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Essays on Defense Economics

Ph.D. Thesis

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To the victims of

the deadly earthquake

in Türkiye and Syria

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Abstract

Security threats in the modern world are determined by the global trends in the first half of the 21st century. The world community is and will remain extraordinarily violent, with the overall economic development that leads to the widening of a gap between rich and poor, between countries and within themselves. The development of the global economy and its complete interdependence creates new forms of vulnerability and the need for security measures. Each government acting on behalf of the public tries to ensure that the military is capable of defending the nation, and promoting peace and safety. A viable approach to national security is to maintain an adequately sized, trained and equipped force that is capable of dissuading, deterring, and – if necessary – defeating a diverse set of future adversaries (Rahman and Siddiqui 2019). Since military power has been proved to be the determining factor for the behavior of states in the international system, the present thesis aims to investigate in today's world, the nature and importance of military expenditures for a higher degree of security and stability.

Specifically, it explores the enduring confrontation between Greece and Turkey, two NATO allies which have been maintaining though an antagonistic relationship. The ongoing hostility has led many to believe that the countries have been engaged in an arms race, particularly due to the Cyprus conflict in 1974, followed by numerous narrowly avoiding war situations, during which the respective forces were placed on full alert (Matthews 1999; Athanassiou and Kollias 2000). Although a number of researchers have tested the dynamics of Greek – Turkish security relations, the extant mixed results, render the subject open to further deliberation. The aim of this study is to ascertain whether or not the rivalry of the two neighboring countries features an arms race, by using a Bayesian approach applied to a VAR model, for an annual dataset running from 1960 to 2020.

Additionally, the thesis studies the dynamic interdependencies between military expenditures and the real economy for the period 1970-2018, by accounting for the interconnection among the top twelve military spenders. The novelty of this effort lies on the modeling of the dynamic interdependencies of defense spillovers across economic units. The modeling technique builds on the prominent work of Acemoglu et al. (2012) and Pesaran and Yang (2020) and utilizes the network system structure,

using a general equilibrium framework. The pervasiveness of each economy in the network is tested following Pesaran and Yang (2020), while the modeling choice of Spatial Vector Autoregressive schemes proposed by these authors, is extended by using a GVAR process, which allows rich and flexible modeling of international shock dynamics, while keeping dimensionality manageable. Finally, based on the selection of dominant entities proposed in Konstantakis et al. (2015) and Tsionas et al. (2016), a robustness analysis is provided for the dominance characterization of each economy (node) in the network.

Furthermore, the dissertation aims to explore whether a country's military activity shapes the terror sentiments of its inhabitants. Particularly, it investigates how the religious and technological gap between two countries involved in a military conflict, affects the fear about an imminent terrorist episode in the near future, within the borders of the country initiating the attack, and in the wider region. The involvement of Europeans to conflict zones in Syria and Iraq as foreign fighters, makes Europe facing the risk that those individuals having gained combat experience, would return to the continent to perpetrate or coordinate long-prepared and sophisticated large-scale attacks or spontaneous and unpredictable ones carried out by "lone-wolves". This concern raises the question of how a country's military activity influences its citizens' perception to admit that the country or Europe might be vulnerable to serious threats. The study, based on detailed data from 27 European countries and 92,636 respondents for the waves 2005-2006 and 2007-2008, contributes to the literature by offering a comprehensive analysis of the fear sentiment formation in countries involved in a military conflict, focusing on the citizens' sentiments of the country that attacks because there is a chance of revenge.

Overall, the empirical analysis on the role of military allocations, undertaken in the present thesis, offers useful and novel insights as for a country's defense policy options in the context of a dynamic international system. The claim that economies plugged into the global chains form their behavior accordingly, based on the network's activity, finds strong support. Globalization and economic interdependence have intensified it, reminding there is a need for units to reorganize their military plans quickly and adapt to the unanticipated shocks, following appropriate actions. Further, the management of public sentiments and opinions might need to be included

as part of a country’s successful policy, since the promotion of safety and solidarity is not associated merely with military strategies.

Περίληψη

Στο πρώτο μισό του 21ου αιώνα, οι παγκόσμιες εξελίξεις είναι εκείνες που καθορίζουν τον τρόπο με τον οποίο εκδηλώνεται η απειλή κατά της ασφάλειας στον σύγχρονο κόσμο. Η παγκόσμια κοινότητα είναι και θα παραμείνει εξαιρετικά βίαιη, εξαιτίας και της συνολικής οικονομικής ανάπτυξης που συνεπάγεται τη διεύρυνση του χάσματος πλουσίων και φτωχών, τόσο εντός των συνόρων μίας χώρας όσο και μεταξύ των κρατών. Η παγκόσμια οικονομική μεγέθυνση καθώς και η έντονη αλληλεπίδραση μεταξύ των χωρών δημιουργεί νέες μορφές τρωτότητας και συνεπώς αυξάνει την ανάγκη της ύπαρξης μέτρων ασφαλείας. Κάθε κυβέρνηση που δρα εκ μέρους των πολιτών της προσπαθεί να τους διασφαλίσει ότι μέσω των αμυντικών δαπανών είναι δυνατόν να επιτευχθεί η υπεράσπιση του έθνους, και η προαγωγή της ειρήνης και της ασφάλειας. Μία βιώσιμη προσέγγιση για την προάσπιση της εθνικής ασφάλειας είναι η κατοχή μιας επαρκούς ποσοτικά, εκπαιδευμένης και κατάλληλα εξοπλισμένης στρατιωτικής δύναμης η οποία θα είναι ικανή να αποθαρρύνει, να αποτρέψει – αλλά και αν αυτό κριθεί απαραίτητο- να εξουδετερώσει ένα ευρύ σύνολο μελλοντικών αντιπάλων (Rahman and Siddiqui 2019). Καθόσον η αμυντική δύναμη έχει αναδειχθεί σε παράγοντα καθοριστικό για τη διαμόρφωση της στάσης των κρατών σε ένα διεθνές σύστημα, η παρούσα διατριβή επιχειρεί να διερευνήσει τη φύση και τη σπουδαιότητα των αμυντικών δαπανών για την επίτευξη ενός υψηλού επιπέδου ασφάλειας και σταθερότητας στον σύγχρονο κόσμο.

Συγκεκριμένα, μελετά την διαρκή αντιπαράθεση μεταξύ Ελλάδας και Τουρκίας, δύο συμμάχων του ΝΑΤΟ, οι οποίοι ωστόσο συντηρούν μία ανταγωνιστική σχέση. Η συνεχής εκδήλωση εχθρότητας μεταξύ αυτών, έχει οδηγήσει αρκετούς στη διαπίστωση ότι οι χώρες εμπλέκονται σε μία κούρσα εξοπλισμών, κυρίως εξαιτίας της εισβολής στην Κύπρο το 1974, που ακολουθήθηκε από μία σειρά γεγονότων κατά τη διάρκεια των οποίων οι αντίστοιχες στρατιωτικές δυνάμεις ήταν σε επιφυλακή και μετά βίας απεφεύχθη η πολεμική σύρραξη (Matthews 1999; Athanassiou and Kollias 2000). Παρόλο που αρκετοί ερευνητές έχουν εξετάσει τη δυναμική των Ελληνοτουρκικών σχέσεων ασφαλείας, τα υφιστάμενα ανάμεικτα αποτελέσματα, καθιστούν το θέμα κατάλληλο για περαιτέρω διερεύνηση. Σκοπός αυτής της μελέτης είναι να εξακριβώσει εάν η αντιπαλότητα των δύο γειτονικών χωρών στοιχειοθετεί

ένα εξοπλιστικό κυνήγι, χρησιμοποιώντας μία Bayesian τεχνική εφαρμοσμένη σε ένα VAR μοντέλο, για ετήσιας βάσης δεδομένα της περιόδου 1960-2020.

Επιπρόσθετα, η διατριβή μελετά τη δυναμική αλληλεξάρτηση μεταξύ των αμυντικών δαπανών και της οικονομίας κατά την περίοδο 1970-2018, λαμβάνοντας υπόψη την αλληλεπίδραση των δώδεκα κορυφαίων, με βάση τις στρατιωτικές δαπάνες, χωρών. Η καινοτομία αυτής της προσπάθειας έγκειται στη μοντελοποίηση της δυναμικής διασύνδεσης και διάχυσης των αμυντικών δαπανών μεταξύ των οικονομικών μονάδων. Η συγκεκριμένη τεχνική στηρίζεται στο διακεκριμένο έργο των Acemoglu et al. (2012) και Pesaran and Yang (2020), και χρησιμοποιεί τη δομή ενός δικτύου βασισμένου στο πλαίσιο των μοντέλων γενικής ισορροπίας. Η διεισδυτικότητα κάθε οικονομίας στο δίκτυο εξετάζεται χρησιμοποιώντας την τεχνική των Pesaran and Yang (2020), ενώ η επιλογή του SpVAR μοντέλου που προτείνεται από τους εν λόγω συγγραφείς, επεκτείνεται με τη χρήση μίας GVAR τεχνικής που εξασφαλίζει αφθονία και ευελιξία ως προς την μοντελοποίηση της δυναμικής των διεθνών κρίσεων, ενώ καθιστά διαχειρίσιμο και το θέμα του διαστατού. Τέλος, με βάση την επιλογή των κυρίαρχων οντοτήτων που προτείνεται από τους Konstantakis et al. (2015) και Tsionas et al. (2016) διενεργείται μία ανάλυση ευαισθησίας για την εύρεση των κυρίαρχων οικονομιών (κόμβων) στο πλαίσιο του δικτύου.

Επίσης, η διατριβή επιδιώκει να εξετάσει εάν η στρατιωτική δραστηριότητα μίας χώρας διαμορφώνει τα αισθήματα τρόμου των πολιτών της. Ειδικότερα, διερευνά τον βαθμό στον οποίο το χάσμα ως προς την θρησκεία και την τεχνολογική ανάπτυξη μεταξύ δύο χωρών που εμπλέκονται σε πολεμική σύγκρουση, επηρεάζει τον φόβο για ένα επερχόμενο τρομοκρατικό χτύπημα στο άμεσο μέλλον, εντός των ορίων της χώρας που επιτίθεται αλλά και στην ευρύτερη περιοχή. Η ανάμειξη των Ευρωπαίων σε εμπόλεμες ζώνες στη Συρία και το Ιράκ με τη μορφή ξένων μαχητών, καθιστά την Ευρώπη αντιμέτωπη με το ρίσκο ότι άτομα τα οποία έχουν αποκτήσει πολεμική εμπειρία θα μπορούσαν να επιστρέψουν στην ευρωπαϊκή ήπειρο να διαπράξουν ή να συντονίσουν μακράς προετοιμασίας και εξελιγμένες, ευρείας κλίμακας επιθέσεις ή παρορμητικά και απρόβλεπτα χτυπήματα εκτελούμενα από «μοναχικούς λύκους». Αυτός ο προβληματισμός εγείρει το ερώτημα πώς η στρατιωτική δραστηριότητα ενός κράτους επηρεάζει την στάση των πολιτών απέναντι στην ομολογία ότι η χώρα τους ή η Ευρώπη είναι ευάλωτη σε σοβαρές απειλές. Η συγκεκριμένη μελέτη, βασισμένη σε δεδομένα από 27 ευρωπαϊκές χώρες και 92.636 ερωτώμενους για τις περιόδους 2005-

2006 και 2007-2008, συνεισφέρει στην υπάρχουσα βιβλιογραφία, διενεργώντας μία ολοκληρωμένη ανάλυση ως προς τη διαμόρφωση του αισθήματος του φόβου σε χώρες εμπλεκόμενες σε πολεμικές συρράξεις, εστιάζοντας ωστόσο στους πολίτες της επιτιθέμενης πλευράς, καθόσον υφίσταται πιθανότητα εκδίκησης.

Εν κατακλείδι, η εμπειρική ανάλυση του ρόλου των αμυντικών δαπανών που πραγματώνεται στην παρούσα εργασία, προσφέρει μία χρήσιμη και ιδιαίτερη εμβάθυνση όσον αφορά στις επιλογές που ακολουθεί μία χώρα για την αμυντική πολιτική της στο πλαίσιο ενός δυναμικού διεθνούς συστήματος. Ο ισχυρισμός ότι οι οικονομίες που είναι δικτυωμένες σε ένα παγκόσμιο πλαίσιο διαμορφώνουν την στάση τους κατάλληλα, με βάση τη γενικότερη δραστηριότητα του δικτύου, επιβεβαιώνεται. Η παγκοσμιοποίηση και η οικονομική αλληλεπίδραση εντείνουν τη συγκεκριμένη τάση, υπενθυμίζοντας ότι είναι επιτακτικό οι οικονομικές μονάδες να επαναπρογραμματίζουν τα αμυντικά τους σχέδια ταχέως και να προσαρμόζονται σε απρόσμενες κρίσεις, ακολουθώντας τις κατάλληλες τακτικές. Επίσης, η διαχείριση των συναισθημάτων και απόψεων του κοινού θα ήταν χρήσιμο να αποτελεί μέρος μίας επιτυχημένης κρατικής πολιτικής, εφόσον η προαγωγή της ασφάλειας και της σταθερότητας δεν συνδέεται αποκλειστικά με αμυντικές στρατηγικές.

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1 Introduction

1.1 Motivation

Conflicts and wars are like laws of nature an integral part of humankind. Since time immemorial, there have been conflicts and wars in the world and thus military forces, their personnel, and the demand for armament goods are an important object of national politics. Military spending is one area where there is no private solution. No single corporation or group of citizens is motivated and trustworthy enough to take financial responsibility for maintaining a nation's military. Adam Smith, a father of free-market economics, identified the defense of society as one of the primary functions of government and a justification for reasonable taxation. The government is acting on behalf of the public to ensure that the military is capable of defending the nation, and promoting peace and stability.

Traditionally, military expenditure has been one of the major concerns for countries (Gong and Zou 2003) regardless of their economic conditions (Raju and Ahmed 2019) and became a particularly important issue during the challenging Covid-19 pandemic (Susilo et al. 2022), as countries faced critical decisions on the prioritization of different types of spending such as healthcare expenditure and military procurement. A viable approach to national security is to maintain an adequately sized, trained and equipped force that is capable of dissuading, deterring, and – if necessary – defeating a diverse set of future adversaries (Rahman and Siddiqui 2019). The allocation of resources to national defense has though, important economic ramifications triggering dilemmas and debates among policy makers and scholars, especially as for developing countries, which are endowed with less resources, compared to developed economies (Kollias and Paleologou 2019, Okwoche 2022).

Military spending could be a wasteful enterprise, leading potentially to arms races or direct military confrontations and to inflation of government debt, questioning the reason for investing great amounts of money in that direction (Caruso and Di Domizio 2017). Contrariwise, critics argue that declined defense outlays could create room for other public expenses, such as health and infrastructure, some of which could be more

beneficial to the economy (Kollias and Paleologou 2016). In a globalized world, however, a country's increased spending on military sector may cause similar pressures to reverberate in other economies that are grappling with different economic burdens, especially if such policy is adopted by a perceived enemy state (Bruce 1990). The understanding of systematic relationships between countries' expenses on defense has occupied a central place in the literature on arms races that traces back to the Richardson's (1960) seminal work. Richardson's model was based on a system of differential equations in which the rate of change of the armaments of one country depended on the level of arms of its rival and vice versa. This study produced an explosion in the number of investigations of arms races and numerous surveys followed up by revisiting this nexus and examining different measures of interdependency among neighboring countries, such as Greece and Turkey.

These two NATO allies, have been maintaining an antagonistic relationship that can be attributed to historical territorial disputes resulting from their intertwined geography, and despite Western – led diplomatic efforts the rivalry remains unresolved (You 2016; Ifantis 2018). The ongoing hostility has led many to believe that the countries have been engaged in an arms race, particularly due to the Cyprus conflict in 1974, followed by numerous narrowly avoiding war situations, during which the respective forces were placed on full alert (Matthews 1999; Athanassiou and Kollias 2000). Their relationship is about bitter history memories, blood spilled, refugee drama, forced population exchanges, conflicting national narratives and, among certain constituencies, racist representation of each other. But it is equally so about geopolitical competition, security anxieties, and competing sovereignty claims (Choulis et al. 2021). The enduring confrontation between these two neighboring states has led a number of researchers to test for the existence of an arms race between them, but studies have given mixed results, rendering the subject open to further deliberation.

Apart from the works that focus on the military allocations of rival pairs, in the field of defense economics there is also a growing number of studies investigating the interconnection of states in the context of a network. A relevant issue that countries need to figure out in their budget allocation to finance their military activities is the free ride effect among allies' defense spending, as an ally's defense demand responds

negatively to the collective defense spending (or defense spillovers) of its allies (Hilton and Vu 1991; Murdoch 1995; Sandler and Hartley 1995; Douch and Solomon 2014). If, however, an ally derives jointly produced country-specific and alliance-wide outputs from its defense spending, then a positive response to allies' defense spillovers may characterize an ally's defense demand (Sandler 1977; Sandler and Murdoch 1990; Sandler and Hartley 2001).

Another issue that emerges as for a country's defense policy is the military involvement – terrorism nexus. Different strands of research argue that military involvement away from home can fuel fears of a terror attack at home. Recent contributions of Savun and Phillips (2009) suggest that states which are actively involved in international politics regardless of their regime type, are prone to transnational terrorism. Carter and Fay (2019) demonstrate that increased US military activity could increase, even only contemporaneously, future displays of terrorism. Terrorists are forced to display publicly just how far they are willing to go to obtain their desired results, because it is hard for weak actors to make credible threats (Kydd and Walter 2006, Nussio et al. 2021). Countries that adopt active foreign policy portfolios or are highly involved in international affairs to form or increase their already existing interests in other countries are likely to foment some sort of aggravation among foreign organizations, and hence may be the target of these aggrieved groups.

From the scope of psychology, combat-related stressors, i.e., threat to life, exposure to death and injury are not the only that cause the pain and suffering of combat. Disruption of the normal routine, increased financial pressures (Freedman 1991) and fear of imminent terrorist attacks – all are part of the experience of nations, communities and families during time of war (Ursano 1996). In a survey conducted by Rosen et al. (1993) there are reports of fear about terrorist attacks throughout the United States expressed by soldiers' children, despite the geographical distance from the Persian Gulf, where hostilities were taking place. Furthermore, after the invasion of Iraq, more Americans were worried that the war had increased the threat of terrorism against their country (Bloch-Elkon 2011).

1.2 Structure of the Thesis

The present thesis aims to explore in today's world, the nature and importance of military expenditures for a higher degree of security and stability, since military power has been proved to be the determining factor for the behavior of states in the international system. To effectively study this issue, the thesis is organized into three essays, each one constituting a separate chapter.

The second chapter focuses exclusively on the Greek – Turkish relations, since it ultimately remains unresolved to what extent their rivalry features an arms race and at the same time, the two militaries are ramping up their capabilities. Evidence suggests that the Greek-Turkish tug of war has manifested at different points in time to an arms race (Öcal 2002; Andreou and Zombanakis 2011), while other studies dispute the findings and instead argue that the two defense budgets operate independently from one another (Öcal and Yildirim 2009; Paparas et al. 2016). Shortly before the end of 2022, Greece affirmed its intention to demarcate the country's territorial waters to twelve nautical miles around Crete, and Turkey stepped up its rhetoric threatening Athens with retaliation, as it could be seen as a casus belli, justifying military action. Airspace violations are also central to the dispute (Kollias 2004; Athanassiou et al. 2006), following an upward trend since 2013. It is clear that the two states have opposing views on their maritime and aerial borders. However, the most serious crisis in Greek – Turkish affairs in years, occurred in 2020. After a sequence of events including a Greek – Egyptian delimitation agreement ignoring the opponent's territorial claims, in August 2020, Turkey sent its navy to sea with drilling and survey ships. Military posturing that lasted for almost 45 days brought the navies of the two neighboring countries to the brink of clashing violently. In order to explore the dynamics of Greek – Turkish security relations, a Bayesian technique is used applied to a Vector Autoregression model for an annual dataset running from 1960 to 2020. Nonetheless, our regression results do not support the existence of an arms race between the two rival countries.

The third chapter studies the dynamic interdependencies between military expenditures and the real economy, for the period 1970-2018, by accounting for the interconnection among the top military spenders that account for more than two-thirds of the global spending. A novelty of this effort is the modeling of the dynamic interdependencies of defense spillovers across economic units. The modeling

technique builds on the prominent work of Acemoglu et al. (2012) and Pesaran and Yang (2020) and utilizes the network system structure, using a general equilibrium framework. The pervasiveness of each economy in the network is tested following Pesaran and Yang (2020), while the modeling choice of Spatial Vector Autoregressive schemes proposed by these authors is extended, by using a GVAR process, which allows rich and flexible modeling of international shock dynamics, while keeping dimensionality manageable. Moreover, based on the selection of dominant entities proposed in Konstantakis et al. (2015) and Tsionas et al. (2016), a robustness analysis is provided for the dominance characterization of each economy (node) in the network. The findings show that China acts as a leader in the global military scene based on the respective centrality measures. Additionally, statistically significant deviations from equilibrium are observed in most of the economies' military expenses, when subjected to an unanticipated unit shock of other countries. Nevertheless, in the medium-run, the shocks tend to die out, and economies converge to an equilibrium position.

The forth chapter explores the extent to which a European country's military activity affects the publics' perceptions about an imminent terrorist attack in country and in Europe during the next twelve months, allowing for a cohort of demographic, social capital and macroeconomic traits. The involvement of Europeans to conflict zones in Syria and Iraq as foreign fighters, makes Europe facing the risk that those individuals having gained combat experience, would return to the continent to perpetrate or coordinate long-prepared and sophisticated large-scale attacks or spontaneous and unpredictable ones carried out by "lone-wolves". This concern raises the question of how a country's military activity influences its citizens' perception to admit that the country or Europe might be vulnerable to serious threats. The individual-level data consist of 92,636 respondents, covering 27 countries for two biennial rounds/waves (2005-2006 and 2007-2008). Relying on an extended ordered probit model (Wooldridge 2010), the results show that military activity and frequency of conflict involvement play an important role in shaping attitudes. Regardless of the impact of other individual-level factors such as age, marital status, education, and origin, respondents in countries which spend great amounts in the defense area, and often participate in armed conflicts tend to express higher probability of a terrorist attack both in their country and in Europe. Technological distance, i.e. the dissimilarity in

R&D investment, and religious closeness between European countries and their enemies in wars, also, appear to influence the participants' anxiety about a terrorist episode, while social capital - trust in people and institutions – seems to reduce the public's "perceived threat".

Overall, the empirical analysis based on the role of military allocations, undertaken in the present thesis, offers useful and novel insights as for a country's defense policy options in the context of a dynamic international system. Specifically, the investigation of the arms race between Greece and Turkey enhances the understanding of the Eastern Mediterranean region security processes. In distinction to those focusing on costly maintenance of strategic balance, it is proved important that these rival states strengthen their cooperation and jointly contribute to the advancement of peace and economic development across the entire area. The claim that economies plugged into the global chains form their behavior accordingly, based on the network's activity, finds strong support. Globalization and economic interdependence have intensified it, reminding there is a need for units to reorganize their military agenda quickly and adapt to the unanticipated shocks, implementing appropriate strategies and actions. Further, military activity adopted to ensure homeland safety does not guarantee the public's thorough security, but renders them occasionally susceptible to a possible terrorist act, inflating their perceived threat. Hence, a successful policy should aim not to exclusively impose stricter defensive measures to meet the challenges associated with the vulnerability of individuals, but also foster the bonding, bridging and linking of different communities, in order to ensure the country's solidarity and prosperity.

2 The Greek-Turkish rivalry: A Bayesian VAR approach

The ongoing Greek-Turkish antagonism has triggered the interest of defense economists to explore whether the two nations are engaged in an arms race. The issues that divide them are complex and rooted in years of conflict and mutual distrust. However, efforts to resolve their disputes have so far been unsuccessful and rapprochements have invariably been short lived. Following gas discoveries in eastern Mediterranean the states nearly came to blows in 2020 and enacted military expansion plans, further risking escalation. Since empirical studies examining the relation between their military expenditures do not offer common answers, we use a novel Bayesian technique applied to VAR models to investigate the possible interdependence between four different proxies of the states' physical arms build-up. Based on an annual dataset running from 1960 to 2020, we find that a shock in each one of the variables capturing a country's military expenditure does not have an impact on the opponent's spending. Thus, in distinction to those focusing on costly maintenance of strategic balance, it is proved important that these rivals strengthen their cooperation and jointly contribute to the advancement of peace and economic development across the entire Mediterranean area.

2.1 Introduction

Empirical studies on the topic of arms race have been one of the focal points of political sciences and defense and peace economics, since the seminal work of Richardson (1960), which explains the time series pattern of military expenditures between potential enemies in an action – reaction framework. It is widely admitted that if (at least) two potential adversaries' defense spending is affected by each other, an arms race would be present among them (Seiglie and Liu 2002).

Greece and Turkey, two NATO allies, have been maintaining an antagonistic relationship that can be attributed to historical territorial disputes resulting from their intertwined geography, and despite Western – led diplomatic efforts the rivalry remains unresolved (You 2016; Ifantis 2018). The ongoing hostility has led many to believe that the countries have been engaged in an arms race, particularly due to the Cyprus conflict in 1974, followed by numerous narrowly avoiding war situations in

1987, 1994 and 1996, during which the respective forces were placed on full alert (Matthews 1999; Athanassiou and Kollias 2000). Apart from the island of Cyprus – the most prominent bone of contention between Greece and Turkey, there are four other primary areas of dispute, namely the extent of territorial waters in the Aegean, the extent of territorial airspace, the continental shelf rights and the militarization of certain Greek Aegean islands. In August 2020, the tensions escalated to dangerous levels after a sequence of events including a Greek – Egyptian delimitation agreement, ignoring the opponent's territorial claims and Turkish drilling ships entering disputed waters, while shortly before the end of 2022, Greece affirmed its intention to demarcate the country's territorial waters to twelve nautical miles around Crete, and Turkey stepped up its rhetoric threatening Athens with retaliation, as it could be seen as a casus belli, justifying military action.

At the same time, the two militaries are ramping up their capabilities. Between 1999 and 2020, the ratio of the states' defense expenses to GDP has been above the average for NATO members and both, are regularly among the top defense spenders globally, with defense budgets sometimes double compared to those of G7 economies. Turkish military burden has increased by 36.5 percent during the past decade, which depicts the imperative need of assuring its national security, as besides the persisting confrontation with Greece, it is surrounded by highly volatile countries, such as Iran, Iraq, Syria and the newly independent follow-on states of the former Soviet Union in central Asia, but also faces internal security considerations regarding Islamic fundamentalism and its restive population of ethnic Kurds (Chletsos and Kollias 1995; Sezgin 1998). Equally, the volatile situation in the Balkans could well be one of the reasons for the high military expenditures of Greece, although, in 1985 the country officially declared a defense policy by identifying Turkey as a principal threat to its national security[1] (Dunne and Vougas 1999) and thereafter despite its economic struggles, continued to allocate an average of 3.12 percent of its GDP to the defense sector. In 2020, Athens aiming to boost its armed forces, announced the purchase of 18 Rafale fighter jets fully deployed in Athens by the summer 2023 and four new

[1] At the same time, the Greek defense doctrine regarded the Warsaw Pact threat as indirect and possible only in the event of a wider East – West conflict (Platias 1991).

frigates, while in 2022 signed with France a contract for the acquisition of six additional Rafale aircrafts, delivered to the Hellenic Airforce by 2024[2].

The extant literature does not offer common answers for the questions "Is there an arms race between these neighboring states?" and "Did this arms race end?". As stated by Brauer (2002) the arms race between Turkey and Greece if any, ended during the period 1985-1990, whilst Tütüncü and Şahiŋgöz (2020) showed that it continued during the years 2000-2014. The current study makes a fresh empirical investigation using a Bayesian Vector Autoregression (BVAR) model for an annual dataset running from 1960 to 2020, in order to explore the dynamics of Greek – Turkish security relations. Specifically, we investigate the nature of the arms race between the two countries to enhance our understanding of the Eastern Mediterranean region security dynamics. As endorsed by the findings of the current study, military expenditures of the rival nations are independent of each other, and may not necessarily be symptomatic of an arms race. In distinction to those focusing on costly maintenance of strategic balance, it is proved important that these opponents strengthen their cooperation and jointly contribute to the advancement of peace and economic development across the entire area.

The remainder of the chapter proceeds as follows: Section 2 offers a brief overview of previous research and poses the testable hypothesis, Section 3 sets out the methodological framework upon which our model is structured, Section 4 presents the data, Section 5 provides the empirical analysis of the results, Section 6 offers an evaluation of the performance of our selected model, while Section 7 concludes.

2.2 Literature Review

The Greek-Turkish relationship is about bitter history memories, blood spilled, refugee drama, forced population exchanges, conflicting national narratives and, among certain constituencies, racist representation of each other. But it is equally so about geopolitical competition, security anxieties and competing sovereignty claims (Choulis et al. 2021). The enduring confrontation between these two neighboring countries has led a number of researchers to test for the existence of an arms race

[2] https://www.gdaee.mil.gr/en/fdi-hn-contracts-signing/, contracts 013G/2020 and 018B/2021

between them, but previous studies have given mixed results. It is possible to divide the Greece and Turkey arms race literature into three categories: works that confirm the arms race hypothesis, those that partially support it and the ones that reject it.

