DISCUSSION PAPER SERIES

No. 7946

TERRORISM NETWORKS AND TRADE: DOES THE NEIGHBOR HURT?

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INTERNATIONAL TRADE AND REGIONAL ECONOMICS

Centre for Economic Policy Research

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ISSN 0265-8003

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Discussion Paper No. 7946
August 2010

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CEPR Discussion Paper No. 7946

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ABSTRACT

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JEL Classification: F12 and F13
Keywords: security, terrorism and trade

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* This paper has circulated so far with a slightly different title “Terrorism and Trade: Does the Neighbor hurt?” We are grateful to James Anderson, Brock Blomberg, Bruce Blonigen, Gregory Hess, Thierry Mayer, Fergal McCann, Marta Reynal-Querol, Mathias Thoenig for their valuable comments and suggestions. We also wish to thank seminar participants at the CEPR-PSE workshop on “Conflicts, Globalization and Development”, U. of Barcelona (EEA), INRA Rennes, U. of Geneva and U. of Tours for their helpful comments. Mirza thanks the CIREM for financial support.

Submitted 14 July 2010

Terrorism Networks and Trade: Does the Neighbor Hurt?*

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June 2010

Abstract

In this paper, we study the impact of transnational terrorism diffusion on security and trade. We set up a simple theoretical model predicting that the closer a country is to a source of terrorism, the higher the negative spillovers on its trade. The idea is that security measures, which impede trade, are directed both against the source country of terror and its neighbor countries where terrorism may diffuse. In contrast, we demonstrate that countries located far from terror could benefit from an increase in security by trading more. Taken to the test, we empirically document these predictions. We find (1) a direct negative impact of transnational terrorism on trade; (2) an indirect negative impact emanating from terrorism of neighbor countries; and (3) that trade is increasing with remoteness to terror. These results are robust to various definitions of the neighboring relationships among countries.

Keywords: Terrorism, trade, security.

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1 Introduction

The last few decades have seen a geographic expansion of terrorist organizations. They now operate in areas that are located thousands of miles away from their origin territory. For instance, Al-Qaeda, originally based in Saudi Arabia, extends

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its network as far as North Africa.[1] Al-Qaeda's expansion is not limited to the Arab World, however. To gain visibility and logistical support, local groups in Non-Arab countries, such as Abu Sayyaf in the Philippines, are increasingly linked to the Al-Qaeda network. Very recently, an Uzbek group, a sort of joint venture of Al-Qaeda and the Taliban, has expanded overseas to establish a terrorist cell in Turkey. This Turkish cell, called the Islamic Jihad Union, aims to recruit nationals and emigrants in European countries for Al-Qaeda's global Jihad [see Steinberg (2008)].

The aim of this paper is to study the impact of transnational diffusion of terrorism on security measures and international trade. As terrorist threats become global, so do the security measures designed by the targeted countries. For instance, the Homeland Security Bill voted by the American congress will impose, by 2012, 100% scanning of containers in foreign ports bound to the U.S. This global security measure is supposed to affect all exporting countries to the U.S. alike. However, a Customs Trade Partnership Against Terrorism and a Container Security Initiative have been implemented to insure faster customs clearing at the U.S. entry for the safest exporting companies. This might induce a distortive effect on trade costs. In fact, the companies, which can bear the costs of the new security measures, are more usually found in developed countries rather than in developing countries.

Global security measures are also accompanied by targeted measures, directed against particular areas or countries. A quick glance at the cross-country differences in the number of U.S. nonimmigrant visas issued to foreign nationals offers an indirect evidence of such measures. In 2002, after the 9/11 attack, almost all of the countries experienced a reduction in visa allowances but some countries have been more affected than others [Cainkar (2004)].[2] The U.S. State Department's Country Reports reveal another piece of evidence for targeted measures of protection. The online day-to-day updated figures, provided to future travelers out of the U.S., support the idea that countries hosting terrorist organizations or their cells, should be

[1]The Algerian-based Salafist Group for Preaching and Combat (SGPC) and the Libyan-based Islamic Fighting Group have joined the Al-Qaeda network in the name of a global Jihad. The SGPC has even changed his name to 'Al-Qaeda in the Islamic Maghreb', announcing its willingness to extend its activities to the other Maghreb countries [see Steinberg and Werenfels (2007)].

[2]On average, Europeans and Asians experienced a 15 and 23% decrease, respectively. Muslim countries experienced a 40% decrease with a large variance: from a - 1% for Eritrea to - 67% for Saudi Arabia.

watched more carefully.[3]

We build a simple theoretical framework of endogenous spatial diffusion of transnational terrorism and security, embedded in a standard new trade theory model. The structure of the terrorism-security framework is fairly simple. The 'headquarter' of a terrorist organization, based in a source country of terrorism, can settle a terrorist cell abroad, say in country z. The purpose of this settlement is to launch an attack against a third country, say U. The ability to settle the cell overseas depends on fixed costs that are increasing with distance to the headquarter. In reaction, authorities of the targeted country U can take optimal security measures against the potential country of settlement z, based on expectations about the terrorist's efficiency. From the game between the terrorist headquarter and security authorities, we obtain that the diffusion of terrorism is conditional upon the distance of z to the headquarter, the terrorist's efficiency and the optimal level of security.

The diffusion of transnational terrorism has spillover implications for trade between U and the potential countries of settlement z. Imposing security measures against people and goods from country z, such as security checks or visa restrictions, is likely to increase trade costs. This implies that the closer a country z is to the terrorist headquarter, the higher the level of security directed against z and the lower its trade with U. However, 'safe' countries (i.e. located far enough from the headquarter) could instead increase their trade with U. The logic is very similar to the inward multilateral resistance effect of Anderson and Van Wincoop (2003). Exports of safe countries into U is increased by high barriers to trade (here, high security measures) set against unsafe source countries of terrorism.

To investigate empirically the predictions of our model, we lack precise data on the location of the headquarter of terrorist organizations. On the other hand, we have information on the source countries of terrorism, which potentially host a headquarter. Then, given the possible diffusion of terrorism (from the source country) to z, we analyze whether trade between z and U is affected by the distance of z to the source country of terrorism. In particular, the closer is z to the source country of terrorism, the higher the supported security measures, and the lower its

[3]See http://travel.state.gov/travel/.

trade with U.

We use the United States as the targeted country U for two reasons. First, it has been the main target of transnational terrorism for the last 40 years. Since the beginning of the nineties, it has been involved in nearly half of total transnational terrorist incidents.[4] Second, the U.S. has been attacked by a large number of different source countries. It is associated with the largest variation across source countries of terrorism.

In the data, we consider a broad interpretation of proximity to terrorism and two different types of measures. The first type is discrete and linked to sharing some characteristics with the source country of terrorism, such as a border, a language or a religion. We argue that the more characteristics a country shares with the source country of terrorism, the closer their neighborly relationship. The second type of measure is taken to be continuous and based on a weighted geodesic distance to source countries of terrorism. This variable suggests that the closer to the source of terrorist incidents a country is, the higher its potential to host incidents itself.

Our empirical analysis employs a large data set of U.S. bilateral imports at the product level. The use of such disaggregated trade data reduces the potential endogeneity between terrorism and trade. In contrast, the theoretical literature suggests that *aggregate* trade affects terrorism activity [see Anderson (2008) and Mirza and Verdier (2006)]. This is because a country's openness to trade might shift resources away from informal sectors, increasing the opportunity cost of engaging in terror activities and pushing labor to more formal sectors. We use fine disaggregated trade data to avoid this potential endogeneity.

Using a gravity-type model of disaggregated trade, we get some noticeable effects of transnational terrorism on U.S. bilateral imports on the period 1993-2006. We find a direct negative impact of terrorism: on average U.S. imports from the source country of terrorism decrease by about 2 percent for every additional incident perpetrated by this country against the U.S. This result is in line with the literature on trade and terrorism [see Blomberg and Hess (2006) and Mirza and Verdier (2008) for

[4] Information on terrorists incidents come from the ITERATE data set which reports transnational terrorist incidents [Mickolus *et al.* (2003)]. See the data section B for details.

a survey]. It also echoes the results of recent works on trade and "insecurity", such as corruption or imperfect contract enforcement [Anderson and Marcouiller (n.d.) and (2002)]. As in our paper, Mirza and Verdier (2006) investigate the relationship between trade, terrorism and security measures. However, they view the terrorism threat as being confined in one source country at a time. We allow instead for the terrorism threat to diffuse across countries. This brings two additional results. First, we find that, when defining proximity to terrorism as a discrete measure, the negative spillover impact on one country's trade is almost as large as the direct impact of terrorism on trade. That is, U.S. imports from one country are reduced by about 1.8 percent for every additional incident perpetrated by terrorist organizations originating from neighboring countries. Besides, when considering the continuous variable of proximity to terrorism, we obtain qualitatively the same results. Finally, we also find that the impact is not neutral on sufficiently remote countries from terror. As expected from our theory, and in line with the Anderson and Van Wincoop (2003) multilateral resistance effect, we document positive spillovers on trade of safe countries, i.e. located far enough from source countries of terrorism.

The rest of the paper is structured as follows. In section 2, we set a simple theoretical framework of endogenous spatial diffusion of terrorism and security, embedded into a new standard trade model. In section 3, we explain the empirical strategy and present data on terrorism. In section 4, we present the benchmark econometric results and robustness checks. Finally, in section 5, we conclude. (The Appendix B reports data details.)

