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Article

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Trade in the Face of Terror: Examining Turkey's Export Dynamics

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Abstract: In the preceding 11 years, Turkey has witnessed 925 terrorist incidents, resulting in the unexpected passing of 1,439 people. Concurrently, the neighbouring nations, Syria, and Iraq, have also experienced a multitude of terrorist activities. This study's main objective is to explore how these events have affected Turkey's exports and intra-industry trade. The investigation is centred on Turkey's trade relationships with 71 countries, representing its primary trading partners, employing a one-way trade model. Utilizing the Poisson pseudo maximum likelihood (PPML) estimator, the study spans 2012 to 2022. The findings underscore the adverse impact of domestic terrorist incidents, casualties in other countries, and the global terrorism index on Turkey's exports. Surprisingly, the investigation finds a positive connection between Turkey's exports and terrorist incidents in both neighbouring and non-bordering countries. Furthermore, the empirical analysis sheds light on Turkey's engagement in intra-industry trade concerning manufacturing industry and GDP similarities. However, the scenario changes for information and communication technology (ICT) exports, revealing an inter-type of industry trade.

Keywords: empirical studies of trade; international conflicts; political economy

JEL Classification: F14; F51; F50

1 Introduction

Terrorism, as defined by Enders and Sandler (2000), is the intentional use of deadly violence or threats to further partisan goals, instilling fear or intimidation among a sizable portion of the population. A key element of this definition is the political motive behind terrorist actions, distinguishing them from ordinary criminal activities that lack such motives. Additionally, terrorism is characterized using extreme violence, often intended to attract media attention.

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Terrorism has long been recognized as a significant disruptor of economic stability and growth. Globally, terrorist activities have been shown to undermine investor confidence, reduce foreign direct investment, and disrupt trade flows, leading to broader economic instability (Abadie and Gardeazabal 2003; Gaibulloev and Sandler 2009, 2019). The economic consequences of terrorism extend far beyond immediate destruction. Terrorism fosters a climate of uncertainty, leading to behavioural changes among economic agents. This can result in reduced investment, decreased consumer spending, and disruptions to international trade. Additionally, the increased costs associated with terrorism, such as higher shipping costs and insurance premiums, can be passed on to consumers, further impacting economic activity (Bandyopadhyay 2017).

The relationship between terrorism and international trade has been of particular interest in recent years, with studies indicating that terrorism can significantly reduce trade flows, disrupt supply chains, and lead to the reallocation of trade routes (Bandyopadhyay 2016). These effects are often compounded in regions with high levels of geopolitical instability, where terrorism worsens existing economic vulnerabilities (Bandyopadhyay, Sandler, and Younas 2014).

Terrorism not only imposes direct human costs but also generates significant economic disruptions, particularly through its impact on international trade. Research has shown that terrorism can create spillover effects, where a terrorist event in one country adversely affects the bilateral trade of neighbouring nations (Pham and Doucouliagos 2017). These spillover effects are long-lasting, often persisting for up to five years after the event and can arise even from incidents with a small death toll. The mechanisms through which terrorism impacts trade include increased trade costs due to stricter security measures, heightened regulatory burdens, and psychological distress among economic agents (Pham and Doucouliagos 2017).

Given Turkey's geopolitical position, understanding these spillover effects is vital. The potential increase in trade costs and resulting frictions are particularly relevant for Turkey, which shares borders with several countries that have experienced significant terrorist activity. This study aims to build on the existing literature by examining how terrorism, both within Turkey and in neighbouring countries, affects Turkey's trade dynamics, with a specific focus on intra-industry trade.

Although the economic impacts of terrorism are well-documented, research specifically examining its effect on intra-industry trade, especially in developing economies like Turkey, remains limited. Turkey's unique position, across both Europe and the Middle East, and its experience with both domestic and transnational terrorism, make it a critical case study for understanding these dynamics (Bilgel and Karahasan 2019).

While some studies examined the effects of terrorist incidents on different areas, for instance, on the Turkish stock market (Aksoy and Demiralay 2019; Gok, Demirdogen, and Topuz 2020), on foreign direct investment (FDI) (Çetin, Keser, and Ay 2019; Ibrahim and Ari 2021) and on domestic bank loans (Ilarslan and Yildiz 2022). To the best of my knowledge, no study has explored the relationship between trade, intra-industry trade, and terrorism, especially regarding Turkey.

Intra-industry trade allows workers and businesses to improve their skills and expertise in specific products, encouraging innovation and leveraging economies of scale. Consequently, a close analysis of how terrorism impacts trade, particularly intra-industry trade, is essential for understanding the unique challenges that could affect Turkey.

Intra-industry trade allows workers and businesses to improve their skills and expertise in specific products, encouraging innovation and leveraging economies of scale. Consequently, a close analysis of how terrorism impacts trade, particularly intra-industry trade, is essential for understanding the unique challenges that could affect Turkey. Despite the significance of intra-industry trade, very few studies have employed gravity models to examine this type of trade, such as (Leitão, Faustino, and Yoshida 2010; Wakasugi 2007; Yoshida, Leitão, and Faustino 2009). However, these studies did not focus on the impact of terrorism, particularly in developing economies like Turkey. This gap in the literature further underscores the importance of the present study.

To achieve the research goals, six unique one-way gravity models were implemented, employing terrorism data sourced from the Institute for Economics and Peace (IEP) (2023). These models were designed to address the following inquiries: (i) What impact do the global terror index (GTI), the frequency of terrorism incidents, and the number of fatalities among Turkey's trading partners have on Turkey's exports? (ii) In light of terrorist attacks, how do Turkey's exports be impacted by the economic similarities with its trade partners? (iii) What effect does Turkey's manufacturing industry similarities with those of the countries it trades with have on Turkey's exports in the case of terrorist incidents? (iv) How does terrorism affect Turkey's intra-industry trade, introducing a novel variable-relative endowment (RELEN) of information and communication technology (ICT) service exports compared to population size to capture the intra-industry trade context?

This study has two major contributions to the literature. First, it considers three distinct terrorism variables: the global terror index (GTI), the number of incidents (INC), and the number of fatalities (FTL) in each incident. Second, the study addresses the terror-trade relationship with a one-way gravity model tailored to Turkey and its top 71 export destination countries.

The study is arranged as follows: Section 2 provides comprehensive definitions relevant to the research context. Section 3 includes an in-depth review of the

literature, current research, and relevant hypotheses about the relationship between international trade and terrorism. Section 4 outlines the empirical strategy and explain data sources. Section 5 is devoted to the model estimation process and the presentation of the estimation results. Section 6 discusses the findings in the context of existing literature, while Section 7 summarizes the key insights and suggests avenues for future research.

2 Theoretical Framework

The gravity model draws its theoretical basis from Newton's law of universal gravitation. This model proposes that the volume of trade between two countries is directly related to their economic sizes and inversely related to the distance between them. This idea originates from Tinbergen (1962), who applied Newton's gravity theory; the model mathematically expresses the total trade (TT) between countries 'i' and 'j' as a function of their gross domestic products (GDP), distance, and an error term.

This can be expressed mathematically,

$$TT_{ij} = \beta_0 \left(\frac{GDP_i^{\beta_1} GDP_j^{\beta_2}}{D_{ij}^{\beta_3}} \right) \varepsilon_{ij} \quad (1)$$

While the theoretical foundation of the gravity model is widely accepted, modern applications have incorporated several adjustments to address economic and econometric challenges, particularly those raised by Anderson and Wincoop (2003) in relation to Multilateral Resistance Terms (MRT). MRT refers to the concept that trade between any two countries depends not only on bilateral factors (such as distance or tariffs) but also on their trade relationships with all other countries. This introduces the need for time-varying importer and exporter fixed effects to control for the unobserved multilateral resistance affecting trade flows. In standard gravity models, failure to account for these MRTs can lead to biased estimates.

To address the econometric challenges presented by Silva and Tenreyro (2006), specifically, the issue of heteroskedasticity and zero trade flows – the Poisson pseudo maximum likelihood (PPML) estimator has become a widely adopted solution. Unlike the traditional log-linearization of the gravity equation, which can produce inconsistent estimates when there are zero trade flows, the PPML estimator handles the multiplicative nature of the trade model in its original form, mitigating biases caused by zero trade observations and heteroskedasticity. The author employed the Poisson pseudo maximum likelihood high dimensional fixed effects (PPMLHDFE) command, as developed by Correia, Guimarães, and Zylkin (2020), for its ability to handle

high-dimensional fixed effects efficiently. This Stata command builds upon the Poisson pseudo maximum likelihood (PPML) estimator and enhances computational performance, particularly when dealing with large datasets and numerous dummy variables.

The primary motivation for employing PPML estimator in this study is its ability to effectively address both the zero-trade flow problem and the numerous dummy variable problem, while also accounting for multilateral resistance via importer fixed effects. The decision to exclude exporter fixed effects in this case is justified by the fact that Turkey is the sole exporter in the model, thus negating the need for such effects, as there is no variation in Turkey's characteristics across observations.

