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Working Paper

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Economics of Security Working Paper, No. 17

Provided in Cooperation with:
German Institute for Economic Research (DIW Berlin)

Suggested Citation: Drakos, Konstantinos (2009) : The Determinants of Terrorist Shocks' Cross-Market Transmission, Economics of Security Working Paper, No. 17, Deutsches Institut für Wirtschaftsforschung (DIW), Berlin

This Version is available at:
https://hdl.handle.net/10419/119344

Economics of Security Working Paper Series

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September 2009

Economics of Security Working Paper 17

European Security Economics
EUSECON
www.economics-of-security.eu

Economics of Security is an initiative managed by DIW Berlin

Economics of Security Working Paper Series

Correct citation: Drakos, K. (2009). “The Determinants of Terrorist Shocks’ Cross-Market Transmission”. Economics of Security Working Paper 17, Berlin: Economics of Security.

First published in 2009

ISSN: 1868-0488

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The determinants of terrorist shocks' cross-market transmission

Konstantinos Drakos[*♣]

Abstract

The determinants of the cross-market transmission mechanism for terrorist shocks are explored, focusing on two major terrorist events and 68 national stock markets. We generate daily abnormal returns from a three-factor world asset pricing model. Abnormal returns are then regressed on proxies of three transmission mechanisms; a world integration channel, a bilateral integration channel, and a liquidity channel. Our findings indicate that terrorism shocks are diffused cross-nationally, and moreover this diffusion is non-uniform. We find empirical support for all three channels when considered separately. The bilateral integration channel contains the highest explanatory power since we find that a third country's trade linkages with the "ground-zero" country explain about 24 % of the stock market reaction. A country's share in the world trade, a proxy for the world integration channel, is able to explain about 12 % of abnormal return variation, while the liquidity channel exhibits the lowest predictive power, with the value of stock trading explaining about 6 %. A hybrid model, were proxies for all channels are included, shows that only the bilateral trade linkages with the "ground-zero" country are significant determinants of the stock market reaction.

Keywords: Linkages, Stock Market Return, Terrorism.

JEL: F36, F32, G15, C21, C23.

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[♣] The author acknowledges financial support by the 7th Framework Program (Grant Agreement 218105).

1. Introduction

In the post 9/11 era a new literature emerged, whose main aim has been to investigate various aspects of terrorism shocks' impacts on capital markets. The extant literature has established the significant - and immediate - negative reaction, to major terrorist attacks, of "ground-zero" countries' capital markets (Abadie and Gardeazabal 2003; Carter and Simkins 2004; Chen and Siems 2004; Drakos 2004; Eldor and Melnick 2004; Maillet and Michel 2005; Gulley and Sultan 2006; Amélie and Darné 2006; Nikkinen *et al*., 2008). This literature has also shown that significant negative reactions are also observed to third countries' markets.

However, an apparent gap in the literature, and in general of our understanding of the issue, relates to what is the underlying diffusion mechanism of major terrorist shocks. In other words, although we suspect that such shocks are indeed transmitted cross-nationally, we have no concrete evidence regarding the determinants of their cross-sectional variation. To put simply, we do not know why and how much third countries react in the occurrence of a major terrorist incident in another country. Clearly, providing an answer to this question would be of value for policy makers and supervision authorities, but more importantly for portfolio managers. Essentially, knowledge of these reaction patterns could assist portfolio managers in assessing whether diversification is possible. For instance, if terrorism shocks exhausted their effect within the "ground-zero" country, then they could be thought as being part of its idiosyncratic risk, and therefore able to be diversified away. If however terrorism shocks were diffused across markets, the diversification scope would depend on the pattern of diffusion. For instance the diversification gains would evaporate if shocks spread uniformly. In contrast, if shocks

are non-uniformly diffused, diversification would be possible, provided that one could pin down the basic anatomy of the transmission mechanism.

Casual empiricism suggests that major shocks, especially of an adverse nature, or crises, even if considered as being mainly local, tend to diffuse cross-nationally. This diffusion is known as contagion, broadly defined as the spread of market disturbances from one country to another. A burgeoning literature has provided the theoretical underpinnings for several alternative explanations for the spread of shocks from their original location (the "ground-zero" country) to third countries (for excellent and extensive reviews see Wolf 1999; Dornbusch *et al*., 2000). One explanation places emphasis on economic linkages, where essentially the spillover to a given third country depends on the degree of its integration with the world markets (Calvo and Reinhart 1996; Masson 1998; Forbes and Rigobon 2002). We hereafter call this diffusion mechanism the *world integration channel.* Another explanation that has been proposed, similar in spirit, suggests that the transmission of shock to a country is facilitated by its economic ties with the "ground-zero" country. We hereafter call this transmission mechanism *bilateral integration channel*. Another class of explanations highlights the role of various 'irrational' phenomena triggered by investors' behavior (Calvo and Mendoza 2001; Pritsker 2001; Kodres and Pritsker 2002). Among this class, we consider the role of liquidity constraints arising in the event of a major shock that may lead investors to sell assets in third countries to meet margin calls. Hence, according to this channel the contagion increases with a country's capital market liquidity. We hereafter call this contagion mechanism the *liquidity channel*.

In the present study we make a first attempt to explore the determinants of terrorist shock diffusion. In particular, focusing in the post 9/11 period, we model stock market reaction patterns across 68 countries on the days of two major terrorist events (Madrid attack, London attack). Reaction is measured by the daily abnormal return, controlling for a three-factor world asset pricing as well as distributed lags of domestic returns. Then the analysis investigates whether the three alternative transmission channels contain any significant explanatory power for abnormal returns.

Our empirical findings suggest that terrorism shocks are indeed diffused cross-nationally, and moreover this diffusion is non-uniform. In particular, we find empirical support for the world integration channel since trade and financial linkages to world markets emerge as important 'predictors' for a country's stock market reaction to terrorist events. Among the trade and financial linkages considered, a country's share in the world trade is able to explain the highest percentage of abnormal return variation in the occurrence of a major terrorist incident (about 12 %). Additionally, the bilateral integration channel is also in operation, where we find that a third country's trade linkages with the "ground-zero" country explain about 24 % of stock market reaction. Moreover we find empirical support for the liquidity channel with the value of stock trading explaining about 6 % of stock market reaction. A hybrid model including proxies for all three channels is able to explain about 24 % of abnormal return variation in the occurrence of major terrorist shocks.

The remainder of the paper is as follows. Section 2 provides the general setup within which one can model the transmission mechanism of terrorist shocks. Section 3 describes data sources, the construction of variables and their sample properties. Section

4 presents the econometric methodology. Section 5 discusses the empirical findings. Finally, in Section 6 we conclude.

2. Returns' generation and shock transmission

2.1 The baseline pricing framework

Our departure point is the asset pricing framework driving international stock market returns. The first building block is the standard Capital Asset Pricing Model (Sharpe 1964; Lintner 1965), where in an international context the global value-weighted market portfolio is the relevant risk factor (Grauer *et al*. 1976; Adler and Dumas 1983). Then we consider an international version of the three-factor model (Fama and French 1993, 1996) as follows:

$$E\left(r_{i,t}\right) = \lambda_{wmp}\beta_{i,wmp} + \lambda_{hml}\beta_{i,hml} + \lambda_{smb}\beta_{i,smb} \quad \textbf{(1)}$$

Where $E\left(r_{i,t}\right)$ is the expected return on stock index (i) at time (t) in excess of a risk-free rate, $\lambda_{wmp} = E\left(r_{wmp,t}\right)$, $\lambda_{hml} = E\left(r_{hml,t}\right)$, and $\lambda_{smb} = E\left(r_{smb,t}\right)$ are the risk premia of the World Market Portfolio, the High-minus-Low earnings-price ratio portfolio, and the Small-minus-Big market value portfolio respectively. Similarly, $\beta_{i,wmp}$, $\beta_{i,hml}$, and $\beta_{i,smb}$ are the betas of stock index (i), measuring its sensitivity to each of the risk factors.