2 A simple model of Trade, Spatial diffusion of Terrorism and Security

In this section we present the basic elements of a simple model of trade, spatial diffusion of transnational terrorism and security. There are two types of countries that are engaged in international trade. First, there is the U.S. (indexed by U) that is the main target of transnational terrorism. Second, there is a continuum of countries of mass 1 (indexed by z) and located on the segment $[0, 1]$. Some of them are potential sources of terrorism against the U.S. (country U).

2.1 Trade

Each country (i.e. U and $z \in [0,1]$) produces differentiated goods under increasing returns. The utility of a representative agent in country U has a standard Dixit-Stiglitz form

$$U_U = \left[n_U x_{UU}^{(1-1/\sigma)} + \int_0^1 n_z x_{Uz}^{(1-1/\sigma)} dz \right]^{1/(1-1/\sigma)},$$

where n_k is the number of varieties produced in each country $k \in \{U, z \in [0,1]\}$. x_{Uk} is country U demand for a variety of country k. All goods produced in k are demanded in the same quantity by symmetry and $\sigma > 1$ is the elasticity of substitution. In country U, this helps define a usual consumer price index:

$$P_U = \left(n_U p_U^{1-\sigma} T_{UU}^{1-\sigma} + \int_0^1 n_z p_z^{1-\sigma} T_{Uz}^{1-\sigma} dz \right)^{1/(1-\sigma)},$$

where p_k is the mill price of products made in k and T_{Uk} are the usual iceberg trade costs between U and K. If one unit of good is exported from country k to country U only $1/T_{Uk}$ units are consumed. Trade costs are assumed to depend on geographical distance, trade restrictions and also on security measures (more on this below). As is well known the value of demand by country U from k is given by

$$m_{Uk} = n_k E_U \left[\frac{p_k T_{Uk}}{P_U} \right]^{1-\sigma} \quad \text{for } k \in \{U, z \in [0,1], R\}, \tag{1}$$

where E_U is the total expenditure of country U.

Labor is the only factor of production in quantity L_k in country $k \in \{U, z \in [0,1]\}$. In each country, the different varieties are produced under monopolistic competition. The entry cost to produce in a monopolistic sector is supposed to be one unit of a freely tradable good which is chosen as world numeraire. This good is produced in perfect competition. This in turn fixes the wage rate to its labor productivity $a = 1$ which is assumed for simplicity to be the same across all countries and sectors. Given this, standard mark-up conditions from profit maximization give that mill prices in the monopolistic competitive sector are identical and equal to the mark-up $\sigma/(\sigma-1)$ times marginal costs (also equal to 1). On the supply side, free entry implies that $n_k = L_k/\sigma$. In equilibrium, the indirect utility of the representative consumer in country U is:

$$W_U = W_U(\mathbf{T}_U) = \frac{E_U}{\frac{\sigma}{\sigma-1}(\sigma)^{\frac{1}{\sigma-1}}} \left(L_U T_{UU}^{1-\sigma} + L \int_0^1 T_{Uz}^{1-\sigma} dz \right)^{1/(\sigma-1)},$$

with $L_z = L$ for all countries $z \in [0,1]$ and $\mathbf{T}_U$ the vector $\{T_{Uk}\}_{k\in\{U,z\in[0,1]\}}$ of bilateral iceberg costs. As is well known from this simple model, one gets bilateral imports of country U from country k as proportional to:

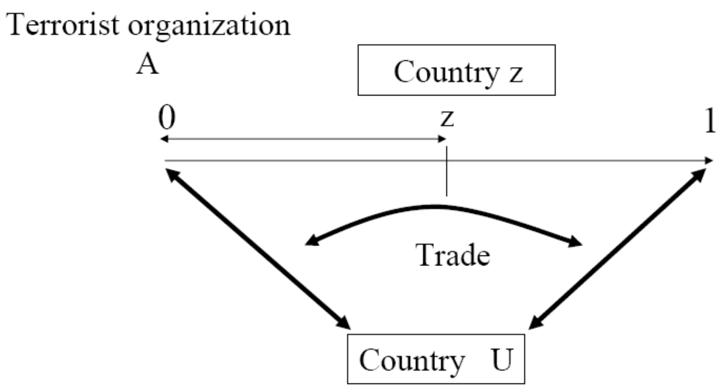
$$m_{Uk} = L_k E_U T_{Uk}^{1-\sigma} P_U^{\sigma-1}. \tag{2}$$

2.2 Terrorism and Security

Terrorist behavior and diffusion of terrorism

We assume that the headquarter of a terrorist organization A is located at $z = 0$ (see Figure 1). A is acting like a multinational terrorist network. Thus, in each country $z \in [0,1]$, A may establish a terrorist cell to gear an attack from z against country U (i.e. the U.S.).

Figure 1



We consider that each cell, once established, benefits from the same technology of terrorism as the headquarter. This is in a sense the intangible specific asset of the multinational terrorist network. However to capture the decentralized organizational feature of the network, we consider that each cell is maximizing her objective function independently from the other cells in the network. The objective function of a particular cell is to get visibility (which helps her capture political or economic rents).[5] More precisely a terrorist cell in country $z \in [0, 1]$ maximizes

$$Max_R \, \Pi(R_z, S_z) V - \theta R_z, \tag{3}$$

where $\Pi(R_z, S_z)$ is the probability of success of a terrorist act against country U launched from country z. It depends positively on the amount of resources R_z invested by the terrorist cell and negatively on security measures S_z implemented by the government of U against z. V is the perceived visibility gain enjoyed by the terrorist cell when terrorism is successful. θ is the marginal resource cost of the terrorist network. As said, it is a specific characteristic of the terrorist network.

We introduce now a spatial dimension. We assume that to establish a cell in country z the terrorist organization A has to spend a fixed organizational resource cost $F(z)$ that depends positively on the distance between country $z = 0$ and country at distance z (i.e. $F'(z) > 0$, $F(0) = 0$, and $\lim_{z \to 1} F(z) = +\infty$). We assume that the terrorist cell will be established in country z if and only if the expected net rent from terrorism is larger than the fixed establishment cost of the cell, namely: Max_{R_z} $[\Pi(R_z, S_z) V - \theta R_z] \geq F(z)$.

We consider a specific parametric form for the probability of success $\Pi(R, S)$. More precisely, we follow Anderson and Marcouiller (2002) and take a simple asymmetric contest success function:

$$\Pi(R, S) = \frac{\varphi R}{\varphi R + S} \ ,$$

with the technological parameter $\varphi > 0$ reflecting the relative efficiency of terrorism compared to security.

[5] We follow here a rationalist view of transnational terrorism (see Sandler *et al.* (1983)).

Denoting $R'_z = \varphi R_z$, the solution of (3) gives the reaction curve of the terrorist group in country z given a certain level of security S_z imposed by country U on z:

$$R'_z = R(S_z, \theta) = \sqrt{\frac{\varphi S_z V}{\theta}} - S_z \quad \text{for} \quad S_z \leq \overline{S}(z, \theta) = \left[\sqrt{V} - \sqrt{F(z)}\right]^2 \frac{\varphi}{\theta}, \qquad \text{(terror)}$$
$$= 0 \qquad \text{for} \quad S_z > \overline{S}(z, \theta).$$

Equation (terror) takes into account the fact that a terrorist cell is established in country z if and only if $Max_{R_z} \left[\Pi\left(R_z, S_z\right) V - \theta R_z\right] \geq F(z)$. The shape of the reaction curve is depicted in Figure 2. When the security level S_z imposed by U against z is below a certain threshold $\overline{S}(z, \theta)$, the transnational terrorist organization chooses to diffuse and to establish a cell in country z, engaging resources locally $R_z = R(S_z, \theta)/\varphi$ in terrorism. Above the threshold $\overline{S}(z, \theta)$, there is no transnational terrorism diffusion to country z and $R_z = 0$.

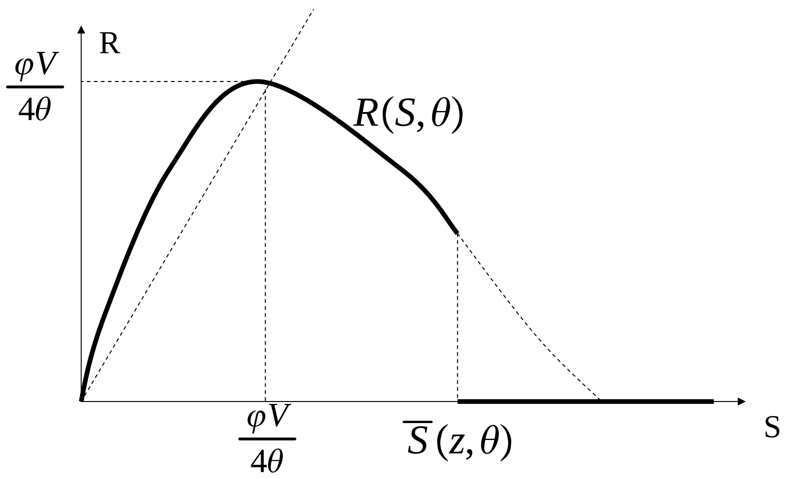


Figure 2: Terrorist Reaction Curve

Security behavior by the U.S.