Given the presence of large dependent variable values (i.e. trade data reported in millions), the PPML estimator is preferred over alternatives like the Pooled Ordinary Least Squares (POLS) or Fixed Effects (FE) estimators. POLS, for instance, fails to account for heteroskedasticity, while FE approaches may introduce collinearity issues when multiple dummy variables are included.

The model specification is expressed as follows:

$$TT_{ij} = \exp [\beta_0 + \beta_1 \ln(\text{GDP}_i) + \beta_2 \ln(\text{GDP}_j) - \beta_3 \ln(\text{Distance}_{ij}) + \mu_{ij}] \varepsilon_{ij} \quad (2)$$

In this formulation, the inclusion of high-dimensional fixed effects – such as importer fixed effects – addresses multilateral resistance and controls for time-varying factors that affect trade flows. Importantly, the model's ability to handle the zero-trade issue and mitigate potential biases stemming from heteroskedasticity makes PPML the appropriate choice.

3 Literature Review

Sandler and Enders (2008, 17–47) underscored the diverse economic ins and outs of terrorism and identified how targeted nations bear financial burdens. These implications span trade restrictions, infrastructure destruction, the diversion of Foreign Direct Investment (FDI), and changes in public investment toward security. Noteworthy research has studied the impact of terrorism on various economic variables, including its impact on FDI (Arif, Rawat, and Khan 2020; Dimitrova, Triki, and Valentino 2022; Lanouar and Shahzad 2021; Polyxeni and Theodore 2019). A comprehensive understanding of these connections is essential for assessing the broader impact on the gross domestic product (GDP) and overall economic growth.

Simultaneously, terrorist attacks impose numerous costs on nations, causing tangible damages to critical infrastructure and property, as well as intangible losses like human lives, labour, and increased insurance risk premiums. The consequences

extend to reduced business profitability, a decline in tourist visits, and an increased demand for enhanced security measures. These multifaceted economic implications highlight the necessity of comprehending the interconnectedness of terrorism and various economic sides. For example, Bilgel and Karahasan (2017) investigated the impact of terrorism on Turkish exports. They revealed that between 1988 and 2001 when the study was conducted, income per person in the country's eastern regions declined by 6.6 %.

While numerous studies have explored the relationships between GDP, imports, exports, FDI, and terrorism, none comprehensively understand the dynamics surrounding trade in the same industry or the impacts of terrorism. Haq, Ullah, and Iqbal (2018) studied the effects of terror incidents on bilateral trade, utilizing a gravity model across 50 developing and developed nations with intense terror incidents from 1990 to 2013. Their research revealed that terrorism exerts an unfavourable effect on imports and exports, particularly when developing nations trade with wealthier counterparts.

Similarly, Baronchelli, Caruso, and Ricciuti (2022) used a gravity model to investigate the impact of arms embargoes on the trade of Small Arms and Light Weapons (SALW) from 1990 to 2017. Their findings showed that while total embargoes reduced SALW trade, EU embargoes were more effective than UN embargoes, which had no measurable impact. This study demonstrates how external restrictions, akin to the pressures terrorism exerts on trade flows, can be effectively analysed using gravity models.

Bandyopadhyay, Sandler, and Younas (2016) extended this investigation to include the analysis of terror incidents' effects on bilateral trade. Their findings indicated that compared to domestic terrorism, terrorist activities abroad have a more pronounced negative impact on overall manufactured trade, including exports, imports, and other categories. Interestingly, this negative effect is more perceivable on imports than on exports.

Chaudhury and Sinha (2019) examined the effects of terrorist activities on GDP and international commerce by using a panel vector autoregressive (VAR) model to examine 44 industrialized and developing nations between 1991 and 2015. Their findings demonstrated that while terror attacks have a more significant negative impact on foreign trade in underdeveloped countries, their influence is less noticeable in rich countries.

Julius, Azu, and Muhammad (2019) contributed to the discourse by examining the implications of terror incidents on commerce within the South African Development Community (SADC) countries, utilizing the Poisson pseudo maximum likelihood (PPML) estimator. Their findings suggested that terrorism has an extremely low effect on bilateral trade, with low- and middle-income countries experiencing

positive effects. In contrast, high-income countries observe negative impacts from terror activities.

In a departure from the direct impact of terrorism on trade, Okafor and Piesse (2018) shifted the focus towards understanding the factors contributing to terrorism. Their examination spanned from 2005 to 2014, involving 38 countries from various regions with the highest ranks on the Fragile States Index (FSI). Their results indicated that factors such as the proportion of refugees, youth unemployment, and countries with unstable economies all positively influence terrorism. Additionally, foreign direct investment (FDI) was identified as having an adverse effect on terrorism.

Pham and Nguyen (2024) investigated the impact of terrorist incidents in one country on a neighbouring country. According to the results of panel data analysis with more than 160 countries, trade with countries neighbouring the country with terrorist incidents decreased, and this effect was mainly in the Sub-Saharan Africa region.

Meierrieks and Schneider (2021) examined how terrorism affected global economic policy for 170 nations. They indicate that governments react to terrorism by adopting more restrictive foreign economic policies to prevent the formation and funding of terrorism, restrict capital flight, stabilize state finances, and demonstrate political determination. More importantly, they argue that the impact of terrorism is especially critical for smaller nations.

Some scholars studied the GDP-terror relationship with different econometric methodologies. Enders, Hoover, and Sandler (2016), in their study, established a Lorenz curve for terrorism to demonstrate the higher concentration of both domestic and international terrorist strikes in middle-income nations, pointing to a nonlinear link between income and terrorism. Their study is significant in the sense that they assume the relationship to be nonlinear. They also employed diverse data from The International Terrorism: Attributes of Terrorist Events (ITERATE) and the Global Terrorism Database (GTD). They also shed light on poverty and terrorism literature and answered questions about whether poverty stimulates terrorism.

Several regional studies have revealed the link between economic indicators and terrorism. Sezgin (2019) devised a novel index for Turkey spanning the years 1970–2016, showing the growth in trade volume relative to the growth of terror incidents. Despite a lack of empirical evidence, the study challenges the prevailing notion that terrorist attacks negatively impact international trade. Notably, Sezgin (2019) investigation failed to identify any substantial evidence supporting the negative influence of terrorism on Turkey's trade.

Ruiz Estrada, Park, and Khan (2018) investigated how Turkey's economic performance was impacted by terrorism. Employing a terrorist attack vulnerability evaluation model covering terror incidents, GDP distribution, and income

distribution, they argued that economic decline escalated between 1990 and 2016. Additionally, Bilgel and Karahasan (2019) focused on the PKK terror group's influence on the Turkish economy, utilizing the synthetic control method for the period 1955–2008. Their findings suggested that Turkey's GDP per capita could have been 13.8 % higher if not for the exposure to PKK terrorism.

While existing studies have extensively explored the connections between terrorism and broader economic indicators, such as GDP, imports, exports, and foreign direct investment, there is a gap in the literature concerning the nuanced effect of terrorism on intra-industry trade. Limited scholarly attention has been given to understanding how terrorism influences the intra-industry trade patterns of nations.

This study aims to address the significant gap in the understanding of the link between terror and intra-industry trade by exploring previously undiscovered areas. This study is the first to focus on this issue, offering a distinctive viewpoint on the financial effects of terrorism. By analysing the data through the lens of the proxy relative endowment (RELEN) calculated from ICT service exports per capita and introducing novel variables such as GDP similarity and manufacturing output similarity, the aim is to enrich the understanding of the interaction between terrorism and the broader economic structure, albeit at a broader level than specific industries.

This approach contributes to the existing trade-terror relationship literature and sheds light on the potential implications for policymaking. This study seeks to broaden the discourse on terrorism's economic impact, particularly in intra-industry trade dynamics, offering fresh insights extending beyond the current scope of scholarly investigation.

Helpman and Krugman (1987) proposed using differences in GDP per capita among countries and economic similarity as proxies for analysing intra-industry trade. Subsequent studies have adopted a similar approach; employing these variables as proxies to understand intra-industry dynamics. Some examples include (Antonucci and Manzocchi 2006; Karacan and Korkmaz 2022; Ülengin et al. 2015).

The literature review provides information on complex relationships between terrorism, economic indicators, and trade dynamics. While existing studies have made significant additions in understanding the macroeconomic impacts of terrorism, a notable gap remains in exploring the trade in the same industry specifically. This work aims to close this gap by focusing on Turkey's exports to 71 countries, employing one-way gravity model and contributing novel insights into the interplay between terrorism and trade, particularly at the intra-industry level.

4 Empirical Model and Data

Using Turkey's export data, I run a one-way gravity model with the 71 countries Turkey exports the most, accounting for 89.50 % of Turkey's total exports. The panel data model covers 11 years from 2012 to 2022. I obtained the export (EXP) dependent variable used in the model from the IMF database and presented it in thousands (IMF 2023). Apart from the dependent variable, export, different dependent variables are used to investigate the terrorism-trade relationship. The global terrorism index (GTI), the number of incidents (INC) and the number of fatalities (FTL) were obtained from the Institute for Economics and Peace (IEP) (2023) and covered the period 2012–2022, which was a limitation for this study. Among the model's other explanatory variables are the sum of the gross domestic product (GDP) of Turkey and the trading country (SUMGDP), economic similarities (SIMGDP), manufacturing industry similarities (SIMMANUF), relative factor endowments (RELEN) calculated by information and communication technology (ICT) service exports and population (POP), distance between the capital cities of the two nations, customs union dummy (CU) (1 if Turkey is a member of the customs union, 0 otherwise), colony dummy (1 if Turkey has a colonial history with Turkey, 0 otherwise), border neighbour dummy (1 if Turkey is a border neighbour, 0 otherwise). All data for dummies and distance data are retrieved from CEPII (2023).