This relationship becomes estimable when we allow for a stochastic shock that generates possibly non-spherical deviations from the long-run as follows:

$$\left(r_{i,t}\right) = r_{wmp,t}\beta_{i,wmp} + r_{hml,t}\beta_{i,hml} + r_{smb,t}\beta_{i,smb} + u_{i,t} \quad \textbf{(2)}$$

2.2 Introducing the terrorism shock

We define $\left(mgt_{gzc,t}\right)$ as an impulse dummy, which denotes the occurrence of a major terrorist incident on day $\left(t\right)$ and country $\left(gzc\right)$, *i.e* the "ground-zero" country, when attains the value of unity. In contrast, when $\left(mgt_{gzc,t}\right)$ attains the value of zero there is no major-terrorist event and therefore denotes 'normal' periods. Thus, in order to investigate whether third countries' markets react to the news of major terrorist attacks in another country, we allow the return generation process to differ between 'normal' periods (*i.e* in the absence of major terrorist events) and periods where such events occur. So returns are determined as follows:

$$r_{i,t} = r_{wmp,t}\beta_{i,wmp} + r_{hml,t}\beta_{i,hml} + r_{smb,t}\beta_{i,smb} + \gamma_i\left(mgt_{gzc,t}\right) + u_{i,t}, \quad \forall\ i \neq gzc \tag{3}$$

The parameter $\left(\gamma_i\right)$ captures the sensitivity of third countries' returns to the news of terrorist attack occurrence in another country and our prior is that it will carry a negative sign. Thus, provided that $\left(\gamma_i\right) < 0$, the realization of a terrorist shock will be diffused to third countries. Moreover, the returns in 'normal' periods (*i.e* in the absence of major terrorist events) are driven by fundamentals as described by a standard asset pricing model. In contrast during non-normal periods, although fundamentals continue to play a role, returns exhibit a transitory deviation from equilibrium. Hence, the following holds:

$$E\left(r_{i,t} \mid mgt_{gzc,t} = 1\right) - E\left(r_{i,t} \mid mgt_{gzc,t} = 0\right) = \gamma_i < 0, \qquad \forall\ i \neq gzc \tag{4}$$

This expression suggests that third countries' abnormal returns on days that major terrorist events occur are, on average, lower than returns on normal periods. This is a testable implication that we will explore later on.

2.3 A look into potential diffusion mechanisms

Recall that our main purpose is to investigate the determinants of third countries' stock market reactions to terrorism shocks. To tackle this issue we consider three types of potential transmission channels. The first focuses on a country's economic linkages with world markets and in particular considers trade and financial linkages. If a country has a high degree of real (trade) or financial linkages with global markets, it is expected to exhibit a more extensive response given a shock in another country. In contrast, countries that are not sufficiently integrated are to some extent immune to the shock (Calvo and Reinhart 1996; Masson 1998; Forbes and Rigobon 2002). The second brings to centre stage a country's relationship *vis-à-vis* the "ground-zero" country, and in particular considers their bilateral trade and financial linkages. The third emphasizes a country's stock market liquidity. The literature advocates that in the occurrence of a major terrorist event, causing downward pressure to a country's asset prices, market participants would benefit most from selling in highly liquid markets since this lowers the impact of their sell orders on prices. (Kodres and Pritsker 2001; Calvo and Mendoza 2001).

Going back to the return generation process, we investigate whether third countries' reaction to major terrorist events is explained by a given channel $\left(x_{i,t}\right)$. Then in the spirit of Bekaert and Harvey (1995, 1997), Ng (2000), Forbes and Rigobon (2002) and Bekaert *et al*. (2005), we allow third countries' sensitivity to be time-varying as follows:

$$\gamma_i = \delta_0 + \delta_{i,1}\left(x_{i,t}\right) \quad \textbf{(5)}$$

Then expression (3) becomes:

$$r_{i,t} = r_{wmp,t}\beta_{i,wmp} + r_{hml,t}\beta_{i,hml} + r_{smb,t}\beta_{i,smb} + \left[\delta_0 + \delta_{i,1}\left(x_{i,t}\right)\right]*\left(mgt_{gzc,t}\right) + u_{i,t} =$$

$$= r_{wmp,t}\beta_{i,wmp} + r_{hml,t}\beta_{i,hml} + r_{smb,t}\beta_{i,smb} + \delta_0\left(mgt_{gzc,t}\right) + \delta_{i,1}\left(x_{i,t}\right)*\left(mgt_{gzc,t}\right) + u_{i,t}$$

(6)

This expression nests various alternative possibilities regarding the diffusion of terrorist shocks, described below:

Case 1: major terrorism events do not affect third countries' capital markets; $\delta_0 = \delta_{i,1} = 0$

Case 2: major terrorist events affect third countries in a uniform manner, irrespectively of their exposure to each transmission channel; $\delta_0 < 0 \wedge \delta_{i,1} = 0$

Case 3: the diffusion of shocks is non-uniform and mirrors differential exposures to the transmission channel; $\delta_0 < 0,\ \delta_{i,1} < 0$

Suppose for the time being that the sign configuration shown in Case 3 is valid then it would imply that:

$$E\left(r_{i,t} \mid mgt_{gzc,t} = 1\right) - E\left(r_{i,t} \mid mgt_{gzc,t} = 0\right) = \delta_0 + \delta_{i,1}E\left(x_{i,t}\right) < 0, \qquad \forall\ i \neq gzc \qquad \textbf{(7)}$$

This expression has two testable implications: (a) third countries' abnormal returns (stock market reactions) are significantly lower on days of major terrorist events' occurrence, *i.e* terrorist shocks are diffused cross-nationally, and (b) the size of reaction (absolute magnitude of abnormal returns) increases with a country's exposure to a given channel.

3. Data issues

3.1 Returns and systematic risk factors

Daily closing prices from 1/1/2002 to 30/12/2005 in local currencies for broad stock market indices where obtained from **Datastream** for the following countries (detailed list of stock indices by country is provided in the Appendix, part A): Argentina, Australia, Austria, Bahrain, Belgium, Brazil, Bulgaria, Canada, Chile, Colombia, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Equador, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Korea, Kuwait, Latvia, Lebanon, Lithuania, Luxemburg, Malaysia, Malta, Mexico, Netherlands, New Zealand, Norway, Oman, Pakistan, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Saudi Arabia, Singapore, Slovakia, Slovenia, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Arab Emirates, United Kingdom, United States, and Venezuela.

Consider a vector of stock market index prices, $\left(I_{i,t}\right)$, where (i) and (t) denote country and day respectively. The daily return $\left(r_{i,t}\right)$ is calculated as follows:

$$\left(r_{i,t}\right)=\left[\frac{I_{i,t}-I_{i,t-1}}{I_{i,t-1}}\right]*100 \qquad \textbf{(8)}$$

The three benchmark portfolios denoting the risk factors are proxied by the global equity market portfolios maintained by World Morgan Stanley Capital International (MSCI World) indices as follows: $\left(r_{wmp,t}\right)$ defined as the return on the world market portfolio, $\left(r_{smb,t}\right)$ defined as the difference between the return on a world portfolio of small capitalization stocks and the return on a portfolio of large capitalization stocks (smb, small minus big), $\left(r_{hml,t}\right)$ defined as the difference between the return on a world

portfolio of high book-to-market stocks (value) and the return on low book-to-market (growth) stocks (hml, high minus low), which proxies the value or distress premium.

