that one time series has a time delay with respect to the other.

2.2.1.3. Significance Tests, Monte Carlo Simulations

To check the statistical significance of the wavelet coherency, WC_{xy}, we rely on Monte Carlo simulations (Schreiber and Schmitz, 1996). We model each time series as an ARMA (p, q) process where $p = q = 1$, with no pre-conditions. Then we assess the statistical significance of the amplitude, not of the phase. The phase difference is not tested as there is no agreement in the scientific community about how to define the procedure. We should only take into account the phase difference when the amplitude of the wavelet coherency is statistically significant.

2.2.2 Vector Auto-Regression Model

Sims (1980) presented the vector auto regression model (VAR) for the dynamic analysis of the economic system. The VAR model treats all of the variables as endogenous, and evaluates the estimation of the dynamic interaction between the economic variables. The VAR model can be expressed as follows:

$$y_t = \phi_1 y_{t-1} + \cdots + \phi_t y_{t-p} + \varepsilon_t, t = 1, 2, \dots, T$$

where y_t is a k-dimensional endogenous variables column vector, p is the lag length, and T is the number of sample.

2.2.2.1. Granger Causality Test

The Granger causality test (Granger, 1969) is used after the VAR model estimation to examine the causality direction two stationary series x_t and y_t. The linear causality test is based on a bivariate vector autoregressive (VAR) representation of the two series, as follow:

$$x_t = a_1 + \sum_{i=1}^{k} \alpha_i x_{t-i} + \sum_{i=1}^{k} \beta_i y_{t-i} + \epsilon_{1t}$$

$$y_t = a_2 + \sum_{i=1}^{k} \gamma_i x_{t-i} + \sum_{i=1}^{k} \delta_i y_{t-i} + \epsilon_{2t}$$

where k is the lag length of the x_t and y_t variables. We can thus test null hypothesis: (1) y does not cause x, which is represented as $H_0^2 = \gamma_1 = \cdots = \gamma_k = 0$. In the first case, causality runs from y_t to x_t when the null is rejected; in the second case, causality runs from x_t to y_t when the null is rejected; and finally, bivariate causality means that both hypotheses are rejected. The test statistic for these hypotheses has a standard Chi-squared distribution.

2.3. EMPIRICAL RESULTS

2.3.1. Data

The data examined in this work correspond to the total international arrivals in the U.S. and the result of multiply the number of terrorist attacks and the number of kills registered by month over the period 1996:01-2016:12. The objetctive of using this terror measure is to control both the effect of the terrorist event and its intensity in terms of the number of death victims.

The total international arrivals data was collected from the National Travel and Tourism Office (NTTO). Total number of terrorist events and number of kills by month was obtained from Global Terrorism Database (National Consortium for the Study of Terrorism and Responses to Terrorism (START), 2015), which records both domestic and transactional terrorism[13].

Figure 1 shows the comparison between both time series.

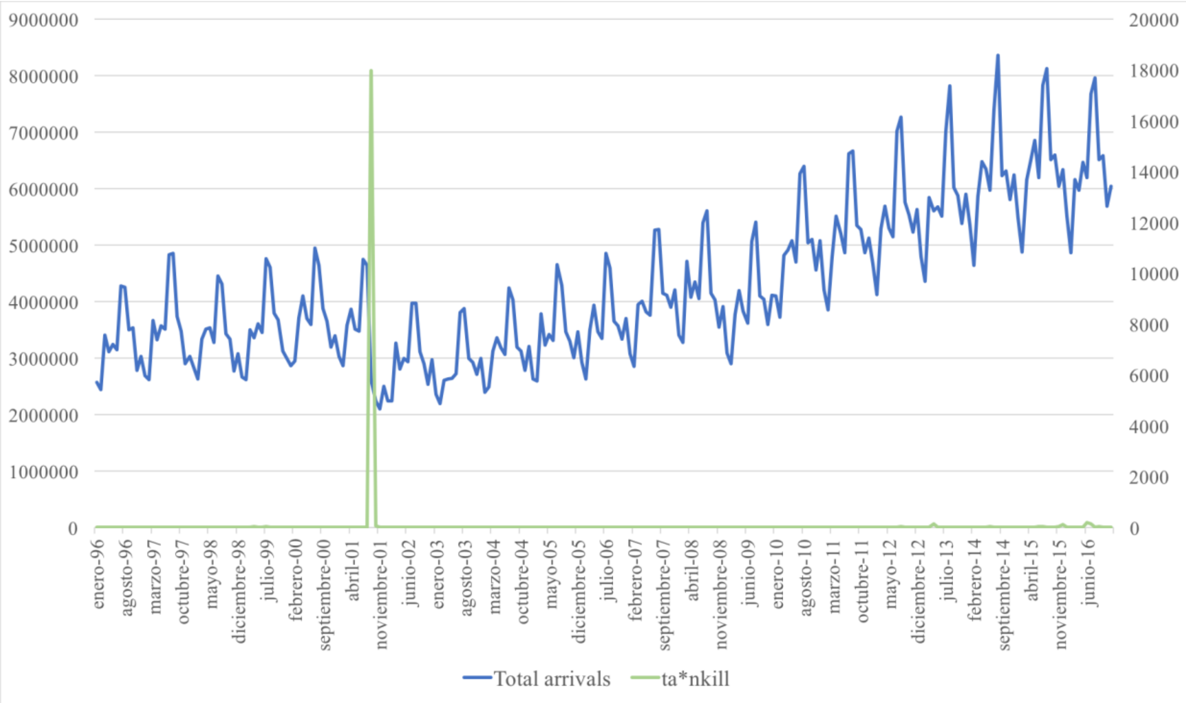


Figure 1: Total International Arrivals in the U.S. and the Terror Measure as the Result of Multiplying the Number of Terrorist Attacks by the Number of Kills.

Table 1 shows the descriptive analysis of both time series.

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Terrorist Attacks	252	75.8373	1133.044	0	17988
U.S. Arrivals	252	4.263425	1.360497	2.096	8.365

Table 1: Descriptive Statistics of the Number of Terrorist Attacks Multiply by the Number of Deaths by Month and the Total Number of Monthly Arrivals to the U.S.

[13] Type of recorded events: assassination, hijacking, kidnapping, barricade incident, bombing/explosion, armed assault, unarmed assault, facility/infrastructure attack.

2.3.2. Empirical Results

2.3.2.1. Continuous Wavelet Transform

We use Continuous Wavelet Transform (CWT) to discover patterns or hidden information between the both time series.

We first estimated the wavelet coherency between the ratio of terrorist attacks per number of kills and total international arrivals in the U.S. This study relied on Monte Carlo simulation to test if the similitude of the wavelet coherency is statistically significant. Then the complex wavelet coherence matrices were computed between a surrogate for ratio and a surrogate for the total international arrivals time series. A total of 1000 simulations were modeled on both time series as an ARMA (p, q) process, with no preconditions on p and q, with p = q = 1.

The wavelet coherency was estimated for frequencies corresponding to periods between 1.5 and 8 years.