The following are variable computations: Helpman and Krugman (1987)

$$\text{SIMGDP}_{ijt} = \ln \left[1 - \left(\frac{\text{GDP}_{it}}{\text{GDP}_{it} + \text{GDP}_{jt}} \right)^2 - \left(\frac{\text{GDP}_{jt}}{\text{GDP}_{it} + \text{GDP}_{jt}} \right)^2 \right] \quad (3)$$

$$\text{SIMMANUF}_{ijt} = \ln \left[1 - \left(\frac{\text{MANUF}_{it}}{\text{GDP}_{it} + \text{GDP}_{jt}} \right)^2 - \left(\frac{\text{MANUF}_{jt}}{\text{GDP}_{it} + \text{GDP}_{jt}} \right)^2 \right] \quad (4)$$

$$\text{RELEN}_{ijt} = \left(\ln \frac{\text{ICT}_{it}}{\text{POP}_{it}} - \ln \frac{\text{ICT}_{jt}}{\text{POP}_{jt}} \right) \quad (5)$$

In this study, I introduce a novel measure known as relative endowment (RELEN), calculated as the ratio of Information and Communication Technology (ICT) service exports (measured in Balance of Payments, current US\$) to the population (POP) of each country. This measure, expressed as ICT per capita (ICT/POP), is a proxy for capturing the Linder effect in international trade. According to Linder (1961), trade between nations is more likely when their demand patterns are comparable.

Employing relative endowment based on ICT per capita, I aim to show the similarity in trading entities' demand structures. A higher relative endowment indicates a greater similarity in the per capita consumption of ICT services between the two countries, aligning with the underlying Linder effect.

Using ICT per capita as a proxy for relative endowment enhances the ability to explore the relationships between countries, providing insights into the potential determinants of their trading patterns. This measure contributes to a broader examination of factors influencing international trade dynamics and provides a unique depth of demand similarities in shaping trade relationships.

The variable RELEN denotes relative endowment. It is calculated as the ratio between the logarithm of ICT service exports with Turkey's population and its trading partner's corresponding values. This metric captures the relative endowment of Information and Communication Technology (ICT) service exports in relation to the population size for both entities 'i' and 'j' at time 't'. Relative factor endowments capture the differences in the resource mix of two entities. A favourable effect indicates a willingness on the part of the entities to participate in inter-industry trade and for intra-industry trade, it is anticipated that the coefficient linked with (RELEN) will exhibit a negative trend.

When examining prior studies, including Antonucci and Manzocchi (2006), the variables SIMGDP, SUMGDP, and RELEN were utilized. It is worth noting that Antonucci and Manzocchi (2006) employed GDP within the computation of relative factor endowment. Building upon this research, subsequent studies by (Karacan and Korkmaz 2022; Ülengin et al. 2015) extended the exploration by incorporating Capital Stock per capita as a key component within their relative endowment analyses. These studies collectively contribute to the understanding of economic factors influencing trade dynamics. The GDP, manufacturing value-added, and ICT service exports data received from The World Bank WDI database The World Bank (2023) and correspondingly derived from GDP (current US\$), manufacturing value-added (current US\$), and ICT service exports Balance of Payments (BoP), (current US\$). Building on this data, I calculated relative endowment using ICT service exports as a key component, allowing for a broader understanding of trade dynamics and economic relationships.

The metric in consideration (SIMGDP) pertains to the assessment of "similarity" in size, and its impact can be either positive or negative, manifesting within a numerical range from -0.69 (indicating perfect similarity) to infinity (indicating perfect dissimilarity). Conversely, when trade extends across different industries, a negative coefficient is expected, reflecting the inclination towards dissimilarity in size Helpman and Krugman (1987). The variable SIMMANUF measures similarity in the manufacturing sector between two entities, 'i' and 'j', for duration 't'. The numerator of each fraction shows the respective entities' manufacturing output (MANUF), while the denominators account for the total economic activity represented by the sum of their GDPs. Like the previously introduced variable (SIMGDP), the range of (SIMMANUF) lies within the logarithmic space. Values approaching zero indicate a high degree of similarity in manufacturing output between entities

i and j , and higher values represent increasing dissimilarity. This logarithmic transformation is applied to maintain symmetry in the measurement scale and effectively capture proportional differences. The SIMMANUF variable represents the logarithm of the complement of the squared proportion of manufacturing output for two countries, adjusted for their respective GDPs. It is designed to capture the similarity in manufacturing composition between the two nations.

To estimate the terror incidences on the export of Turkey, I applied augmented gravity model with Poisson pseudo maximum likelihood (PPML) estimator. All variables except the dependent variable and the dummies are in log form.

I estimated six models and included the SUMGDP variable in three of these models and the SUMMANUF variable in the other three. In this way, I investigated the effect of similarities in GDP and manufacturing industries on Turkish exports for 71 countries trading with Turkey. To analyse the effect of terrorism on Turkey's exports, I separately include the global terrorism index (GTI), the number of terrorist incidents (INC) and the number of fatalities in terrorist incidents (FTL). I also include Border*INC, Border*FTL and Border*GTI interaction variables to estimate the impact of terrorist incidents in countries bordering Turkey. I also added the GTI*FTL interaction variable to have more information on the terrorism index and the number of deaths in countries that do not border Turkey. The model specifications of augmented gravity models are as follows:

In the gravity model equations used in this study, i refers to Turkey, the sole exporter, while j represents the various destination countries. Since there is only one exporter, Turkey's characteristics do not vary across observations and are therefore not included as a fixed effect. Instead, the focus is on the variations between the importing countries (denoted by j) over time.

The one-way gravity model applied in this study is designed to reflect the specific structure of the data, where exports from Turkey to 71 different countries form the basis of the analysis. As such, the estimation equations include variables like the Global Terror Index (GTI), sum of gross domestic product (SUMGDP), and trade-related factors that vary by destination country and time. The general model specifications are as follows:

$$\begin{aligned} \text{EXP}_{ijt} = \exp & \left[\alpha + \beta_1 \text{GTI}_{jt} + \beta_2 \text{GTI}_{it} + \beta_3 \text{SUMGDP}_{ijt} + \beta_4 \text{SIMGDP}_{ijt} + \beta_5 \text{RELEN}_{ijt} \right. \\ & + \beta_6 \text{POP}_{jt} + \beta_7 \text{POP}_{it} + \beta_8 \text{Distance}_{ij} + \beta_9 \text{Border}_{ij} + \beta_{10} \text{Colony}_{ijt} + \beta_{11} \text{CU}_{jt} \\ & \left. + \mu_{ij} \right] + \varepsilon_{ijt} \end{aligned} \quad (6)$$

$$\begin{aligned} \text{EXP}_{ijt} = \exp & \left[\alpha + \beta_1 \text{GTI}_{jt} + \beta_2 \text{GTI}_{it} + \beta_3 \text{SUMGDP}_{ijt} + \beta_4 \text{SIMMANUF}_{ijt} + \beta_5 \text{RELEN}_{ijt} \right. \\ & + \beta_6 \text{POP}_{jt} + \beta_7 \text{POP}_{it} + \beta_8 \text{Distance}_{ij} + \beta_9 \text{Border}_{ij} + \beta_{10} \text{Colony}_{ijt} + \beta_{11} \text{CU}_{jt} \\ & \left. + \mu_{ij} \right] + \varepsilon_{ijt} \end{aligned} \quad (7)$$

$$\begin{aligned}
 \text{EXP}_{ijt} = \exp & \left[\alpha + \beta_1 \text{INC}_{jt} + \beta_2 \text{INC}_{it} + \beta_3 \text{SUMGDP}_{ijt} + \beta_4 \text{SIMGDP}_{ijt} + \beta_5 \text{RELEN}_{ijt} \right. \\
 & + \beta_6 \text{POP}_{jt} + \beta_7 \text{POP}_{it} + \beta_8 \text{Distance}_{ij} + \beta_9 \text{Border}_{ij} + \beta_{10} \text{Colony}_{ijt} + \beta_{11} \text{CU}_{jt} \\
 & \left. + \beta_{12} \text{Border} * \text{INC}_{ijt} + \mu_{ij} \right] + \varepsilon_{ijt}
 \end{aligned} \tag{8}$$