3.2 Construction of transmission channels' proxies

Let (i) denote the country and (y) the year. To measure a country's trade integration with world markets we use data from the IMF's **International Financial Statistics** (IFS) database**.** The IFS provides the value (in US Dollars) of trade (imports and exports) between a given country and all of its trading partners. Then for each country we calculate the sum of its exports $\left(X_{i,y}\right)$ and imports $\left(M_{i,y}\right)$, and measure what percentage it represented in global international trade $\left[\sum_{world}(M+X)_{i,y}\right]$:

$$trade_{i,y} = \left[\frac{(M+X)_{i,y}}{\sum_{world}(M+X)_{i,y}}\right] * 100 \qquad \textbf{(9)}$$

We also consider whether there are any differences between the explanatory powers of export and import linkages. In order to do so we construct the following variables:

$$imp_{i,y} = \left[\frac{(M)_{i,y}}{\sum_{world}(M)_{i,y}}\right] * 100 \qquad \textbf{(10)}$$

$$\exp_{i,y} = \left[\frac{(X)_{i,y}}{\sum_{world}(X)_{i,y}}\right] * 100 \qquad \textbf{(11)}$$

A country's financial linkages with world markets are based on the IMF's **Coordinated Portfolio Investment Survey** (CPIS) database, which provides information on the stock of cross-border holdings of securities (equity and debt securities) valued at

market prices prevailing at the end of each year, and broken down by the economy of residence of the issuer of the securities. Note that these securities are not part of the balance of payments data categories of direct investment, reserve assets, or financial derivatives. The CPIS provides information on the following: (i) inward $\left(eqin_{i,y}\right)$ and outward $\left(eqout_{i,y}\right)$ investment on equity securities, (ii) inward $\left(dein_{i,y}\right)$ and outward $\left(deout_{i,y}\right)$ investment in debt securities. In a manner similar to the trade linkages, we construct a proxy for the degree of a country's financial linkages with the world as follows:

$$fina_{i,y} = \left[\frac{\left[\left(eqin + eqout\right) + \left(dein + deout\right)\right]_{i,y}}{\sum_{world}\left[\left(eqin + eqout\right) + \left(dein + deout\right)\right]_{i,y}}\right] * 100 \quad \textbf{(12)}$$

We also construct alternative proxies by breaking total portfolio investment assets into equity and debt securities as follows:

$$equ_{i,y} = \left[\frac{\left[\left(eqin + eqout\right)\right]_{i,y}}{\sum_{world}\left[\left(eqin + eqout\right)\right]_{i,y}}\right] * 100 \quad \textbf{(13)}$$

$$debt_{i,y} = \left[\frac{\left[\left(dein + deout\right)\right]_{i,y}}{\sum_{world}\left[\left(dein + deout\right)\right]_{i,y}}\right] * 100 \quad \textbf{(14)}$$

In order to capture the linkages with the "ground-zero" country we resort to two metrics. The first captures bilateral trade linkages, and is defined as the percentage their bilateral imports and exports $\left(bitrade_{gzc}\right)_{i,y}$ represent to both countries' trade with the rest of the world; $\left\{\sum_{world}\left[\left(trade_{i,y}\right) + \left(trade_{gzc,y}\right)\right]\right\}$:

$$tradegzc_{i,y} = \left[\frac{\left(bitrade_{gzc}\right)_{i,y}}{\sum_{world}\left[\left(trade_{i,y}\right)+\left(trade_{gzc,y}\right)\right]} \right] * 100 \quad \textbf{(15)}$$

The data for the trade bilateral linkages were obtained from the United Nation's **Commodity Trade Statistics Database** (COMTRADE). The UN also compiles a similar database covering services trade, however there are severe limitations due to a substantial portion of missing data.

The second measures a country's overall financial linkages with the "ground-zero" country, defined as the percentage their bilateral financial linkages $\left(bifina_{gzc}\right)_{i,y}$ represent to both countries' financial linkages with the rest of the world; $\left\{\sum_{world}\left[\left(fina_{i,y}\right)+\left(fina_{gzc,y}\right)\right]\right\}$:

$$finagzc_{i,y} = \left[\frac{\left(bifina_{gzc}\right)_{i,y}}{\sum_{world}\left[\left(fina_{i,y}\right)+\left(fina_{gzc,y}\right)\right]} \right] * 100 \quad \textbf{(16)}$$

Using data from the World Bank's **World Development Indicators** we proxy a country's stock market liquidity by two alternative metrics; the stock market capitalization $\left(MC_{i,y}\right)$ as a ratio to gross domestic product, and the value of stock trading $\left(VT_{i,y}\right)$ as a ratio to gross domestic product.:

$$smc_{i,y} = \left(\frac{MC_{i,y}}{GDP_{i,y}} \right) * 100 \quad \textbf{(17)}$$

$$vst_{i,y} = \left(\frac{VT_{i,y}}{GDP_{i,y}} \right) * 100 \quad \textbf{(18)}$$

In Table 1 we report the basic descriptive statistics for the potential transmission channel proxies, while in Table 2 we report their pairwise sample correlations. Note the strong correlation between any pair of proxies belonging to the same channel, which is indicative of the commonality in information that precludes their joint inclusion as explanatory variables in any model. In contrast, the correlations of proxies between channels are substantially lower, allowing one to consider combinations of channels as regressors.

----------***Table 1***----------

----------***Table 2***----------

3.3 Identifying major terrorist attacks: the stimulus

Apparently there is no hard definition of what constitutes a major-terrorist incident and consequently some arbitrariness in the choice of events is in order. We use the following terrorist incidents: the Madrid attack on March 11th 2004 and the London attack on July 7th 2005. Table 3 provides some important background information related to these attacks.

----------***Table 3***----------

4. Econometric methodology

We use a flexible empirical specification whose core is a three-factor world model where, apart from the current values of the risk factors, we also include up to five lags to capture any non-synchronization in trading. In addition, we allow for a similar autoregressive structure for country returns. In order to capture any calendar anomalies we use fixed month and day effects, over and above year effects (Gibbons and Hess 1981; Jaffe and

Westerfield 1985; Kato and Shallheim 1985; Board and Sutcliffe 1988; Choudhry 2001). The employed baseline empirical model is of the following form:

$$\left(r_{i,t}\right)=\alpha_0+\left(\sum_{j=0}^{5}\beta_{wmp,j}r_{wmp,t-j}\right)+\left(\sum_{j=0}^{5}\beta_{smb,j}r_{smb,t-j}\right)+\left(\sum_{j=0}^{5}\beta_{hml,j}r_{hml,t-j}\right)+\left(\sum_{j=1}^{5}\phi_j r_{i,t-j}\right)$$

$$+\left(\text{year effects}\right)+\left(\text{month effects}\right)+\left(\text{day effects}\right)+\mu_i+\varepsilon_{i,t} \qquad \textbf{(19)}$$

Given the panel dimension we condition on country heterogeneity allowing for an unobserved effect μ_i treated as random, assuming that $E\left(r_{i,t-j}\mu_i\right)=0 \quad \forall\, i,j,t$.