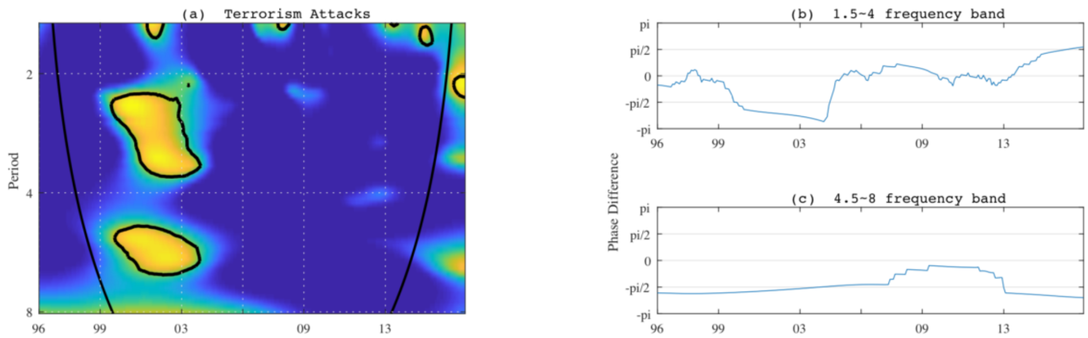


Figure 2: Wavelet coherency and phase difference between the ratio of terrorist attacks per number of kills and total international arrivals in the USA. The contour designates the 5% significance level. Left: Wavelet coherency between the ratio of terrorist attacks per number of kills and total international arrivals in the USA. Right: Phase difference between the ratio of terrorist attacks per number of kills and total international arrivals in the USA at 1.5-4 year (top) and 4.5-8 year (bottom) frequency bands.

Figure 2 displays the empirical results. The left panel (a) has the wavelet coherency between the ratio of terrorist attacks per number of kills and total international arrivals in the U.S. [14]. The right has the phase differences: on the top (b) is the phase difference in the 1.5-4 year frequency band; at the bottom (c) is the phase difference in the 4.5-8 year frequency band. The regions surrounded by the black contour are the high coherency regions with significant values at 5%.

Analyzing the wavelet coherency between the ratio of terrorist attacks per number of kills and total international arrivals in the U.S., we appreciate that the most important region with higher coherency is between 2000 and 2004. The phase difference analysis is focused on two frequency bands: 1.5-4 and 4.5-8 years.

To analyze the wavelet coherency graph, we have to focus on the regions of high coherency of the chart. In those regions, we can observe the phase difference of the frequency band to extract some conclusions.

In the 1.5-4 and 4.5-8 year band, we identify a region of high coherency between 2000 and 2004, in the frequency bands between 2.5 and 3.5 years and between 5 and 6.5 years, respectively with a corresponding phase difference in these bands between $-\pi$ and $-\pi/2$. These results suggest that terrorist attacks per number of kills and total international arrivals in the U.S. time series are out of phase (negative correlated) with terrorism leading. This suggest that terrorist attacks increase precede a decrease on total international arrivals in the U.S.

From this wavelet coherency figure, we can observe a change across time in the common frequency bands between terrorism and total international arrivals in the U.S.; Lower frequency between the years 2000-2004 indicates a long-term component, i.e. a lower frequency band of

[14] Coherency ranges from blue (low coherency) to red (high coherency). The cone of influence is shown with a thick line, which is the region subject to border distortions.

approximately 5 to 7 years, suggest a longer-term impact of the terrorist attacks over total international arrivals in the U.S.

2.3.2.2. Unit Root Tests

The VAR model is implemented to explore the terrorist attacks and international arrivals in the USA nexus.

Initially, a unit root test should be used to examine the statistical properties of the time series that are used in the VAR model. We select the Augmented Dickey-Fuller test (ADF, Dickey and Fuller, 1979), the Phillips Perron test (PP, Phillips and Perron, 1988) and the Kwiatkowski-Phillips-Schmidt-Shin test (KPSS, Kwiatkowski et al., 1992) to obtain robust results. Table 2 displays the results, which clearly suggest that the ratio of terrorist attacks per number of kills time series is stationary I(0) and total international arrivals in the USA is nonstationary I(1). These methods indicate that is important to do the first differences of total international arrivals time series to construct the VAR model.

	ADF				PP				KPSS	
	C		C&T		C		C&T		C	C&T
	TS	p-value	TS	p-value	TS	p-value	TS	p-value	TS	TS
Total Arrivals USA	-0.272169	0.9256	-1.915549	0.6433	-3.688790	0.0048	-6.750384	0.0000	1.833854	0.513684
ta*n_kills	-15.78568	0.0000	-15.78824	0.0000	-15.78568	0.0000	15.78824	0.0000	0.126158	0.053665

*Table 2: Unit Root Tests. Where ta*nkill is the result of multiplying the total number of terrorist attacks by the total number of kills during the period, Total Arrivals U.S. is the total number of international arrivals to the U.S. by month.TS – test statistic; C – Constant; T – trend, ADF is the Augmented Dickey-Fuller test, PP is the Phillips Perron test, KPSS is the Kwiatkowski-Phillips-Schmidt-Shin test.*

2.3.2.3. Granger Causality Test

The Granger causality test is used first to examine the interactions between the ratio constructed by terrorist attacks and number of kills and total international arrivals in the USA. The Granger causality test is based on VAR model with variables placed in the following order: first difference of total arrivals and ratio of terrorist attacks per number of kills.

The Granger causality test results of these two time series are shown in Table 3.

Dependent	Independent	Chi-sq	Prob
D(Total_arrivals)	Ta_nkill	40.97152	0.0001
Ta_nkill	D(Total_arrivals)	9.892468	0.7027

Table 3: The Granger causality test results for the VAR model. Where ta_nkill is the result of multiplying the total number of terrorist attacks by the total number of kills during the period, D (Total_arrivals) is the total number of international arrivals to the U.S. by month.

After obtaining the results, we only found causality from terrorism to international arrivals.

We can conclude that the total international arrivals in the U.S. have not a bidirectional Granger causality relation with terrorism. Only the terrorism explains the total international arrivals in the U.S.

2.3.2.4. Impulse Response of Terrorism to the Total International Arrivals in the U.S.

Finally, for the asymmetric effect of the total arrivals in U.S., we need to identify the response direction of the U.S. tourism to the terrorism events.

Based on the VAR model, the impulse response function could offer refined insight into the response of the U.S. tourist arrivals to terrorism events in the same region in terms of the response amplitude and direction. In Figure 4, the upper row is the responses of the total international arrivals in the U.S. to the terrorism events, and the second row, at the bottom, is the responses of the terrorism events to the total international arrivals in the U.S.

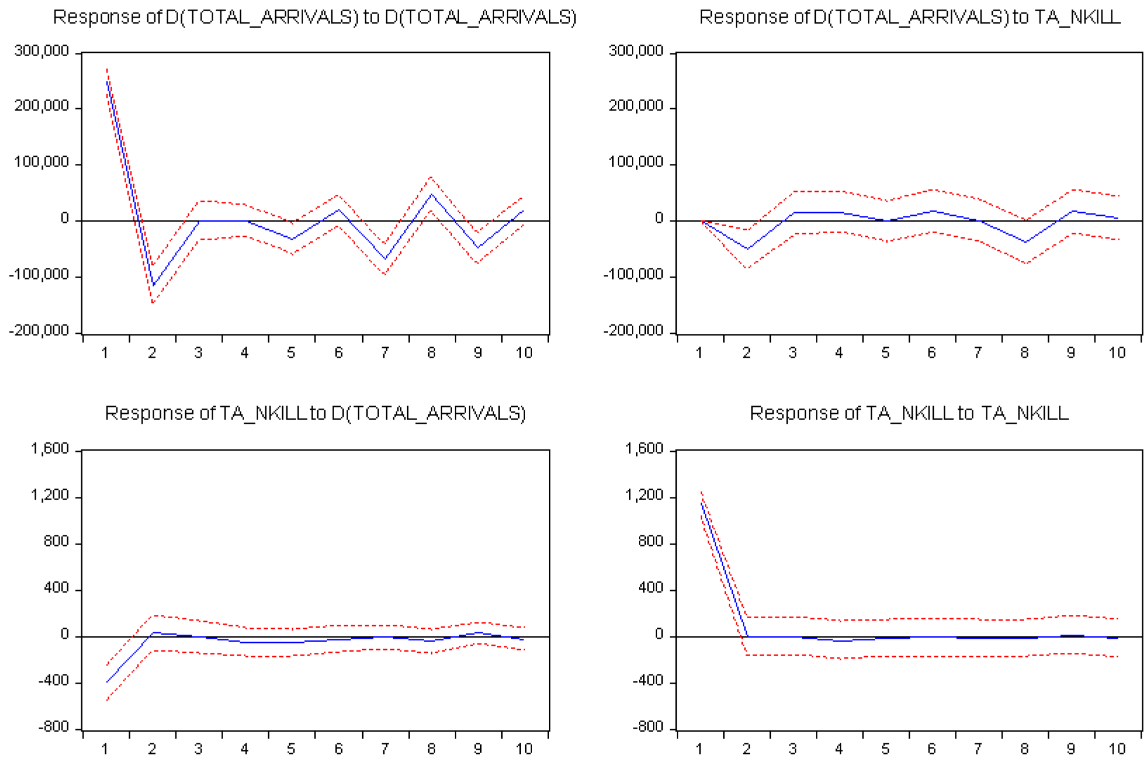


Figure 3: Impulse Response Function of the Total International Arrivals in the U.S. VAR Model.