$$\begin{aligned}
 \text{EXP}_{ijt} = \exp & \left[\alpha + \beta_1 \text{INC}_{jt} + \beta_2 \text{INC}_{it} + \beta_3 \text{SUMGDP}_{ijt} + \beta_4 \text{SIMMANUF}_{ijt} + \beta_5 \text{RELEN}_{ijt} \right. \\
 & + \beta_6 \text{POP}_{jt} + \beta_7 \text{POP}_{it} + \beta_8 \text{Distance}_{ij} + \beta_9 \text{Border}_{ij} + \beta_{10} \text{Colony}_{ijt} + \beta_{11} \text{CU}_{jt} \\
 & \left. + \beta_{12} \text{Border} * \text{INC}_{ijt} + \mu_{ij} \right] + \varepsilon_{ijt}
 \end{aligned} \tag{9}$$

$$\begin{aligned}
 \text{EXP}_{ijt} = \exp & \left[\alpha + \beta_1 \text{FTL}_{jt} + \beta_2 \text{FTL}_{it} + \beta_3 \text{SUMGDP}_{ijt} + \beta_4 \text{SIMGDP}_{ijt} + \beta_5 \text{RELEN}_{ijt} \right. \\
 & + \beta_6 \text{POP}_{jt} + \beta_7 \text{POP}_{it} + \beta_8 \text{Distance}_{ij} + \beta_9 \text{Border}_{ij} + \beta_{10} \text{Colony}_{ijt} \\
 & \left. + \beta_{11} \text{CU}_{jt} + \beta_{12} \text{Border} * \text{FTL}_{ijt} + \mu_{ij} \right] + \varepsilon_{ijt}
 \end{aligned} \tag{10}$$

$$\begin{aligned}
 \text{EXP}_{ijt} = \exp & \left[\alpha + \beta_1 \text{GTI}_{jt} + \beta_2 \text{GTI}_{it} + \beta_3 \text{FTL}_{jt} + \beta_4 \text{FTL}_{it} + \beta_5 \text{SUMGDP}_{ijt} \right. \\
 & + \beta_6 \text{SIMMANUF}_{ijt} + \beta_7 \text{RELEN}_{ijt} + \beta_8 \text{POP}_{jt} + \beta_9 \text{POP}_{it} + \beta_{10} \text{Distance}_{ij} \\
 & + \beta_{11} \text{Border}_{ij} + \beta_{12} \text{Colony}_{ijt} + \beta_{13} \text{CU}_{jt} + \beta_{14} \text{GTI} * \text{FTL}_{jt} + \beta_{15} \text{Border} * \text{GTI}_{ijt} \\
 & \left. + \mu_{ij} \right] + \varepsilon_{ijt}
 \end{aligned} \tag{11}$$

Given that Turkey is the sole exporter, there is only one i , and hence the exporter fixed effects do not add value. This distinction is important because the model primarily examines variations on the importing side, i.e. across j (the destination countries). The fixed effects μ_{ij} capture unobserved bilateral heterogeneity, and time-varying factors are incorporated through destination-specific variables, including the Global Terror Index, population, and GDP. Importer fixed effects are applied in the robustness check section to ensure that the multilateral resistance terms (MRT) are adequately addressed, as recommended in gravity model literature. Additionally, a random coefficients model is estimated to account for heterogeneity across countries.

By focusing on the relationship between Turkey and its trading partners, the one-way gravity model effectively captures the dynamics of trade flows where Turkey remains the consistent exporter, and the variation stems from changes in the importing countries' characteristics.

The list of countries included in this study, which account for 89.50 percent of Turkey's total exports, is given in Table 1.

This section summarizes the dataset, data calculations, and interaction terms. I have also presented the specifications of the six models used in the analysis. Subsequent dedicated sections provide detailed explanations and discussions about the

Table 1: List of countries included in the research.

Algeria	Côte d'Ivoire	Iraq	Netherlands	Spain
Argentina	Croatia	Ireland	Norway	Sweden
Australia	Czech Republic	Israel	Oman	Switzerland
Austria	Denmark	Italy	Pakistan	Syrian Arab Republic
Azerbaijan	Egypt	Japan	Peru	Thailand
Bahrain	Finland	Kazakhstan	Poland	Tunisia
Bangladesh	France	Korea Republic	Portugal	Turkmenistan
Belarus	Georgia	Libya	Qatar	Ukraine
Belgium	Germany	Lithuania	Romania	United Arab Emirates
Brazil	Greece	Malaysia	Russia	United Kingdom
Bulgaria	Hungary	Mauritania	Saudi Arabia	United States
Canada	India	Mexico	Singapore	Uzbekistan
Chile	Indonesia	Moldova	Slovak Republic	Venezuela
China	Iran	Morocco	Republic of Slovenia	Vietnam
Colombia				

estimation method, model assumptions, model results, model validation, and statistical significance.

5 Estimation Results

In this part of the research, I present a complete analysis of the estimation results relating to Turkey's exports and intra-industry trade and the relationship between terrorism indicators and trade dynamics. To ensure a thorough understanding of the dataset, a brief review of descriptive statistics and graphical representations is conducted before examining the specific results.

Two graphical representations accompany the quantitative analysis. Figure 1 shows the geographical distribution of terrorist incidents by provinces in Turkey. Figure 2 shows the distribution of the number of deaths in terrorist incidents by provinces.^{1,2}

Figure 1 illustrates the geographic distribution of terrorism-related incidents in Turkey between 2012 and 2020. The data reveals a spatial concentration of incidents

¹ The data used for the illustration of the figures are obtained from "START (National Consortium for the Study of Terrorism and Responses to Terrorism). (2022). Global Terrorism Database, 1970–2020 [data file]. <https://www.start.umd.edu/gtd>".

² The terrorist incidents and deaths depicted in the figures are caused by multiple terrorist organisations.

Geographic Distribution of Terror Incidents in Turkey

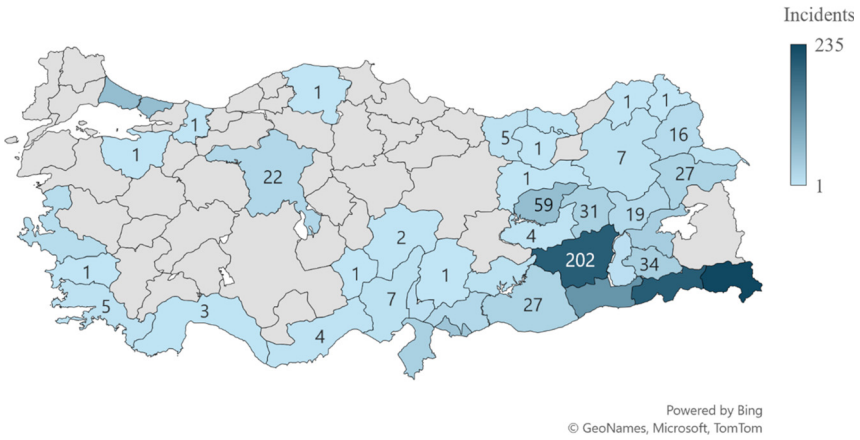


Figure 1: Terror incidents in Turkey according to cities between 2012 and 2020.

Geographic Distribution of Terrorism-Related Fatalities in Turkey

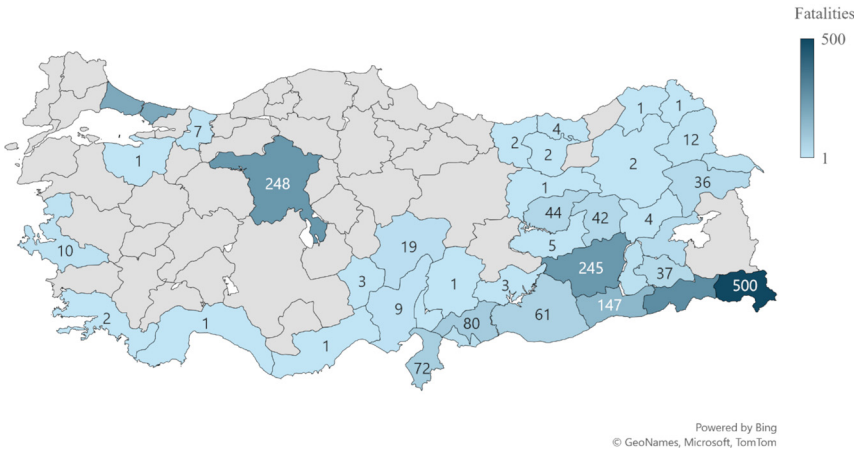


Figure 2: Terrorism-related fatalities in Turkey according to cities between 2012 and 2020.

within the Eastern Anatolia Region, particularly near the Iraq-Syria border. Conversely, the Southeastern Anatolia Region experienced a lower frequency of such events.

Cities with the highest number of incidents include Hakkari, Şırnak, Diyarbakır, Mardin, Van, and Tunceli. Notably, major urban centres like Istanbul and Ankara witnessed 59 and 22 incidents, respectively. Conversely, the Mediterranean and Aegean coastal areas generally reported fewer occurrences.

This spatial pattern aligns with the presence of established terrorist organizations near the Iraq-Syria border. As noted by the Republic of Türkiye Ministry of Foreign Affairs (2022a), the PKK terrorist group, maintains training camps in the Qandil Mountains, enabling them to infiltrate Turkey and launch attacks (Republic of Türkiye Ministry of Foreign Affairs 2022b). We see a decline in PKK-related incidents following counter-terrorism operations by the Turkish Armed Forces. The number of incidents attributed to the PKK reportedly decreased from 147 in 2016 to 10 in 2020.³

This figure presents the spatial distribution of terrorism-related fatalities across Turkey from 2012 to 2020. The map visualizes cumulative fatalities in various regions, highlighting cities with varying levels of impact.