Majeski and Jones (1981) and Majeski (1985) using statistical causality analysis, test for interdependence in the military expenditures of Greece and Turkey for the period 1949-1975 and find that each nation responds to the current behavior of its rival, which is indicative of the interest the countries attribute to the arms behavior of their opponents. Kollias and Makrydakis (1997) and Kollias and Paleologou (2002) are also among the studies that find bidirectional causality relation between the two states, according to the causality test results. Öcal (2002) considers the hypothesis based on the impact of countries' military spending mutually by using Smooth Transition Regression (STR) and Logistic Smooth Transition Regression (LSTR) models, and shows that the change in Turkey's military expenditures affects the corresponding expenses of Greece. The LSTR model results reveal that Greece does not want to fall behind compared to its opponent. Andreou and Zombanakis (2011) after dividing their research into two sub-periods - before and after 2000- employing an artificial neural networks method, indicate the leading role of the demographic preponderance of Turkey over Greece. Even after 2000, the former continued to set the arms race rules by determining the defense spending of its enemy.

Among the studies that partially confirm the presence of an arms race, Kollias (1991) applies the classical Richardson model over the periods 1950-1986 and 1974-1986, but the way the model is specified does not seem to work in this case, since it approaches defense expenditures and the arms race from outside, without allowing for the specific strategic environment nor for the way in which decisions are reached by military planners. Only after employing specific indices of military capabilities, Greek military spending is found to depend on Turkish relative size of the armed forces and defense expenses. Dunne et al. (2005) show some form of cointegration between the military expenditures in both countries, though not of Richardson arms race type, but one in which relative military burdens adjust, with income variables playing an important role. Moreover, the study of Tütüncü and Şahïngöz (2020) elaborated for the years 1960-2016 proves by using asymmetric causality tests that a mutual relationship exists between the nations' defense expenses, whilst the bootstrap causality testing, results in a unidirectional causality relation.

At the other end of the spectrum, Georgiou (1990) finds no evidence of an arms race over the period 1958-1987. Georgiou et al. (1996), based on the work of McGuire (1977) and Desai and Blake (1981), use a vector autoregression specification and their empirical findings provide little corroboration of the view that there is an arms race. Smith et al. (2000) benefit from game theory and Hamilton's regime-switching model and their statement that each country plays independently is accepted by the data, whereas in a similar vein, Şahin and Özsoy (2008), employ a Markov switching approach for a dataset running from 1958 to 2004 and detect no interdependence between the defense spending of the two states. Further, Öcal and Yildirim (2009) use Threshold Autoregressive (TAR) and Momentum Threshold Autoregressive (M-TAR) cointegration models to investigate the possibility of an asymmetric error correction for the long-run equilibrium, and find that Turkish military expenses harmonize with long-run deviations, whilst Greek ones fail to do so. Paparas et al. (2016) in a study over the period 1957-2013 find that there is no evidence of causality between Greek and Turkish military spending, which means that the countries act independently.

Given this contradictory situation, focusing on the political and strategic environment in the region, and following the theoretical arguments and empirical evidence, it seems appropriate to investigate, using up-to-date data, the Greek – Turkish relationship, anew. The political and military history of the nations and the existing agreements between them may affect the extent of an arms race. The discovery of gas in the eastern Mediterranean has exacerbated Greek – Turkish contestations over maritime borders and the August 2020 naval stand-off was the latest chapter in a series of high-risk military crises, dating back to 1976. Military posturing that lasted for almost 45 days brought the opponent navies to the brink of clashing violently. Further, Turkish violations of the Greek – claimed airspace that represent a measure of the intensity with which Turkey pursues the conflict (Kollias 2004; Athanassiou et al. 2006), have been on the rise since 2013 with 2020 acknowledged as a record year. In Brauer's (2002) article which constitutes a critical review of the literate on Greek – Turkish relations, it is implied though, that the arms race if any, ended somewhere in the mid-to late-1980s, while according to the time-varying causality testing results in Tütüncü and Şahingöz (2020), the presence of an arms race can be confirmed for the sub-periods 1975-1990 and 2000-2014. Nevertheless, the hostility between two

nations does not necessarily lead to an arms race and may be expressed in diverse ways (Amir-ud-Din et al. 2020). The rivalry can take different forms such as periodic exchanges of bellicose rhetoric; economic, political and diplomatic maneuvering; lobbing within existing alliances; political, historical and cultural propaganda (Georgiou et al. 1996). Therefore, we form our hypothesis as follows:

H: The hostility between the neighboring countries Greece and Turkey does not feature an arms race.

Next section develops the model and the econometric techniques to formally explore this hypothesis.

2.3 Methodology

Part of the confusion of findings in the empirical studies stems from the models used in each case and the specification problems encountered, reflected among others in the extensive use of dummy variables. Over the past several decades the Vector auto-regressive models (VARs) have been extensively used as standard tools in macroeconomic analysis and forecasting (Sims 1980; 1992; Christiano et al. 1999), mainly due to their simple formulation. Moreover, their popularity is attributed to the successful capture of dynamic linear relationships between time series without imposing restrictions on parameters, in contrast to the structural VAR models (Lopreite and Zhu 2020). However, when the frequentist approach is applied to VAR estimation, they present several deficiencies. First, VARs may suffer from a loss of degrees of freedom, which decrease geometrically with the number of variables and proportionally with the number of lags included, ending up with large standard errors and unstable point estimates. Secondly, a typical VAR model works better with a small number of variables. Given their generous parameterization, as the number of unrestricted parameters that can be estimated is limited, we may result in the over-fitting phenomenon. Lastly, the VAR models are not parsimonious because they contain many parameters, tending to be poor in forecasting and in structural analysis for omitted variables bias (Giannone and Reichlin 2006).

In recent years, Bayesian techniques applied to VAR models (B-VAR models) provide logical and consistent solutions to VAR problems and have been introduced in several fields – especially macroeconomics and finance (Lopreite and Mauro 2017; Brancaccio et al. 2019). The reasons why B-VAR models are more effective than

VAR models in forecasting and macro dynamic analysis is that they impose the restrictions (priors) on the model coefficients assuming that they are more likely close to zero with respect to the coefficients of the shorter lags (Litterman 1981; 1986; Doan et al. 1984). Specifically, in this case, it is possible to reduce the estimation error and generate only a relative small bias on the estimated parameters. The problems associated with overfitting and the poor forecasting performance introduced by the VAR methodology when the number of the parameters is large, the dataset is short or the sample information is weak, can be mitigated with the B-VAR approach (Sims et al. 1982; Stock and Watson 2001; Canova 2007; Kanngiesser et al. 2020). A number of studies have confirmed that the B-VAR methodology can successfully be used even for large datasets as well as datasets with a moderate level of cointegration (Bańbura et al. 2010; Auer 2014). Since in a classical estimation framework based on a frequentist VAR approach it is difficult to incorporate non-sample information into the estimation, the use of Baye's theorem promotes the incorporation of our knowledge about the parameters observed from the data, into the Bayesian framework. The Bayesian approach combines the sample information with the researcher's prior information on the coefficients to derive a posterior distribution.

The choice of a prior distribution summarizing the researcher's uncertainty over the model parameters is a crucial step in specifying a B-VAR (Ciccarelli and Rebucci 2003); if the prior is too loose the risk of overfitting is hard to reduce, whereas if it is too tight the data are not allowed to speak. As pointed out by Learner (1978) prior information matters in the sense that two researchers can legitimately make different inferences from the same dataset. The usage of the priors could balance the trade – off between less overfitting data and more signal extraction capabilities. In other words, their specification provides a solution to the problem that equations with too many free parameters tend to contain excess noise, while equations with too few parameters fail to pick up the signal.

We start our analysis from a typical VAR(p) model:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + C x_t + u_t, \quad t = 1, \ldots, T \qquad (1)$$

where y_t is a $K \times 1$ vector of endogenous (dependent) variables, x_t is a m x 1 vector of exogenous variables, $A_l = \left(a_{ij}^l\right)$ are K x K matrices of unknown endogenous-variables lag coefficients ($l = 1, \ldots p$), $C = (c_{is})$ is a K x m matrix of exogenous-

variables coefficients, and u_t is a K x 1 vector of error terms with a K x K covariance matrix Σ.

Equation (1) can be written in a compact form as follows:

$$Y = X*B + U \quad (2)$$

where,

$$Y = \begin{pmatrix} y_1' \\ \vdots \\ y_T' \end{pmatrix}, X = \begin{pmatrix} y_0' y_{-1}' & \cdots & y_{1-p}' x_1' \\ \vdots & \ddots & \vdots \\ y_{T-1}' y_{T-2}' & \cdots & y_{T-p}' x_T' \end{pmatrix}, B = \begin{pmatrix} A_1' \\ \vdots \\ A_p' \\ C' \end{pmatrix}, U = \begin{pmatrix} u_1' \\ \vdots \\ u_T' \end{pmatrix} \quad (3)$$

Y is a T x k matrix, X is a T x (Kp+m) matrix, B is a (Kp + m) x K matrix of the coefficients, and U is a T x K matrix.

The vectorized form of equation (2) is

$$Y = X*\beta + u \quad (4)$$

where, y = vec(Y) is a *KT x 1* vector, X* = $I_K \otimes X$ *is* a *KT x K(Kp + m)* matrix *(I_K* is a *K x K* identity matrix and ⊗ is the Kronecker product), β = vec(B) is a K(Kp +m) x 1 vector of all the coefficients, and u = vec(U) is a KT x 1 error vector with Σ* = Σ ⊗ I_T a KT x KT covariance matrix.

Estimating equation (4) in a Bayesian way, works as follows. Given the probability density function (pdf) of the data conditional on the model's parameters, that is the information contained in the data, in the form of a likelihood function,

$$L(Y|\beta,\Sigma) \propto |\Sigma|^{-T/2} exp\left\{-\frac{1}{2}\sum_t (Y_t - X_t\beta)'\Sigma^{-1}(Y_t - X_t\beta)\right\}, \quad (5)$$

and a joint prior distribution on the parameters, *p(β, Σ)*, the joint posterior distribution of the parameters conditional on the data is obtained by using the rule of Bayes,

$$p(\beta,\Sigma \mid Y) = \frac{p(\beta,\Sigma)L(Y|\beta,\Sigma)}{p(Y)} \quad (6)$$

$$\propto p(\beta,\Sigma)L(Y|\beta,\Sigma),$$

where, the joint pdf of the data and the parameters p(*β*, Σ, Y), by definition of conditional probability, can be written as:

$$p(\beta,\Sigma,Y)$$
$$= L(Y|\beta,\Sigma)p(\beta,\Sigma)$$

$$= p(\beta, \Sigma|Y)p(Y) \quad (7)$$

The marginal posterior distributions conditional on the data, $p(\beta|Y)$ and $p(\Sigma|Y)$, can be obtained by integrating out Σ and β from $p(\beta, \Sigma \mid Y)$, respectively.

Next, we describe the Minnesota[3] (M) (Litterman 1980; 1986) and the Inverse Wishart (IW) priors employed in our modeling approach, a set of priors commonly used in VAR modeling.

The original M prior assumes that the variance-covariance matrix of the error vector u is fixed and known based on an approximation which involves substituting Σ with an estimate Σ_e, ignoring any uncertainty in this parameter. Specifically:

$u \sim N(0, \Sigma_e \otimes I_T)$.

This approximation sets the Σ matrix to be diagonal ($\Sigma_e = diag(\sigma_1^2, \dots\dots\dots\dots \sigma_n^2)$), simplifying the computation of the model, as the errors are assumed to be independent for each equation. This matrix is usually set by fitting a univariate autoregression for each series or the OLS residual variance from a classical VAR.

Given a diagonal variance-covariance matrix, we need to specify the prior covariance for β, taking into account a set of hyperparameters. The Minnesota prior for the vector coefficient β is a Multivariate Normal prior, where following Karlsson (2013):

$\beta \sim N(\beta_0, \Sigma \otimes \Phi_0)$.

The prior mean vector β_0 is a vector of 1s and 0s, with 1s corresponding to the self-variables first-lag coefficients, and Φ_0 is a fixed diagonal covariance matrix whose elements are defined for $l = 1, \dots p,\ j = 1, \dots K$, and $s = 1, \dots, m$ as below:

For endogenous-variables lag coefficients:

$$\sigma_{\alpha_j^l}^2 = \left(\frac{1}{\hat{\sigma}_j^2}\right)\left(\frac{\lambda_1}{l^{\lambda 2}}\right)^2 \quad (8)$$

For exogenous-variables coefficients:

$$\sigma_{c_s}^2 = (\lambda_1 \lambda_3)^2 \quad (9).$$

[3] According to Giannone et al. (2015) this prior is centered on the premise that each variable follows a random walk process, maybe with drift, which is a "reasonable approximation of the behavior of an economic variable".

The above formulas are controlled from the following scalars: (a) λ_1 controls the tightness of the prior variance for endogenous-variables lag coefficients. Small values imply that the prior information dominates the sample information. Contrariwise, large λ_1 values make the prior become non-informative and the posterior estimates converge to the unrestricted VAR coefficients. (b) λ_2 controls the lag attenuation (the higher the lag, the tighter the prior variances). Setting $\lambda_2 = 1$ implies a linear decay, and (c) λ_3 controls the prior variance of the exogenous-variables coefficients. Following similar literature (see *inter alia:* Bańbura et al. 2010; Koop and Korobilis 2010; Koop 2013; Brancaccio et al. 2019; Lopreite and Zhu 2020; Cafiso 2022) we give to our main hyperparameter of interest λ_1 (prior information) a small value (an evaluation of different values is provided in Section 6), λ_2 is set to represent a linear decay of lag attenuation, and λ_3 takes a value greater than zero as the information of exogenous variables is important in our analysis.

Although the above case is quite common in a BVAR modeling, it ignores any uncertainty associated with the variance-covariance matrix Σ. The IW prior, alternatively, has the twofold advantage first, to relax the strong assumption of a fixed and diagonal variance-covariance matrix of the error terms, and second be simple to interpret with convenient calculations, since the posterior distribution follows the same parametric form as the prior distribution.

So, in this case we have:

$u \sim N(0, \Sigma \otimes I_T)$ where, $\Sigma \sim IW(\alpha_0, S_0)$.

In our analysis, we select a typically used specification for the IW prior (Schuurman et al. 2016), where the hyperparameter α_0 (degrees of freedom) is set to the minimum possible[4] K+2 and S_0 refers to the identity matrix.

2.4 Data

In this section, we introduce the endogenous and exogenous variables of our modeling approach. To test our hypothesis we examine as endogenous variables four different proxies for physical arms build - up, according to the notion that increases in the arsenal of the two rivals should be echoed by upward changes in their military

[4] Kadiyala and Karlsson (1997) and Giannone et al. (2015) follow a similar specification, as this setting is the minimum value that guarantees the existence of the prior mean of Σ.

spending (Kollias and Makrydakis 1997). Following the classical Richardon model (Dunne et al. 2001; Dunne et al. 2005) a bivariate BVAR approach is applied. In this context, each proxy is introduced into the model as two different series (one for Greece and one for Turkey), while we focus our interest on the interrelationship between them. Specifically, we use a) Military spending levels (in constant 2015 USA dollars), b) Military stock levels (in constant 2015 USA dollars), c) Military spending per capita of armed forces (in constant 2015 USA dollars), and d) Military burden (military spending as % GDP). Data on countries' military expenditures, are obtained from the World Bank, World Development Indicators database-WDI (2021). This is in line with much of the literature on the Greek – Turkish relations (Kollias 1996; Avramides 1997). In Brauer's (2002) study, it is stated that when analyzing imminent military threat and testing for the presence or absence of an arms race, it is proper to use level or stock data, since levels and stocks indicate actual or expected fighting capabilities of oneself vis-à-vis the putative adversary. Thus, countries' military stocks are captured by a second proxy, evaluated by using the perpetual inventory method[5]. Furthermore, since the existing literature points out that military capability is not appropriately measured by levels of military expenditures per se either but rather in the labor and capital, we obtain data on the Greek and Turkish armed forces for the period 1962-1992 from Kollias (1996), and extend this time series to also include the years 1993-2020 using data stemming from the World Bank (2021), in order to capture the military capability that such expenditures finance. Finally, we also use the countries' military burden, a common measure met in the conventional defense literature, despite the admission that share data may be more appropriate, when the substantive concern is about the economic impact of military spending on variables of economic performance, such as economic growth (Sandler and Hartley 1995; Gold 1997)[6]. Except for the forth proxy which appears in the models in first difference, all the other variables are introduced as ln-transformed differences.

[5] The main idea of the method is the construction of yearly military stocks by adding each year's military expenditures and subtracting each year's depreciation of the existing stock by a specific rate. We construct the military stocks by using a 15% depreciation rate. Following the extant literature, we have tried different depreciation rates, e.g., 10%, and 20%, with overall similar results.

[6] While use of share data confers certain statistical advantages such as, comparability across countries, no need to deal with inflation and deflators or with exchange rate conversions into a common currency,

Our basic modeling approach further, includes an exogenous variable, proxied by the world GDP growth, in order to account for global factors (Berument et al. 2010; Comunale 2017).

Table 2.1, presents the descriptive statistics for all the variables detailed above, while Figure 2.1, illustrates a first view of the over – time levels of Greek and Turkish physical arms build-up.

Table 2. 1: Variable Definitions and Descriptive Statistics

Variable Description	Variable code	Mean	Std.dev.	Min	Max
Greece					
Military Expenditures (millions US$ constant 2015) – **Proxy 1**	gr_mil_con	5610.78	1733.49	1927.95	8348.37
Stock of Military Expenditures (millions US$ constant 2015) – **Proxy 2**	gr_mil_stock	35118.63	11410.85	12194.11	46751.88
Military Expenditures per armed forces capita (US$ constant 2015) – **Proxy 3**	gr_mil_parm	32765.06	9542.76	12049.7	57247.59
Military expenditures as % GDP – **Proxy 4**	gr_mil_gdp	3.77	1.01	2.35	5.91
Turkey					
Military Expenditures (millions US$ constant 2015) – **Proxy 1**	tr_mil_con	10484.43	5808.22	2434.85	26801.61
Stock of Military Expenditures (millions US$ constant 2015) – **Proxy 2**	tr_mil_stock	59022.48	32453.16	13004.76	129487.4
Military Expenditures per armed forces capita (US$ constant 2015) – **Proxy 3**	tr_mil_parm	16450.73	10038.55	6038.3	52346.9
Military Expenditures as % GDP – **Proxy 4**	tr_mil_gdp	3.28	0.78	1.81	5.12
Global					
World GDP growth	world_gdp_gr	3.44	1.72	-3.12	6.56

Notes: We account for four different proxies of the physical arms build-up. Prefixes used throughout the text are d_ for first difference, ln_ for natural logarithm, and L_ for lagged values.

one cannot ignore Smith's (1998) sentiment that statistical convenience may not supplant substantive considerations.

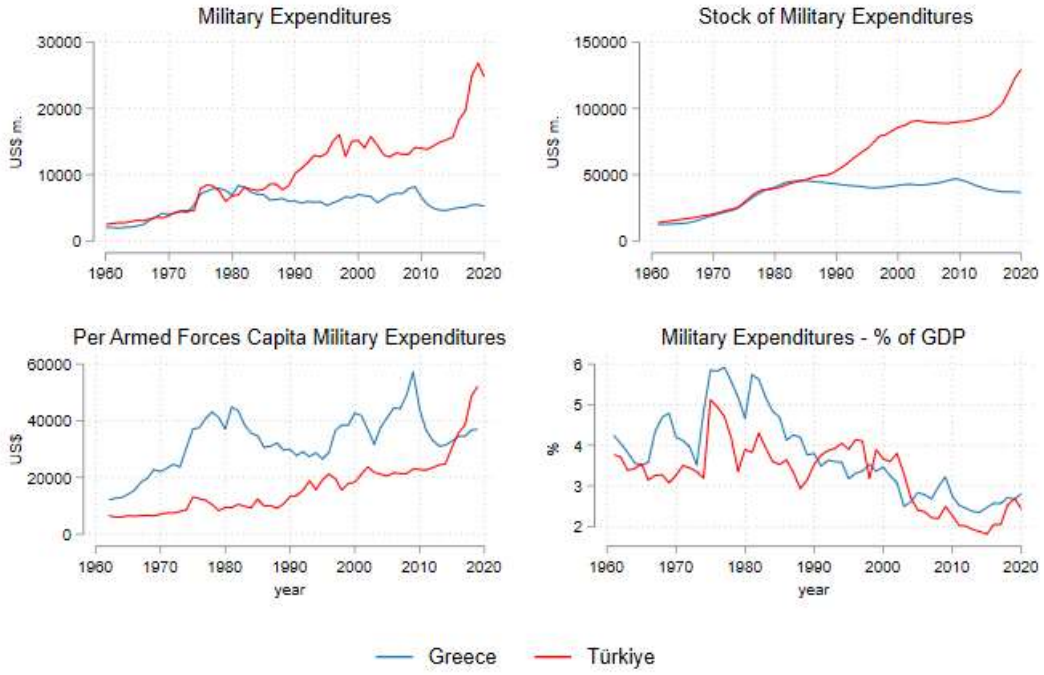


Figure 2. 1: The four proxies of physical arms build – up through time

At first, focusing on the two opponent states' military expenditures in constant prices, one can observe that from 1960 to 1966, both increase in line with each other, but Turkey's ones are at a higher level than Greece's. The first structural break occurs in 1967 and from then on, until around the mid - 1980's the two variables are tracing each other fairly closely. The Greece's spending upward trend documented from the early 1970's, could be attributed to weapon embargoes during the seven year dictatorship which forced government-controlled defense industries to be established, as well as to the increasing tensions with Turkey (Avramides 1997), which urged the country to assert its independence in weapon procurement. A huge increase in both states' military spending is evident in 1974, due to the Turkish invasion in Cyprus, which was accompanied by and created a domino effect causing the Greek military junta to collapse[7]. From 1984 onwards, the level of Greek defense spending appears to be falling short of its Turkish counterpart. In fact, the year 1983 marks the second visually clear structural break and whereas Greece's military expenses stay almost

[7] The decline in Turkish GDP growth and an economic crisis in the late 1970's were followed by a political crisis and the imposition of a military coup in 1980, which adopted a more outward looking economic strategy causing dramatic improvements for the Turkish economy.

perfectly flat, Turkey's continue to rise, so that the divergence grows in Turkey's favor. Two reasons can be put forward in explaining the visual disparity of the two series until 1995. First, the implemented stabilization programs in Greece in the late 80's have seriously curtailed the availability of the funds needed for the country to modernize its arsenal at the same rate as in the past, and be able to keep pace with the considerable arms purchases its adversary has been indulging into, during the same period[8]. Second, the intensification of Turkish internal security problems regarding the Kurdish movement for autonomy may partly justify the sustained upward development in its military expenses[9]. Another interesting pattern that also emerges according to the upper left figure, is the severe impact of the 2009 financial crisis on the Greek defense budget (Kollias et al. 2016), which limited the ability of the Greek government to direct resources to national defense[10]. The recent years, as Turkey increases the government spending for military purposes, Greece tries not to fall behind but has been unable to keep up with its rival. It is meaningful though, to note that both states have been yearly allocating an appreciable share of their national income to defense, a conclusion drawn both from the average values and the plot of the variables which capture the relevant military spending %GDP. Their defense burden has invariably been above the 2% guideline agreed among the NATO allies in 2006[11]. Specifically, Turkey allocates on average 3.28% of GDP on its military sector, while Greece 3.77%, a proportion higher than the NATO average (Choulis et al.

[8] Meanwhile, the events in the Balkans did not associate with amendments to the Greek military planning. Yugoslavia began to break up, and Greece was particularly upset about the creation of a state called Macedonia, but also about the treatment of Greek minority in Albania. Although the trends seemed primarily to require additional security concerns, none of these countries possessed large military establishments and the Greek defense policy remained almost unaltered (Dunne et al. 2001).

[9] The Turkish security forces had been fighting for almost a decade a costly and bloody – war with Kurdish separatists in the south – eastern provinces of the country (Günlük-Şeneser 1995; Kollias 1997).

[10] While Turkish military spending was driven solely by security concerns, Greece's decision – making on military expenses was more restricted due to its European Monetary Union membership (Waszkiewicz 2016).

[11] NATO Defense Ministers agreed to commit a minimum of 2% of their GDP to defense spending to continue to ensure the Alliance's military readiness. This guideline also serves as an indicator of a country's political will to contribute to NATO's common defense efforts, since the defense capacity of each member has an impact on the overall perception of the Alliance's credibility as a politico-military organization.

2021). The bottom left graph is lastly, indicative of Greece's effort to respond to the military capabilities of its adversary by enhancing the capital intensity of its armed forces, which in principle, offsets its quantitative disadvantage resulting from its size and population constraints. Military expenditure per soldier can be treated as a proxy indicating the degree of weapon sophistication and the level of personnel training. Assuming that quality is provided at a higher cost, a well-trained army using modern weapons system is more expensive to maintain than a poorly trained one using outdated armaments (Kollias 1996). Greece's higher values observed until 2015, prove that Greek defense planners attempt to counterbalance the country's disadvantage in numbers, by deploying more capital-intensive mechanized armed forces.

2.5 Results

2.5.1 B-VAR analysis: impulse response functions and forecast error variance decomposition

In this section, we present the BVAR results, focusing our interest on the Impulse Response Functions (IRFs), which are commonly used to summarize VAR models. IRFs measure the effect of one variable's shock, called impulse variable, on a given response variable. The impact of the shock on the response variable is identified over a predefined future period. We draw the posterior mean estimates of IRF coefficients along with the 95% CrIs[12].

First, for every variation of our endogenous variables we have to select the number of lags, a process which constitutes an important consideration in the VAR models. In the Bayesian framework, we compute the model posterior probability, conditional on the observed data, assuming that each model is equally likely a priori considering a maximum number of five lags (max p=5). Results are reported in Panel A of Table 2.2. For all endogenous variables' variations the highest posterior probability appears

[12] Bayesian credible intervals (CrIs) are actual probability distributions, and their interpretation is that there is a 95% probability that the true (unknown) estimate would lie within the interval, given the evidence provided by the observed data. On the other hand, the interpretation of the frequentist 95% confidence interval is the following: we can be 95% confident that the true (unknown) estimate would lie within the lower and upper limits of the interval, based on hypothesized repeats of the experiment.

for one lag, except for Proxy 4 - Mil.Exp. as % GDP, where the highest posterior probability emerges for four lags.

Table 2. 2: Model's posterior probabilities and probabilities of eigenvalues lie inside the unit circle

	Proxy 1 Mil. Exp. (m. US$ constant 2015)	**Proxy 2** Stock of Mil. Exp. (m. US$ constant 2015)	**Proxy 3** Mil. Exp. per Armed Forces Capita (US$ constant 2015)	**Proxy 4** Mil. Exp. (% GDP)
Panel A	P(M|y)	P(M|y)	P(M|y)	P(M|y)
1 lag	**0.8625**	**0.8961**	**0.7462**	0.0749
2 lags	0.1010	0.0992	0.1824	0.2319
3 lags	0.0351	0.0046	0.0600	0.1752
4 lags	0.0012	0.0001	0.0108	**0.3104**
5 lags	0.0001	0.0000	0.0006	0.2075
Panel B				
Pr(eigenvalues lie inside the unit circle)	0.9974	0.8715	0.9965	0.9932

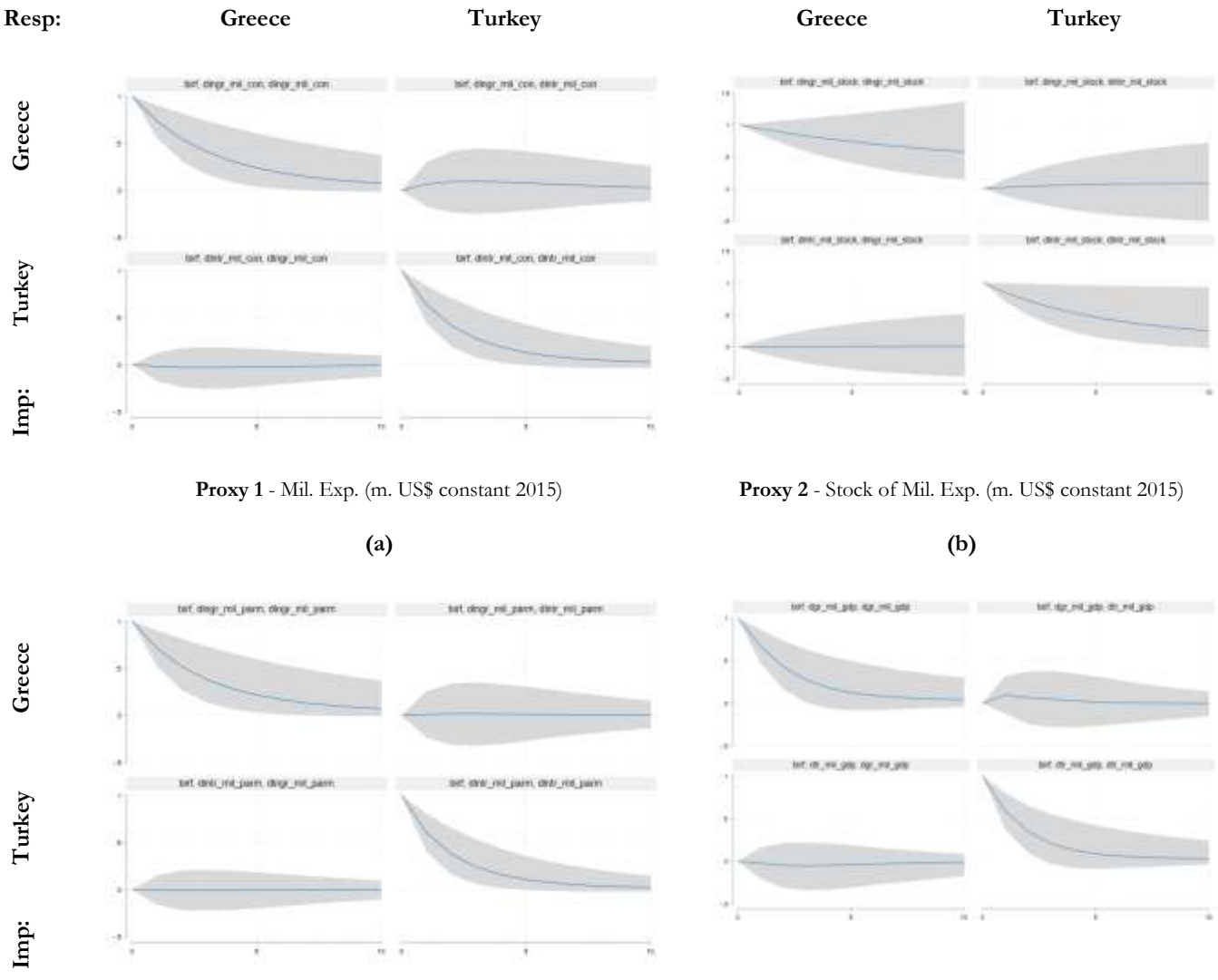
Notes: We account for four different proxies of the physical arms build-up. The model posterior probability P(M|y) is defined as the probability of a model M computed given the observed data y, P(M|y) = P(M)P(y|M) = P(M)m(y) where P(M) is the prior probability of a model M and m(y) is the marginal likelihood under model M. In our case we assume P(M)=0.2.