The government of country U is concerned both by the economic welfare of the representative consumer $W_U(\mathbf{T}_U)$ and the expected social cost of terrorism imposed on its citizens $E(C)$. To fix ideas, consider that he maximizes

$$G_U = LogW_U(\mathbf{T}_U) - E(C),$$

where C is the social cost of terrorism in country U when it succeeds. We assume that, because of pervasive problems of asymmetric information, the government of country U, when deciding its security level S_z against country $z \in [0,1]$, does not know the true value of the marginal resource cost θ of the terrorist network. He has beliefs on this parameter summarized by the density function $f(\theta)$ defined on an interval $[\underline{\theta}, \overline{\theta}]$. Also, the decision on security measures S_z is made simultaneously with the decision of all terrorist cells in the various countries $z \in [0,1]$. Given this, and an expectation of terrorist activity in country z, $R_z^e(\theta)$,

$$E(C) = E_\theta \left[\int_0^1 \Pi\left(R_z^e(\theta), S_z\right) dz \right] C,$$

where $E_\theta(.)$ reflects the expectation operator of government of country U on the level of terrorist resource $R_z^e(\theta)$ undertaken in country z.

Security measures $\mathbf{S} = \{S_z\}_{z\in[0,1]}$ against terrorists involve trade costs.[6] Imposing security measures against people and goods from country z is likely to increase transactions costs on trade flows (e.g. security checks, time delays, restrictions on visa allowances to business people, immigration controls) and we simply pose that

$$T_{Uz} = T(S_z) \text{ with } T'(.) \geq 0,\ T''(.) > 0 \text{ and } T'(0) = 0. \tag{4}$$

According to the type θ of the terrorist network, country U's problem is simply:

$$Max_{S_z}\ LogW_U(\mathbf{T}_U) -\ E_\theta \left[\int_0^1 \Pi\left(R_z^e(\theta), S_z\right) dz \right] C. \tag{US}$$

Given that the equilibrium wage is 1 and the labour force available for production in country U is L_U, country U's expenditure on consumption goods are written as

[6]In doing so, we neglect the budgetary costs of security measures on the welfare of the U.S. citizen and concentrate only on the economic distortion costs of security measures. As well, the reader will also notice that in our formulation of the equilibrium number of varieties produced in any country z, we neglected the effect of the resource cost of terrorism activity on the labor force of that country. In most cases, this is reasonable as the labor force engaged into terrorist activity in any country z is certainly a small fraction of the total active labor force of that country.

$E_U = L_U$. Neglecting constant terms and noting $R^e(.) = (R^e_z(.))_{z\in(0,1)}$, the problem (US) can be rewritten as:

$$\begin{aligned} Max_S\ W(S, R^e(.)) &= Max_S\ \frac{1}{\sigma-1}Log\left(L_U T_{UU}^{1-\sigma} + L\int_0^1 T_{Uz}^{1-\sigma}dz\right) \\ &\quad -C\int_{\underline{\theta}}^{\overline{\theta}}\left[\int_0^1 \frac{\varphi R^e_z(\theta)}{\varphi R^e_z(\theta)+S_z}dz\right]f(\theta)d\theta. \end{aligned}$$

Using Fubini's theorem, the government of country U maximizes:

$$\begin{aligned} Max_S\ W(S, R^e(.)) &= Max_S\ \frac{1}{\sigma-1}Log\left(L_U T_{UU}^{1-\sigma} + L\int_0^1 T_{Uz}^{1-\sigma}dz\right) \\ &\quad -C\int_0^1\left[\int_{\underline{\theta}}^{\overline{\theta}} \frac{\varphi R^e_z(\theta)}{\varphi R^e_z(\theta)+S_z}f(\theta)d\theta\right]dz. \end{aligned}$$

Equilibrium

We now look for the Bayesian Nash equilibrium of the terrorism-security game. More precisely a Bayesian Nash equilibrium

$$\left(S^N, R^N(\theta)\right) = \left(\left\{S^N_z\right\}_{z\in[0,1]}, \left\{R^N_z(\theta)\right\}_{z\in[0,1]}\right),$$

is, for each country $z \in [0,1]$, a security level S^N_z and a terrorist activity function $R^N_z(.)$ defined on $\left[\underline{\theta}, \overline{\theta}\right]$ and characterized by the two following conditions:

$$(i)\ S^N = Arg\max_S\ W(S, R^N(.)),$$

$$(ii)\begin{cases} R^N_z(\theta) = R(S^N_z,\theta) = \dfrac{1}{\varphi}\left[\sqrt{\dfrac{\varphi V}{\theta}}\sqrt{S^N_z} - S^N_z\right] & \text{for } \theta \text{ such that } S^N_z \leq \overline{S}(z,\theta), \\ \qquad = 0 & \text{for } \theta \text{ such that } S^N_z > \overline{S}(z,\theta). \end{cases}$$

We can equivalently redefine the Bayesian Nash equilibrium as a couple (S^N, θ^N), with $S^N = (S^N_z)$ and $\theta^N = (\theta^N_z)$ such that

$$(i)\ S^N = Arg\max_S \left[\begin{array}{c} \frac{1}{\sigma-1}Log\left(L_U T_{UU}^{1-\sigma} + L\int_0^1 T_{Uz}^{1-\sigma}dz\right) \\ -\ C\ \int_0^1\left[\int_{\underline{\theta}}^{\theta^N_z} \frac{\varphi R^N_z(\theta)}{\varphi R^N_z(\theta)+S_z}\ f(\theta)d\theta\right]dz \end{array}\right], \tag{5}$$

$$(ii)\begin{cases} R^N_z(\theta) = \dfrac{1}{\varphi}\left[\sqrt{\dfrac{\varphi V}{\theta}}\sqrt{S^N_z} - S^N_z\right] & \text{for } \theta < \theta^N_z, \\ \qquad = 0 & \text{for } \theta \geq \theta^N_z, \end{cases} \tag{6}$$

and the equilibrium thresholds θ_z^N for all $z \in [0,1]$ are defined by

$$\overline{S}(z, \theta_z^N) = S_z^N. \tag{7}$$

Given that $\overline{S}(z,\theta) = \left[\sqrt{V} - \sqrt{F(z)}\right]^2 \frac{\varphi}{\theta}$, inverting (7) provides a threshold function $\widetilde{\theta}(.)$ such that[7]

$$\theta_z^N = \widetilde{\theta}\left(S_z^N, z\right).$$

For a given threshold θ_z, the first order condition of problem (5) writes as:

$$MC(S_z, \widetilde{T}) = \frac{LT_{Uz}^{-\sigma}}{\widetilde{T}^{1-\sigma}} \frac{dT_{Uz}}{dS_z} = C \int_{\underline{\theta}}^{\theta_z} \frac{\varphi R_z^N(\theta)}{\left[\varphi R_z^N(\theta) + S_z\right]^2} f(\theta) d\theta,$$

where $\widetilde{T}$ is a trade friction cost index proportional to the aggregate price index of country U:

$$\widetilde{T}^{1-\sigma} = \left(L_U T_{UU}^{1-\sigma} + L \int_0^1 T_{Uz}^{1-\sigma} dz\right).$$

The left hand side of equation (2.2) is the marginal cost $MC(S_z, \widetilde{T})$ of security measures S_z applied against country z. It is simply the marginal distortion cost of imposing security measures on bilateral trade flows between U and z. $MC(S_z, \widetilde{T})$ is increasing in S_z when $T_{Uz}(.)$ is convex enough in S_z. We noted also its dependence on the aggregate trade friction cost index $\widetilde{T}$ of country U. The larger this index, the larger the volume that country U imports from country z and the more costly it is at the margin to impose trade frictions between U and z. Hence the larger the marginal cost $MC(S_z, \widetilde{T})$ of security measures S_z between U and z.

The right hand side of (2.2) is the marginal benefit $RM(S_z)$ of security measures on the probability of no occurrence of a terrorist act emanating from z. It depends on the beliefs that the government of U has on the amount of resources $R_z^N(\theta)$ spent

[7]The threshold function $\widetilde{\theta}(.)$ is defined by

$$\widetilde{\theta}(S,z) = Max\left[Min\left(\frac{\left[\sqrt{V} - \sqrt{F(z)}\right]^2 \varphi}{S}; \overline{\theta}\right); \underline{\theta}\right],$$

and is also defined for all distance z such that $\sqrt{V} - \sqrt{F(z)} \geq 0$ (i.e. $z \leq \widetilde{z} = F^{-1}(V)$) takes into account that $\widetilde{\theta}(S,z)$ takes values in the interval $\left[\underline{\theta}, \overline{\theta}\right]$. For $z > \widetilde{z}$, it is never optimal for a transnational terrorist organization to diffuse to country z and we simply pose in that case $\widetilde{\theta}(S,z) = \underline{\theta}$.

by a terrorist cell in z. It is easy to see that $RM(S_z)$ is decreasing in S_z.

Substituting (6) into the first order condition we get

$$MC(S_z, \widetilde{T}) = C \int_{\underline{\theta}}^{\theta_z} \left(\frac{\sqrt{\theta}}{\sqrt{\varphi V}} \frac{1}{\sqrt{S_z}} - \frac{\theta}{\varphi V} \right) f(\theta) d\theta. \tag{8}$$

This is illustrated in figure 3a. The right hand side of (8) is the marginal benefit of security $RM(S_z)$. It is shifted up with the threshold θ_z. In other words, the larger the set of parameters θ such that transnational terrorism diffuses to country z, the larger the marginal gain to impose security against that country. Simple inspection shows that (8) has a unique solution $S_z = \widetilde{S}(\theta_z, \widetilde{T})$ which is increasing in the threshold θ_z, decreasing in $\widetilde{T}$ and such that $\widetilde{S}(\underline{\theta}, \widetilde{T}) = 0$.