The Eastern Anatolia Region experienced the most significant concentration of fatalities, with cities like Hakkari, Şırnak, Diyarbakır, Mardin, and Gaziantep reporting particularly high numbers. Additionally, Istanbul and Ankara, major urban centres, recorded a total of 191 and 248 fatalities, respectively. These incidents targeted not only security personnel but also civilians, underscoring the indiscriminate nature of terrorist attacks.

A particularly devastating event was the Ankara train station bombings of October 2015, which claimed the lives of 109 civilians. This attack remains the deadliest terrorist incident in Turkey's history.

In 2016, Fethullah Gülen Terrorist Organization (FETO) had a coup attempt. Two thousand people were injured, and 246 people died during the coup attempt. The Turkish Parliament and the Presidential Palace were two of the several government structures that were bombarded. This coup attempt was thwarted, and the Turkish people upheld democracy and the rule of law: the Prime Minister, the Government, the Members of the Grand National Assembly, and the President, as stated by the Republic of Türkiye Ministry of Foreign Affairs (2022b).

After conducting graphical analysis to explore the relationship between terror incidents and fatalities, attention turns to the descriptive statistics presented in Table 2. This table provides a summary of the data used to explore the relationship between trade and terrorism.

Table 2 provides a summary of terrorism incidents, associated fatalities and other variables among Turkey's trading partners. The data reveals a wide range of

³ For chronological calculation the following data are used: "START (National Consortium for the Study of Terrorism and Responses to Terrorism). (2022). Global Terrorism Database, 1970–2020 [data file]. <https://www.start.umd.edu/gtd>".

Table 2: Descriptive statistics.

Variable	N	Mean	Std Dev	Min	Max
Export _{ijt}	777	2,318,208	3,221,849	1,076.295	20,900,000
Global Terror Index (GTI) of partner	781	2.967	2.554	0	10
Global Terror Index (GTI) of Turkey	781	6.963	0.791	5.600	8.173
Incidents (INC) in partner	781	39.450	176.148	0	2,974
Incidents (INC) in Turkey	781	84.090	84.768	10	247
Fatalities (FTL) in partner	781	61.649	339.642	0	4,807
Fatalities (FTL) in Turkey	781	130.818	168.697	6	591
Sum of GDPs	769	1,960,000 ^a	2,890,000 ^a	729,000 ^a	26,400,000 ^a
GDP similarity	769	0.675	0.523	0.013	1.971
Manufacturing similarity	723	0.597	0.492	0.005	1.931
Relative endowment (ICT per capita)	703	1.106	0.635	0.008	1.987
Population of trading partner	781	82,700,000	228,000,000	1,224,939	1,420,000,000
Population of Turkey	781	81,200,000	3,243,524	75,300,000	85,300,000
Distance _{ij}	781	4,178.751	3,604.307	779.451	14,512.600

^aRepresented in thousands.

incidents, from zero to 2,974 (in Iraq, 2015). Turkey itself experienced incidents ranging from 10 to 247. Fatalities also varied significantly, with Iraq reporting a maximum of 4,807 (in 2015) and Turkey's highest being 591.

Regarding exports, Turkey's largest trading partners included Germany (US\$20.90 billion), the United States, the United Kingdom, Iraq, and Italy. In contrast, Bahrain, Mauritania, and Venezuela received relatively low exports from Turkey.

Following the presentation of Table 2, which shows the descriptive statistics of the data used in this study, Table 3 presents the estimation results. Six distinct models were conducted to analyse the relationship between terrorism, Turkey's exports, and intra-industry trade. The PPML estimator was employed in both models, and the correctness of the model specifications was assessed using the Reset Test.

The estimation results for the six econometric models are presented in Table 3. Models 1 and 2 correspond to Equations (6) and (7), respectively, focusing on the impact of terrorism on Turkey's exports using the "Global Terror Index" (GTI) as the primary variable. Models 3 and 4, derived from Equations (8) and (9), incorporate "terror incidents" (INC) as a key measure. Finally, Models 5 and 6, based on Equations (10) and (11), introduce "fatalities" (FTL) as an additional explanatory variable, with Model 6 assessing the combined effects of GTI and FTL. The results underscore the significant influence of terrorism on Turkey's export performance, whether the threat is domestic or originates from the trading partner.

Models 1, 2, and 6 highlight the Global Terror Index (GTI) as a critical explanatory factor. In these models, the GTI of partner countries exerts a positive and significant

Table 3: Gravity model estimation results using PPML estimator.

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Global Terror Index (GTI) of partner	0.265 ^c (5.37)	0.352 ^c (6.80)				0.119 ^b (2.20)
Global Terror Index (GTI) of Turkey	-0.863 ^c (-2.96)	-1.097 ^c (-3.32)				-0.099 (-1.04)
Incidents (INC) in partner			0.020 (1.19)	0.0349 ^a (1.73)		
Incidents (INC) in Turkey			-0.040 ^b (-2.10)	-0.047 ^b (-2.10)		
Fatalities (FTL) in partner					-0.008 (-0.45)	0.175 (1.27)
Fatalities (FTL) in Turkey					-0.041 ^b (-2.17)	0.001 (0.03)
Sum of GDPs	0.484 ^c (5.29)	0.817 ^c (10.38)	0.758 ^c (8.15)	1.221 ^c (19.82)	0.808 ^c (7.61)	1.154 ^c (16.91)
GDP similarity	1.508 ^c (8.36)		1.387 ^c (6.80)		1.310 ^c (5.37)	
Manufacturing similarity		0.493 ^c (3.02)		0.235 ^c (2.80)		0.336 ^c (3.85)
Relative endowment (ICT per capita)	0.071 ^c (3.11)	0.024 (0.91)	0.073 ^c (2.71)	0.068 ^b (2.20)	0.080 ^c (2.96)	0.0698 ^b (2.23)
Population of trading partner	-0.188 ^c (-4.63)	-0.046 (-1.08)	-0.267 ^c (-6.48)	-0.165 ^c (-3.77)	-0.281 ^c (-6.62)	-0.219 ^c (-4.90)
Population of Turkey	0.621 (0.74)	1.351 (1.49)	1.190 ^b (2.10)	2.202 ^c (3.08)	1.154 ^a (1.75)	0.758 (1.15)
Distance _{ij}	-0.862 ^c (-20.31)	-0.848 ^c (-19.34)	-0.925 ^c (-19.88)	-0.986 ^b (-18.56)	-0.934 ^c (-18.01)	-0.934 ^c (-15.00)
Border _{ij}	0.336 ^b (2.10)	0.371 ^b (2.10)	-2.121 ^c (-5.92)	-2.551 ^c (-6.02)	-0.968 ^c (-3.72)	-5.805 ^c (-5.39)
Colony _{ij}	0.314 ^c (3.29)	0.099 (1.04)	0.313 ^b (2.28)	0.066 (0.45)	0.388 ^c (2.87)	0.359 ^c (2.64)
Customs union	0.280 ^c (3.28)	0.527 ^c (5.37)	0.337 ^c (3.37)	0.584 ^c (5.71)	0.402 ^c (3.60)	0.657 ^c (6.54)
Border*Incidents			0.501 ^c (9.53)	0.598 ^c (8.61)		
Border*Fatalities					0.329 ^c (9.32)	
GlobalTerrorIndex*Fatalities						-0.132 ^a (-1.83)
Border*GlobalTerrorIndex						3.540 ^c (7.05)
Constant	-0.215 (-0.01)	-24.339 (-1.43)	-17.620 (-1.64)	-49.081 ^c (-3.89)	-17.867 (-1.38)	-20.227 ^a (-1.75)

Table 3: (continued)

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
N	561	546	358	349	253	244
Pseudo R ²	0.7662	0.7282	0.8835	0.8577	0.9073	0.9006
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Reset test	[0.610]	[0.290]	[0.184]	[0.435]	[0.793]	[0.276]

(), [] denote t-statistics and p-values respectively. ^(a), ^(b), ^(c) indicate significance at 10 %, 5 % and 1 % respectively. PPMLHDFE command is used for the estimates.

effect on Turkey's exports. For example, the coefficients in Model 1 (0.265) and Model 2 (0.352) are significant at the 1 % level, suggesting that heightened terrorism risks in partner countries are associated with increased trade volumes for Turkey. In contrast, Turkey's own GTI consistently shows a negative impact on exports, with coefficients of -0.863 (Model 1) and -1.097 (Model 2), both significant at the 1 % level, indicating that elevated terrorism risks within Turkey reduce its export performance. In Model 6, the interaction between GTI and border proximity exhibits a significant positive effect (coefficient of 3.540), suggesting that geographical proximity to high-risk areas can paradoxically enhance Turkey's exports.