Next, having selected the number of lags for each one of our four different proxies, we proceed with the stability and graphical diagnostics' checks, while we explore whether the Markov Chain Monte Carlo (MCMC) algorithm has converged. In Panel B of Table 2.2, it is shown that in every case, the posterior probability that all eigenvalues lie in the unit circle is close to one, having no reason to suspect a violation of the stability assumption. Then, for the case of the proxy constant-value military expenditures (Proxy 1), Figure A.1 in the Appendix, shows that the trace plot does not exhibit any trend, and the autocorrelation is low, indicating that the MCMC has converged. Results are similar for the rest three of our endogenous proxies' variations[13].

Figure 2.2, depicts the IRFs for the BVAR models for the four different endogenous variables that we use as proxies (Proxies 1 to 4) of the physical arms build – up for Greece and Turkey. As an exogenous variable, the world GDP growth is included in all specifications in order to account for global factors. The shaded regions are the 95% CrIs obtained through Gibbs Sampling, using a total number of 12,500 iterations, including 2,500 burn-in iterations. We present the responses of each country's

[13] Results are not reported for sake of brevity but are available upon request.

variable (Proxy) to a shock (1% increase) from itself and the other country's same variable in the bivariate BVAR model for a ten - year period.



Proxy 1 - Mil. Exp. (m. US$ constant 2015)

(a)

Proxy 2 - Stock of Mil. Exp. (m. US$ constant 2015)

(b)

Proxy 3 - Mil. Exp. per Armed Forces Capita (US$ constant 2015)

(c)

Proxy 4 - Mil. Exp. (% GDP)

(d)

Figure 2. 2: Bayesian IRFs and 95% credible intervals for the four different proxies of the physical arms build – up for the bivariate BVAR models between Greece and Turkey (10 - year horizon)

As it can clearly be seen, the IRFs indicate that for every Proxy the results are significant only for the own country's shocks (impulses). Specifically, for Proxy 1, Greece's own shock has a positive effect that remains significant till year 5 (row one, column one, Figure 2.2a), while Turkey's self shock is significant for a four - year period (row two, column two, Figure 2.2a). For Proxy 2, the significance of a country's own shocks is detected for longer periods, capturing the long run nature of

building a nation's defense armaments, through military equipment programs (row one, column one, and row two, column two, Figure 2.2b). For Proxy 3, the results are similar to those concerning Proxy 1 (Figure 2.2c). Finally, for Proxy 4, for both countries, state's own impulses have significant positive effects for a three - year period (row one, column one, and row two, column two, Figure 2.2d). As for the other county's shocks, results indicate a negligible/ insignificant positive effect from Greece to Turkey for Proxy 1 (row one, column two, Figure 2.2a) and for Proxy 4 (row one, column two, Figure 2.2d).

To gain a deeper understanding of the potential interdependencies and the relative importance of the variables, we further, conduct an analysis of forecast error variance decomposition (FEVD), using a predicting period of ten years following the initial shock. The FEVD measures the proportion of forecast error variance explained by the variables themselves and the other model variables. In Table 2.3, we present the results for each one of our Proxies of interest. In every case, the contribution to the variance of the other country's variable is minor, less than 10% in the ten - year horizon. The only exception is the case of Proxy 2, where Greece's Military Stock shows a contribution of 16% on Turkey's Military Stock total variance in the 10th year after the initial shock. On average, the other country's shocks do not have a notable power of explaining the own country's forecast error variance, confirming the results of the impulse response function analysis, and validating our hypothesis that the hostility between the two neighboring countries does not feature an arms race.

Table 2. 3: BVAR forecast-error variance decomposition (10 - year horizon)

Endogenous Variable:	**Proxy 1** - Mil. Exp. (m. US$ constant 2015)				**Proxy 2** - Stock of Mil. Exp. (m. US$ constant 2015)			
Impulse:	Greece		Turkey		Greece		Turkey	
Response:	Greece	Turkey	Greece	Turkey	Greece	Turkey	Greece	Turkey
Steps								
1	100.00(0.00)	1.83(2.48)	0.00(0.00)	98.17(2.48)	100.00(0.00)	9.59(6.62)	0.00(0.00)	90.41(6.62)
2	99.31(1.02)	2.82(3.23)	0.69(1.02)	97.18(3.23)	99.74(0.39)	10.16(6.90)	0.26(0.39)	89.84(6.90)
3	98.38(2.34)	4.06(4.41)	1.62(2.34)	95.94(4.41)	99.24(1.12)	10.83(7.40)	0.76(1.12)	89.17(7.40)
4	97.52(3.53)	5.19(5.57)	2.48(3.53)	94.81(5.57)	98.60(2.04)	11.57(8.05)	1.40(2.04)	88.43(8.05)
5	96.84(4.48)	6.10(6.52)	3.16(4.48)	93.90(6.52)	97.87(3.05)	12.35(8.78)	2.13(3.05)	87.65(8.78)
6	96.33(5.19)	6.77(7.25)	3.67(5.19)	93.23(7.25)	97.12(4.08)	13.15(9.55)	2.88(4.08)	86.85(9.55)
7	95.96(5.72)	7.26(7.80)	4.04(5.72)	92.74(7.80)	96.37(5.09)	13.95(10.31)	3.63(5.09)	86.05(10.31)
8	95.70(6.10)	7.60(8.22)	4.30(6.10)	92.40(8.22)	95.64(6.06)	14.73(11.06)	4.36(6.06)	85.27(11.06)
9	95.52(6.39)	7.85(8.53)	4.48(6.39)	92.15(8.53)	94.95(6.96)	15.48(11.77)	5.05(6.96)	84.52(11.77)
10	95.39(6.61)	8.03(8.76)	4.61(6.61)	91.97(8.76)	94.30(7.81)	16.20(12.44)	5.70(7.81)	83.80(12.44)

Endogenous Variable:	**Proxy 3** - Mil. Exp. per Armed Forces Capita (US$ constant 2015)				**Proxy 4** - Mil. Exp. (% GDP)			
Impulse:	Greece		Turkey		Greece		Turkey	
Response:	Greece	Turkey	Greece	Turkey	Greece	Turkey	Greece	Turkey
Steps								
1	100.00(0.00)	1.72(2.37)	0.00(0.00)	98.28(2.37)	100.00(0.00)	1.80(2.48)	0.00(0.00)	98.20(2.48)
2	99.29(1.05)	2.38(2.70)	0.71(1.05)	97.62(2.70)	99.21(1.17)	2.82(2.97)	0.79(1.17)	97.18(2.97)
3	98.39(2.32)	3.28(3.53)	1.61(2.32)	96.72(3.53)	97.89(2.86)	3.99(4.10)	2.11(2.86)	96.01(4.10)
4	97.61(3.40)	4.12(4.43)	2.39(3.40)	95.88(4.43)	96.61(4.42)	5.13(5.22)	3.39(4.42)	94.87(5.22)
5	97.03(4.21)	4.78(5.18)	2.97(4.21)	95.22(5.18)	95.60(5.59)	6.04(6.08)	4.40(5.59)	93.96(6.08)
6	96.61(4.80)	5.26(5.77)	3.39(4.80)	94.74(5.77)	94.89(6.39)	6.69(6.69)	5.11(6.39)	93.31(6.69)
7	96.31(5.23)	5.61(6.23)	3.69(5.23)	94.39(6.23)	94.43(6.95)	7.13(7.13)	5.57(6.95)	92.87(7.13)
8	96.11(5.53)	5.85(6.58)	3.89(5.53)	94.15(6.58)	94.14(7.34)	7.41(7.45)	5.86(7.34)	92.59(7.45)
9	95.97(5.76)	6.03(6.85)	4.03(5.76)	93.97(6.85)	93.94(7.62)	7.60(7.68)	6.06(7.62)	92.40(7.68)
10	95.88(5.92)	6.16(7.07)	4.12(5.92)	93.84(7.07)	93.81(7.84)	7.73(7.87)	6.19(7.84)	92.27(7.87)

Note: We account for four different proxies of the physical arms build-up. Numbers in parentheses denote standard errors.

2.5.2 Robustness Analysis

Several additional analyses are performed to assess the robustness of our results, as we are particularly interested in further exploring contingent interrelationships between the two countries.

First, we split our sample in two sub-periods, 1960-1974 and 1975-2020, because it was the summer of 1974, when the threshold of military engagement was crossed, with the Turkish Armed Forces invading and violating the sovereignty of Cyprus. Moreover, 1975, was the year during which Turkey called on Greece to limit its national airspace from 10 to 6 nautical miles, in line with the delimitation of its continental shelf[14]. Results presented in Figures A.2 and A.3 in the Appendix do not reveal any impacts of interdependence. Then, we test the sub-periods 1960-1993 and 1994-2020 - before and after - the establishment of the Common Foreign and Security Policy (CFSP) under the Treaty of Maastricht in Europe, as a probable time benchmark for a structural change in the policy concerning the defense sector. Results do not alter significantly. The same findings apply for the period 1975-1993, in contradiction to those reported in the work of Tütüncü and Şahingöz (2020), which confirm the presence of an arms race for the sub-period 1975-1990.

Subsequently, we insert a number of additional variables in our models to uncover any potential correlation between the rivals' military expenses. At first, since defense spending is used as an explicitly electoral tool, with spending levels rising just before elections to stimulate the economy and improve incumbent party's prospects (Mayer 2002), we account for this process, by constructing two exogenous dummy variables each of which takes the value of 1, if elections took place in the year under observation in Greece and Turkey, respectively, and zero otherwise. In addition, we use an exogenous dummy indicating whether Recep Tayyip Erdoğan was the country's leader in a given year, because it is possible that he is "structurally different" than his predecessors, as he has now ruled for twenty years, since taking prime ministerial office in 2003, whilst that position was held by eight different individuals in the previous twenty-year-long period. Moreover, we use a dummy in order to allow for the substantial shift in foreign and defense policy that occurred in 1981, when the socialist party came into office in Greece, and a second one to capture if an

[14] The root of the problem lies in a reform enacted by Greece in the 1930s to delimit airspace of 6-10 nautical miles above international waters. The 1944 Chicago Convention on International Civil Aviation, however, stipulated that airspace can only exist over land areas and territorial waters, yet no one addressed the issue of Greece's expansion of its airspace over international waters.

observation occurred in or after the 2016 coup attempt, which resulted in an important change in Turkish civil military relations, thus potentially affecting both Turkish military spending and Greek perceptions of the danger posed by its rival. We also, insert in our models a Political Regime proxy using data from the Polity IV Project. The results emerging from IRFs remain unchanged throughout. As for economic factors, following previous studies, we include in an augmented BVAR modeling approach, variables to capture investments as %GDP and GDP growth (Kollias and Paleologou 2010; 2016; 2019), but also urban population (% of total population), and age dependency ratio (% of working-age population) (Amir-ud-Din et al. 2020), deriving data from WDI. The results of the dynamic IRFs analysis between the rivals are barely modified. Lastly, we account for the serious Greek – Turkish disputes and include a variable, taking a value of 1 for the years 1963, 1974, 1977, 1987, 1994, 1996, 1999 and 2018-2020 (Clogg 1991; Brauer 2002; Tütüncü and Şahingöz 2020; Choulis et al. 2021), but additionally, take into consideration the significance of each state's internal security environment. Given the dramatic changes in the Balkan region and the tensions that had been developed between Greece and two of its northern neighbors, Albania and North Macedonia (Klok 2003), a dummy is inserted in the models taking the value of 1 for the years 1991-1995, allowing for the Balkan area developments. Similarly, since Turkey is also facing a relevant domestic security challenge from the PKK and more severe internal conflict may be correlated with increased military spending, we construct a dummy which takes the value of 1 for each one of the years the Turkish security forces were involved in a struggle with the PKK militants (Thomas and Zanotti 2019). Results concerning our main proxies of interest remain almost unaltered. Overall, the results do not vary in any substantial way across alternative variables, subsets and specifications.

2.6 Forecast evaluation

To validate our choice of a Bayesian framework and evaluate the performance of our selected model, in this section, we compare the forecast accuracy resulted from four different models: the unrestricted VAR and three BVAR models for the four different endogenous variables with the same specification (lags and exogenous variable). We evaluate three different BVAR models, for each one of our proxies, where in the first model the main hyperparameter λ_1 (which controls the prior variance for endogenous variables lag coefficients) is set to the value 0.1 indicating an informative prior, in the second model it is set to the value 0.5, and in the third to 1 indicating a quite non-informative prior. To perform the evaluation we do not use the entire available time span, but taking into account the low number of observations, we

drop the last six (10% of our sample) and use them for comparison reasons. These observations are computed from the fitted models in order to evaluate which model has the highest forecast accuracy. Two relevant metrics are used, the Root Mean Square Error (RMSE) and the Mean Absolute Error (MAE) defined as:

$$RMSE = \sqrt{\frac{\sum_i^n (y_i - \bar{y}_i)^2}{n}} \text{ and } MAE = \frac{\sum_i^n |y_i - \bar{y}_i|}{n} \quad (10)$$

where, y_i are the observed data and $\bar{y}_i$ the corresponding forecast values. Both metrics are reported, as the first is more sensitive to larger deviations and the second one more sensitive to smaller deviations from the true values. A better forecast performance corresponds to the lower values for both metrics.

The evaluation presented in Table 2.4, illustrates important benefits from applying Bayesian techniques and confirms our choice for the prior specification: on average, the poor performance of the frequentist VAR model in comparison to the BVAR models, and especially the one where the hyperparameter λ_1 is set to 0.1, suggests that the informative priors considerably enhanced the forecast of our modeling approach.

Table 2. 4: Forecasting comparison of different VAR and BVAR models

Variable	RMSE				MAE			
	VAR	BVAR λ_1=1	BVAR λ_1=0.5	BVAR λ_1=0.1	VAR	BVAR λ_1=1	BVAR λ_1=0.5	BVAR λ_1=0.1
Proxy 1 - Mil. Exp. (m. US$ constant 2015)								
Greece	0.0673	0.0638	0.0599	**0.0592**	0.0487	0.0459	0.0494	**0.0435**
Turkey	0.0433	0.0429	0.0422	**0.0365**	0.0289	0.0283	0.0279	**0.0226**
Proxy 2 - Stock of Mil. Exp. (m. US$ constant 2015)								
Greece	0.0292	0.0284	0.0283	**0.0268**	0.0265	0.0256	0.0256	**0.0240**
Turkey	0.0106	0.0109	0.0108	**0.0098**	0.0096	0.0097	0.0096	**0.0081**
Proxy 3 – Mil. Exp. per Armed Forces Capita (US$ constant 2015)								
Greece	0.0750	0.0718	0.0667	**0.0648**	0.0541	0.0522	**0.0492**	0.0526
Turkey	0.0734	0.0737	0.0734	**0.0672**	0.0469	0.0469	0.0466	**0.0416**
Proxy 4 – Mil. Exp. (% GDP)								
Greece	0.0812	0.0800	**0.0790**	0.1001	0.0726	0.0829	0.0705	**0.0678**
Turkey	0.1152	0.1074	0.1024	**0.1013**	0.0887	0.0854	0.0853	**0.0820**

Notes: We account for four different proxies of the physical arms build-up.

2.7 Conclusion

For more than thirty years, Greece and Turkey have been at odds over the occupation of the northern portion of Cyprus, and have conflicting claims of sovereignty over the continental shelf, sea, and air regions of the Aegean Sea. Based on their intense disagreement, there is a strong belief that the two nations have been engaged in an arms race, which appears to have escalated the past decade due to the gas discoveries in the eastern Mediterranean, the Libyan – Turkish maritime agreement and the territorial demarcations between Greece and Egypt. This study constitutes another attempt to shed new light on the issue, where the previous literature has produced poor and mixed results. Using a Bayesian Vector Autoregression (BVAR) model for an annual dataset running from 1960 to 2020, we make an empirical investigation of Greek-Turkish relations, focusing on four different proxies of the states' physical arms build – up. The findings indicate that a shock in each one of the variables which capture the country's military expenditure does not have an impact on the opponent's spending, confirming our hypothesis that the rivalry between the neighbors does not feature an arms race. The policy implications are straightforward and demand the attention of the academic community and policy experts. The proliferation of these disputes in a volatile strategic environment, could threaten the development and stability of the wider region of Southeast Europe and the Eastern Mediterranean. A reduction in the tension could be achieved through a gradual, step-by-step approach to the bilateral differences, involving an arms control agreement aiming at stabilizing or even limiting the current levels of weapon stocks. Instead of weaving a canvass of ever-increasing hostility and claims that bring the two countries to the brink of an armed conflict, a just and stable solution of the problems could impose a balance of power at lower armament levels and hence, the reduction of the cost of arming would allow the reallocation of resources to more productive uses in the economy, yielding a piece dividend for both nations.

3 Military expenses and Economic activity in the World Economy: A GVAR approach

According to the Stockholm International Peace Research Institute world military spending recorded an upward trend the last seven years and despite the economic fallout of the global Covid-19 pandemic, countries around the world increased their arsenals. In this study, we employ a Network General Equilibrium GVAR model to analyze the dynamic interdependencies between military expenditures and the real economy for the period 1970-2018, and our approach allows for the existence of dominant economies in the system. By accounting for the interconnection among the top twelve military spenders, our findings show that China acts as a leader in the global military scene based on the respective centrality measures. Meanwhile, statistically significant deviations from equilibrium are observed in most of the economies' military expenses, when subjected to an unanticipated unit shock of other countries. Nonetheless, in the medium-run, the shocks tend to die out, and economies converge to an equilibrium position.

3.1 Introduction

World military expenditures have been on the rising over the last decade, with the year 2021 to surpass the two trillion US dollar mark for the first time, accounted to 2.2 per cent of the global gross domestic product (GDP), which equates to approximately $249 per person.[15]

Traditionally, military expenditure has been one of the major concerns for countries (Gong and Zou 2003) regardless of their economic conditions (Raju and Ahmed 2019) and became a particularly important issue during the Covid-19 pandemic (Susilo et al. 2022), as countries faced critical decisions on the prioritization of different types of spending such as healthcare expenditure and military procurement. A viable approach to national security is to maintain an adequately sized, trained, and equipped force that is capable of dissuading, deterring, and – if necessary – defeating a diverse set of future adversaries (Rahman and Siddiqui 2019).

The finance though, of military expenses is through taxes or by issuing public debt. The allocation of resources to national defense has important economic ramifications triggering dilemmas and debates among policy makers and in the literature, especially in developing

[15] Stockholm International Peace Research Institute (SIPRI) 2021 fact sheet

countries, which are endowed with less resources compared to developed economies (Kollias and Paleologou 2019; Okwoche 2022). The reason is that military expenses could be a wasteful enterprise, leading potentially to inflation of government debt, questioning the reason for investing great amounts of money in that direction (Caruso and Di Domizio 2017). This spending could well be devoted to more productive activities that would increase the level of human capital and living conditions, instead (Kollias and Paleologou 2016). Furthermore, in a globalized world, the (path of) spending on the military sector may also lead to arms races or direct military confrontations, triggering equivalent reactions from neighboring or hostile countries, as increases in a perceived enemy's defense spending or threat are anticipated to augment a country's defense spending (Bruce 1990).

A relevant issue that countries need also, to figure out in their budget allocation to finance their military activities is the free ride effect among allies' defense spending, as an ally's defense demand responds negatively to the collective defense spending (or defense spillovers) of its allies (Hilton and Vu 1991; Murdoch 1995; Sandler and Hartley 1995; Douch and Solomon 2014). If, however, an ally derives jointly produced country-specific and alliance-wide outputs from its defense spending, then a positive response to allies' defense spillovers may characterize an ally's defense demand (Sandler 1977; Sandler and Murdoch 1990; Sandler and Hartley 2001).

This chapter studies the dynamic interdependencies between military expenditures and the real economy, by accounting for the interconnection among the top military spenders that account for more than two-thirds of the global spending. A novelty of this effort is the modeling of the dynamic interdependencies of defense spillovers across economic units. Our modeling technique builds on the prominent work of Acemoglu et al. (2012) and Pesaran and Yang (2020) and utilizes the network system structure, using a general equilibrium framework. The pervasiveness of each economy in the network is tested following Pesaran and Yang (2020), while we extend the modeling choice of Spatial Vector Autoregressive schemes proposed by these authors, by using a GVAR process, which allows rich and flexible modeling of international shock dynamics, while keeping dimensionality manageable. Finally, based on the selection of dominant entities proposed in Konstantakis et al. (2015) and Tsionas et al. (2016), we provide a robustness analysis for the dominance characterization of each economy (node) in the network.

We apply our modeling approach to the top twelve military spenders (USA, China, India, United Kingdom, Russian Federation, France, Germany, Japan, South Korea, Italy, Australia and Brazil) for the period 1970-2018[16], with two key questions in mind: (i) Is there a dominant economy in the world's military arena?, and (ii) Do unanticipated shocks in the military spending levels of one country, influence the behavior of another?

In the field of defense economics there are a growing number of studies investigating the nexus of military expenditures and economic activity (Deger and Smith 1983; Mintz and Stevenson 1995), but also the response of a country's defense spending to that of its allies or enemies. These surveys mainly based their analysis on using panel or time series data (Douch and Solomon 2014; Graham and Mueller 2019; Saba and Ngepah 2019; Amir-ud-Din et al. 2020) and spatial methods (Goldsmith 2007; Flores 2011; Skogstad 2016; Yesilyurt and Elhorst 2017; George and Sandler 2018; George et al. 2019). Our study contributes to this strand of literature by applying a novel network-theoretic model, which builds on general equilibrium theory and the GVAR framework to investigate the dynamics of global military expenses. With our methodology we are able to capture not only the effect of nearness on a country's military spending, as the past literature has documented, but also a country's defense and economic dependencies with other countries and how a unit's military expenses could shape the spending of the rest. Using state-to-the-art quantitative and econometric techniques, we provide robust and comprehensive analysis.

Our findings show that China acts as a leader in the global military scene based on the respective centrality measures. Additionally, statistically significant deviations from equilibrium are observed in most of the economies' military expenses, when subjected to an unanticipated unit shock of other countries. Nevertheless, in the medium-run, the shocks tend to die out, and economies converge to an equilibrium position.

The remainder of the chapter proceeds as follows: Section 2 poses the testable hypotheses, and sets out the methodological framework upon which our model is structured, Section 3 presents the data and provides the empirical analysis of the results, Section 4 discusses the findings, while Section 5 concludes.

[16] Unfortunately, the lack of data on Saudi Arabia keeps us from including it in the analysis.

3.2 Methodology

3.2.1 Testable Hypotheses

Defense economists have long been interested in the driver of demand for military expenditure and potential arms races (Sandler and Hartley 2007; Markowski et al. 2017). Broadly speaking, both history and theory indicate that military spending is strategic in nature – a country's military expenditures depend on the military allocations of other countries (Flores 2011).

The understanding of systematic relationships between countries' expenses on defense has occupied a central place in the literature on arms races that traces back to Richardson (1960). Richardson's model was based on a system of differential equations in which the rate of change of the armaments of one country depended on the level of arms of its rival and vice versa.

What constituted though, also a point of concern in the field of defense economics was the structure of the world power and a country's possible dominance in the global military arena. Posen (2009) argues that the characterization of the system as unipolar, which emerged quickly after the collapse of the Soviet Union and has gained wide currency since, remains difficult to dispute. The USA has the diplomatic skills and military might necessary to manage and sustain a truly global foreign policy and hence, enjoys a comfortable margin of superiority over other nations. However, Fingar (2009) states that a multipolar world – that is, a world of multiple power centers – is gradually emerging. The report attributes the finding that unipolarity is on the wane, to a globalizing economy, a historic transfer of relative wealth and economic power from west to east, the rise of emerging powers, and the growing influence of non - state actors.

Given these trends, it seems appropriate to investigate whether there is one country that dominates the military developments, acting as a leader - with the rest lagging - and therefore we form the first hypothesis as follows:

H_1: There is one dominant country in the military arena, while the rest are followers.

No country is though, isolated from the world economy, and external shocks are increasingly important. With the accelerating pace of globalization, the question of how different countries react to different shocks is of heightened significance (Lucas 1977). In similar fashion, unanticipated changes in military expenditures in a country could influence the military

spending behavior of others. A number of studies of arms races and numerous surveys have investigated this effect and examined different measures of interdependency among countries.

China's military expenses take into consideration American, Soviet, and Taiwanese spending on the defense sector (Sun and Yu 1999), whereas Canadian and American militaries are so closely intertwined that they share command of air forces through the North American Air Defense Command (Barry and Bratt 2008). Greece's military expenses depend on Turkey's military allocations (Kollias 1996; Avramides 1997). Defense spending in Angola and Mozambique is strongly determined by South African military expenditures (Batchelor et al. 2002), while Israeli military allocations are strong determinants of Egyptian, Syrian, and Jordanian ones (Mintz and Ward 1988). A mutual causal relationship is detected between the military expenditures of India and Pakistan (Paul et al. 2005; Yildirim and Öcal 2006), whilst the paper of Amir-ud-Din et al. (2020) finds that while military expenditure of Pakistan is shaped by the Indian military expenditure, the latter is not Pakistan-specific. A list of similar examples can be extended almost indefinitely, though, countries do not simply react according to the decisions of a sole country; they respond to the military efforts of their neighbors, allies, enemies, and neutral states.

When threatened by a revisionist state, in some cases countries might increase militaries, while others might decrease allocations, if they belong to a defensive alliance. Countries in unstable regions might constantly increase spending on their defense sector regardless of alliance membership (Flores 2011).

In an initial spatial study of defense spending, Goldsmith (2007) examines a global sample of 120 countries in 1991 and finds that nearby states have similar levels of spending. Flores (2011) applies spatial methods to defense spillovers based on some measure of propinquity or connectivity, such as contiguity or nearness in distance and shows that a country's military expenses are positively correlated with those of its geographic neighbors and its alliance partners. In a subsequent study, Skogstad (2016) employs specially developed weighting matrices for 124 countries over a 16-year time period starting in 1993 to indicate that military burdens of neighboring countries are positively correlated, while a country's regional location may also influence its defense spending.

Follow – up studies include spatial weights applied to NATO allies' spillovers based on contiguity and inverse distance (George and Sandler 2018), but also spatial econometric

techniques and data pertaining to 144 countries over the period 1993-2007 to clarify the impact of neighboring countries on military expenditures (Yesilyurt and Elhorst 2017). Furthermore, a number of recent surveys focus on specific geographical regions. For instance, Christie (2019) uses an empirical model to investigate European defense spending over the 2007-2016 period and results suggest that Russia has recently come to be seen as a potential military threat by European nations, leading to defense spending increases, the more so the shorter the distance to stationed or deployed Russian forces, and particularly so by those that have a land border with Russia. Also, the study of George et al. (2019) examines the demand for military expenditure in a sample of key Asia – Pacific countries using various spatial autoregression models where spatial connectivity is based on regional membership, contiguity, inverse distance, and power-projection considerations. Results emerging in the spatial runs show that free riding opportunities are prevalent, while the projection of Chinese or American power is a relevant spatial factor.

Aiming to contribute to the large body of literature, the second hypothesis we aim to test is the following:

H_2: *Unanticipated shocks in the military spending of one country influence the military behavior of another belonging to the network of the top defense spenders.*

Next subsection develops the model to formally explore those hypotheses.

3.2.2 The node theoretic-GVAR model

In order to consistently derive a node-theoretic GVAR model, a number of fairly standard assumptions need to be made. To begin with, we need to define the network structure of our model, in a multi-country set up. In this context, Definition 1 characterizes the network in terms of its nodes.