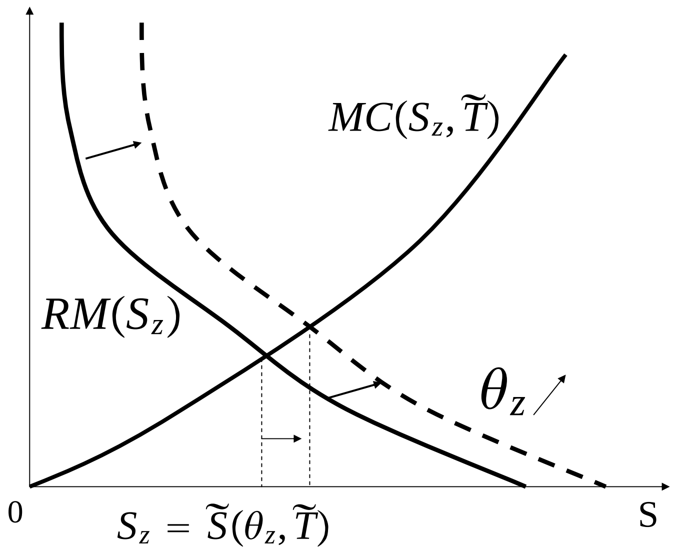


Figure 3a): Optimal Security Measure

We get easily the following proposition:

Proposition 1. *There is a unique Bayesian Nash equilibrium of the transnational terrorism-security game such that:*

i) For $z > \widetilde{z}$, there is no diffusion of terrorism and no security measure applied against country z (i.e. $R_z^N(\theta) = 0 \ \forall \theta \in \left[\underline{\theta}, \overline{\theta}\right]$, $\theta_z^N = \underline{\theta}$ and $S_z^N = 0$).

ii) For $z \leq \widetilde{z}$, there is a unique threshold $\theta_z^N \in]\underline{\theta}, \overline{\theta}]$ such that terrorism diffuses to country z if and only if the terrorist resource cost θ is less than θ_z^N. The level of security applied against country z is S_z^N and the level of terrorist resources engaged in country z is:

$$R_z^N(\theta) = R(S_z^N, \theta) = \frac{1}{\varphi}\left[\sqrt{\frac{\varphi V}{\theta} S_z^N} - S_z^N\right] \quad \text{for } \theta < \theta_z^N,$$
$$= 0 \qquad \text{for } \theta \geq \theta_z^N.$$

iii) The equilibrium expected probability of occurrence of a terrorist action originating from country z is given by : $\Pi_z = 0$ for $z > \widetilde{z}$ and

$$\Pi_z = \int_{\underline{\theta}}^{\theta_z^N} \left(1 - \sqrt{\frac{\theta}{\varphi V}} \sqrt{S_z^N}\right) f(\theta) d\theta \text{ for } z \leq \widetilde{z}.$$

Characterization of the Bayesian equilibrium is illustrated in Figure 3b for $z \leq \widetilde{z}$.

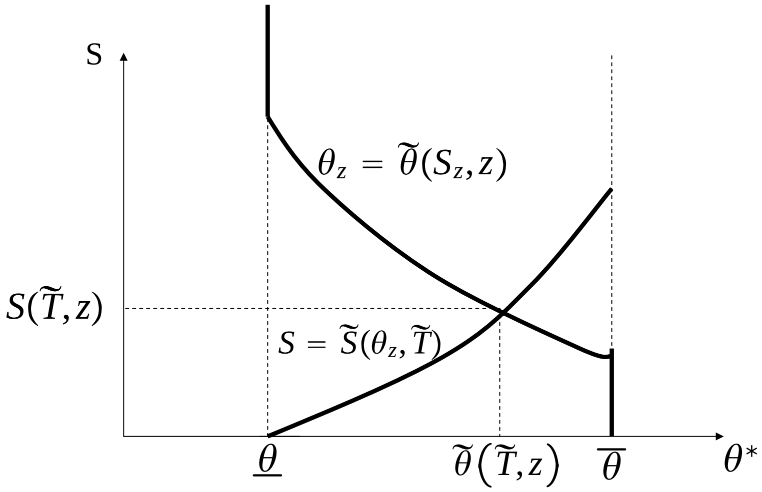


Figure 3b) : Bayesian Equilibrium

The security curve $S = \widetilde{S}(\theta_z, \widetilde{T})$ is an upward sloping curve of the threshold θ_z. The larger the threshold below which transnational terrorism diffuses, the larger the benefits of security measures imposed by country U against country z. The threshold curve $\theta_z = \widetilde{\theta}\,(S_z, z)$ on the other hand is decreasing in S_z. A larger level of security against country z reduces the profitability of establishing a terrorist cell in that country. This establishment requires indeed a higher level of efficiency (i.e. a lower value of θ). The intersection of these two curves gives a solution $S_z = S(\widetilde{T}, z)$ and $\theta_z = \widetilde{\theta}\left(\widetilde{T}, z\right)$. On appendix A we show that there is a unique $\widetilde{T}$ consistent with these solutions and therefore a unique Bayesian Nash equilibrium.

We can now derive our two main comparative statics:

a) How does distance to the terrorist organization headquarter influence transnational terrorism diffusion, bilateral security and trade flows across countries?

b) How does an exogenous shock on security measures (due to the occurrence of increased terrorist action against the U.S. or a higher sensitivity of the U.S. to terrorism) affect trade flows across countries?

Let us consider the first comparative static. Simple inspection of Figure 3b shows immediately how the equilibrium outcome varies with distance z to the terrorist organization headquarter.

Proposition 2. *Whenever transnational terrorism diffuses, (i.e. for $z \leq \widetilde{z}$), we get that: i) θ_z^N is a decreasing function of z, ii) S_z^N is a decreasing function of z.*

Hence both the incentives for diffusion of transnational terrorism and the level of security applied to country z tend to decrease with the distance z to the terrorist organization headquarter. In other words, as distance z increases the organizational cost to establish a terrorist cell, the perceived probability of diffusion of terrorist activity decreases. This in turn reduces the level of bilateral security imposed by country U. These two effects are summarized in the first two panels of Figure 4.

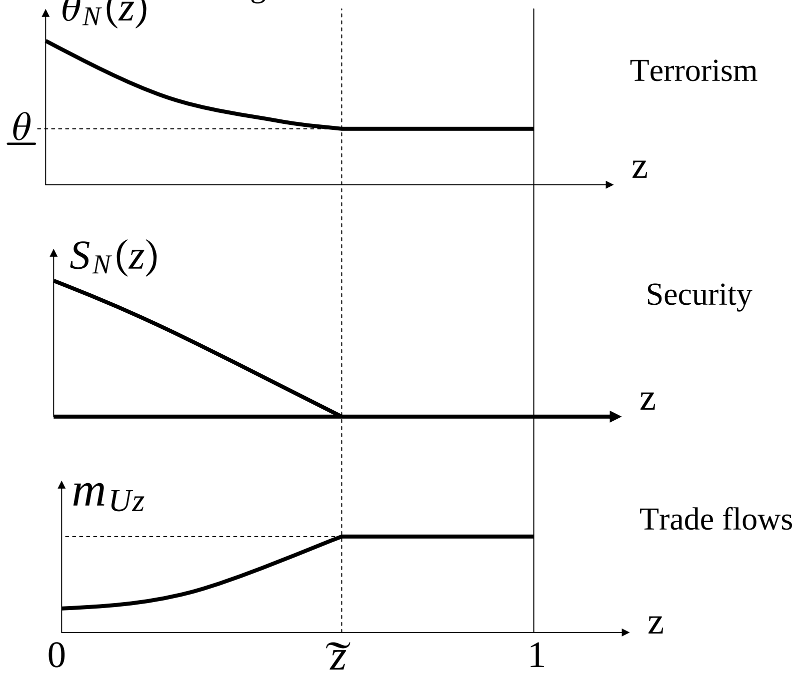
The effect of terrorism diffusion on trade flows between country U and country z is easily deduced from the equation characterizing their bilateral trade:

$$m_{Uz} = \frac{LL_U T (S_z^N)^{1-\sigma}}{(\widetilde{T}^*)^{1-\sigma}}. \tag{9}$$

It is easily verified that:

Proposition 3. *m_{Uz} is strictly increasing in z for $z \leq \widetilde{z}$ and $m_{Uz} = const.$ for $z > \widetilde{z}$ (i.e. is unaffected by terrorism).*

Figure 4: Effect of distance

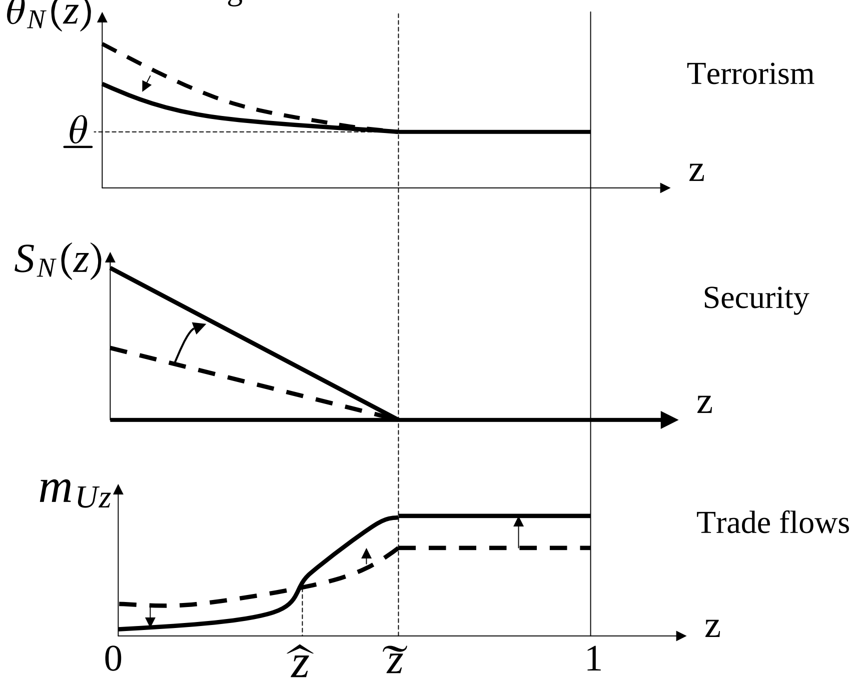


Proposition (3) says that transnational terrorism has some local negative spillover effects on bilateral trade (m_{UZ}). The closer the location of country z is to the terrorist organization headquarter in 0, the lower is trade between countries U and z. This effect is depicted in the bottom panel of Figure 4.