Models 3 and 4 examine the influence of terrorism incidents (INC) on Turkey's exports. The findings reveal that an increase in the number of incidents in partner countries has a modestly positive impact on exports, with a coefficient of 0.0349 in Model 4, significant at the 10 % level. Conversely, terrorism incidents within Turkey have a consistently negative effect on exports, with coefficients of -0.040 (Model 3) and -0.047 (Model 4), both significant at the 5 % level. These results indicate that while rising terrorism incidents in partner countries may marginally boost trade, increased incidents within Turkey lead to reduced export performance. Furthermore, the interaction between border proximity and incidents is significant and positive in both models, with coefficients of 0.501 (Model 3) and 0.598 (Model 4), both significant at the 1 % level, suggesting that incidents near borders may encourage cross-border trade, possibly due to security-related commerce.

Models 5 and 6 focus on the effect of fatalities (FTL) on Turkey's exports. The analysis shows that fatalities in partner countries do not have a significant impact on Turkey's exports, as evidenced by the insignificant coefficients in both models. However, fatalities within Turkey exhibit a significant negative impact on exports in Model 5, with a coefficient of -0.041 . Interestingly, this relationship becomes insignificant in Model 6. The interaction between border proximity and fatalities in Model 5 is positive and significant (coefficient of 0.329), implying that fatalities near borders may stimulate cross-border trade.

Economic indicators such as the sum of GDPs and GDP similarity emerge as consistent and significant drivers of trade across all models. The sum of GDPs yields coefficients ranging from 0.484 in Model 1 to 1.221 in Model 4, while GDP similarity has coefficients ranging from 1.310 in Model 5 to 1.508 in Model 1, aligning with economic theory that suggests larger and economically similar countries tend to trade more with each other. Manufacturing similarity is also significant in Models 2, 4, and 6, with coefficients between 0.235 and 0.493, indicating that greater similarity in manufacturing structures fosters increased trade. Additionally, the relative endowment of ICT per capita is significant in most models, with coefficients reflecting that countries with better ICT capabilities engage more in trade. The coefficient sign of ICT service export per capita is positive in all six models indicating inter-type of trade. Population dynamics show mixed effects: while the trading partner's population consistently has a negative impact on exports, with coefficients ranging from -0.046 to -0.281 , the significance of Turkey's population varies across models. Both economic similarities (SIMGDP) and manufacturing industry similarities (SIMMANUF) coefficients are positive, indicating intra-industry trade. This implies that Turkey and its partner countries are engaging in intra-industry trade, corroborating the findings of Karacan and Korkmaz (2022).

Geographical distance between trading partners remains a significant constraint on trade across all models, with coefficients ranging from -0.848 to -0.986 . Border proximity and colonial ties generally enhance trade, although their effects vary between models. The presence of a customs union consistently shows a significant and positive impact on trade, with coefficients between 0.280 and 0.657, highlighting its role in facilitating cross-border commerce.

All models include high-dimensional fixed effects and pass the RESET test for functional form misspecification, indicating that the models are well-specified. The pseudo-R-squared values range from 0.7282 to 0.9073, suggesting a good fit for the trade data.

The empirical findings of this study align with existing literature, which consistently highlights the negative impact of terrorism on trade. Doucouliagos (2017) reported that an additional terrorist attack in a bordering country could reduce bilateral trade by approximately 0.013 %, leading to a loss of roughly \$6.4 million USD in total trade value. Additionally, fatalities resulting from terrorist events have a diminishing effect on bilateral trade. Similarly, Shah, Hasnat, and Sarath (2020) found that a 1 % increase in terror incidents led to a 0.091 % reduction in Pakistan's exports. Comparable results were obtained by Egger and Gassebner (2015), who demonstrated that terrorist activities, both historical and ongoing, in exporting and importing countries typically result in a decline in trade. However, the extent of this impact varies depending on the timing of the attacks and the characteristics of the countries involved. Furthermore, their analysis underscores the

potential for time aggregation bias, which could affect the precision of the findings. Bardwell and Iqbal (2021) further noted that 74 % of terror-related fatalities occurred in Syria, Iraq, Afghanistan, Nigeria, and Pakistan, leading to a 22 % decrease in Afghanistan's GDP in 2018 and a 27 % decrease in Iraq's GDP in 2014.

While Turkey is a developing nation, it faces challenges related to terrorism, a pervasive issue in many regions (Luca 2021). suggests that developed economies are often better equipped to mitigate the economic consequences of terrorism due to their stronger security capabilities and faster response mechanisms. Conversely, underdeveloped nations like Syria, Iraq, and Afghanistan have borne a disproportionate economic burden, with terrorism accounting for over 50 % of GDP in some cases. The findings of this study are consistent with those reported by (Çetin, Keser, and Ay 2019), who observed that terrorism exerts a negative influence on key macroeconomic indicators, including GDP, exports, and foreign investment, particularly in the Middle East. Like the estimation results in this study, they found that the economic impact of terrorism is especially pronounced in Turkey, where it significantly increases public expenditure. Their use of spatial lag estimation further supports the idea that the effects of terrorism are not confined to the countries directly experiencing the attacks but have broader regional implications due to international interactions. This aligns with the findings that highlight the substantial impact of terrorism on Turkey's exports, particularly when considering border proximity and regional instability.

In line with the broader literature on the impact of violence, including terrorism and conflict, the findings of this study echo the conclusions drawn by Dinçer and Yüksel (2019), who emphasize that conflict risks lead to significant economic and social disruptions in affected countries. Like how terrorism negatively impacts GDP, exports, and public expenditure, conflicts also result in lower economic growth and heightened unemployment, particularly in the Middle East. The overlap between the economic consequences of terrorism and conflict is evident in the destabilizing effects observed in countries like Syria, Iraq, and Turkey. Furthermore, the social and political repercussions of violence, such as increased corruption and reduced government effectiveness, align with the observed negative impacts of terrorism on macroeconomic stability.

6 Robustness Checks

6.1 Estimation with Year and Importer Fixed Effects

To test the robustness of the findings presented in Table 3, I re-estimate the models using the PPML estimator while incorporating year and importer fixed effects. The

Table 4: Gravity model estimation results using PPML estimator with “year” and “importer fixed effects”.

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Global Terror Index (GTI) of partner	−0.050 (−1.38)	−0.054 (−1.47)				0.057 ^a (1.79)
Incidents (INC) in partner			0.025 ^b (2.08)	0.022 ^a (1.91)		
Fatalities (FTL) in partner					−0.013 (−1.33)	−0.019 (−1.20)
Sum of GDPs	0.603 ^c (2.65)	0.598 ^c (2.61)	0.989 ^c (4.12)	1.334 ^c (6.60)	1.624 ^c (6.87)	1.160 ^c (5.18)
GDP similarity	0.952 ^b (2.39)		0.830 ^b (2.04)		0.837 ^b (2.68)	
Manufacturing similarity		0.277 ^b (2.04)		0.260 ^b (2.29)		0.215 ^a (1.68)
Relative endowment (ICT per capita)	0.095 (1.43)	0.078 (1.11)	0.120 (1.65)	0.178 ^c (4.18)	0.084 ^a (1.80)	0.032 (0.48)
Population of trading partner	−1.734 ^c (−4.42)	−1.837 ^c (−3.89)	−0.989 ^b (−2.04)	0.418 (1.12)	0.420 (1.10)	−0.128 (−0.27)
Customs union	−0.051 (−1.13)	−0.074 ^a (−1.75)	−0.103 ^a (−1.86)	−0.266 ^c (−5.21)	−0.151 ^c (−3.19)	−0.033 (−0.57)
Constant	28.176 ^c (2.82)	31.304 ^c (2.68)	4.216 (0.35)	−29.610 ^c (−2.85)	−39.425 ^c (−3.42)	−15.503 (−1.27)
N	613	597	375	366	269	262
Pseudo R ²	0.970	0.970	0.976	0.972	0.9751	0.977
Fixed effects	Importer year	Importer year	Importer year	Importer year	Importer year	Importer year
Reset test	[0.3574]	[0.145]	[0.061]	[0.286]	[0.1676]	[0.6454]

(), [] denote z-statistics and p-values respectively. (°), (°), (°) indicate significance at 10 %, 5 % and 1 % respectively. PPMLHDFE command is used for the estimates.

results of these estimations are displayed in Table 4. This approach allows us to control for any unobserved time-variant or country-specific factors that may influence Turkey's exports, providing a more comprehensive understanding of the relationships between terrorism, economic indicators, and trade performance.

Models 1 and 2 in Table 4 include the Global Terror Index (GTI) as the primary explanatory variable, while Models 3 and 4 focus on terror incidents (INC), and Models 5 and 6 incorporate fatalities (FTL) as key measures. These results are compared with the baseline models (without fixed effects) to assess the consistency and robustness of the estimates.

Unlike the previous estimations, where the GTI of partner countries had a positive and significant effect on Turkey's exports, in the robustness models, the effect is either insignificant or marginally significant. For instance, in Models 1 and 2,

the coefficients are (-0.050) and (-0.054) , respectively, with both being statistically insignificant. However, Model 6 shows a positive and marginally significant effect (0.057, significant at the 10 % level). This contrasts with the results in Table 3, where the GTI of partner countries consistently exhibited a positive and highly significant effect.