The shocks in this study are measured by the Cholesky one standard deviation innovations (Hamilton, 1994). Figures 3 shows the ways in which total international arrivals in the U.S. responds to the shock occurring with the terrorist attacks in U.S. over 10 monthly periods. In the case of total arrivals, a shock in the variable itself (see the top left panel in Figure 4) will have a relatively larger impact on the current level of arrivals and this impact will gradually die off and disappear after 10 periods (in our case, 10 months).

The top right panel of Figure 4 show that tourist arrivals respond negatively to the shock in terrorist events and number of kills and the momentum of this impact take about 3 months to disappear.

2.4. CONCLUSIONS

This chapter contributes to the literature on how terrorist attacks affect the behavior of international monthly arrivals in United States by studying its dynamic in the time-frequency domain. Assuming that there is empirical evidence on the link between terrorism and the tourism sector (Enders et al., 1992), we combine the Continuous Wavelet Transform (CWT) and the Vector Autoregression Model (VAR) to examine the dynamic relations between both time series. In this research, we have analyzed the number of terrorist events per number of kills by month from Global Terrorism Database (National Consortium for the Study of Terrorism and Responses to Terrorism (START), 2015) and its effects on international monthly arrivals in United States.

The first step in this research chapter has been to analyze the wavelet coherency. We appreciate that the regions with higher coherency, which are also statistically significant (the 5% significance level estimated from Monte Carlo simulations), are between 2000 and 2004. The phase information about this period is located, 2000-2004, is in the frequency bands between 2.5 and 3.5 years and between 5 and 6.5 years, respectively, with a corresponding phase difference in these bands between $-\pi$ and $-\pi/2$, suggesting a negative relation between terrorist attacks and international arrivals in the U.S. In other words, our results suggest that terrorist attacks increases precede a decrease on total international arrivals. From this wavelet coherency figure, we can also observe a change across time in the common frequency bands between terrorism and total international arrivals in the U.S.; Lower frequency between the years 2000-2004 indicates a long-term component, i.e. a lower frequency band of approximately 5 to 7 years, suggest a longer-term impact of the terrorist attacks over total international arrivals in the U.S.

In the second part of this research we have employed a causality test after the VAR model estimation to provide evidence that terrorism explains the total international arrivals in the U.S. Finally, using the impulse response function from VAR estimation, we have found a negative response of tourism to terrorist incidents. Our results corroborate the results and finding that other authors develop in the literature through other statistical methods.

Definitely, our results corroborate the results and findings that other authors have documented in the literature through other statistical methods. As was expected, the influence of 9/11 attacks in New York City has a profound effect on the number of arrivals to the U.S., not only due to the direct effect on the national image and reputation abroad, but also due to the VISA limitations and security requirements, what made the country a less attractive travel destination.

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Chapter 3

Terrorism and Oil Production Behavior in OPEC Countries

3.1. INTRODUCTION

Terrorism is one of the main concerns of governments and citizen all over the world, not least because its direct effects on population and infrastructures, but also for its significant consequences for the global economy. In the last decades, terrorism has represented a significant and increasing threat to the human society. Terrorism is considered a specific form of political violence, and is important to know if this political violence is also linked to oil.

Collier and Hoeffler (1998); Ross (2004b); Fearon (2005); Humphreys (2005) and Colgan (2013) show that oil and energy play an impeding role to political stability, where oil is a potential cause of interstate wars and may induce civil conflicts as well. Ross (2001); Jensen and Wantchekon (2004); Morrison (2009); Aslaksen (2010) and Ramsay (2011) show that countries rich in oil may produce some adverse effects, as lower level of democracy. Sachs and Warner (1995) and Ross (1999) show that oil abundance produce slow economic growth and Collier and Hoeffler (1998); Ross

(2004b); Fearon (2005); Humphreys (2005) and Ross (2004a) show that to be a rich oil country produce frequent civil conflicts. Also, Eubank and Weinberg (1994), (2001); Weinberg and Eubank (1998); Savun and Phillips (2009); Chenoweth (2010) and Lee (2013) concluded that a country's economic and political conditions may substantially influence the level of its vulnerability to terrorism. Lee (2016) affirms that oil has negative political and economic effects, so the existence of oil may be channeled into political or economic circumstances that are (un)favorable to terrorists.

According to Lee (2016), oil-producing countries are prone to terrorism because they are important targets of terrorists who may attack oil facilities to cause greater impact and to harm powerful countries' overseas interests and also because oil often generates grievances or greed among local people who may in turn engage in terrorist activities.

Also, Hoffman (2006) argued that terrorism causes a lot of shock and fear, and it is important to study how and if those reactions carry over to the economy. Sectors as important and strategic such as the energetic, and more specifically the producers of fossil fuels such as oil, have become target for terrorism as in lot of cases it represents the main funding source for these terrorist groups. Moreover, most of the developed countries in the world show oil dependence, which makes their economies dangerously vulnerable to external policies, especially from potential producers such as OPEC, USA or Russia. Furthermore, producing countries are, in many cases, undiversified economies, unable to face macroeconomic turbulences and conflicts that may hit their oil industry capability. The strategic importance of the oil industry may also guide economic, political and military decisions of influence groups, leaders and governments.

According to U.S. Energy Information Administration (EIA, 2018), much of the world's crude oil is located in regions that have been prone historically to political upheaval or have had their oil production disrupted due to political events.

Recent attacks and war conflicts in some of the main oil producing countries during the last 30 years have rekind the efforts towards better understanding the consequences of terrorism events on oil production. Moreover, oil sector has recently experienced an escalated threat of terrorism because of the spread of ISIS (Islamic State of Iraq and Syria) control over oil installations and the ideological radicalization of several producer countries such as Saudi Arabia. According to Weisenthal (2012), of today's current top 20 oil producing countries, 7 are located in the Middle East and North Africa region, which become this region a potential risk for terrorism damages. Moreover, Şen and Babalı (2007) indicated that it is important to note that OPEC member countries such as Saudi Arabia, Iran, Iraq, Kuwait, UAE or Qatar comprise 65-70% of the world's oil reserves.

U.S. Energy Information Administration (EIA) affirms that OPEC's crude oil production is an important factor that affects oil prices and the economies, respectively. OPEC seeks to actively manage oil production in its member countries by setting production targets. This organization produce about 40 percent of the world's crude oil and historically, crude oil prices have seen increases in times when OPEC's production targets are reduced, affecting to the world economies. Coleman (2012) concluded that prices reflect supply-demand equilibrium and shocks are caused by exogenous shortfalls in supply, whose initiators lie in markets, inventory, or supplier behaviour, or when demand rises faster than expected. For these reasons, we consider an important issue how affects the terrorist events in the crude oil production behavior.

It is due to this that makes this study crucial and timely, because given the importance of oil in the economic, political science and international relations literature, there is surprisingly little scholarly discussion of the role terrorism plays in oil production.