Consider now the second comparative static, i.e. the effect of an exogenous shock on security measures. As can be seen on (8), this shock will increase the value of bilateral security $S = \widetilde{S}(\theta_z, \widetilde{T})$. It can be shown that the equilibrium value S_z^N will increase for $z \leq \widetilde{z}$ and remain constant ($S_z^N = 0$) for $z > \widetilde{z}$. The security function S_z^N rotates around point $z = \widetilde{z}$ (recall that $\widetilde{z}$ is independent from C). In turn, it can be shown that a larger level of security requires a higher level of efficiency (i.e. a lower value of θ). Hence the equilibrium threshold value θ_z^N will decrease for $z \leq \widetilde{z}$ and remain constant $\theta_z^N = \underline{\theta}$ for $z > \widetilde{z}$. These two effects are depicted in the first two panels of Figure 5.

Two effects on trade volumes can be distinguished. They are summarized in the bottom panel of Figure 5. First, it can be shown that the increase in security also shifts up the trade friction cost index $\widetilde{T}^*$. Consequently, all countries benefit

Figure 5: Effect of shock on terrorist cost C



from a positive (inward) multilateral trade resistance effect that tend to increase their bilateral trade m_{Uz} with country U. On the other hand, countries with $z \leq \widetilde{z}$ also suffer from increased bilateral security measures which penalize their trade with U. The overall effect will depend on the location of z to the terrorist organization headquarter at $z = 0$. Trade with country U will increase for countries with $z > \widetilde{z}$, as they only face the positive multilateral effect. However, countries close to $z = 0$ will face a decrease in their volume of trade with U (i.e. m_{U0} goes down), as such countries are more affected by the negative bilateral effect than the positive multilateral effect of increased security.[8] In other words, for countries z close enough to the terrorist headquarter (i.e. $z \leq \widehat{z} \leq \widetilde{z}$), their trade with country U is smaller after the shift in C, while for countries further away from U, (i.e. $z > \widehat{z}$) their trade with country U is larger. The preceding discussion can be summarized in the following proposition:

Proposition 4. *An exogenous increase in the cost of terrorism C reduces trade flows m_{Uz} with country U for countries such that $z \leq \widehat{z}$ and increases m_{Uz} for countries such that $z > \widehat{z}$.*

[8]This can be shown when the transport cost function $T(S)$ is convex enough in S.

3 Empirical analysis

There is one implication of the model worth noting even though we cannot test it due to lack of security data: the level of security of U applied against country z tends to decrease with the distance of z to the headquarter of terrorist organizations. However, we can investigate two other implications related to trade patterns. The model first predicts that the closer is country z to the headquarter, the higher the negative spillovers on its trade with country U. However, the model also predicts that 'safe' countries, i.e. located far enough from the headquarter, may instead increase their trade with country U. We will investigate below the empirical validity of these two implications with a large data set of trade relationships and terrorist incidents against the United States on the 1993-2006 period.

3.1 Data description on transnational terrorism

Data on transnational terrorist incidents come from the ITERATE database set-up by Mickolus, Sandler, Murdock and Flemming (2003).[9] ITERATE is an event-based data set that lists all of the incidents in the world that have been reported in the medias since 1968 onwards. It provides information on the date, the country of location of the attack, and the country of first nationality of terrorists and victims. This helps to define the target country and the source (or origin) country of terrorism.

Target country of terrorism. The country is coded as a target when it represents that of the first nationality of the victims.[10] Nearly 80% of the victims are associated with only one nationality. Consequently, we could assign in a relatively confident way only one target country to an incident. We also consider that the target country can be hit at home or abroad. As an illustration, when an U.S. embassy is hit abroad, the U.S. is coded as the target country.

[9] ITERATE defines terrorism acts as "the use, or threat of use, of anxiety-inducing, extra-normal violence for political purposes by any individual or group, whether acting for or in opposition to established governmental authority, when such action is intended to influence the attitudes and behavior of a target group wider than the immediate victims and when, through the nationality or foreign ties of its perpetrators, its location, the nature of its institutional or human victims, or the mechanics of its resolution, its ramifications transcend national boundaries."

[10] ITERATE defines victims as "those who are directly affected by the terrorist incident by the loss of property, lives, or liberty."

As noted above, we focus on transnational incidents where the U.S. has been the main target, via its representative authorities, its army or its civilians anywhere in the world. One reason is that the U.S. is by far the country that is most hit by transnational terrorism attacks since 1968, before France, Israel and Great Britain. Moreover, the distribution of incidents against the U.S. is spread over a large number of different source countries. Having sorted the number of 'bilateral' incidents (i.e. between source and target countries) between 1968 and 2003, Mirza and Verdier (2006) observe that about one third of the top 65 bilateral incidents involve the U.S. as a target country.[11]

Source country of terrorism. The country is coded as a source when it represents that of the first nationality of the attacking force. Three potential issues are here worth mentioning.[12] First, we may be concerned that there is no one first nationality in the attacking group but different equally-sized nationalities. However, as noted by Blomberg and Rosendorff (2009), 98% of incidents are reported with only one source country. Second, the nationality of the attacking force may not represent the view of the country with which it is associated. We abstract from this problem as long as the U.S. implements security measures against a country hosting attacking forces, regardless of the representativeness of the terrorist's views. Moreover, "this problem is no less severe than what we encounter when we try to measure any international variable" [Blomberg and Rosendorff (2009)] such as investment or trade. Third, the source country might not be the country of location of the incidents, defined as the place where the incidents have taken place. However, we observe in the data that in 96% of the incidents perpetrated against the U.S. the source country is the country of location of the incident.

According to the ITERATE data set, around half of the countries in the world have been at the source of at least one transnational terrorist incident from 1968 onwards. In terms of numbers, the top 10 source countries of transnational terrorism

[11]This is obviously not the case for Israel, France or Great Britain which are associated with at most 3 countries in the top 65.

[12]It is also worth noting that one third of total incidents have been perpetrated by unknown groups with which no source country has been associated.

(i.e. Columbia, Turkey, Iran, Lebanon, Cuba, Spain, Greece, Philippines, Great-Britain and Peru) have perpetrated about 200 transnational incidents each since 1968. The rest of data sources are described in Appendix B.

3.2 Construction of the proximity to terrorism

We do not, unfortunately, have information on the location of the headquarter of terrorist organizations. On the other hand, we have information on the source countries of terrorism. Each one potentially hosts a headquarter (or an affiliate) from which it may diffuse terrorism abroad. To analyze empirically the predictions of the theory, we thus consider the source or origin country of terrorism as the country $z = 0$, and call it country o. Thus, the terrorist organization based in o may establish a terrorist cell in country z to launch an attack against the U.S. The closer is the country z to country o, the higher the probability to host a cell, the higher the U.S. security measures against z and the higher the negative spillover on its trade with the U.S. To evaluate this prediction, we should give an empirical content to the theoretical concept of distance between the country o and the country z where the terrorist cell can be established.

We consider a broad interpretation of the proximity between o and z and use two different types of measure. The first type is continuous and based on the geodesic distance; the second type is discrete and linked to sharing some characteristics among countries o and z, such as a border, a language or a religion. We use both types of measure to check the robustness of our results. We first present the discrete version, and then the continuous one.

Discrete version of proximity to terrorism

Defining a discrete version of proximity to terrorism, we proceed in two steps. First, we determine the number of neighbor countries $i = 0, 1, ..., N$ of a given country z. We use different definitions of these neighborly relationships to test the robustness of our results. Each definition is based on the sharing of different characteristics between i and z: a land border, an official (or primary) language and/or a religion.[13] As a benchmark, let us consider two different combinations of characteristics. The first one defines neighboring relationships based on the sharing of a border, a language *and* a religion.[14] As an illustration, Sudan shares a border, a language and a religion with three countries in our sample (Chad, Egypt and Libya). However, note that among them, in 1993, only one neighbor is considered as a source country of terrorism, which attacks the U.S. (namely Egypt). The second combination is based on the sharing of a border only.[15] Using this combination, Sudan has seven contiguous neighbors i in our sample (Central African Republic, Chad, Democratic Republic of the Congo, Egypt, Ethiopia, Kenya, Libya and Uganda). Among them, in 1993, two are attacking the U.S. (namely Egypt and Ethiopia).