Definition 1: Consider a network with $i = 1, \dots, N$ nodes where each node represents an entity in an economic system. Each node is described by a unique set of characteristics which are solely dependent on the identity of the node, i.e. each node is described by a vector of characteristics x_i.

Based on Definition 1, each entity in the network has its own set of characteristics that are depicted by vector x_i and could of course vary across the various nodes. Next, Definition 2 characterizes the economic network structure in terms of its edges, which depict the interconnection among the various entities.

Definition 2: Consider a network with $i = 1, \dots, N$ nodes, where each node represents an entity in an economic system. Each node in this economic network communicates with the rest of the nodes through the edges of the network, which can be compactly represented either by a trade weight matrix, or by the transformed input-output (IO) Leontief weights.

Concerning the time dimension of the network the following assumption (Assumption 1) holds.

Assumption 1: The network evolves in time, i.e. the position of each node (economy) changes over time, following a change in the elements of the transformed IO weights or changes in the trade weight matrix.

In this context, each time stamp $t \in T$ represents a snapshot of the network in time, while also an assumption is needed regarding the structure of the network (Assumption 2).

Assumption 2: For reasons of simplification, we assume that the number of network nodes remains fixed over time, i.e. no node can either exit or enter the network.

Having established the basic structure of the network, we proceed by determining the econometric framework upon which our analysis will be built. Notice that based on our network structure, each node can be directly influenced by all its neighbouring nodes which are directly linked via a specific edge. Nevertheless, indirect links between non-neighbouring nodes could also not be excluded. To coherently model these potential indirect links, unobserved factors need to be included in our model. Thus, in order to compactly describe the dynamic interdependencies among the various nodes of the network, an econometric model which could incorporate both direct and indirect effects between the various nodes in the network, is needed.

In this context, consider a canonical factor model of the form:

$$z_{it} = \Gamma_i f_t + \xi_{it}, i = 1, \dots, N \textbf{ [1]}$$

where: Γ_i is a matrix of factor loadings which capture both the indirect and direct links between the various nodes, whereas Γ_i is assumed to be uniformly bounded and ξ_{it} is a vector of economy (node) specific shocks, whereas we assume that the factors and the economy/node specific shocks follow:

$$\Delta f_t = \Lambda_f(L)\eta_f, \eta_f \sim IID(0, I) \textbf{ [2]}$$

$$\Delta\xi_{it} = \Xi_i(L)\omega_{it}, \omega_{it} \sim IID(0, I)$$ **[3]**

where: Λ_f and Ξ_i are uniformly absolute summable, so as to ensure the existence of $Var(\Delta f_t)$ and $Var(\Delta\xi_{it})$.

Based on this set of assumptions, Dees et *al.* (2007) demonstrated that the unobserved common factors could be estimated using linear combinations of cross section averages of the observable variables y_{it} as:

$$z_{it}{}^{*} = W_i{}'z = \Gamma_i{}^{*} f_t + \xi_{it}{}^{*}$$ **[4]**

which corresponds to a conditional VARX model for each economy (node) in the network of the form:

$$y'_{i,t} = a_{i0} + \Phi(L_1)y'_{j,t} + \Phi(L_2)y'_{i,t}{}^{*} + u_{i,t},\ j\epsilon\{1,..,N,N+1,...N+k\}$$**[5]**

where a_{i0} denotes a $(1xm)$ vector of m intercepts, $y'_{i,t} = [y_{i_1,t}, \dots, y_{i_m,t}]$ denotes the transpose of a $(1xm)$ vector $y_{i,t}$ of m variables for each economy $i = 1,..,N$ expressing the country specific variables; $y'_{j,t} = [y_{i_1,t}, \dots, y_{i_m,t}, y_{i_{k_1},t}, \dots, y_{i_{k_m},t}, \dots, y_{i_{k_K}.t}, \dots, y_{i_{k_K}.t}]$ denotes the transpose of a $((m + Km)x1)$ endogenous variables. The m endogenous variables are augmented by the km variables of the dominant entities, and $\Phi(L_1)$ is the $\big((m + Km)xL_1\big)$ matrix of the associated lag polynomial; $y'_{i,t}{}^{*} = [y_{i_1,t}{}^{*}, \dots, y_{i_m,t}{}^{*}]$ denotes the transpose of a $(mx1)$ vector $y^{*}{}_{i,t}$, of m foreign-specific variables for each economy $i = 1, \dots, N-1$ and $\Phi(L_2)$ is an (mxL_2) matrix of the associated lag polynomial. Generally, m and p may be allowed to vary between economies.

In the same spirit, the dominant economies $k = 1,..,K$ follow the scheme:

$$y'_{k,t} = a_{k0} + \Phi(L_4)y'_{k,t} + \Phi(L_5)y'_{k,t}{}^{*} + \Phi(L_6)g'_{k,t} + u_{k,t},\ k\epsilon\{1, \dots, K\}$$**[6]**

In general, the GVAR model is estimated using OLS equation by equation following Pesaran et *al.* (2004).

Following Koop et *al.* (1996) and Pesaran and Shin (1998), the dynamic characteristics of the GVAR model are examined through the so-called Generalized Impulse Response Functions (GIRFs). Analytically, aiming at determining the extent to which each economy responds to a shock, a positive standard error unit shock is examined on every variable in the universe of our model. Furthermore, we investigate the extent and way these shocks can have persistent

effects. A main advantage of this approach is that the GIRFs are invariant to the ordering of the equations.

The (Generalized) Impulse Response Function (GIRF) can be expressed as follows (Koop et *al.* 1996; Pesaran and Shin 1998):

$$I_{j\,(n)} = {\sigma_{jj}}^{-1/2} + B_n \Sigma e_j \forall n = 1, 2, \ldots N \textbf{ [7]}$$

where: $I_{j\,(n)}$ is the Impulse Response Function *n* periods after a positive standard error unit shock; σ_{jj} is the *j*th row and *j*th column element of the variance–covariance matrix of the lower Cholesky decomposition matrix of the error term, that we assume to be normally distributed; B is the coefficients' matrix when inversely expressing the VAR model as an equivalent MA process and e_j is the column vector of a unity matrix. Simulation from their posterior distribution is straightforward.

Construction of the Weight Matrix from the Input-Output Matrix

In the context of our network structure, each node interacts with the rest of the nodes via its weighted edges. In this work, the weights are computed on the basis of the Input-Output matrix. In order to construct the trade weight matrix using the IO matrix that will be used in the proposed GVAR model, we proceed as follows:

Based on the matrix of technical coefficients A, we construct matrix Q with dimensions nxn, which has the following form:

$$Q = \begin{pmatrix} x_{11} & \ldots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{n1} & \ldots & x_{nn} \end{pmatrix} \textbf{ [8]}$$

where each element of Q is given by the expression:

$$x_{ij} = a_{ij} X_j \textbf{ [9]}$$

where the x_{ij} element of matrix Q expresses the product of economy i that is used from economy j, X_j is the total output of the j-th economy and a_{ij} is interpreted as the quantity of output from economy i required to produce one unit of output in economy j. As it is known, in the Input-Output matrix, Q, the row elements express the quantities of goods and services, in value terms, supplied by one economy to itself and all others. Likewise, column elements express quantities obtained by an economy from itself and all others.

We proceed by constructing the transpose of matrix Q, i.e. Q^T. In matrix Q^T, the row elements express quantities obtained by an economy from itself and all other economies, whilst the column elements express quantities supplied by an economy to itself and all others. Now, let matrix D be determined as the difference between matrix Q and its transpose, Q^T, or in matrix notation:

$$D \equiv Q - Q^T \textbf{ [10]}$$

Thus, the typical element, d_{ij}, of matrix D equals to:

$$d_{ij} = x_{ij} - x_{ji} \textbf{ [11]}$$

Each element, d_{ij}, measures the net amount of goods and services, in value terms, that flows in a respective year between itself and the other economies.

Evidently, D, is a matrix with zeros in the main diagonal. In matrix form:

$$D = \begin{pmatrix} 0 & \dots & d_{1n} \\ \vdots & \ddots & \vdots \\ d_{1n} & \dots & 0 \end{pmatrix} \textbf{ [12]}$$

since, by definition, every element of its main diagonal expresses the quantities that each economy obtains and supplies to itself, which, in a general equilibrium framework, are equal to each other.

Since we focus on constructing the so-called weight matrix, close to the spirit of the GVAR model at the international level (Pesaran et *al.* 2004), we continue as follows:

Let NQ, be the matrix whose typical element, nq_{ij}, is given by the following formula:

$$nq_{ij} \equiv \left|d_{ij}\right| = \left|x_{ij} - x_{ji}\right| \textbf{ [13]}$$

A net intra-economic flow weight is defined as the ratio of flows of goods and services between economy i and economy j, over the total flows of goods and services realized by economy i. Or in a mathematical expression:

$$w_{ij} = \frac{nq_{ij}}{\sum_{i=1}^{n} nq_{ij}} \textbf{ [14]}$$

Obviously, W is a matrix with zeros in the main diagonal since, $nq_{ii} = 0$ as discussed earlier. Note that, $w_{ij} \neq w_{ji}, \forall i \neq j$. In matrix form:

$$W = \begin{pmatrix} 0 & \dots & w_{1n} \\ \vdots & \ddots & \vdots \\ w_{n1} & \dots & 0 \end{pmatrix} \textbf{[15]}$$

For example, the element w_{12} indicates the flows of goods and services, between economy 1 and economy 2 as a proportion of the total flows of economy 1.

The proposed weights can be easily computed from the data contained in the Word Input Output Tables (WIOD) that are publically available. The weight matrix W, derived by the previous procedure, is directly analogous to the typical weight matrix of the GVAR model at the international level.

Dominant Entities

Based on the concept of centrality (Freeman 1979), we examine which economies are dominant, by using two main node theory measures, namely: (i) degree centrality and (ii) eigenvector centrality.

(i) The degree centrality of a node indicates how connected a node is to the other nodes in the graph. See, among others, Bates et *al.* (2014) and Ying et *al.* (2014). The centrality, c_i, of each node is given by the following expression:

$$c_i = d(i) \sum_{j=1}^{N} w_{ij} \textbf{ (16)}$$

where $d(i)$ is the degree of each node, that is the number of ties with the rest of the nodes (Fagiolo et *al.* 2008), and w_{ij} are the respective flows between the various nodes that come directly from the weight matrix described earlier. In this context, the dominant economies are those, which exhibit the largest centrality. Thus, the largest c_i corresponds to the dominant economy, the second largest c_i to the second-dominant one, and so on.

However, degree centrality does not take into account how the neighbors of each node interact with the rest of the nodes. In this context, we use an additional measure of node centrality namely, eigenvector centrality (Bonacich and Lloyd 2001).

(ii) **Eigenvector centrality** of a node, i, was developed by Bonacich (1987) and can detect the centrality power of a node according to the distant neighbors of the specific node. It is given by the following expression:

$$EC_i = \lambda^{-1} \sum_{j=1}^{N} W_{ij} e_j \textbf{ (17)}$$

where: λ^{-1} denotes the inverse of the Perron-Frobenious eigenvalue of the adjacent matrix, e_j the respective eigenvector, $W_{ij} = [w_{ij}], i, j \in \{1, \dots, N+K\}$ is the adjacency matrix. Apparently, dominant economies are those with the largest values of eigenvector centrality.

3.3 Empirical Analysis

3.3.1 Data and Variables

Our empirical analysis focuses on a selected panel of the world's top 12 military spenders in 2021[17] (values expressed in billions of USA dollars, based on current market exchange rates) and includes USA (USA), China (CHN), India (IND), United Kingdom (GBR), Russian Federation (RUS), France (FRA), Germany (DEU), Japan (JPN), South Korea (KOR), Italy (ITA), Australia (AUS) and Brazil (BRA) for the period 1970-2018. These economies account for about 76% of the world military spending according to the Stockholm International Peace Research Institute (SIPRI) 2021 fact sheet, a proportion calculated after excluding Saudi Arabia due to data unavailability. The data collected are annual in nature, but following the Denton (1971) method were converted into monthly by means of Stata software.

In order to consistently estimate the general equilibrium price equation of the network system of economies, we use two main variables for each economy: GDP and Military Expenditures. Information on GDP (constant process 2010; billions of USA dollars) and Military Spending (Military Expenditures % GDP) comes from the World Bank, World Development Indicators, while information on Global Credit, i.e. Worldwide Total Credit (constant 2010 prices; billions of USA dollars) and Global Trade, i.e. Worldwide Total Trade (constant 2010 prices; billions of USA dollars) is derived from OECD, Main Economic Indicators. The last two variables act as transmission channels of the crisis in our model (Xu 2012; Cesa-Bianchi 2013; Eickmeier and Ng 2015). Finally, the Input-Output tables, which are used to construct the time varying GVAR weight matrices, come from the World Input-Output Database.

Figure 3.1, below, depicts the ranking of the sample countries according to their mean values of defense spending % GDP (left graph) and their military expenses in constant 2010 prices (right graph), over our whole period 1970-2018. One can clearly see that the United States is by far the largest spender in the world, paying in nominal terms, almost as much as the next

[17] Likewise in 2018

10 listed countries, combined. China's military budget despite the substantial expansion recorded the recent years, pales in comparison to that of the leader. However, the fact can be attributed to the latter's primary focus on security issues within the Indo-Pacific region, in contrast to the former, which maintains a global arms presence. China, also, has followed a policy of linking increase in military spending with economic growth, justifying the classification on the left side of the following figure. Although Russia occupies the sixth place at the right graph, scores highly at the left one, confirming its title of the most powerful military in Europe and one of the largest forces in the world. Furthermore, the United Kingdom is ranked 4 out of the top 12, meaning that it is enlisted among the major drivers, while, South Korea (rank 3 according to the graph 3.1a), has invested heavily in strengthening its defense capabilities, to ensure the weapons platforms and resources availability, in case a war breaks out. A salient finding that emerges is that France, Germany and Italy traditionally put great amounts on their defense sector reflecting on Europe's position as the third-largest spending region consecutively, after the Americas and Asia - Oceania. The last one's expenditures continued an uninterrupted upward trend dating back to at least 1989, with India, Japan and Australia contributing considerably, as India's tensions and rivalry with China and Pakistan drive its defense spending consistently, Japan has accorded a relatively high priority on enhancing the status of national defense, while Australia implements an aggressive strategy aimed at countering threats to its security. Brazil's high proportion of defense expenses ranks it as one of the dominant spenders, although the country was embroiled in a mix of political and economic crises, being faced with guaranteeing a stable source of funding in an austerity environment.

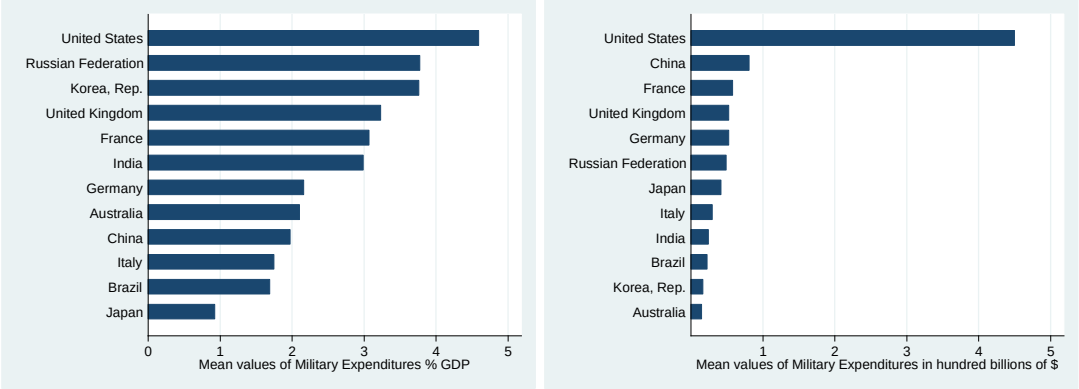


Figure 3. 1 a,b: Mean values of Military expenditures % GDP and in hundred billions $ over the period 1970-2018, respectively

It is also, interesting to explore whether countries' policy on defense spending changes over

time. Figure 3.2, visualizes the trend of military burden – military expenditure as a share of GDP- over the period 1990-2018 for half of the sample countries; USA, United Kingdom, France and Italy were in 1949 four of the twelve founding members of the North Atlantic Treaty Organization (NATO), Russia signed with the Alliance in 1997 the Founding Act on Mutual Relations, Cooperation and Security, creating the NATO Russia Permanent Joint Council, while together with the USA hold more than 90% of the global inventories of nuclear weapons, and China as well, whose military spending has increased continuously since 1994 (for 24 consecutive years). A few things are worth noting: First, after the Soviet Union fell in 1991, US military expenses dipped, but never went below 2 percent and in response to the attacks on Sept. 11, 2001, they moved sharply higher. Moreover, although its allies France and the United Kingdom – Europe's two biggest military powers- hardly hit the benchmark of 2%[18] and Italy still lags far behind, the US pays much more the agreed rate, remaining the largest spender in the world. In spite though the recent increases that followed seven years of continuous decline between 2010 and 2017, the US military burden remained almost 32% lower than its peak in 2010, when it was 4.9% of GDP. As for Russia, its spending share has grown significantly over the past two decades, being by 2018, 9.5% higher than in 2010, 18.4% higher than in 2000, but 28.7% lower than the peak of 5.5%, reached in 2016. The latter, can be partly explained by a large budgetary allocation in 2016 to pay the arms industry for past deliveries of equipment. China, which hacks its way to economic supremacy and seeks for regional dominance, exhibits an increasing tendency on its expenses, albeit in a way tied to its GDP, leading to a share hovering at around 2% since 2000. According to SIPRI (2019), Chinese claims and activities in the South China Sea, have challenged several states to increase in the past decade their spending to expand the capabilities of their armed forces, facing it as a worrying threat.

[18] The goal had been present in the debate over NATO's future and burden sharing at least since the alliance's summit in Riga in 2006 (Techau 2015).

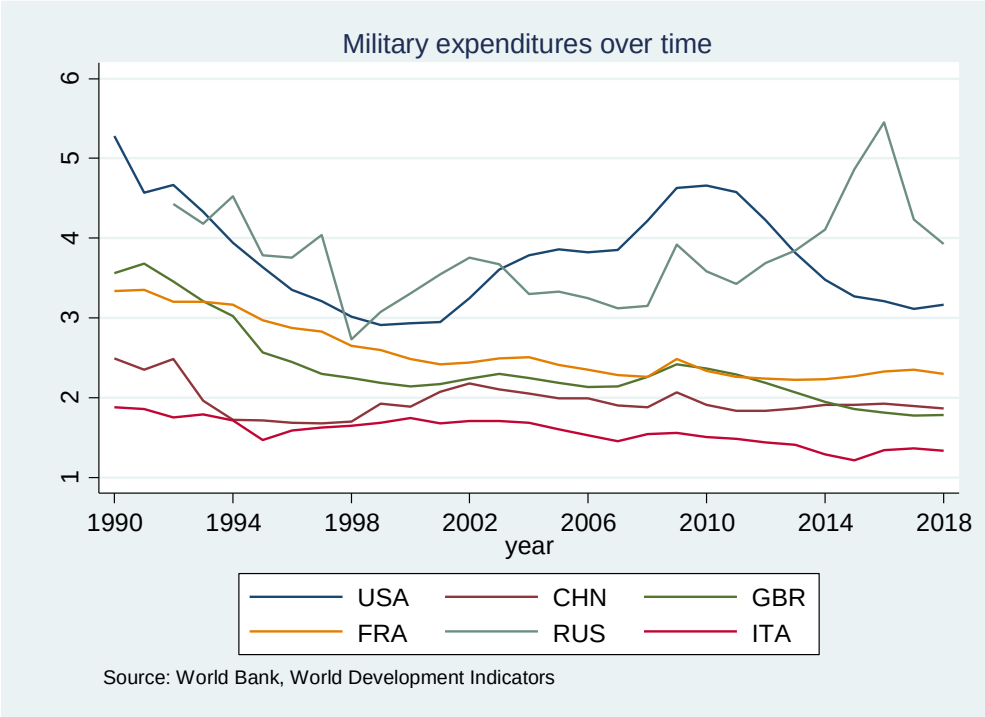


Figure 3. 2: Trend of military burden over the period 1990-2018

3.3.2 The Network

Figure 3.3, below, presents the weighted network of the selected economies that enter our model. The network's structure is cyclical, since all economies interconnect with each other. From visual inspection we can infer that the largest economy in terms of each edges connection is the Chinese economy.

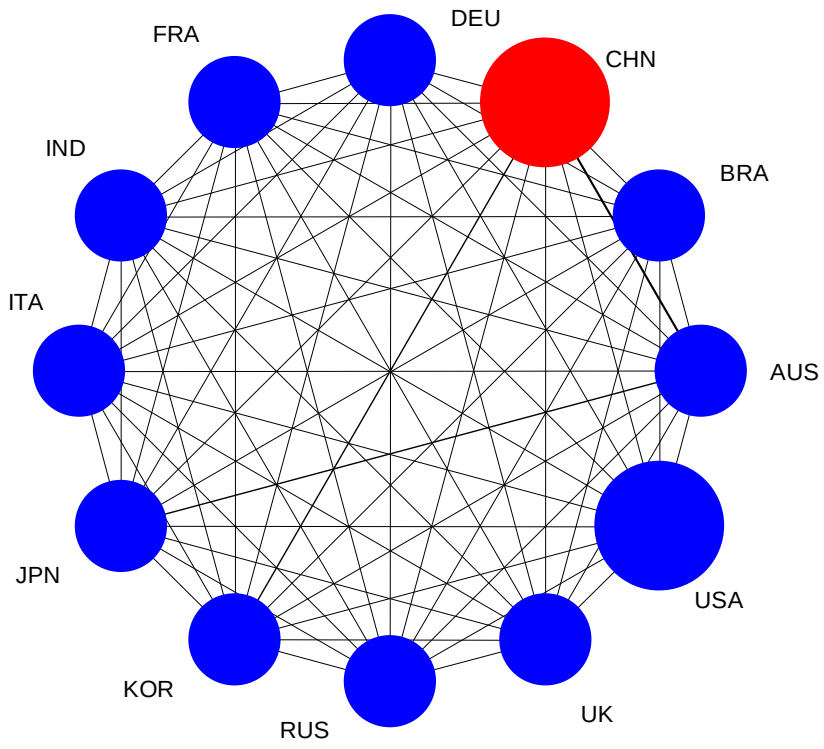


Figure 3. 3: Network Plot

We continue with the confirmation of the dominant economy in our network, following the centrality measures introduced earlier. In this context, Table 3.1 presents the mean value estimates of the specific centrality measures. Note that the quarter-by quarter centrality measures, which are available upon request, did not present any significant volatility, whereas the ranking of each economy according to both centrality measures, remained unaffected throughout the period investigated.

Table 3. 1: Centrality Measures

Economies	Eigenvector Centrality	Degree Centrality
AUS	0.489	0.078
BRA	0.250	0.042
CHN	0.546	0.109
DEU	0.152	0.044
FRA	0.101	0.029
IND	0.178	0.030
ITA	0.101	0.026
JPN	0.327	0.055
KOR	0.310	0.052
RUS	0.136	0.027
UK	0.101	0.035
USA	0.293	0.064

Based on our findings, the economy of China is the dominant economy in the network structure, since it exhibits the largest degree and eigenvector centrality throughout the period of our investigation.

Relevant Tests

Before we estimate the price equation using the GVAR model, following Pesaran et *al*. (2004), we check the order of integration of the time series variables that enter the analysis. Based on our findings, most of the variables were found to be I(1), i.e. stationary in first differences, see Tables 3.2 and 3.3.

Table 3. 2: Phillips Perron Unit Root Test in Levels

Economy	Variable	p-value
AUS	GDP	0.002
	Military_Exp	0.678
BRA	GDP	0.969
	Military_Exp	0.086
CHN	GDP	0.634
	Military_Exp	0.595
DEU	GDP	0.389
	Military_Exp	0.000
FRA	GDP	0.905
	Military_Exp	0.777
IND	GDP	0.981
	Military_Exp	0.944
ITA	GDP	0.921
	Military_Exp	0.892
JPN	GDP	0.405
	Military_Exp	0.746
KOR	GDP	0.113
	Military_Exp	0.649
RUS	GDP	0.877
	Military_Exp	0.641
UK	GDP	0.892
	Military_Exp	0.521
USA	GDP	0.867
	Military_Exp	0.937

Table 3. 3: Phillips Perron Unit Root Test in First Differences

Economy	Variable	p-value
AUS	**GDP**	
	Military_Exp	0.090
BRA	**GDP**	0.048
	Military_Exp	
CHN	**GDP**	0.001
	Military_Exp	0.051
DEU	**GDP**	0.002
	Military_Exp	
FRA	**GDP**	0.019
	Military_Exp	0.005
IND	**GDP**	0.097
	Military_Exp	0.016
ITA	**GDP**	0.025
	Military_Exp	0.008
JPN	**GDP**	0.002
	Military_Exp	0.004
KOR	**GDP**	0.001
	Military_Exp	0.088
RUS	**GDP**	0.088
	Military_Exp	0.062
UK	**GDP**	0.028
	Military_Exp	0.092
USA	**GDP**	0.025
	Military_Exp	0.055

Next, in the presence of I(1) variables we tested for cointegration using the Johansen and Juselius (1990) methodology. The results are presented in Table 3.4. Based on our findings, cointegration was present in all models.

Table 3. 4: Johansen Cointegration tests for each VARX model

AUS			
Coint Rank	**Maximum-Eigenvalue**	**Trace-statistic**	**Critical-value 5%**
0	.	3445.407	47.21
1	0.94436	23.8706*	29.68
2	0.13938	72.088	15.41
3	0.05980	0.3641	3.76
4	0.00328		
BRA			
0	.	2587.152	47.21
1	0.84562	513.327	29.68
2	0.33749	5.6325*	15.41
3	0.04895	0.0617	3.76
4	0.00056		
CHN			
0	.	1707.041	15.41
1	0.78355	0.8326*	3.76
2	0.00747		
DEU			
0	.	4348.196	47.21
1	0.96562	607.131	29.68
2	0.31358	189.480	15.41
3	0.15055	0.8360*	3.76
4	0.00750		
FRA			
0	.	3522.188	47.21
1	0.93829	430.425	29.68
2	0.29598	4.0872*	15.41
3	0.02724	10.222	3.76
4	0.00917		
IND			
0	.	3912.036	47.21

ITA			
Coint Rank	**Maximum-Eigenvalue**	**Trace-statistic**	**Critical-value 5%**
0	.	3.675.926	47.21
1	0.95465	24.2191*	29.68
2	0.15425	56.226	15.41
3	0.04936	0.0037	3.76
4	0.00003		
JPN			
0	.	3.493.914	47.21
1	0.92835	567.964	29.68
2	0.25207	245.576	15.41
3	0.19279	0.7849*	3.76
4	0.00705		
KOR			
0	.	3.529.927	47.21
1	0.95295	13.7131*	29.68
2	0.07653	48.761	15.41
3	0.04259	0.0448	3.76
4	0.00040		
RUS			
0	.	4.454.488	47.21
1	0.96257	807.744	29.68
2	0.44168	160.818	15.41
3	0.12061	1.8157*	3.76
4	0.01622		
UK			
0	.	4.828.635	47.21
1	0.94820	1.542.617	29.68
2	0.56624	615.462	15.41
3	0.42561	0.0025*	3.76
4	0.00002		

In the presence of long-run equilibrium relationships among the various variables our GVAR model has to be transformed into a GVEC model so as to explicitly account for these relations. Finally, one lag was selected in the VECX models based on the Schwarz-Bayes information criterion and the results are available upon request.

Dynamic Responses

Having determined the VARX(q)/VECX(p, q) specification for each economy, we proceed by estimating our GVAR model. Following the notation presented in the methodology section earlier, our GVAR estimation has the following basic components:

$i = 1,..11$ small open economies where $i = \{AUS, BRA, DEU, FRA, IND, ITA, JPN, KOR, RUS, GBR, USA\}$

$k = 1$ dominant economies where $k = \{CHN\}$

$y_{j,t} = (GDP_{j,t},\ Mil\_Exp_{j,t}\ }$ where $j = 1, \dots N + K$

Having estimated our GVER we computed the GIRFs, following Pesaran and Shin (1998). Each GIRF shows the dynamic response of Military Expenditures to unit shocks in the rest of the economies' Military Expenditures of up to sixteen (16) quarters. The use of a sixteen-quarter horizon, i.e. four (4) years, lies on the nature of dynamic interdependencies among the variables under investigation, since any deviations from the initial equilibrium position will fade rapidly.

Figure 3.4, presents the response of the Australian military expenditures to unit shocks on the military expenditures of the rest of the economies. Based on our findings, the military expenditures of the Australian economy are statistically significantly affected by the military expenditures of Japan and Korea, in the medium run, i.e. 4-8 quarters. At the end of our horizon, i.e. four years, the Australian military expenditures return back to their initial equilibrium position.