Lee (2016) discusses the reasons and identifies three mechanisms why oil-producing countries may be prone to terrorism. First, oil wealth may be used to fund terrorism and thus oil-producing countries may be terrorism sponsors or producers; second, oil-producing countries are salient terrorist targets not only because terrorists often attack oil facilities but also because of their strategic importance to powerful countries, particularly the United States; third, oil may motivate separatists or local residents who are resentful of the government to resort to terrorist acts.

Furthermore, Essaddam and Karagianis (2014) found evidence about channels through which terrorism can affect the economy. From a country perspective, terrorism affects commerce though increasing transaction costs and producing changes in the regulatory environment. Terrorism also consumes government resources, as future attacks must be prevented. It can also affect foreign international investment as investors will prefer to transfer their funds to safer areas with equivalent profitability ratios.

However, the direct impact of a terrorist attack is subject of debate. Kunreuther et al., (2003) argued that the sum of the direct and indirect cost of the hijackings on 11 September 2001 was between $80 and $90 billion. It is important to mention that the total GDP of the U.S. in 2001 was $10 trillion. Indirect effects are also remarkable, even more when we talk about energy interests. Although 9/11 did not technically contribute to the rise of oil prices, Jackson (2008) argue that the U.S. response invading Afghanistan and Iraq may have contributed to the industry behavior. Enders and Sandler (2006) and Gaibulloev and Sandler (2011) concluded that it is also important to note that big and advanced economies are able to face better the attacks as many monetary and fiscal tools are available to improve the behavior of the economy after a terror event.

In summary, Sandler and Enders (2008) affirm that terrorism causes a small, but significant nega- tive impact on per capita GDP growth.

According to Farrel (2016), despite the obvious importance of the topic, only a few empirical stud- ies focus on the consequences of terrorism on oil prices. Şen and Babalı (2007), conclude that terrorist attacks have also direct effects over oil supply security matters. Toft (2011) investigates how often and how much outbreaks of intrastate conflict in oil producing states translates into oil supply shortfalls. He concludes that outbreak of conflict does not translate into production decline with any certainty and in many cases growing oil production actually followed conflict. Barros et al. (2011) use monthly data from 1973 to 2008 for 13 OPEC member countries to study the time series behavior of oil production for OPEC member countries within a fractional integration modelling framework recognizing the potential for structural breaks and outliers. Monge et al. (2017) investigate the crude oil price behaviour before and after military conflicts and geopolitical events since World War II using techniques based on unit roots and fractional integration, finding evidence of persistence and breaks in the oil prices series and stationary long memory in the ab- solute returns. However, they do not observe significant differences before and after the conflicts and geopolitical events.

It exist some other studies which study the consequences of terrorism on other economic indicators such as the price-stock index (Kollias et al., 2013) or tourism demand (Santana-Gallego et al., 2016).

Kollias et al. (2013) argue that geopolitical events, especially war and terrorism, can have an important effect on market behavior. However, the time length of this effect and its intensity can vary. Moreover, terrorism is a one-off event that cannot be forecast by the market. The literature shows a short-term fall but a quick rebound for markets following a terrorist event. Findings indicate the market ability to adjust for conflicts in the long-term.

Much of the research actually consists of how terrorism is fueled by oil as it was studied by Hendrix (2014). In this line, Colgan (2010) found that petrostates engaged in militarizes interstate conflicts 50% more frequently than its non-petrostates counterparts. On the other hand, the existing literature analyzes these relationships in global or country level terms and not for an influence industry group as the OPEP[15].

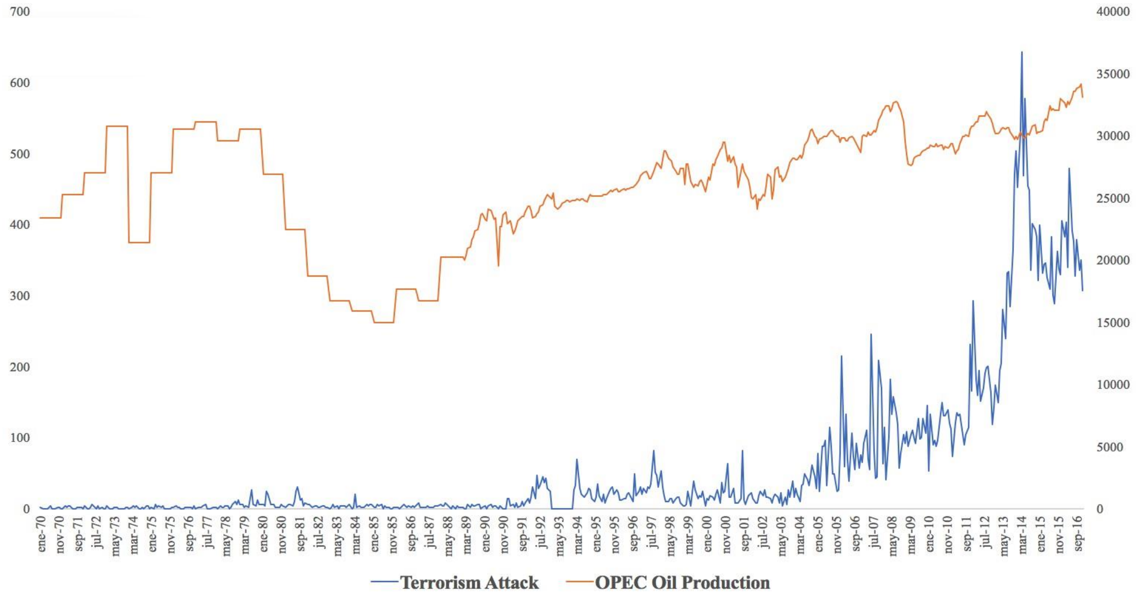

Figure 1: Terrorist Attacks in OPEC Countries and OPEC Total Crude Oil Production.

It is common in the literature to utilize Fourier analysis to analyse the different relations at different frequencies, omitting the time information, despite it being difficult to identify structural changes with this type of analysis.

Following Pinto et al. (2016) the economic time series are an aggregation of components operating on different frequencies and we need the frequency information because the

[15] Of the United States' oil imports of the last 20 years, approximately over 40% of that total originated from OPEC countries (Farrel, 2016).

most distinguished information is hidden in the frequency content of the signal. Moreover, we use wavelet analysis instead of Fourier Transform (FT) because we loose the time information and cannot locate drift, trends, abrupt changes, beginning and ends of events, etc.

The wavelet analysis performs the estimation of the spectral characteristics of a time series as a function of time, revealing how the different periodic components of the time series change over time, using different scales to study the rapidly changing details (low scale) like volatility and business cycles and slowly changing features (high scale) like trends. Applying the Wavelet Continuous transform, which is a function of two variables (the translation parameter in time and the scale parameter) other authors will be able to estimate the wavelet coherency to localize the structural changes on time and then the Phase Difference to know about the synchronism between the time series employed

In this paper we analyse the relationship of terrorist attacks and crude oil production in OPEC countries by studying its dynamic in the time-frequency domain through the application of wavelet tools for its resolution.

The contributions of this paper are twofold. First, to our knowledge this is the first paper that propose to answer the question how affects terrorism to the crude oil production in OPEC countries using monthly data. Second, we use a methodology based on a time-frequency technique that it is able to analyse the evolution of the different frequency components of the time series overtime. Applying the wavelet transform it is possible to detect the evolution in time of the low frequency. This low frequency is related with the trend or long run component in the time series. Also, applying the wavelet transform we can detect the evolution overtime of the high frequency components related to seasonality or the short run component, as well as the rapid changes in the time series[16].