In the second step, we construct a variable, $discrete\_closeness^{c}_{zt}$, for each combination c of characteristics shared by countries i and z.[16] It sums, for each combination, the number of terrorist incidents perpetrated against the U.S. by the neighbor(s) of a given country z in a year t. As an illustration, in 1993, Sudan's neighbor country (i.e. Egypt), with whom it shares a border, a language and a religion, perpetrated 4 terrorists incidents against the U.S.

The $discrete\_closeness^{c}_{zt}$ variable represents a proxy for the proximity to terrorism. First, for a given combination c, the higher the number of terrorist incidents perpetrated by z's neighbor(s), the closer is z to terrorism. Moreover, we argue that the more characteristics a neighbor country shares with z, the closer their neighborly relationship. Thus, we expect that an additional terrorist incident of the neighbor(s) against the U.S. will be more detrimental to trade when the neighbor shares several characteristics with z than only one. We will below incorporate the different combinations of $discrete\_closeness^{c}_{zt}$ in the trade specification.

[13]We consider that i and z share a religion when a common religion is practised by at least 50% of the population in each country. Our results appear to be robust to the use of a different threshold, namely 10 and 20%. They can be provided upon request.

[14]The left part of Table 5 in Appendix C reports the number of neighbors of each country in our sample, based on the sharing of all the three characteristics.

[15]The right part of Table 5 (in Appendix C) reports the number of contiguous neighbors of each country in our sample.

[16]We use seven different combinations: {border, language, religion}, {border, language}, {border, religion}, {language, religion}, {border}, {language} and {religion}.

Continuous version of proximity to terrorism

Defining a continuous version of proximity to terrorism, we make use of the geodesic distance and construct a $continous\_closeness_{zt}$ variable as

$$continuous\_closeness_{zt} = \frac{1}{\sum_i (w_{it}).\text{Geodist}_{iz}},$$

where w_{it} is the share of country i's incidents against the U.S. in the total world incidents against the U.S. in year t; and $Geodist_{iz}$ is the bilateral geodesic distance between country i and country z. This inverse measure simplifies the interpretation of the empirical results and allows for a more direct comparison with the estimates of the discrete versions of proximity to terrorism. This variable has an interesting feature in that it resembles that of a market potential variable in the trade literature. It says that the higher is the variable, the closer to the source of incidents a country z is, the higher its potential to host incidents itself.

3.3 Trade specification

To account for the times-series dimension of the data, we rewrite equation (2), derived in the theoretical part, as

$$m_{Uzt} = L_{zt} L_{Ut} T_{Uzt}^{1-\sigma} P_{Ut}^{\sigma-1}, \tag{10}$$

where m_{Uzt} is an $z \times 1$ vector with row z equal to U.S. imports from country z in year t.[17] Equation (10) defines a gravity-like model of trade. It relates trade between the U.S. and country z to their economic size (L_{zt} and L_{Ut}), their bilateral trade costs T_{Uzt} and the importing price index P_{Ut}. We now fit the equation to the data as follows. First, we discard importing country-variable controls, i.e. U-specific controls, such as economic size and price index. We may discard these variables because in our data set the importing country is always the U.S. and these variables only have time-series variation. We capture such variation by allowing for year specific effects in trade. Second, we proxy the number of workers available for production in the

[17]Note that we abstract here from using U.S. intra-national trade, as expressed in equation (2), due to data constraints and data compatibility with U.S. international trade (see Appendix B for data sources).

exporting country z, L_zt, by the gross domestic product GDP_{zt}. Then, we decompose GDP_{zt} in population (POP_{zt}) and GDP per capita (GDP_{zt}/POP_{zt}), to control, respectively, for size and development differences across exporting countries. Third, we use disaggregated trade data to cope with differences in specialization between developing and developed exporting countries. Using trade data at the product level (5-digit) allows us to control for the relative specialization of countries which might be correlated both with aggregate bilateral trade and terrorism activities (see above). Fourth, we posit that trade costs (T_{Uzt}) are a log-linear function of observables ϕ_{zt}^m:

$$T_{Uzt} = \prod_{m=1}^{M} (\phi_{zt}^m)^{\gamma_m}. \tag{11}$$

Normalizing such that $\phi_{zt}^m = 1$ measures zero trade barriers associated with a given variable m, $(\phi_{zt}^m)^{\gamma_m}$ is equal to one plus the tariff equivalent of trade barriers associated with this variable [Anderson and van Wincoop (2004)]. As in many empirical applications, the list of observables ϕ_{zt}^m includes the bilateral geodesic distance of country z to U (Geodist_z), and a dummy variable indicating whether the U.S. shares a language with the exporting country z (Lang_z). Moreover, following our theoretical setting, we consider that trade costs are increased by the counter-terrorism measures implemented by the U.S. government. Such measures are largely unobservable but are arguably positively correlated with transnational terrorism activity. Consequently, we proxy the level of the U.S. security measures against z by the incidents perpetrated by z ($Terror_{zt}$) and its neighbors ($\mathbf{Neighborterror}_{zt}$) against the U.S. The variable $Terror_{zt}$ simply sums the number of incidents of country z against the U.S. in year t. The elements of the vector $\mathbf{Neighborterror}_{zt}$ are the discrete and continuous versions of the distance to terrorism. We also add an error term (ϵ_{zt}) to equation to capture all the unobserved linkages between U and z that affect bilateral trade costs.

Finally, we benefit from the multiplicative form of equation (2) to operate a log-linear transformation of the model. Dropping the country U subscripts for notational convenience while considering countries z that are exporting to the U.S., we obtain the following estimated equation:

$$\ln(m_{zst}) = \ln(POP)_{zt} + \ln(GDP/POP)_{zt} + \alpha_1 \ln(Geodist)_z + \alpha_2(Lang)_z + \beta_1(Terror)_{zt} + \beta_2(\textbf{Neighborterror})_{zt} + \rho_t + \rho_s + \epsilon_{zt}, \quad (12)$$

where the year and product observed are represented by t and s subscripts respectively, m_{zst} is a column vector with row zst equal to U.S. imports from country z in a given year t for a given product s; ρ_t is a year fixed effect capturing time-series variation of the U.S. country-variable controls; ρ_s denotes product fixed effects; $\alpha_1 = (1-\sigma)\delta$, $\alpha_2 = (1-\sigma)\gamma_1$, $\beta_1 = (1-\sigma)\gamma_2$, and $\beta_2 = (1-\sigma)\gamma_3$. β_1 and β_2 are here our coefficients of interest. They are expected to be both negative: an increase in the number of terrorist incidents, perpetrated by country z or its neighbors (in the continuous or discrete version), increases security measures (to prevent from potential future incidents), which leads to a decrease in U.S. imports.

4 Empirical results

4.1 Benchmark results

We first present the results for the discrete measure of the **Neighborterror** vector, then those for the continuous measure.

Discrete version of proximity to transnational terrorism

In Table 1, we report results for equation (12), using different combinations of the discrete measure of distance to terrorism ($discrete\_closeness^c_{zt}$). All specifications include a full set of year-specific and product-specific (5-digit) dummies. Standard errors are clustered at the country z-year level to address potential problems of heteroskedasticity and autocorrelation in the error terms.

Before proceeding to the analysis of the terrorist incidents variables, notice that, in all regressions, the traditional gravity estimates, like economic size, distance and common language, appear with the expected signs. The results show that increases in exporter country per capita income and population promote exports to the U.S.

with elasticities close to one as predicted by the model.[18] In line with the literature, the share of the English language increases trade with the U.S. On the other hand, the elasticity of trade to distance is negative but with a lower estimate than in the literature [around a mean elasticity of 0.9; see Disdier and Head (2008)].

Table 1: Trade and proximity to transnational terrorism (discrete version)

Dependent variable	ln(U.S. imports)				
	(1)	(2)	(3)	(4)	(5)
Definition of proximity to transnational terrorism	Linguistic	Religious	Contiguous	Contiguous & Linguistic	Contiguous & Linguistic & Religious
$\ln(\text{Population})_{zt}$	0.957^a	0.955^a	0.962^a	0.960^a	0.957^a
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
$\ln(\text{GDP/Population})_{zt}$	0.887^a	0.892^a	0.886^a	0.886^a	0.886^a
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
$\ln(\text{Distance})_z$	-0.642^a	-0.660^a	-0.636^a	-0.640^a	-0.641^a
	(0.048)	(0.049)	(0.048)	(0.048)	(0.048)
English Language_z	0.457^a	0.421^a	0.427^a	0.421^a	0.424^a
	(0.050)	(0.044)	(0.045)	(0.045)	(0.045)
Terror_{zt}	-0.019^b	-0.021^b	-0.019^b	-0.019^b	-0.018^b
	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)
Neighbor $\mathbf{Terror}_{zt}$	-0.004	-0.006^a	-0.011^a	-0.014^a	-0.017^a
	(0.003)	(0.002)	(0.003)	(0.003)	(0.004)
Fixed Effects:					
Year	yes	yes	yes	yes	yes
Product (5-digit)	yes	yes	yes	yes	yes
Adj. R^2	0.38	0.38	0.38	0.38	0.38
# of Observations	449832	449832	449832	449832	449832

Notes: In parentheses: heteroskedastic-robust standard errors, clustered by country z and year. ^{a} and ^{b} denote significance at the 1% and 5% level respectively. Constant and fixed effects are not reported.