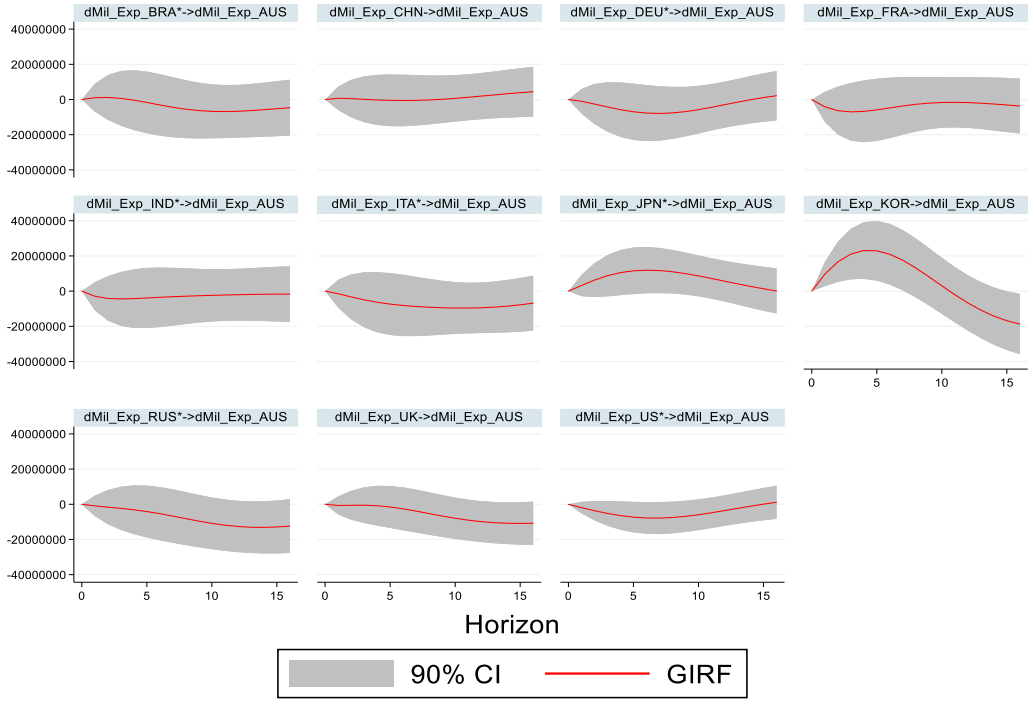


Figure 3. 4: Response of Australia's military expenditures to unit shocks on the military expenditures of the rest of the economies

Based on the GIRFs of Figure 3.5, the military expenditures of the Brazilian economy are statistically significantly affected by the military expenditures of China and Russia. The effects have a medium ran character, since the GIRFs return back to their initial equilibrium position.

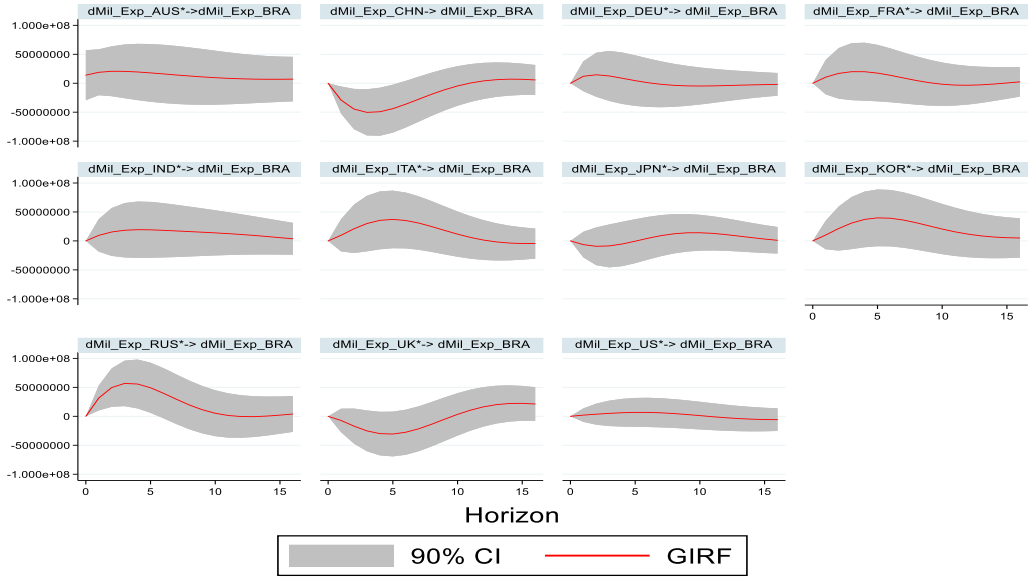


Figure 3. 5: Response of Brazil's military expenditures to unit shocks on the military expenditures of the rest of the economies

Next, according to Figure 3.6, the military expenditures of the Chinese economy are statistically significantly affected by a unit shock in the military expenditures of Japan, Korea and the UK. These effects have a medium run character since the GIRFs return back to their initial equilibrium position.

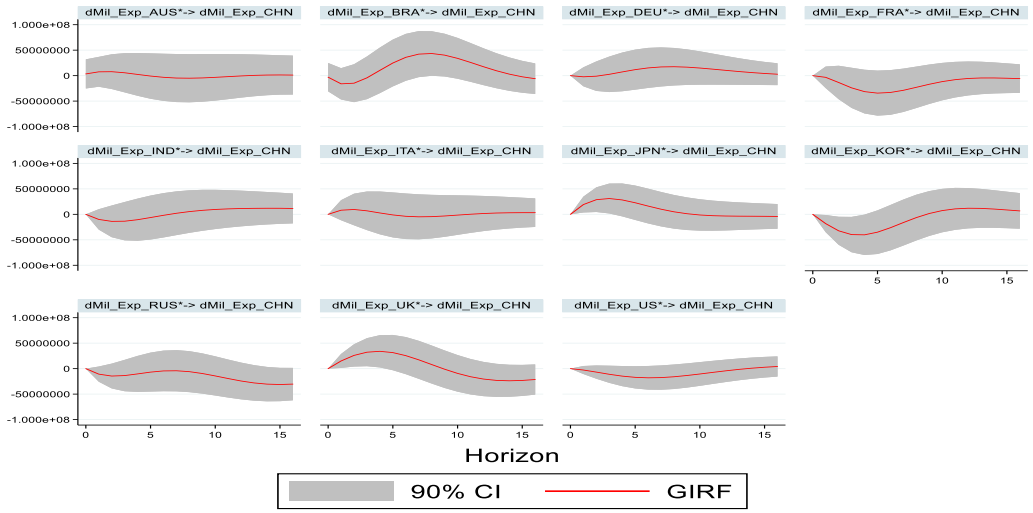


Figure 3. 6: Response of China's military expenditures to unit shocks on the military expenditures of the rest of the economies

According to Figure 3.7, the military expenditures of the German economy are statistically significantly affected by unit shocks on the military expenditures of Russia and the UK. Once again, these effects die out at the end of year four, since the respective GIRFs return back to their initial equilibrium position.

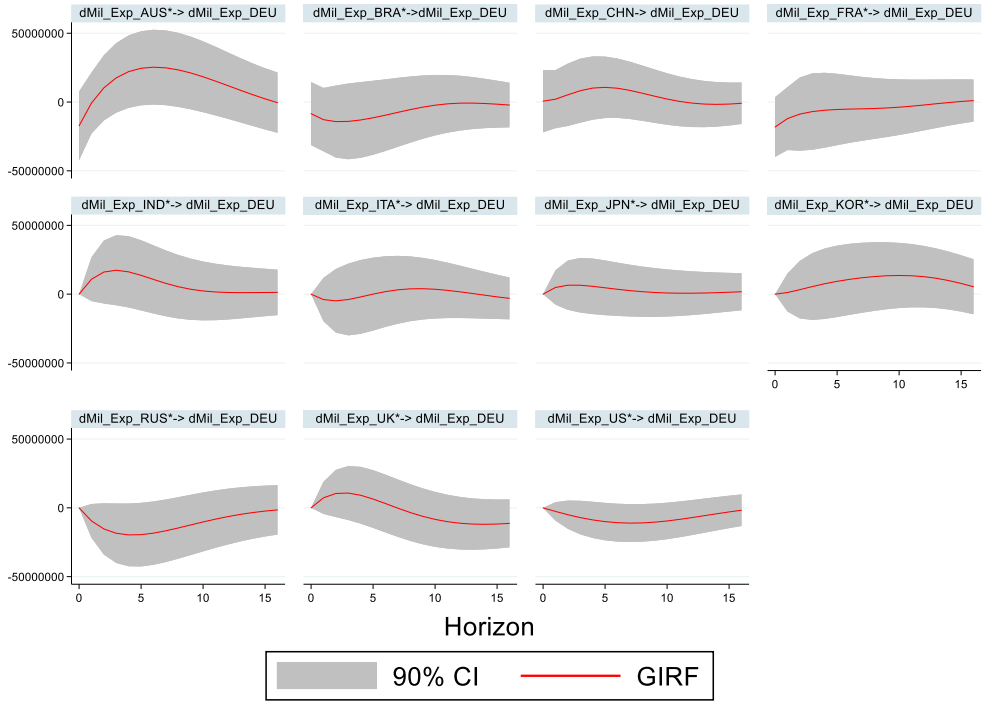


Figure 3. 7: Response of Germany's military expenditures to unit shocks on the military expenditures of the rest of the economies

Turning to Figure 3.8, the military expenditures of the French economy are statistically significantly affected by a unit shock in the military expenditures of Australia and Japan. This medium ran effects die out at the end of our horizon.

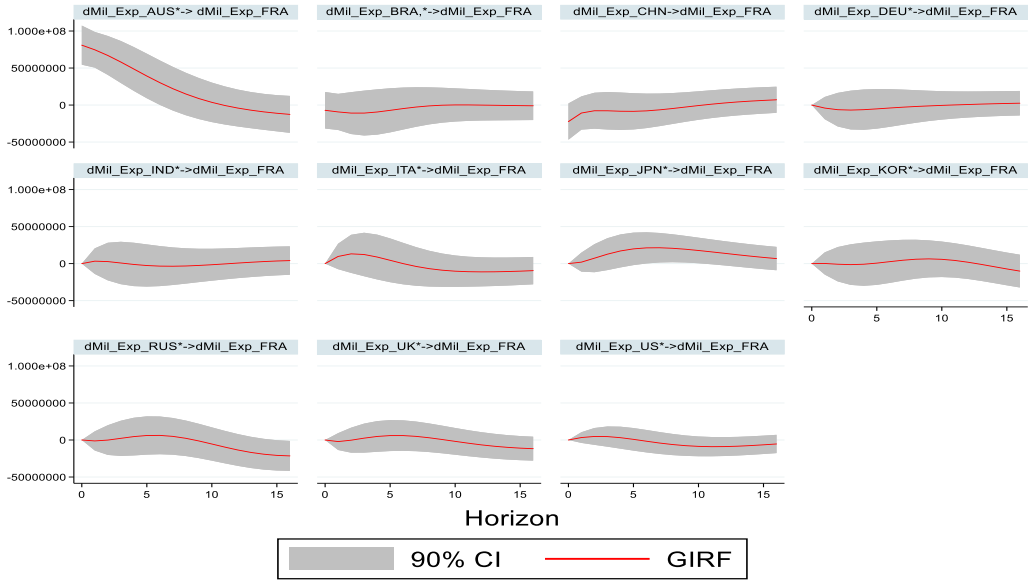


Figure 3. 8: Response of France's military expenditures to unit shocks on the military expenditures of the rest of the economies

Based on the GIRFs presented in Figure 3.9, the military expenditures of India are statistically significantly affected in the medium ran by unit shocks in the military expenditures of Australia, Germany and France. Nonetheless, these effects are temporary, since they die out at the end of our horizon of investigation, i.e. after sixteen quarters.

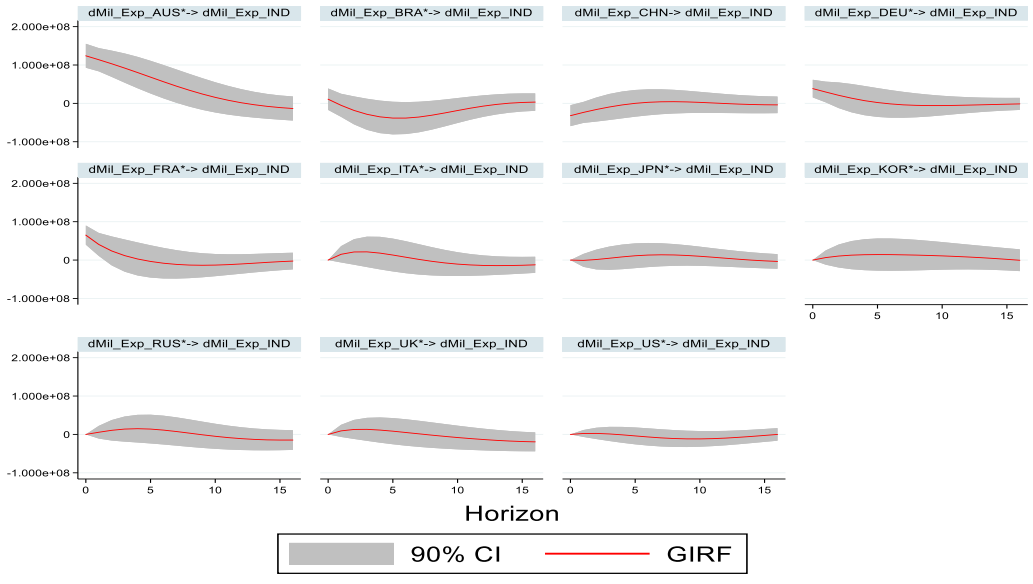


Figure 3. 9: Response of India's military expenditures to unit shocks on the military expenditures of the rest of the economies

According to Figure 3.10, the military expenditures of the Italian economy are statistically significantly affected in the medium run by unit shocks induced in the military expenditures of Brazil, Korea and the USA. One more, these effects die out rather quickly.

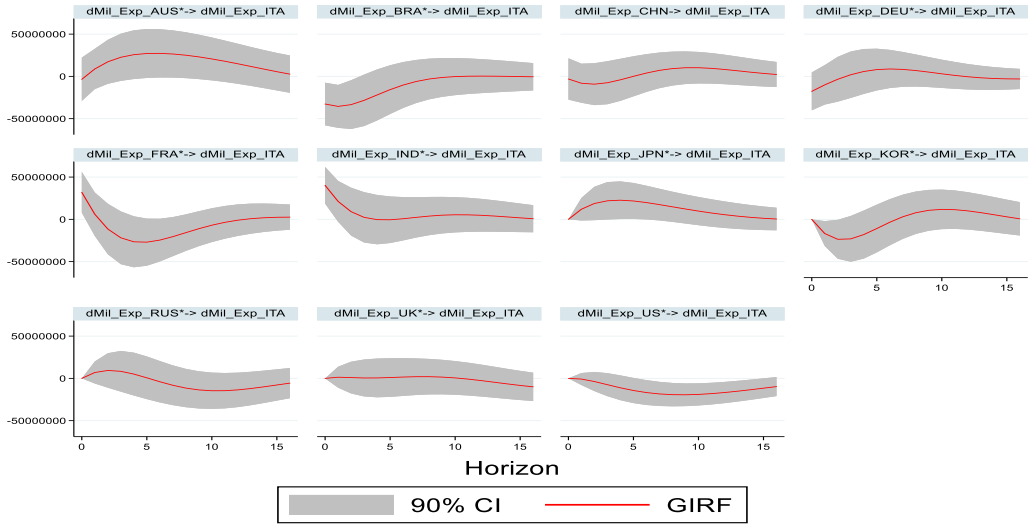


Figure 3. 10: Response of Italy's military expenditures to unit shocks on the military expenditures of the rest of the economies

Based on Figure 3.11, the Japanese military expenditures are statistically significantly affected, in the medium run by unit shocks in the military expenditures of Australia, Italy, Russia, India and the USA.

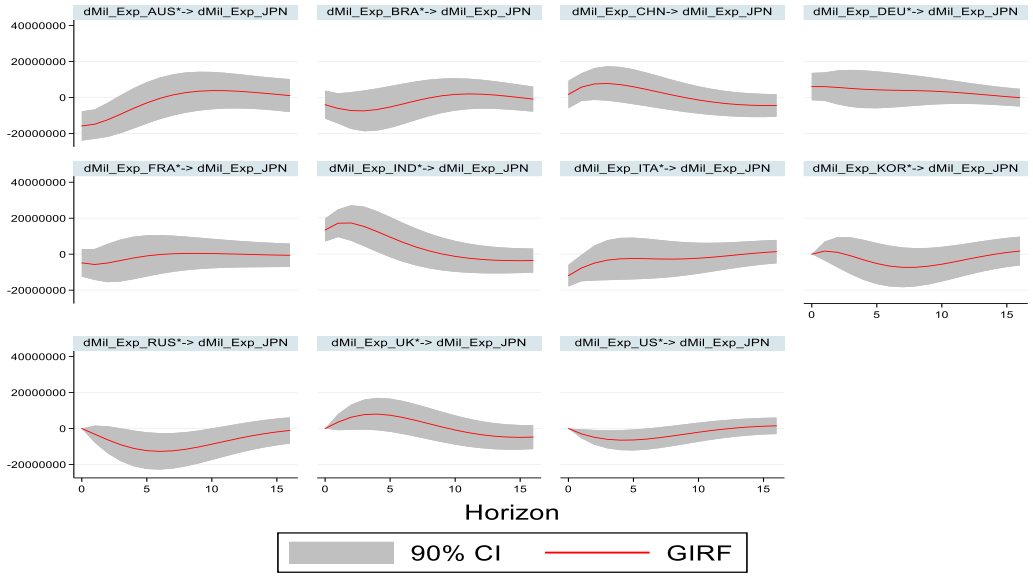


Figure 3. 11: Response of Japan's military expenditures to unit shocks on the military expenditures of the rest of the economies

Next, based on Figure 3.12, the military expenditures of Korea are statistically significantly affected in the medium run by unit shocks in the military expenditures of Australia, China and the USA. These effects have a temporary character, since they die out rather quickly and the respective GIRFs return back to their initial equilibrium position.

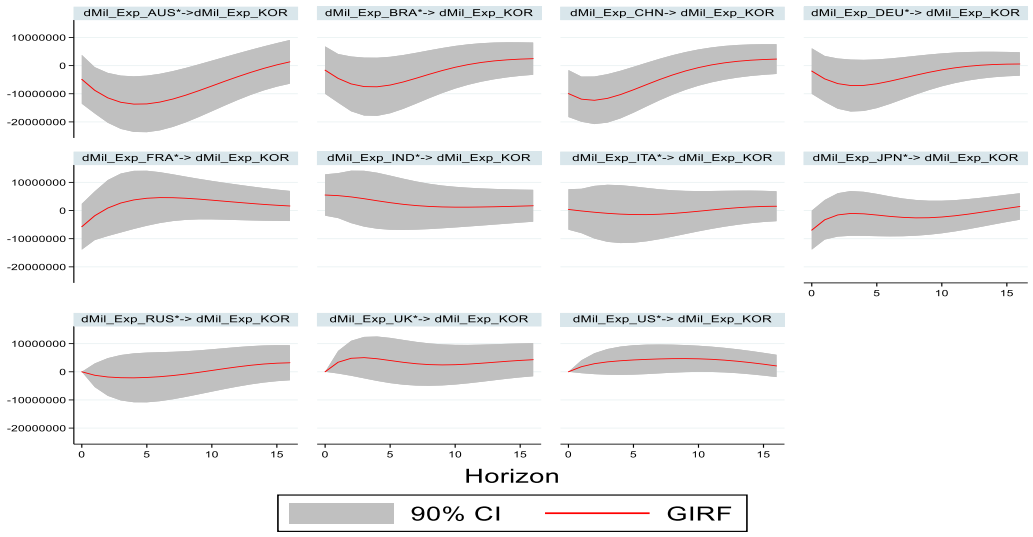


Figure 3. 12: Response of Korea's military expenditures to unit shocks on the military expenditures of the rest of the economies

According to Figure 3.13, the military expenditures of the Russian economy are statistically significantly affected by a unit shock in the military expenditures of Australia, Brazil, China, Japan and Korea. However, these effects die out at the end of our horizon of investigation, i.e. four years.

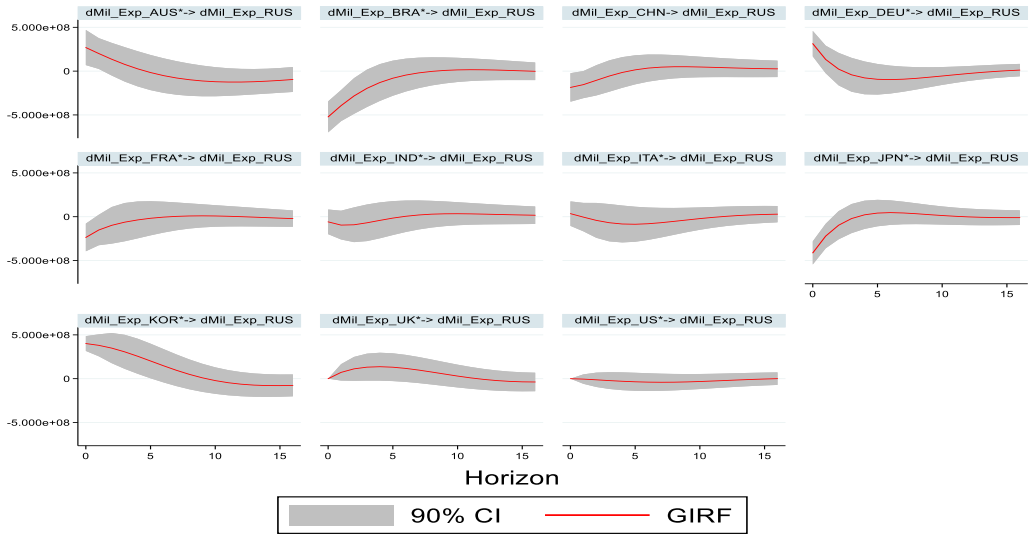


Figure 3. 13: Response of Russia's military expenditures to unit shocks on the military expenditures of the rest of the economies

Next, turning to Figure 3.14, the military expenditures of the UK are statistically significantly affected in the medium run by unit shocks on the military expenditures of Germany, France, India, Italy, Korea and the USA.

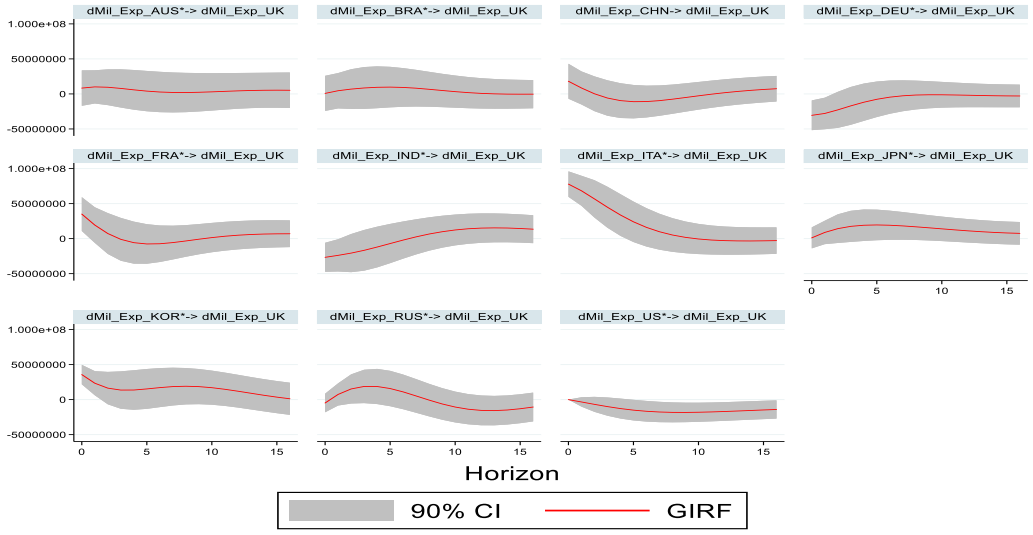


Figure 3. 14: Response of the UK's military expenditures to unit shocks on the military expenditures of the rest of the economies

Finally, based on the GIRFs presented in Figure 3.15, the military expenditures of the USA economy are statistically significantly affected by unit shocks in the military expenditures of

Brazil, Germany, Italy, Japan, Korea, Russia, and the UK. Again, these effects die out quickly, since the respective GIRFs return back to their initial equilibrium position.

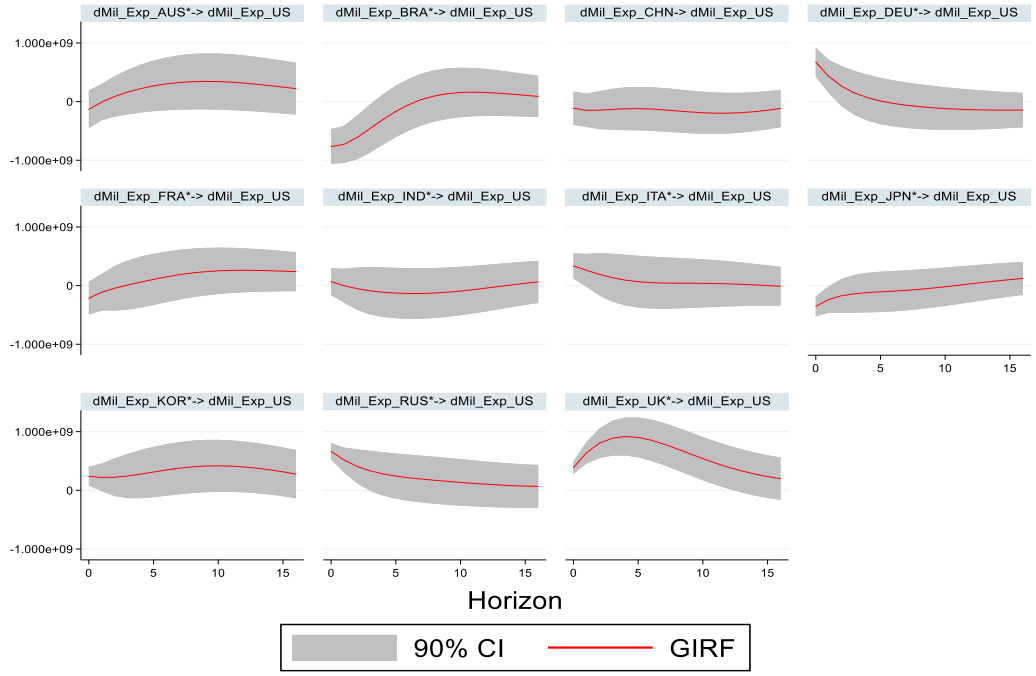


Figure 3. 15: Response of the USA's military expenditures to unit shocks on the military expenditures of the rest of the economies

All the statistically significantly medium run effects of the GIRFs presented in Figures 3.4-3.15, are also depicted in the form of a network in Figure 3.16.

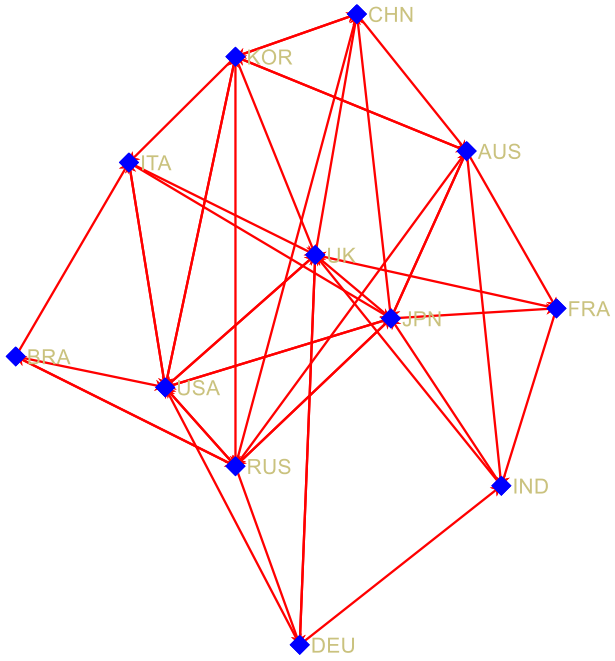


Figure 3. 16: Statistically significant medium run effects in our network

Finally, our findings regarding the various GIRFs are stable, since the eigenvalue distribution of the GVAR model employed lies inside the unit circle, based on Figure 3.17.

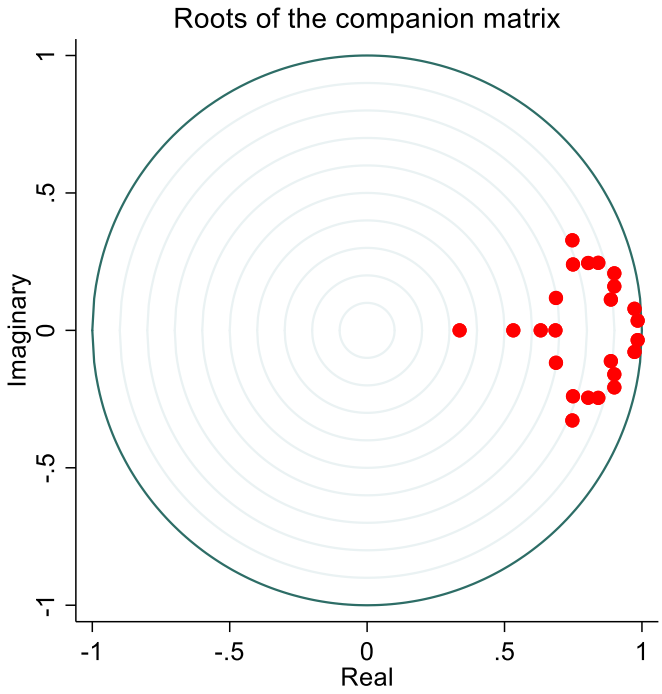


Figure 3. 17: Stability GVAR model

3.4 Discussion

Since the seminal work on the economic theory of alliances by Olson and Zeckhauser (1966), the response of a country's defense spending to that of its allies or enemies has been an important research topic (see e.g. Smith 1980; 1995; Bruce 1990). The last five years an important trend toward new or expanded defense cooperation among EU member states has been unfolding, with the launch of the Permanent Structured Cooperation (PESCO) and the scope to foster common security and defense in the area. Cooperation is also evident among U.S. allies and security partners in the Indo-Pacific, having the potential to create, realign, or simply reflect changes in regional actors' interests, identities, and commitments in important ways that could reinforce or reduce U.S. influence. What is more, the key U.S. allies are also cooperating more with countries such as India, Indonesia, and Vietnam that, while not U.S. treaty allies, have nonetheless aligned themselves more closely with the United States, as China has grown both more powerful and more assertive in recent years.