We use wavelets to analyse the relationship between terrorist attacks and crude oil production in OPEC countries for the time period 1970-2016. Following Aguiar-Conraria and Soares (2011a,b), two tools are used to analyse the impact of crude oil production on the crude oil prices: the wavelet coherency and the wavelet phase-difference. The wavelet coherence is a localized correlation coefficient in the time-frequency space. The information on the delay between the oscillations of two time-series is the phase-difference. These concepts developed by Aguiar-Conraria were previously examined in Naccache (2011), analysing the relationship between oil price and the economy. The analysis is performed in the time-frequency domain, using wavelet analysis. Following these authors, we use this methodology for three reasons. First, stationarity is not required in the wavelet analysis (in our case, oil prices are non-stationary). On the other hand, we can study how relations evolve between time and frequencies. And the last reason is related with the energy markets and the research by Kyrtsou et al. (2009). They argue that several energy markets display consistent non-linear dependencies.

The paper is organized as follows. Section 2 provides a brief introduction to the mathematics of wavelets and explains how to derive the metric that is used to compare the terrorist attack and OPEC's crude oil production. The data are described and the main results are presented in Section 3, while Section 4 concludes.

[16] Hogan and Lakey (2005) examined the relationship between time-frequency and time-scale (wavelets) methods.

3.2. METHODOLOGY

3.2.1. Wavelet Analysis

The wavelet transform offers localized frequency decomposition, providing information about frequency components. Wavelets have significant advantages over basic Fourier analysis when the series under study is stationary –see Gençay et al., (2002), Percival and Walden (2000) and Ram- say (2002). In our research we use continuous wavelet analysis tools, mainly wavelet coherence, measuring the degree of local correlation between two-time series in the time-frequency domain, and the wavelet coherence phase differences.

3.2.1.1.The Continuous Wavelet Transform

The continuous wavelet transform of a time series $x(t)$, with respect to the wavelet ψ, is a function $WT_x(a, \tau)$ defined as:

$$WT_x(a,\tau) = \int_{-\infty}^{+\infty} x(t)\psi_{a,\tau}^*(t)dt, \quad (1)$$

where $WT_x(a,\tau)$ are the wavelet coefficients of $x(t)$ at a certain scale a and a shift τ, where,

$$\psi_{a,\tau}^* = \frac{1}{\sqrt{a}}\psi^*\left(\frac{t-\tau}{a}\right) \quad (2)$$

is the complex conjugate of the wavelet function ψ. The parameter a is a scaling factor that controls the stretching factor of the wavelet and τ is a location parameter in time. Then, $WT_x(a,\tau)$ will be a matrix of time series. The scaling factor a is a positive real number that simply means stretching it (if $a > 1$), or compressing it (if $a < 1$). If a is positive, we assume that we are using an analytic or progressive wavelet, i.e., its Fourier transform is defined by the positive frequency axis, $\Psi(\omega) = 0$ when $\omega < 0$.

The lower the value of the scaling factor, the more higher frequency components are reflected in the continuous wavelet transform, thus we are dealing with the short-run components of the signal. As the scaling factor increases, we are dealing with lower frequency components of the time series, focussing on the long-run components. Then, the continuous wavelet transform is a multidimensional transform; from one-time series we obtain a matrix of time series that show different frequency components (depending on the scaling factor) of the original one.

If the wavelet function ψ is complex, then the wavelet transform $WT_x(a, \tau)$ will also be complex, with amplitude, $|WT_x(a, \tau)|$, and phase, $\phi_x(a, \tau)$. The real part of the wavelet transform, $\Re\mathrm{e}\{WT_x\}$, and its imaginary part, $\Im\mathrm{m}\{WT_x\}$ define the phase or phase-angle of the wavelet transform:

$$\phi_x = \mathrm{Arctan}\left(\frac{\Im\mathrm{m}\{WT_x\}}{\Re\mathrm{e}\{WT_x\}}\right). \quad (3)$$

The phase of a given time-series $x(t)$ is measured in radians, ranging from $-\pi/2$ to $+\pi/2$. Then, the phase is also a matrix containing the angle of each frequency component of the original time series. The phase will be used to extract conclusions of the synchronism between two time series, applying the wavelet coherency and the phase difference between time series (Aguiar-Conraria and Soares, 2011a,b and 2014).

The wavelet or mother wavelet used to analyze the time series must satisfy certain technical conditions to provide effective time-frequency location properties (Daubechies, 1992). First, it has to be a function of finite energy, $\int_{-\infty}^{+\infty} \psi(t)dt = 0$. There are many different wavelet families, but the election of a certain wavelet will depend on the application itself.

Related to time localization properties, we can normalize the wavelet function so that $\int_{-\infty}^{+\infty}|\psi(t)|^2 dt = 1$. $|\psi(t)|^2$ defines a probability density function, and therefore we can obtain the mean, μ_ψ, and the standard deviation, σ_ψ, of this distribution. They are called the center and the radius of the wavelet, respectively. If we consider the Fourier transform of the mother wavelet, $\Psi(\omega)$, in a similar way we can calculate its mean and standard deviation, μ_Ψ and σ_Ψ.

These quantities define the Heisenberg box in the time-frequency plane: $[\mu_\psi - \sigma_\psi, \mu_\psi + \sigma_\psi] \times [\mu_\Psi - \sigma_\Psi, \mu_\Psi - \sigma_\Psi]$. We say that ψ is localized around the point (μ_ψ, μ_Ψ) of the time–frequency plane with an uncertainty given by $\sigma_\psi \sigma_\Psi$. In our context, the Heisenberg's uncertainty principle establishes that $\sigma_\psi \sigma_\Psi \geq 1/2$.

The Morlet wavelet,

$$\psi(t) = \pi^{-\frac{1}{4}} e^{i\omega_0 t} e^{-t^2/2} \qquad (4)$$

is a complex valued wavelet, so we will be able to measure the synchronism between two time series. This wavelet has optimal time–frequency concentration, in the sense that $\sigma_\psi \sigma_\Psi = 1/2$. Therefore, using this wavelet, we have the optimum trade off between time and frequency resolution. On the other hand, the Morlet can be considered as a wavelet (with finite energy, defined as before) when the frequency parameter $\omega_0 = 6$. For this value of the Morlet wavelet, the wavelet scale, *a*, satisfies the inverse relation $f \approx 1/a$, as the rest of the most used mother wavelets.

3.2.1.2.Wavelet and Cross Wavelet Power Spectrum, and Wavelet Coherency

The wavelet power spectrum (WPS) or the scalogram of a time series $x(t)$, as it is called, is the squared amplitude of the wavelet transform, that is: $WPS_x(a,\tau) = |WT_x(a,\tau)|^2$. The wavelet power spectrum lets us know the distribution of the energy (spectral density) of a time-series across the two-dimensional time–frequency representation.

While the wavelet power spectrum shows the variance of a time-series in the time-frequency plane, the cross wavelet power spectrum (CWPS) of two time-series $x(t)$ and $y(t)$ shows the covariance between these time series in the time-frequency plane:

$$CWPS_{xy}(a,\tau) = \left|WT_x(a,\tau)WT_y(a,\tau)^*\right|, \qquad (5)$$

where * represents the complex conjugate, as before.

Therefore, the complex wavelet coherency between two time series $x(t)$ and $y(t)$ is defined as the ratio of the cross-spectrum and the product of the power spectrum of both series:

$$WCO_{xy} = \frac{SO\left(WT_x(a,\tau)WT_y(a,\tau)^*\right)}{\sqrt{SO(|WT_x(a,\tau)|^2)SO\left(\left|WT_y(a,\tau)\right|^2\right)}}, \qquad (6)$$

where SO is a smoothing operator in both time and scale. Without the smoothing operator, the wavelet coherency would be always one for all times and scales (see Aguiar-Conraria et al., 2008 for details).