A well established empirical regularity is the volatility clustering exhibited by daily returns (Engle 1982; Bollerslev 1986). Thus, in order to control for this we employ a Pooled Panel GARCH (PP-GARCH hereafter) model for the conditional volatility of stock returns (Cermeno and Grier 2006). Although multivariate GARCH models are also available, they are not practical for most panel applications because they require the estimation of a large number of parameters which consumes degrees of freedom rapidly. In contrast, PP-GARCH estimation by imposing common dynamics on the variance-covariance process across cross-sectional units reduces the number of parameters dramatically ensuring parsimony. We then allow a more flexible specification for the error term with:

$E\left(\varepsilon_{i,t}\right)=0$ and $E\left(\varepsilon_{i,t}^2\right)=\sigma_{i,t}^2$

In particular, assuming that $\varepsilon_{i,t}\sim N\left[0,\Omega_{i,t}\right]$, *i.e.* are multivariate normal error terms with a time-varying conditional variance-covariance matrix produces a PP-GARCH

model (Cermeno and Grier 2006). The variance-covariance matrix $\Omega_{i,t}$ is time-dependent and its diagonal and off-diagonal elements are given by the following equations:

$$\sigma_{i,t}^2 = \theta_0 + \sum_{n=1}^{N} \theta_n^* \sigma_{i,t-n}^2 + \sum_{l=1}^{L} \eta_l v_{i,t-l}^2$$

$$\sigma_{i,j,t} = \psi_0 + \sum_{n=1}^{p} \psi_n \sigma_{i,j,t-n} + \sum_{m=1}^{k} \rho_m v_{i,t-m} v_{j,t-m}, \quad \text{for } i \neq j \tag{20}$$

where the θ^*'s, ψ's, η's and ρ's denote unknown constant parameters to be estimated.

4.1 The effect of transmission channels

In order to investigate whether linkages contain significant information for abnormal returns, we recover the residuals $\left(\hat{\varepsilon}_{i,t} \mid mgt_{gzc,t} = 1\right)$ from model (19) focusing on the days of the two major terrorist events. It should be noted that due to the different time zones of countries included in the sample, one should correct for the non-synchronous trading. We have followed the standard practice of using the lag or the lead of the return for countries at different time zones accordingly. However, in order to avoid further complication of notation we denote all abnormal returns at time (t).

Let $\left(x_{m,i,t}\right)$ denote the possible reaction determinant where (m) denotes a particular transmission channel proxy. Then we project the residuals on each of these proxies allowing for up to a third-order polynomial to capture potential non-linearities:

$$\left(\hat{\varepsilon}_{i,t} \mid mgt_{gzc,t} = 1\right) = \gamma_0 + \sum_{s=1}^{3} \gamma_{m,s} \left(x_{m,i,t}\right)^s + u_{m,i,t} \tag{21}$$

After the estimation stage we proceed with three steps. Firstly, for each potential channel proxy, by the means of formal hypotheses testing, we establish the preferred

specification (*i.e* linear, quadratic or cubic). Secondly, we explore whether each type of linkages contains significant explanatory power over abnormal returns by testing:

$$H_0 : \gamma_{m,s} = 0, \ \forall \ m,s \qquad \textbf{(22)}$$

Provided that a particular set of hypotheses is rejected, it would imply that the associated channel of diffusion is in operation and furthermore, that the diffusion of terrorist shocks is non-uniformly distributed across countries. Thirdly we embark on a comparison between potential diffusion channels in terms of their relative explanatory power over abnormal returns.

5. Empirical results

5.1 Preliminary unconditional analysis

As a prelude to the subsequent econometric analysis we provide some descriptive statistics that will shed light in data properties. The sample mean of (pooled) realized returns excluding the days of major attacks was 0.092 % with a standard deviation of 1.26 %, while the corresponding figures on the days of these attacks were -0.409 % and 1.35 %. This information is indicative of large negative market reactions on days of major attack occurrences.

5.2 Main Results

Before we move to the investigation of our main hypotheses, we first estimate the parameters of the three-factor world model under a set of alternative techniques and specifications, with the aim to select the one which more adequately fits daily returns. In particular, we use a Random-Effects, and three Pooled Panel GARCH models; a PP-ARCH(1), a PP-ARCH(2) and a PP-GARCH(1,1) (estimation results are given in Table A1 in the Appendix, part B). The RE model is outperformed by its PP-GARCH

counterparts, since in every specification the parameters in the conditional volatility equation are highly significant, suggesting that volatility clustering is present. Then after a sequence of Likelihood Ratio tests, the PP-GARCH(1,1) emerges as the preferred specification.

Then, we recover the residuals obtained from the PP-GARCH(1,1) model, which we regress on each of the potential transmission channels, considering three competing specifications (a linear, a quadratic and a cubic). Based on formal hypotheses tests we selected the specification that best fitted the data (detailed results are provided in the in Tables A2-A6 in the Appendix, part B).

5.2.1 The role of the world integration channel

In Table 4 we report the results from projecting abnormal returns to proxies of the world integration channel corresponding to the selected specifications. All trade linkages' proxies contain significant explanatory power for abnormal returns. The relationship between abnormal returns and linkages is non-linear, and in particular is found to be cubic for overall trade and imports, while quadratic for exports. Turning now our attention to linkages' explanatory power (adjusted coefficient of determination) we find that overall trade linkages explain about 14.4 %, while imports and exports are able to explain about 14.5 % and 11 % of abnormal return variation.

----------***Table 4***---------

In Table 5 we report the results for the financial linkages with world markets. Total portfolio investment linkages account for 7 % of abnormal returns' variation. However, the decomposition of total financial linkages into its main constituents, equity

and debt linkages reveals that equity investment has a very poor explanatory power (about 2 %). In contrast, debt linkages explain about 8 % of abnormal return variation.

----------***Table 5***---------

Thus, among the proxies for the world integration channel considered, overall trade linkages have the highest explanatory power over cross-country stock market reactions.

5.2.2 The roles of the bilateral linkages and liquidity channels

In Table 6 we summarize the estimation results from regressing abnormal returns on proxies of the bilateral integration and liquidity channels. Trade linkages with the "ground-zero" country emerge as the most important determinant of stock market reaction, accounting for about 24 % of abnormal return variation. Financial linkages with the "ground-zero" countries are also significant, accounting for about 7 % of abnormal return variation. The estimated parameters indicate that, in the occurrence of a major terrorist event in a given country, third countries' stock market reaction increases with their ties with the "ground-zero" country.

As it regards to the liquidity channel, we find that abnormal returns are significantly correlated both with the stock market capitalization and the value of stock market trading. In particular, stock market capitalization explains about 5.5 % of stock market reactions while the value of trading about 6 %. These findings suggest that indeed more liquid markets tend to react more strongly as suggested by theory.

----------***Table 6***---------

5.2.3 A hybrid model for stock market reactions

Our estimation results suggest that all three transmission channels are in operation when considered separately. Now we construct a hybrid model that brings together all three with the aim to better fit observed stock market reactions. From each channel we select the proxy with the highest explanatory power provided that it is not collinear with the rest of the channel proxies, *i.e*. overall trade linkages with the world (world integration channel), trade linkages with the "ground-zero" country (bilateral integration channel) and stock market capitalization (liquidity channel). Table 7 summarizes the estimation results. The hybrid model accounts for 24 % of abnormal return variation, whose explanatory power is comparable to that obtained from trade linkages with the "ground-zero" country. The hypotheses tests for the significance of each channel, controlling for the presence of the other channels, indicate that only the bilateral integration channel is significant at all conventional levels.