Territorial disputes between China and other countries in the region characterize 1991-2015 and raise concerns about how defense demands are formed and interact. Our evidence shows that China is the dominant economy in the world military league validating our first hypothesis (H_1) and its military expenditures are affected by a unit shock in military expenses of Japan, Korea, and the United Kingdom. This linkage could be attributed to the following reasons: First, Japan and China disputed the sovereignty of the Diaoyu (Senkaku) Islands (Lee 2002), second, Korea and China were in conflict about a submerged reef, the Socotra Rock since 1995 (Horesh et al. 2014), while a British colonial rule imposed in Hong Kong, dating back to 1841 and lasting for 156 years, has left enduring marks on China's economic and political fabric (Munn 2013).

Australia, Japan, and Korea appear to be the subsequent primary entities in the network, according to the eigenvector centrality measure. They have similar political and economic systems and share an important ally, the USA. One major difference among them is the common threat perception. While Japan and South Korea perceive more direct threats from North Korea and China, Australia's perception of China is more nuanced and less direct (Brustad and Kim 2020), which is line with our findings. Australia's defense expenses appear to be affected by unit shocks induced in the military spending of Japan and Korea, but remain unaffected to that of China. Moreover, although it seems natural to assume that Japan and

South Korea would boast a closer security relationship, Brustad and Kim (2020) prove that this is not the case. They have concluded that while strategic factors are important, identity ones, in particular the historical tension between the two countries and the lack thereof between Japan and Australia, allowed the latter to build a strong 'in-group', based on common democratic values and strategic incentives. Our results corroborate this argument, as Japan seems to be influenced by unit shocks in the military expenditures of Australia, but a statistically significant impact is not traceable by a unit shock of Korea.

To move on within the context of the Asia and Oceania region, the gradual post–Cold War diversification of India's external relations extended to Australia. Harold et al. (2019) assert that although India still does not view it as among its first-tier strategic partners or as a great power deserving of attention and resources, the signing of a nuclear deal in 2014 has substantially removed one long-standing obstacle to further expanding bilateral defense and strategic cooperation. Similarly, the revival of the Quad[19] 2017 marked a milestone in India's willingness to elevate collaboration with Australia at a multilateral level, enhancing the accuracy of our findings. A statistically significant impact on India's military expenditures is detected in case of a unit shock in Australia's ones. Furthermore, India appears to be affected by two European countries- France and Germany – which is not unanticipated for two main reasons: First, both constitute India's primary defense suppliers and can play the role of a more independent partner with less demands and a history of tested cooperation over the years. Second, France is the only European country which has around one million citizens in the Indian Ocean, and is therefore considered as the most natural European partner in military and security issues (De Vergeron 2015).

Turning to the America's region, a result that emerges proves Armijo's (2007) arguments that American hegemony has passed its peak and the twenty-first century sees a more multipolar international system. From our analysis, it follows that unit shocks in military expenditures of the sample European economies (Germany, Italy, Russia, United Kingdom), Brazil, Japan and Korea do have a statistically significant impact on the defense spending of the USA, whilst a shock in the military expenses of the US affects Japan's, Korea's, the UK's and Italy's ones. The latter supports the mechanism 'leader/follower' with respect to the US,

[19] The Quadrilateral Security Dialogue is an informal strategic forum between the United States, Japan, Australia and India that is maintained by semi-regular summits, information exchanges and military drills between member countries, initiated in 2007.

witnessed in the study of Caruso and Di Domizio (2016), where an increase in the US military burden is interpreted by the countries – 'followers' as a credible signal of increased threats. At the other end of the spectrum, Brazil, appears to be affected only from two economies, China and Russia. As Bertonha (2010) states, Brazil's image in the world, is in general a positive one and in a region without great rivals the country can progress without meeting major problems. Among the other BRIC countries, Brazil is though, the only nation that does not have nuclear weapons, which limits its international intervention capacity and implies it is essential that Brazil has military tools to act beyond its frontiers, claiming its place in the global stage. Its involvement in the United Nations Interim Force in Lebanon (UNIFIL) since 2011, has allowed for a direct participation as part of international peace and security efforts in the Middle East, strengthening the country's credentials as it presents itself as a 'peace provider' and has significant implications for its defense policy agenda.

Russia is a military power of the first magnitude with a diplomatic tradition and capacity to project power, beyond its immediate post-Soviet periphery. Based on the results, its military expenses, appear to be influenced mostly by the corresponding spending of countries designated as major non-NATO allies, displaying a defense complementarity reaction. The imperative to focus mainly on military-to-military contacts and cooperation between Russia and China, stems from the deterioration of Russia-US relations as a consequence of the Ukraine crisis and growing tensions in US-China relations, which have given rise to the perception that China and Russia are an actual or incipient alliance (Korolev 2019). Nevertheless, it is far from clear that China has wished to adopt the role of Russia's key partner for any substantive global concert, as ambivalence characterizes their reactions to issues of crucial importance, e.g., China's stance towards Russia's behavior in Ukraine in 2014 and Russia's posture to the SCS dispute (Alison 2013).

Proceeding with the NATO European countries, significant security milestones seem to shape their interlinkages, such as terrorist attacks against the USA, current relations between NATO and Russia[20] and participation of NATO troops against terrorism headed by the US. Shocks

[20] A mechanism, the NATO-Russia Council (NRC), was established in 2002 for consultation, consensus-building, cooperation, joint decision and action. Within the NRC, the individual NATO member states and Russia have worked as equal partners on a wide spectrum of security issues of common interest. In response to Russia's military intervention in Ukraine and its occupation and annexation of Crimea, which Allies disapproved in the strongest terms, all practical civilian and military cooperation under the NRC has been suspended since April 2014. Russia's full scale invasion of Ukraine on Feb. 24, 2022 was also, condemned by

stemming from Russia appear to influence Germany's military expenditures[21], while those caused by Australia affect France's, a finding supported also by the diplomatic crisis broke out in 2021 after Australia's decision to renege on a deal with French military shipyard Naval Group, concerning the order of a new conventional submarine fleet (Staunton and Day 2022). Also, the interaction detected between France and the UK could be attributed to the Paradox in the Franco-British security relationship[22], while the interplay among Germany, France and the UK could be justified in the context of the Big Three European members (E3), which are provided with impetus for new policies especially in the post-Brexit era (Urbanovská et al. 2022).

Remaining within the European borders and analyzing the effect on the countries' defense spending by the rest of our network, we turn to NATO's attainment to deepen relations beyond the transatlantic community, forging an international partnership with non-European states, which provides a forum for expanded dialogue with other major democratic countries. Among them, Japan and Korea have sent substantial numbers of troops to Iraq in support of efforts by NATO members to stabilize the country. Together with other non-NATO democracies, such as Brazil and India, they have also contributed significantly to peacekeeping operations around the world (Daalder and Goldgeier 2006). The aforementioned economies appear to influence the military expenditures of the sample NATO European countries[23], indicative of spillover complementarity in a rapidly changing geopolitical and strategic environment.

Overall, evidence that emerges confirms our second hypothesis (H_2) that unanticipated shocks in the defense spending of one country influence the military behavior of another belonging to the network of the top spenders.

NATO member countries and multiple international sanctions were imposed on Russia to compel the de-escalation of the crisis (Ozili 2022).

[21] In the light of the Russian invasion of Ukraine in February 2022, the new German Government stated its intention to increase military spending further in the coming years (Mardones 2022).

[22] Howorth (2005) claims that the two sides cannot manage European security policy without one another; yet they have enormous difficulty, where transatlantic policy is concerned, in working jointly, mainly due to their contradictory interpretation of the likely USA's reaction to the advent of serious European military muscle.

[23] UK and Italy are affected by Korea, India affects the UK, Brazil has an impact on Italy, while France is affected by Australia and Japan.

3.5 Conclusion

The point of departure of our investigation has been the continuous upward trend in world military expenditure seen since 2015, despite the economic effects of the Covid-19 pandemic, along with NATO's decision to formalize the target of spending at least two percent of GDP on the military – largely prompted by the Russian annexation of Crimea[24]. In this context, we employ a network GVAR model in order to explore first, whether there is a country leader in the global military race – the rest follow - and second whether a potential shock in a country's defense spending levels, shape another's activity. We express a selected panel of top twelve military spenders as a network system, whereas using data on the GDP and Military expenditures for these economies over the period 1970-2018, we estimate the respective price equations for each economy in a general equilibrium framework. Moreover, we investigate the degree of pervasiveness of each entity, which relates to the possible existence of dominant economies in the GVAR model.

Our main findings can be summarized as follows: The Chinese economy is considered as being dominant, irrespectively of the criterion used for the selection process. A unit shock in Australia's military expenses has a statistically significant impact on the economies of Japan, Korea and India, whilst the former appears to be affected only by Japan and Korea. An intense interdependence is found in the case of the US, as more than half of the sample countries appear to exert a statistically significant impact on its economy, whereas a unit shock in the military expenditures of China and Russian Federation affects Brazil's ones. Russia's military expenses are affected by a unit shock stemming from the Asian and Oceanian countries, while the NATO European members are found to have forged an international partnership with non-European states (a unit shock in the military expenses of Australia and Japan affects France) but also with other non-NATO democracies (a unit shock in India's military expenses affects the UK). However, in all cases unexpected shocks are temporary and countries return back to their initial equilibrium positions.

The results seem to give a credit to the view that China acts as a bandwagon of global growth whose military spending has increased for 27 consecutive years recording the longest uninterrupted sequence of increases by any country in the SIPRI Military Expenditure Database. It remains unaffected by a unit shock in the military expenses of Russia and the

[24] SIPRI 2021 fact sheet

US, being an independent player in the military league, which aims to mitigate its geopolitical fragility and shield itself from the superpowers' manipulation. Furthermore, the claim that economies plugged into the global chains form their behavior accordingly, based on the network's activity, finds strong support. Globalization and economic interdependence have intensified it, reminding there is a need for units to reorganize their military agenda quickly and adapt to the unanticipated shocks, implementing appropriate strategies and actions. Future research, within the same framework could focus on bringing evidence on how arms procurement and military research and development shape other countries' activity and for how long. Additionally, it could be investigated whether the international financial crisis played a distinct role in each country's defense budget and in this context, whether an endogenously determined structural break could be detected possibly changing the complex interactions between the various entities.

4 Military activity and terrorism fear in Europe

The present chapter explores the extent to which a European country's military activity affects the publics' perceptions about an imminent terrorist attack in country and in Europe during the next twelve months, allowing for a cohort of demographic, social capital and macroeconomic traits. Based on 92,636 respondents from 27 countries and for the period 2005-2008 we find a salient and positive relationship between a state's military action and its citizens' worry about future supplies of terrorism. As military expenses increase and armed conflicts - with less technologically developed and religiously divergent countries - become more frequent, a relative rise in the probability of anticipating a terrorist act in country and in Europe, as well, is expected. The aspects of social capital, though – social and institutional trust – and interviewee's education and origin seem to significantly restrict such negative feelings and sentiments.

4.1 Introduction

In 1996, Osama Bin Laden claimed many of the problems faced by the Muslim community were directly related to American actions and called on Muslims to unite against the US and its allies (Marlin 2004). Five years earlier, US troops occupied Middle East – a holy land of the Islamic world. Then, five years after the announcement and 10 years after Iraq's invasion by the US, unprecedented terror attacks hit hard the US, culminating with the collapse of the twin towers on September 11, 2001.

Over the past decades, terrorist attacks also occurred with sufficient frequency and lethality to constitute a realistic threat to the well-being of the European public. Sensing this concern, politicians emphasize the threat of violent attacks, raising security to the top of the agenda, and making public safety a priority.

An interesting question that emerges and is rather overlooked in the literature, is whether a country's military involvement shapes the terror sentiments of its inhabitants. Particularly, this chapter aims to explore how the religious and technological gap between two countries involved in a military conflict, affects the fear about an imminent terrorist episode in the near future, within the borders of the country initiating the attack, and in the wider region.

To our knowledge, this is the first attempt that studies this relationship. There is only one study which argues that there is a positive spiral relationship between a terrorist attack and military activity (Carter and Fay 2019). However, this paper does not discuss identification

issues. Our study contributes to the literature by offering a comprehensive analysis of the fear sentiment formation in countries involved in a military conflict. Our focus is on the citizens' sentiments of the country that attacks because there is a chance of revenge. An imminent terror attack increases the collective sense of fear and vulnerability (Kuzma 2000) and can have important consequences on the election outcomes (Kibris 2011), taxation and government (military) spending (Meierrieks and Schneider 2021; Rees and Smith 2022).

Our evidence based on 27 countries for the period 2005-2008, shows that military activity and frequency of conflict involvement play an important role in shaping attitudes. Regardless of the impact of other individual-level factors such as age, marital status, education, and origin, respondents in countries which spend great amounts in the defense area, and often participate in armed conflicts tend to express higher probability of a terrorist attack both in their country and in Europe. Technological distance, i.e. the dissimilarity in R&D investment, and religious closeness between European countries and their enemies in wars, also, appear to influence the participants' anxiety about a terrorist episode, while social capital - trust in people and institutions – seems to reduce the public's "perceived threat".

The remainder of the chapter proceeds as follows. Section 2 sets out the methodological framework upon which our model is structured, Section 3 presents the data, Section 4 provides the empirical analysis of the results and discusses the findings, while Section 5 concludes.

4.2 A framework of Analysis

4.2.1 Development of Hypotheses

Different strands of research argue that military involvement away from home can fuel fears of a terror attack at home. For example, recent contributions of Savun and Phillips (2009) suggest that states which are actively involved in international politics regardless of their regime type, are prone to transnational terrorism. Carter and Fay (2019) demonstrate that increased US military activity could increase, even only contemporaneously, future displays of terrorism.

Terrorists are forced to display publicly just how far they are willing to go to obtain their desired results, because it is hard for weak actors to make credible threats (Kydd and Walter 2006). Countries that adopt active foreign policy portfolios or are highly involved in international affairs to form or increase their already existing interests in other countries are

likely to foment some sort of aggravation among foreign organizations, and hence may be the target of these aggrieved groups.

In the same vein, another branch of studies coming from the psychology literature argues that combat-related stressors, i.e. threat to life, exposure to death and injury are not the only that cause the pain and suffering of combat. Disruption of the normal routine, increased financial pressures (Freedman 1991) and fear of imminent terrorist attacks – all are part of the experience of nations, communities and families during time of war (Ursano 1996). In a survey conducted by Rosen et al. (1993) there are reports of fear about terrorist attacks throughout the United States expressed by soldiers' children, despite the geographical distance from the Persian Gulf, where hostilities were taking place.

We therefore posit that increased military expenses and conflict engagement will make the public more anxious and fearful about a terrorist attack in their country and in Europe during the next year and form the first hypothesis as follows:

H_1: *Country's military activity tends to relate to its citizens' fear about a terrorist event*

Next, we aim at exploring whether the effect is more pronounced the higher the dissimilarity in the religion and technology level is between the two involved countries. Concerning the religion distance of the conflict pairs, Krieger and Meierrieks (2011) find that when groups exhibit different religions, this may lead to more conflict. Ciftsi (2012) explains that a good number of Westerns think of Muslims as violent and fanatical individuals while some believe that they support al-Qaida. Muslims constitute a large proportion of the enemy populations and are perceived as belonging to the "out-group"-ethnic outsiders to the Westerners. Empirical research has shown that the strength of group identification increases the fear of the out-group (Bloom et al. 2015), while a positive correlation between religiosity and expression of terrorism concerns is also detected (Adamczyk and LaFree 2015).

With respect to the technological distance of the conflict pairs, Tingbani et al. (2019) state that the effect of terrorism is more pronounced in developing countries due to scarcity of resources and institutional fragility. Uddin et al. (2019) point out that negative effects of terrorist threats in developing countries are generally higher as the institutions are weaker and not capable to support any corrective measure from the government (Khanna and Palepu 2005). Nevertheless, Blomberg et al. (2004) find that although the negative influence of terrorist incidents on growth is greater in developing nations, they are considerably more

frequent in advanced countries. Based on the above theoretical arguments and empirical evidence, the second hypothesis we aim to test is the following:

H_2: Religious and technological distance act as moderators – the larger the differences are, the higher the public concerns are about an imminent terrorist threat.

Next section presents the model and the econometric techniques to test for these two hypotheses.

4.2.2 Modeling Individual's concerns toward Terrorist Attacks

The probability of an individual reporting as very likely the occurrence of a terrorist attack can be described by an ordered probit model defined as follows:

$$Prob(Y=c|Xi)=F(Xi\beta) \quad (1),$$

where the endogenous variable Y describes the individuals' assessment about a future terrorist event and is an integer ranging from 1 (Not at all likely) to 4 (Very likely); F is the standard normal cumulative distribution function; and x is a set of covariates detailed below.

The vector x includes *Sociodemographic*, *Social Capital*, *Macroeconomic*, and *Defense* sets of variables. More analytically, the set of *Sociodemographic* contains characteristics that were requested and recorded from the participants, such as gender, age, education, marital status, net income, political orientation, hours of watching news/ politics on TV per day[25] and the origin of the interviewee. The aforementioned factors have been broadly used in the terrorism field as mediating in the terrorism – public attitudes nexus and the evidence corroborate their importance and predictive power. Hassan and Martin (2015) find that older people and women in Australia are more fearful of terrorism, while educational attainment is inversely correlated to such fear. The survey of Economou and Kollias (2019), conducted a few months after the 2015 terrorist attacks in Paris, compares the responses of French citizens to those of an aggregate EU sample and two other EU member states. They detect that older individuals assess the threat of an imminent terrorist attack as greater than younger ones, in the case of France. Moreover, being male rather than female was associated with a smaller

[25]The media plays a key role in framing issues and shaping public perception (Gilks 2020). The intense media coverage about terrorist events causes a substantial negative sentiment effect (Nellis and Savage 2012).

probability of viewing the risk as high, and political ideology was a significant determinant of terrorist risk assessments, with leftists feeling more secure than centrists, whereas rightists feeling less secure than centrists.

Next set of variables, is what the literature calls "social capital"[26] i.e. the stock of social relations which involves shared norms and values, cooperation, and reciprocity aiming to enhance collective action and achieve social efficiency and growth. Two distinct, though interlinked, types of trust, which constitute the core aspect of social capital, are identified in the relevant literature: institutional or political and interpersonal or social trust[27] that creates bonds between people, influences individual outcomes as well as social group interactions, facilitates cooperation, coherence and trust in the quality of the political, legal and institutional environment (North 1990), increasing thus society overall effectiveness (Paldam 2001). One would expect that being a truster is associated with a smaller probability of anticipating an imminent terrorist act. The "mechanism" that links social trust and less severe risk perception is that trusters exclude heuristics and cues based on racial or cultural stereotypes when forming their beliefs about other people's trustworthiness, while institutional trust makes people more confident for the society they live in and the way it copes with stressful situations.

The set *Macroeconomic* includes variables that characterize a country's economic environment and ethnic diversity, as well as the flow of terror activity, that could also affect public assessments. A number of studies have investigated the economic impact of counterterrorism measures, specifically the effect of counterterrorism policies on fiscal policy and investment prospects, or on the whole of government spending (Lis 2007), but to our knowledge the relationship between economic aspects and fear of terrorism has not received

[26] The *Social Capital* set includes three dimensions, as proposed by Coleman (1988): (i) trust in people and institutions, (ii) interpersonal networks which can be further subdivided into informal, Putnam-type social activities, yielding positive externalities (informally meeting with friends, relatives, colleagues, but also participating in associations such as churches, voluntary work), and formal, Olson-type special interest group engagement such as work for political parties, professional organizations or trade unions, which may yield negative externalities in a society, and (iii) norms and effective sanctions.

[27] Alternative measures based on civic participation and association membership contradict trust variables and should not be mixed together in constructing composite indicators of social capital (van Staveren and Knorringa 2007).

considerable attention. We examine a number of factors, namely the gross domestic product (GDP) per capita, unemployment, central government debt, social benefits, the Gini coefficient to proxy economic welfare, fiscal burden and (in)equality conditions. We further consider the presence of foreign-stock in a country (i.e. foreign-born, first and second generation of immigrants; asylum seekers; nationality acquisitors). Immigrants are more likely to be relatively impoverished compared to natives in their new homes and hence, even if the migration reduced global terror attacks, they could increase the number of attacks in destination countries. This impact may be particularly relevant in the European context of highly regulated labor markets that often do not integrate new immigrants well (Fraytag et al. 2011). Moreover, following the work of Eckstein and Tsiddon (2004) and Carter and Fay (2019), we also, use a terrorism index variable to capture not only the number of attacks, but also the varying intensities, as higher intensity attacks are likely to elicit a higher index of public fear.

The set *Defense* contains a number of variables which relate to the country's military outlays and conflict experience as well as two constructed indexes capturing the technological and religious proximity with their opponents in the wars fought. It has been empirically demonstrated that increased use of military measures may incite anti-American sentiment, deeply rooted anti-western grievances, and even increase future supplies of terrorism (Savun and Phillips 2009; Neumayer and Plümper 2011). Additionally, increased military activity, by way of deployments, used force or conflict against terrorism prone countries, cultivates resentment and induces harmful events to the origin state.[28] Although these theories have been broadly investigated, leave out a very important element of the cycle of security and defense campaigns, namely the public's anxiety about an imminent terrorist episode. Furthermore, in an effort to capture the religious propinquity between each sample country and its enemies, we focus on engaged in conflict pairs and produce the mean value of the similarities the countries have as for their religious communities. Prejudice against Muslims has existed in some form or another in the West since the dawn of Islam (Abbas 2011), and is empirically linked to security (Gilks 2020). Following the same technique, technological nearness is computed using values of R&D investment. The work of Uddin et al. (2021), asserts that if overall growth is greater, the opportunity cost of terrorism would be higher,

[28] Conrad (2011) finds that states involved in ongoing rivalries with other states are the victims of more terrorist attacks than those that are not involved in such hostile interstate relationships.

automatically discouraging people to engage in terrorist activities. Nevertheless, terrorism threats are reported more frequently in developed countries (Blomberg et al. 2004), despite they have relatively stronger institutional environment (Erbaş 2004).

4.2.3 Estimation Strategy

Our dependent variable, individuals' concern about a terrorist episode is an ordinal one, which means that although we can categorize the values, the distance between the classes is not observed. Interviewees refer that it is "Not very likely" terrorists attack their country/ Europe in the next twelve months, if their latent concern exceeds a threshold c1, "Likely" if their latent concern exceeds a much higher threshold, c2, and "Very likely" if it exceeds an even higher threshold c3.[29] The vector parameter b and c= (c1, c2, c3)' can then be chosen such as to maximize the likelihood of observing the sample on hand. Assuming a standard normal distribution function for the error term ε, we employ an ordered probit model and estimate it using maximum likelihood estimation techniques. Then, the estimated set of regression coefficients (b), predict the probability of the outcome of interest.

However, one could argue in favor of endogeneity because of reverse causality, a spurious relationship due to omitted variable bias and/or measurement error. To overcome the potential susceptibility that the results are possibly driven by endogeneity we rely on an extended ordered probit model (Wooldridge 2010).[30]

The study of Carter and Fay (2019) demonstrates that terrorism has direct effects on public spending, which in turn has a direct effect on military activity. As terrorist attacks increase in frequency and magnitude, so too does the call of the public for heightened security by way of military action, which constitutes the indirect effect of terrorism on the military, filtered through public opinion. Meanwhile, as increased military activity increases, even only contemporaneously future supplies of terrorism, military spending and conflict involvement could be endogenous and bias our estimates. To account for endogeneity issues, we construct the mean value of the military expenses and number of conflicts of the neighboring

[29] A terrorist episode is considered "Not at all likely" if individuals' latent concern is below threshold c1.

[30] The model is estimated with the Stata command eoprobit. For further details see Wooldridge (2010) and StataCorp (2017). Gaganis et al. (2021) follow a similar approach.

countries[31]. The option of the specific instrumental strategy relies on the political science literature. Different channels are discussed to shape the behavior of neighboring countries: economic competition, spillovers, learning, socialization, mimicking and coercion (Buera et al. 2011; Giuliano et al. 2013). From an econometric point of view, military expenditures and involvement in armed conflicts of neighboring countries capture the exogenous source of variation in domestic defense policy agenda regarding spending and conflict experience (Ades and Chua 1997)[32]. On statistical front, the instruments used constitute a reasonable choice as they are strongly correlated with the endogenous variables under consideration i.e. Military Expenses and Number of Conflicts whilst, little related with the error term and the dependent variables i.e. the individuals' concerns about a future terrorist event in country and in Europe. Actually, the correlations between the instruments and the endogenous variables are 0.61 and 0.56 for Military Expenses and Number of Conflicts, respectively, while those between the instruments and the estimated errors, or the dependent variables vary between -0.06 to 0.08.

4.3 Data Description and Analysis

This empirical analysis relies on data obtained from the European Social Survey (ESS), a large-scale biennial study of attitudes and values. Our individual-level data consist of 92,636 respondents, covering 27 countries[33] for two biennial rounds/waves (2005-2006 and 2007-2008).[34] The dependent variable (y) is a vector and contains individuals' responses on two

[31] The average values of the same variable in neighboring countries has been conventionally used as an instrument in the literature in various contexts, for example, to instrument for energy subsidies (Ebeke and Ngouana 2015), domestic output and growth performance (Cherif et al. 2018) and fiscal reforms (Caselli and Reynaud 2020) among others. In our work, information on the sample countries' neighbors is retrieved from Ades and Chua (1997), but Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, and Ukraine are not included in their study's appendix and data result from authors' own calculations.

[32] Regional instability associates with military outlays. Defense expenditures are higher in counties with politically unstable neighbors.

[33] Table C.1, in the Appendix, presents the participating countries and the number of observations per country in each wave.

[34] The ESS data were gathered in face-to-face interviews conducted in the native language of the interviewee. Data are available at http://www.europeansocialsurvey.org.

statements about terrorism: “Not at all likely/Very likely” the occurrence of a terrorist event during the next twelve months in the country (*Terror Fear in Country*) and in Europe (*Terror Fear in Europe*). The interviewees had to choose among four points (1-Not at all likely, 2-Not very likely, 3-Likely, 4-Very likely). Raw data were adjusted using post-stratification and population size weights, provided by the ESS to control for qualitative characteristics of the respondents, to reduce the sampling error and potential non-response bias, and to correct for the different population sizes of the countries[35].

A number of regressors are included in the vector set, x. Data on the sociodemographic variables (*Sociodemographic*) – gender (*Gender*), age category (*Age*), education level (*Education*), marital status (*Marital status*), net income level (*Income*), political orientation (*Political orientation*), hours of watching news/politics on TV per day (*Hours of watching news/politics on TV*) and whether one of the parents was immigrant (*Immigrant parents*) - are also derived from the ESS database.

Information on the two types of trust (*Social capital*) – trust in people (*Trust people*) and in institutions (*Trust legal system*)[36] – is retrieved from the ESS and the range of the responses was modified.

Data on macroeconomic variables (*Macroeconomic*) – Gross Domestic Product (GDP) per capita (constant 2011 thousand dollars, purchasing power parity) (*GDPcap*) and the Gini coefficient (*Gini index*) come from the World Bank, World Development Indicators (WDI) database,[37] while the percentage of foreigners (foreign-born, first and second generation) to country’s population (*Stock of immigrants*), is derived from the Organization for Economic

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[35] A detailed discussion on weights is available at https://www.europeansocial-survey.org/docs/methodology/ESS_weighting_data_1.pdf.

[36] For robustness, we further considered the state of health services (*State of health services*) and the state of education system (*State of education system*) – also, derived from the ESS database.

[37] We aimed to include more macroeconomic factors such as central government debt ratio to GDP (*Debt/GDP*), unemployment rate (*Unemployment rate*) and social benefits as percentage of GDP (*Social Benefits*), but collinearity among variables was significant.

Co-operation and Development (OECD)[38]. Moreover, the construction of the terror index (*Terror index*) is based to prior approaches which have used mainly the number of attacks (a), the number of injuries (i) and the number of casualties (k) to capture the intensity of terrorism. The index variable which has the benefit of incorporating intensity and frequency of terrorism into the measurement is given by the following equation:

$$\text{Terror index} = \ln(e+(a+i+k)/3) \quad (2),$$

and data come from the Global Terrorism Database (GTD).