The results for terror incidents (INC) in partner countries in Models 3 and 4 remain consistent with those in Table 3. The coefficient for incidents is positive and significant in both models, with the effect being stronger and more statistically significant in Model 3 (0.025, significant at the 5 % level). This aligns with the previous finding that increasing terrorism incidents in partner countries can paradoxically boost Turkey's exports.

Fatalities (FTL) in partner countries continue to show no significant impact on Turkey's exports across Models 5 and 6. This finding remains consistent with the estimation results presented in Table 3, indicating that fatalities in trading partners do not exert a direct influence on trade performance.

Economic factors such as the sum of GDPs and GDP similarity remain highly significant across all models, consistent with the previous estimation. The sum of GDPs continues to exhibit strong positive effects on Turkey's exports, with coefficients ranging from 0.603 (Model 1) to 1.624 (Model 5), all significant at the 1 % level. GDP similarity also remains a positive and significant driver of trade, though the coefficients are slightly lower than in the previous models, ranging from 0.830 (Model 3) to 0.952 (Model 1).

Like the previous estimated models, manufacturing similarity continues to exert a positive and significant influence on exports. The coefficients are smaller in magnitude, ranging from 0.215 to 0.277, but remain significant in Models 2, 4, and 6, indicating the importance of intra-industry trade.

The population of trading partners exhibits a strong negative effect in Models 1. However, in Models 4, 5, and 6, the significance of the population variable diminishes, with coefficients becoming either insignificant or changing signs. This divergence could be attributed to the inclusion of fixed effects, which control for unobserved country-specific characteristics that may be correlated with population.

The customs union variable, which was previously positive and significant in Table 3, now exhibits negative or insignificant coefficients across most models in Table 4. The inclusion of fixed effects appears to alter the impact of customs unions on Turkey's exports, suggesting that the positive association observed earlier may be driven by unobserved factors captured by the importer or year effects.

The RESET test results across all models indicate that the models are correctly specified in terms of functional form. Only importer fixed effects are included in Model 4 and Model 5 because including year effects resulted in a specification error, as identified by the RESET test. This ensures that the model remains well-specified

and avoids overfitting by focusing on the significant importer-specific variations without introducing unnecessary year effects.

When comparing the results from Table 4 (with year and importer fixed effects) to those in Table 3 (without fixed effects), several differences emerge:

- The positive impact of the Global Terror Index of partner countries observed in Table 3 becomes weaker or insignificant in Table 4, suggesting that controlling for unobserved importer and year-specific factors alters the relationship between terrorism and trade.
- The effects of terror incidents in partner countries remain consistent across both tables, reinforcing the finding that an increase in incidents may boost exports.
- Economic variables such as the sum of GDPs and GDP similarity remain robust and significant across both models, highlighting their strong influence on trade performance.
- The influence of population and customs unions varies between the two sets of results, with the fixed-effects models providing more nuanced insights into these relationships.

Including year and importer fixed effects provides a more refined understanding of the factors affecting Turkey's exports, particularly in terms of the role of terrorism and economic indicators. While some results remain consistent with the no-effects models, others, such as the impact of the Global Terror Index and customs unions, suggest that unobserved factors play a critical role in shaping these relationships.

6.2 Random Coefficients Model

The application of random coefficients models is particularly suited for capturing the inherent complexity and heterogeneity in gravity models. As noted by Baltagi, Egger, and Pfaffermayr (2014), random effects models effectively handle the double or even triple indexing of country pairs, addressing the unobserved heterogeneity that arises in bilateral trade relationships. In gravity models, unobserved factors such as cultural affinity, historical ties, or participation in trade agreements often vary across countries and are not directly measurable. By incorporating random effects, the model introduces flexibility, allowing these unobserved factors to be treated as random, rather than fixed, across country pairs. This enables the model to account for variations in the way different countries interact in trade, without the restrictive assumptions imposed by fixed-effects models.

Mathematically, consider a standard gravity model of trade where bilateral trade flows Y_{ij} between country i and country j are influenced by observed factors X_{ij}

(such as GDP, distance, and tariffs). A basic fixed-effects model assumes that the unobserved heterogeneity across country pairs is constant:

$$Y_{ij} = X_{ij}\beta + \alpha_i + \alpha_j + \varepsilon_{ij} \quad (12)$$

where α_i and α_j represent country-specific fixed effects. However, this specification may not capture the full complexity of trade relationships, especially when the unobserved factors are not constant across trading partners. By contrast, a random coefficients model assumes that the impact of some explanatory variables varies across countries:

$$Y_{ij} = X_{ij}(\beta + u_{ij}) + \alpha_i + \alpha_j + \varepsilon_{ij} \quad (13)$$

where u_i represents the random deviation from the average effect of X_{ij} , allowing for heterogeneity in the coefficients across country pairs. This random variation captures the idea that, for instance, the effect of distance or tariffs on trade may differ depending on the specific trade relationship.

Egger and Prusa (2014) further justify the use of random coefficients models in the presence of measurement error or heterogeneous responses to variables like tariffs and distance. In trade models, these variables are often subject to varying levels of accuracy or influence depending on the countries involved. For example, the impact of the Global Terrorism Index (GTI) or GDP on trade may not be uniform across all countries; some trading relationships may be more sensitive to terrorism or economic size than others. A random coefficients model captures this variation by allowing for different sensitivities across trading partners, thus reflecting the nuanced nature of international trade dynamics.

To formalize this, consider the random coefficient for a variable X_{ij} in the context of international trade. The model can be represented as:

$$Y_{ij} = X_{ij}\beta + Z_{ij}(\gamma + u_{ij}) + \varepsilon_{ij} \quad (14)$$

here, Z_{ij} represents the set of variables for which the coefficients γ are allowed to vary across countries, with $u_{ij} \sim N(0, \sigma^2)$ representing the random coefficients. This specification introduces flexibility, as it accounts for the country-specific or pair-specific deviations from the average effect, providing a more accurate representation of the heterogeneous nature of trade flows.

In conclusion, the adoption of a random coefficients model allows for a more realistic and flexible approach to modelling international trade, particularly when dealing with complex phenomena such as terrorism's impact on trade. Standard fixed-effects models impose uniformity on the relationships between variables, which may be overly restrictive in a global context where economic, political, and social conditions vary widely. By allowing key variables such as the GTI and GDP to have different effects across countries, random coefficients models offer a more

nuanced and accurate understanding of trade dynamics. This robustness check, therefore, enhances the model's ability to reflect the true nature of international trade relationships in the presence of terrorism and other disruptive forces.

The mixed-effects Maximum Likelihood (ML) regression results using random coefficients models provide insights into how terrorism-related factors, along with economic variables, influence trade between countries. The estimation results using random coefficients model are presented in Table 5. The Likelihood Ratio (LR) test results, as presented in Table 6, indicate that only importer-specific effects (σ_{ν}) should be included in the model, while the LR test statistic for year effects (σ_{λ}) is 1.00, demonstrating that no significant year effects are present. Since Turkey is the sole exporter in the analysis, exporter effects are not included, as they would not contribute additional explanatory power. Focusing on importer effects allows the model to capture the variability driven by differences among the importing countries. Also, the absence of year effects simplifies the model further without compromising its robustness.

According to the estimation results without fixed effects in Table 3, the GTI of partner countries shows a consistently positive and significant impact on trade (e.g. Model 1: 0.265, $p < 0.01$; Model 2: 0.352, $p < 0.01$). This suggests that higher terrorism in partner countries is paradoxically linked to an increase in Turkey's exports. In contrast, in random coefficients model Turkey's own GTI shows a negative impact on trade (Model 1: -0.863 , $p < 0.01$; Model 2: -0.992 , $p < 0.01$), confirming that domestic terrorism hinders export performance.

In the random coefficients model, the impact of the GTI of partner countries becomes statistically insignificant in most models except for Model 6 (0.137, $p < 0.05$), where it remains positive but smaller. Meanwhile, Turkey's own GTI still shows a significant negative effect on trade (Model 1: -0.875 , $p < 0.01$), like the estimations in Table 3. This highlights that while the estimation results in Table 3 emphasizes the significance of the partner's GTI, the random coefficients model accounts for heterogeneity and reveals that the effect varies across countries.

According to Table 3, incidents in partner countries have a modestly positive effect on trade (e.g. Model 4: 0.0349, $p < 0.10$), while incidents in Turkey have a negative and significant impact (e.g. Model 3: -0.040 , $p < 0.05$). Similarly, fatalities in Turkey reduce trade (Model 5: -0.041 , $p < 0.05$). In the random coefficients model, the effect of incidents and fatalities is more nuanced. Incidents in Turkey continue to have a negative impact, but their magnitude is larger (e.g. Model 5: -0.067 , $p < 0.01$). However, the effect of partner incidents is only marginally significant in some models, suggesting that the no effects model may overstate the consistency of this relationship across all trade partners.

Both models show that economic factors like the sum of GDPs and GDP similarity are strong positive predictors of trade. The coefficients differ in the random

Table 5: Gravity model estimation results using “mixed effects Maximum Likelihood Regression”-random coefficients models.