----------***Table 7***---------

6. Conclusions

In the present study we make a first attempt to investigate the underlying cross-market transmission mechanism of major terrorist shocks, which has so far been unexplored. In particular, focusing in the post 9/11 period, we use two major terrorist events (Madrid and London attacks) and model stock market reaction patterns across 68 countries. Reaction is measured by the daily abnormal return, controlling for a three-factor world asset pricing, as well as distributed lags of domestic returns. Then the analysis investigates three potential channels for the cross-country diffusion of terrorist shocks: (i) integration with world markets, (ii) linkages vis-à-vis the "ground-zero" country, and (iii) stock market liquidity.

Our empirical findings suggest that terrorism shocks are indeed diffused cross-nationally, and moreover this diffusion is non-uniform. In particular, we find empirical support for the world integration channel since trade and financial linkages emerge as significant predictors for a country's stock market reaction to terrorist events. Among the trade and financial linkages considered, a country's share in world trade is able to explain the highest percentage of abnormal return variation in the occurrence of a major terrorist incident. The bilateral linkages channel is also active where third countries' trade linkages with the "ground-zero" country account for about 24 % of the cross-country variation in reaction to terrorist shocks. Moreover we find empirical support for the liquidity channel since stock market capitalization is also a significant determinant of stock market reaction. A hybrid model were all three channels are jointly included suggest that only bilateral trade linkages with the "ground-zero" country are significant determinants of stock market reaction.

These findings have important implications for supervision authorities but more importantly for portfolio managers. The non-uniform reaction to major terrorist shocks implies that there is ample scope for diversification. Future research could extend the set of explanatory variables including other structural country characteristics over and above linkages, such as market structure, ownership structure and liquidity. In addition, non-financial factors could also be explored, such as the impact of terrorism shocks on investor sentiment and risk aversion.

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Appendix

A. List of stock market indices / country:

Merval / Argentina, **ASX All Ordinaries Index** / Australia, **ATX** / Austria, **Bahrain Stock Exchange Index** / Bahrain, **BEL 20** / Belgium, **Bovespa** / Brazil, **BSE SOFIX** / Bulgaria, **S&P/TSX Composite Index** / Canada, **Chile General (IGPA)** / Chile, **IGBC Index** / Colombia, **CROBEX** / Croatia, **Cyprus General** / Cyprus, **Prague SE PX** / Czech Republic, **OMX Copenhagen** / Denmark, **ECU Price Index** / Ecuador, **Hermes Financial** / Egypt, **OMX Tallinn** / Estonia, **OMX Helsinki** / Finland, **CAC 40** / France, **DAX 30** / Germany, **Athex Composite** / Greece, **Hang Seng** / Hong Kong, **Budapest Index (BUX)** / Hungary, **OMX Iceland All Share** / Iceland, **BSE 100** / India, **Jakarta SE Composite** / Indonesia, **Ireland SE Overall** / Ireland, **Israel TA 100** / Israel, **Milan MIDEX** / Italy, **Nikkei 225** / Japan, **Amman SE Financial Market** / Jordan, **Korea SE Composite (KOSPI)** / Korea, **Kuwait KIC General** / Kuwait, **OMX Riga** / Latvia, **Lebanon Blom** / Lebanon, **OMX Vilnius** / Lithuania, **Luxemburg SE General** / Luxemburg, **KLCI Composite** / Malaysia, **MSE** / Malta, **Mexico IPC (BOLSA)** / Mexico, **AEX Index** / Netherlands, **NZX 50** / New Zealand, **Oslo Exchange All Share** / Norway, **Oman Muscat Securities** / Oman, **Karachi SE 100** / Pakistan, **Lima SE General (IGBL)** / Peru, **Phillipine SE (PSEI)** / Philippines, **Warsaw General Index** / Poland, **Portugal PSI General** / Portugal, **Doha Securities General Index** / Qatar, **BET Composite Index** / Romania, **Russia RTS Index** / Russian Federation, **All Share Index (TASI)** / Saudi Arabia, **Straits Times Index** / Singapore, **Slovak Share Index (SAX)** / Slovakia, **Slovene Stock Exchange Index (SBI 20)** / Slovenia, **Madrid SE General** / Spain, **Colombo SE All Share Index** / Sri Lanka, **OMX Stockholm** / Sweden, **Swiss Market Price Index** / Switzerland, **Taiwan SE Weighted** / Taiwan, **Bangkok SET Price Index** / Thailand, **ISE National 100** / Turkey, **Kinto KINDEX** / Ukraine, **Abu Dhabi All Securities Index** / United Arab Emirates, **FTSE All Share** / United Kingdom, **NYSE Composite** / United States, and **Venezuela SE General** / Venezuela.

B. Tables

Table A1. Baseline specification for daily stock returns: Three-Factor World Model (2002-2005)				
	Random Effects	**PP-ARCH(1)** [a]	**PP-ARCH(2)**	**PP-GARCH(1,1)**
Regressor	**Point estimate (z-score)** [b]			
	Mean equation			
$r_{wmp,t}$	0.292*** (6.27)	0.335*** (5.95)	0.246*** (5.05)	0.328*** (7.82)
$r_{wmp,t-1}$	0.555*** (6.05)	0.508*** (4.75)	0.430*** (4.30)	0.249*** (3.11)
$r_{wmp,t-2}$	-0.566*** (-5.16)	-0.445*** (-3.57)	-0.377*** (-3.29)	-0.231** (-2.37)
$r_{wmp,t-3}$	0.672*** (6.33)	0.547*** (4.87)	0.398*** (4.07)	0.321*** (3.37)
$r_{wmp,t-4}$	-0.595*** (-6.97)	-0.443*** (-5.03)	-0.267*** (-3.27)	-0.292*** (-3.96)
$r_{wmp,t-5}$	0.287*** (7.31)	0.202*** (4.62)	0.122*** (2.92)	0.157*** (4.91)
$r_{smb,t}$	-0.003 (-0.17)	-0.027 (-1.12)	-0.036 (-1.12)	-0.004 (-0.27)
$r_{smb,t-1}$	0.159*** (8.32)	0.178** (6.61)	0.194*** (8.86)	0.199*** (9.72)
$r_{smb,t-2}$	0.128*** (6.69)	0.141*** (6.12)	0.078** (2.58)	0.126*** (8.89)
$r_{smb,t-3}$	0.019 (0.98)	0.028 (1.22)	-0.001 (-0.09)	-0.008 (-0.47)
$r_{smb,t-4}$	-0.0001 (-0.01)	0.024 (1.22)	0.074* (1.83)	0.002 (0.18)
$r_{smb,t-5}$	0.010 (0.59)	-0.0162 (-0.58)	0.011 (0.60)	0.022 (1.49)
$r_{hml,t}$	0.054*** (6.59)	0.0483 (5.27)	0.025** (2.14)	0.028*** (4.29)
$r_{hml,t-1}$	0.139*** (3.22)	0.089* (1.74)	0.115** (2.50)	0.023 (0.64)
$r_{hml,t-2}$	-0.248*** (-4.35)	-0.209*** (-3.36)	-0.175*** (-2.75)	-0.084* (-1.70)
$r_{hml,t-3}$	0.316*** (5.22)	0.248*** (3.56)	0.171*** (2.78)	0.119** (2.10)
$r_{hml,t-4}$	-0.321*** (-5.97)	-0.257*** (-4.69)	-0.171*** (-3.40)	-0.171*** (-3.80)
$r_{hml,t-5}$	0.290*** (7.19)	0.198*** (4.31)	0.118*** (2.75)	0.143*** (4.41)
$r_{i,t-1}$	-0.013 (-1.47)	-0.062** (-2.34)	0.023* (1.88)	0.011 (1.44)
$r_{i,t-2}$	-0.010 (-0.67)	-0.037** (-2.05)	0.033* (1.96)	0.023** (2.31)
$r_{i,t-3}$	-0.013** (-2.24)	0.003 (0.28)	-0.015 (-1.59)	-0.019** (-2.17)
$r_{i,t-4}$	0.0043 (0.57)	0.001 (0.09)	-0.016 (-1.43)	-0.005 (-0.86)
$r_{i,t-5}$	-0.0077 (-1.09)	0.002 (0.19)	0.026** (2.35)	0.007 (0.77)
intercept	-0.0429 (-1.64)	-0.045** (-1.75)	-0.007 (-0.29)	0.0004 (0.02)