Defense economics literature suggests that expenditures are the best indication of military activity. More specifically, military response is motivated by national security and protection from transnational threat rather than other domestic concerns, meaning the military is more likely to respond to instances of transnational threat, such as terrorist attacks, than to any type of domestic threat or crime (Carter and Fay 2019). The Defense set (*Defense*) includes a variable for the expenditure data as percentage of GDP (*Military expenses*), derived from the WDI database. Also, information on the countries' number of conflicts (*Number of Conflicts*) is retrieved from the Uppsala Conflict Data Program and International Peace Research Institute Oslo (UCDP/PRIO) database. A country is given a point for each one of the opponents faced during the period 2005–2008.[39]

We furthermore, compute indices of religion and technological similarity. To construct the former one (*Religion similarity*), we derive data on the percentage of population adhering to one of eight major religions from the CIA World Factbook dataset, following Miguélez (2018), and proxy religion propinquity for each country pair (states i and j), engaged in a conflict with an index built as follows:

$$\text{ReligionSimilarity}_{ij}=(\%\text{muslim}_i*\%\text{muslim}_j)+(\%\text{catholic}_i*\%\text{catholic}_j)+(\%\text{orthodox}_i*\%\text{orthodox}_j)+(\%\text{protestant}_i*\%\text{protestant}_j)+(\%\text{hinduism}_i*\%\text{hinduism}_j)+(\%\text{buddhist}_i*\%\text{buddhist}_j)+(\%\text{eastern}_i*\%\text{eastern}_j)+(\%\text{judaism}_i*\%\text{judaism}_j) \quad (3).$$

[38] We considered also the percentage of asylum seekers (*Asylum seekers*) and nationality acquisitions (*Nationality acquisition*) to country's population - also, derived from OECD.

[39] Tables C.2 and C.3 in the Appendix, show the military organizations each state fought with and their operational area, respectively.

The formula for each country pair results in a variable ranging from 0 (no believers in common) to 1. As a state may be engaged in more than one conflicts in a specific year, we calculate for each sample country the mean value of the similarities.

Finally, we use research and development expenditures (%GDP) from the WDI database, as a proxy for how technologically advanced a country is. The mean value of the enemies' R&D investments is subtracted from the sample country's ones, reflecting their technological difference (*Technological distance*). The final value is scaled using the min max normalization.

As summary statistics reveal in Table C.4 in the Appendix, the respondents are on average rather fearful of a terrorist attack in Europe, while they perceive as not very likely such an event in their country in the next twelve months, according to the scores of the two aspects of the dependent variable. In some respect, this is in line with the study of Economou and Kollias (2019), which detects that only 20% of Greek interviewers assign a high level of risk to an imminent terrorist attack in their country.[40] On average, Europeans seem to be, in their majority, either of higher or middle educational status, spend a few hours watching news/ politics on a daily basis and are more social trusters than distrusters in others and their institutions. Moreover, on average, almost 6.6% of the population of a European country are foreigners (immigrants), while the values of the Terror index indicate a rather low intensity of terrorist attacks during the period under investigation. Finally, the states spend about 1.68% of GDP on military expenditures, have on average been engaged almost three times in a conflict, whilst a relatively high religious and technological distance is detected between them and their opponents.

To obtain more insights, Figures C.1 and C.2 in the Appendix, visualize fear about a terrorist attack in country and in Europe, respectively, according to the responses of Europeans over the sample period. As one can see, public worry is rather higher in the case of the European territory compared to that related to the state. Spain, United Kingdom and Russia show the most anxious perceptions to both statements, while Czech Republic and Hungary the least. The results could be attributed to the challenges Europe has been through that traumatized and horrified the public; the 2004 Madrid train bombings in Spain (almost simultaneous, coordinated bombings against the Cercanías commuter train system of Madrid, on the

[40] The responses of the Dutch sample and the EU-27 mean, approach the values of 32% and 26%, respectively.

morning of March 11 2004, which killed 192 and injured 2,050 people), the 7/7 central London bombings conducted in 2005 by four separate Islamist extremist suicide bombers, which targeted civilians using the public transport system during the morning rush hour and killed 52, while around 700 more were injured, and the Beslan school siege in 2004, that involved the imprisonment of more than 1,100 people as hostages and ended with the deaths of more than 330, over half of them children.

The involvement of Europeans to conflict zones in Syria and Iraq as foreign fighters, makes Europe facing the risk that those individuals having gained combat experience, would return to the continent to perpetrate or coordinate long-prepared and sophisticated large-scale attacks or spontaneous and unpredictable ones carried out by "lone-wolves". This concern raises the question of how a country's military activity influences its citizens' perception to admit that the country or Europe might be vulnerable to serious threats.

Next, in Figure C.3 in the Appendix we explore how anxiety about an imminent terrorist episode alters in response to country's military spending. A number of interesting patterns emerge: First, citizens' worry in Russia, Greece and Ukraine, is in a way tied to the amounts spent to the defense sector; meaning that trends in military spending follow changes in public opinion as policy outputs internalize feedback on public outputs and adjust accordingly (Pierson 1993), but also, may suggest that military action alone is insufficient to reduce concerns. Second, the disruptive shock of terrorism in Spain and the United Kingdom, is not linked to equivalent military action, possibly because an increased demand for defense spending by the public produces upward pressure on the defense budget, but will do so at lagged intervals (Wlezien 1995). Third, in Belgium, Ireland and Germany the apparent gap between the two variables with pronounced the anxiety for a terrorist attack, could be attributed to the geographical proximity to countries suffering the period's worst attacks in terms of fatalities. Unfortunately, the ESS database lacks information on public perceptions after the 2008 wave, when a number of major terrorist attacks took place not only in European capitals such as Berlin and Brussels, but also in more peripheral places such as Ansbach in Germany – a constraint that potentially limits our conclusions.

4.4 Empirical results

4.4.1 Main results

This section presents our results. In Tables 4.1 and 4.2 we estimate different specifications that correspond to the effects of various sets of variables on public concerns about an imminent terrorist attack during the next twelve months in their country and in Europe, respectively. *Sociodemographic* factors estimates are reported in column (1), *Social capital* variables in column (2), *Macroeconomic* ones in column (3), and all sets together along with factors included in the *Defense* set are shown in column (4), while empirical results appeared in column (5) have emerged after correcting for endogeneity. Heteroscedasticity-adjusted standard errors are reported in parentheses.

The estimates above are odd ratios. One can read the odd ratios as follows: if the odd ratio, a, is bigger than one (a>1), then the probability of an individual to consider as very likely the manifestation of a terrorist attack (y_{it} = 4, i.e. maximum level) increases by (a-1)*100%, whereas the probability decreases by (1-a)*100%, if the odd ratio is smaller than one (a<1).

Table 4. 1: Estimates (odd ratios) of Europeans' perceptions about an imminent terrorist attack in country

y = Terror Fear in Country	Ordered Probit Models				Extended Ordered Probit Model
Independent Variables	(1)	(2)	(3)	(4)	(5)
Male Gender	1.013	1.020	1.020	1.022	1.019
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Age	1.036***	1.035***	1.059***	1.061***	1.061***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)
Education	1.121***	1.120***	0.975	0.941**	0.926***
	(0.029)	(0.029)	(0.026)	(0.026)	(0.025)
Marital status	1.064***	1.056***	1.039**	1.037**	1.036**
	(0.018)	(0.017)	(0.018)	(0.018)	(0.018)
Income	0.952***	0.981	1.001	0.988	1.024*
	(0.011)	(0.011)	(0.012)	(0.012)	(0.013)
Political orientation	0.999	0.998	1.000	1.002	0.994
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Hours of watching news/politics on TV	0.985	0.988	1.004	1.003	0.995
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Immigrant parents	0.872***	0.880***	0.876***	0.881***	0.858***
	(0.020)	(0.020)	(0.021)	(0.021)	(0.021)
Trust people		0.897***	0.895***	0.880***	0.881***
		(0.015)	(0.016)	(0.016)	(0.016)
Trust legal system		0.814***	0.829***	0.832***	0.833***
		(0.014)	(0.015)	(0.015)	(0.015)
Terror index			1.293***	1.276***	1.028*

			(0.008)	(0.011)	(0.012)
Ln(GDPcap)			1.238***	1.196***	2.387***
			(0.037)	(0.045)	(0.185)
Gini index			1.010***	1.024***	1.031***
			(0.003)	(0.003)	(0.003)
Stock of immigrants			1.015***	1.033***	1.060***
			(0.002)	(0.003)	(0.003)
Military expenses				1.013	2.597***
				(0.028)	(0.248)
Number of conflicts				1.074***	1.073***
				(0.008)	(0.007)
Religion similarity				0.675***	0.210***
				(0.041)	(0.029)
Technological distance				1.182***	1.694***
				(0.043)	(0.087)
Observations	51,883	51,883	51,883	51,883	51,883

Table 4. 2: Estimates (odd ratios) of Europeans' perceptions about an imminent terrorist attack in Europe

y = Terror Fear in Europe	Ordered Probit Models				Extended Ordered Probit Model
Independent Variables	(1)	(2)	(3)	(4)	(5)
Male Gender	0.958***	0.962**	0.960**	0.963**	0.963**
	(0.015)	(0.016)	(0.016)	(0.016)	(0.016)
Age	1.028***	1.028***	1.032***	1.031***	1.031***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Education	0.968	0.966	0.879***	0.853***	0.851***
	(0.026)	(0.026)	(0.024)	(0.023)	(0.024)
Marital status	1.028	1.022	1.029	1.036**	1.036**
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Income	1.057***	1.078***	1.062***	1.048***	1.053***
	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)
Political orientation	1.003	1.002	1.012	1.017	1.015
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Hours of watching news/politics on TV	0.992	0.994	1.000	1.000	0.999
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Immigrant parents	0.891***	0.897***	0.884***	0.879***	0.876***
	(0.021)	(0.021)	(0.021)	(0.022)	(0.021)
Trust people		0.934***	0.924***	0.906***	0.906***
		(0.016)	(0.016)	(0.016)	(0.016)
Trust legal system		0.869***	0.860***	0.852***	0.851***
		(0.015)	(0.015)	(0.015)	(0.015)
Terror index			1.134***	1.103***	1.070***
			(0.007)	(0.010)	(0.024)
Ln(GDPcap)			1.239***	1.048	1.159*
			(0.033)	(0.037)	(0.099)
Gini index			0.995*	1.035***	1.036***
			(0.003)	(0.003)	(0.003)
Stock of immigrants			1.010***	1.025***	1.029***
			(0.002)	(0.002)	(0.003)

Military expenses				1.152***	1.320***
				(0.032)	(0.137)
Number of conflicts				1.072***	1.072***
				(0.008)	(0.008)
Religion similarity				0.442***	0.373***
				(0.027)	(0.057)
Technological distance				2.671***	2.814***
				(0.099)	(0.152)
Observations	51,883	51,883	51,883	51,883	51,883

Notes: Results in columns (1)-(4) concern an ordered probit model, while in column (5) an extended ordered probit model is used to overcome the potential endogeneity. Instrumented variables: Military expenses %GDP and number of conflicts. Instruments used: Mean values of the military expenses and number of conflicts of the neighboring countries along with the rest of the regressors of eq.(1). Heteroscedasticity-adjusted standard errors are given in parentheses. (*): p<0.1, (**): p<0.05, (***): p<0.01 significance at 10%, 5%, and 1%, respectively.

In terms of individual characteristics, the educational level of the individual matters the most. Respondents of higher educational status are less likely to assess as high the risk of a terrorist attack in their country and in Europe as well, compared to interviewees of low educational attainment (Economou and Kollias 2019). The link between education and attitudes is deeply rooted in the fact that educational systems tend to have fear-eliminating effects, eradicate negative stereotypes, prejudice and racism towards minorities (Herreros and Criado 2009), and promote acceptance of different cultural values and beliefs (Hainmueller and Hiscox 2007). The origin of the respondent's parents is also an important contributor to less fearful perceptions towards a terrorist event, as individuals who are raised by immigrant parent(s) are exposed to different cultures and experiences, developing more tolerance to them (Goldstein and Peters 2014). In contrast, being a woman appears to be associated with higher levels of risk assessment in Europe, which lines up with evidence from the literature that women feel and express negative, powerless emotions such as fear more than men (Hollander 2001; Sutton and Farrall 2005); however that finding is not significant for the occurrence of a terrorist act in the country. Moreover, high income level, age (getting older) and marital status (being married) are positively associated with a greater probability of anticipating an imminent terrorist episode. More specifically, higher income level, being an older respondent and being married make an individual about 2.4%, 6.1% and 3.6%, respectively, more prone to assessing as greater the threat of an attack in their country (effects are similar for the case of Europe).[41,42,43] Political ideology does not seem to exert a statistically significant impact on

[41] Although high levels of income provide financial security, terrorism has adverse economic consequences which affect citizens and societies alike.

public's perceptions,[44] while also hours of watching news/politics on a daily basis play little role in shaping fear about an attack in country/Europe as the coefficients in all specifications indicate,[45] a finding counter to our expectations. Although as noted, our measure is not specific to exposure to terrorism-related news, the results could suggest that the news media in general may not have consistent fear-arousing effects on the public. Rather, it is possible, that greater interest in political news indicates awareness of current issues and not an association to the likelihood of emotional responses to terrorism.

The next set of estimates analyzes the role of social capital. A crucial dimension of social capital is trust. Our evidence corroborates to its important role in shaping perceptions about an imminent terrorist act, as the coefficients related to "trust in people" and "trust in institutions" are significant and to the expected direction. Social trust is associated with lower probabilities of expecting a terrorist incident in the country (11.9%) and in Europe (9.4%) than social distrust. This result is also confirmed by the study of ter Huurne and Gutteling (2009), which assigns a very important role to social trust in shaping public's feelings of fear and anxiety, following a terrorist event. Likewise, institutional trust associates with 11.7%

[42] Hassan and Martin (2015) find that older people in Australia feel more vulnerable and insecure to an imminent attack, whereas Haner et al. (2019) suggest that older Americans are less likely to worry about attacks. Given the relative infrequency of terrorist acts in the US, older interviewees could have more experience supporting that these are relatively rare events thus making them less worrisome.

[43] Marital status (being married versus all alternatives) of the individual plays significant role in affecting risk perception as the coefficients are statistically significant in all specifications. Safety issues, especially if the family has children, could be part of the explanation.

[44] Labour and Greens voters and those with no political party affiliation display significantly less fear of terrorism (Hassan and Martin 2015).

[45] Slone (2000) investigates the differential anxiety response of different groups of individuals to television coverage of political terrorism in Israel and supports the powerful effect of the mass media. Moreover, scholars who have examined the American culture of fear point to the role of media in arousing and manipulating the fears of the public (Best 2018).

and 14.9% lower probability of anticipating an attack in country and in Europe, respectively.[46]

We continue with macroeconomic conditions. We find that countries with higher GDP per capita are 138.7% and 15.9% more probable to associate with greater risk perceptions about an attack in country and in Europe, respectively. Income inequality also appears to be an important aspect of the public's anxiety. Countries with high values of Gini index are about 3.1% more prone to associate with higher probabilities of anticipating a terrorist incident in the country (3.6% in Europe), compared to countries with a low Gini coefficient. In contrast to the literature that provides mixed evidence on the link of macroenvironment and terrorism,[47] we find strong and clear results concerning its effect on public sentiments. The stock of foreigners contributes to the multicultural profile of a country. The latter may stir up both positive and negative reactions: it can disprove prejudicial beliefs and increase the cognitive abilities to allow sophisticated analysis of the "out-group" qualities or can intensify unfavorable attitudes toward immigrants, associating them with violence, fanaticism or terrorism. Our results show that citizens in countries with many foreigners are about 6% and 2.9%, respectively, more possible to anticipate a terrorist event in the country and in Europe, compared to citizens who live in countries with more ethnically homogenous population.[48] Furthermore, higher levels of the Terror index do matter for public assessments regarding the

[46] Arvanitidis et al. (2016) argue that in the aftermath of the attack in Spain in 2004, as time elapsed the strengthening of institutional trust exhibited signs of reversing possibly back to its pre-terrorist attack levels, proving that it is determined by broader and more deeply embedded factors and is ruffled only temporarily by one-off terrorist incidents.

[47] Ahern (2018) focuses on regions not directly affected by a local terrorist attack, but whose population is affected by foreign attacks and it is found that as a larger fraction of a region's population is exposed to terrorism in their home countries, the region's GDP per capita and GDP growth increase, whereas the study of Blomberg et al. (2004) detects an association between terrorism and decreases in GDP.

[48] Bove and Böhmelt (2016) state that origin countries with higher levels of terrorism tend to transmit terrorist activity to destination countries that receive more migrants from them. Dreher et al. (2020) find no evidence to suggest that immigration from Muslim countries of origin leads to higher terrorism risk in destination countries; however, they find a heightened terrorism risk arising from terror-rich origin countries. Forrester et al. (2019) assert that fears of the mass immigration of Muslims originating from war torn areas in Muslim majority countries spreading terrorism to Europe, are largely mistaken.

possible occurrence of an attack in country and in Europe, as the coefficients indicate (2.8% and 7%, respectively). It is evident that higher intensity attacks are likely to elicit stronger feelings of worry and anxiety, that is not to say that low intensity attacks do not render an impact, as in some cases the infliction of fear alone is enough to even call the government to action.[49]

Finally, the variables of the *Defense* set do shape as well the public's assessments. The government and policy makers are expected to ensure the public they are protected, reducing insecurity and allowing for maneuverability in response to current attacks and prevention of future ones (Carter and Fay 2019). We find though a strong, positive direct relationship between military expenditures and probabilities of anticipating a terrorist incident in country and in Europe, as well (higher levels of spending associate with an increase by 159.7% and 32%, respectively). The result is somewhat consistent with the studies of Braithwaite and Li (2007), Savun and Phillips (2009) and Azam and Thelen (2010), who assert that military use of force, in one capacity or another increases terrorism. Similarly, the intensity of a country's involvement in armed conflicts appears to have a positive and statistically significant effect on perceptions about an imminent terrorist act. This finding is unsurprising, as numerous studies note the parallels between an internal armed conflict or an internationalized one and the incidence of terrorism (Findley and Young 2012; Fortna 2015). Overall, the results validate our first hypothesis (H_1) that country's military activity relates to its citizens' fear about a terrorist event both inside the country and in Europe. Furthermore, the index capturing the religious proximity between the countries engaged in a war associates with lower levels of worry. In a nutshell, the more intense is the religious gap between the opponents in a conflict, the higher becomes the probability of anticipating a terrorist episode in country (increase by 79%) and in Europe (increase by 62.7%). Since Muslims constitute a large proportion of the population in enemy countries, and are viewed as violent and supportive of terrorism, they may be perceived as a threat for the Western societies. Cesari (2004) argues that a "Bin Laden Effect" has transformed Muslims into a public enemy, while the fact that terrorist bombings in the European capitals were carried by Muslims may also have contributed to this kind of threat perceptions (Leiken 2005). The indicator used to track the technological distance of the conflict pairs plays additionally, an important role in shaping

[49] Feridun and Shahbaz (2010) state that if the frequency or intensity of terrorist attacks increases, this can lead to a growing public pressure on the government to take further anti-terrorism measures.

public's estimations. More specifically, respondents are about 69.4% more prone to anticipate a terrorist event in the country and 181.4% in Europe, the wider is the technological gap between the countries involved in an armed conflict. This finding accords with previous literature which highlights the frequency of terrorism threats in developed societies (Blomberg et al. 2004), although they possess more capable governmental institutions to recover from either a large-scale attack or a prolonged campaign (Sandler and Enders 2008). Evidence that emerges regarding the impact of the two constructed indexes confirms our second hypothesis (H_2) that religious and technological differentiation of the opponents acts as a moderator of the public concerns formation about an imminent terrorist threat.

Overall, our empirical analysis demonstrates a salient and positive relationship between a country's military action and its citizens' worry about future supplies of terrorism. As military expenditures increase and armed conflicts - with less technologically developed and religiously divergent countries - become more frequent, we should expect a relative rise in the probability of anticipating an imminent terrorist attack in country and in Europe, as well. The two testable hypotheses find hence strong support. The aspects of social capital, though – social and institutional trust - seem to smooth out the public's fear and anxiety, while also interviewee's education and origin negatively associate with such feelings and sentiments.

4.4.2 Robustness

We have performed a battery of sensitivity analysis to sharpen the robustness of our results. We classified our countries into various groups, for instance North and South, and estimated equation (1) for each group. The results did not alter significantly. We also, included various control variables in the Z set, namely, unemployment, central government debt, and social benefits, to proxy fiscal burden and (in)equality conditions. The estimates were statistically insignificant, and the rest of the results were barely modified. Further, we replaced stock of foreigners (%population) with the number of asylum seekers (%population) and nationality acquisitors (%population). Following the example of Forrester et al. (2019) and Dreher et al. (2020), we also, narrowed our focus to immigration form Muslim majority countries to better examine the impact on public's worry about a terrorist incident. The results mildly varied without, however, showing any significant change. We moreover, used the variables *State of health services* and *State of education system* instead of *Trust legal system*, which is an important dimension of social capital in order to re-estimate the effect of the respondent's

trust in institutions, on their fear, while we further defined *Number of Conflicts* as a variable capturing the number of military organizations each sample country faced during the period 2005-2008 and used it alternatively in equation (1). The results remained unaltered. Finally, concerning the instrumental variable approach, we also employed the lagged values of the endogenous variables as alternative instruments. Overall, the findings do not change in any significant way across different specifications, subsamples, and definitions.

4.5 Conclusion

The present chapter has examined the question of how public anxiety is formed about a terrorist attack in a European country involved into military expeditions, and in Europe as a whole, focusing particularly on the role of the counties' military activity as well as the technological and religious gap between the war opponents. Based on detailed data from the ESS database on 92,636 respondents for the waves 2005-2006 and 2007-2008, we find a salient and positive relationship between a country's military action and its citizens' worry about future supplies of terrorism. As military expenses increase and armed conflicts - with less technologically developed and religiously divergent countries - become more frequent, a relative rise in the probability of anticipating an imminent terrorist attack in country and in Europe, as well, is expected. The aspects of social capital, though – social and institutional trust - seem to negatively associate with the public's fear and anxiety, while interviewee's education and origin significantly smooth out such feelings and sentiments.

The implication of our results is straightforward. Military activity implemented to ensure homeland safety does not guarantee the public's thorough security, but renders them occasionally susceptible to a possible terrorist act, inflating their perceived threat. Hence, a successful policy should aim not to exclusively impose stricter defensive measures to meet the challenges associated with the vulnerability of individuals, but also foster the bonding, bridging and linking of different communities, in order to ensure the country's solidarity and prosperity.

5 Conclusion

The present dissertation investigates the nature and importance of military expenditures for a higher degree of security and stability, since military power has been proved to be the determining factor for the behavior of states in the international system, and to effectively tackle this issue, it is organized into three essays.

The first one focuses exclusively on the topic of arms race between Greece and Turkey, as empirical studies examining this relationship have produced mixed results which could be divided into three categories: works that confirm the arms race hypothesis (Majeski and Jones 1981; Majeski 1985; Kollias and Makrydakis 1997; Kollias and Paleologou 2002; Andreou and Zombanakis 2011), those that partially support it (Kollias 1991; Dunne et al. 2005; Tütüncü and Şahingöz 2020) and the ones that reject it (McGuire 1977; Desai and Blake 1981; Georgiou 1990; Georgiou et al. 1996; Smith et al. 2000; Şahin and Özsoy 2008; Paparas et al. 2016). The current study makes a fresh empirical investigation applying a Bayesian technique to Vector Autoregression models for an annual dataset running from 1960 to 2020, in order to explore the dynamics of Greek – Turkish security relations. Two questions thus far have not found common answers in the extant literature "Is there an arms race between the two neighboring states?" and "Did this arms race end?". The political and military history of the nations and the existing agreements between them affects the extent of the arms race. The discovery of gas in the eastern Mediterranean has exacerbated Greek – Turkish contestations over maritime borders and the August 2020 naval stand-off was the latest chapter in a series of high-risk military crises, dating back to 1976. Military posturing that lasted for almost 45 days brought the opponent navies to the brink of clashing violently. Further, Turkish violations of the Greek – claimed airspace that represent a measure of the intensity with which Turkey pursues the conflict (Kollias 2004; Athanassiou et al. 2006), have been on the rise since 2013 with 2020 acknowledged as a record year. In Brauer's (2002) article which constitutes a critical review of the literate on Greek – Turkish relations, it is implied that the arms race if any, ended somewhere in the mid-to late-1980s, while according to the time-varying causality testing results in Tütüncü and Şahingöz (2020), the presence of an arms race can be confirmed for the sub-periods 1975-1990 and 2000-2014. Our regression results based on for different proxies of the states' physical arms build – up show that a shock in a country's military expenditure does not have an impact on the opponent's spending, indicating that the rivalry between the neighbors does not feature an arms race.

The second essay studies the dynamic interdependencies between military expenditures and the real economy, for the period 1970-2018, by accounting for the interconnection among the top twelve military spenders. The dynamics of global military expenses are explored by applying a novel network-theoretic model, which builds on general equilibrium theory and the GVAR framework. With the specific methodology we are able to capture not only the effect of nearness on a country's military spending, as the past literature has documented, but also a country's defense and economic dependencies with other countries and how a unit's military expenses could shape the spending of the rest. Moreover, based on the selection of dominant entities proposed in Konstantakis et al. (2015) and Tsionas et al. (2016), a robustness analysis is provided for the dominance characterization of each economy (node) in the network. The main findings can be summarized as follows: The Chinese economy is considered as being dominant, irrespectively of the criterion used for the selection process. A unit shock in Australia's military expenses has a statistically significant impact on the economies of Japan, Korea and India, whilst the former appears to be affected only by Japan and Korea. An intense interdependence is found in the case of the US, as more than half of the sample countries appear to exert a statistically significant impact on its economy, whereas a unit shock in the military expenditures of China and Russian Federation affects Brazil's ones. Russia's military expenses are affected by a unit shock stemming from the Asian and Oceanian countries, while the NATO European members are found to have forged an international partnership with non-European states (a unit shock in the military expenses of Australia and Japan affects France) but also with other non-NATO democracies (a unit shock in India's military expenses affects the UK). However, in all cases unexpected shocks are temporary and countries return back to their initial equilibrium positions. The results seem to give a credit to the view that China acts as a bandwagon of global growth whose military spending has increased for 27 consecutive years recording the longest uninterrupted sequence of increases by any country in the SIPRI Military Expenditure Database. It aims to mitigate its geopolitical fragility and shield itself from the superpowers' manipulation. Though, with the accelerating pace of globalization, no country is isolated from the world economy, and external shocks are increasingly important. Hence, there is a need for units to reorganize their military agenda quickly and adapt competently, implementing appropriate strategies and actions.

The third essay investigates whether a country's military activity shapes the terror sentiments of its inhabitants. The involvement of Europeans to conflict zones in Syria and Iraq as foreign

fighters, makes Europe facing the risk that those individuals having gained combat experience, would return to the continent to perpetrate or coordinate long-prepared and sophisticated large-scale attacks or spontaneous and unpredictable ones carried out by "lone-wolves". This concern raises the question of how a country's military action influences its citizens' perception to admit that the country or Europe might be vulnerable to serious threats. Particularly, this study aims to explore how the religious and technological gap between two countries involved in a military conflict, affects the fear about an imminent terrorist episode in the near future, within the borders of the country initiating the attack, and in the wider region. Based on detailed data from the ESS database on 92,636 European respondents, for the waves 2005-2006 and 2007-2008, a salient and positive relationship is detected between a country's military activity and its citizens' worry about future supplies of terrorism. As military expenses increase and armed conflicts - with less technologically developed and religiously divergent countries - become more frequent, a relative rise in the probability of anticipating an imminent terrorist attack in country and in Europe, as well, is expected. The aspects of social capital, though – social and institutional trust - seem to negatively associate with the public's fear and anxiety, while interviewee's education and origin significantly smooth out such feelings and sentiments. The implication of the results is straightforward. Military activity implemented to ensure homeland safety does not guarantee the public's thorough security, but renders them occasionally susceptible to a possible terrorist act, inflating their perceived threat. In an effort to ensure solidarity and prosperity, the countries should not exclusively impose stricter defensive measures to meet the challenges associated with the vulnerability of individuals but also, adopt a policy which invests in fostering the bonding, bridging and linking of different communities.

Overall, the empirical analysis based on the role of military allocations, undertaken in the present thesis, offers useful and novel insights as for a country's defense policy options in the context of a dynamic international system. The claim that economies plugged into the global chains form their behavior accordingly, based on the network's activity, finds strong support. Globalization and economic interdependence have intensified it, reminding there is a need for units to reorganize their military plans quickly and adapt to the unanticipated shocks, following appropriate actions. In the case of two rival states such as Greece and Turkey, in distinction to those focusing on costly maintenance of strategic balance, it is proved important that these opponents strengthen their cooperation and jointly contribute to the advancement of peace and economic development across the entire Eastern Mediterranean

region. Further, the government's spending in the sector of defense as well as the country's conflict involvement emerge as affecting the European public perceptions. Particularly, the findings suggest that aggressive military measures may actually attract future supplies of terrorism and therefore increase the inhabitants' fear about an imminent terrorist episode within the borders of their state and in the wider area. Thus, the management of public sentiments and opinions might need to be included as part of a country's successful policy, since the promotion of safety and solidarity is not associated merely with military strategies.