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Global Terror Index (GTI) of partner	0.002 (0.05)	0.003 (0.09)				0.137 ^b (2.02)
Global Terror Index (GTI) of Turkey	-0.875 ^c (-4.84)	-0.992 ^c (-5.17)				-0.249 ^b (-2.42)
Incidents (INC) in partner			0.048 ^a (1.85)	0.046 ^a (1.71)		
Incidents (INC) in Turkey			-0.052 ^b (-2.25)	-0.067 ^c (-2.82)		
Fatalities (FTL) in partner					-0.006 (-0.22)	0.178 (1.00)
Fatalities (FTL) in Turkey					-0.057 ^b (-2.49)	0.042 (0.82)
Sum of GDPs	0.402 ^b (2.18)	0.570 ^c (3.09)	0.462 ^b (2.01)	0.767 ^c (3.23)	0.603 ^c (2.75)	0.751 ^c (3.15)
GDP similarity	1.226 ^c (4.25)		1.558 ^c (4.43)	0.819 ^b (2.28)	1.489 ^c (4.21)	
Manufacturing similarity		0.770 ^c (2.84)				1.008 ^c (2.75)
Relative endowment (ICT per capita)	-0.004 (-0.11)	-0.044 (-1.01)	0.038 (0.70)	-0.037 (-0.63)	0.066 (1.13)	-0.029 (-0.47)
Population of trading partner	0.089 (0.98)	0.158 (1.63)	-0.076 (-0.77)	0.042 (0.38)	-0.162 ^a (-1.77)	-0.093 (-0.86)
Population of Turkey	1.045 ^a (1.74)	1.965 ^c (3.71)	0.839 (0.99)	2.358 ^c (3.21)	0.427 (0.44)	1.323 (1.49)
Distance _{ij}	-0.930 ^c (-7.00)	-0.853 ^c (-5.92)	-0.951 ^c (-7.39)	-0.860 ^c (-5.92)	-0.961 ^c (-7.66)	-0.786 ^c (-5.31)
Border _{ij}	0.413 (1.23)	0.646 ^a (1.66)	-0.012 (-0.03)	0.186 (0.39)	-0.649 (-1.61)	-3.639 ^c (-2.84)
Colony _{ij}	0.556 ^a (1.88)	0.660 ^b (1.99)	0.416 (1.41)	0.488 (1.41)	0.424 (1.52)	0.563 ^a (1.67)
Customs Union	0.103 (0.59)	0.141 (0.75)	0.108 (0.59)	0.095 (0.47)	0.283 (1.41)	0.319 (1.41)
Border*Incidents			0.137 (1.61)	0.139 (1.46)		
Border*Fatalities					0.277 ^c (3.63)	
GlobalTerrorIndex*Fatalities						-0.132 (-1.34)
Border*GlobalTerrorIndex						2.533 ^c (3.42)

Table 5: (continued)

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Constant	-9.738 (-0.67)	-32.467 ^c (-2.60)	-6.361 (-0.33)	-44.802 ^c (-2.80)	-1.003 (-0.05)	-23.009 (-1.25)
N	561	546	358	349	253	244
Wald χ^2_{11}	χ^2_{11} 287.42	χ^2_{11} 231.50	χ^2_{12} 258.59	χ^2_{12} 189	χ^2_{12} 298.22	χ^2_{15} 218.16
σ_{y_i}	0.0570 ^c (10.39)	0.649 ^c (10.39)	0.523 ^c (8.20)	0.605 ^c (8.72)	0.408 (6.03)	0.508 (6.85)
LR Test	0.00	0.00	0.00	0.00	0.00	0.00

() denote z-statistics. (^a), (^b), (^c) indicate significance at 10 %, 5 % and 1 % respectively.

Table 6: LR test statistics for both models.

Hypothesis	LR test statistics (prob.-values)
$H_0 = \sigma_\gamma = \sigma_\lambda = 0$	0.000
$H_0 = \sigma_\gamma = 0$	0.000
$H_0 = \sigma_\lambda = 0$	1.000

σ_λ indicates year effects, while σ_γ indicates importer fixed effects.

coefficients model (e.g. Model 4: 0.767, $p < 0.01$) compared to the no effects model (Model 4: 1.221, $p < 0.01$). This suggests that allowing for random variation in the impact of GDP across countries provides a more flexible and accurate explanation of trade dynamics. Manufacturing similarity is also a significant driver in both models, though the coefficients are larger and more significant in the random coefficients model (e.g. Model 6: 1.008, $p < 0.01$), indicating a strong influence of industry-level similarities on trade.

Distance remains a significant negative factor in both models, with similar magnitudes across all models (e.g. random coefficients Model 1: -0.930, $p < 0.01$, while in Table 3, Model 1: -0.862, $p < 0.01$).

The border and colonial ties show more variability in their effects across models. For example, in the random coefficients model, the interaction between border proximity and terrorism is significant and positive (Model 6: 2.533, $p < 0.01$), suggesting that terrorism near borders can sometimes stimulate trade, likely due to cross-border commerce in insecure regions. In the no effects model, similar interactions are found, but the coefficients are larger (Model 6: 3.540, $p < 0.01$).

In conclusion, the estimation results without fixed effects in Table 3 included highlights consistent relationships across countries, particularly emphasizing the

role of the Global Terror Index and geographical proximity on trade, but it assumes homogeneity in the impacts of these variables. By contrast, the random coefficients model allows for variability across country pairs, revealing that the effects of terrorism and economic factors are not uniform across all trade relationships. The random coefficients model provides a more nuanced and flexible approach, capturing the heterogeneity in how different countries respond to terrorism and trade-related variables.

7 Discussion

The results of this study provide critical insights into the complex relationship between terrorism and trade, particularly concerning Turkey's export performance. The findings confirm that terrorism, whether occurring within Turkey or in its trading partners, significantly influences export dynamics. The negative impact of Turkey's own Global Terror Index (GTI) on exports aligns with earlier studies, such as those by Doucouliagos (2017) and Shah, Hasnat, and Sarath (2020), which also highlight the detrimental effects of terrorism on bilateral trade.

Interestingly, the observation that terrorism in partner countries may lead to an increase in Turkey's exports warrants further exploration. This counterintuitive result could suggest a reallocation of trade routes or increased security-related commerce near borders, as traders and firms might seek to exploit new opportunities or avoid more dangerous areas.

These findings have important implications for policymakers in Turkey and other countries affected by terrorism. Efforts to mitigate the impact of terrorism on trade should consider not only the direct effects within a country but also how terrorism in neighbouring countries or trading partners can influence economic outcomes.

However, it is essential to acknowledge the limitations of this study, including the potential for time aggregation bias and the challenges of accurately capturing the dynamic effects of terrorism over time. Future research could address these limitations by exploring more granular data or by examining the long-term impacts of sustained terrorist activity on trade relationships.

8 Conclusions

This study utilized a one-way gravity model to examine the relationship between terrorism and Turkey's export dynamics, focusing on 71 major trading partners, which represent approximately 89.50 % of Turkey's total exports from 2012 to 2022.

By incorporating variables such as the Global Terror Index (GTI), the number of terror incidents, and fatalities in both Turkey and its trading partners, the analysis provided a comprehensive understanding of the economic consequences of terrorism. Additionally, factors such as economic similarity, manufacturing industry similarity, and relative endowment were considered to capture the distinctions of intra-industry and inter-industry trade patterns. The PPML estimator was employed to address the zero-trade problem and heteroskedasticity, ensuring robust results.

The findings revealed that Turkey engages predominantly in intra-industry trade with economically and industrially similar partners, while its ICT service exports remain largely inter-industry. The study also highlighted the paradoxical effect of terrorism: while terrorist incidents within Turkey significantly diminish its export performance, similar incidents in its trading partners appear to enhance Turkey's trade. These results, consistent with existing literature, underscore the dual-edged nature of terrorism's impact on international trade.

Given that exports are a critical component of Turkey's GDP, the study also identified that terrorism – through incidents, fatalities, and a higher GTI – collectively reduces Turkey's overall trade. This aligns with previous findings indicating that terrorism has a detrimental impact on economic growth, particularly in Turkey's Southeastern and Eastern regions.

The insights derived from this study have important implications for public policy, particularly in the context of promoting peace and economic stability. First, Turkey should prioritize enhancing trade intensity with neighbouring countries while continuing its rigorous counter-terrorism efforts. Strengthening economic ties with nearby nations can create a buffer against the destabilizing effects of terrorism, fostering regional cooperation and economic resilience.

Moreover, Turkey should focus on supporting and expanding its ICT services sector. Given the sector's current inter-industry trade pattern, policies that encourage domestic production and innovation in ICT could shift Turkey towards a more balanced intra-industry trade framework. This strategic shift would not only enhance Turkey's integration into global value chains but also augment its economic resilience against external shocks, including those posed by terrorism.

In conclusion, this study contributes to the broader discourse on the economic impacts of terrorism by providing targeted policy recommendations aimed at mitigating these effects. By fostering stronger economic ties within its region and enhancing its ICT sector, Turkey can strengthen its economic foundations, thereby promoting sustainable development and contributing to long-term peace and stability.

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