Year effects [c]	included	included	included	included
Month effects	included	included	included	included
Day effects	included	included	included	Included
Conditional Variance Equation				
ARCH(1)	-	0.416*** (12.84)	0.298*** (15.41)	0.147*** (16.20)
ARCH(2)	-	-	0.354*** (8.69)	-
GARCH(1)	-	-	-	0.857*** (90.05)
intercept	-	0.971*** (25.66)	0.652*** (34.10)	0.012*** (4.25)
Log Likelihood	-	-78155.37	-75874.70	-72791.05
LR Test [d]: PP-ARCH(2) vs. PP-ARCH(1)	4561.34***			
LR Test: PP-GARCH(1,1) vs. PP-ARCH(2)	6167.30***			
Observations	49918			

Notes: (a) PP-ARCH stands for Pooled Panel Autoregressive Conditional Heteroscedasticty, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) Year, Month, Day effects denote 3, 11, and 4 zero / one dummies identifying each year, month and day, (d) LR stands for Likelihood Ratio**.**

Table A2. World integration channel and abnormal returns I: Trade, Financial linkages [a, b, c]			
Panel A: Overall Trade linkages			
Regressor [d]	**Linear**	**Quadratic**	**Cubic**
$(trade)$	-0.046* (-1.70)	-0.178*** (-2.99)	-0.457*** (-4.58)
$(trade)^2$	-	0.006** (2.06)	0.042*** (4.22)
$(trade)^3$	-	-	-0.009*10^{-1}*** (-3.99)
R^2	0.028	0.079	0.144
Adjusted R^2	0.020	0.064	0.123
Observations	125	125	125
Hypotheses tests			
Cubic vs. linear [e]	-	-	9.59***
Cubic vs. quadratic [f]	-	-	15.88***
Quadratic vs. linear [g]	-	4.23**	-
Linkages not a diffusion channel [h]	2.90*	5.18***	8.35***
Panel B: Overall Financial linkages			
Regressor [i]	**Linear**	**Quadratic**	**Cubic**
$(fina)$	-0.037** (-2.08)	-0.080* (-1.86)	-0.364*** (-2.87)
$(fina)^2$	-	0.001 (1.49)	0.032** (2.40)
$(fina)^3$	-	-	-0.006*10^{-1}** (-2.28)
R^2	0.040	0.039	0.095
Adjusted R^2	0.019	0.021	0.069
Observations	111	111	111
Hypotheses Tests			
Cubic vs. linear	-	-	3.70**
Cubic vs. quadratic	-	-	5.21**
Quadratic vs. linear	-	2.22	-
Linkages not a diffusion channel	4.31**	2.12	12.82***

Notes: (a) dependent variable is the abnormal return obtained from the PP-GARCH(1,1) model, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) numbers in brackets denote t-tests based on robust standard errors, (d) $(trade)$ stands for overall trade linkages with the world, (e) F-test for the null hypotheses that the coefficients of the cubic and square terms are jointly zero, (f) F-test for the null hypothesis that the coefficient of the cubic term is zero, (g) F-test for the null hypothesis that the coefficient of the squared term is zero, (h) F-test for model overall significance, (i) $(fina)$ stands for overall financial linkages with the world.

Table A3. World integration channel and abnormal returns II: Imports, Exports [a, b, c]			
Panel A: Imports			
Regressor [d]	**Linear**	**Quadratic**	**Cubic**
(imp)	-0.098** (-2.00)	-0.257** (-2.54)	-0.928*** (-4.65)
$(imp)^2$	-	0.013** (2.20)	0.170*** (4.38)
$(imp)^3$	-	-	-0.006*** (-4.28)
R^2	0.033	0.061	0.145
Adjusted R^2	0.025	0.046	0.124
Observations	125	125	125
Hypotheses Tests			
Cubic vs. linear [e]	-	-	9.85***
Cubic vs. quadratic [f]	-	-	18.32***
Quadratic vs. linear [g]	-	4.83**	-
Linkages not a diffusion channel [h]	3.99**	3.21**	25.82***
Panel B: Exports			
Regressor [i]	**Linear**	**Quadratic**	**Cubic**
$(\exp)$	-0.077 (-1.37)	-0.507** (-3.86)	-0.608*** (-2.54)
$(\exp)^2$	-	0.046*** (3.47)	0.078 (1.34)
$(\exp)^3$	-	-	-0.002 (-0.57)
R^2	0.020	0.111	0.113
Adjusted R^2	0.012	0.097	0.091
Observations	125	125	125
Hypotheses Tests			
Cubic vs. linear	-	-	6.05***
Cubic vs. quadratic	-	-	0.32
Quadratic vs. linear	-	12.05***	-
Linkages not a diffusion channel	1.87	7.65***	5.07***

Notes: (a) dependent variable is the abnormal return obtained from the PP-GARCH(1,1) model, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) numbers in brackets denote t-tests based on robust standard errors, (d) (imp) stands for import linkages with the world (e) F-test for the null hypotheses that the coefficients of the cubic and square terms are jointly zero, (f) F-test for the null hypothesis that the coefficient of the cubic term is zero, (g) F-test for the null hypothesis that the coefficient of the squared term is zero, (h) F-test for model overall significance, (i) $(\exp)$ stands for export linkages with the world.

Table A4. World integration channel and abnormal returns III: Equity, Debt [a, b, c]			
Panel A: Equity			
Regressor [d]	**Linear**	**Quadratic**	**Cubic**
(equ)	-0.034** (-2.25)	-0.076** (-2.01)	-0.217** (-2.18)
$(equ)^2$	-	0.001 (1.63)	0.015 (1.63)
$(equ)^3$	-	-	-0.002*10^{-1} (-1.51)
R^2	0.028	0.041	0.066
Adjusted R^2	0.019	0.023	0.040
Observations	111	111	111
Hypotheses Tests			
Cubic vs. linear [e]	-	-	2.32
Cubic vs. quadratic [f]	-	-	2.27
Quadratic vs. linear [g]	-	2.66	-
Linkages not a diffusion channel [h]	5.08**	3.95**	14.10***
Panel B: Debt			
Regressor [i]	**Linear**	**Quadratic**	**Cubic**
$(debt)$	-0.036* (-1.77)	-0.099** (-1.99)	-0.410*** (-3.39)
$(debt)^2$	-	0.003 (1.51)	0.037*** (3.06)
$(debt)^3$	-	-	-0.008*10^{-1}*** (-2.95)
R^2	0.026	0.041	0.106
Adjusted R^2	0.017	0.024	0.080
Observations	111	111	111
Hypotheses Tests			
Cubic vs. linear	-	-	4.89***
Cubic vs. quadratic	-	-	8.73***
Quadratic vs. linear	-	2.29	-
Linkages not a diffusion channel	3.14*	2.18	13.66***

Notes: (a) dependent variable is the abnormal return obtained from the PP-GARCH(1,1) model, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) numbers in brackets denote t-tests based on robust standard errors, (d) (equ) stands for equity linkages with the world, (e) F-test for the null hypotheses that the coefficients of the cubic and square terms are jointly zero, (f) F-test for the null hypothesis that the coefficient of the cubic term is zero, (g) F-test for the null hypothesis that the coefficient of the squared term is zero, (h) F-test for model overall significance, (i) $(debt)$ stands for debt linkages with the world.