As the WCO_{xy} is a matrix of complex time series, we can split it again into amplitude and phase, $WCO_{xy} = \left|WCO_{xy}\right|e^{i\phi_{xy}}$. The amplitude matrix is the wavelet coherency, WC_{xy} and the angle ϕ_{xy} is called the phase difference between both time series:

$$\phi_{xy} = \text{Arctan}\left(\frac{\Im\text{m}\{WCO_{xy}\}}{\Re\text{e}\{WCO_{xy}\}}\right), \quad (7)$$

ϕ_{xy} is the phase difference between time series $x(t)$ and $y(t)$, and tells us about the synchronism between those time series. ϕ_{xy} ranging from $-\pi$ to π.

On the one hand, if $\phi_{xy} = 0$ then both time series move in phase. This will mean that both time series increase or decrease their values at the same time. If $\phi_{xy} \epsilon \left(-\frac{\pi}{2}, 0\right)$, they move in phase but the time series $x(t)$ is leading; if $\phi_{xy} \epsilon \left(0, \frac{\pi}{2}\right)$, the time series $y(t)$ is leading. Therefore, in these cases we can find that one time series anticipates the increase or decrease of the other one. On the other hand, a phase difference of π or – π indicates an anti-phase relation, when one time series increases, the other one is decreasing in time. Finally, if $\phi_{xy} \epsilon \left(-\frac{\pi}{2}, -\pi\right)$, both time series are out of phase but $x(t)$ is leading; if $\phi_{xy} \epsilon \left(\frac{\pi}{2}, \pi\right)$, $y(t)$ is leading. In this case this means that one time series has a time delay with respect to the other.

3.2.1.3.Significance Tests, Monte Carlo Simulations

To check the statistical significance of the wavelet coherency, WC_{xy}, we rely on Monte Carlo simulations (Schreiber and Schmitz, 1996). We model each time series as an ARMA (p, q) process where $p = q = 1$, with no pre-conditions. Then we assess the statistical significance of the amplitude, not of the phase. The phase difference is not tested as there is no agreement in the scientific community about how to define the procedure. We should only take into account the phase difference when the amplitude of the wavelet coherency is statistically significant.

3.3. EMPIRICAL RESULTS

3.3.1. Data

The data examined in this work correspond to OPEC Crude Oil Production by country member and the total number of terrorist events registered by month on each country over the period 1970:01-2016:12.

The crude oil production data was obtained from Bloomberg. The database represents OPEC total crude oil production in millions barrels per day.

Total number of terrorist events by month was obtained from Global Terrorism Database (National Consortium for the Study of Terrorism and Responses to Terrorism (START), 2015), which records both domestic and transactional terrorism[17].

Table 1 shows the descriptive analysis of both time series.

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Terrorist Attacks	564	57.51418	107.3298	0	642
OPEP Oil Production	564	26046.61	4693.716	14921	34140

Table 1: Descriptive Statistics of the Number of Terrorist Attacks by Month and the OPEC Total Crude Oil Production in Millions Barrels by Month.

3.3.2. Empirical Results

We first estimated the wavelet coherency between the monthly data of terrorist attacks and OPEC oil production. This study relied on Monte Carlo simulation to test if the similitude of the wavelet coherency is statistically significant. Then the complex wavelet coherence matrices were computed between a surrogate for OPEC oil production and a

[17] Type of recorded events: assassination, hijacking, kidnapping, barricade incident, bombing/explosion, armed assault, unarmed assault, facility/infrastructure attack).

surrogate for the terrorist attacks time series. A total of 1,000 simulations were modeled on both time series as an ARMA (p, q) process, with no preconditions on p and q, with p = q = 1. The wavelet coherency was estimated for frequencies corresponding to periods between 1.5 and 8 years, which are the ones related to the business cycles.

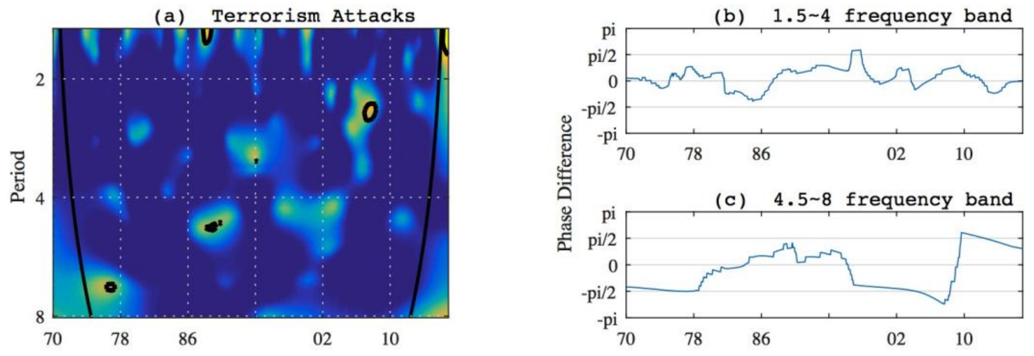

Figure 2: Wavelet coherency and phase difference between terrorist attacks in the OPEC countries and the oil production at OPEC countries. The contour designates the 5% significance level. Coherency ranges from blue (low coherency) to yellow (high coherency). Left: Wavelet coherency between terrorist attacks in the OPEC countries and the oil production at OPEC countries. Right: Phase difference between terrorist attacks in the OPEC countries and the oil production at OPEC countries at 1.5-4 year (top) and 4.5-8 year(bottom) frequency bands.

Figure 1 displays the empirical results. The left panel (a) has the wavelet coherency between terrorist attacks in the OPEC countries and the oil production at OPEC countries [18]. The right has the phase differences: on the top (b) is the phase difference in the 1.5-4 year frequency band; at the bottom (c) is the phase difference in the 4.5-8 year frequency band. The regions surrounded by the black contour are the high coherency regions with significant values at 5%.

Analyzing the wavelet coherency between terrorist attacks in the OPEC countries and the oil production at OPEC countries, we appreciate that the regions with higher coherency are three; the first is between 1976 and 1978, the second is between 1988 and 1991, corresponding to the wavelet scales of periods from 4 to 8 year bands; and

[18] Coherency ranges from blue (low coherency) to red (high coherency). The cone of influence is shown with a thick line, which is the region subject to border distortions.

the third region is between 2007 and 2009, corresponding to the wavelet scales of periods 1 to 4 year bands. The phase difference analysis is focused on two frequency bands: 1.5-4 and 4.5-8 years.

To analyse the wavelet coherency graph, we have to focus on the regions of high coherency of the chart. In those regions we can observe the phase difference of the frequency band to extract some conclusions.

In the 4-8 year band, we identify a region of high coherency between 1976 and 1978, in the frequency bands between 7 and 8 years with a corresponding phase difference in this band between $-\pi$ and $-\pi/2$, suggesting that terrorist attacks and OPEC oil production time series are out of phase (negative correlated) with terrorism leading. This suggest that terrorist attacks increases precede a decrease on OPEC oil production.

We can find also a region of high coherency between 1988 and 1991 in the 4 and 8 year band, specifically between the 4.5 and 5.5 period frequency bands. The phase difference of that period stays between 0 and $\pi/2$, suggesting that terrorism in the OPEC countries and the oil production at OPEC countries time series are in phase, they move together, with terrorist attacks leading.

In the 1.5-4 year band, we identify a region of high coherency between 2007 and 2009, in the frequency bands between 2 and 3 years with a corresponding phase difference in this band between 0 and $\pi/2$. These results suggest that terrorism in the OPEC countries and the oil production at OPEC countries time series are in phase, they move together, with terrorist attacks leading.

From this wavelet coherency figure, we can observe a change across time in the common frequency bands between terrorism and oil production at OPEC countries; Lower frequencies between the years 1976-1978 and 1988-1991 indicate a long term component, i.e. a lower frequency band of approximately 7 to 8 years and 4.5 to 5.5 years, respectively, suggest a longer term impact of the terrorist attacks over oil production.

Also, higher frequency between the years 2007 and 2009 suggests that the influence in this period of time is a short-term relationship, reaching a maximum at the 3 year frequency band. This means that the terrorism influences oil production in OPEC countries faster that in preceding years.