As expected, we find a negative effect on U.S. imports of terrorist incidents perpetrated by country z against the U.S. In all regressions, the semi-elasticity of $Terror_{zt}$ is statistically significant. On average, exports to the U.S. decrease by about 2 percent for every additional terrorist incident against the U.S. This effect is economically significant. However, what does an additional terrorist incident against the U.S. represent? To help with the interpretation of the results, and to

[18] Instead of GDP per capita and population, we used two alternative methods to capture the economic size effect of the exporting country: (1) GDP and (2) GDP per capita and GDP, respectively. None of these alternative methods changes the results on the incident variables.

compare the effects of this particular variable with the other estimated coefficients, we compute standardized (beta) coefficients from the estimates of Table (1). These are the regression coefficients obtained by standardizing all variables to have a mean of 0 and standard deviation of 1. It follows, in column (1), that a one standard-deviation increase in the number of terrorist incidents decreases U.S. imports by .016 standard deviation. In absolute value, this magnitude appears to be lower than the standardized effect of the traditional gravity variables: .475 for population, .394 for GDP per capita, -.115 for distance, and .057 for common English language. These results suggest that an additional terrorist incident leads to an economically significant effect but its occurrence is rare.

Our theory predicts negative local spillovers on imports to the U.S., when exporter's close neighbors attack the U.S. Empirical results of Table 1 confirm this prediction. In all columns, we find negative semi-elasticities of trade to the number of incidents of the exporter's neighbors. Some differences across regressions are worth mentioning, however. For instance, in column (1), we find a negative but statistically insignificant effect when defining neighborhood on a linguistic basis. In contrast, in column (2), we find a significant negative effect: on average exports of country z to the U.S. decrease by 0.6 percent for every additional terrorist incident perpetrated by the exporter's religious neighbors against the U.S. In column (3), we find a slightly larger effect when defining neighborhood on contiguity. These results are reassuring if we consider that the U.S. security is discriminatory and regional, i.e. directed against particular geographic areas. A given country z could indeed share the language of a source country of terror o while being geographically far remote from o, with a low probability to host a terrorist cell. This could explain why the $NeighborTerror$ estimate is not significant in column (1), when proximity to terrorism is only defined on a linguistic basis. The ensuing columns (4) and (5) of Table 1 highlight larger semi-elasticities for the $NeighborTerror$ variable. Thus, a closer proximity to source countries of terrorism appears to induce a bigger negative effect on US imports. It seems in fact reasonable to consider that neighbors are closer when they share a border, a language and a religion (column 5) than only a border (column 3) or only a religion (column 2). These results are thus in line with the theoretical prediction that the closer the location of the exporting country to the source country 0, the higher the negative local spillover effects on its U.S. trade.

Continuous version of proximity to transnational terrorism

The above discrete measures offer us a comparison between the situations where countries share or not some closeness characteristics. However, the differences of ($\widehat{\beta_2}$) across regressions (3) to (5) are probably not statistically significant despite precise estimates (p<0.01) and different magnitudes. To further investigate the empirical validity of our main theoretical predictions, we use our continuous variable of proximity to terrorist incidents $closeness\_continuous_{zt}$. This variable is computed as the inverse of the weighted average distance of a given country z to source countries of terrorism against the U.S. The result reported in Table 2 shows that a one-percent increase in the closeness to terrorist incidents decreases U.S. imports by 0.6 percent. This effect is economically and statistically highly significant.

In contrast, we may wonder if 'safe' countries (i.e. located far from terror) could benefit, in terms of trade, from an increase in security. To investigate this part of proposition 4, we decompose in column (2), the $closeness\_continuous_{zt}$ variable in three categories. Each category represents one-third of the observations: the dummy *close to terror* equals one for the closest countries to terror; the dummy *Far from terror* equals one for the farthest countries to terror. The in-between group is omitted and represents the group of comparison. Based on this comparison, we find as expected a significant positive estimate for the farthest countries to terror and a significant negative estimate for the closest countries to terror. As noted above, the logic is very similar to the inward multilateral resistance effect of Anderson and Van Wincoop (2003). Exports of safe countries into the U.S. is increased by high barriers to trade (here, high security measures) set against unsafe source countries of terrorism. In contrast, countries close to terror trade less with the U.S.

4.2 Robustness checks

In this section, we investigate the robustness of our results first with respect to the addition of new controls, and then to alternative definitions of the neighborhood.

Table 2: Trade and proximity to transnational terrorism (continuous version)

Dependent variable	ln(US imports)	
	(1)	(2)
ln(Population)$_{zt}$	0.954^a	0.953^a
	(0.016)	(0.017)
ln(GDP/Population)$_{zt}$	0.908^a	0.913^a
	(0.012)	(0.012)
ln(Distance)$_z$	-0.616^a	-0.604^a
	(0.048)	(0.047)
(English Language) dummy$_z$	0.351^a	0.360^a
	(0.048)	(0.047)
Terror$_{zt}$	-0.020^b	-0.021^b
	(0.009)	(0.009)
Neighbor Terror$_{zt}$	-0.627^a	
	(0.069)	
(**Far from terror**) dummy$_{zt}$		0.252^a
		(0.061)
(**Close to terror**) dummy$_{zt}$		-0.266^a
		(0.065)
Fixed Effects:		
Year	yes	yes
Product (5-digit)	yes	yes
Adj. R^2	0.38	0.38
# of Observations	449832	449832

Notes: In parentheses: heteroskedastic-robust standard errors, clustered by country z and year. ^{a} and ^{b} denote significance at the 1% and 5% level respectively. Constant, fixed effects and estimates of other controls are not reported.

Additional exporter controls

We attempt here to control for potential omitted characteristics of the exporting country in specification (12). The objective is to isolate all the forces that affect both bilateral trade and terrorism incidents. A solution to capture time-*independent* idiosyncrasies of the exporters would be to introduce into the regression country z fixed-effects. However, our variables of terrorism incidents are country z-specific and the overlap with the country z dummies is considerable. Hence, introducing the terror variables and country-z fixed effects would introduce high multicollinearity into the regression. We alleviate this problem by adding a set of income group dummies, following the World Bank's definition: HOECD (High Income OECD); HOTHR (High Income Others); MIDUP (Upper Middle Income); MIDLW (Lower Middle Income) and LOW (Low Income).

Table 3: Trade and proximity to transnational terrorism: income group z dummies

	(1)	(2)	(3)	(4)
Definition of proximity to transnational terrorism	Discrete		Continuous	
	Contiguous	Contiguous & Linguistic & Religious		
(Other controls)	(...)	(...)	(...)	(...)
Terror_{zt}	-0.020^b	-0.020^b	-0.020^b	-0.021^b
	(0.010)	(0.009)	(0.010)	(0.010)
Neighbor Terror $_{zt}$	-0.013^a	-0.018^a	-0.704^a	
	(0.003)	(0.004)	(0.066)	
(Far from terror) dummy_{zt}				0.371^a
				(0.068)
(Close to terror) dummy_{zt}				-0.245^a
				(0.063)
Fixed Effects:				
Year	yes	yes	yes	yes
Product (5-digit)	yes	yes	yes	yes
Income group z	yes	yes	yes	yes
Adj. R^2	0.38	0.38	0.39	0.39
# of Observations	449832	449832	449832	449832

Notes: In parentheses: heteroskedastic-robust standard errors, clustered by country z and year. ^{a} and ^{b} denote significance at the 1% and 5% level respectively. Constant, fixed effects and estimates of other controls are not reported. See text for details about the definition of proximity to transnational terrorism.

Table 3 depicts the results of this robustness check using different definitions of proximity to terrorism based on: the share of only a border in column (1); the share of a border, a language and a religion in column (2); the log of the continuous variable in column (3) and its decomposition in column (4). To save space, we only present the estimates of $\widehat{\beta}_1$ and $\widehat{\beta}_2$. The other estimates are in line with the results of Tables 1 and 2 and can be provided upon request. The result concerning the income group dummies (not reported here) is worth mentioning, however. All regressions exhibit statistically significant differences across income groups. On average, the low income countries (LOW) trade less with the U.S. than the middle income countries (MIDLW and MIDUP), which trade less with the U.S. than the high income countries (HOECD and HOTHR).

Concerning the terror estimates, results are not sensitive to these additional controls. We observe that they are little changed compared to those of Tables 1 and 2. We still find local negative spillovers on U.S. trade related to the terrorist incidents perpetrated by the neighbor countries. In addition, countries located far enough from the terrorist incidents instead increase their trade with the U.S.

We may be concerned by the fact that time-*dependent* factors, such as the outward multilateral resistance index, affect our terror estimates. In our theory, all countries trade with the U.S. but are assumed not to trade with each other. This simplification allows us to embed the terrorism - U.S. security game in a simple new trade theory model and to obtain a simple testable U.S. bilateral imports specification. Except that in general equilibrium *à la* Anderson and Van Wincoop (2003), where all countries trade together, an additional exporter variable should enter the equation. This is the outward multilateral resistance (OMR), which represents an index of trade costs that exporter faces on its shipments.