Table A5. Bilateral integration channel and abnormal returns III: Trade, Financial [a, b, c]			
Panel A: Trade			
Regressor [d]	**Linear**	**Quadratic**	**Cubic**
$(tradegzc)$	-0.323*** (-2.72)	-1.165*** (-2.92)	-3.042*** (-6.18)
$(tradegzc)^2$	-	0.203* (1.89)	1.331*** (5.46)
$(tradegzc)^3$	-	-	-0.155*** (-5.19)
R^2	0.081	0.147	0.261
Adjusted R^2	0.073	0.133	0.242
Observations	121	121	121
Hypotheses Tests			
Cubic vs. linear [e]	-	-	15.05***
Cubic vs. quadratic [f]	-	-	26.93***
Quadratic vs. linear [g]	-	3.56*	-
Linkages not a diffusion channel [h]	7.40***	8.14***	18.50***
Panel B: Financial			
Regressor [i]	**Linear**	**Quadratic**	**Cubic**
$(finagzc)$	-0.165 (-1.56)	-0.442 (-1.51)	-1.740*** (-3.25)
$(finagzc)^2$	-	0.074 (1.11)	0.920*** (2.81)
$(finagzc)^3$	-	-	-0.123** (-2.57)
R^2	0.026	0.038	0.101
Adjusted R^2	0.015	0.016	0.070
Observations	91	91	91
Hypotheses Tests			
Cubic vs. linear	-	-	4.20**
Cubic vs. quadratic	-	-	6.62**
Quadratic vs. linear	-	1.22	-
Linkages not a diffusion channel	2.44	1.45	4.15***

Notes: (a) dependent variable is the abnormal return obtained from the PP-GARCH(1,1) model, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) numbers in brackets denote t-tests based on robust standard errors, (d) $(tradegzc)$ stands for bilateral trade linkages with the "ground-zero" country (e) F-test for the null hypotheses that the coefficients of the cubic and square terms are jointly zero, (f) F-test for the null hypothesis that the coefficient of the cubic term is zero, (g) F-test for the null hypothesis that the coefficient of the squared term is zero, (h) F-test for model overall significance, (i) $(finagzc)$ stands for bilateral financial linkages with the "ground-zero" country.

Table A6. Liquidity channel and abnormal returns III: Stock market capitalization, value of stock trading [a, b, c]

Panel A: Stock market capitalization			
Regressor [d]	**Linear**	**Quadratic**	**Cubic**
(smc)	-0.002** (-2.43)	-0.009** (-2.39)	-0.026*** (-3.03)
$(smc)^2$	-	$0.002*10^{-2}$ * (1.98)	$0.001*10^{-1}$ *** (2.65)
$(smc)^3$	-	-	$-0.002*10^{-4}$ ** (-2.48)
R^2	0.025	0.047	0.077
Adjusted R^2	0.017	0.032	0.055
Observations	125	125	125
Hypotheses Tests			
Cubic vs. linear [e]	-	-	3.95**
Cubic vs. quadratic [f]	-	-	6.15**
Quadratic vs. linear [g]	-	3.90*	-
Linkages not a diffusion channel [h]	5.89**	3.59**	4.77***
Panel B: Value of stock trading			
Regressor [i]	**Linear**	**Quadratic**	**Cubic**
(vst)	-0.005*** (-2.98)	-0.010*** (-3.01)	-0.014* (-1.72)
$(vst)^2$	-	$0.002*10^{-2}$ ** (2.31)	$0.0007*10^{-1}$ (0.92)
$(vst)^3$	-	-	$-0.0001*10^{-3}$ (-0.66)
R^2	0.059	0.075	0.078
Adjusted R^2	0.052	0.060	0.055
Observations	125	125	125
Hypotheses Tests			
Cubic vs. linear	-	-	2.91*
Cubic vs. quadratic	-	-	0.44
Quadratic vs. linear	-	5.34**	-
Linkages not a diffusion channel	8.88***	5.93***	4.90***

Notes: (a) dependent variable is the abnormal return obtained from the PP-GARCH(1,1) model, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) numbers in brackets denote t-tests based on robust standard errors, (d) (smc) stands for the ratio of stock market capitalization to GDP, e) F-test for the null hypotheses that the coefficients of the cubic and square terms are jointly zero, (f) F-test for the null hypothesis that the coefficient of the cubic term is zero, (g) F-test for the null hypothesis that the coefficient of the squatted term is zero, (h) F-test for model overall significance, (i) (vst) stands for the ratio of value of stock trading to GDP.

Tables

Table 1. Descriptive statistics (time period 2002-2005)					
World integration channel					
Proxy [a, b, c, d, e]	Mean [f]	Std. Dev.	Min	Max	Obs
$(trade)$	2.98	4.77	0.08	29.47	133
(imp)	1.47	2.65	0.04	18.06	133
$(\exp)$	1.48	2.25	0.02	11.41	133
$(fina)$	3.16	6.46	0.003	38.27	109
(equ)	3.34	7.48	0.001	47.50	109
$(debt)$	3.04	5.99	0.001	31.88	109
Bilateral integration channel					
$(tradegzc)$	0.68	1.08	0.01	5.69	127
$(finagzc)$	0.81	1.41	0.00	9.54	100
Liquidity channel					
(smc)	77.93	71.17	3.00	401.00	133
(vst)	49.64	61.75	0.00	350.00	132

Notes: (a) $(trade), (imp), (\exp)$ stand for overall trade, import, and export linkages with the world respectively, (b) $(fina), (equ), (debt)$ stand for overall financial, equity and debt linkages with the world respectively, (c) $(tradegzc), (finagzc)$ stand for bilateral trade and financial linkages with the "ground-zero" country respectively, (d) $(smc), (vst)$ stand for the ratio of stock market capitalization and value of stock trading to GDP respectively, (e) Original data sources: $(trade), (imp), (\exp)$; IMF's **International Financial Statistics**, $(fina), (equ), (debt)$; IMF's **Coordinated Portfolio Investment Survey**, $(tradegzc), (finagzc)$; UN's **Commodity Trade Statistics Database**, $(smc), (vst)$; World Bank's **World Development Indicators**, and own calculations, (f) Mean, Std. Dev, Min, Max, Obs, stand for the sample mean, standard deviation, maximum, minimum, and number of observations respectively.