3.4. CONCLUSIONS

This paper contributes to the literature on how terrorist attacks affect the behaviour of crude oil production in OPEC countries by studying its dynamic in the time-frequency domain. In this research we have analyzed the number of terrorist events by month from Global Terrorism Database (National Consortium for the Study of Terrorism and Responses to Terrorism (START), 2015) and its effects on crude oil production behaviour using wavelets tools for its resolution.

Assuming that OPEC has a dominant supply feature of the oil market, accounting for representing half the total; assuming that OPEC has a superior understanding of the dynamics of the market and the ability to restrict supplies (Hansen and Lindholt, 2008) and in accordance with the terrorism and war events occurred in the main oil producing countries during the last 30 years, we analyze these two time series to understand the consequences of terrorist events on OPEC's crude oil production studying its dynamics in the time-frequency domain and applying wavelet tools for its resolution.

Analyzing the wavelet coherency which is also statistically significant (the 5% significant level estimated from Monte Carlo simulations), we appreciate that the regions with higher coherency are three.

The phase information about the first period, 1976-1978, in the frequency bands between 7 and 8 years with a corresponding phase difference in this band between $-\pi$ and $-\pi/2$, show us an anti-phase relation with terrorist attacks leading. This suggest that terrorist attacks increases precede a decrease on OPEC oil production.

The second period, 1988-1991, in the scale 4.5-5.5 period suggests that terrorism in the OPEC countries and the oil production at OPEC countries time series are in phase, they move together, with terrorist attack leading.

Finally, the third period 2007-2009, in the scale 2 and 3 periods suggests that terrorist attack in the OPEC countries and the oil production at OPEC countries time series are in phase, they move together, with terrorist attack leading.

These results reinforce the hypothesis that terrorism affects to the oil production in OPEC countries.

From this wavelet coherency figure, we can observe a change across time in the common frequency bands between terrorism and oil production at OPEC countries; Lower frequencies between the years 1976-1978 and 1988-1991 indicate a long term component, i.e. a lower frequency band of approximately 7 to 8 periods and 4.5 to 5.5 periods, respectively, suggest a longer term impact of the terrorist attacks over oil production.

Also, higher frequency between the years 2007 and 2009 suggests that the influence in this period of time is a short-term relationship, reaching a maximum at the 3 year frequency band. This means that the terrorism influences oil production in OPEC countries faster that in preceding period.

It would be also reasonable to extend this research to other influence groups in the oil industry or high producing countries such as the U.S. or Russia, even more so when the development of new production techniques such as fracking are gaining relevance in recent years, increasing worldwide oil reserves and modifying influence schemes.

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Chapter 4

Final Conclusions

These three research papers of the thesis try to obtain a better understanding, through frequency and time-frequency techniques, what the economic consequences of terrorism events on an economy are, particularly on the oil and tourism industry.

The September 11, 2001 attack in NYC stablished a before and after in the studies on the effects of terrorism on the economy. The forcefulness with which the greatest military and economic power of the planet was hit had important geo-political consequences such as the Irak war or the creation and spread of ISIS (Islamic State of Irak and Syria).

Since then, numerous attacks have been perpetrated in developed economies such as France, the U.S., Belgium and the U.K.; increasing the efforts towards a better understanding of the economic consequences of terrorism.

The terrorism database we use during this research project is the Global Terrorism Database (National Consortium for the Study of Terrorism Responses to Terrorism, START), which has recorded both domestic and transactional individual terrorism events since 1970. Extensive information about terrorist activity has been grouped in months and years according to the analysis needs of each study. It is important to mention that different types of terrorist events are recorded in the database: assassination, hijacking, kidnapping, barricade incidents, bombing/explosion, armed assault, unarmed assault, facility/infrastructure attack.

Our analysis focuses on two sectors.

First, we have analyzed the tourism industry. In particular, our analysis focused on the consequences of terrorism events on the international number of arrivals (Ferium, 2011; Neumayer, 2004; Santana-Gallego et al., 2016). It seems reasonable to use this variable as it is easier to count tourists than to estimate tourism revenues of tourists in the destination country, as some authors do in their research projects. Hence, it seems reasonable to create a demand model which explains the behavior of tourism in the face of terror with a worldwide sample and then to focus on a particular country. In our thesis, we analyze the effects of terrorism on tourism for the U.S. as it is one of the top tourism countries in the world, and one of the main actors on the international scene (UNWTO, 2016).

We also have analyzed the reaction of oil industry production to terror. Several studies focus on the inverse relationship, that is, how oil production affects terrorism. These studies start from the assumption that wealthy oil producing countries are prone to suffer from political instability which can be the cause of wars of succession and civil conflicts (Collier and Hoeffler, 1988; Ross, 20004b; Fearon, 2005; Humphreys, 2005 and Colgan, 2013). Hence, the existence of oil may favor political or economic circumstances that could lead to terrorism (Lee, 2016). It is precisely for this reason why we decided to focus our analyses in OPEC countries, as seven of the main members are located in the Middle East and North Africa, regions which are historically affected by arms conflicts and terrorism (EIA, 2018; Weisenthal, 2012). It is also in these regions or in neighboring ones where the spread of ISIS has been most noteworthy during the last decade. Moreover, some of the producing countries have been exposed to radicalization processes that affect their economies and their image abroad. To analyze the link between terror and oil production in these countries becomes more important when the policy and military decisions of these countries are highly dependent on the oil industry and when terrorism is in many cases the main funding source for terrorist groups.

The structure of the thesis is as follows. First, we analyze the consequences of terrorism on the number of international arrivals for a sample of 167 countries for the period 1995 to 2014. Second, we focus on the U.S. tourism sector, analyzing the effect of terrorism on the number of international arrivals for the period 1996 to 2016. Third, we study the consequences of terrorism on oil production for OPEP country members with monthly data for the period 1960 to 2016.

In the first paper, "International Effects of Terrorism on Tourism Demand: a Panel Data Approach", I provide an analysis of the effects of terrorist attacks on the number of international arrivals by using an unbalanced panel data set with country and year fixed effects, and using annual observations for 167 countries for the period 1995 to 2014. We employ the number of international arrivals as the dependent term because this variable has the advantage of being measured with great precision for the simple reason that it is easier to count tourists than to estimate tourism revenues in the destination country (Feridun, 2011; Neumayer, 2004). In our model, we include the number of terrorist events per year and country as an independent variable, and as an adequate proxy to measure the effects of terrorism on tourism demand (Drakos and Kutan, 2003;

Robbins, 2012). We decided not to include measures for the intensity of the attacks such as the number of fatal victims because of the potential collinearity problems which might arise when analyzing them together in a panel scheme. Several controls have been included in order to model tourism demand. Among them, we find the voice and accountability index in order to measure the quality of institutions in a particular country and the freedom of its citizens belonging to a particular region, GDP at purchaser´s prices; measures of national income or population level. Year and country fixed effect have been also included in order to control for the idiosyncratic characteristics of each country and the time-invariant variables over time (Neumayer, 2004, Saha and Yap, 2014; Santana-Gallego et al., 2016). The Hausman test has been also carried out with the objective of testing the convenience of using fixed effects in our model (Hausman, 1978).