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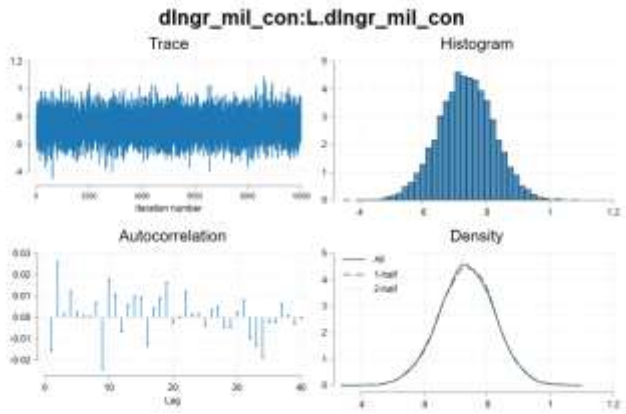
Appendix A



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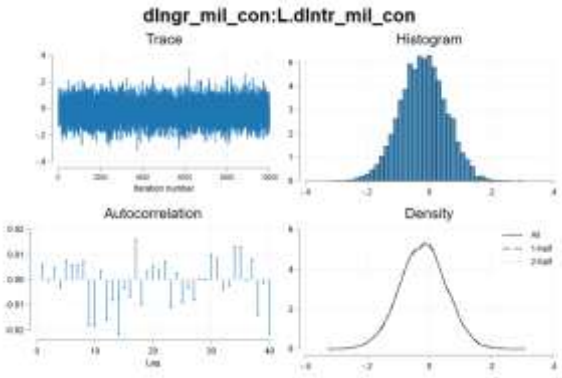

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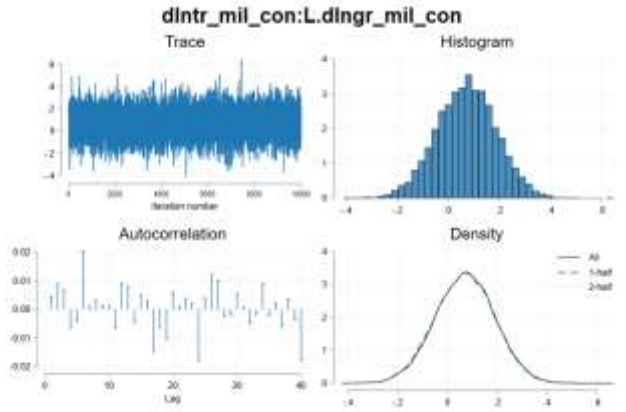

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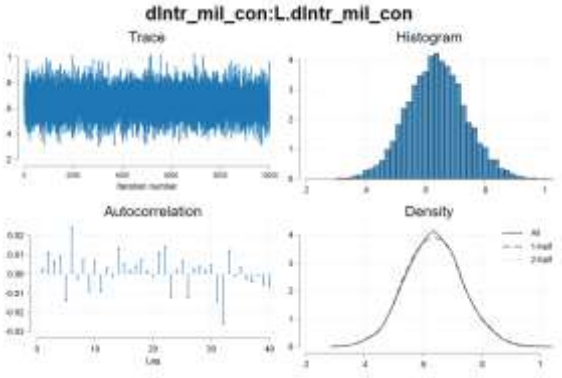
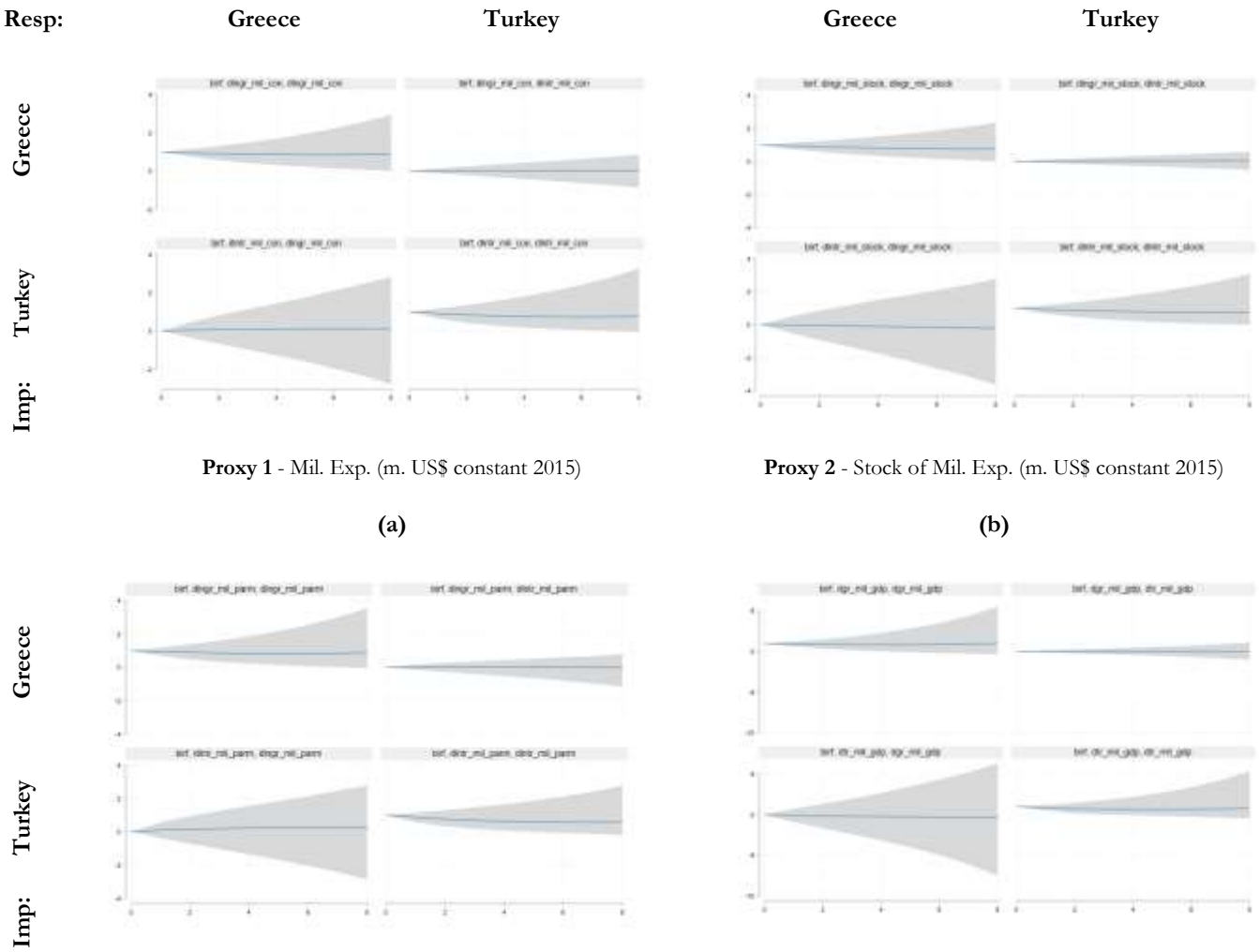


(d)

Figure A. 1: Diagnostics' checks for BVAR(1) model with the endogenous variable Proxy 1 - Military Expenditures (m. constant 2015 US$)



Proxy 1 - Mil. Exp. (m. US$ constant 2015)

(a)

Proxy 2 - Stock of Mil. Exp. (m. US$ constant 2015)

(b)

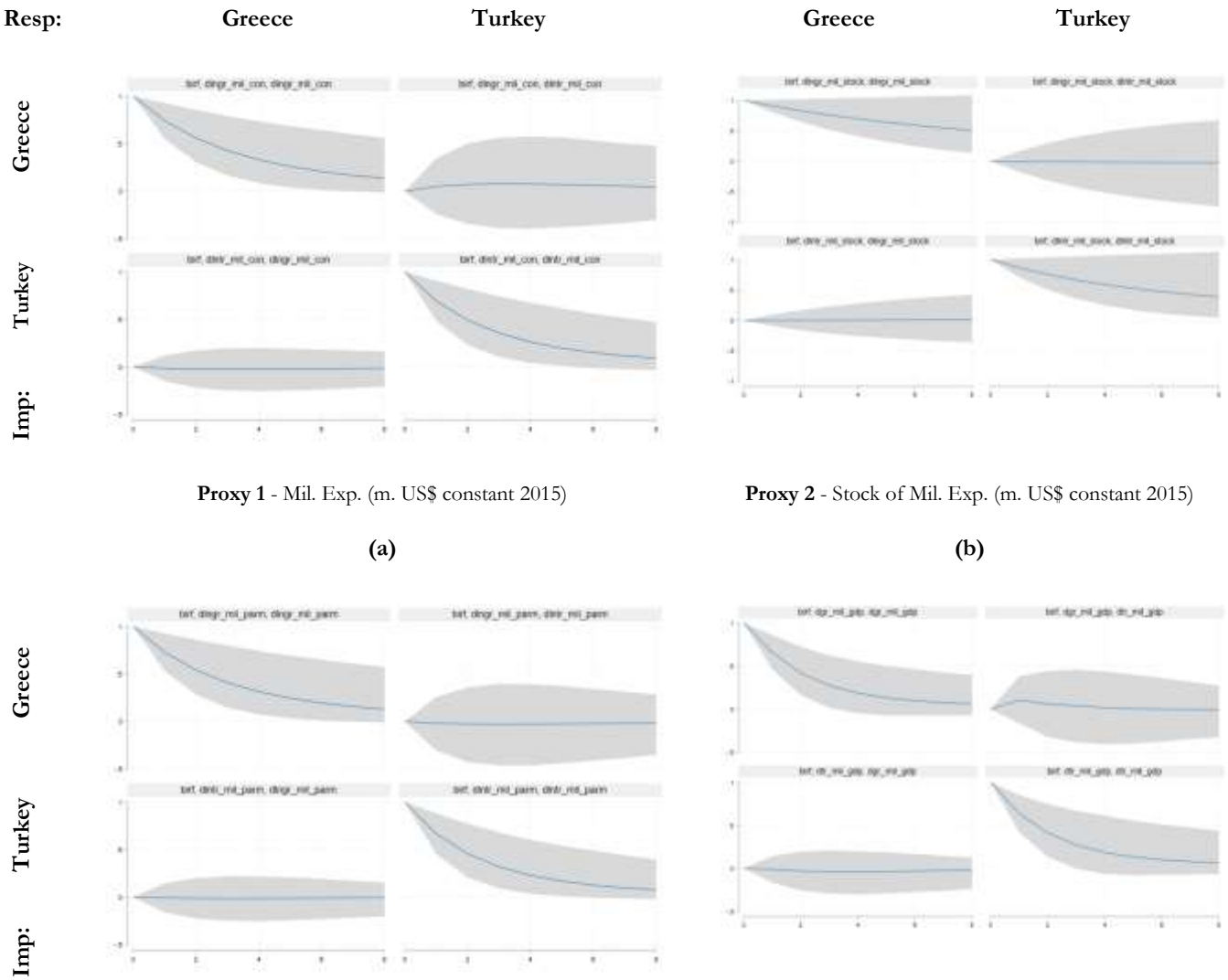
Proxy 3 - Mil. Exp. per Armed Forces Capita (US$ constant 2015)

(c)

Proxy 4 - Mil. Exp. (% GDP)

(d)

Figure A. 2: Bayesian IRFs and 95% credible intervals for the four different proxies of the physical arms build – up for years 1960-1974



Proxy 1 - Mil. Exp. (m. US$ constant 2015)

(a)

Proxy 2 - Stock of Mil. Exp. (m. US$ constant 2015)

(b)

Proxy 3 - Mil. Exp. per Armed Forces Capita (US$ constant 2015)

(c)

Proxy 4 - Mil. Exp. (% GDP)

(d)

Figure A. 3: Bayesian IRFs and 95% credible intervals for the four different proxies of the physical arms build – up for years 1975-2020

Appendix B

Relevant Tests

A number of relevant tests need to be carried out.

Stationarity

We start by testing for stationarity. In case the time series employed are not stationary, we induce stationarity following, among others, Koop (2013).

There are several formal tests of stationarity, among which quite popular is the Phillips-Perron (PP) test. Phillips and Perron's test statistics can be viewed as a Dickey–Fuller statistics that have been made robust to serial correlation by using the Newey–West (1987) heteroskedasticity -and autocorrelation- consistent covariance matrix estimator. The main advantage of the PP tests over the ADF tests is that the PP tests are robust to general forms of heteroskedasticity in the error term u_t. Another important advantage is that no *a-priori* specification of the lag length for the test regression is required.

The Phillips–Perron (1988) test involves fitting the model:

$$Y_t = a + \rho Y_{t-1} + \varepsilon_t \text{ [1]}$$

where we may exclude the constant or include a trend term. There are two statistics, Z_ρ and Z_τ, calculated as follows:

$$Z_\rho = T(\widehat{\rho_T} - 1) - \frac{1}{2}\frac{n^2\widehat{\sigma^2}}{s_T^2}\left(\widehat{\lambda_T^2} - \widehat{\gamma_{0,T}}\right) \text{ [2]}$$

$$Z_\tau = \sqrt{\frac{\widehat{\gamma_{0,T}}}{\widehat{\lambda_T^2}}}\frac{\widehat{\rho_T} - 1}{\hat{\sigma}} - \frac{1}{2}\left(\widehat{\lambda_T^2} - \widehat{\gamma_{0,T}}\right)\frac{1}{\widehat{\lambda_T^2}}\frac{T\hat{\sigma}}{s_T} \text{ [3]}$$

where $\gamma_{j,T} = \frac{1}{T}\sum_{t=j+1}^{T}\widehat{u_t}\widehat{u_{t-J}}$ [4], $\widehat{\lambda_T^2} = \widehat{\gamma_{0,T}} + 2\sum_{j=1}^{q}(1 - \frac{j}{q+1})\gamma_{j,T}$ [5] and $s_T^2 = \frac{1}{T-k}\sum_{t=1}^{T}\widehat{u_t^2}$ [6]

where u_t is the OLS residual, k is the number of covariates in the regression, q is the number of Newey–West lags to use in calculating λ_T^2, and $\hat{\sigma}$ is the OLS s.e. error of $\hat{\rho}$.

Under the null hypothesis that $\rho = 0$, the PP statistics, Z_ρ and Z_τ, have the same asymptotic distributions as the Augmented Dickey–Fuller (ADF) t-statistic and normalized bias statistics. If the series are not stationary, we induce stationarity by means of first differencing.

Optimum Lag Length

We make use of the BIC (Schwartz 1978) and the optimum lag length is given by the following objective function:

$$\hat{\xi} = argmin_{\xi \leq n} \left\{ -2\frac{\ln(LL(\xi))}{n} + \xi\frac{\ln(n)}{n} \right\} \text{ [7]}$$

where LL(ξ) is the log-likelihood function of a VAR(ξ) model, n is the number of observations, ξ is the number of lags and $\hat{\xi}$ is the optimum lag length selected.

Cointegration

We have to check for cointegration, since if cointegration is present then the Error Correction Terms have to be employed in the estimation of the GVAR model. We employ the popular Johansen and Juselius (1990) methodology that allows for more than one cointegrating relationships, in contrast to other tests. The methodology is based on the following equation:

$$\Delta y_t = m + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + e_p \text{ [8]}$$

$$\text{where: } \Pi = \sum_{\iota=1}^{p} A_i - I \; and \Gamma_i = -\sum_{j=i+1}^{p} A_p \text{ [9]}$$

The existence of cointegration depends upon the rank of the coefficient matrix Π which is tested through the likelihood ratio, namely the trace test described by the following formula:

$$J_{trace} = -T \sum_{i=r+1}^{k} \log(1 - \lambda_i) \text{ [10]}$$

where T is the sample size and λ_i is the largest canonical correlation.

The trace test tests the null hypothesis of $r<n$ cointegrating vectors and the critical values are found in Johansen and Juselius (1990). Also, having stationary variables in the system is not an issue according to Johansen (1995) as long as all the time series are integrated of the same order.

Asymptotic Properties

For the purpose of estimation and inference in stationary models, Chudik and Pesaran (2011) showed that the relevant asymptotics are:

$$\frac{T}{N} \to k < \infty \text{ [11]}$$

Stability Conditions

Following Pesaran et *al.* (2004) and Mutl (2009), it is not sufficient to examine the country-by-country stability. In this work, to determine whether the model is stable, we check the stability of the whole system. Hence, we require that: $\rho_{system\,(i)} < 1$ for stability, where $\rho_{system\,(i)}$ is the spectral radius of the GVAR matrix.

Appendix C

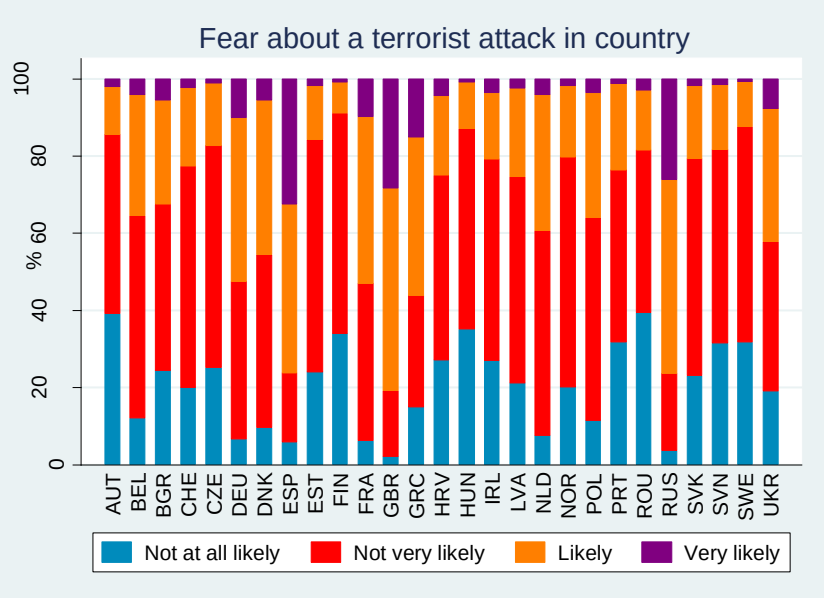


Figure C. 1: Fear about a terrorist attack in country

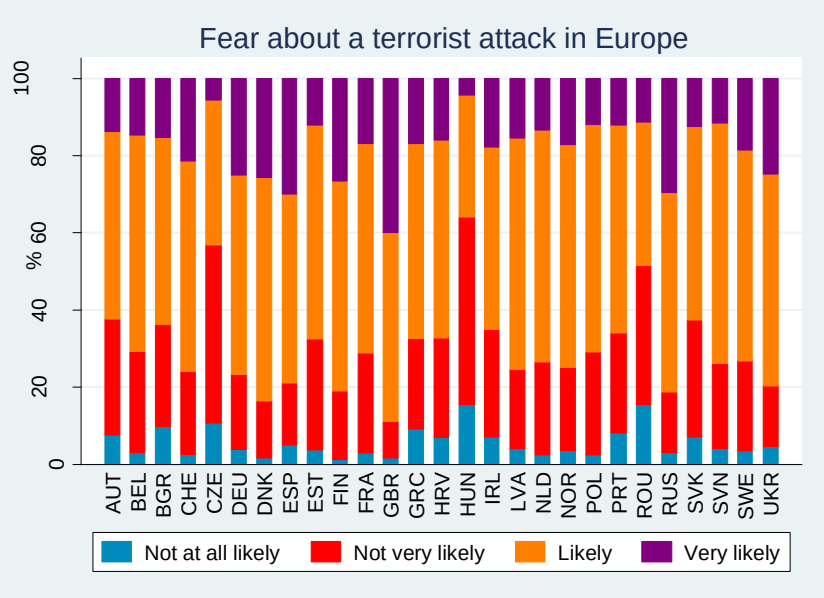


Figure C. 2: Fear about a terrorist attack in Europe

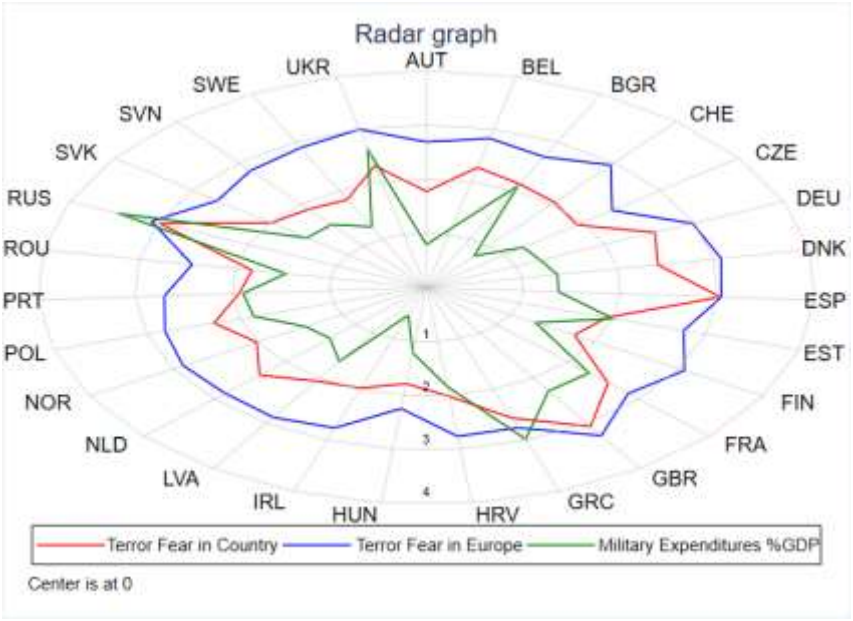


Figure C. 3**:** Public concerns about a terrorist incident and military expenditures (%GDP)

Table C. 1: Number of observations (obs) by County and Wave

Country	Country Code	European Social Survey (ESS) Waves	
		2005-2006 (obs)	2007-2008 (obs)
Austria	AUT	2,405	-
Belgium	BEL	1,798	1,760
Bulgaria	BGR	1,400	2,230
Croatia	HRV	-	1,484
Czech Republic	CZE	-	2,018
Denmark	DNK	1,505	1,610
Estonia	EST	1,517	1,661
Finland	FIN	1,896	2,195
France	FRA	1,986	2,073
Germany	DEU	2,916	2,751
Greece	GRC	-	2,072
Hungary	HUN	1,518	1,544
Ireland	IRL	1,800	1,764
Latvia	LVA	-	1,980
Netherlands	NLD	1,889	1,778
Norway	NOR	1,750	1,549
Poland	POL	1,721	1,619
Portugal	PRT	2,222	2,367
Romania	ROU	-	2,146
Russian Federation	RUS	2,437	2,512
Slovak Republic	SVK	1,766	1,810

Slovenia	SVN	1,476	1,286
Spain	ESP	1,876	2,576
Sweden	SWE	1,927	1,830
Switzerland	CHE	1,804	1,819
Ukraine	UKR	2,002	1,845
United Kingdom	GBR	2,394	2,352

Table C. 2: Countries' Opponents by year

Country	Country Code	Sample Period			
		2005	2006	2007	2008
Austria	AUT	-	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Belgium	BEL	Taleban,al-Qaida	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Bulgaria	BGR	Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban, Ansar al-Islam/IS/RJF	Taleban, al-Mahdi Army/ Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/ Taleban, al-Mahdi Army/IS
Croatia	HRV	al-Qaida	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Czech Republic	CZE	Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban, Ansar al-Islam/IS/RJF	Taleban,al-Mahdi Army/ Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/ Taleban, al-Qaida, al-Mahdi Army/IS
Denmark	DNK	Taleban, al-Qaida, Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban,	Taleban,al-Mahdi Army/ Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/ Taleban

			Ansar al-Islam/IS/RJF		
Estonia	EST	al-Qaida, Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban, Ansar al-Islam/IS/RJF	Taleban, al-Mahdi Army/ Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/ Taleban, al-Mahdi Army/IS
Finland	FIN	-	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
France	FRA	Taleban, al-Qaida	Hizb-i Islami-yi Afghanistan/Taleban, UFDR	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Germany	DEU	Taleban	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Greece	GRC	-	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Hungary	HUN	-	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Ireland	IRL	-	Hizb-i Islami-yi	Taleban	Hizb-i Islami-yi Afghanistan/

			Afghanistan/Taleban		Taleban
Latvia	LVA	Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban, Ansar al-Islam/IS/RJF	Taleban, al-Mahdi Army/ Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/ Taleban, al-Mahdi Army/IS
Netherlands	NLD	Taleban, al-Qaida, Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Norway	NOR	Taleban, al-Qaida, Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Poland	POL	Taleban, al-Qaida, Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban, Ansar al-Islam/IS/RJF	Taleban, al-Mahdi Army/ Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/ Taleban, al-Mahdi Army/IS
Portugal	PRT	Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Romania	ROU	Taleban, al-Qaida, Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban, Ansar al-Islam/IS/RJF	Taleban,al-Mahdi Army/ Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/ Taleban, al-Qaida, al-Mahdi Army/IS

Russian Federation	RUS	Chechen Republic of Ichkeria	Chechen Republic of Ichkeria	Chechen Republic of Ichkeria,Forces of the Caucasus Emirate	Georgia, Forces of the Caucasus Emirate
Slovak Republic	SVK	Taleban,al-Qaida,Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban, Ansar al-Islam/IS/RJF	Taleban,al-Mahdi Army/ Ansar al-Islam/ IS/ RJF	Hizb-i Islami-yi Afghanistan/ Taleban
Slovenia	SVN	-	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Spain	ESP	Taleban, al-Qaida	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Sweden	SWE	-	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	Hizb-i Islami-yi Afghanistan/ Taleban
Switzerland	CHE	-	Hizb-i Islami-yi Afghanistan/Taleban	Taleban	-
Ukraine	UKR	Ansar al-Islam/IS/RJF	-	-	al-Mahdi Army/IS
United Kingdom	GBR	Taleban,al-Qaida,Ansar al-Islam/IS/RJF	Hizb-i Islami-yi Afghanistan/Taleban, al-	Taleban,al-Qaida, al-Mahdi Army/Ansar al-	Hizb-i Islami-yi Afghanistan/ Taleban,al-Mahdi Army/IS

Qaida,Ansar al-Islam/IS/RJF	Islam/ IS/ RJF

Table C. 3: Opponents' operational area

Opponent	Operational Area
al-Qaida	Afghanistan, Iraq, Pakistan[50]
al-Mahdi Army	Iraq
Ansar al-Islam	Iraq, Syria
Chechen Republic of Ichkeria	Russian Federation
Forces of the Caucasus Emirate	Syria, Russian Federation, Iraq, Georgia, Azerbaijan
Georgia	Georgia
Hizb-i Islami-yi Afghanistan	Afghanistan
Islamic State (IS)	Iraq, Syria
Reformation and Jihad Front (RJF)	Iraq
Taleban	Afghanistan
Union of Democratic Forces for Unity (UFDR)	Central African Republic

[50] Al-Qaida is a Salafi militant organization with a network of members and affiliates around the world (https://cisac.fsi.stanford.edu/mappingmilitants/profiles/al-qaeda#highlight_text_13266). In response to the 9/11 attacks President George W. Bush declared the "War on Terror" and a US-led international coalition invaded Afghanistan in late 2001 to oust the Taliban regime, but bin Laden and several al-Qaida members managed to escape. Al-Qaida continued to thrive in the Afghanistan-Pakistan border areas, supporting the guerrilla war in Afghanistan and spreading its influence across the Muslim world. In 2003, the invasion of the United States in Iraq gave al-Qaida the opportunity to mobilize the Muslim world in a call for "jihad" against American forces in the area, while at this point, it had started to establish local branches across the Middle East and North Africa (Stenersen 2017).

Table C. 4: Summary statistics

Variable	Obs	Mean	Standard Deviation	Min	Max
y variables					
Terror in Country	85,359	2.253	0.848	1	4
Terror in Europe	84,479	2.860	0.777	1	4
x variables					
Sociodemographic					
Male Gender	92,509	0.453	0.498	0	1
Age Category	92,636	3.748	1.697	1	6
Education level	92,321	2.143	0.617	1	3
Marital status	92,636	0.502	0.500	0	1
Income level	66,092	1.840	0.753	1	3
Political orientation	77,595	1.928	0.751	1	3
Hours of watching news/ politics on TV	89,026	1.826	0.772	1	3
Immigrant parents	92,491	0.140	0.347	0	1
Social capital					
Trust people	92,192	0.606	0.489	0	1
Trust legal system	89,728	0.583	0.493	0	1
Macroeconomic					
Terror index	92,636	1.896	1.369	1	5.689
Logarithm of GDPcap	92,636	10.339	0.449	8.965	11.085
Gini index	92,636	31.790	4.211	23.72	41.54
Stock of immigrants	92,636	6.551	4.809	0.017	21.431

Defense

Military expenses %GDP	92,636	1.677	0.680		0.513	3.5
Number of conflicts	92,636	2.738	1.421	1	6	
Religion similarity	92,636	0.203	0.219		0	1
Technological distance	92,636	0.393	0.275		0	1

Notes: Obs: observations; Min: minimum; Max: maximum; Terror in Europe/ country: 1: Not at all likely, 2: Not very likely, 3: Likely, 4: Very likely; Male Gender: 0: Female, 1: Male; Age Category: 1: Under 25, 2: 25-34, 3: 35-44, 4: 45-54, 5: 55-64, 6: Upper 64; Education level: 1: Primary, 2: Secondary, 3: Tertiary; Marital status: 0: Non Married, 1: Married; Income level: 1: Low Income, 2: Medium Income, 3: High Income; Political orientation: 1: Left, 2: Middle, 3: Right; Hours of watching news/ politics on TV: 1: Low, 2: Medium, 3: High; Immigrant Parents: 0: No, 1: Yes; Trust people/ legal system: 0: Not Trusted, 1: Trusted.