Table 2. Sample correlation matrix of diffusion channel proxies [a, b, c, d]

	$(trade)$	(imp)	$(\exp)$	$(fina)$	(equ)	$(debt)$	$(tradegzc)$	$(finagzc)$	(smc)	(vst)
$(trade)$	1.00	-	-	-	-	-	-	-	-	-
(imp)	0.96	1.00	-	-	-	-	-	-	-	-
$(\exp)$	0.96	0.87	1.00	-	-	-	-	-	-	-
$(fina)$	0.85	0.92	0.78	1.00	-	-	-	-	-	-
(equ)	0.76	0.89	0.68	0.97	1.00	-	-	-	-	-
$(debt)$	0.87	0.92	0.82	0.98	0.92	1.00	-	-	-	-
$(tradegzc)$	0.44	0.28	0.35	0.27	0.17	0.33	1.00	-	-	-
$(finagzc)$	0.46	0.40	0.37	0.47	0.42	0.48	0.58	1.00	-	-
(smc)	0.11	0.21	0.07	0.21	0.27	0.15	-0.05	0.15	1.00	-
(vst)	0.35	0.52	0.37	0.48	0.51	0.44	0.18	0.26	0.65	1.00

Notes: (a) $(trade)$, (imp), $(\exp)$ stand for overall trade, import, and export linkages with the world respectively, (b) $(fina)$, (equ), $(debt)$ stand for overall financial, equity and debt linkages with the world respectively, (c) $(tradegzc)$, $(finagzc)$ stand for bilateral trade and financial linkages with the "ground-zero" country respectively, (d) (smc), (vst) stand for the ratio of stock market capitalization and value of stock trading to GDP respectively.

Table 3: Background information on major terrorist attacks used as stimulus

City	Date	Timing	Location	Deaths	Injuries
Madrid	March 11th 2004	7:37 am local time (6:37 am GMT)	Train stations	191	1876
London	July 7th 2005	8:50 – 9:47 am local time	Underground trains, bus	54	700

Notes: Source "Patterns of Global Terrorism: Part 4 Chronology of Significant Terrorist Events 1985-2005", U.S. Department of State, 2005.

Table 4. World integration channel and abnormal returns I: trade linkages [a, b, c, d]			
Parameter / Diffusion channel proxy [e]	$(trade)$	(imp)	$(\exp)$
$\gamma_{m,1}$	-0.457*** (-4.58)	-0.928*** (-4.65)	-0.507** (-3.86)
$\gamma_{m,2}$	0.042*** (4.22)	0.170*** (4.38)	0.046*** (3.47)
$\gamma_{m,3}$	$-0.009*10^{-1}$ *** (-3.99)	-0.006*** (-4.28)	-
R^2	0.144	0.145	0.111
Adjusted R^2	0.123	0.124	0.097
Observations	125	125	125
Diffusion channel not in operation [h]	8.35***	25.82***	7.65***

Notes: (a) dependent variable is the abnormal return obtained from the PP-GARCH(1,1) model, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) numbers in brackets denote t-tests based on robust standard errors, (d) each column reports the estimation results from the preferred specification (full results for the linear, quadratic and cubic models are provided in the Appendix, (e) $(trade)$, (imp), $(\exp)$ stand for overall trade, import, and export linkages with the world respectively, (f) F-test for the null hypotheses that the coefficients of the cubic and square terms are jointly zero, (g) F-test for the null hypothesis that the coefficient of the cubic term is zero, (h) F-test for model overall significance.

Table 5. World integration channel and abnormal returns II: financial linkages [a, b, c, d]			
Parameter / Diffusion channel proxy [e]	$(fina)$	(equ)	$(debt)$
$\gamma_{m,1}$	-0.364*** (-2.87)	-0.034** (-2.25)	-0.410*** (-3.39)
$\gamma_{m,2}$	0.032** (2.40)	-	0.037*** (3.06)
$\gamma_{m,3}$	-0.006*10^{-1}** (-2.28)	-	-0.008*10^{-1}*** (-2.95)
R^2	0.095	0.028	0.106
Adjusted R^2	0.069	0.019	0.080
Observations	111	111	111
Diffusion channel not in operation [h]	12.82***	5.08***	13.66***

Notes: (a) dependent variable is the abnormal return obtained from the PP-GARCH(1,1) model, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) numbers in brackets denote t-tests based on robust standard errors, (d) each column reports the estimation results from the preferred specification (full results for the linear, quadratic and cubic models are provided in the Appendix, (e) $(fina)$, (equ), $(debt)$ stand for overall financial, equity and debt linkages with the world respectively , (f) F-test for the null hypotheses that the coefficients of the cubic and square terms are jointly zero, (g) F-test for the null hypothesis that the coefficient of the cubic term is zero, (h) F-test for model overall significance.

Table 6. Bilateral integration, Liquidity channels and abnormal returns [a, b, c, d]				
Diffusion channel	**Linkages with "ground-zero" country** [e]		**Liquidity** [f]	
Parameter / Diffusion channel proxy	$(tradegzc)$	$(finagzc)$	(smc)	(vst)
$\gamma_{m,1}$	-3.042*** (-6.18)	-1.740*** (-3.25)	-0.026*** (-3.03)	-0.010*** (-3.01)
$\gamma_{m,2}$	1.331*** (5.46)	0.920*** (2.81)	$0.001*10^{-1}$*** (2.65)	$0.002*10^{-2}$** (2.31)
$\gamma_{m,3}$	-0.155*** (-5.19)	-0.123** (-2.57)	$-0.002*10^{-4}$** (-2.48)	-
R^2	0.261	0.101	0.077	0.075
Adjusted R^2	0.242	0.070	0.055	0.060
Observations	121	91	125	125
Diffusion channel not in operation [i]	18.50***	4.15***	4.77***	5.93***

Notes: (a) dependent variable is the abnormal return obtained from the PP-GARCH(1,1) model, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) numbers in brackets denote t-tests based on robust standard errors, (d) each column reports the estimation results from the preferred specification (full results for the linear, quadratic and cubic models are provided in the Appendix, (e) $(tradegzc)$, $(finagzc)$ stand for bilateral trade and financial linkages with the "ground-zero" country respectively, (f) (smc), (vst) stand for the ratio of stock market capitalization and value of stock trading to GDP respectively, (g) F-test for the null hypotheses that the coefficients of the cubic and square terms are jointly zero, (h) F-test for the null hypothesis that the coefficient of the cubic term is zero, (i) F-test for model overall significance.

Table 7. Hybrid model for abnormal returns [a, b, c]	
Regressor [d]	**Point estimate (t-test)**
$(trade)$	-0.120 (-0.85)
$(trade)^2$	0.017 (1.29)
$(trade)^3$	$-0.004*10^{-1}$ (-1.43)
$(tradegzc)$	-2.671^{***} (-4.33)
$(tradegzc)^2$	1.161^{***} (4.21)
$(tradegzc)^3$	-0.138^{***} (-4.28)
(smc)	-0.013 (-1.49)
$(smc)^2$	$0.008*10^{-2}$ (1.60)
$(smc)^3$	$-0.001*10^{-4}$ * (-1.72)
R^2	0.297
Adjusted R^2	0.240
Observations	121
Hypotheses Tests	
World integration channel not a diffusion mechanism [e]	1.12
Bilateral integration channel not a diffusion mechanism [f]	9.69^{***}
Liquidity channel not a diffusion mechanism [g]	1.70
Overall significance [h]	7.72^{***}

Notes: (a) dependent variable is the abnormal return obtained from the PP-GARCH(1,1) model, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) numbers in brackets denote t-tests based on robust standard errors, (d) $(trade)$, $(tradegzc)$, and (smc) stand for overall trade linkages with the world, bilateral trade linkages with the "ground-zero" country, and stock market capitalization over GDP respectively, (e) F-test for the null hypothesis that the coefficients of $(trade)$, $(trade)^2$, $(trade)^3$ are jointly zero, (f) F-test for the null hypotheses that the coefficients of $(tradegzc), (tradegzc)^2$, $(tradegzc)^3$ are jointly zero, (g) F-test for the null hypothesis that the coefficients of $(smc), (smc)^2$, $(smc)^3$ are jointly zero, (h) F-test for model overall significance.