The results suggest that when terrorist attacks increase, we observe a decrease in the number of international arrivals. Hence, it seems that the more risky the country is, the lower the number of tourists that are received by that country. This supported our assumptions as it was observed that countries that suffer from terrorist events tend to experience a reduction in number of arrivals. A spillover effect was also observed from affected countries to countries and regions which had not been attacked (Enders and Sandler, 1992; Drakos and Kutan, 2003). Hence, tourists may change their travel decisions when a terrorist event occurs, moving from risky to safer areas both within and outside of the region. At this point it is important to mention that a higher substitution effect is observed in favor of countries located in the same region. This means that travelers seem to change their destination country when a terrorist attack occurs, but not so much their regional preferences. Nevertheless, the replacement ratio of gain does not differ a lot between hit and un-hit regions. Finally, we show that in countries where terrorist attacks are present, a particular level of military expenditure over GDP is observed above which an increase in the number of arrivals can be seen. To be precise, this is when military expenditure over GDP is higher than 4.46%. Several examples can be found in 2016, such as Saudi Arabia (9.8%) or Israel (5.7%). Countries that tend to suffers attacks are definitely recommended to invest in military expenditure of above 4.46% over GDP if they want to improve tourism rates. If their military expenditure is not high enough, their budget efforts in avoiding the effects of terrorism on tourism will not be efficient. By not spending enough on military expenditure I posit that countries could even affect their tourism demand negatively, as resources are spent on the military instead of being invested in infrastructures or on other areas that might favor tourism.

Our findings show, not only the economic impact of terrorism on tourism, but also an important set of significant political, social and geographical assertions that have potential implications for policy makers who undertake counterterrorism measures with the objective of defending the tourism sector.

In the paper form the second thesis, “Terrorism in the Behavior of International Monthly Arrivals in the United States” we analyze the effect of terrorism on monthly international arrivals in the USA. Employing wavelet transformation tools and the vector auto regression model (VAR), we examined the dynamic relations between both time series for the period 1996 to 2016. Wavelet analysis offers localized frequency decomposition, providing information about frequency components over time (Gençay et al., 2002; Percival and Walden, 2000; Ramsey, 2002). The study relied on Monte

Carlo simulation to test if the similitude of the wavelet coherency is statistically significant (Schreiber and Schmitz, 1996).

We complete our analysis through a VAR model, which treats all the variables as endogenous. The objective is to determine what the causal relationship is between our variables through the Granger Causality test (Granger, 1969), and how the number of arrivals respond to the terror measure through the impulse response function.

Monthly number of arrivals to the U.S. have been used to measure the tourism demand for the country (NTTO, 2018). As we mention in the previous chapter, this measure is easier to count than to estimate tourism revenues in the destination country. Our explanatory variable will be the result of multiplying the number of terrorist attacks per month and the number of fatalities registered monthly. The objective is to measure both the number of events and their intensity in terms of the number of victims.

Our wavelet analysis results suggest that, in our high coherency period 2000-2004 (with significant values at 5%), terrorist attacks increase precede a decrease in total number of arrivals in the USA. Our results also show that when the terrorist attack occurs during the high coherency period 2000-2004, we observe a trend change in the effect of the attacks that goes from a short-term impact between 2.5 and 3.5 periods, to a long-term impact of the terrorist attacks over total international arrivals to the U.S. between 5 to 6.5 periods. Results of Granger Causality Tests after the VAR model provide evidence that terrorism explains the total number of arrivals to the USA. Finally, through the impulse response function from VAR estimation, we have found a negative response of tourism to terrorist events.

Our results corroborate the results and findings that other authors have documented in the literature through other statistical methods. As was expected, the influence of 9/11 attacks in New York City has a profound effect on the number of arrivals to the U.S., not only due to the direct effect on the national image and reputation abroad, but also due to the VISA limitations and security requirements, what made the country a less attractive travel destination (Lee et al., 2005; Blunk et al., 2006).

In the third part of our empirical work, “Terrorism and Oil Production Behavior in OPEC Countries”, we analyze how terrorist attacks affect the behavior of crude oil production in OPEP countries by studying its dynamics in the time-frequency domain through wavelet coherency methods. We mainly study wavelet coherence (with significant values at 5%), measuring the degree of local correlation between our two time series terrorist attacks and crude oil production in the time-frequency domain and the wavelet coherence phase differences (frequency band of analysis: 1.5-4 and 4.5-8 years). As previously mentioned, wavelet analysis techniques allow the evolution in time of the high and low frequency components to be detected in order to determine the trend in the short and long run time (Gençay et al., 2002; Percival and Walden, 2000; Ramsey, 2002). The study relied on Monte Carlo simulation to test if the similitude of the wavelet coherency is statistically significant (Schreiber and Schmitz, 1996).

The data we employ refers to the number of million oil barrels produced per month in OPEP countries for the period 1970 to 2016 (Bloomberg, 2018). Our independent variable is the number of terrorist incidents per month for each country for the identical period of time (Feridun, 2011; Neumayer, 2004).

We find evidence of three different sub-periods along the sample. First, 1976-1978, suggesting that terrorist attacks and OPEP oil production time series are out of phase (negative correlated) with terrorism heading. Hence, our results suggest that terrorist attack increases precede a decrease in OPEP oil production. This historical period could correspond with the effects of the global oil crisis of 1973. Second, 1988-1991, where both series are in phase, they move together, with terrorist attacks in OPEP countries leading to over oil production. Third, 2007-2009, where both series are in phase, they move together, with terrorist attacks leading and revealing a shorter-term impact over the oil production, reaching a maximum at the 3 year frequency band. For the first two high coherency regions, we observe a longer term impact of terrorism on oil production for OPEP countries; approximately of 7 to 8 years and 4.5 to 5.5 years respectively. This reduction through the years could be explained by the improvement in the policy tools available for these countries to use, which could have enabled them to respond to terrorist events more effectively.

As emphasized in the introduction, it would be also reasonable to extend this research to other influence groups in the oil industry or high producing countries such as the U.S. or Russia, even more so when the development of new production techniques such as fracking are gaining relevance in recent years, increasing worldwide oil reserves and modifying influence schemes.

Definitively, our empirical research tries to provide a better understanding of what the effects of terrorism are in the economy, in particular, its effects on highly relevant industries such as tourism and the oil industry. The develop of a tourism demand model which enables us to explain the behavior of the number of arrivals to countries which have suffered terrorist events with a global sample unable us to understand the way in which terrorism events, political, military and location factors affect tourism demand. The importance of quantifying the spill-over effect from regions affected by a terrorist event to other countries out or inside the hit regions, is also one of main achievements of the study. Moreover, the possibility of quantifying the percentage of military expenditure as a percentage of GDP that it is necessary to spend in order to improve the tourism rate is also one of the main contributions in the first chapter. All these results help to improve knowledge about the behavior of the tourism industry when a terrorist event occurs. Hence, the paper becomes a useful tool for governments and politicians who want to forecast and prevent the consequences of terrorism on tourism demand on a global scale.

The importance of the U.S. as an essential actor in the international scene and as a target for most of the terrorist activities, not only for the direct effects on its economy and policy, but also because of its influence on other countries, made this country an ideal study subject. The conclusions we obtained show that the September 11th attacks in New York generated a decrease in the number of international arrivals, damaging the USA image abroad and changing the preferences of travelers; especially from overseas.

The oil industry is determinant in all the economies in the World, even more so when there exists a strong dependent relationship on the part of developed countries and when it is also, in many cases, the leading economic sector in the majority of the major oil producing countries.

For all these reasons, we understand that it is crucial to analyze the relationship between terrorism and oil production in OPEP countries, precisely because most of its members are the main determinants of the global oil supply and they are located in regions that are historically prone to receive attacks or to suffer civil conflicts and wars.

Our results show the clear effect of terrorist activities on oil production for OPEP countries. However, we also observe that these countries seem to have improved their state structures, as the effects of these attacks have become shorter lasting in recent years. This means that better policy tools are being employed to face terror in OPEP countries, avoiding a long term effect of terrorism on oil production.

In conclusion, our study shows that terrorist events negatively affect the economy, in particular the tourism sector and the oil industry. The research also highlights the importance of studying terrorist effects in the economy, as numerous variables and actors are affected by terrorist activity with profound consequences for citizens and businesses all over the World. Our findings help to provide a better understanding of the behavior of the economies when terrorist event occurs, enabling greater efficiency in the decision-making process of governments and politicians.

Chapter 5

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