The ideal would be to include in our specification either (1) time-varying exporter fixed effects or (2) estimated OMRs like in Anderson and Van Wincoop (2003) or Anderson and Yotov (2008). Unfortunately, the structure of our data does not allow taking these two routes. The first solution introduces perfect multicollinearity into the regression. Our variables of terrorist incidents represent indeed a linear combination of the exporter-year dummy variables. The second solution is theoretically consistent in a panel setting [Anderson and Yotov (2008)]. However, it proved very difficult (if not impossible) to apply Anderson and Yotov's approach to our data. First, this approach requires to expand the number of importing countries. To compute the OMR indexes we need information on trade costs that each exporter faces on *all* its shipments, beyond the U.S. market. However, country's bilateral trade data are not available for all exporters at the 5-digit SITC level over the period 1993-2006. This is all the more problematic for developing countries. Second, we need data on country expenditures at the product level (5-digit) to calculate the OMR [see equation (5) of Anderson and Yotov (2008)]. Unfortunately, we cannot construct these expenditures due to lack of data.[19]

Nevertheless, we may wonder whether the estimates of **Neighborterror** are biased by the omission of the outward multilateral resistance. And if so, in which direction? In fact, one can easily figure out that the estimates (in absolute value) are being *underestimated.* To see why, consider an increase in terrorism activity in a given source country. Let's assume that the U.S. responds by increasing security against this country and its close neighbors. It follows that the OMR of these countries will increase, i.e. the index of trade costs that they face on their exports will be higher. The consequence for a given country, close to terror, will be to *increase* its bilateral exports to the U.S. In other words, this effect work as follows: a higher resistance to shipments from this country to its other markets, captured by a higher OMR, tips more trade back into the U.S. Hence, our negative estimate of **Neighborterror** captures both the documented negative effect of the increase of security on trade costs and the positive effect of an OMR increase. As a result, the omission of the OMR variable biases toward zero the estimate of **Neighborterror**. To put it differently, if we could find a way of conditioning out the OMR, the coefficient on the closeness to terror variable should be even more negative.

Alternative definitions of proximity to transnational terrorism

Table 4 deals with a second set of robustness checks with respect to alternative definitions of our variables of interest, $\mathbf{Neighborterror}_{zt}$ and $Terror_{zt}$. These variables were computed based on the terrorist incidents perpetrated against the U.S.

[19]Another issue would have to deal computationally with a matrix of exporter and importer multilateral resistance indexes at the product level.

on the current year t. We now sum the terrorist incidents over three and five years, respectively. Thus, the top panel of Table 4 presents the results of the summation of the number of incidents over three years: t, t_{-1} and t_{-2}. The bottom panel shows the summation over five years.

As in Table 3, we only report the estimates of $\widehat{\beta}_1$ and $\widehat{\beta}_2$ and use the same definitions of proximity to transnational terrorism.[20] Our main results are still valid. We find (1) a direct negative impact of transnational terrorism on trade; (2) an indirect negative impact emanating from terrorism of neighbor countries; and (3) that trade is increasing with remoteness to terror.

5 Conclusion

In this paper we have examined the impact of transnational terrorism diffusion on security and international trade. To counter the diffusion of transnational terrorism, governments implement comprehensive security measures. These measures are directed both against the source countries of terror and their neighbor countries where terrorism may diffuse. By raising trade costs, these measures may affect international trade.

We set up a simple theoretical model predicting that the closer a country is to a source of terrorism, the higher the negative spillovers on its trade. In contrast, we demonstrate that countries located far from terror could benefit from an increase in security by trading more. We investigate the empirical validity of these implications with a large data set of international trade relationships and transnational terrorist incidents against the United States on the 1993-2006 period. We find (1) a direct negative impact of transnational terrorism on U.S. imports; (2) an indirect negative impact emanating from terrorism of neighbor countries; and (3) that U.S. imports from a given country are increasing with its remoteness to terror. These results are robust to various definitions of the neighboring relationships among countries (i.e. adjacent, linguistic, religious and geographical).

[20]The estimated coefficients of the other variables remained unchanged compared to Tables 1 and 2 can be provided upon request.

Table 4: Trade and proximity to transnational terrorism: past incidents

Definition of proximity to transnational terrorism	(1)	(2)	(3)	(4)
	Discrete		Continuous	
	Contiguous	Contiguous & Linguistic & Religious		
	Incidents summed over three years			
(Other controls)	(...)	(...)	(...)	(...)
Terror_{zt}	-0.015^a	-0.014^a	-0.017^a	-0.021^b
	(0.004)	(0.004)	(0.004)	(0.009)
Neighbor Terror_{zt}	-0.008^a	-0.014^a	-0.815^a	
	(0.002)	(0.002)	(0.080)	
(Far from terror) dummy_{zt}				0.378^a
				(0.062)
(Close to terror) dummy_{zt}				-0.251^a
				(0.066)
Fixed Effects:				
Year	yes	yes	yes	yes
Product (5-digit)	yes	yes	yes	yes
Adj. R^2	0.38	0.38	0.38	0.38
# of Observations	449832	449832	449832	449832
	Incidents summed over five years			
(Other controls)	(...)	(...)	(...)	(...)
Terror_{zt}	-0.010^a	-0.010^a	-0.014^a	-0.024^a
	(0.002)	(0.002)	(0.002)	(0.011)
Neighbor Terror_{zt}	-0.007^a	-0.011^a	-1.139^a	
	(0.001)	(0.001)	(0.099)	
(Far from terror) dummy_{zt}				0.477^a
				(0.061)
(Close to terror) dummy_{zt}				-0.232^a
				(0.066)
Fixed Effects:				
Year	yes	yes	yes	yes
Product (5-digit)	yes	yes	yes	yes
Adj. R^2	0.38	0.38	0.39	0.39
# of Observations	449832	449832	449832	449832

Notes: In parentheses: heteroskedastic-robust standard errors, clustered by country z and year. ^{a} and ^{b} denote significance at the 1% and 5% level respectively. Constant, fixed effects and estimates of other controls are not reported. See text for details about the definition of proximity to transnational terrorism.

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A Appendix. Existence of the Bayesian Nash equilibrium

A Bayesian Nash equilibrium $\left(S_z^N, \theta_z^N\right)$ of the terrorism-security game is characterized by the set of equations such that for all $z \in [0,1]$:

$$\begin{aligned} S_z^N &= \widetilde{S}(\theta_z^N, \widetilde{T}), \\ \theta_z^N &= \widetilde{\theta}\left(S_z^N, z\right), \end{aligned}$$

and

$$\widetilde{T}^{1-\sigma} = \left(L_U T_{UU}^{1-\sigma} + L\int_0^1 T(S_z^N)^{1-\sigma} dz\right).$$

Inspection of Figure 3b shows that $S(\widetilde{T}, z)$ is decreasing in $\widetilde{T}$ while $\widetilde{\theta}\left(\widetilde{T}, z\right)$ is increasing in $\widetilde{T}$.[21] From this, it follows that

$$\begin{aligned} H(\widetilde{T}) &= L_U T_{UU}^{1-\sigma} + L \int_0^1 T(S_z)^{1-\sigma} dz \\ &= L_U T_{UU}^{1-\sigma} + L \int_0^1 T(S(\widetilde{T}, z))^{1-\sigma} dz, \end{aligned}$$

is an increasing function of $\widetilde{T}$. Now the equilibrium value of $\widetilde{T}$ has to satisfy the following equation

$$\widetilde{T}^{1-\sigma} = H(\widetilde{T}). \tag{13}$$

The left hand side of this equation is a decreasing function of $\widetilde{T}$ (for $\sigma > 1$) going from $+\infty$ to 0 as $\widetilde{T}$ goes from 0 to $+\infty$. As $H(\widetilde{T})$ is an increasing function of $\widetilde{T}$ with $H(0) \geq 0$ and $\lim_{\widetilde{T} \to \infty} H(\widetilde{T}) > 0$, it follows that equation (13) has a unique solution $\widetilde{T}^*$. Substitution gives immediately $S_z^N = S(\widetilde{T}^*, z)$ and $\theta_z^N = \widetilde{\theta}(\widetilde{T}^*, z)$ for $z \leq \widetilde{z}$.

B Appendix. Data sources

Bilateral imports of the United States at the 5-digit SITC level, over the period 1993-2006, come from the NBER World Trade Data [see Feenstra, Schott and Romalis (n.d.) for details]. Data on distance, contiguity and language come from the CEPII (http://www.cepii.fr/anglais-graph/bdd/distances.htm). Data on population and GDP per capita come from the World Bank (World Development Indicators). Information on religion come from Alesina *et al.* (2003).

C Appendix. Neighborly relationships

Table 5 depicts the distribution of the neighborly relationships among countries in our sample. The left part of Table 5 gives the number of neighbors of each country in our sample based on the sharing of a border, a language *and* a religion. In that case, 100 countries have *no* neighbors, while 69 have at least one. In contrast, one country, Saudi Arabia, has 7 neighbors: Iraq, Jordan, Kuwait, Oman, Qatar, United Arab Emirates and Yemen. The right part of Table 5 gives the number

[21] Note that $\widetilde{T}$ is also endogenous in the model as, in turn, it depends on the level of security measures imposed on all countries $z \in [0, 1]$ (see equation 4).

Table 5: Sample distribution of the neighbor relationships

Countries share:					
a border, a language and a religion[a]			a border[b]		
# of neighbors	Freq. of countries	in %	# of neighbors	Freq. of countries	in %
0	100	59.17	0	29	17.16
1	22	13.02	1	15	8.88
2	22	13.02	2	29	17.16
3	13	7.69	3	23	13.61
4	8	4.73	4	26	15.38
5	2	1.18	5	24	14.20
6	1	0.59	6	7	4.14
7	1	0.59	7	9	5.33
Total	169		8	3	1.78
			9	2	1.18
			14	1	0.59
			15	1	0.59
			Total	169	

Notes: [a] Left part: number of neighbors of each country in our sample based on the sharing of a border, a language *and* a religion. [b] Right part: number of contiguous neighbors of each country in our sample.

of contiguous neighbors of each country in our sample. In that case, 29 countries have *no* (contiguous) neighbors. They represent island countries and/or distinct statistical territories. In contrast, one country, China, has 15 contiguous neighbors.